JUNEAU COMMISSION ON SUSTAINABILITY AGENDA

June 04, 2025 at 12:00 PM

Zoom Webinar

https://juneau.zoom.us/j/88069534778 or 1-253-215-8782 Meeting ID: 880 6953 4778

A. CALL TO ORDER

B. LAND ACKNOWLEDGEMENT

We would like to acknowledge that the City and Borough of Juneau is on Tlingit land, and wish to honor the indigenous people of this land. For more than ten thousand years, Alaska Native people have been and continue to be integral to the well-being of our community. We are grateful to be in this place, a part of this community, and to honor the culture, traditions, and resilience of the Tlingit people. Gunalchéesh!

C. ROLL CALL

D. APPROVAL OF AGENDA

E. APPROVAL OF MINUTES

1. JCOS Regular Meeting, May 7, 2025
2. JCOS Worksession, May 21, 2025

F. PUBLIC PARTICIPATION

G. AGENDA TOPICS

3. Sustainability Session/Outreach Update – Griffin
4. Solid Waste Update - Dianna

H. INFORMATION ITEMS

5. Jacob's Engineering Final Technical Memorandum – Juneau Solid Waste Disposal Facility Feasibility and Capital Costs
6. National Renewable Energy Lab (NREL) TA Report: Resource and Energy Recovery Opportunities from Waste in Juneau, Alaska

I. COMMITTEE MEMBER / LIAISON COMMENTS AND QUESTIONS

J. NEXT MEETING DATE

7. Worksession June 18, 2025 12 PM @ Zoom

   Regular Meeting July 2, 2025 12 PM @ Zoom

K. ADJOURNMENT

ADA accommodations available upon request: Please contact the Clerk's office 36 hours prior to any meeting so arrangements can be made for closed captioning or sign language interpreter services depending on the meeting format. The Clerk's office telephone number is 586-5278, e-mail: city.clerk@juneau.gov.

Juneau Commission on Sustainability
Minutes—Meeting of May 7, 2025

A. CALL TO ORDER
The meeting was called to order by Co-Chair Marian Call at 12:03 pm.

B. LAND ACKNOWLEDGEMENT

C. ROLL CALL
Present: Marian Call, Duff Mitchell, Brennen McCulloch, Jessica Barker, David Teal, Nick Waldo, Griffin Plush
Absent: Jim Powell, Laura Achee
Staff & Others Present: CBJ Staff Ashley Heimbigner, CBJ Staff Nate Abott, Lori, Zach Gianotti (DEC), Nina Keller (PC)

D. APPROVAL OF AGENDA
1. Approved with the additional topic of JCOS member terms and recruitment without objection.

E. APPROVAL OF MINUTES
1. 03/24/2025 JCOS Worksession--Approved without Objection
2. 04/02/2025 Regular Meeting--Approved without Objection

F. PUBLIC PARTICIPATION
Zach Gianotti (DEC) introduced himself as a solid waste regulator for Southeast Alaska and requested advisory input from JCOS for future Southeast Conference solid waste meetings. Will follow up with opportunities for JCOS to comment on regional projects.

G. AGENDA TOPICS
2. CBJ Energy Management Discussion - Nate Abbott, CBJ Facilities Maintenance Superintendent

   Nate Abbott shared CBJ's energy management progress and fielded questions:
   - CBJ has been using an energy tracking software for three years. Electricity tracking is straightforward while fuel data is delayed due to billing cycles and more challenging to interpret.
   - Fuel-reduction efforts include recent and upcoming boiler upgrades at Glacier Fire Station, Eagle Valley Center, and Auke Bay Fire Station.
   - The Floyd Dryden and Marie Drake buildings are particularly high energy consumers. A controls project at Floyd Dryden is expected to significantly improve efficiency.
   - Efforts to convert boilers at the wastewater treatment plant to electric are underway.

- New projects are evaluated based on energy savings, life safety, functionality, cost savings, and facility age.
- While school district buildings are expected to have similar inefficiencies to Floyd Dryden, limited funding restricts school district action. However, the district is participating in a federally funded energy audit and upgrade program.
- Nate raised concerns about inadequate commissioning frequency. Currently, new systems are only commissioned once; twice-yearly commissioning would better reflect seasonal performance. Examples cited include issues with the ground source heat pump systems at Dimond Park and the Valley Library.
- A recent facility-wide energy audit will soon be released publicly.
- Nate encouraged JCOS to support CBJ’s capital renewal (deferred maintenance) funding efforts, which is how most of these types of projects are funded.

3. JCOS Member Terms and Recruitment
   - Nick Waldo and Duff Mitchell announced they will not seek reappointment when their terms expire on June 30. Both are open to remaining informal resources. Duff noted potential conflict of interest as Juneau Hydropower progresses.
   - Marian encouraged members to invite potential candidates. David expressed interest in retaining institutional knowledge and encouraged Nick and Duff to consider continued involvement in some capacity.

H. INFORMATION ITEMS

1. Marian Call shared that a new mining project by Grande Portage Resources is starting sampling near the Herbert River. Duff Mitchelld added that the company plans to power operations electrically and ship ore north for processing.
2. Marian Call encouraged members to share agenda-linked resources, including comprehensive plan materials. Griffin Plush is serving on the advisory committee for the Comprehensive Plan and available for questions.
3. Nina Keller: Reminded members of the Downtown Douglas/West Juneau Draft Area Plan Open House, May 7, 5:30–7:30 PM at Sayeik: Gastineau Community School Commons. The plan spans Sandy Beach to the Douglas Bridge and will guide local development if adopted.

I. COMMITTEE MEMBER / LIAISON COMMENTS AND QUESTIONS
None

J. NEXT MEETING DATE

June 4, 2025, 12 PM @ Zoom

K. ADJOURNMENT
Adjourned at 1:02 pm

Juneau Commission on Sustainability
Minutes—Work Session of May 21, 2025

A. CALL TO ORDER
The meeting was called to order by Co Chair Griffin Plush at 12:03 pm.

B. LAND ACKNOWLEDGEMENT

C. ROLL CALL
Present: Griffin Plush, Nick Waldo, Brennen McColloch, Jessica Barker
Absent:Marian Call, Duff Mitchell, Griffin Plush, Laura Achee, Jim Powell, David Teal
Staff & Others Present: Dianna Robinson (CBJ)

D. APPROVAL OF MINUTES
1. None

E. PUBLIC PARTICIPATION
None

F. AGENDA TOPICS
1. Planning for Outdoor Sustainability Sessions - The Commission brainstormed ideas for upcoming outdoor sustainability sessions, considering seasonal opportunities and potential partnerships.

Event Timing:
- Sun Day (September 21) was proposed as a potential anchor date, with related events the preceding week (September 15–21).

Energy Systems Tours:
- Gold Creek Hydro Plant (AEL&P) – Potential tour site; point of contact: Lauri or Alec at AEL&P.
- Franklin Dock & Cruise Ship Tours – Could highlight cruise ship shore power connections. Alex Pierce has previously offered to arrange ship tours (e.g., Holland America Princess), including overviews of onboard wastewater systems and exhaust scrubbing.

Solid Waste, Water, and Wastewater:
- New Solid Waste/Compost Facility Site – Campus of future facilities may be of interest, but construction hasn’t begun. Revisit in the fall.
- Perseverance & Gold Creek Water Sources – Visually interesting but lower priority; could pair with discussions about water rate increases.
- Current Landfill – Tour must occur during the workday (closes at 5 PM).

- Mendenhall Wastewater Treatment Plant – Tour is feasible; PPE and headcount required. Contact: Brian (CBJ).
- Compost Facility – A tour of the current composting operation was suggested.

Land Use & Redevelopment:
- Fish Creek Gravel Pit – Explore history of redevelopment plans.
- Mendenhall Wetlands (Second Crossing) – Potential walk-through and discussion on the proposed project and its implications. Could serve as a public engagement opportunity.

Preliminary Session Schedule:
- June/July: Mendenhall Wastewater Plant tour
- August/September: Gold Creek Hydro (linked with Sun Day events)
- October: Solid Waste campus site visit (dependent on daylight and staff availability)

Action Items:
- Griffin will reach out to Lauri at AEL&P to coordinate a hydro plant tour.
- Dianna will connect JCOS with Brian to arrange the wastewater plant tour.

G. INFORMATION ITEMS
Staff Update – Dianna Robinson announced she will be leaving her position and moving out of town in July.

H. COMMITTEE MEMBER / LIAISON COMMENTS AND QUESTIONS
None

I. NEXT MEETING DATE
June 4th, 2025, noon @ Zoom

J. ADJOURNMENT
Adjourned at 1 pm

Juneau Solid Waste Disposal Facility Feasibility and Capital Costs – Technical Memorandum

Date:	March 20, 2025
Project Name:	CBJ Solid Waste Study
Project No:	CBJSWS01
Company:	City and Borough of Juneau (CBJ)
Prepared By:	Jacobs
Contract No:	E24-328

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1. Executive Summary

The City and Borough of Juneau (CBJ) is exploring various options for long-term management of solid waste. Currently, solid waste management in Juneau is exclusively handled by private companies, with the CBJ having no active role in this process. Residents in Juneau can either bring their solid waste directly to the private landfill owned by Waste Management, at a cost of $215 per ton (with a minimum charge of $153.32), or they can participate in curbside collection services provided by the privately owned company Alaska Waste. Waste hauling is overseen by the Regulatory Commission of Alaska (RCA). Consequently, there is no public input into operational decisions or rate determination, apart from waste hauling. The CBJ has identified only three municipalities in Alaska – Juneau, Haines, and Glenallen – that do not have a role in solid waste management. Given the impending closure of the Capitol Disposal Landfill, anticipated to occur in the next decade, and the approximately 10-year timespan to plan and permit a new solid waste disposal facility, the CBJ is exploring future disposal options and assessing the high-level feasibility of possible solutions. Operational costs will be an important aspect of planning for a future facility. This study's scope was to focus on the high-level feasibility and capital costs for the three scenarios. Operational costs should be explored in detail in the future.

This study is a limited high-level discussion of capital costs and technical feasibility of three scenarios chosen by the CBJ based on several past studies and Assembly-level conversations over the course of four decades (CBJ 2024a). It is intended to be a starting point for community conversations around future solid waste management. It does not include in-depth analyses of operational costs, cost-benefit analyses of the scenarios, comparisons of different thermal treatment (incineration) technologies, or much discussion of diversion practices such as recycling or composting. Additionally, this study does not include biosolid disposal in any of these options, as the CBJ are in the planning stages of a stand-alone project for biosolid incineration (CBJ 2025d). Although each of these are important considerations for overall solid waste planning, they are outside the scope of this study and will be evaluated if the community chooses to move forward with the planning and construction of a publicly owned disposal facility.[1] The focus on disposal has been prioritized due to the looming closure of the only landfill within the community. Section 5.2 provides the recommended next steps in the planning process.

[1] Planning for future diversion facilities will take place separately in early-to-mid 2025.

The CBJ is considering the following three scenarios; notably, each scenario includes a transfer processing facility[2]:

Scenario A: Construct a new landfill and transfer processing facility with recyclables sent south by barge for diversion.

Scenario B: Construct a transfer processing facility with waste and recyclables sent south by barge for recycling and disposal.

Scenario C: Construct a Waste-to-Energy (WTE) facility and transfer processing facility for municipal solid waste (MSW) with noncombustibles, recyclables, and ash sent south by barge for disposal.

The purpose of this Solid Waste Study is to provide a high-level evaluation of the economic feasibility, logistical feasibility, and level of flow control in relation to these scenarios. Although operational costs are an important aspect of the decision-making process, estimating those costs accurately are outside the confines of this study and will need to be addressed later if the CBJ moves forward with any of the proposed scenarios. A brief overview of operational considerations is provided in Section 3.1. This technical memorandum provides an overview of the scenarios and presents the findings from the evaluation to inform elected officials and key partners of the feasibility of the three scenarios. The sections of this technical memorandum are organized as follows:

1. Executive Summary
2. Study Background and Limitations
3. Facilities: Capacity, Sizing, and Capital Costs
4. Regulations and Permitting
5. Summary and Recommendations

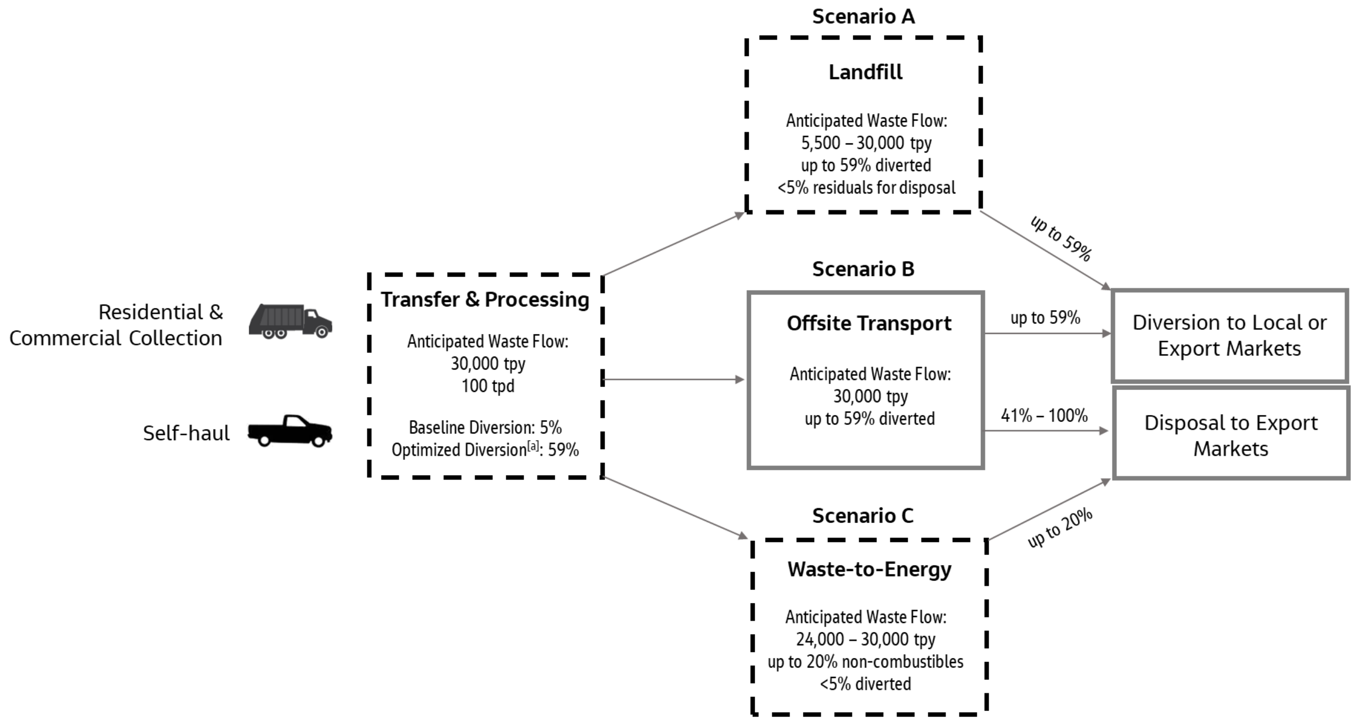
Section 1 synthesizes information from subsequent sections of this technical memorandum to provide an overview of the facility needs, estimated total costs, and considerations for each of the solid waste management scenarios. Section 2 introduces the study objectives and key assumptions required for this high-level evaluation. Sections 3 and 4 summarize the findings from an evaluation of the facilities, permit, and compliance requirements. Section 5 offers a high-level feasibility ranking for each scenario based on the current information, along with the recommended next steps.

1.1 Solid Waste Management Scenarios

This subsection provides an overview of the major considerations for each of the solid waste management scenarios based on analyses of the facilities, costs, and regulatory considerations described in Sections 3 and 4. The anticipated flow of waste in each of the three scenarios is depicted on Figure 1.

[2] Transfer Processing Facility (that is, a Transfer Station): Centralized facility to manage all CBJ waste streams from residents (self-haul) and commercial haulers and consolidate for efficient transportation to end markets.

Figure 1. Flow Diagram of Solid Waste Management Scenarios A, B, and C



[a] Optimized Diversion of 59% was derived from the 2024 Waste Characterization Study (Cascadia Consulting Group 2024).

Note: Boxes with dashed outlines indicate facilities that are anticipated to be under CBJ ownership.

1.1.1 Scenario A

The key distinction in Scenario A is the construction of a landfill within the CBJ. In this scenario, waste would first be taken to a transfer processing facility for processing. At this point, waste is consolidated and loaded into transfer trucks for transport to the landfill. Since the landfill is assumed to be within the CBJ's jurisdiction, the transportation distance between the transfer processing facility and the landfill would be minimal (anticipated less than 15 miles) based on the 1993 landfill siting study (Brown et al. 1993). The transfer processing facility would provide the CBJ with additional control and flexibility for solid waste management, thus the economics of hauling distance between the transfer processing facility and the landfill is not considered as a factor in this scenario.

Key considerations in this scenario include the timeline and capital costs for permitting and constructing a new landfill. A small transfer processing facility, sized between 9,000 and 13,000 square feet, would suffice since the CBJ would have greater control over the waste stream with a local, CBJ-owned landfill. The estimated capital costs range from $59 million to $182 million for constructing both the transfer processing facility and a 50-year landfill.[3] Because of the significant rainfall in Juneau, leachate treatment will be a substantial capital and operating expense for a new landfill. Importantly, since a site has not yet been selected for the landfill, siting and permitting could take 10 years, or up to 30 years with significant delays, to complete.

[3] Landfills are constructed in stages; thus, the total estimated capital cost assumes construction of a 50-year landfill is provided for this initial estimate for Scenario A. Costs can vary significantly depending on the operating conditions and geometry of the landfill. The provided estimates are conservative.

1.1.2 Scenario B

Alternatively, the CBJ may opt not to construct a new landfill or WTE facility. Scenario B involves shipping nearly all solid waste generated in the CBJ to an offsite landfill and recycling markets via barge. This approach avoids significant capital and operating costs for building and maintaining a disposal facility, but the CBJ relinquishes control over the final disposal of MSW, posing risks if barge services are delayed or disrupted. The CBJ can mitigate this risk by ensuring increased storage space at the transfer facility; therefore, the transfer processing facility is especially valuable under this scenario.

The capital costs in this scenario are solely based on construction of a transfer processing facility with increased storage capacity, with capital costs ranging from $14 million to $40 million for a transfer processing facility sized between 13,000 and 26,000 square feet. In this scenario, the cost of offsite transportation is a significant portion of annual costs that may be negotiated with the transportation company. Barge transportation fees vary based on the type of waste (for example, hazardous materials may incur higher costs), volume and weight of the waste, and the distance traveled. Costs for offsite transportation and disposal have been reported to reach up to $250 per ton (DMC Technologies 2003, CBJ 2025b).[4] Fuel surcharges fluctuate based on current fuel prices and will add to the overall cost.

It is important to consider that offsite transportation of waste and recyclables will increase transfer truck traffic, fuel consumption, and associated greenhouse gas emissions from both truck and barge traffic. Additionally, contamination in the waste stream can pose hazards. Fires caused by contaminated waste have occurred during offsite transportation from Alaskan communities, leading to significant danger and expense (Rose 2021). To mitigate this risk, baling or compacting waste in closed containers at the transfer processing facility can minimize fire hazards and reduce transportation frequency. However, this requires local baling equipment and costs, and not all receiving facilities can accommodate bales.

1.1.3 Scenario C

The distinguishing feature of Scenario C is the construction of a WTE facility. In this scenario, waste would first be taken to the transfer processing facility, where it would be inspected for hazards, dried, and shredded in preparation for combustion. The waste then would be fed into the WTE plant and converted into energy. To maximize the efficiency of the WTE facility, nearly all MSW would be directed for combustion, with minimal diversion (such as recycling and composting).

Key considerations include the timeline and capital costs for permitting and constructing a WTE facility and the energy benefit for the CBJ. A small transfer processing facility (9,000 to 13,000 square feet) would suffice with a WTE facility. Estimated capital costs range from $99 million to $110 million for constructing both the transfer processing facility and a WTE facility. Because a site has not yet been selected, siting and permitting must be completed for this scenario; thus, the timeline is expected to be similar to or longer than that of the landfill in Scenario A.

Notably, the CBJ's electricity currently is nearly 100% renewable hydroelectric power and the utility company, AEL&P, does not provide energy credits for surplus generation. As such, the power produced from a WTE plant would offset the parasitic load but not provide an electricity benefit for the CBJ. In addition, the RCA requires that a power purchase agreement (PPA) is established with the electric utility provider for the sale, transmission, and distribution of power. This would be a key aspect of future discussions to advance this scenario.

[4] The cost for the CBJ to ship and dispose of biosolids ranges between $216 to $930 per ton depending on whether the biosolids are shipped wet or dry. The cost is $6,500 per container.

Furthermore, WTE is an advanced technology that requires specialized skills for construction, operation, and maintenance. It may be difficult to find local technicians with the skillset to manage this type of facility, and it may be necessary to bring in and provide lodging for out-of-state contractors. There are many options for waste incineration, including incineration without energy recovery and varieties of WTE technologies, some of which have not been vetted or proven feasible on a commercial scale; a comparison of these options is outside the scope of this study but may be considered by the CBJ in future evaluations.

2. Study Background and Limitations

The CBJ contracted with Jacobs under agreement number E24-328 dated August 19, 2024, to complete a high-level evaluation of the feasibility of three potential solid waste management scenarios, described in Table 1. Each scenario includes the construction of a transfer processing facility to receive and process all waste generated in the CBJ before the waste is routed for final disposal or diversion.

Table 1. Summary of Three Solid Waste Management Scenarios for the City and Borough of Juneau

Scenario	Facilities and Potential Ownership	Key Partners	Waste Streams		
			Waste Disposal	Diversion	Residuals[a]
A. Construct a new landfill and transfer processing facility with recyclables sent south by barge for diversion.	CBJ-owned landfill; CBJ-owned or private partnership transfer facility	Landfill operator; transfer station operator (if separate from CBJ)	Disposed of in new landfill on CBJ property; potential to contract with private company for operation of the landfill	Recyclables diverted to local markets or transported south by barge	Residuals that cannot be landfilled are transported south by barge
B. Construct a transfer processing facility with waste and recyclables sent south by barge for recycling and disposal.	CBJ-owned or private partnership transfer facility	Shipping company; offsite landfill; transfer station operator (if separate from CBJ)	CBJ agreement with offsite landfill for disposal Transportation and disposal fees to be negotiated	Recyclables diverted to local markets or transported south by barge	All waste transported south by barge
C. Construct a WTE facility and transfer processing facility for MSW with noncombustibles, recyclables, and ash sent south by barge for disposal.	CBJ-owned or private partnership transfer facility and WTE facility	AEL&P; WTE operator; transfer station operator (if separate from CBJ)	Incinerated with energy recovery; CBJ energy agreement with AEL&P	Limited diversion to optimize efficiency of WTE plant operations	Noncombustible materials and ash transported south by barge[b]

[a] Residuals are defined as wastes that cannot be landfilled or diverted, such as hazardous waste.

[b] An alternative to shipping ash south by barge is to send it to a local monofill. A new monofill would need to be constructed and is not included as a part of these scenarios.

AEL&P = Alaska Electric Light & Power Company

The evaluation considered readily available data and literature to assess the feasibility of these three scenarios based on the following factors that may affect their feasibility or costs:

- Waste stream composition and quantity
- Estimated capital costs for construction of each facility with a discussion of operating cost components and facility needs
- Federal, state, and local regulations and permit requirements

2.1 Study Assumptions

A variety of assumptions were necessary to perform this high-level evaluation, including the following:

- **Unchanging Waste Tonnage and Composition**: It is assumed that there will be no significant change in waste tonnage or composition over the lifetime of the project. Information on waste composition was derived from the 2024 Waste Characterization Study (Cascadia Consulting Group 2024).
  - Seasonal fluctuations, junk vehicles, and non-CBJ waste are not considered relevant for this comparison. Biosolids are currently shipped south by barge, and planning is underway to build a pyrolysis unit at the wastewater utility for biosolids incineration, so separate treatment for biosolids is not included in this assessment.
  - Specific to tourism, this evaluation did not consider seasonal waste streams from cruise ships, which previously contributed 1,650 tons of waste in 2018 (CBJ 2024a). Under a Memorandum of Understanding (MOU) between the CBJ and the Cruise Lines International Association, the amount of waste entering the Capitol Disposal Landfill from cruise ships was reduced to 125 tons per year (tpy) in 2022.
  - The population of Juneau has remained stable or has declined slightly over the past decade, hovering around 32,000 residents. This evaluation assumes no population growth (Juneau Economic Development Council 2023).
  - The waste stream in the CBJ is assumed to remain consistent in terms of composition, based on the average MSW and construction and demolition (C&D) waste quantities from fiscal years 2016 to 2023. For this evaluation, the average waste stream was approximated at 30,000 tpy. Regional waste streams were not considered in this study but represent another 23,000 tpy (Southeast Conference 2006; Cascadia Consulting Group 2024).
- **Transfer Facility Site Location**: The new transfer processing facility is assumed to be in lower Lemon Creek on a 27-acre site owned by CBJ, approximately 0.4 mile northeast of the Lemon Creek Correctional Center. The site is rural reserve and industrial, with the nearest residential area more than 0.5 mile away. The site was chosen for its central location, suitable soils, topography, and sufficient space to construct a transfer processing facility. Other waste management facilities are in the planning process for this site, including a municipal composting facility, recycling center, and household hazardous waste facility. This study assumes the CBJ would address zoning for this property, as applicable.
- **Other Future Facility Locations**: Locations for the landfill and WTE facility have not been selected yet and additional siting may be necessary.
- **Long-Term Capacity Planning**: Facility capacity calculations are based on standard 50- and 100-year waste stream projections. A regional facility taking more than the current CBJ waste stream would require further assessment of the materials and regions to be served.
- **Diversion Rates**: In this study, diversion is defined as waste materials that are systematically redirected from disposal to be reused, recycled, repurposed for beneficial use, or composted. Diversion does not

include materials incinerated for WTE. This study accounts for management of MSW and C&D waste that is destined for the landfill and assumes that existing facilities are sufficient to manage the current stream of source-separated recyclables (approximately 5% of total waste tonnage), bulky or white goods[5], and household hazardous waste (HHW).

- **Barge Loading Facility Assumptions**: Existing facilities and processes for loading and offsite transportation of materials are assumed adequate for transporting all waste and recyclables. The CBJ may need to further evaluate barge facilities and services to better compare the operating expenses of the scenarios.

2.2 Overview of Solid Waste Management Operations in the CBJ

The CBJ faces several unique challenges in managing its solid waste. Being land-locked by the Juneau Ice Field and Inside Passage, Juneau is an isolated community, resulting in limited disposal and affordable recycling options. Furthermore, the CBJ does not own the Capitol Disposal Landfill or manage waste hauling services, resulting in limited control over the community's waste flow. The landfill is projected to reach capacity in 10 to 15 years, prompting the CBJ to explore alternative waste management solutions (CBJ 2024b).

Since the establishment of the CBJ, the control of solid waste flow has remained in the hands of the private sector. Conversations between the CBJ, the Alaska Department of Environmental Conservation (ADEC), and the RCA have indicated that Juneau is one of only three municipalities in Alaska without public flow control, alongside Haines and Glenallen. For more than 60 years, the majority of MSW in the CBJ has been privately collected under an RCA Certificate of Convenience held by various private entities and hauled to the privately owned Capitol Disposal Landfill. The Capitol Disposal Landfill receives waste from both private commercial haulers and individuals (self-haul). Until the early 2000s, some MSW was incinerated without energy recovery to reduce the volume sent to the landfill (CBJ 2024a). Currently, the CBJ operates a recycling center and an HHW facility at the landfill site, diverting approximately 5% of materials for recycling, including glass, aluminum, and steel cans (CBJ 2024b). Additionally, Juneau Composts!, a private composting business established in 2017, offers collection and drop-off services for food scraps and yard debris, which are processed at their commercial composting facility.

Efforts to expand the landfill have been unsuccessful because of the inability of a private owner to acquire adjacent land, the proximity of the landfill to other land uses, and potential adverse environmental effects on nearby wetlands. The current solid waste management system is delocalized, with MSW, recyclables, HHW, junk vehicles, and C&D processed at different facilities that are geographically or operationally disconnected.

2.3 Waste Stream Quantity and Composition

With a population of approximately 32,000 residents, the CBJ region generated an average of 30,000 tons of MSW annually from 2016 to 2023 (Table 2). Assuming that a waste management facility operates for 300 days a year (6 days per week less an allowance for some holidays and other closures), the CBJ generates an average of 100 tons of solid waste daily that must be managed. Given the relatively static population level in CBJ, this total was applied to the entire period of the solid waste management scenarios. While outside waste streams were not considered as part of this evaluation, they could be factored into the scenarios as the CBJ moves forward with planning.

[5] White goods are large household electrical products, such as refrigerators and washing machines, typically white in color.

Table 2. Tonnage of MSW and C&D waste Landfilled in the CBJ Between 2016 to 2023

Fiscal Year (July to June)	MSW (tons)	C&D (tons) [a]	Total (tons)
2016	23,542	8,555	32,097
2017	23,760	8,065	31,825
2018	23,735	6,968	30,703
2019	23,867	6,011	29,878
2020	20,626	7,299	27,925
2021	22,398	5,730	28,128
2022	24,750	4,138	28,888
2023	22,346	5,176	27,522
Average	23,128	6,493	29,621
Rounded Average[b]	23,500	6,500	30,000

Source: MSW and C&D totals per Fiscal Year provided by Waste Management.

[a] C&D waste is variable based on local construction projects and timelines.

[b] Values rounded up to the nearest 500th to approximate waste for capacity calculations.

In 2024, the CBJ contracted Cascadia Consulting Group to conduct a Waste Characterization Study. This study revealed a significant potential for increased waste diversion: 18% of waste is recyclable, 32% is compostable, 9% is reusable, for a total of 59% diverted under optimized diversion programs that are currently in place (Cascadia Consulting Group 2024).

Based on the waste quantities provided by Waste Management (Table 2) and the types of waste from the CBJ's Waste Characterization Study, the amount of diversion under each scenario is estimated to be as follows:

- Scenario A: recyclables for diversion
  - Baseline Diversion (5%): 1,500 tpy
  - Optimized Diversion (59%)[6]: 17,500 tpy
- Scenario B: recyclables for diversion
  - Baseline Diversion (5%): 1,500 tpy
  - Optimized Diversion (59%): 17,500 tpy
- Scenario C: non-combustible recyclables for diversion
  - Baseline Diversion (5%): less than 500 tpy
  - Optimized Diversion (59% of approximately 20% non-combustibles [Cascadia Consulting Group 2024]): 3,500 tpy

The amount exported for offsite disposal in each scenario is estimated to be as follows:

[6] The optimized diversion rate is derived from the 2024 Waste Characterization Study performed by Cascadia Consulting Group (2024). This 59% diversion represents the total amount that could be diverted through diversion programs that are already in place, including recycling, composting, household hazardous waste disposal, and reuse.

- Scenario A: less than 1,500 tpy of residuals for disposal
- Scenario B: 12,500 – 30,000 tpy of waste for disposal
- Scenario C: less than 6,000 tpy of noncombustibles for disposal

2.4 Concurrent Regional Planning

An effort is now underway by Southeast Conference and the Southeast Alaska Solid Waste Authority (SEASWA) to develop a Regional Municipal Solid Waste Strategy. The project will include a thorough analysis of methods and processes for the disposal of MSW to better control the costs of handling, processing, shipping, and ultimate disposal of MSW in the region. The strategy seeks to improve solid waste disposal services for Southeast Alaska communities through a collaborative effort of towns and governmental agencies. The goal of the project is to identify how to achieve safer, more efficient and cost-effective waste management systems for Southeast Alaska communities by fully exploring available options and technologies used in the management of MSW, including diversion of compostable and recyclable materials, waste to energy opportunities, and finding mutually agreeable resolutions for Southeast Alaska communities, Tribes, and SEASWA members (CBJ 2025c).

Although not the focus of this technical memorandum, the community of Juneau and the CBJ may choose to consider sizing a future disposal facility to capture this regional waste in order to maximize efficiencies of scale, which could help financially support the operational needs of the facility while providing other communities with a regional disposal option.

3. Facilities: Estimates of Capacity, Sizing, and Costs

This section presents the methodology used and estimates for the capacity, sizing, and potential capital costs of solid waste management facilities for the three scenarios. The solid waste management scenarios that are introduced in Table 1 and elaborated on in Section 4 involve various combinations of these facilities; thus, this section describes each facility individually. For example, the transfer processing facility is applicable to all three scenarios, while the landfill and WTE facility are specific to Scenarios A and C, respectively.

Jacobs estimated future facility capacity needs based on a total generation of 30,000 tpy of waste for processing, transferring, diversion, and disposal, as shown in Table 1.

This study assesses the potential cost ranges for each scenario by conducting a high-level review of publicly available information on construction and operating expenses. The cost ranges also incorporate internal estimates provided by Jacobs for other projects, as well as the industry expertise of Jacobs and their subconsultant, Raftelis. With expertise in economic and feasibility analyses for Juneau, Raftelis provided industry insight to validate the estimated WTE facility costs and assumptions for this study. Prior to making financial decisions or establishing final budgets, the CBJ should conduct a detailed evaluation of capital and operating costs that is based on engineer's estimates and considers specific facility conditions and sites.

The anticipated capital costs for a new transfer processing facility and landfill were estimated using the construction costs of five U.S. transfer stations and three landfills. Because of the unknown timeline for financing and construction of the facilities in Juneau, costs per unit area were calculated and inflated to first quarter (Q1) 2025 prices using the *Engineering News-Record* (ENR) Construction Cost Index. These costs were further adjusted for Juneau-specific expenses using the RSMeans 2024 City Cost Index. An additional 30% markup was added to the adjusted unit costs for facility examples located outside of Alaska based on the CBJ's experience with actual cost inflations for factors such as materials shipping and storage in Juneau (CBJ 2025a).

The cost to build a new WTE facility was modeled based on the construction costs for 18 different WTE plants of varying capacities constructed in the United States, United Kingdom, and Asia. The modeled capital costs for a WTE facility were adjusted to Q1 2025 and inflated for Juneau by applying a 30% markup to the forecasted construction cost.

The collection of solid waste is considered a utility in the state of Alaska; therefore, it is regulated by the RCA. In previous years, the CBJ considered purchasing the Certificate of Convenience and Public Necessity from the certificate holder (currently Alaska Waste) along with other strategies as part of a larger solid waste management strategy (CBJ 2008). It is not necessary to own a refuse hauling utility Certificate of Convenience to operate a solid waste management disposal facility. The Certificate of Convenience holder must justify all rate increases to the RCA and will seek out the lowest cost options for their rate payers.

As this study is focused on post-collection disposal options, and to avoid skewing the capital cost estimates for a particular scenario, the purchase of the RCA Certificate of Convenience is not included as a component of any scenario.[7]

3.1 Additional Preconstruction and Operating Costs

In addition to facility construction costs described in the following sections, preconstruction costs can be approximated as a percent of total capital costs from 15% to 25% of the total project cost.[8] These expenses cover site surveys; environmental impact assessments; state and local permitting; creation of architectural, design, and engineering plans; and services during construction. Proper planning in this phase is crucial to ensure the project meets all regulatory requirements and operates efficiently.

Operating costs include labor, equipment, maintenance, utilities, and insurance, all of which are necessary to keep the facilities running smoothly. Labor and equipment commonly constitute the largest portion of overall operating costs. For instance, at the Great Falls Landfill in Montana, heavy equipment rental, labor hours, and benefits make up 74% of the estimated operating expenses (AE_2S and Jacobs 2021). Operating WTE facilities may require advanced equipment and facilities, which require specialized skills at a higher labor expense.

Although this study does not investigate or compare operational costs for these facilities, it is important to note that available data shows that the cost per ton to dispose of waste through a WTE facility is often higher, and in some cases more than twice the cost of landfill disposal or offsite shipment (Arsova et al. 2008, DOE 2019).

These preconstruction and operating costs are not included in subsequent estimates of cost ranges provided in this evaluation because of the many unknowns associated with these activities. The level of analysis needed for estimating operating costs is beyond the scope of this evaluation and should be considered as the CBJ moves forward with planning.

3.2 Ownership Models

The CBJ can explore various ownership models for new facilities and solid waste management services that are described in this memorandum. The CBJ may choose to form a partnership with the private sector for financing, ownership, and operations of the solid waste management system to find a balance of

[7] The price to purchase the Certificate of Convenience was quoted at $14 million in 2008 (Cascadia Consulting Group 2024, CBJ 2024a). Acquiring the RCA Certificate of Convenience from the current certificate holder, Alaska Waste, is an independent action that could apply to any scenario.

[8] Approximate range based on industry practice.

control and risk (Table 3). In addition to the current model of private ownership and operation, examples of different ownership models include the following:

- **Public-private partnership**: The public and private entities share responsibility and risk for different aspects of the solid waste management system, such as collection, transportation, processing, and disposal facility ownership and operation. Sometimes, a public entity will provide the land for a solid waste facility but then enter into an agreement with a private entity for the design/build or design/build/operation of a solid waste facility. The division of control and financing is determined by agreements between the public and private entities, such as publicly owned facilities with privately owned or contracted collection services.
- **Publicly owned with limited private involvement under contract**: The public entity contracts with private companies for select roles. Potential roles that the private sector could contribute to are facility design, construction, and some collection or operating activities. The public entity is responsible for financing the facility and relinquishes some control over rate changes, but with reduced risks and staffing requirements.
- **Publicly owned and operated**: The public entity finances, owns, and operates the entire solid waste management system using internal resources. The public entity has maximum control over the entire process from construction through operation, is responsible for all financing, and accepts all risks.

Table 3. Benefits, Risks, and Examples of Ownership and Operation Models

Ownership/ Operation Model[a]	Public Entity's Role	Benefits to Public Entity	Risks to Public Entity	Example
Public-Private Partnership	Division of control and financing determined by agreements	Benefits shared between public and private entity (specifics depend on division of roles)	Risks shared between public and private entity (specifics depend on division of roles)	Public entity owns facility but enters into an agreement with private entity to construct and operate; private bidder arranges for financing to cover capital costs
Publicly Owned, Limited Private Involvement Under Contract	Facility and RCA ownership, establishes competitive procurement process for private services	Freedom to select services and contractors through bids; reduces burden on internal resources	Subject to rate increases, especially if there are fewer competing contractors	Public entity owns entire solid waste management system and contracts with private entities for specific services through competitive process
Publicly Owned & Operated	Owns and manages entire solid waste management system	Maximum control over rates and services	Public entity accepts all risks and is responsible for all financing	Public entity finances construction and manages all solid waste operations

[a] General ownership models, regardless of chosen scenario, and not specific to Juneau.

3.3 Transfer Processing Facility

The purpose of the transfer processing facility is to provide the necessary space and flexibility to manage waste disposal and diversion, regardless of the scenario. The CBJ assumes that a transfer processing facility is necessary for all three scenarios for initial waste processing and consolidation prior to transporting to the final disposal or diversion facility.

Functionally, waste from commercial haulers and residents is unloaded at the transfer processing facility, sorted, and consolidated into intermodal containers or transfer vehicles for recycling and disposal elsewhere. The facility could be constructed with separate drop-off locations for source-separated recyclables and compostables.

3.3.1 Capacity and Sizing

The transfer processing facility should have sufficient storage to handle temporary changes in the waste stream. The necessary storage, equipment, and operations at a transfer processing facility depend on the ultimate disposal method (landfill, WTE, or offsite shipment) because different processes are required to prepare waste for disposal, shipment, or incineration (sorting, shredding, or loading onto transfer trucks versus intermodal containers). Thus, the estimated size of the transfer station varies between the scenarios. Additional discussion of transfer station needs for each scenario is included in Section 4. The capacity of the transfer processing facility is highly dependent on operating conditions; for example, the types and numbers of residential or commercial hauling vehicles, the desired storage capacity, and the degree of waste recovery and sorting.

When there are reliable waste disposal options nearby, such as a landfill or WTE facility, transfer stations generally are designed to have 1 to 2 days of storage capacity. Although more-detailed calculations of facility space are required prior to the design stage, initial estimates suggest a tipping floor space of at least 6,000 square feet to manage 100 tons of waste per day (tpd) and a peaking factor of 2.3.[9,10] Comparisons to constructed transfer stations across the United States, along with CBJ input, indicate that a transfer processing facility sized between 9,000 and 13,000 square feet would be sufficient to meet current and future needs and an allowance for the peaking factor, assuming reliable waste disposal facilities also are available within the CBJ.

However, if the CBJ chooses to transport all waste and recyclables to a distant offsite facility by barge (Scenario B), it is recommended to increase the size of the transfer processing facility to include additional storage space in case of unexpected disruptions to offsite transportation services. This is especially important in a remote and isolated location such as Juneau. A transfer processing facility that prepares waste for offsite disposal is assumed to be sized between 13,000 and 26,000 square feet to accommodate 7 to 14 days of storage and additional processing space.

The CBJ may consider facilities to centralize drop-off and processing of additional waste streams, such as white goods, organics, and junk vehicles, as well as a repair and reuse staging area and compost sales area. These additional prospective elements are not included in subsequent estimates of cost ranges.

3.3.2 Construction Costs

Table 4 outlines the approximate unit construction costs for five example transfer stations located across the western United States. These examples provide rough approximations of estimated construction costs for transfer station facilities with various design capacities and services. All facilities include tipping floor space with at least 1 day of waste storage and vehicle stalls, while the larger facilities include additional features like office buildings, parking areas, and recycling and HHW drop-off areas. These examples are

[9] The U.S. Environmental Protection Agency suggests approximating tipping floor space by starting with a base area of 4,000 square feet and adding 20 square feet for each ton of waste received in a day. This assumes the height of the waste pile at 6 feet. Using this approximation, the tipping floor space required to manage 100 tons per day of waste is at least 6,000 square feet.

[10] Peaking factor calculated from average and peak daily waste totals for 2024 provided by Waste Management.

based on estimates acquired at different stages, such as planning level to engineer's estimates, to provide a range of potential construction costs. The adjusted cost per unit size illustrates the escalated unit costs through Q1 2025 and adjusted for Juneau. As demonstrated by these examples, larger facilities generally are more cost-effective per unit area.

Table 4. Examples of Estimated Construction Costs for Four Example Transfer Stations

Name	Location	Estimate Stage	Estimate Year	Facility Size (SF)	Cost per SF	Adjusted Cost per SF[a]
Central Transfer and Recycling Station (Clark County Environmental Health 2023)	Washington	Class 3 planning estimate	2023	63,000	$540	$800
North Area Recovery Station (County of Sacramento 2023, Jacobs 2020)	California	Engineer's estimate	2023	51,000	$680	$920
Municipality of Anchorage Central Transfer Station (Waste Advantage 2024)	Alaska	Construction estimate	2024	133,000	$800	$1,000
Great Falls Transfer Station (AE$_2$S and Jacobs 2023)	Montana	Class 4 planning estimate	2023	11,000	$630	$1,040
New Transfer Station in Portland Region[b]	Oregon	Order-of-magnitude estimate	2023	13,000	$1,000	$1,550

[a] The adjusted costs per acre were inflated to Q1 2025$ using the ENR Construction Cost Index and tailored for Juneau using City Cost Index values from RSMeans, as well as an additional 30% markup to account for cost inflations for materials shipping and storage in Alaska.

[b] Costs were derived from internal estimates for other projects, which are not publicly available.

SF = square foot (feet)

Based on the examples in Table 4 and assuming the higher range of per-unit construction costs for smaller facilities, the estimated construction cost ranges for a transfer processing facility are as follows:

- Transfer processing facility, prepares MSW for local disposal: $9 million to $20 million (2025$)
- Transfer processing facility, prepares MSW for offsite transport: $14 million to $40 million (2025$)

These estimated capital costs are for the initial cost of the facility and do not include equipment replacement costs, which typically occur every 5 to 20 years, or infrastructure repairs, typically every 50 to 75 years.[11] These estimates also do not factor in construction additions such as roads, utility connections, bridges, water management, intermodal container loading areas, or geotechnical needs for the site, which could add considerable costs. Furthermore, optional features such as centralized drop-off areas and public amenities may add to the size estimates. These features may be considered based on the needs of the CBJ and goals for creating a centralized drop-off location for waste.

[11] Approximate range based on industry practice.

3.4 New Landfill

Anticipating future solid waste management needs, the CBJ identified three potential landfill sites in the early 1990s, based on regulatory requirements, CBJ-specific criteria, and in-person reconnaissance (Brown et al. 1993). All three sites have enough space for a landfill; are set back from population centers, homes, and the Juneau Airport; and are close to existing or planned roads. Two of these sites are owned by CBJ and are near Lemon Creek in Hidden Valley between the CBJ's North Lemon Creek material source and the SECON company's material source, while the third is federal land in the Tongass National Forest across from Amalga Harbor. A new or updated siting study will be required for a Juneau landfill.

3.4.1 Capacity and Sizing

Capital estimates can vary based on landfill geometry and design parameters. Additionally, the lifespan of a landfill is highly variable, influenced by factors such as how the air space is filled, cover and soil utilization, compaction rate, and various operational parameters that depend on the selected site, implemented design, and operational efficiency. For example, a smaller footprint, such as 20 acres for a 100-year landfill, is possible with greater operational efficiencies and optimal geometry (including height) using the same values for all other estimating assumptions. Without an understanding of these unknowns, conservative estimates were used in calculations that result in a larger landfill footprint and increase the landfill capital cost.

The necessary size of a new landfill for both 50- and 100-year design capacities was estimated based on several possible geometries and a waste flow of 30,000 tpy. Sizing estimates were calculated for both the landfill fill area and the total site area. The landfill fill area refers to the lined modules that will receive the waste, while the total size area also accommodates access and operational roads, buffer space, environmental monitoring networks, stormwater and leachate management systems, equipment yards and maintenance areas, an entrance/gate area, security systems, scale houses, and gas collection and management systems.

Based on these factors, the approximate size of a 50-year landfill is as follows:

- Total landfill volume (including cover materials) = 2.5 million cubic yards
- Landfill fill area = 30 to 50 acres
- Total site area = 50 to 100 acres

The approximate size of a 100-year landfill is as follows:

- Total landfill volume (including cover materials) = 5 million cubic yards
- Landfill fill area = 60 to 100 acres
- Total site area = 100 to 200 acres

It is important to note that capital costs are not applied over the same time period across all constructed facilities. For example, the landfill capital would be applied over a 50-year period, while the transfer station and WTE may require significant replacement capital over the same 50-year period. Assessment of these factors would be completed with a more comprehensive economic analysis.

3.4.2 Construction Costs

The basic costs for landfill construction include expenses for ground clearing, excavation, and constructing landfill cell components such as perimeter berms, clay liners, geomembranes, soil modification, and leachate conveyance systems. A contingency fund of 10% to 30% of the total construction cost is commonly included to cover unforeseen expenses and project delays.[12] Table 5 outlines the unit construction costs for three landfills located in Alaska and California for comparison. The adjusted cost per unit size illustrates adjusted costs through Q1 2025 and inflated for Juneau.

Table 5. Examples of Estimated Construction Costs for Three Example Landfills

Name	Location	Estimate Stage	Estimate Year	Landfill Footprint (Acres)	Cost per Acre	Adjusted Cost per Acre[a]
Anchorage Landfill Expansion[b][c]	Alaska	Construction bid	2020	15	$419,500	$477,500
Western Placer Waste Management Authority Landfill (Jacobs and CH2M 2019)	California	Class 4 planning estimate	2018	253	$1,008,000	$1,654,000[d]
Kodiak Landfill[c]	Alaska	Payment Records	2013 to 2016	10	$2,282,500	$3,232,000

[a] The adjusted costs per acre were inflated to Q1 2025$ using the ENR Construction Cost Index and tailored for Juneau using City Cost Index values from RSMeans.

[b] Costs to construct landfill cells only; operating and maintenance facilities not included.

[c] Costs were derived from internal estimates for other projects, which are not publicly available.

[d] Adjusted cost includes an additional 30% markup to account for cost inflations for materials shipping and storage in Alaska.

The landfill construction for Anchorage was a landfill cell expansion project; therefore, the costs did not include the construction of operational buildings for staff or equipment or other components for new landfills that would add to the costs. In contrast, the Kodiak landfill project is more comparable to what would be required in Juneau. The construction cost for the Kodiak landfill included major access roads and a dedicated leachate treatment plant with operations control rooms for staff. Since the lined landfill cells generated large volumes of leachate that could not be processed by the existing wastewater treatment plant, a new leachate treatment plant was necessary. Similarly, a new landfill in the CBJ may need its own leachate treatment plant if the existing wastewater treatment plant cannot handle the leachate treatment, leading to higher construction costs that are comparable to those of the Kodiak landfill. In addition, similar to Kodiak, factors such as high rainfall, glacial soils, remote location, and seasonal weather events leading to construction delays will increase capital costs for a new landfill in the CBJ.

Based on the examples in Table 5 and assuming the higher range of per-unit construction costs, the estimated construction cost ranges for the landfill footprint are as follows:

- 50-year landfill: $50 million to $162 million (2025$)
- 100-year landfill: $99 million to $323 million (2025$)

The landfill costs can vary significantly depending on the operating conditions and geometry of the landfill, so the provided estimates are conservative.

Because a landfill is built in stages, a reasonable assumption at this time would be that up to half of this cost would be paid up front. The initial capital outlay could be much lower than the total capital costs identified above, as these capital costs are provided as a conservative estimate for landfill cell

[12] Approximate range based on industry practice.

construction. Additional capital for future landfill cell construction could be accrued as part of tip fees. These estimates also do not factor in excessive construction additions such as major roads, utility connections, bridges, water management, or geotechnical needs for the site, which could add considerable costs.

When a landfill is at capacity, the landfill must be capped and covered, the costs for which are not included in these capital cost estimates. Post-closure requirements include a minimum of 30 years of ongoing monitoring and reporting.

3.5 Waste-to-Energy Facility

A WTE facility uses waste as fuel to initiate the conversion of combustible waste into electrical power under tight environmental controls. WTE can reduce the volume of landfilled materials by up to 90% and requires a smaller footprint compared to landfills. However, given the relatively low waste tonnage within the CBJ, diversion practices such as recycling and composting will need to be minimized to maximize operating efficiency. Additionally, WTE facilities also can mitigate issues related to odor and wildlife attraction because the waste is enclosed. A facility that recovers and utilizes combined heat and electricity will have similar limitations.

A siting study is needed to evaluate potential locations. Interconnecting the WTE facility involves considerations such as connecting to transformers and transmission lines, ensuring reliability during emergencies, having backup energy sources, managing peak and deficit periods, and assessing the energy's value. The facility must be near the existing power infrastructure or have space for new transformers, roads, and utilities. Early consultation with CBJ's public utilities company, AEL&P, is essential for siting and costing the WTE facility.

3.5.1 Capacity and Sizing

Fewer than 10% of WTE facilities in the United States are designed to process less than 200 tpd of waste. In contrast, 60% of these facilities handle more than 800 tpd of waste (Michaels and Krishna 2018). Constructing and operating larger facilities likely offers improved economics due to economies of scale. At just 100 tpd of waste generated in Juneau, the CBJ will likely want to consider minimizing diversion and routing all combustible recyclables to the WTE system to make it economical, and even so would likely suffer from low thermal efficiency and power output. Adding regional waste could add approximately 77,000 tpd (23,000 tpy) but will also require increased inter-regional shipping options (Southeast Conference 2006). The design and capacity of the WTE plant is further impacted by parameters of the selected technology, such as the boiler system pressure, type of condensing device (air or water cooled), heat source to pre-heat combustion air, and the number of boilers and turbines.

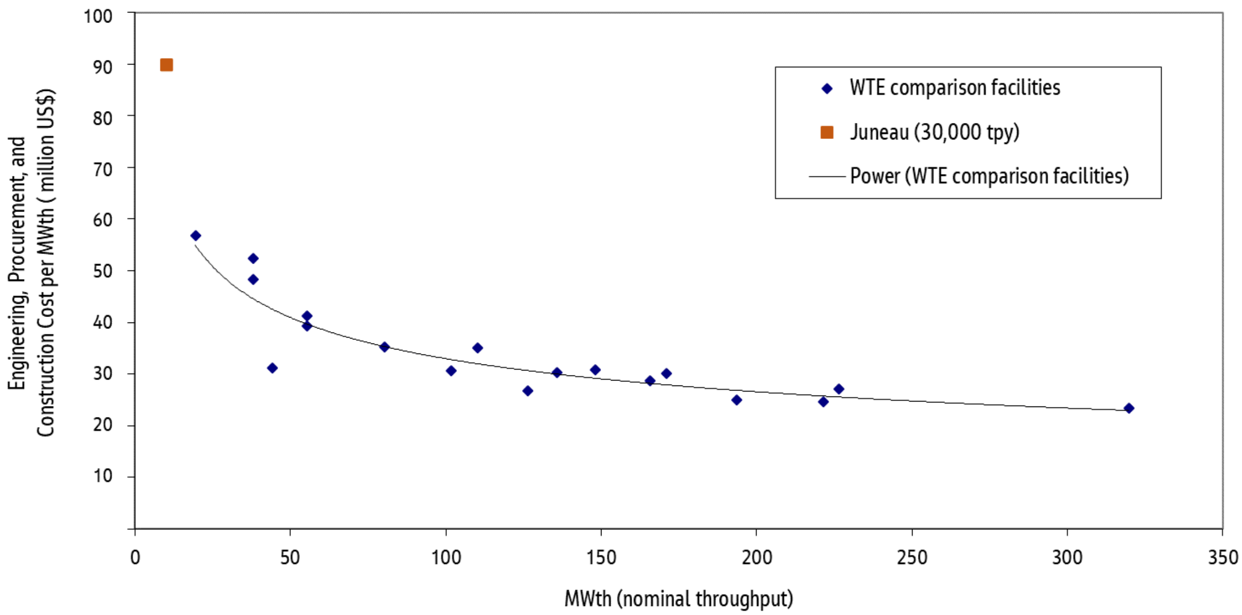
3.5.2 Construction Costs

Figure 2 depicts the forecasted construction cost for a small WTE facility to process 30,000 tpy of MSW at approximately $90 million (2025$).[13] It is notable that facilities of this small capacity are limited, and the dataset used to generate the estimate did not include any facilities below an annual waste throughput of 60,000 tpy, which may introduce additional uncertainty to the estimate. Construction costs for WTE plants will be impacted predominantly by the size and capacity of the facility and the caloric value of the waste

[13] This estimate is considered an order-of-magnitude Class 5 as defined by the Association for the Advancement of Cost Engineering International (AACE International) with a range of accuracy between +100% to -50%. An additional 30% markup was added to account for cost inflations for materials shipping and storage in Alaska. The capital cost for a WTE facility was derived using different estimating methods than for a landfill and transfer processing facility, and the variability in the estimate is reflected in this range of accuracy. All cost estimates should be reassessed for budgeting and financing.

stream. The calculations for the 30,000 tpy facility used a calorific value of 9.2 megajoules per kilogram, which is typical for MSW in the U.S. The CBJ's waste likely will have a higher moisture content, leading to a lower heating value.

Figure 2. Modeled Engineering, Procurement, and Construction Costs per Megawatt of Nominal Throughput



These estimated capital costs are for the initial cost of the facility and do not include equipment replacement costs, which typically occur every 5 to 20 years, or infrastructure repairs, typically every 50 to 75 years.[14] The highly complex nature of WTE systems could increase the frequency of facility or equipment replacement. These estimates also do not factor in excessive construction additions such as roads, utility connections, bridges, water management, or geotechnical needs for the site, which could add considerable costs.

As the power trendline in Figure 2 indicates, there is an economic benefit of constructing large facilities with the capacity to produce approximately 100 megawatts or more of thermal energy (MWth). For example, in 2019, Anchorage, Alaska, estimated that a WTE facility constructed to manage greater than 300,000 tpy of MSW would cost approximately $322.7 million (2019$) (Municipality of Anchorage 2019). In contrast, the municipality of Skagway operates a batch load incinerator to process just 1,300 tpy of waste (Respec 2024). Batch load incineration processes, preferred over continuous systems for smaller communities, use a dual-chamber system with intermittent burning and cooling periods, requiring a smaller footprint and fewer pollution control systems. The total construction cost for this facility was $2.4 million (1998$) (Southeast Conference 2021). As a simple comparison, the facility costs per ton of waste managed by the facility are as follows:[15]

- Anchorage: $322.7 million/300,000 tpy = $1,076 per ton (2019$)
- Skagway: $2.4 million/1,300 tpy = $1,846 per ton (1998$)

[14] Approximate range based on industry practice.

[15] Provided as a high-level comparison to illustrate the impact of economies of scale on WTE facility costs. The actual cost per ton for a WTE facility is affected by several factors, including the caloric efficiency of the waste stream, operational expenses, revenues from power generation, and additional considerations not included in this simplified calculation.

Despite more than 20 years of inflation, differing regulatory requirements, and advancements in technology, the per-ton cost to construct the smaller Skagway facility was approximately 70% higher than the estimate for the Anchorage facility.

4. Regulations and Permitting

Regulations impacting the design, construction, and operation of new solid waste management facilities affect the feasibility of each scenario. These facilities must comply with federal, state, and local regulations on land use, air quality, waste handling, and stormwater management. If discharging liquids into the municipal sanitary sewer system, wastewater monitoring and pretreatment may be required. This section summarizes the key components and highlights major regulations and permitting. A comprehensive list of relevant regulations and permits is provided in Appendix A. Key considerations for regulations and permitting are listed in the following sections.

The U.S. Environmental Protection Agency (EPA) has authorized Alaska to implement federal landfill requirements under the Resource Conservation and Recovery Act (RCRA), Subtitle D. All facilities must adhere to the National Pollutant Discharge Elimination System, the Clean Air Act, and state and local permits for siting, design, construction, and operation.

4.1 Waste Storage, Disposal, and Operations

Municipal solid waste landfills in Alaska must adhere to state permitting requirements for waste disposal management, including applying for a waste disposal permit and complying with siting, design, and operating standards, as defined by the ADEC under Title18 of the Alaska Administrative Code (AAC), Chapter 60, including requirements for landfill location, liners, leachate collection and removal, operating practices, stormwater controls, groundwater and landfill gas monitoring, landfill closure, post-closure requirements, and financial assurance.

Transfer facilities must comply with waste accumulation, storage, and treatment requirements for nuisance, animals and vector control, and runoff requirements (18 AAC 60.010). There also may be waste storage limits anticipated in the permits for transfer and WTE facilities. Owners or operators of landfills are required to provide financial assurance for the cost of landfill closure and post-closure under 18 AAC 60.265, which should be considered alongside an assessment of the operating model.

4.2 Environmental and Hydrology

If federal funding is secured for the construction of a future solid waste disposal facility, it may trigger the National Environmental Policy Act of 1969 (NEPA), which is a federal law that establishes a national policy for protecting the environment. The project proponent (CBJ) will be the entity responsible for NEPA compliance; this process typically involves partner engagement, environmental review, and some level of permitting depending upon the site location. The NEPA process addresses a broad grouping of environmental and cultural resource impacts, which could obstruct development of a new project.

Stormwater and regional hydrology, along with consistent high precipitation, would need to be considered during the design, construction, and operating stages of all facilities to ensure site stability and proper drainage. If stormwater runoff from the site reaches surface waters, an Industrial Stormwater Permit, which includes a Stormwater Pollution Prevention Plan and the application of control measures, would be necessary.

4.3 Air Quality

Subtitle D of RCRA and the Clean Air Act are the typical federal regulations to control pollutants and ensure air quality standards. The EPA requires that landfill gas is controlled by converting it to energy, by collecting and selling it, or by flaring it to convert methane into carbon dioxide (dependent on operating size). Furthermore, if a landfill generates 25,000 metric tons or more of carbon dioxide equivalent annually, it must report greenhouse gas emissions through the EPA's Greenhouse Gas Reporting Program.

Air quality regulations tend to be the primary concern for WTE facilities in particular. The EPA New Source Performance requires enhanced air emissions monitoring for new WTE facilities, and ADEC has adopted these standards by reference under 18 AAC 50.040. In addition, all facilities subject to federal emission standards of the Clean Air Act must obtain a Title V Operating Permit. Particulate matter in the form of fugitive dust and fly ash, as well as noxious gases such as hydrogen chloride, sulfur oxides, volatile organic compounds (VOCs), hazardous air pollutants (HAP), and nitrogen oxides, are regulated under an operating permit and thus must be controlled from WTE facility emissions. WTE facilities use various air pollutant control technologies to eliminate these emissions, including scrubbers, filters, and reaction vessels. Continuous monitoring may be required to demonstrate that emissions are within air quality limits. A minor permit through ADEC is required for facilities with the potential to emit over permit thresholds and with a capacity greater than 1,000 pounds per hour (18 AAC 50.050(a) and (b)). Locally, the Mendenhall Valley Area has a Particulate Matter Maintenance Plan that might need to be considered during design, operation, and monitoring.

The future of federal air pollution regulations for municipal combustion facilities is unknown; the EPA has delayed the final update to air pollution regulations for large municipal waste combustors until December 22, 2025 (Wallace 2024a). Political opposition and regulatory changes could be an ongoing barrier to the success of WTE facilities in the United States (Wallace 2024b; Senior 2024).

4.4 Ash

For WTE facilities, ash consists of remaining solids that were not converted to energy during combustion. Typically, ash makes up 5 to 15% of the volume of processed MSW. If ash generated from waste combustion exceeds toxicity limits under 40 *Code of Federal Regulations* Section 261.24, it is considered a hazardous waste and must be considered as such when preparing it for transportation to offsite disposal. This situation is common. However, even if the ash does not exceed toxicity limits, it is still considered a nonhazardous secondary material and may require special permitting and disposal precautions (EPA 2024).

4.5 Timeline Considerations

Public opposition often makes it difficult to site new solid waste facilities, particularly landfills and WTE plants, near population centers because of concerns about nuisances, visual impacts, and potential health and safety risks (EPA 2002). NEPA and the public engagement and hearing processes for permits typically are the primary avenues for capturing these concerns. Therefore, permitting any type of solid waste facility can take many years, or even decades, because of multiple stages of review, partner engagement, public consultation, and potential legal challenges. If a NEPA process is not triggered, a public comment period of at least 30 days is required by ADEC to ensure the public has an opportunity to provide input on applicable permits. There could be a range of other public comment, meetings, or involvement cycles depending on the nature of construction, such as whether land use designation changes are required or the extent of air permits required. In general, regardless of NEPA, the CBJ should anticipate the permitting timeline to be a multi-year process with project siting, design, regulatory review, and public engagement.

Generally, in Jacobs' experience, transfer station permitting is less complex and, therefore, more streamlined than landfill and WTE permitting. Permitting is just one aspect of site development, which also includes siting, design, construction, and startup. Jacobs typically observes the following general timelines:

- Developing a new transfer station typically takes at least 5 years, assuming the site has been selected and includes design, permitting, construction, and startup.
- New landfill development usually takes 7 to 10 years, with siting being a major variable. Some projects have taken more than 30 years because of delays in siting and permitting.
- WTE facilities are rarely developed nationwide, and none have been developed in Alaska to date; as such, the design process is complex, and the permitting cycles are not clearly defined. It is expected that permitting for a WTE facility would take at least as long as a landfill, if not longer. Preconstruction air quality monitoring and permitting alone can take 3 years or more.

5. Summary and Recommendations

This study provides an initial, high-level evaluation of three solid waste management scenarios. Table 6 outlines the estimated capital costs, pros, and cons for each scenario discussed in Sections 2 through 4 and also provides a relative feasibility ranking based on the following criteria agreed to with the CBJ as part of the project kickoff and as refined over the course of the project:

- Relative estimated capital costs and discussion of operating cost components
- Overall environmental impacts
- Ability to address waste streams and the CBJ's goals for diversion

Table 6 separately lists the capital costs, and the remaining criteria are included as part of the overall pros and cons. Community and key partner buy-in will be addressed by the CBJ separately from this high-level feasibility evaluation. Additionally, all the alternatives seem to be feasible from a regulatory standpoint, although their complexity and timelines will differ. The rankings are subject to change as the CBJ investigates funding opportunities and offsite shipping contracts.

Table 6. Pros, Cons, Cost Ranges, and Relative Feasibility Rankings for Each Scenario

Scenario	Capital Cost Range[a]	Pros	Cons	Feasibility Ranking
A. Construct a new landfill and transfer processing facility with recyclables sent south by barge for diversion.	Transfer Processing Facility = $9 million – $20 million 50-year Landfill[b] = $50 million – $162 million **Total = $59 million – $182 million**	▪ High level of control over operating costs, rates, and solid waste flow.	▪ Construction of a new landfill is expensive. ▪ Siting and permitting likely to take an extensive amount of time. ▪ Operating costs would be sustained by the CBJ unless the CBJ enters into an operating agreement with a private company. ▪ Leachate treatment and stormwater management could be a significant cost factor.	2
B. Construct a transfer processing facility with waste and recyclables sent south by barge for recycling and disposal.	**Transfer Processing Facility = $14 million – $40 million** (offsite shipping costs negotiated in transportation contract)	▪ No capital costs to construct a new solid waste management facility. ▪ Minimal regulatory requirements without a landfill or WTE facility.	▪ Offsite transportation costs, impacts, and availability of markets to accept material are outside of CBJ control; exposure to financial risks. ▪ Operating costs are transferred into higher fees from the hauler and operator.	1
C. Construct a WTE facility and transfer processing facility for MSW with noncombustibles, recyclables, and ash sent south by barge for disposal.	Transfer Processing Facility = $9 million – $20 million WTE = $90 million[c] **Total =** **$99 million – $110 million**	▪ High level of control over operating costs, rates, and solid waste flow. ▪ Minimizes solid waste volume and land use impacts.	▪ Diversion would likely be minimized to optimize efficiency of energy recovery. ▪ No potential for revenue from net metering. ▪ Does not improve the renewable energy profile for the CBJ. ▪ WTE requires a high level of expertise and is more expensive to construct and operate than the other scenarios.	3

[a] Capital costs are not applied over the same time period across all scenarios. For example, the landfill capital would be applied over a 50-year period, while the transfer station and WTE may require significant replacement capital over the same 50-year period. Assessment of these factors would be completed with a more comprehensive economic analysis.

[b] Landfill construction costs are calculated based on the estimated size and capacity of a 50-year landfill for the CBJ. Costs can vary significantly depending on the operating conditions and geometry of the landfill. The provided estimates are conservative.

[c] This estimate is considered an order-of-magnitude Class 5 as defined by AACE International with a range of accuracy between +100% to -50%. The capital cost for a WTE facility was derived using different estimating methods than for a landfill and transfer processing facility, and the variability in the estimate is reflected in this range of accuracy.

5.1 Feasibility Discussion

As described in Section 5 above, Jacobs and the CBJ have assigned the following relative feasibility ranking of the three scenarios in Juneau[16]:

1. Scenario B: Construct a transfer processing facility with waste and recyclables sent south by barge for recycling and disposal.
2. Scenario A: Construct a new landfill and transfer processing facility with recyclables sent south by barge for diversion.
3. Scenario C: Construct a WTE facility and transfer processing facility for MSW with noncombustibles, recyclables, and ash sent south by barge for disposal.

Considering that 30,000 tpy of solid waste is generated in Juneau, Scenario C is the least desirable and feasible of the three scenarios because of the high relative cost of constructing and operating a small capacity WTE facility, particularly without an energy benefit for Juneau (AEL&P does not provide energy credits for surplus generation). Additionally, a WTE facility would require specialized labor and technologies that may not be available locally and thus are anticipated to increase the costs of construction and operation.

A transfer processing facility would provide many benefits for the CBJ and is a key component of all three scenarios. A transfer processing facility provides the following:

- Offers an interim waste management solution while the CBJ pursues additional siting, design, permitting, and construction for a local landfill or WTE facility, if desired.
- Enables the CBJ to quickly adapt to a sudden influx of disaster debris, tourism waste, or changing waste management needs as the landfill reaches capacity.
- Provides a one-stop-shop for residents and contractors, reducing vehicle traffic from waste collections and hauling to disposal facilities, cutting fuel and transportation costs, reducing emissions, and addressing safety and environmental concerns.
- Provides flexibility to consolidate recycling operations, increase waste diversion practices, and adapt practices for changing recovery and recycling markets.
- Could enable regional waste management partnerships and diversion opportunities.

Ideally, the facility would have sufficient space to expand, in case Scenario B is later determined to be the best long-term solution. The CBJ may consider establishing drop-off and processing areas for all MSW, recycling, organics, C&D, white goods, and bulky waste to enhance efficiency and waste diversion. The CBJ also has proposed a reuse staging area to provide storage and processing for repair, restoration, and other processing activities to encourage reuse and repurpose activities for diversion. Adding these services likely would increase the size estimates for the transfer processing facility.

Scenario A provides the CBJ with greater control over future waste diversion, MSW management, and risk mitigation, which is particularly advantageous during sudden waste influxes, such as the disaster debris from the 2023 and 2024 glacial outburst flood events. However, the capital costs for constructing a new landfill may be prohibitively high if funding is not available. Therefore, the CBJ should consider developing funding options for landfill development while simultaneously engaging in discussions with shipping providers and offsite landfills to negotiate contract terms and rates for offsite shipping and disposal. This

[16] The rankings are subject to change as the CBJ investigates funding opportunities and offsite shipping contracts.

will allow for a detailed comparison of long-term costs and help determine the breakeven point between Scenarios A and B.

Economic barriers lower the feasibility ranking of Scenario C because the small quantity of waste generated in the CBJ would make a WTE facility inefficient. In addition, the energy produced would not benefit the CBJ given its current renewable energy mix. The CBJ may choose to re-evaluate the feasibility of WTE under new conditions, such as incorporating additional waste streams, or exploring options for combined heat and power generation, or using the energy to power other nearby facilities.

Based on economies of scale, it is more cost-effective to build and operate landfills that can manage large volumes of waste from a broader geographic area. Consequently, there has been a trend toward regional landfills during the past 20 years. Since 2006, the Southeast Conference and the SEASWA have explored regional solutions for remote communities in southeast Alaska (Southeast Conference 2006). Juneau produces more waste than all nine SEASWA communities combined, potentially making a regional disposal approach more viable. However, transportation challenges have been a major barrier to implementing a regional strategy. If desired, the CBJ may choose to continue discussions with SEASWA regarding the potential for a regional landfill or WTE facility.

While this memorandum outlines the key considerations and differentiating factors for the three waste management scenarios, several factors outside the scope of this review may impact capital costs, operating costs, and customer rate changes. For instance, the following aspects could affect the overall financial viability of these scenarios:

- **Limited Construction Season and Long Lead Times**: Alaska's construction season is limited because of weather and, even during the construction season, the CBJ experiences frequent rain delays. Combined with the need to have materials ready when needed, there is a resulting long lead time to order materials and a resulting need to store them securely, which adds expense.
- **Location Accessibility**: Shipping costs can vary significantly depending on whether the project is on the Alaska road system, near a port, or only accessible by cargo aircraft. Additionally, the most cost-effective shipping methods may only be available during the summer.
- **Number of Bidders**: Projects with only one bidder often incur higher costs compared to those with at least three bidders. Because of its geographic isolation, there tend to be fewer contractors responding to bid opportunities in Alaska, particularly for specialty services. There may be additional transportation and lodging costs incurred to bring in out-of-state contractors.
- **Local Housing and Food Services**: The availability of local housing and food services can impact costs. If these are not available, contractors may need to provide housing and kitchen services onsite.
- **Liquidated Damages and Construction Schedule**: The amount of liquidated damages agreed upon in the construction contract and the feasibility of the construction schedule without extra effort from the contractor can affect costs. Sometimes, extending the schedule by a year is a more practical decision.
- **Pre-engineered Buildings and Equipment Lead Times**: If the project includes a pre-engineered building, delivery times can add up to a year to the project timeline. Recently, long lead times for electrical equipment have been a significant factor for construction projects throughout the U.S., not just in Alaska.
- **Ownership and Operation Model:** The ownership model, as described in Section 3.2, will impact the CBJ's share of capital and operating costs.

Consequently, the actual costs may vary; detailed scopes and cost estimates are necessary before making financial decisions or setting final budgets. The CBJ should consider the feasibility of compliance with the financial assurance requirements of 18 AAC 60.265.

5.2 Next Steps

With the current landfill near capacity, time is pressing; thus, Jacobs recommends the following next steps:

1. Decide whether to stay with the "status quo"—leaving all solid waste disposal decisions in Juneau to the private sector with no public involvement—or have the CBJ and the community gain a level of control over the solid waste system by owning a future disposal facility via one of the ownership models described in Section 3.2.
2. Proceed to develop a transfer processing facility that can be used regardless of the scenario selected with design considerations for future expansion.
3. Engage with shipping partners to evaluate the capacity of the current shipping facility and network to further evaluate the feasibility of Scenario B and to begin assessing the contractual requirements.
4. Estimate the present value cost and associated service cost (tipping fees and collection fees) for Scenarios A and B (including operating costs). Consider a lifecycle cost evaluation of one or more scenarios that enables a more robust comparison.
5. Evaluate waste facility and program ownership, operations, and revenue to implement the desired scenario(s).
6. Assess the CBJ community interest in landfill options through public discussions and workshops. Early public engagement through outreach, education, and opportunities for input is crucial to ensure community participation and support for these initiatives.
7. Based on the findings from Steps 3 through 6, reconsider locations, funding options, and feasibility to construct a landfill for Scenario A, which would provide the CBJ with a higher level of control over future solid waste disposal costs and diversion relative to Scenario B.

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Appendix A

Applicable Federal, State, and Local Regulations

Name	Relevant Section(s)	Summary	Applicable Facility
Federal Regulations			
EPA Air Quality Requirements - Incinerators	40 CFR 60, Subpart AAAA, Standards of Performance for Small Municipal Waste Combustion Units	Establishes new source performance standards for new small municipal waste combustion units with a capacity greater than 35 tons per day but less than 250 tons per day.	Waste-to-Energy
	40 CFR 60, Subpart EEEE, Other Solid Waste Incinerators	Other Solid Waste Incinerators are very small MSW combustion units with a capacity less than 35 tons per day. Exemption from federal standard if the incinerator qualifies as a small power production facility under section 3(17)(C) of the Federal Power Act, though permitting could be required through Federal Power Act requirements.	Waste-to-Energy
EPA Air Quality Requirements - Major Source Operating Permit	Title V Operating Permit for Air Quality under the Clean Air Act (covering federal and state requirements)	Alaska has adopted Subparts WWW, HH, EEEE, and AAAA by reference in state regulations. Facilities are subject to comply with other applicable Subparts that are not adopted by reference.	Landfill, Waste-to-Energy
EPA New Source Review	New Source Review preconstruction permit for new or modified sources under the Clean Air Act	Preconstruction air quality review requirement for construction permits. Prevention of Significant Deterioration permits required for new major sources in accordance with National Ambient Air Quality Standards. Nonattainment permits require installation of the lowest achievable emission rate, emission offsets, and an opportunity for public involvement. A Minor New Source Review applies for facilities that do not require the permits identified above. ADEC issues the applicable permit before construction begins, then requests a Title V operating permit application within 6 months if there is potential for emissions that crosses operating permit thresholds.	Waste-to-Energy
RCRA Requirements - Subtitle D	40 CFR 239 - 259 Solid Waste	Major criteria for municipal landfills in 40 CFR Part 258 (location, liners, leachate collection/removal, operating practices, groundwater monitoring, closure and post-closure, corrective action, financial assurance) 40 CFR Part 240 applies to thermal processing facilities designed to process 50 tons or more per day of municipal-type solid wastes The EPA has authorized Alaska to implement federal landfill requirements under RCRA Subtitle D	Landfill, Waste-to-Energy
RCRA Requirements - Standardized Permit	40 CFR 124 Subpart G - Procedures for RCRA Standardized Permit (Hazardous Waste)	Eligible when: (1) the facility generates hazardous waste and then store or non-thermally treat the hazardous waste on-site in containers, tanks, or containment buildings; or (2) You receive hazardous waste generated off-site by a generator under the same ownership as the receiving facility, and then you store or non-thermally treat the hazardous waste in containers, tanks, or containment buildings. Exemption for small quantity generators who generate less than 1,000 kg of hazardous waste and less than 10 kg of acutely hazardous waste per month.	Consider for Transfer Processing Facility, dependent on hazardous waste generation
NEPA Requirements	Applies when federally permitted or funded (ex: if Title V applies)	Environmental Impact Statement or Environmental Assessment prior to construction	Landfill, Transfer Processing Facility, Waste-to-Energy
NPDES Requirements - General Permit	40 CFR 122 Subpart B (Permit application 122.21,Stowmwater discharges 122.26, General permits 122.28)	Dependent on point (40 CFR Part 445 for landfills) vs non-point discharge, and where discharge occurs (surface water, stormwater system, publicly owned treatment system).	Landfill, Transfer Processing Facility, Waste-to-Energy
NPDES Requirements - Industrial Stormwater Permit	40 CFR 122.26(b)(14)(v): Landfills and Land Application Sites - for runoff from landfills to surface water.	Stormwater Pollution Prevention Plan, implementation of control measures, and submittal of request for permit coverage (NOI)	Landfill, Transfer Processing Facility, Waste-to-Energy
EPA National Pretreatment Program	40 CFR 403 - federal leachate pretreatment requirements	Facilities that discharge leachate into a POTWs must comply with regulations (limiting pollutant concentrations - like heavy metals, pH levels, and other contaminants)	Landfill
ADEC Waste Disposal Management 18 AAC 60			
State Class Number	18 AAC 60.300 Purpose, scope, and applicability; classes of Municipal Solid Waste Landfills	23,000 tons annually ~ 63 tons/day, Class I landfills "accepts, for incineration or disposal, 20 tons or more of municipal solid waste and other solid wastes daily, based on an annual average"	Landfill
Accumulation, storage, and treatment	18 AAC 60.010 for transfer stations designed to hold >20 cubic yards of waste	Nuisance, animal, disease vector control, and runoff requirements (18 AAC 60.010(f)).	Transfer Processing Facility
State Waste Disposal Permit	18 AAC 60.200	Permit application (18 AAC 60.210), design approval (18 AAC 60.203), approved liner & leachate system (18 AAC 60.213), and additional requirements (18 AAC 60.217 - 18 AAC 270)	Landfill
State Siting (Location) Standards	18 AAC 60.305 - 18 AAC 60.320	Airport runway proximity (18 AAC 60.305), floodplains (18 AAC 60.310), wetlands (18 AAC 60.315), fault areas and seismic zones (18 AAC 60.320)	Landfill
State Design Standards	Established in 18 AAC 60.330 (supplement 18 AAC 60.220 – 18 AAC 60.230)	The department will consider hydrogeologic characteristics, climatic factors, and the volume and physical and chemical characteristics of the leachate.	Landfill
State Operating Standards	Must be applied in conjunction with 18 AAC 60.220 – 18 AAC 60.240, and are established in 18 AAC 60.335 – 18 AAC 60.380	Liquid restrictions (18 AAC 60.360), co-disposal of sewage solids (18 AAC 60.365), corrective action (18 AAC 60.375), recordkeeping (18 AAC 60.380)	Landfill
State Groundwater Monitoring Standards	18 AAC 60.820 - 18 AAC 60.860	Groundwater monitoring and corrective action requirements if the facility has potential to discharge to an aquifer.	Landfill
ADEC Air Quality Control 18 AAC 50			
Air Quality Requirements - Incinerators	18 AAC 50.050(a) and (b)	Permit Required when the incinerator capacity is >1,000 pounds per hour.	Waste-to-Energy
New Source Performance Standards	18 AAC 50.040	Alaska has adopted Federal standards by reference in state regulations	Waste-to-Energy
Minor Air Permit	18 AAC 50.502 – 18 AAC 50.560	Required when a new source has the potential to emit >15 tons per year of PM-10 or >10 tons per year of PM-2.5.	Landfill, Transfer Processing Facility (unlikely to apply, but consider for fugitive dust), Waste-to-Energy

Name	Relevant Section(s)	Summary	Applicable Facility
ADEC Environmental Discharge Permits			
Construction General Permit	The 2021 Construction General Permit became effective on February 1, 2021 and will expire on January 31, 2026.	Large and small construction-related activities that result in a total land disturbance of >= 1 acre and where those discharges enter waters of the U.S. (directly or through a stormwater conveyance system) or a municipal separate storm sewer system (MS4) leading to waters of the U.S. subject to the conditions set forth in the permit.	Landfill, Transfer Processing Facility, Waste-to-Energy
Alaska Pollutant Discharge Elimination System	18 AAC 83.990, effective April 2024	Facility operator must apply for permit if discharging to surface waters or land, including wastewater and storm water discharges.	Landfill, Transfer Processing Facility, Waste-to-Energy
Local City and Borough of Juneau Regulations and Concerns			
Mendenhall Valley Area Particulate Matter Maintenance Plan	18 AAC 50.030(a)(2) adopts by reference the Code of the City and Borough of Juneau, Alaska, Chapter 36.40 Serial No. 2008-28, sec. 2	Purpose to respond to increases in particulate matter releases less than 10 microns in diameter (PM-10)	Landfill, Transfer Processing Facility (unlikely to apply, but consider for fugitive dust), Waste-to-Energy
City of Juneau Code of Ordinances	75.20.080 - Use of public sewers; regulations. 75.02.090 - Prohibited discharges.	75.20.080(d) - Where preliminary treatment facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at the owner's expense. Preliminary treatment facilities shall not be permitted for or in residential neighborhoods.	Landfill, Transfer Processing Facility, Waste-to-Energy
City and Borough of Juneau Permits	Development Permit, City/State project and Land Action Purview, Floodplain Development, Flood Zone Exemption, Noise permit	Dependent on construction, operation, and location of facilities.	Landfill, Transfer Processing Facility, Waste-to-Energy

EPA = Environmental Protection Agency
RCRA = Resource Conservation and Recovery Act
NEPA = National Environmental Policy Act
ADEC = Alaska Department of Conservation

Resource and Energy Recovery Opportunities from Waste in Juneau, Alaska

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March 21, 2025

Introduction

The City and Borough of Juneau, Alaska has engaged with NREL through the Waste-to-Energy (WTE) Technical Assistance program to provide subject-matter expertise concerning options for waste resource and energy recovery from the City's municipal solid waste (MSW) resources. Initial motivation for the study stems from concerns regarding landfill availability and options for waste minimization with the goal of a zero-waste outcome at some point in the future.

This study provides a high-level overview of available options with the objective of helping to identify potential technology solution pathways. It focuses primarily on WTE technologies, including biological, thermochemical, and mechanical conversion processes that generate energy or energy products from waste. While some technologies overlap with resource recovery, the assessment does not cover conventional recycling or other dedicated resource recovery strategies. By concentrating on energy-producing solutions, this study provides a targeted evaluation of alternative waste management options that align with Juneau's broader energy and economic priorities.

Waste Composition and Quantity

A MSW characterization for Juneau was completed and published by Cascadia Consulting Group in 2023, providing data to inform this analysis.[1] The waste was originally grouped into four categories: recyclable, compostable, recoverable, and reusable. For this study, those classifications have been restructured to align with resource recovery and WTE conversion technologies, as follows:

- Organics (largely food waste)
- Paper and cardboard
- Metal
- Plastics
- Wood (including construction and demolition [C&D] wood)
- Tires
- Textiles

Assumptions and restrictions: In the case of plastics, it is assumed that no attempt will be made to recover recyclables such as PET, PP, PS, and HDPE plastics[2] from the waste stream; indeed

[1] City and Borough of Juneau Waste Characterization Study (2024), Cascadia Consulting Group, https://juneau.org/wp-content/uploads/2024/10/Juneau-Waste-Characterization-Study-2024-Report_2024-10-8.pdf

[2] PET = polyethylene terephthalate; PP = polypropylene; PS = polystyrene; HDPE = high-density polyethylene

these recyclable plastics comprise less than 2% of the total waste stream and costs to implement sorting for purposes of recovery of recyclable plastics are likely to be greater than revenue Some textiles contain significant amounts of materials that could also be classified as organics (e.g., cotton, wool) or plastics (e.g., synthetic performance fabrics). Carpet falls into this mixed-material category as well; however, due to the lack of detailed composition data—and because carpets can be made from either synthetic (e.g., nylon) or natural (e.g., wool) fibers—it has been excluded from the Textile category. This analysis does not include other potentially available waste streams—such as wastewater treatment solids—which could offer additional feedstock for some of the WTE pathways under consideration.

Waste resources quantity: The City and Borough of Juneau disposed of 22,346 tons of waste in 2023 consisting of a composite from commercial, residential, and self-haul sources (Table 1). A more detailed composition of the City's MSW waste stream is presented in Table A1 (Appendix). Some of the data have been excluded from this analysis (called out in the footnotes to Table 2) as being either not relevant or poorly defined. The majority (approximately one third) of the waste is classified as organics (e.g., food waste, yard trimmings) and almost half is comprised of organics and paper/cardboard which are excellent feedstocks for many resource recovery and WTE technologies. This breakdown is important and will be used to inform the analysis of each technology pathway under consideration.

Table 1. Composition and Quantity of MSW Generated in City and Borough of Juneau

Type	Organics	Paper & Cardboard	Metal & Glass	Plastics	Clean Wood	Tires	Textiles	Other*	TOTAL
Tons/Y	6,053	4,312	1,824	2,084	2,149	134	2,202	3,588	22,346
%	27	19	8	9	10	0.5	10	16	100

*Other materials include e-waste, carpet, refrigerant-containing items, mattresses, household hazardous waste, etc.

Waste-to-Energy and Resource Recovery Technologies

The diverse waste streams in Juneau present opportunities for WTE and resource recovery technologies. WTE and resource recovery are related but not identical concepts. Both aim to extract value from waste and reduce landfill disposal. They often overlap, as some WTE technologies (e.g., anaerobic digestion) recover both energy and materials. While WTE focuses on converting waste into energy (electricity, heat, or transportation fuels), resource recovery emphasizes reclaiming valuable materials (e.g., metals, plastics, organics) for reuse or recycling. In an integrated waste management system, resource recovery typically comes first (e.g., recycling and composting), with WTE handling non-recyclable waste.

While some of these processes exhibit economies of scale, small-scale and modular applications may also be feasible. However, successful implementation of these technologies will require some level of waste sorting to ensure feedstock quality and process efficiency. Many WTE technologies perform best when waste is pre-sorted to remove contaminants and separate high-energy-value materials. Sorting can be accomplished through source-separation programs, material recovery facilities (MRFs), or a combination of mechanical and manual processing methods. Without proper sorting, contamination could reduce system efficiency, increase operational costs, and limit marketability of recovered resources.

Below is an overview of suitable WTE and resource recovery technologies for waste streams.

Biological conversion technologies are well-suited for processing organic waste, including food waste, animal manure, wastewater sludge, yard trimmings, and fats, oils, and greases (FOG). Once separated from other waste streams, these organics can be converted into valuable products through composting or anaerobic digestion. FOG could also be collected and provided to existing regional biodiesel or renewable diesel plants where FOG can supplement other feedstock, such as vegetable oils. Technologies for biodiesel and renewable diesel production are not evaluated in this analysis, but additional information is available upon request. Similarly, data on animal manure and wastewater sludge are not included here but can be provided if needed.

Composting is a biological process that takes place in an open-air environment where microorganisms break down biodegradable material in the presence of oxygen. The produced product is compost, which can be used as a soil amendment. With composting, no energy (e.g., biogas) is produced, and any energy required in the process must be supplied from an outside source. Composting results in a net greenhouse gas (GHG) emissions of negative 0.12 metric tons carbon dioxide equivalent ($MTCO_2E$) per ton of organics as compared to traditional landfilling. Potential revenue streams from composting include revenue from tipping fees, compost sale, and any relevant policy incentives. Generally speaking, a lower level of training is required to run a compost system versus an anaerobic digestion system.[3]

Composting can have different cost and land requirements depending on the system used. In windrow composting, organics are piled in long rows and the piles are periodically turned to aerate the system. While this system is the simplest, it also requires a large footprint, about 15 to 20 acres on average. Capital costs for windrow composting can be $4.3 million for a 30,000 ton per year system. Operating costs for a 30,000 ton per year system range from $437 to $765 thousand annually, while operating costs for a 25,000 ton per year system were found to be $362 thousand. Costs are listed in 2020$.[4]

In aerated static pile (ASP) composting, the piles are placed directly over an air source, providing air circulation without physical manipulation of the piles. ASP is moderate in complexity and has a smaller land footprint than windrow, about 6 to 8 acres on average.[5] Capital and operating costs for ASP systems of various sizes can be seen in Table 2.

[3] https://www.nrel.gov/docs/fy22osti/81024.pdf
[4] https://www.nrel.gov/docs/fy22osti/81024.pdf
[5] https://www.nrel.gov/docs/fy22osti/81024.pdf

Table 2. Capital & Operating Costs for ASP Composting Systems

System capacity (tons/year)	Capital cost (million USD)	Operating costs (thousand USD/yr)
1,800	1.7	247
5,200	2.6	NA
40,000	8.9	NA
180,000	25	1,000

NA – data not available. Data in 2020 USD[6]

In-vessel is the most compact system of composting, but also the most complex. Organics are confined within a building, container, or vessel, and thus air flow and temperature are better controlled. In-vessel composting has a small footprint, about 3 to 6 acres on average.[7] These systems come in a variety of sizes: as little as 100 pounds per day to over 10 tons daily.[8] Capital costs also vary depending on complexity and location. For example, the capital cost for a 1,000 pounds per day facility could be up to $850/ton.[9]

Ohio University, OH – In 2009, Ohio University, a public university of approximately 30,000 students, launched a solar powered in-vessel composting system. The system is designed to accept two tons of material per day, with an overall capacity of twenty-eight tons. The facility site includes a rainwater harvesting system to assist with system water needs and a 10-kW photovoltaic array, which provides roughly fifty percent of the electricity needed for operation. Capital costs for the facility were around $800,000 (2009USD). A 2012 expansion allowed for an additional four tons per day of processing capacity. Annual operating costs are about $225,000, with three employees running the facility.[10] More information about the project can be found at Ohio University's website.[11]

For more information on in-vessel composting, BioCycle has a guide on *In-Vessel Composting Options for Medium-Scale Food Waste Generators*. The guide contains important considerations, as well as a hypothetical case study, and a list of companies that sold mid-sized in-vessel composting units at the time of publishing.[12] Sustainable Generation also has a list of project profiles and case studies of locales utilizing GORE® covered compost systems.[13]

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[6] ttps://www.nrel.gov/docs/fy22osti/81024.pdf
[7] https://www.nrel.gov/docs/fy22osti/81024.pdf
[8] https://resource-recycling.com/recycling/2019/03/30/data-corner-the-ins-and-outs-of-in-vessel-composting/
[9] https://resource-recycling.com/recycling/2019/03/30/data-corner-the-ins-and-outs-of-in-vessel-composting/
[10] https://www.biocycle.net/site-large-scale-food-waste-composting/
[11] https://www.ohio.edu/facilities/grounds/compost
[12] https://www.biocycle.net/in-vessel-composting-options-for-medium-scale-food-waste-generators/
[13] https://www.sustainable-generation.com/project-profiles

Anaerobic digestion (AD) is a biological process in an enclosed environment where microorganisms break down biodegradable material in the absence of oxygen. The main product is biogas, a mixture of methane and CO_2, which is an intermediate that can be used to produce heat, electricity, or renewable natural gas (RNG). AD results in a net GHG emissions ranging from negative 0.04 to negative 0.14 $MTCO_2E$ per ton of organics as compared to traditional landfilling, depending on the type of AD – wet or dry – and whether the digestate is further cured or directly land applied. While AD requires energy input into the system, the energy can be supplied through its own production of biogas.[14] AD is widely practiced in cold weather climates such as Northern Europe. The low average annual temperatures in places such as Sweden and Finland can be accommodated by process design and recycle of waste heat from power generation.

Feedstocks for AD must be pre-sorted to remove inorganics such as glass and metal, as well as contaminants from C&D waste, including drywall. Plastics are non-reactive under AD conditions and should also be excluded. Several waste stream characteristics influence the feasibility of AD:

1. Organics: Well-suited for AD, with high moisture content (up to 50% by weight) that does not hinder the process.
2. Wood, paper, and cardboard: These materials are rich in recalcitrant biopolymers like cellulose and lignin, resulting in slow reaction rates and low biogas yields. However, pretreatment methods such as steam explosion can significantly improve their digestibility and gas production potential.[15]

Potential revenue streams from AD include revenue from tipping fees, selling electricity or RNG, and relevant incentives. It is important to recognize that the residual material from the AD unit (the digestate) may pose a disposal problem. Digestate is typically separated into a solid and liquid fraction. The amount of each fraction is difficult to estimate; solids are approximately equal to the fixed carbon content of the feedstock to the digester. The liquids can be re-used in the digester to some extent or for crop irrigation. The solid fraction can be used as fertilizer, animal bedding, or pelletized and used for heating, as well as used for construction material (e.g., fiberboard) and in other applications that can bring additional revenue.

Modeled capital and operating costs for AD systems of different capacities can be found in Table 3. The complexity of AD can vary depending on the system; newer systems, which have become easier to operate and maintain, have moderate complexity. A properly designed and operated AD system is very safe. However, strict gas handling standards must be maintained.[16]

[14] https://www.nrel.gov/docs/fy22osti/81024.pdf
[15] https://joneseng.com/additional-services/bioenergy/
[16] https://www.nrel.gov/docs/fy22osti/81024.pdf

Table 3. Capital & Operating Costs for Anaerobic Digestion Systems

System capacity (tons/year)	Capital cost (million USD)	Operating costs (thousand USD/yr)
2,500	3.0	85
5,000	4.7	171
25,000	12.3	854
50,000	18.6	1,707
100,000	28.2	3,415
200,000	42.7	6,830

Data in 2020 USD[17]

AD is generally less land intensive than composting, with a typical requirement of 3-6 acres. Modern systems can be even more streamlined to reduce their footprint. Since AD systems are fully enclosed, odors are contained. If the system is run inefficiently, such as in the case of digester spills, odor may occur. More information on AD can be found at Milbrandt, 2021[18].

Thermochemical conversion processes are effective for managing both solid and, to some extent, wet waste, including materials like plastics, tires, and wood (e.g., clean pallets, residential or utility tree trimmings, brush and branches from wildfire mitigation). Once separated, these materials can be transformed into valuable products through processes like combustion, pyrolysis, and gasification.

Combustion for Combined Heat and Power (CHP): In principle, simple combustion provides a feasible and low-cost solution that could be applied to woody feedstock. Combustion of biomass to generate heat and power is commercial technology. Recovery and/or sequestration or utilization of CO_2 from the combustor flue gas (carbon capture and sequestration [CCS]) is an option that could be considered for this application; however, further evaluation of the systems required to carry out CCS would be needed. Use of wood for CHP technology at small scale has been demonstrated and deployed broadly (e.g., hospitals, schools, and office buildings) and some examples are presented below.

New Hanover County, NC – New Hanover County began recycling pallets as part of its C&D recycling efforts in 2005. Pallets are collected along with mixed C&D waste at the county landfill at a cost to disposers of $59 per ton. Pallets and clean wood waste are sorted from the mixed C&D material until approximately 800 tons have accumulated, at which point pallets are ground using a contract grinder, and the mulch material is sold as boiler fuel. Costs to run the program are embedded in the total cost to manage a low-level C&D recycling operation. The C&D pad is operated by two landfill employees and the county negotiated a highly competitive rate for the grinding services[19].

Carson City, NV: In June 2009, the Northern Nevada Correctional Center (NNCC), located in Carson City, Nevada, completed installation of a $6.4 million biomass system. The CHP system

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[17] https://www.nrel.gov/docs/fy22osti/81024.pdf
[18] https://www.nrel.gov/docs/fy22osti/81024.pdf
[19] https://www.deq.nc.gov/environmental-assistance-and-customer-service/wooden-pallets/newhanovercounty/download

produces 1 MW of electricity and requires 16,000 tons of wood annually. The system is estimated to save the NNCC $1 million per year. The wood is sourced from slash piles created from forest management activities as well as landfills where it would otherwise be buried[20].

University of Idaho, ID - University of Idaho uses a district energy system to heat and cool the campus. In 1986 the university secured and built a wood chip-fueled boiler using wood waste/residues from lumber mills[21].

Pyrolysis: The process of pyrolysis consists of heating a material to temperatures in the range between (generally) 500 – 600 °C in the absence of air such that combustion does not take place. Feedstocks suitable for pyrolysis include dewatered wet waste (e.g., sludge), paper and cardboard, plastics, wood, tires, and textiles, which represent most of the waste resources considered in this study and available in Juneau. Products from thermal pyrolysis include char, non-condensable gases (largely carbon monoxide [CO] and CO_2 with some light hydrocarbons), and a condensable organic liquid known as bio-oil. This bio-oil retains much of the heating value of the feed biomass and could be used for generating electricity in either a steam or gas turbine or used for home or district heating. Pyrolysis can be classified as fast or slow process depending on the heating rate, temperature, residence time, and pressure. Slow heating rates on the order of just a few degrees per minute produce mostly char with some bio-oil; fast heating rates (flash or fast pyrolysis) of hundreds of degrees per second produce more bio-oil; 60 to 70% of the feedstock can be liquefied to make bio-oil using fast pyrolysis.

The type and composition of the feedstock plays a crucial role in determining the properties of the resulting products. Bio-oil produced from the fast pyrolysis of MSW can be highly acidic (low pH), unstable, and unsuitable for direct use unless extensively upgraded to reduce its organic oxygen and water content. Char from organic sources (e.g., wood, biosolids) can be used in agriculture and environmental remediation while char from inorganic matter (e.g., waste plastic and tires) is mostly used in industrial applications.

Pyrolysis of plastic waste is still in its early stages of commercial development. Several companies are working in this space with differing end products and business models. For example, New Hope Energy (Tyler, Texas) focuses on producing petrochemical feedstocks. These feedstocks are supplied to TotalEnergies, which further processes them into circular polymers—recycled plastics suitable for food-grade packaging and other applications.

As noted earlier, pyrolysis converts waste materials into char, a valuable carbon-based product, commonly referred to as biochar when derived from biomass and recovered carbon black (rCB) when sourced from waste tires. While both are carbon-rich materials, they serve distinct purposes based on their properties and applications.

- Biochar is a porous, high-carbon product derived from biomass sources such as wood waste, crop residues, and biosolids. It is primarily used as a soil amendment, improving

[20] https://www.hurstboiler.com/news/hurst_boiler_sponsors_fuels_for_schools
[21] https://www.uidaho.edu/dfa/division-operations/utilities/energy

water retention, nutrient absorption, and carbon sequestration.[22] Additionally, biochar has applications in contaminant remediation, including binding per- and poly-fluoroalkyl substances (PFAS) and heavy metals in soil to prevent leaching into groundwater. The domestic biochar market is expanding, with California leading the country in both production and demand. Market prices in California range from $600 to $1,300 per ton, while production costs range from $200 to $1,000 per ton (2021 USD). Companies such as GECA and Biochar Now have successfully commercialized biochar production from clean wood waste, while Silicon Valley Clean Water has demonstrated biochar production from biosolids.

- Recovered Carbon Black (rCB) is a fine black powder produced from the pyrolysis of waste tires. Unlike biochar, rCB has high surface area but lacks the porosity needed for soil applications. Instead, it is used as a reinforcing filler in rubber, plastics, and coatings, providing a sustainable alternative to virgin carbon black. Companies such as Bolder Industries, Delta Ducon, and Klean Industries have developed pyrolysis technologies to recover rCB from tires. Bolder Industries produces BolderBlack®, a sustainable rCB used in new tires, coatings, and plastics, while Klean Industries integrates rCB into tire manufacturing, reducing reliance on fossil-based carbon black. These companies also produce bio-oil as byproduct, supporting further waste material valorization.

Gasification is another thermochemical conversion process that can transform MSW into valuable energy and products. Unlike pyrolysis, which operates in the absence of oxygen, gasification usually occurs in the presence of limited oxygen, enabling the partial oxidation of waste materials. This process generates syngas (a mixture of CO and hydrogen) and CO_2, which can be used to produce electricity, heat, or fuels. Gasification offers a flexible solution for MSW, particularly in areas with large waste volumes, by reducing landfill dependency while producing renewable energy. While gasification technologies require substantial infrastructure, they can be adapted to smaller-scale operations, making them suitable for both large municipal systems and more localized energy generation needs.

Large-scale MSW gasification has been successfully implemented in Europe and Asia, where it is commonly used for CHP applications. In these regions, gasification systems are integrated into district heating networks or industrial processes, providing a reliable and sustainable source of energy while reducing dependence on landfills. For instance, gasification plants in countries like Sweden and Japan have been in operation for years, demonstrating the feasibility of large-scale gasification to convert MSW into syngas for electricity and heat generation. These projects benefit from economies of scale, advanced technologies, and supportive waste management policies, making them more cost-effective compared to smaller operations. However, projects focused on fuel production, such as those by Enerkem in Edmonton, Alberta, and Fulcrum Sierra Biofuels in Reno, Nevada, have struggled to achieve the same level of success. These projects face challenges related to feedstock supply, high capital costs, and the complex nature of downstream processes required to convert MSW-derived syngas into liquid fuels, which has delayed commercial-scale operations.

[22] Kalu, S., Kulmala, L., Zrim, J., Peltokangas, K., Tammeorg, P., Rasa, K., Kitzler, B., Pihlatie, M., and Karhu, K. Potential of biochar to reduce greenhouse gas emissions and increase nitrogen use efficiency in boreal arable soils in the long-term. Front. Environ. Sci., 10. DOI: 10.3389/fenvs.2022.914766.

Small-scale MSW gasification projects provide a flexible, modular solution for localized waste-to-energy needs, particularly in smaller municipalities or rural areas. These systems are easier to scale and deploy, making them attractive for regions with limited waste streams. However, their success depends on feedstock consistency, technology maturity, and financial backing. Economic sustainability remains a challenge, especially in areas with low waste generation, as the economics of small-scale gasification are still evolving. In China, small-scale projects (ranging from 3 t/day to 20 t/day) have successfully used modular gasification technology to convert MSW into syngas for local power generation, showcasing the potential of small-scale solutions to meet urban waste and energy needs.[23]

Mechanical conversion processes include **densification** which is the process of increasing the bulk density of the feedstock (biomass, MSW) by reducing its bulk volume.[24] Pelletization and briquetting are the most common densification processes. Densified products (pellets and briquettes) have benefits over raw feedstock such as more uniform properties, increased energy density, and reduced transportation costs and storage space.[25] For example, the calorific value of raw MSW is about 1,000 kcal/kg while that of fuel pellets is 4,000 kcal/kg.[26] The major markets for these products are residential and industrial heating and electricity generation. They can also be used as a uniform feed for thermochemical processes such as pyrolysis and gasification. Various biomass resources could be used to generate densified products. Typically, mill residues, forest residues, and low-quality logs are used in the production of densified products, but agricultural waste could also be used as feedstock, as well as mixed MSW or individual components such as paper/cardboard or wood pallets.[27]

Wood pellet manufacturing is a well-established process, and the general steps include drying, crushing, compressing, and cooling of the final product. In addition to being a high energy-value product, wood pellets can be easily handled and transported efficiently over long distances. The cost of a biomass pellet project can vary widely depending on several factors, including scale, feedstock, equipment, infrastructure, and labor. The project cost can range between $50,000 and $200,000 for a 1-1.5 tons/hour project to between $380,000 and $1.5 million for a 15-20 tons/hour project. [28] It takes 1.1 million British Thermal Units (MBTUs) of electrical energy to produce a ton of delivered pellets, which could be supplied with renewable energy such as solar panels.[29] While most wood pellets manufacturing in the United States occurs in the Southeast, there are recent efforts in other states as well (e.g., California, Rocky Mountain states) focused on using pine beetle kill wood and brush/branches from wildfire mitigation. There are also companies using clean wood pallets to produce pellets such as Energy Pellets of America, Hay Creek Companies, and Easy Heat Wood Pellets.

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[23] https://task33.ieabioenergy.com/wp-content/uploads/sites/33/2023/11/China.pdf
[24] https://ohioline.osu.edu/factsheet/fabe-6605
[25] https://www.sciencedirect.com/science/article/abs/pii/S1364032123003775?via%3Dihub
[26] https://www.biopelletmachine.com/biopellet-making-guidance/municipal-solid-waste-pellets-making.html#:~:text=MSW%20fuel%20pellet%20or%20briquett,excellent%20substiture%20for%20fossil%20fuels.
[27] https://biomassmagazine.com/articles/pellets-from-pallets-15549
[28] https://www.richipelletmachine.com/biomass-pellet-project-cost/
[29] https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2023/10/W214.pdf

Briquetting is a similar process to pelletization but it uses different production equipment (briquette press) and produces larger densified products (briquettes) with defined shapes such as cylinders or squares. The average briquette plant cost is $60,000 which will vary depending on configuration.[30] Biomass Secure Power Inc. (BMS PF) is developing a torrefied biomass briquette plant at Natchitoches, Louisiana. The facility will process forest residuals, cull, thinnings, slash, tree tops, woodchips, lumber mill residuals and branches. Construction will proceed in 3 phases with phase 1 producing 240,000 tonnes/yr of briquettes.[31]

Discussion and Conclusions

The waste resources identified in the City and Borough of Juneau illustrate a range of potential feedstocks in the area, offering various pathways for energy and resource recovery. The choice of technology ultimately depends on the desired end products—whether the community prioritizes energy generation, soil amendments like compost or biochar, or other resource recovery applications. Given the city's relatively small waste generation, technologies must be appropriately sized to ensure economic feasibility.

For **biological processes**, AD and composting present viable options for managing organic waste in Juneau. The total organic waste available for AD amounts to approximately 5,400 tons per year, comprising of 4,324 tons of food waste, 893 tons of grass/leaves, and 187 tons of other compostable material. Depending on the feedstock composition and digester system, organic waste can generate between 3,000 and 6,000 cubic feet of biogas per ton.[32] This suggests a potential annual biogas production of roughly 16 to 32 million cubic feet, which could be used for heat, electricity generation, or upgraded to RNG. In energy terms, this equates to approximately 96,000 to 192,000 therms of natural gas or 9,600 to 19,200 MMBtu per year. However, upgrading biogas to RNG requires significant capital investment in gas purification technology, which can be cost-prohibitive for small-scale projects due to economies of scale.

Composting offers a simpler, lower-cost alternative for organic waste management. On average, composting reduces the original feedstock weight by 40-50%, meaning Juneau could produce approximately 2,100 to 2,700 tons of compost per year. However, the feasibility of composting depends on the local/regional demand for soil amendment. If there is no viable market or end use for the compost, the investment may not be justifiable.

When comparing these two approaches, AD involves higher capital expenditures but provides the added benefit of renewable energy generation, whereas composting is more cost-effective but relies on strong local demand for compost. The decision should consider both the city’s energy needs and market potential for soil amendment products. Based on the previously outlined waste composition, roughly one quarter of the total waste stream is suitable for AD and/or composting, highlighting significant potential for waste reduction.

[30] https://www.abcmach.com/news/biomass-briquette-plant-cost-Middle-East.html
[31] http://bmspf.com/html/projects.html
[32] https://www.tandfonline.com/doi/full/10.1080/10962247.2017.1316326?utm_source=chatgpt.com#abstract

Thermochemical conversion processes, including combustion, pyrolysis, and gasification, provide alternative pathways for energy recovery. The city generates approximately 17,000 tons of waste resources annually suitable for thermochemical conversions addressing over 75% of the total waste stream (excluding metal, glass, and other materials) and thus presenting an attractive option for waste minimization. These waste streams could serve as feedstock for small- to medium-scale systems which convert waste into CHP, biochar, and other valuable products. However, these technologies can be capital-intensive, requiring careful cost-benefit analysis. Another attractive option, and potentially more cost-effective approach, may involve **densifying** MSW into fuel pellets. On average, about 15-20 tons of pellets can be produced from every 100 tons of processed waste, meaning Juneau's select MSW could yield roughly 2,500–3,400 tons of fuel pellets per year.[33] These pellets could be used for local heating applications or marketed externally, depending on regional demand and infrastructure. When comparing all these approaches, gasification and pyrolysis have high capital and operating costs, while pelletization may be more economically feasible and provide a transportable fuel product.

An estimated 2,149 wet tons (approximately 1,700 dry tons) of **clean MSW wood** are available annually within the City and Bourgh of Juneau. This supply could be supplemented with additional woody biomass from sources such as prunings, fire-prevention thinnings, and natural tree mortality, helping improve economies of scale. Given Juneau's surrounding forested landscape, it is reasonable to assume that a substantial volume of woody biomass from forest maintenance is available through ongoing sustainable land management practices. With this resource base, Juneau could explore a range of conversion technologies, including CHP via combustion for local use, pyrolysis for biochar or bio-oil production, gasification to generate CHP or syngas, or pelletization for fuel manufacturing. Using a conservative estimate of 5,000 Btu per pound of dry wood, Juneau's clean MSW wood could generate around 17 billion Btu per year which could significantly contribute to heat and power consumption at a school, municipal building, or other local facility. One ton of woody biomass can produce approximately 30% biochar by weight (300kg), meaning Juneau's clean MSW wood could yield roughly 510 tons of biochar annually. Using the average conversion of 15–20 tons of fuel pellets per 100 tons of raw feedstock noted earlier, Juneau's clean MSW wood could produce 250–340 tons of pellets annually. These estimates would be much higher if additional woody biomass is considered as feedstock for any of these applications. When comparing all these approaches, CHP provides local energy benefits, biochar may have niche markets, while pellets can be a scalable and transportable product.

This assessment provides a high-level overview of technology options and their feasibility, serving as a foundation for more detailed evaluations. Next steps could include a cost-benefit analysis for different pathways comparing capital cost, operational expenditures, and revenue potential to determine each pathway's economic viability. If Juneau determines a specific end-product preference, a detailed feasibility study could refine technical and economic aspects further, including an examination of site-specific logistics, detailed feedstock availability, permitting requirements, and potential off-takers for energy or material products. Additionally, a market analysis would help identify demand for potential products like compost, biochar, or fuel

[33] https://www.biopelletmachine.com/biopellet-making-guidance/municipal-solid-waste-pellets-making.html#:~:text=MSW%20fuel%20pellet%20or%20briquett,excellent%20substiture%20for%20fossil%20fuels.

pellets, ensuring alignment with local and regional opportunities. Ultimately, the best approach will balance technical feasibility, economic viability, and community needs to maximize the value of available waste resources. By pursuing these next steps, the City and Borough of Juneau can make informed decisions on alternative waste management and energy solutions that align with its economic and environmental goals. Whether through localized energy generation, soil amendment production, or material recovery, these strategies have the potential to enhance resilience and resource utilization in the community.

Appendix

Table A1. Detailed overall (composite) municipal solid waste characterization, Juneau (2023)

Confidence intervals calculated at the 90% confidence level. Percentages and tons for subtotals are rounded and may not sum to the totals shown.

Material	Est. %	+ / -	Est. Tons	Material	Est. %	+ / -	Est. Tons
Recyclable	**18.0%**	**2.8%**	**4,025**	**Food**	**19.4%**	**4.2%**	**4,324**
Compostable	**31.7%**	**6.6%**	**7,083**	Food - Packaged Edible	6.1%	1.3%	1,356
Potentially Recoverable	**22.4%**	**5.2%**	**4,998**	Food - Packaged Inedible	3.8%	4.1%	853
Reusable	**8.5%**	**5.2%**	**1,907**	Food - Unpackaged Edible	3.6%	1.2%	804
Non-recoverable	**19.4%**	**2.5%**	**4,333**	Food - Unpackaged Inedible	5.3%	1.7%	1,183
Paper & Cardboard	**19.3%**	**3.6%**	**4,312**	Beverages	0.6%	0.1%	128
Uncoated Corrugated Cardboard	4.4%	1.4%	992	**Yard Debris**	**5.7%**	**1.3%**	**1,267**
Typically Recyclable Paper	5.5%	2.3%	1,225	Leaves & Grass	4.0%	1.1%	893
Food Soiled/Compostable Paper	5.8%	1.0%	1,298	Woody Yard Debris	1.7%	1.1%	374
Non-recyclable or Non-compostable Paper	3.6%	1.1%	796	**Other Organics**	**11.7%**	**5.4%**	**2,610**
Plastic	**9.3%**	**1.2%**	**2,084**	Manures	-	-	-
#1 PET Rigid Plastic Packaging	1.0%	0.1%	234	Remainder/Composite Organic - Compostable	0.8%	0.4%	187
#2 HDPE Rigid Plastic Packaging	0.6%	0.1%	123	Other Clean Wood	1.4%	1.0%	316
#4 LDPE Rigid Plastic Packaging	0.0%	0.0%	4	Reusable Clean Wood	6.5%	5.3%	1,459
#5 PP Rigid Plastic Packaging	0.7%	0.2%	150	Remainder/Composite Organic - Non-compostable	2.9%	0.9%	649
Compostable Rigid Plastic Packaging	0.0%	0.0%	5	**Special Materials**	**11.7%**	**2.9%**	**2,615**
Compostable Plastic Single Use Food Service Ware	0.0%	0.0%	2	Other Inert Construction Debris	6.1%	2.6%	1,370
Other Rigid Plastic Packaging	0.4%	0.1%	97	Carpet	1.5%	1.6%	333
Other Durable Rigid Plastic Items	0.4%	0.1%	91	E-waste	0.7%	0.3%	148
Reusable Durable Rigid Plastic Items	1.4%	0.8%	304	Tires	0.6%	0.6%	134
Non-compostable Plastic Single Use Food Service War	0.1%	0.0%	14	Refrigerant-containing Items	0.1%	0.1%	19
Single-layer Plastic Film	3.9%	0.5%	865	Mattresses	0.0%	0.0%	0
Multi-layer Plastic Film	0.3%	0.0%	62	Broken Metal Furniture	1.0%	0.6%	219
Durable Film Plastic Items	0.0%	0.0%	0	Household Hazardous Waste	0.3%	0.2%	69
Remainder/Composite Plastic	0.6%	0.3%	131	Reusable Inert Construction Debris	0.3%	0.4%	74
Metal	**4.4%**	**1.0%**	**988**	Reusable Wood Furniture	0.3%	0.3%	70
Tin/Steel Cans	0.6%	0.2%	145	Reusable Metal Furniture	0.0%	0.0%	0
Aluminum Cans	0.6%	0.1%	142	Special Waste	0.5%	0.4%	122
Other Ferrous	1.7%	0.8%	370	Broken Wood Furniture	0.3%	0.2%	56
Other Non-ferrous	0.4%	0.1%	95	**Textiles**	**9.9%**	**4.3%**	**2,202**
Remainder/Composite Metal	1.1%	0.6%	236	Textiles - Organic	0.1%	0.1%	33
Glass	**2.8%**	**0.6%**	**617**	Textiles - Synthetic, Mixed, & Unknown	9.7%	4.3%	2,169
Glass Bottles & Containers	2.4%	0.5%	545	**Other Materials**	**5.9%**	**0.9%**	**1,328**
Remainder/Composite Glass	0.3%	0.3%	72	Fines	2.8%	0.5%	621
				Mixed Residue	3.2%	0.7%	707
Sample Count	*76*			**Total**	**100%**		**22,346**

Source: City and Borough of Juneau Waste Characterization Study (2024), Cascadia Consulting Group, https://juneau.org/wp-content/uploads/2024/10/Juneau-Waste-Characterization-Study-2024-Report_2024-10-8.pdf

Notes

1. Inert Construction Debris is considered to be not suitable for any of the WTE technology pathways considered in this report.
2. E-waste, carpet, refrigerant-containing items, mattresses, household hazardous waste, and special waste are excluded from this analysis.
3. Wood furniture is coated with chemicals and thus not considered suitable for resource and energy recovery although these materials, along with others, are often combusted in MSW incinerators.
4. Other Materials are excluded due to lack of information on characteristics.