KING COUNTY BIOSOLIDS PROGRAM STRATEGIC PLAN 2018–2037

King County

Department of Natural Resources and Parks

Wastewater Treatment Division

Back of Front Cover

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Table of Contents

Introduction

The King County Wastewater Treatment Division (WTD) Biosolids Program plays a key role in the County's future sustainability and its progress toward achieving carbon neutrality. To this end, in 2012, the Biosolids Program developed a four-year biosolids plan to expand its existing customer base and guide WTD through changes in the soil amendment industry. In the 2012 to 2016 plan, WTD committed to continue using 100 percent of its Class B[1] Loop® biosolids as a soil amendment, expanding its marketing and customer base, and supporting ongoing biosolids research. Although WTD consistently uses 100 percent of its Class B Loop biosolids and supports biosolids research, expanding its customer base remains a challenge.

In this updated 2018 to 2037 Biosolids Program Strategic Plan, WTD is committed to producing a King County-owned Class A biosolids product by 2023 and expanding the market for its Class B Biosolids Program. Producing Class A and B products in a diversified market will increase WTD's adaptive capacity to consistently and beneficially use 100 percent of its biosolids. The specific Class A production method used by the Biosolids Program will be determined as part of the implementation of this strategic plan.

Program Challenges

King County has used 100 percent of its Loop biosolids for decades; returning valuable carbon and nutrients back to the soil and helping the County fight climate change. However, the resiliency of WTD's Biosolids Program has decreased over the past decade. With a reduction in forestry application and a decline in compost production from the Biosolids Program's current compost partner, the program has become reliant on farmers in Douglas County to manage approximately 90 percent of WTD biosolids production.

Having only one reliable biosolids management approach leaves WTD vulnerable and with few options when highway passes close, fields are inaccessible, biosolids production increases, or farming practices change. Moreover, farmers are increasingly moving toward organic or no-till farming or both. While the Biosolids Program has made as many accommodations as possible to provide equipment capable of meeting the strict no-till methods, biosolids are not an approved fertilizer option for organic farming.

Additionally, while the program has been successful in creating a recognizable brand for its Loop biosolids product, this branding effort has also created some confusion among the public about who can purchase and use Loop. Currently, Loop biosolids are sold to commercial customers only, although the program has experienced increasing requests for the product from residential customers in and around King County. Unfortunately, because of federal use regulations with the current Class B product, WTD's only avenue for providing a retail product for the public is through a contract partnership with a private compost company that creates a

[1] Class A biosolids = 99–100% of pathogens eliminated; can be sold as a consumer retail product
Class B biosolids = 95–99% of pathogens eliminated; can be sold to permitted customers only

Class A product. Because King County does not make, own, or sell the final Class A compost product, this further limits the Biosolids Program in developing a consistent local market and expanding its customer base.

Strategic Plan Purpose

This Biosolids Program Strategic Plan re-evaluates WTD's biosolids management strategies from the 2012–2016 Biosolids Plan,[2] including marketing, production, further product development, technology, regulations, and cost.

Specifically, the Biosolids Program Strategic Plan:

- Identifies strategies and actions to sustain the long history of beneficial use of the Loop biosolids product and ensure cost-effective, beneficial use continues into the future
- Identifies opportunities for optimizing the resource value derived from Loop biosolids
- Identifies barriers and risks for Loop biosolids and the current Biosolids Program and evaluates options for the future of WTD's Class A and B biosolids products and corresponding Biosolids Program
- Identifies potential synergies between WTD's Biosolids, Energy, and Recycled Water Programs and the Technology Assessment and Innovation (TAIP) Program
- Initiates decision-making on capital investments to ensure that WTD's Biosolids Program meets the future needs of customers and King County
- Ensures WTD's biosolids-related decisions are integrated with other strategies and decisions across WTD (particularly operations), King County, and the region

The Biosolids Strategic Plan will be used by WTD to:

- Provide information for the Systemwide Comprehensive Plan for King County's regional wastewater system
- Provide direction for future program activities and decision-making
- Prioritize resources for programs within the division
- Communicate with stakeholders about the program's direction

Strategic Planning Process

Strategic planning is a continuous, iterative process that involves envisioning a successful future, identifying where a program is in relation to that vision, developing goals to fulfill that vision, implementing strategies to achieve those goals, and monitoring progress toward implementation. Strategic plans are dynamic documents that need updates over time as conditions and situations change.

[2] The 2012–2016 Biosolids Plan is available at: https://www.kingcounty.gov/~/media/services/environment/wastewater/resource-recovery/docs/biosolids/Biosolids_Plan.ashx?la=en

The Biosolids Program followed six steps to develop its strategic plan:

1) **Standardization of strategic planning elements** across the Biosolids and Recycled Water Programs and TAIP
2) **Goals** and **objectives** development and development of targets and/or measures for tracking progress toward objectives
3) **Strategies** development
4) **Alternatives** identification, evaluation, and selection
5) Strategies **prioritization**
6) **Actions** development

Program staff participated in team meetings at each step of the strategic planning process, one workshop involving the Recycled Water and TAIP teams, and regular check-ins with WTD management. The Biosolids Program Strategic Plan was also informed by technical research conducted by a consultant-team subject matter expert.

Strategic Plan Overview

The following table summarizes all final goals, objectives, alternatives, strategies, and actions developed for the Biosolids Program Strategic Plan.

GOALS[i]	OBJECTIVES[ii]	STRATEGIES[iii]	ACTIONS[iv]
1: Recycle 100% of Loop – Consistently and reliably achieve 100% beneficial use of Loop biosolids.	**1.1)** Impacts from transportation delays are reduced by 2019 • Target A): Secure west-side storage site by fall 2019. • Target B): Contract with City of Everett is ceased.	**1a)** Secure flexible and large-capacity west-side emergency storage (two-year strategy).	• Increase mobile storage: Implement trailer storage at existing sites/facilities within 1 year. • Contract with current partners to secure storage site. • Continue efforts to complete the Loop Maintenance Facility in North Bend.
	1.2) WTD management adopts a plan for phosphorus removal by 2025 • Target A): One written plan for phosphorus removal by 2020	**1b)** In advance of regulatory restrictions, implement a nutrient study focused on phosphorus removal (six-year strategy).	• Commission TAIP to partner with University of Washington fellowship program to examine phosphorus removal and recovery from biosolids, including: ○ Available recovery technologies and options for both liquid and solid streams ○ Phosphorus levels in liquid and solid streams after removal ○ Additional uses, products, and markets (for byproducts of phosphorus recovery) • Complete research by 2020 and use outcomes of research to inform next steps for phosphorus recovery.
	1.3) Biosolids Program serves an expanded Class B market. • Target A): One additional Washington State Department of Natural Resources (WA DNR) application site by 2020	**1c)** Expand partnerships with WA DNR to expand lands in Western Washington for biosolids applications.	• Explore feasibility of expanded WA DNR application with WA DNR staff. • Develop a proposal with WA DNR for expansion, preferred locations, site requirement access, amount of product, and other requirements. • Meet permit requirements and prepare addendums to existing permits or apply for new permits as needed. • Amend existing agreements as necessary. • Coordinate truck availability and South Treatment Plant operations plan to accommodate expanded forestry program. • Develop a business plan for second mobile operation, including equipment, staffing, and Contractors.
		1d) Expand agricultural land application in Eastern Washington through regional partnerships, communication, and demonstration of Class B biosolids	• By April 2018, West Lincoln Project Beneficial Use Facility is permitted • Provide technical support to potential farmers interested in permitting their own Beneficial Use Facility. • Attend more farmer-focused events and meetings and continue word-of-mouth marketing and relationship-building to stay up-to-date on the newest trends and research.
2: Diversify biosolids products and distribution – Manage a resilient program that can withstand market changes in one or more sectors and has broad geographic distribution.	**2.1)** Begin process to produce a Class A product by 2023—either owned/operated by King County or through regional partnerships • Target A): Pilot compost facility to begin in 2019 • Target B): Capital project process in progress • Target C): Marketable Class A product by 2023	**2a)** Start a capital project for biosolids improvement to Class A compost by 2020 and develop a product by 2023.	• Gain 2019–2020 budget approval for full-scale compost pilot facility. • Begin operations of a compost pilot facility by 2020. • Put full-scale compost facility in capital project formulation. • Begin the capital project process for full-scale compost facility by 2023. • Evaluate and implement regional partnerships for a King County-owned Class A product. • Evaluate land availability and potential partners for Western Washington beneficial use program (using Class A products only).
		2b) As digesters are upgraded, invest in solids treatment process technology to reduce biosolids volume (through improved solids destruction) and produce a Class A biosolids cake product by 2038.	• Develop a plan for coordination between treatment plant operations staff and Biosolids Program for digester upgrades at the West Point Treatment Plant and other treatment plants as upgrades occur.

<table>
<tr><th>GOALS[i]</th><th>OBJECTIVES[ii]</th><th>STRATEGIES[iii]</th><th>ACTIONS[iv]</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">2.2) A comprehensive biosolids market strategy and communications plan is developed by 2020
• Target A): Increase number of new research initiatives
  ▪ Measure: Number of research initiatives
• Target B): Develop a list of grants and alternative funding sources by the end of 2019.
• Target C): A written internal and external communications plan is in use by 2019 and a marketing plan is in use by 2020
  ▪ Measure: Increased internal and external awareness of Loop biosolids brand and Biosolids Program</td><td>2c) Emphasize research studies on the benefits of biosolids.</td><td>• Propose new research ideas and partnerships, internally and externally.
• Ensure that research studies also evaluate alternatives to biosolids.
• Leverage other agencies and NW Biosolids to pool resources.
• Identify grants or alternative funding sources to expand existing research program.</td></tr>
<tr><td>2d) Increase awareness and support of the Loop biosolids product and program with internal and external stakeholders, customers, and policy-making audiences.</td><td>• Identify target audiences.
• Identify potential partner agencies and community groups, internally and externally.
• Engage in relationship-building with policy-making audiences.
• Promote science-based policy changes that allow wider use of biosolids.
• Expand awareness and use of biosolids products across King County departments and divisions.
• Write a long-term communications plan that prioritizes target audiences, strategies, and actions to meet specific communications goals by 2020.
  ○ Identify potential customers and a go-to market strategy.
  ○ Create a long-term marketing plan.
  ○ Create a long-term policy plan.</td></tr>
<tr><td rowspan="2">3: Integrate activities across the division – Ensure Biosolids, Energy, and Recycled Water Programs and TAIP planning and projects are synchronized across the division and within WTD's capital system.</td><td rowspan="2">3.1) Capital projects that could impact the Biosolids Program align with the strategic goals of the Biosolids Program.
• Target A): Biosolids Program has a mechanism to evaluate resource recovery considerations in capital projects</td><td>3a) Establish shared understanding of priorities across the division, increase collaboration with the capital project process, and seek opportunities to coordinate and formally integrate resource recovery considerations in the planning process.</td><td>• Work with the sustainability team to identify opportunities to integrate resource recovery considerations and potential biosolids impacts early in the capital improvement process through the sustainability scorecard or a similar mechanism.</td></tr>
<tr><td>3b) Include biosolids as part of WTD's comprehensive planning workgroup.</td><td>• Identify workgroup lead and opportunities for participation.</td></tr>
</table>

[i] Goals = broad, aspirational outcomes the organization wishes to achieve related directly to its values
[ii] Objectives = outcomes that represent progress toward goals and better define what success looks like for each goal. Objectives should be SMART—Specific, Measurable, Attainable, Relevant, and Time-Bound.
[iii] Strategies = specific types of actions taken to achieve goals and objectives. Strategies describe *how* goals and objectives will be achieved.
[iv] Actions = discrete, actionable tasks that implement one or more strategies

Alternatives Evaluation and Selection

Strategic planning alternatives are specific options for how strategies can be achieved. They are variations/iterations of strategies that require analysis and comparison and that determine different sets of actions for implementing a strategy and, ultimately, achieving a goal.

The Biosolids Program considered 12 alternatives that would guide the future direction of the Biosolids Program and many of the strategies, and strategy prioritization, in this strategic plan:

- **Existing Class B Program:** The County produces approximately 120,000 wet tons of Class B biosolids each year, the majority of which is used as a soil amendment for agricultural crops in Eastern Washington or commercial forests in east King County.
- **Class B Land Application Program with Western Washington Sites:** The County would procure land to develop a local land application program and eventually construct an off-site biosolids storage or handling facility.
- **Class A Dryer:** Thermal drying technology removes water via evaporation from dewatered biosolids, reducing the volume and weight of dewatered cake making a Class A dried product.
- **Class A Lime Stabilization:** Alkaline treatment stabilization (e.g., the use of lime) typically raises the pH of biosolids above 12.0 to produce a Class A product.
- **Class A Biosolids Composting – Static Aerated Pile and Covered Aerated Static Pile:** Composting typically requires mixing biosolids with a carbonaceous bulking agent such as sawdust, wood chips, or ground yard debris. Composting is a treatment process that uses time and temperature to produce a final Class A product.
- **Class A Thermophilic Digestion:** Anaerobic digestion is a biological process in which anaerobic bacteria convert organic matter into methane and carbon dioxide (sometimes called biogas) in the absence of air. The process stabilizes the organic matter in wastewater solids, reduces pathogens and odors, and reduces the total solids quantity.
- **Class A Solar Drying:** The basic principle of operating a solar drying system is to evaporate water from biosolids using the sun's solar energy. The drying process occurs in impervious drying beds and produces a Class A product.
- **Contract Management of Biosolids – Haul Class B to Contractor/Municipal Class A Facility:** The County would haul Class B biosolids to a third-party contractor or other municipality for further treatment to achieve a Class A product.
- **Thermal Conversion – Incineration:** Incineration is a thermal oxidation or combustion process in which the organic matter or volatile fat is destroyed at high temperatures and in the presence of oxygen. Incineration of biosolids is typically accomplished using a fluidized bed incinerator or a multiple hearth furnace.
- **Thermal Conversion – Gasification:** Gasification is a process sometimes implemented outside of North America to recover the energy contained within the organic fraction of biosolids. Gasification is accomplished by heating the feedstock under low quantities of air and sometimes with the addition of steam.
- **Class A Thermal Hydrolysis:** Thermal hydrolysis is a pretreatment process that uses heat and pressure to treat primary sludge and waste activated sludge streams prior to digestion. This process reduces the volume of biosolids.

Alternatives Evaluation

As part of the strategic planning process, WTD and the consultant-team subject matter expert performed a triple bottom line (TBL) analysis of the 12 biosolids management alternatives considered. This analysis supports prioritization of strategies and conclusions reached in other phases of the planning process and provides information to consider in implementing the Biosolids Program Strategic Plan. Further evaluation, costing analysis, and technical review may be required to explore an alternative in more detail (these factors were not within the scope of strategic plan development).

Triple Bottom Line Analysis Overview

A TBL analysis presents a range of values for measuring organizational and societal success for the County's Biosolids Program, including social, environmental, and economic values. Criteria are specified within each TBL category, and each biosolids alternative was scored for each criterion. All TBL criteria are found in Appendix C. The end analysis of this evaluation was a number from 1 to 100, with 1 being the lowest-rated (least preferred) alternative possible and 100 being the highest-rated (most preferred) alternative possible. Complete results of the TBL evaluation are presented in Table 1 and detailed in Appendix C.

Table 1. TBL Evaluation Results

Alternative	TBL Evaluation Score
Class A Covered Aerated Static Pile Composting	69
Class A Static Aerated Pile Composting	67
Existing Class B Program	61
Class A Thermophilic Digestion	61
Class B Land Application Program with Western Washington Sites	56
Contract Management of Biosolids	54
Solar Drying	50
Class A Thermal Hydrolysis (includes soil blending)	47
Class A Dryer	36
Class A Lime Stabilization	34
Thermal Conversion – Incineration	17
Thermal Conversion – Gasification	14

Scoring systems established for the TBL evaluations allow objective comparisons between alternatives. Twenty-year high-level life cycle costs, including capital and operations and maintenance costs, were estimated for incineration and the three highest ranking biosolids management alternatives:

- Class A Aerated Static Pile Composting (with or without membrane cover system)
- Class A Thermophilic Digestion with Soil Blending
- The existing Class B Land Application Program

The highest-ranking alternative was Class A biosolids composting. This alternative received the highest ranking because it produces a highly marketable, King County-owned, local retail product. It also implements well-established technologies. A compost product allows entry into a variety of local markets and addresses current program challenges regarding transportation, market portfolio, and public perception. Additionally, Class A biosolids composting aligns closely with the Biosolids Program's strategic plan goals, priority strategies, and actions, and it also aligns with WTD's and King County's goals for equity and social Justice, sustainability, and resiliency.

A brief description of incineration, and the three highest ranking biosolids management alternatives, is provided below. Detailed TBL scores for all management alternatives considered are shown in the consultant-team subject matter expert's TBL report in Appendix C.

Alternatives Description and Scores

Class A Biosolids Composting – Aerated Static Pile and Aerated Static Pile with Membrane System

The highest-ranking alternative was Class A biosolids composting for a variety of reasons. This alternative received the highest ranking because it produces a highly marketable, King County-owned, and local retail product. It also implements well-established technologies. A compost product allows entry into a variety of local markets and addresses current program challenges regarding transportation, market portfolio, and public perception. Other key benefits of this alternative include: relatively short haul distances and availability for emergency storage; availability of wood debris bulking agents from King County Road Services, Solid Waste, and Parks divisions; and avoidance of significant recycling and tipping fees. Class A biosolids composting aligns closely with the Biosolids Program's strategic plan goals, priority strategies, and actions. Some drawbacks include: capital costs, need for local land acquisition, and market fluctuations in sourcing additional reliable bulking agents.

Existing Class B Land Application Program

Maintaining the County's existing Class B land application program was the second-highest-ranked alternative. The County produces approximately 120,000 wet tons of Class B biosolids each year, the majority of which is used as a soil amendment for agricultural crops in Eastern Washington or commercial forests in east King County. A small percentage of biosolids is presently sent to a private composter that produces and sells compost. The biosolids portfolio for the County is presently trending toward a reduction in the diversity of end users. There are several key benefits of maintaining the current program, including the following: there are no major program changes required; the Eastern Washington agricultural market is large, with an established customer base; and the program is well known to WTD and operations staff. The program has several drawbacks including: limited diversity in market portfolio, long hauling distances, winter pass closure issues, farmers moving toward organically certified practices, price of wheat (primary market) is declining, and more regulatory restrictions on Class B product use are being realized.

Class A Thermophilic Digestion

Thermophilic digestion is capable of producing Class A biosolids. In this alternative, it was assumed the existing digesters are upgraded to thermophilic digestion at West Point Treatment Plant to maintain the existing treatment plant footprint. The digesters would produce Class A biosolids. Twenty-thousand wet tons of Class A biosolids will be trucked to a County-owned soil-blending facility to be developed into a soil-blend product that will be locally marketed. The remaining Class A biosolids will continue to be used for forestry and agricultural application. The key benefits from this alternative include: alignment with asset management of West Point digesters; County-owned and marketed product; revenue from retail sales; short haul distances and availability of emergency storage; availability of wood debris bulking agents from King County Road Services, Solid Waste, and Parks divisions; and avoidance of significant recycling and tipping fees. There are several potential drawbacks of this alternative, including: capital costs and need for land acquisition, long timeframe for implementation, and market fluctuations in sourcing additional reliable bulking agents.

Thermal Conversion – Incineration

Although incineration ranked very low in the TBL analysis, it is summarized here because of external stakeholder interest in the technology. Incineration is a thermal oxidation or combustion process in which the organic matter or volatile fat is destroyed at high temperatures and in the presence of oxygen. All the energy going into the biosolids is burned and converted to hot gases, which are exhausted through an emission stack. Heat is required when combusting raw or digested biosolids to remove the water. All of the energy in the digested biosolids is, therefore, lost. Incineration of biosolids is a typical method for biosolids disposal that creates a small-volume, inert material for landfilling.

A key benefit of incineration is that there is no product to manage except ash (which requires landfilling). Incineration typically provides an alternative to landfill disposal of municipal solid waste, but without the benefit of energy recovery. Many existing facilities were designed this way before the era of high energy prices and sustainability considerations. Conversely, an incineration facility requires major capital investment and air quality permitting, has high energy use and a large carbon footprint, faces potential social justice concerns with facility location, typically encompasses a long timeframe for implementation, and possesses no opportunity for resource recovery. Therefore, more biosolids incinerators are being taken out of commission nationally than are being constructed. Finally, the Washington State Department of Ecology (Ecology) does not consider incineration to be a beneficial use of biosolids.

Alternatives Conclusions

As a result of this TBL analysis, incineration will not be considered further for WTD biosolids. The remaining three alternatives informed the refinement and prioritization of biosolids strategies and actions.

Goals, Objectives, and Strategies Background

The goals, objectives, and strategies of the Biosolids Program Strategic Plan address biosolids beneficial use and reliability, biosolids products and distribution, and integration of Biosolids Program activities with the rest of WTD. This section describes how these goals, objectives, and strategies were developed.

Goals and Objectives

Biosolids Program staff brainstormed program goals, from which a smaller set was identified to include in the plan. For goals 1 and 2, program staff conducted a strengths, weaknesses, opportunities, and challenges (SWOC) analysis. The SWOC analysis helped staff refine the wording of goals, identify measurable objectives, and consider potential strategies.

Strategies

Biosolids Program staff developed an initial list of potential strategies to achieve program goals, which program staff further refined to develop a prioritized list of 10 strategies. Staff also identified a small list of strategies for future consideration. Additional details are found in the Strategies Prioritization section of this plan.

Technical Research

Strategic planning consultant team subject matter experts conducted a TBL analysis to inform the identification, evaluation, and selection of future WTD biosolids management alternatives. The consultant and WTD staff developed social, economic, and environmental criteria for evaluating 12 potential biosolids management alternatives. The consultant then described and evaluated each alternative. After the Biosolids Program narrowed down its consideration to four alternatives, the consultant provided a conceptual or high-level cost estimate for those alternatives to inform the Biosolids Program's selection of an alternative as well as strategies and actions to implement. Results of the TBL analysis are found in the Alternatives Evaluation and Selection section and in Appendix C.

Goals Rationale

This section summarizes the Biosolids Program's reasoning behind all three of its goals and strategies to achieve those goals. The goals of the Biosolids Program were developed to specifically address the program challenges and issues described in the Introduction section, including issues surrounding the resiliency of the program to market and regulatory changes, maximizing resource recovery, identification of barriers and risks, responding to customer needs, and integration with other WTD programs.

Goal 1: Recycle 100 Percent of Loop

WTD has a long history of 100 percent beneficial use of Loop biosolids, and all biosolids producers are required by Ecology to beneficially use biosolids while being protective of human health and the environment. Landfill and incineration are not authorized beneficial uses per WAC 173-308, which is enforced by Ecology. Biosolids goal 1 seeks to ensure that Loop is not diverted to landfills. (See pages 7-8 for actions to implement strategies for achieving goal 1).

Goal 2: Diversify Biosolids Products and Distribution

In 2016, 94 percent of Loop biosolids was delivered east of the Cascade mountains, almost entirely to one of two long-time agricultural partners: Boulder Park and Natural Selection Farms, located in Douglas County and the Yakima Valley, respectively. The majority of this agricultural application went to Boulder Park and was used to provide nutrients for wheat and other crops. The remaining biosolids went to forestry applications in Western Washington (5.5 percent) and a local composter (0.5 percent). King County does not have ownership of a Class A product, limiting WTD's ability to broaden potential equity, social justice, and sustainability goals. Building a resilient program requires inclusion of local use and decreased operational risk. Goal 2 broadens the biosolids customer base from rural communities outside of King County to urban communities within King County.

Goal 3: Integrate Activities Across the Division

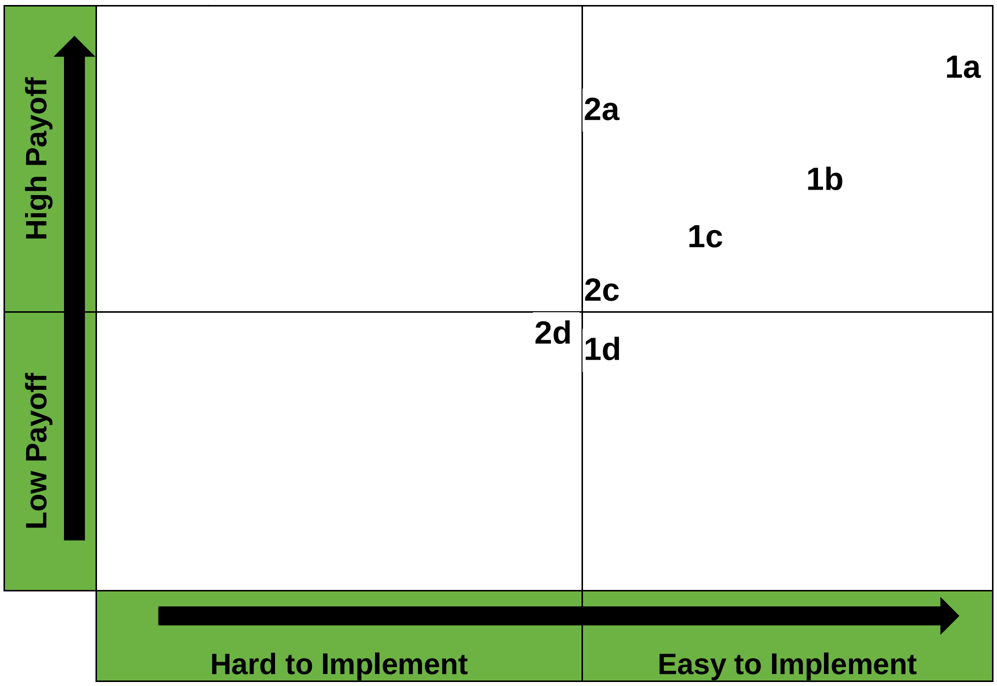
While Biosolids and Recycled Water Program and TAIP strategic plans include goals, objectives, and strategies for individual programs, there are commonalities and interconnections across all resource recovery programs and other programs within WTD. This common goal is shared among the Biosolids Program, Recycled Water Program, and TAIP. This common goal also ensures that the implementation of individual plan strategies is done in a way that increases the efficiency of implementation, draws from overlapping efforts across WTD, and considers how strategies affect other WTD programs.

Strategies Prioritization

Prioritization is a critical part of the strategic planning process in which organizations compare strategies to one another in terms of their payoff/impact and the level of effort to implement. Prioritization helps programs determine the sequence of strategy implementation as well as where to focus their resources.

To prioritize strategies, the Biosolids Program ranked its strategies and discussed the results to refine that ranking. Program staff also considered the amount of payoff and ease of implementation for each strategy, as shown in the strategies payoff matrix in Figure 1.[3,4]

Figure 1. Strategies Payoff Matrix



Key: 1a) Secure flexible and large capacity west-side emergency storage; 1b) In advance of regulatory restrictions, implement a nutrient study focused on phosphorus removal; 1c) Expand partnerships with WA DNR to expand lands in Western Washington for biosolids applications; 2a) Start a capital project for biosolids improvement to Class A compost by 2020 and develop a product by 2023; 2c) Emphasize research studies on the benefits of biosolids; 1d) Expand agricultural land application in Eastern Washington through regional partnerships, communication, and demonstration of Class B biosolids; 2d) Increase awareness and support of Loop Biosolids Program and product with internal and external stakeholders, customers, and policymaking audiences.

The payoff matrix evaluation was also helpful to the Biosolids Program in prioritizing and refining the wording of its strategies and guiding the development of actions. After completing the priority matrix, but before developing actions to implement Biosolids Program strategies, program staff identified the overall priority order of all of its strategies across all goals. The current order of strategies found in the Strategic Plan Overview section reflects the priority order of biosolids strategies within each goal.

[3] This payoff matrix in an approximate representation of the payoff/implementation designations the Biosolids Program gave to each of its strategies at a meeting on January 30, 2018. At the time of that meeting, the wording of some strategies was different than the final wording.

[4] The wording of strategy 2b changed significantly after the Biosolids Program completed the payoff matrix evaluation.

Implementing Actions

Methods to implement Biosolids Program actions will vary significantly depending on the type of action and its complexity. Actions will be incorporated into WTD's work planning process, and the following strategic planning details will be identified through that process:

- **Champions:** Strategic plan champions are individuals who advocate for and support an action or set of actions. Champions advocate for actions to program decision-makers and search for solutions to barriers to implementing actions. Often, the champion for an action is different from the individual(s) leading an action to completion.
- **Leads:** Action leads take responsibility to ensure an action is successfully implemented by tracking progress, monitoring the budget, and delegating work to complete an action during strategic plan implementation.
- **Costs:** During the strategic planning process, the budget for implementing an action may not be known. However, the program should be able to identify *types* of costs that may be required to implement an action, such as capital, operational, travel, membership, consultant, or other costs.
- **Measures and Milestones Refinement:** The program should identify specific measures and milestones for tracking progress toward targets they set for each objective. This can be done through updates to the program's existing internal work planning processes.
- **Timeframe:** During the strategic planning process, it may not be feasible to identify specific milestones and deadlines for completing different parts of an action. However, the program should be able to identify the approximate *timeframe* for starting and completing an action. Also, to the extent possible, the program should identify the *sequence* for implementing actions (i.e., which actions should be started first, second, etc., and which actions must be completed before other actions can begin).
- **Stakeholder Engagement:** Key stakeholder groups will be consulted throughout implementation of the strategic plan.
- **Monitoring and Maintenance:** The program should develop a system for regularly monitoring progress toward achievement of strategic plan goals. Measures identified for each objective will be a useful guide in plan monitoring. Also, the strategic plan may occasionally be revisited and updated as conditions change.

Appendices

- **Appendix A**: Biosolids Strategic Plan Charter
- **Appendix B**: WTD Strategic Planning Team Members
- **Appendix C**: Biosolids Program Alternatives Triple Bottom Line (TBL) Analysis

Appendix A

Project Charter

Project Identification

Name: Biosolids Strategic Plan

Project Number: 1047375

Project Sponsor: Sandy Kilroy

Project Manager: Steve Tolzman

Need/Justification (1-2 paragraphs)

The Wastewater Treatment Division (WTD) biosolids management program plays a significant role in WTD's sustainable future and its progress towards carbon neutrality. In the current Biosolids Plan, WTD committed to using 100% of its Class B Loop® biosolids as a soil amendment, expand its marketing and customer base and support ongoing research. Since the plan was written, the region has experienced increased biosolids loads, increased regional traffic congestion, and opposition to biosolids activities. WTD has also seen a steady decrease in reliability from GroCo Inc., who provides a consumer biosolids product (GroCo compost) which King County does not own or distribute. We expect GroCo to no longer be in business in the next 2-5 years.

This Strategic Plan will re-evaluate the division's biosolids management strategies including marketing, technology, regulations and cost. The new plan is expected to:

- Identify strategies and actions to sustain the long history of beneficial use of the Loop biosolids product and ensure cost-effective, beneficial use continues into the future
- Identify opportunities for optimizing the resource value derived from Loop
- Identify barriers and risks for Loop and the current biosolids program, and evaluate options for the future of WTD's Class A or B biosolids products and corresponding biosolids program.
- Identify potential synergies between WTD's biosolids, energy, recycled water and technology assessment programs
- Initiate decision-making on capital investments to ensure that WTD's biosolids program meets the future needs of customers and the County
- Ensure WTD's biosolids-related decisions are integrated with other strategies and decisions across the division (particularly operations), county and region.

Project Audience (1 paragraph)

The Biosolids Strategic Plan is being prepared to provide guidance for internal decision-making and to define the direction of the WTD biosolids operating and capital programs. The Plan is being prepared as a WTD-internal planning document to provide guidance to internal decision-making. The primary audience is WTD management and WTD staff.

Project Objective (1-2 paragraphs)

The primary objective is to develop a strategic approach for biosolids production, distribution and use with a 20-year horizon including a 5-year action plan. This plan will build upon the previous Biosolids Plan (2012-2016) to develop a predictable, sustainable and resilient program that will be effective at adapting to changing conditions. This plan will also be developed in coordination with similar plans for recycled water, energy and technology assessment.

Project Scope Statement (1 paragraph)

The major topics and questions that the project team will explore in the development of the plan are as follows:

- Building a predictable, sustainable, cost-effective, and resilient program that can adapt to changing conditions.
    - What is the vision for WTD's biosolids program in the future?
    - What are the barriers and risk our existing program is facing?
    - What are the potential markets for Class A and Class B biosolids in this region?
    - Identify compliance constraints of the future and insure King County continues to meet or exceed state and federal regulations.
    - What products will be most successful in the marketplace; what do customers want in a biosolids product?
    - What other KC entities, for example Solid Waste or Roads, can WTD collaborate with to combine raw materials, facilities or financing to develop new biosolids based products or uses?
    - How can we meet ESJ and SCAP near- and long-term goals?
    - What policy, regulatory, or capital investments are required to move WTD toward the model program of the future?
- Compare alternatives to implement strategies to reach WTD's biosolids goals, including possible products and potential technologies to produce a product, as well as the cost, and potential markets and customers for those products.

To help answer these questions, the project team will consider the list of more detailed questions/topics in *Attachment A* to this charter.

Other scope of work tasks will include the following:

- Evaluation of current business conditions
    - Current processing technology
    - Current customers and markets
    - Market drivers and restrictions
- Identify KC biosolids program goals and how they align with KC policies
- Identify challenges for future goals and strategies to address those challenges
- Develop advocacy strategy that emphasizes partnerships with community and environmental organization to strengthen and build public support for biosolids recycling

- Develop a set of alternatives for KC's biosolids program
  - Preliminary operating and capital cost analyses for alternative technologies and program scenarios
  - Preliminary energy and carbon accounting
- Prioritize near-term actions necessary to move WTD toward its future program
  - Roadmap
  - Steps to implementation

Project Cost Rough Estimate

Project Resources	Estimated Labor Hours	Estimated Cost
Biosolids Lead	300	$41,400
Biosolids Program staff Time	250	$34,500
PPD staff (lifecycle analysis of alternatives)	80	$11,000
O&M Staff	120	$16,500
ECSS Staff	40	$5,500
WTD Finance staff	60	$8,200
OSI staff (option A/option B)[B]	200/80	$27,600/$11,000
Consultant (option A/option	125/285	$50,000/$114,00
Total	1335/2750	$222,300/$269,700

*Note: A. Estimation given to provide an estimation if the consultant does not write the plan.
B. Option A assumes that WTD will be responsible for evaluating existing and developing technologies for biosolids processing. Option B assumes that the consultant is responsible for technology assessment.

Project Schedule

A draft plan is expected to be ready for WTD Division Director's review by early 2018. The goal date for a final draft for DNRP Director's Office review is mid-2018.

Project Deliverables

The major deliverable is a report (strategic plan) that defines the division's vision for its Biosolids Program, including guiding principles and implementation. The plan will also identify near-term and long-term tactics and activities that could enable the division to create a program consistent with its vision of a *Utility of the Future*. The report will also identify next steps, opportunities, challenges, and issues that need to be addressed in order to implement the strategic plan.

Initial Project Assumptions

The initial project assumptions are that: (1) the effort to complete the project is staff-driven and (2) that the staff needed to complete this project will be available and not have competing priorities.

Initial Project Constraints

Primary constraints include staff availability, budget availability, and the need to complete the plan by 2018.

Initial Project Driver

The expiration of the 2012-2016 Biosolids Plan is the initial project driver.

Project Priority

Meeting this project's objective is the project priority.

I have reviewed and approved this Charter.

Signature: ______________ Date: 6/6/17

Name: Sandra Kilroy

Title: Chief Strategy & Sustainability Officer

Project Role: Sponsor

ATTACHMENT A

Questions and Topics to be Considered in the Development of
WTD's Strategic Biosolids Plan*

(These are in addition to the major questions and topics outlined in the plan's charter)

Overarching

- What are the current policies that guide WTD's Loop biosolids program (such as RWSP, KC Strategic Plan, KC Comp Plan, SCAP)? Are additional policies needed?
- Will new directions for the program align with King County's other goals and plans? Is there support in King County's comprehensive and strategic plans for new uses for Loop?
- What guiding principles were developed for the past and current biosolids plans? Which ones are still relevant; are there more appropriate ones at this time?
- How can WTD use Loop to help meet SCAP goals while still maintaining the essential strengths of the program (for example, continuing to maintain strong and reliable markets even at some energy cost)?

Studies/Strategies to Consider

- What can WTD do to limit the amount of phosphorus in dewatered biosolids, which is limiting the agricultural customer base for Loop biosolids.
- Have any of the Class A trigger events (Brown & Caldwell, 2005) occurred, and what is WTD's best response to these situations?
- What advantages would these products provide:
    - a dewatered Class A biosolids
    - a biosolids-based compost retail product
    - a Class A biosolids cake mixed with wood, sand, and bark (such as Tagro)

Lessons Learned to Investigate/Apply

There are four alternatives for biosolids use:

- GroCo compost
- Boulder Park Project
- Natural Selection Farms
- Campbell/DNR – Snoqualmie

During winter months, snow and rain limit land application. In the past, biosolids were land applied in the woods during winter months to offset limited pass access. This, along with GroCo, would provide enough distribution to maintain digester levels at the plants. As a last alternative for closed passes and woods application due to snow, we contract with Everett for short term storage. The 2016/17 Fall/Winter tested our distribution resources. During one week passes were closed, trucks were stuck in snow and mud, several trucks were down for maintenance, the woods were closed due to snow/mud, GroCo was at capacity. Our only recourse was Everett. Everett holds 70 loads and we utilized the entire space within a week. We had used all of our distribution/storage options. We need to explore alternative distribution/storage on the West side.

Relations to other King County/WTD Initiatives and Planning Efforts

- Are there technologies that give WTD a Class A biosolids and also provide important benefits to plant operations?
- How can the Biosolids Program and Operations (dewatering) work together seamlessly to optimize product quality?
- What are the best practices to ensure routine coordination between staff and managers responsible for biosolids, recycled water, energy, technology assessment, industrial waste, and plant operations?
- Several plans underway in WTD and other parts of DNRP will require coordination:
    - WTD: Strategic Plans for biosolids, technology assessment, recycled water, energy
    - SWD: anaerobic digestion study for organic materials
- The Biosolids Strategic Plan should also recognize the regional nature of biosolids management in the PNW and the benefits of regular coordination with
    - other KC divisions that have similar interests in management of raw organic materials: DOT's Road Services Division, Parks Division, Solid Waste
    - other wastewater utilities throughout WA, OR, ID, and BC through membership and joint projects with NW Biosolids
    - other wastewater utilities that depend on WTD land application projects to manage their biosolids

**NOTE: This does not represent an all-inclusive list of questions; they reflect general topics for consideration.*

Appendix B

King County Wastewater Treatment Division

2017-2018 Strategic Planning Team Members

<table>
<tr><th colspan="2">Biosolids Team</th><th>Recycled Water Team</th><th>Technology Assessment & Innovation Team</th></tr>
<tr><td colspan="2">Ben Axt
Rick Butler
Henry Campbell
Tony Chiras
Dave Dittmar
Scott Drennen
Jake Finlinson
Sharman Herrin
Isaiah Langi
Sekhar Palepu
Alison Saperstein
Rebecca Singer</td><td>Rick Butler
Dave Dittmar
Sharman Herrin
Steve Hirschey
Jacque Klug
Sue Meyer
Matt Nolan
Alison Saperstein
Kristina Westbrook</td><td>Bob Bucher
Pedro de Arteaga
John Smyth
Curtis Steinke
Andy Strehler
Pardi Sukapanpotharam
Bruce Tiffany</td></tr>
<tr><th colspan="2">Oversight and Management Teams</th><th colspan="2">Consultant Team</th></tr>
<tr><td>Project Management Team
Ashley Mihle
Steve Tolzman

Oversight Team
Sue Kaufman-Una
Sandra Kilroy
Sarah Ogier
Rebecca Singer
Chris Townsend</td><td>WTD Management Team
Tim Aratani
Mark Isaacson
Bruce Kessler
Rebecca Singer
Lisa Taylor
Chris Townsend
Robert Waddle</td><td>Triangle Associates, Inc.
Betsy Daniels
Shay Huff
Evan Lewis
Bob Wheeler</td><td>O’Brien & Company:
Justus Stewart

Kennedy/Jenks Consultants, Inc.
Mark Cullington
Dana Devin-Clarke
Jean Debroux
Heather Stevens
Chris Stoll
Stephen Timko</td></tr>
</table>

26 March 2018

Technical Memorandum

To: Rebecca Singer, King County

From: Mark Cullington, Kennedy/Jenks Consultants

Dana Devin-Clarke, Kennedy/Jenks Consultants

Subject: Biosolids Program Alternatives Triple Bottom Line Analysis
K/J 1797003.00

The following technical memorandum presents a Triple Bottom Line (TBL) analysis of twelve biosolids management alternatives for King County (County). The results of the TBL will aid the County in developing a plan for their future biosolids program. Goals for a future program include developing a diversified biosolids market, optimizing biosolids beneficial use, and contributing to the County-wide goal of achieving carbon neutrality by 2025.

Triple Bottom Line Evaluation

A Triple Bottom Line (commonly referred to as "TBL," "3BL," or "People, Planet, Profit") presents a range of values for measuring organizational and societal success for the County's biosolids program including:

A. **Social** ("People"). Social considerations include activities that shape local, national, and international public policy, equality, treatment of minorities, quality of life, and issues of public concern.

B. **Environmental** ("Planet"). Environmental considerations include the effect of processes, products, or services on the environment. These may include air, water, land, natural resources, flora, fauna, and human health.

C. **Economic** ("Profit"). Economic considerations reflect activities related to shaping demand for products and services, employee compensation, community contributions, local procurement policies, and other monetary issues related to company activities.

The TBL phrase was coined by John Elkington in 1994 (Elkington, 1994) and later expanded in his 1998 book *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. The International Council for Local Environmental Initiatives (UN ICLEI) ratified TBL standards for urban and community accounting in early 2007, and since ratification, TBL has become the dominant approach to public sector full cost accounting. In practical terms, TBL accounting means expanding the traditional reporting framework to consider social and environmental performance in addition to financial performance.

The social factors for evaluation include quality of life, working conditions, and the creation of jobs for County staff. Environmental factors in this evaluation include sustainability and regulatory compliance. The last criteria, sustainability, we evaluated in terms of beneficial use of biosolids, energy requirements, and carbon footprint. The TBL also includes qualitative cost comparisons for the various biosolids alternatives. Economic criteria include operations and maintenance costs, capital costs, process reliability, marketability of product, and environmental permitting costs.

The end analysis of this evaluation is a number from 1 to 100, with 1 being the lowest rated alternative possible, and 100 being the highest rated alternative possible.

Scoring systems established for the carbon footprint and TBL evaluations allow semi-objective comparisons between alternatives. These non-cost aspects should be considered similarly with the financial costs required for each biosolids program alternative.

Background

Biosolids are a nutrient rich organic byproduct of municipal wastewater treatment. The residual solid material is treated using carefully regulated processes to make biosolids that are safe for beneficial use. These uses include application to primarily non-food crops such as seed, feed and fiber crops, forests, and disturbed land reclamation. Other uses include the production of compost and other amendments for landscape and garden applications. Across the United States, thousands of municipalities recycle their biosolids by applying them to land. Agricultural and non-agricultural sites benefit from the nutrients and soil conditioning value of biosolids. Last year, approximately 50 percent (%) of the biosolids produced were applied to less than 1% of all land available for agriculture within the United States (U.S. EPA, 2014).

Biosolids are classified into two categories based on pathogen reduction: Class B and Class A. Class B biosolids are treated but still contain detectable levels of pathogens. When utilizing Class B biosolids for land application, the site must be permitted. Application rates are specified and buffer requirements, public access restrictions, and crop harvesting restrictions must be met. This allows time for any pathogens that are present to be destroyed by environmental exposures to temperature changes, sunlight, drying, and competing soil microorganisms. Class A biosolids receive additional treatment and contain no detectable levels of pathogens. Class A biosolids have no restrictions of use or sale.

Alternatives Description

A diverse biosolids program will provide multiple benefits to a utility including revenue from the biosolids product and additional resource recovery. The following section is a discussion of twelve biosolids management alternatives. They were evaluated to identify a biosolids program that is cost-effective, environmentally sustainable, and socially responsible.

Existing Class B Land Application Program

The County produces approximately 120,000 wet tons of Class B biosolids each year, the majority of which is used as a soil amendment for agricultural crops in Central Washington or commercial forests in east King County. A small percentage of biosolids is sent to a private composter who produces and sells GroCo compost. The current customer profile for the County's biosolids is listed in Table 1.

Table 1: King County's Biosolids Management Projects

Project	Beneficial Use	Biosolids Received in 2011 (wet tons)	Biosolids Received in 2016 (wet tons	Biosolids Received in 2017 (wet tons)	Customers
Boulder Park (Douglas County)	Dryland Wheat	68,000	92,000	80,000	Farmers
Natural Selection Farms (Yakima County)	Canola, hops, misc. crops	20,000	23,000	17,000	Farmers
Snoqualmie Forest	Commercial Forests	25,000	5,000	12,000	Forest management company
WA Dept Natural Resources	Commercial Forests	5,000	0	3,000	State forest management agency
GroCo Inc.	Class A EQ Compost Product	1,500	1,000	1,000	Landscapers and general public
City of Everett	Temporary Storage	None	1,000	1,000	City

Source: KC Biosolids Plan, 2012 and KC Communication, 2018

The biosolids portfolio for the County is trending towards a reduction in diversity of end users as can be seen in Table 1 above. In 2011, 74% of the biosolids produced went to agricultural land, 25% went to forestry applications, and 1% went to GroCo. In 2016, 94% went to agricultural land, 0% went to forestry, 0.8% went to GroCo and 0.8% went to temporary storage. Last year, slightly more solids went to forestry applications, but the majority of solids again went to agricultural applications.

As seen in Table 1, the largest markets for the County's Class B biosolids are in Douglas and Yakima Counties, where farmer-owned companies receive and manage the application of biosolids on their own farmland to primarily grow wheat crops. The Central Washington market for biosolids has been reliable and stable for more than 15 years, however, the location requires regular truck deliveries across the mountain passes year-round. Fluctuating fuel costs and winter closures of the mountain passes has significant impacts on the program. The future of biosolids application in these counties is less certain. Many farmers are converting to organic practices and the price of wheat is declining indicating that demand for biosolids may decrease in the immediate future.

Class B Land Application Program with Western Washington Sites

Class B biosolids land application with Western Washington sites would build upon the foundation of the existing County program. In this alternative, the County would develop a local land application program in cooperation with customers to form a beneficial use facility. During the summer, the County could reduce their fuel costs with a local land application program. During the winter, they would have a location to store solids during mountain pass closures. One difficulty of implementing this alternative is the availability of land and customers on the Western side of the state. In addition, population growth could put the County at risk in the future with no control over the future neighbors of an offsite facility.

Class A Dryer

Thermal drying technology removes water via evaporation from dewatered biosolids, reducing the volume and weight. The thermal energy used for drying is generated by combustion of natural gas but can be offset using waste heat from combustion of digester gas. The high temperatures utilized by a dryer ensure that the Environmental Protection Agency (EPA) time and temperature requirements for Class A biosolids are met. Thermal drying results in a material with a solids content greater than 90% dry weight. Heat drying can be accomplished by one of two main drying technologies: direct or indirect dryers.

A thermally dried Class A biosolids product has universal applications. The dried biosolids can be supplemented for fuel, land-applied for reclamation and other soil improvement projects, or blended with other materials to create topsoil. The cost of transport is much reduced compared to biosolids due to volume reduction. To haul the same quantity of biosolids, 3 to 4 times as many truckloads are required to transport dewatered biosolids compared to a dried product. Finally, as the biosolids are a Class A product there are no restrictions in use or sale. Installation of a biosolids dryer will increase annual operation and maintenance costs. Running a dryer could require an additional plant operator and will also increase electrical costs.

Class A Lime Stabilization

Alkaline treatment stabilization (e.g., the use of lime) typically raises the pH of biosolids above 12.0 to produce a Class A product. According to the EPA, lime stabilization has been demonstrated to effectively eliminate odors, improve bacterial and pathogenic organism control, and provide stable material for application to agricultural land (Otoski, 1981). If the pH drops below 11, however, biological decomposition will resume and produce odors.

The liming agent destroys pathogens, negating the necessity for digestion. Lime stabilization can also accommodate major fluctuations in solids production. High pH biosolids are valued in Western Washington's typically acidic soils, however, the added value of high pH is lost on agricultural land in Central Washington, which already has alkaline soils.

A disadvantage to alkaline processes is the quantity of biosolids increases with lime addition. This can increase the cost for transport. In addition, the lime stabilization process causes the solids to appear light grey or whiteish in color. The color can be off-putting for customers who are used to more of a soil-like material.

Class A Biosolids Composting - Static Aerated Pile and Aerated Static Pile with Membrane System

Composting typically requires mixing biosolids with a carbonaceous bulking agent such as sawdust, wood chips, or ground woody yard debris. Composting is a treatment process that uses time and temperature to produce a final product that meets Class A pathogen reduction criteria and is highly marketable. Biosolids can also be composted with other organic materials such as food waste.

The aerated static pile process maintains aerobic conditions by blowing air through the piled media instead of physical manipulation of the material. The finished compost product is highly marketable because of its neutral odor and user-friendly, soil-like appearance. Compost can be distributed in bulk for commercial use or bagged and sold in smaller quantities directly to the public. The beneficial use of Class A biosolids compost is relatively well known in the marketplace with several Northwest utilities relying on this process for treating biosolids. Costs for producing biosolids compost can be variable if bulking agents must be purchased, and can be expensive if an enclosed system is required.

An aerated static pile with a membrane system utilizes a membrane cover that captures and controls volatile organic carbon (VOCs) and Greenhouse gas emissions (ECS, 2012).

If the County elects to develop its own composting operation, further evaluation is needed to determine siting for a compost operation. For the purposes of this evaluation, it was assumed that a 10-15 acre parcel in King County is purchased or transferred to the Wastewater Treatment Division. Property acquisition included average land value for 15 acres and average costs for site improvements. The compost system will be used to convert 20,000 tons of Class B biosolids to Class A compost.

A County owned compost operation provides multiple benefits. Developing a Class A compost product would provide a King County owned, local consumer retail product that will allow the County to maintain a diversified biosolids product portfolio. In addition, the County would remain in control of the product quality as they will not have to rely on a third-party contractor to generate the product. The County would be generating the biosolids product close to the intended market, reducing annual hauling costs. Finally, some bulking agents such as clean woody debris can be provided by the County Division of Solid Waste, Roads or Parks. This will reduce the impact of fluctuations in market rates of wood bulking agents.

A possible disadvantage of compost production is the quantity of compost product increases due to the addition of bulking agents.

Class A Thermophilic Digestion

Anaerobic digestion is a biological process in which anaerobic bacteria convert organic matter into methane and carbon dioxide (sometimes called biogas) in the absence of air. The process stabilizes the organic matter in wastewater solids, reduces pathogens and odors, and reduces the total solids quantity. Solids are reduced by converting the volatile solids fraction of the wastewater into biogas. Digesters run at thermophilic temperature (120-140 ºF) result in solids destruction and biogas outputs higher than that of conventional mesophilic digestion. Thermophilic digestion is capable of producing Class A biosolids.

Both the current digester capacity and treatment plant footprint at West Point is limited. To meet future capacity requirements, either a new mesophilic digester will need to be constructed or the existing mesophilic digesters will need to be converted to thermophilic digestion. In this alternative, it was assumed the existing digesters are upgraded to thermophilic digestion at West Point to maintain the existing treatment plant footprint. The digesters would produce Class A biosolids. Twenty-thousand wet tons of Class A will be trucked to County purchased and owned 5 acre soil blending facility. The land acquisition was based on average land values and average costs for site improvement. The Class A biosolids will be developed into a soil blend product that will be locally marketed. The remaining Class A biosolids will continue to be used for forestry and agricultural application. Developing a Class A soil blend product would provide a

King County owned, local consumer retail product that will allow the County to maintain a diversified biosolids product portfolio. In addition, the County would remain in control of the product quality as they will not have to rely on a third-party contractor to generate the product. The County would be generating the biosolids product close to the intended market, reducing annual hauling costs.

Class A Solar Drying

The basic principle of operating a solar drying system is to evaporate water from biosolids using the sun's solar energy. The drying process occurs in impervious drying beds. The operation is simple, and maintenance is minimal. Solar drying technology can be used to produce a Class A or Class B product. Both the City of Bend, Oregon and Wenatchee, Washington produce a Class A biosolids product via solar drying. The high solids content in the final biosolids product minimizes the hauling volume to land application sites. The disadvantage of this option is it requires a large footprint. Dry conditions and large available land areas in Central Washington make this alternative viable. The County would haul biosolids east and then return with a dried Class A product. This option is susceptible to fluctuating fuel costs and mountain pass closures. In addition, the County would need to procure land to site the facility.

Contract Management of Biosolids – Haul Class B to Contractor/Municipal Class A Facility

The County currently contracts with GroCo, Inc. to compost less than 5% of their biosolids. In 2016, GroCo composted less than 1% of the overall biosolids production. The County would need to find a new third-party contractor for implementation of this alternative.

In this alternative, the County would haul Class B biosolids to a third-party contractor or other municipality for further treatment to achieve Class A. This would be similar to the current relationship the County has with GroCo Inc. The County would be able to avoid costly land acquisition and other capital improvements required to implement a composting or other Class A program. There is a concern, however, relying on another organization for the management of County biosolids. This would increase risk to the County and present little control over the production and distribution of their biosolids. To date, there has been minimal to no response to King County's previous request for proposals from other local composting companies. More compost companies are available in Central and Eastern Washington. While this would allow the County to operate a diversified biosolids product portfolio, the biosolids would still need to be trucked over the mountain passes in the winter.

Thermal Conversion – Incineration

Incineration is a thermal oxidation or combustion process in which the organic matter or volatile fat is destroyed at high temperatures and in the presence of oxygen. Incineration of biosolids is typically accomplished using a Fluidized Bed Incinerator or a Multiple Hearth Furnace. Incineration is an energy consumer. All the energy going into the biosolids is burned and converted to hot gases, which are exhausted through an emission stack. Biosolids are typically 20% solids and 80% water. Auxiliary heat is required when combusting raw or digested biosolids to remove the water. All of the energy in the digested biosolids is therefore lost. Incineration of biosolids is typically a method for biosolids disposal which creates a small-volume, inert material for landfilling.

Incineration typically provides an alternative to landfill disposal of municipal solid waste without the benefit of energy recovery. Many existing facilities were designed this way prior to the era of high energy prices and sustainability considerations. An incineration facility requires major capital investment and loses the opportunity for resource recovery. More biosolids incinerators are being taken out of commission than being constructed. Finally, the Washington Department of Ecology does not consider incineration to be a beneficial use of biosolids.

Thermal Conversion – Gasification

Gasification is a process sometimes implemented outside of North America to recover the energy contained within the organic fraction of biosolids. Gasification is accomplished by heating the feedstock under low quantities of air and sometimes with the addition of steam. The low oxygen content combusts a small portion of the gases generated, approximately 10-30%. The resultant gaseous products contain carbon monoxide, methane, hydrogen, and other volatile components. This gas stream, known as “syngas” or “producer gas,” is a source of gaseous fuel, which can be combusted and converted to usable energy. In addition to being combusted immediately after the gasification process, the syngas can be cleaned or scrubbed and used as a fuel substitute. A small amount of ash is formed and must be disposed of in a landfill.

Gasification of biosolids is embryonic and only a few production-scale units are in operation. Often, the biosolids are mixed with other materials (e.g., wood waste or municipal solid waste) to increase fuel content, process stability, and conversion efficiency. Biosolids can generally be gasified only if the moisture content is very low. Historically, gasification systems have a poor track record and operational problems, such as fusion of entrained ash and control difficulties. Gasification as a technology is emerging and has been fraught with many problems while trying to become established.

Thermal Hydrolysis

Thermal hydrolysis is a pretreatment process that uses heat and pressure to treat primary sludge and waste activated sludge (WAS) streams prior to digestion. Pretreatment occurs in a two-stage process. In the first stage, the combined solids stream is pressurized and cooked at 340^{o} F in a batch process for 30 minutes. The material is then conveyed to a flash tank operating at atmospheric pressure. The drop-in pressure lyses or bursts the cells, releasing necessary food and proteins for microbes in the digester. Increased microbial activity in the digester results in increased gas production and greater solids destruction. Thermal hydrolysis meets time and temperature requirements for Class A biosolids if used to treat both the primary sludge and WAS streams going into the digester. This pretreatment technology can also be utilized to just treat the WAS stream in which the resulting product would be Class B.

The already partially degraded solids stream undergoes further solids destruction in the digester. Thermal hydrolysis pretreatment results in greater solids destruction and gas production in the digester as well as improved cell dewaterability, resulting in drier biosolids typically between 28 and 32% solids. Thermal hydrolysis is considered an emerging technology with few installations within the United States, however, it does have a proven track record in Europe. It has a small overall energy demand because the increase in energy usage to run the process is offset by the additional gas production and potential for increased heat utilization. The process requires a specially trained operator to be onsite during operation of the boiler that produces steam. The thermal hydrolysis process also results in a higher level of ammonia in the dewatering side stream than conventional anaerobic digestion. This side stream is fed back to the head of the plant, increasing the ammonia in the liquid stream.

Thermal hydrolysis can be implemented when there are space constraints and a digester is approaching capacity limits. In this case, it could be implemented at West Point to extend the capacity of the existing digesters. Additional benefits of implementation include higher energy recovery and reduced quantity of solids compared to other stabilization technologies. One disadvantage is that a full-time operator would be required to run the system due to the use of an onsite boiler.

Triple Bottom Line Summary

Alternatives Evaluation Procedure

Alternatives were evaluated using a matrix-based approach incorporating quantitative criteria related to capital and life-cycle cost, as well as qualitative criteria related to environmental and social benefits. The “no change” alternative was not an element in this evaluation process because the goal of this analysis was comparing Class A, B, and thermal conversion options. Alternative ratings are calculated providing an independent score for each of the stated evaluation criteria multiplied by a relative importance, or weighting, to each criterion according to the following formula:

$$AlternativeRating = \sum_{Criteria} Score \times Weighting$$

Environmental and social benefits are quantified based on qualitative evaluations of relevant benefits and drawbacks for each alternative.

Score and Weighting

Alternatives should be scored for each criterion on a scale of one (1) to five (5), with 1 being lowest and 5 being highest. The weighting factor is a percentage-based multiplier that places greater emphasis on specific criteria deemed to be of higher value, allowing economic criteria (capital and lifecycle cost) to be considered along with more qualitative criteria for social and environmental criteria.

Evaluation Criteria

Evaluation criteria used in the alternative evaluation along with weighting factor and the total criteria weight are summarized in Table 2 below. Each criterion was assigned a weighting factor to indicate overall importance in the alternative evaluation. Weighting factors reviewed and recommended by County staff are summarized in Table 2.

Table 2: Triple Bottom Line Evaluation Criteria and Weighting Factors

Evaluation Criteria	Weighting Factor	Total Criteria Weight
SOCIAL CONSIDERATIONS		
Community Quality of Life	5	
Working Conditions	5	
Local Job Creation	5	
	Subtotal	**15**
ENVIRONMENTAL CONSIDERATIONS		
Sustainability	15	
Regulatory Compliance	15	
	Subtotal	**30**
ECONOMIC CONSIDERATIONS		
Operations and Maintenance Costs	15	
Capital Cost	20	
Process Reliability	10	
Marketability of Product	5	
Environmental Permitting Costs	5	
	Subtotal	**55**

Evaluation Criteria	Weighting Factor	Total Criteria Weight
	Total	100

Social Considerations

Community Quality of Life (5%)

Quality of life considerations will factor into how Class A, B, and thermal conversion options increase or decrease the quality of life of the County residents, including potential improvement of parks and open spaces for community recreation, and any impacts to overall quality of life such as air quality, noise, and odors from biosolids management operations.

Working Conditions (5%)

Working conditions for County public works staff were considered as they relate to Class A, B, and thermal conversion options including operation of new treatment facility processes.

Local Job Creation (5%)

Consideration was given to increased availability of Class A, B, and thermal conversion options in creating economic opportunities for farmers, nursery owners, contractors, or other businesses, which in turn could stimulate the local economy, and return benefits to the community through increased capital.

Environmental Considerations

Sustainability (15%)

King County has developed a Strategic Climate Action Plan with a goal to achieve carbon-neutral operation by 2025. Management of a biosolids program with a focus on energy recovery can do a lot to support this goal. A carbon footprint analysis was used to look at the energy and fuel consumption to produce Class A or B biosolids, or thermal conversion of biosolids. A concise Carbon Footprint Evaluation was completed for this portion of the report. Details are contained below.

Regulatory Compliance (15%)

For Class B biosolids, all options are capable of being in complete compliance with WAC 173-308 and 40 CFR Part 503.

For Class A EQ biosolids, all the technologies evaluated are capable of meeting requirements for pathogens and vector attraction reduction, and achieving pollutant concentrations below those listed in 40 CFR 503.13 - Table 3.

The ability for adaption to meet future regulation requirements of each alternative will also be evaluated.

Economic Considerations

Lifecycle Cost (15%)

Lifecycle costs for operations and maintenance (O&M) were compared on a net present worth (NPW) basis. O&M costs will be estimated annual costs for County staff to operate and maintain the proposed facilities, including general equipment maintenance, equipment replacement, energy costs, and other related costs over a 20-year useful service life.

Capital Cost (20%)

Capital costs are those costs associated with construction or procurement of required facilities or land for each alternative.

Process Reliability (10%)

It is of prime importance that the recommended biosolids utilization alternative has maximum reliability ensuring a continuously viable end use option. For each technology, a minimum of four (4) operating facilities must exist within the United States.

Product Marketability (5%)

Class B biosolids have some end use restrictions while Class A biosolids can be utilized with no restrictions. Consideration was given for the ability to develop a diversified biosolids utilization portfolio.

Environmental Permitting Costs (5%)

Environmental permitting issues were evaluated for each alternative. Considerations were given for the overall environmental permitting complexity and timelines anticipated for each alternative, and costs for environmental studies if needed (i.e., Environmental Assessments and Biological Assessments). Environmental and permitting issues may involve biosolids management plans, site authorizations, wetlands permitting and mitigation, land use permitting, and planning applications and permits.

Carbon Footprint Evaluation

Introduction

If managed appropriately, biosolids production and utilization is a way to offset carbon emissions from wastewater treatment plant operations, accrue carbon credits, and achieve carbon neutrality goals.

As part of the environmental considerations, qualitative carbon footprints were estimated for the proposed biosolids alternatives. The sum of carbon debits (emissions) and credits (sinks or offsets) result in the net carbon footprint. In this case, the carbon debits quantify emissions due to transportation and product development. Biosolids alternatives can also provide credits by production of renewable sources of energy and nutrients that can serve to offset equivalent emissions associated with nonrenewable sources of energy and nutrients.

A summary of the carbon footprint for each biosolids management alternatives is presented in Table 3.

Table 3: Carbon Footprint Summary

Alternative	Debits & Credits	CO_2 Net Emissions
(A) Existing Class B Land Application Program	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to Central Washington and incorporation into agricultural fields. **Potential Credits:** Energy production from digestion, carbon sequestration, offset chemical fertilizer use.	Credit
(B) Class B Land Application Program	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to Western	Credit

Alternative	Debits & Credits	CO_2 Net Emissions
with Western Washington Sites	Washington and incorporation into agricultural fields. **Potential Credits:** Energy production from digestion, carbon sequestration, offset chemical fertilizer use.	
(C) Class A Dryer	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to local markets. **Potential Credits:** Carbon sequestration, offset chemical fertilizer use.	Debit
(D) Class A Lime Stabilization	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul product to local markets. **Potential Credits:** Carbon sequestration, offset chemical fertilizer use.	Debit
(E) Class A Composting – Static Aerated Pile	**Debits:** Diesel use to haul biosolids and wood chips to local site, process emissions (pile turnover), diesel use to take product to local markets. **Potential Credits:** Carbon sequestration, offset chemical fertilizer use.	Credit
(F) Class A Composting – Aerated Static Pile with Membrane System	**Debits:** Diesel use to haul biosolids and wood chips to local site, process emissions (pile turnover), diesel use to take product to local markets. **Potential Credits:** Carbon sequestration, offset chemical fertilizer use.	Credit
(G) Class A Thermophilic Digestion	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to local market. **Potential Credits:** Energy production (biogas) from digestion, carbon sequestration, offset chemical fertilizer use.	Credit
(H) Class A Solar Drying	**Debits:** Process emissions (fossil fuel for pile turnover), diesel fuel to haul biosolids to Central Washington and Class A biosolids back to Western Washington markets. **Potential Credits:** Energy production (biogas), carbon sequestration, offset chemical fertilizer use.	Credit

Alternative	Debits & Credits	CO_2 Net Emissions
(I) Contract Management of Biosolids – Hauling Class B to contractor/municipal Class A Facility	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to contractor facility. **Potential Credits:** Energy production from digestion, carbon sequestration, offset chemical fertilizer use.	Credit
(J) Thermal Conversion – Incineration	**Debits:** Process emissions (fossil fuel use), fugitive emissions, diesel fuel to haul fly ash to landfill. **Potential Credits:** Energy value (heat) from biosolids.	Debit
(K) Thermal Conversion - Gasification	**Debits:** Process emissions (fossil fuel use), fugitive emissions. **Potential Credits:** Energy value (synthetic gas) from biosolids.	Debit
(L) Thermal Hydrolysis	**Debits:** Process emissions (fossil fuel for stabilization and chemical addition), diesel fuel to haul to local markets. **Potential Credits:** Energy production (biogas), carbon sequestration, offset chemical fertilizer use.	Credit

Carbon Footprint Evaluation Discussion

For the purpose of this discussion, the twelve alternatives under evaluation were separated into three categories based on the assumed stabilization technology: digestion, alternative stabilization, and thermal conversion.

Digestion

The alternatives that utilized digestion processes for stabilization resulted in a low to medium carbon footprint rating. These alternatives include both land application programs, Class A thermophilic digestion, Thermal Hydrolysis, Class A solar drying and the contract management of biosolids alternative. Stabilization of biosolids occurs in a digester which generates biogas. The biogas can be utilized onsite for digester heating completely offsetting fossil fuel use for these stabilization technologies. Leftover gas can be used in a cogeneration system to generate electricity and waste heat or can be scrubbed and sold offsite compensating the purchase of nonrenewable fossil fuels. Therefore, the process emissions for these alternatives are relatively low. Electricity is used to dewater the biosolids with some carbon debits associated with use of dewatering polymer. Then diesel fuel is used to haul the biosolids to a land application site, local market, or third-party facility for further processing. Class B biosolids were assumed to be hauled to Central Washington for land application, while Class A biosolids were assumed to be used locally in an alternative market. Both thermophilic digestion and thermal hydrolysis have greater volatile solids destruction and thus fewer biosolids being produced than mesophilic digestion, requiring less energy inputs for dewatering and a lower quantity of trucks to haul the Class A to a local market.

Solar drying utilizes renewable solar energy and therefore has a very low carbon footprint rating. Diesel fuel is used for trucking Class B solids to Central Washington and for a tractor to move the solids within the drying beds.

Alternative Stabilization

Alternative stabilization technologies evaluated included lime stabilization, composting, and a Class A dryer. Composting has a low carbon footprint. Process emissions are associated with fossil fuel use for incorporating any bulking agents such as wood chips and electricity to run the blowers. Hauling and delivery of wood chips and biosolids requires diesel fuel for trucking. The resulting Class A product is assumed to be used locally.

Lime stabilization has a high carbon footprint rating because lime production is extremely energy intensive. Process emissions are associated with electricity used to mix the solids and lime and diesel fuel for trucking the product to local market.

A biosolids dryer requires a significant quantity of natural gas to dewater the solids. The carbon footprint of biosolids dryers can be significant. But the footprint can be improved by utilizing biogas in place of natural gas. Also, a dry Class A biosolids product greatly reduces trucking requirements.

Thermal Conversion

The thermal conversion alternatives (incineration and gasification) can offset some of the fossil fuel use due to the inherent energy value of biosolids. Additional energy inputs, however, are still required to completely evaporate all the water. In addition, to a large energy footprint, these technologies produce a byproduct that must be hauled to landfill for disposal requiring diesel fuel for trucking.

All alternatives where the end product (dewatered biosolids, compost, or thermally dried biosolids product) is applied to land have the potential opportunity for credits. Credits can be taken for carbon sequestration as scientific research has shown that repeated biosolids application can improve the soils carbon storage capacity. Biosolids nutrient value also provides benefits. A credit can be taken for avoidance of chemical fertilizer for nitrogen and phosphorous addition.

20-Year Lifecycle Cost Estimating Methodology

An economic model was developed that considered a 20-year planning horizon through 2038, considering capital and operation and maintenance (O&M) costs for each of the four alternatives.

The O&M costs include estimated annual costs for City staff to operate and maintain the solids process equipment, energy costs to run equipment, and chemical costs.

The results of this analysis helps inform the various alternatives rankings for the economic portion of the TBL.

The foundation of any cost model is comprised of the assumptions and data used as a basis for calculations. Following is a list of the economic assumptions used to develop the annual maintenance O&M costs that were common to all alternatives:

- Biosolids Total Solids (Avg. of all three plants): 24%
- Sale of a Class A biosolids product (compost or soil blend) is $20/DT
- Ancillary Costs: 50%
- Contingency Costs: 30%
- Evaluation Period: 20 years
- Escalation Rate: 4%
- Discount Rate: 6%
- Biosolids Growth Rate: 0.5%
- Equipment power and chemical use was based on vendor supplied data.
- Labor costs were not included as part of this analysis

The 20-year life cycle cost estimating was conducted for four of the alternatives including: the existing Class B Land Application Program, Class A Compost, Class A Thermophilic Digestion and Incineration. Class A Compost and Class A Thermophilic Digestion alternatives assume a mixed Class A and Class B biosolids program, where approximately 85% of biosolids produced are sent to the existing Class B Land Application Program. Incineration is assumed to receive

100% of biosolids produced. The analysis is included in Appendix A. The results of the analysis are shown in Figure 1 below.

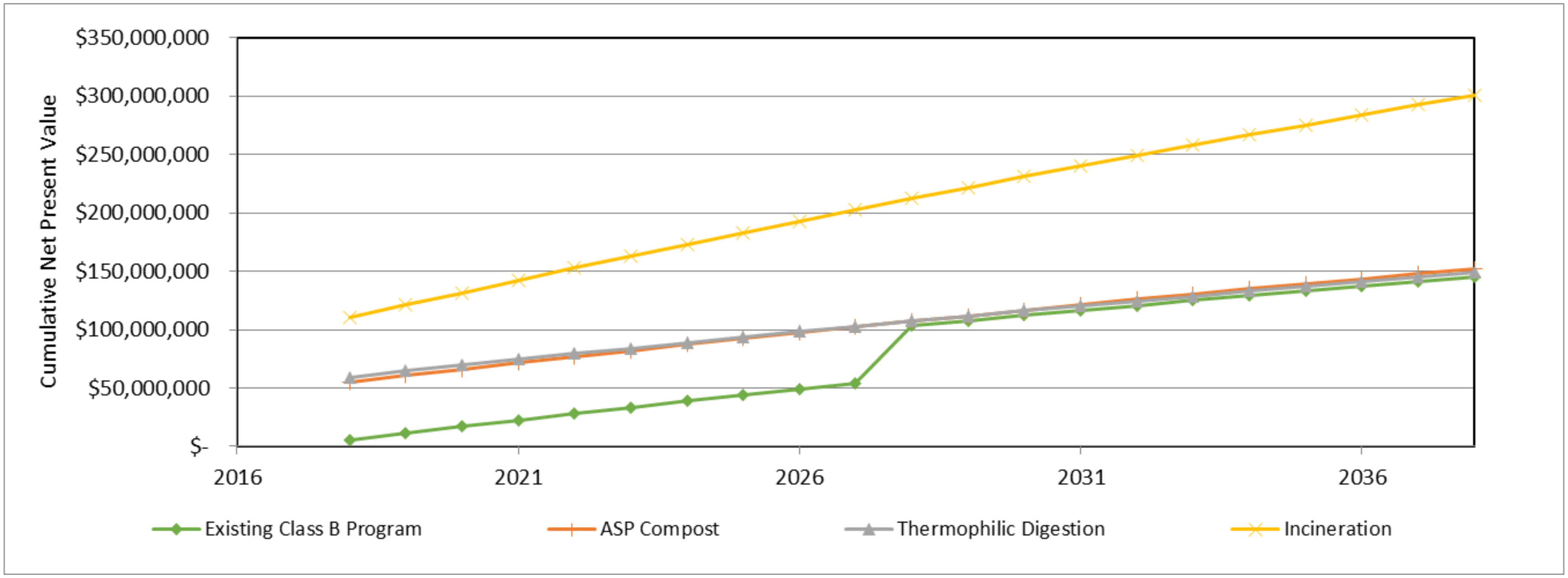


Figure 1. 20-Year Net Present Value Analysis of Four Alternatives

Incineration resulted in the highest cumulative net present value due to high initial capital costs as well as high operation costs. The high annual operation costs are attributed to use of two biosolids dryers which are needed to increase the total solids in the biosolids from 24% to 95%. Removal of all water is required to optimize incineration.

The existing Class B program, the Class A compost alternative and the Class A thermophilic digestion with soil blending alternative have similar capital expenditures and operating costs over the 20-year period. While both Class A compost and thermophilic digestion alternatives have initial capital cost the revenue generated from each program generates income that offsets their annual operating costs resulting in a lower or similar net present value to the existing program. In addition, the existing program will incur capital costs in 10 years to accommodate asset management of the digesters at West Point.

Alternatives Ranking

The evaluation matrix below ranks the twelve biosolids alternatives based on the TBL criteria discussed above.

Table 4: Net Present Value Summary

Alternative	Description	Capital Costs	Annual O&M	Cumulative 20-yr NPV
Alt 1	Existing Class B Program	$54,094,203	$5,790,000	(144,880,000)
Alt 2	ASP Compost	$49,696,920	$6,000,000	(152,100,000)
Alt 3	Thermophilic Digestion	$54,094,203	$5,850,000	(148,760,000)
Alt 4	Incineration	$99,028,800	$11,040,000	(300,560,000)

Appendix A: Triple Bottom Line Evaluation Criteria and Weighting Factors

Evaluation Criteria	Weighting Factor (%)	Existing Class B Program	Class A Covered Static Aerated Pile Compost	Class As Static Aerated Pile Compost	Class A Thermophilic Digestion (with soil blending)	Class B Land App Western WA	Contract Mgmt Biosolids (to produce Class A Product)	Solar Drying	Class A Thermal Hydrolysis (includes soil blending)	Class A Dryer	Class A Lime Pasteurization	Thermal Conversion Incineration	Thermal Conversion Gasification
SOCIAL CONSIDERATIONS													
Community, Quality of Life	10%	50	80	80	85	55	40	50	85	35	30	10	10
Working Conditions	5%	90	80	80	80	70	90	90	80	30	10	20	20
Local Job Creation in KC (are we stimulating the KC economy)	5%	10	40	40	30	20	10	10	30	5	10	0	0
Subtotal													
ENVIRONMENTAL CONSIDERATIONS													
Carbon Footprint	15%	60	75	70	50	70	40	60	50	10	20	10	10
Regulatory Compliance	5%	80	100	100	100	80	100	30	100	100	100	0	0
Subtotal													
ECONOMIC CONSIDERATIONS													
Lifecycle Cost	20%	50	60	60	50	60	60	60	50	40	30	40	30
Capital Cost	15%	80	50	40	20	70	80	30	0	30	30	20	20
Process Reliability (resiliency - both for tech and process)	15%	65	75	75	85	40	30	50	10	40	40	10	0
Marketability of Product (geographic and market)	5%	30	90	90	90	20	30	40	90	40	20	0	10
Environmental Permitting Costs	5%	90	70	70	80	30	70	60	80	80	80	10	10
Subtotal													
TOTAL	**100%**	**60.8**	**69.0**	**66.8**	**60.8**	**55.5**	**53.5**	**49.5**	**46.5**	**36.3**	**33.5**	**16.5**	**13.5**

$$AlternativeRating = \sum_{Criteria}(Score * Weighting)$$

Source: KC Workshop 23 January 2018