FINAL

City of Unalaska Landfill Master Plan

Prepared for

City of Unalaska

September 2017

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Executive Summary

Introduction

This City of Unalaska (City) Landfill Master Plan is intended to: assess and summarize current landfill operations; identify regulatory-driven current and future changes, upgrades, or deficiencies that will require future action or funding; and evaluate options for the most cost-effective waste disposal operations in the future. To accomplish these goals, a data review and site visit were first conducted to understand existing landfill operations and gather data. During the site visit, key personnel from the City were interviewed, and documents and data that provided background on types and quantities of waste received, handling processes, and facilities/equipment were collected.

Alternatives Evaluation

The information obtained during the site visit was then used to evaluate the current landfill processes and infrastructure. This included the baler facility, landfill cells, and potential impacts of adding biosolids to the waste stream as well as to consider how current and future regulations would apply to and effect landfill operations. Regulatory changes with the potential to effect landfill operations include updates to Code of Federal Regulations 40.136 (40 CFR 136), that will likely require lining for new construction and demolition waste cells and potential new requirements for surface water analytical methods. In addition, changes to Alaska Pollutant Discharge Elimination System regulations, 18 Alaska Administrative Code (AAC) 83, may increase methane monitoring requirements. Additional permitting and monitoring requirements may apply depending upon the future waste disposal alternative selected for Unalaska.

A high-level spreadsheet-based economic model was used to estimate and compare the present value of life-cycle costs for the five long-term waste management alternatives:

- Continued landfilling
- Landfilling with composting
- Off-site disposal via baling and barging
- Gasification with landfill of ash
- Gasification with composting

Recommended Long-Term Alternative

The analysis shows that the most cost-effective long-term waste management alternative for the City is gasification with landfill of ash.

Gasification is a proven technology, currently used in Dillingham and Skagway, Alaska, which converts waste to synthesis gas (syngas) and ash. First, non-combustible materials are manually removed from the waste stream. Waste is then loaded into the primary chamber. Conversion takes place in the oxygen-starved gasification equipment’s primary chamber using liquid fuel (diesel), which then releases syngas from the waste material. The diesel is used to maintain a high enough temperature to assure that the gasification reactions occur when the feedstock has a very high moisture content. The thermo-chemical conversion of the solid feedstock to syngas occurs, and is sustained, using the heat content in the feedstock. The syngas is then combusted in the equipment’s secondary chamber, discharging permit compliant emissions to the atmosphere. Ash is removed and landfilled.

Installation of Gasification System, Dillingham, Alaska

The 30-year present value of the gasification option is estimated to be about $72.5 million, which is $18 million less than the 30-year present worth of the landfilling alternative. Gasification and landfill of ash is less expensive in the long run because landfill cell closure and post-closure costs are reduced. For gasification, the required annual closure fund contribution stops as soon as the system is running because there is already enough money in the closure fund and enough landfill space for the ash. This is an annual savings of approximately $140,000 (year 2018).

Conclusions and Recommendations

The economic analysis summary is as follows:

Table ES-1. City of Unalaska Disposal Alternatives Evaluation
Cost Summary Based on 30 Years of Operation (2017-2047)

	Landfill	**Landfill with Composting**	**Bale and Barge**	**Gasification**	**Gasification with Composting**
Present Value	$90,903,000[a]	$95,558,000[a]	$149,503,000	$72,495,000	$83,397,000
Levelized Tip Fee[b] ($/ton)	$562	$591	$925	$449	$516

[a] For the landfill and landfill with composting alternatives, another landfill location would be required in 2045, so there will be added costs for future development that are not currently included in these estimates.

[b] The Levelized Tip Fee represents a tip fee that if multiplied by tons in each year, the resulting stream of annual dollar amounts will equal the present value of costs shown in the row above.

In approximately 30 years, Unalaska will be looking for a new landfill, and the property and development costs will be on the order of $20 million. Based on the economic and technical evaluation of Unalaska's current solid waste management plan, and forecasted growth in the annual waste generation, CH2M recommends that the City consider a switch from landfilling to gasification. With gasification, the required volume of landfill is reduced by almost 90%, meaning that Unalaska's existing landfill space will be sufficient for the next 30 years and property and development costs can be deferred. The City would always have the option to switch back to landfilling during emergencies or periods of high fuel cost.

We also recommend that the City begin planning, design, and budgeting for a composting system for biosolids and food waste. Composting removes these organic resources from the waste stream and conserves landfill airspace. Composting is compatible with both landfilling and gasification.

Biosolids Composting System, Kodiak, Alaska

The recommended next step is to conduct more thorough analyses of gasification and composting. For gasification, further analysis is needed to confirm feedstock types and properties, waste feed rate requirements and variability, infrastructure requirements including emissions controls and costs, and a community communication plan to generate public support for the recommended project. For composting, the availability and feasibility of separating food waste and providing a sufficient mix of bulking agent needs to be confirmed. Funding requirements and the overall project schedules need to be developed in more detail, and a plan to engage public support for bond issuance may be needed.

In the meantime, near-term non-regulatory driven capital improvements are necessary to sustain existing landfill operations. A prioritized list of recommended capital improvements is shown in the Table ES-2.

Table ES-2. City of Unalaska Prioritized Capital Improvement Plan Recommendations

Priority	Capital Improvement	ROM Cost[a]	Fiscal Year
1	Leachate force main improvements, installation of air/vacuum valves	$66,000	2019
2	Check valve and vault replacement	$85,000	2019
3	Leachate lift station pump servicing	$12,000	2019
4	Baler building insulation repairs	$537,000	2019
5	Composting system preliminary design and cost estimate	$97,000	2019
6	Composting system pilot test	$184,000	2019
7	Composting full scale design and permitting	$448,000	2020
8	Composting facility construction	$2,986,000	2021
8	Composting Facility engineering services during construction	$448,000	2021
9	Gasification detailed analysis	$100,000	2019

ROM = Rough Order of Magnitude

[a] Estimated costs are in 2017 dollars. Contingency is included in construction costs. 15% for full scale design and permitting. 15% for engineering services during construction.

Contents

Acronyms and Abbreviations

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
C&D	construction and demolition
CFR	Code of Federal Regulations
City	City of Unalaska
EPA	Environmental Protection Agency
PVC	polyvinyl chloride
WWTP	wastewater treatment plant

1. Introduction

This City of Unalaska (City) Landfill Master Plan is intended to: assess and summarize current landfill operations; identify regulatory-driven current and future changes, upgrades, or deficiencies that will require future action or funding; and evaluate options for the most cost-effective waste disposal operations in the future. To accomplish these goals, a data review and site visit were first conducted to understand existing landfill operations and gather data. During the site visit, key personnel from the City were interviewed, and documents and data that provided background on waste handling processes, content, and facilities/equipment were collected (Section 2).

Regulatory changes with the potential to effect current and future landfill operations were considered (Section 3). Waste disposal alternatives for the City, including continued use of on-site disposal cells, off-site disposal through barging/transfer, composting, and gasification were considered (Sections 4.1 through 4.5). The future cost of these alternatives was evaluated using a high-level spreadsheet-based economic model. The evaluation results and recommendations are presented in Section 4.6. Sections 5 and 6 identify what tasks are needed for inclusion in the City's Capital Improvements Program and a more detailed explanation of their cost and application.

2. Data Review and Site Visit

The City provided an extensive set of landfill related files and documents to CH2M during the site visit conducted from February 20 through the 23, 2017. The files included previous reports, drawings, cost estimates, historical landfill waste data, and City budgets. These resources were reviewed to provide an understanding of current and past operations and to provide a basis for developing future solid waste planning recommendations.

During the site visit, CH2M toured the landfill and wastewater treatment plant (WWTP) to observe operations, and also met with the Landfill Manager, WWTP Manager, City Engineer, and the Director of Public Utilities. Discussions focused on the landfill and WWTP processes and related infrastructure, including waste baling, landfill cell operations, leachate pumping and treatment, and wastewater treatment. Additional topics included staffing shortage at the landfill, and the current regulations and requirements effecting WWTP effluent. Attachment 1 provides a detailed summary of the February 2017 site visit.

3. Existing Landfill Assessment

3.1 Landfill Infrastructure

The landfill is located on Unalaska Island off of Summer Bay Rd., near the eastern shore of Iliuliuk Bay (see Figure 3-1). Landfill infrastructure includes Baler Facility, landfill cells, and the leachate collection and pre-treatment system. Figure 3-2 provides an overview of the layout of the landfill's infrastructure. CH2M visited these facilities, spoke to managers, and reviewed data and reports. Our assessment is as follows:

3.1.1 Baler Facility

The Baler Facility is a pre-engineered steel building with office, weigh scales, overhead doors, tipping floor, push wall, conveyor, baler, loading ramp, and squeezings drainage system. The building was constructed in 1997. Structural members and exterior panels appear to be in good condition, but the interior insulation has disintegrated and requires replacement. Insulation replacement with a polyvinyl chloride (PVC) liner panel (bird protection) installed over all the building insulation is a priority and has been programmed for FY 2019 (2017 Final Budget, Capital Major Maintenance Program).

The baler and conveyor were installed in 1997 and are approaching the end of their useable life. Recent repairs, specifically the rebuilding of select baler members and conveyor system by the City's Solid Waste Division staff, has extended the equipments' life by a few years. Full replacement of the baler and conveyor will be required in approximately five years if baler operations will continue.

3.1.2 Landfill Cells

The City landfill currently has six lined landfill cells (Cells 1 – 4, and Cells II-1 (also known as Cell 5) and II-2 (also known as Cell 6)). There is space and development plans for up to three additional lined landfill cells (Cells II-3, II-4, and II-5). Leachate is collected from lined landfill cells and is routed to a storage, pretreatment, and pumping facility at the landfill. Figure 3-2 shows the layout of current and planned landfill cells.

CH2M reviewed the City's data on landfilled waste and recommends using a 3 percent expected growth rate to forecast future waste quantities and cell life. This growth rate is on the lower end of landfilled waste tonnage growth in recent years, and has been observed to be the approximate growth rate at other similarly sized municipal landfills. Timelines for landfill cells construction and closure in previous estimates and the CH2M 2017 estimates with 3% growth are provided in Table 3-1. This table also includes estimated total costs for landfill cell construction and closure.

Table 3-1. Comparison of Projected Cell Life and Activity Timelines, Alternative No. 1, Landfilling

Construction Activity	Original Estimated Construction Year[a]	Revised Estimated Construction Year[b]	Estimated Total Cost[c]
Construct Closure Area 2	2017	2018	$336,000
Construct Cell II-3	2026	2026	$5,893,000
Begin Landfill Operations in Cell II-3	2027	2027	N/A
Construct Closure Area 3	2020	2028	$628,000
Construct Closure Area 4	2028	2028	$1,022,000
Construct Cell II-5	2034	2033	$6,608,000
Begin Landfill Operations in Cell II-5	2035	2034	N/A
Construct Closure Area 5	2036	2034	$1,171,000
Construct Cell II-4	2040	2037	$6,512,000
Begin Landfill Operations in Cell II-4	2041	2038	N/A
Construct Closure Area 6	2042	2039	$1,189,000
Construct Closure Area 7	2051	2045	$1,875,000

[a] Timeline for cell construction based on 2006 projected growth (Bristol, 2006)

[b] Timeline for cell construction based on CH2M 2017 estimate of 3 percent growth

[c] Cell construction costs are from the Unalaska Landfill Expansion Report (Bristol, 2006), escalated to 2017 dollars. Cell closure costs were estimated by CH2M in 2017 dollars. Costs include design, permitting, and contingency.

The revised cell construction and closure years are used for the landfilling alternatives economic evaluation and comparison in Section 4.

3.1.3 Biosolids Impact on Leachate Quality

The following subsections provide assessments of two compounds found in landfilled WWTP sludge (biosolids) that may impact leachate quality.

3.1.3.1 Ammonia

CH2M's experience at Kodiak, Alaska is that co-disposal of biosolids with municipal solid waste increases landfill leachate ammonia concentrations. Ammonia is considered a nutrient necessary for biological life, but excess ammonia is harmful to aquatic life. The City's WWTP treats the landfill leachate and this has not created any effluent discharge issues since the 2015 Chemically Enhanced Primary Treatment (CEPT) upgrades because the WWTP is currently only treating for biochemical oxygen demand and total suspended solids.

Most WWTPs in the continental U.S. that discharge to the ocean are not nutrient removal limited, but the City's WWTP effluent discharge to the head of Captains Bay may have future ammonia concentration limits imposed by the Alaska Department of Environmental Conservation (ADEC) as has happened recently for other Alaska dischargers.

3.1.3.2 Copper

Average levels of copper in Unalaska's wastewater effluent are currently about half of the water quality limit for seawater, considering the 100:1 mixing zone. If future permitting altered the mixing zone to 50:1, then Unalaska would frequently exceed the water quality limit. Even lower bioinhibition limits for copper would apply if a future process included biological treatment. Therefore, levels of copper in wastewater, biosolids, and landfill leachate are a concern.

The City has determined that copper is coming from the drinking water system. The copper passes through the wastewater collection and treatment system where only about half is removed by the CEPT process. Biosolids delivered to the landfill and leachate returned to the wastewater system create a closed loop that will increase copper levels. If composting is implemented, the amount of copper in the landfill leachate likely will decrease the copper content in the WWTP influent and effluent and sludge. A recommendation for planning, design, and implementation for composting is included in Section 4.7.

CH2M recommends the City undertake a study to determine the best way to boost the potable water supply's pH to decrease its corrosivity thereby decreasing the amount of dissolved copper in the City's wastewater. Laboratory tests can be conducted to estimate the amount of copper reduction that is possible at reasonable cost by increasing the water's pH.. After those tests are completed the City will have data that can be used to decide how to implement a drinking water corrosion control program. Not only will this be useful for wastewater effluent requirements but will help the City meet the Lead and Copper Rule(LCR) requirements for drinking water. Due to the recent Flint, Michigan issues and other concerns future LCR requirements could be more restrictive.

Many Alaska communities add soda ash (sodium carbonate) to add alkalinity to the water and adjust the water's pH to at least 8.0 to reduce corrosion potential in the water distribution system. This is important because lead and copper components in both the City water distribution system and customer plumbing systems more readily dissolve in waters with pH below 7.0 compared to water with higher pH. Ketchikan Public Utilities is adding soda ash, with a target pH of 8.3, and orthophosphate for corrosion control. Many other Alaska communities add soda ash to their drinking water for corrosion control.

Most Alaska communities have switched from gaseous chlorine disinfection to on-site generated sodium hypochorite disinfection. This has been primarily done for community and operator safety reasons, but a secondary impact has been to significantly increased pH in low alkalinity water after the switch was made. This is because gaseous chlorine forms hypochlorous acid which can significantly decrease the water's pH, making it more acidic. It is understood that there are unique transportation and access issues at the City's remote water treatment plant that resulted in the City choosing gaseous chlorine over on-site generated sodium hypochorite. Since that decision has been made and a new gaseous chlorine system has been installed it just means a more aggressive corrosion control program may be needed to achieve the desired wastewater copper reductions as compared to community that no longer use gaseous chlorine.

3.1.4 Deferred Maintenance and Landfill Staffing

Our observations are that the Solid Waste Division is short staffed. There are significant pumping/piping problems in the incoming and outgoing leachate piping that need to be systematically investigated and addressed. Investigation of these issues is kept on the backburner, and management of special wastes like baling of tires have been postponed to focus on the core mission of managing incoming waste and keeping the baler system running. Solid waste managers report that they were shorthanded by one employee before startup of the new leachate facility in 2013 and the addition of tire baling. This is confirmed by the Solid Waste Division's need to hire one to two temporary employees for at least half the year. Even with one to two temporary employees much of the year, landfill staff cannot properly maintain the leachate facility and they have postponed tire baling.

The Landfill has operated with a staff of four since the baler facility started operating in 1997. The tons of waste landfilled since 2000 has increased by over 40 percent. Landfill staff are highly stressed year round and when employees take vacations or are on extended sick or injury leave, the stress is even more amplified.

Regardless of the City's decision on long-term waste management, landfilling will need to continue for at least the next 5 years. Based on our observations and information gathered for this study, we recommend that the solid waste utility hire two additional full time employees to properly manage the baling and landfill operations with all the associated activities including segregation and management of special wastes (including baling of tires) and maintenance of the leachate system. We recommend that the City conduct a staffing analysis to determine if more than 2 additional employees are needed.

3.2 Regulatory Review

Current state and federal regulations applicable to the City landfill as well as projected changes to the regulations were assessed, including solid waste and clean water act requirements. Potential areas of landfill operations that may be effected include environmental monitoring, permitting, and design of future landfill cells (specifically for construction and demolition [C&D] debris). The alternatives included in Section 4 were also considered for potential regulatory requirements. Table 3-2 summarizes the regulatory findings. Attachment 2 provides extensive regulatory review information.

Table 3-2. Summary of Current and Projected Regulatory Requirements for the City of Unalaska Solid Waste Landfill

Topic	Regulation Status: Current/Projected: (Date)	Description	Citation	Unalaska Document	Action
Facility Design (general)	Current	General requirements for landfills by class (City of Unalaska Landfill is a Class I) including: siting, liners, leachate management, operating practices, groundwater monitoring, closure/post closure care, and financial assurance.	40 CFR 258	Phase II Design Plans	Periodic check for regulatory updates.
Facility Design (C&D Cells)	Projected (est. 2022)	New C&D cells do not currently require a liner, but may require them in the future. Expansion of current cells would not be effected (no liners required for extensions of existing cells).	40 CFR 136	TBD	Program cost for lining future C&D cells
Biosolids	Current	If the City of Unalaska continues to allow disposal of biosolids at the landfill, a permit would be required by ADEC, and additional monitoring requirements would also need to be implemented. Additional EPA regulations would apply if the waste was treated for any other use besides co-disposal (as compost, etc.).	18 AAC 60 40 CFR 503	Landfill monitoring Plan, New ADEC Permit	Confer with ADEC and EPA if disposal of biosolids implemented
Composting	Current	If the City of Unalaska opted to implement composting of certain wastes, a permit would be required by ADEC, which would specify additional monitoring requirements for pathogens.	18 AAC 60	Landfill monitoring Plan, New ADEC Permit	Confer with ADEC and EPA if composting implemented
Transfer/Barging of Waste	Current	If the City of Unalaska opted to implement transfer/barging of waste, coordination with the shipping company would be required to determine appropriate shipping containers, and any other requirements for acceptance.	NA	TBD	Confer with shipping company of offsite transfer/barging implemented
Gasification	Current	A minor permit or Title V permit may be required from ADEC.	18 AAC 50	New ADEC Permit	Confer with ADEC if gasification is implemented
Surface Water Monitoring	Current	Monitoring of surface water to identify potential impacts by the landfill (annual).	18 AAC 70 40 CFR 258 Appendix II (Detection Monitoring[a])	Landfill Monitoring Plan	Periodic check for regulatory updates.
Surface Water Monitoring	Projected (Unknown)	ADEC is proposing a change to analytical methods used for surface water monitoring.	Proposed new analytical methods are under 40 CFR 136	Landfill Monitoring Plan	Update Landfill Monitoring Plan, verify laboratory accredited to use proposed analytical methods

Table 3-2. Summary of Current and Projected Regulatory Requirements for the City of Unalaska Solid Waste Landfill

Topic	Regulation Status: Current/Projected: (Date)	Description	Citation	Unalaska Document	Action
Visual Monitoring	Current	Conducting visual observations to monitor for potential issues to human health, the environment, or permit violations (using a site-specific checklist).	18 AAC 60	Landfill Monitoring Plan	Periodic check for regulatory updates.
Gas Monitoring	Current	Landfill gas monitoring at surface and facility boundaries to determine if explosive or hazardous gases are present and/or migrating off site.	18 AAC 60	Landfill Monitoring Plan	Periodic check for regulatory updates.
Gas Monitoring	Projected (Unknown)	EPA recently added requirements to capture methane at larger facilities (producing over 34 megagrams of methane per year). EPA may require smaller facilities to conduct additional surface monitoring to prove they generate less than the 34 megagrams per year benchmark.	40 CFR 258	Landfill Monitoring Plan	Monitor regulations for changes to methane emission requirements for smaller landfills
Stormwater	Current	Multi Sector General Permit, as enforced by ADEC under Alaska Pollutant Discharge Elimination System, includes planning for and controlling stormwater runoff, visual and analytical monitoring, and annual reporting.	18 AAC 83	Landfill stormwater pollution prevention plan (SWPPP)	Periodic check for regulatory updates.

[a] If impact to surface water is ever suspected, 40 CFR 58 will require "Assessment Monitoring" with additional analytical, included in 40 CFR 258 Appendix II.

Notes:

AAC = Alaska Administrative Code

ADEC = Alaska Department of Environmental Conservation

C&D = Construction and Demolition

CFR = Code of Federal Regulations

EPA = Environmental Protection Agency

4. Long-Term Waste Management Alternatives Evaluation

The City Landfill has an estimated 30-year remaining life through full build-out. Because the costs for landfill operations, closure, and post-closure care are substantial, the costs for other waste management alternatives were evaluated and compared using 30-year present value costs. Each of the five long-term waste management alternatives are described and an economic analysis summary is presented below.

4.1 Landfilling – Alternative No. 1

This alternative is to continue current operations of baling, bagging and landfilling all solid waste. Revised landfill cell life estimates, operating costs, and baler replacement costs have been included in the long-term cost estimations. Landfill cells II-3, II-4, and II-5 (also known as Cells 7, 8 and 9) would be constructed and closed as planned. Baler operation continues throughout the landfill's life, with periodic equipment replacement. Closure and post-closure costs are applied to all landfill cells.

4.2 Landfilling with Composting – Alternative No. 2

This alternative consists of separation and composting of biosolids from the WWTP and select food waste from processor galleys, the Grand Aleutian kitchen, and Safeway. Based on 2016 data, these wastes represent approximately 20% of the total incoming waste tonnage. The amount of compostable waste varies seasonally.

Biosolids and food wastes would be mixed with cardboard and wood chips (from pallets and other scrap wood) and composted using the aerated static pile method to Class A (unlimited distribution) standard. This is similar to the method of composting at the City of Kodiak. An estimated 18 cubic yards a week of compost would be produced for use as landfill cover or community-wide distribution. Capital costs assume aerated static pile composting in a fabric covered truss-arch type structure. A preliminary estimate of capital cost is approximately $3.0 million. Operating costs assume 1 full time employee to process biosolids and food waste. The annual operating cost is estimated to be $400,000. The economic evaluation assumes no resale value for the compost, but also no cost for distribution. In other words, the compost would be used at the landfill or made available to the public for self-haul at no cost. Attachment 3 provides details and cost basis for the composting alternative.

4.3 Baling and Barging – Alternative No. 3

This alternative involves baling waste and loading the bales into shipping containers for off-island disposal. Loaded containers are transported to the City Dock, shipped by Sampson Tug and Barge to the Port of Tacoma, transferred to rail, and disposed at Waste Management's Columbia Ridge Landfill in Arlington, OR. The City and Borough of Juneau has been shipping their sewage biosolids to this same facility. The economic analysis assumes that the transfer/barging will start in 2023. Operating costs would then consist of baler operation and maintenance, transport, and disposal. No new landfill cells would be constructed beyond the existing Phase II-1/II-2 cells (Cells 5 and 6). Closure and post-closure costs would be reduced accordingly. Barging and disposal costs are based on a budgetary quote received from Waste Management, Inc. which included loading, transport, and disposal.

4.4 Gasification – Alternative No. 4

This alternative involves construction of a new Gasification Facility. Originally, we had proposed conversion of the Baler Facility to a Gasification Facility. Following discussions with the City, it was decided to keep the Baler Facility intact, which would serve as a backup, and assume construction of a new building for gasification. This system includes two new gasifier units. Incoming waste is separated to remove non-combustible materials from the waste stream, which are landfilled directly. Remaining wastes are fed into the gasifier's primary chamber. Conversion takes place in the oxygen-starved primary chamber using liquid fuel (diesel), thereby releasing the syngas. The diesel is used to maintain a high enough temperature to assure that the gasification reactions occur when the feedstock has a very high moisture content. The thermo-chemical conversion of the solid feedstock to syngas occurs, and is sustained, using the heat content in the feedstock. The syngas is then combusted in the gasifier's secondary chamber, yielding permit compliant emissions through a stack to atmosphere. Ash is removed and landfilled. Based on the gasification analysis, waste mass will be reduced by 88 percent.

No new landfill cells would be constructed beyond the existing Phase II-1/II-2 cells (Cells 5 and 6). Closure and post-closure costs are reduced accordingly. Energy recovery may be possible, but is not included in the economic evaluation. Attachment 4 provides details on the gasification alternative.

4.5 Gasification with Composting – Alternative No. 5

This alternative includes construction of a new gasification building and a composting facility. Capital costs are higher than Alternative 4 (gasification only), but the gasification operating costs are reduced because the relatively wet organic waste is removed from the waste stream which reduces fuel usage. Volume of landfilled ash is expected to be similar to Alternative 4, and therefore no new landfill cells would be constructed beyond the existing Phase II-1/II-2 cells (Cells 5 and 6). Closure and post-closure costs are expected to be the same as Alternative 4.

4.6 Economic Analysis Summary

Table 4-1 summarizes the estimated cost for four long-term waste management alternatives, including the total cost, and the average price per ton of waste during that time period.

Table 4-1. City of Unalaska Disposal Alternatives Evaluation
Cost Summary Based on 30 Years of Operation (2017-2047)

	Landfill	**Landfill with Composting**	**Bale and Barge**	**Gasification**	**Gasification with Composting**
Present Value	$90,903,000[a]	$95,558,000[a]	$149,503,000	$72,495,000	$83,397,000
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[a] For the landfill and landfill with composting alternatives, another landfill location would be required in 2045, so there will be added costs for future development that are not currently included in these estimates.

[b] The Levelized Tip Fee represents a tip fee that if multiplied by tons in each year, the resulting stream of annual dollar amounts will equal the present value of costs shown in the row above.

4.7 Conclusions and Recommendations

Based on the economic and technical evaluation of Unalaska's current solid waste management plan, and the forecasted growth in the annual quantity of waste generation, CH2M recommends that the City consider a switch from landfilling to gasification, Alternative No. 4. The economic analysis shows the long-term gasification alternative's 30-year present worth is about $72.5 million. This is estimated to be approximately $18 million lower than the 30-year present worth of the landfilling alternative.

The shift from landfilling to gasification would be a major change for the City. The recommended next step is to conduct a more thorough analysis of the gasification facility details to confirm feedstock types and properties, waste feed rate requirements and variability, infrastructure requirements including emissions controls and costs, and develop and implement a community communication plan.

We also recommend that the City begin planning, design, and budgeting for a composting system for wastewater biosolids and food waste. Composting removes these organic resources from the waste stream, conserves landfill airspace, and will reduce the impacts of ammonia and copper on the wastewater treatment system. Composting is compatible with both landfilling and gasification.

Once a decision is made by the City, appropriate planning and design for infrastructure and equipment can begin. In the interim, landfilling will continue for at least 5 years and capital improvements must be made to sustain the operation.

5. Capital Improvements Program Summary

The following are recommended capital improvements.

5.1 Leachate Force Main Improvements

Leachate is pumped from the storage tank at the landfill to the WWTP through a force main. Pumping rates are much lower than the pumps' rated capacity. The pumps increase the leachate's hydraulic head in order to move the leachate through the one-mile long 4" force main. The force main and downstream gravity piping transport the leachate to WWTP where it is mixed with the incoming community wastewater flow for treatment and discharge to the outfall. Figure 5-1 shows the location and path of the leachate force main.

The reduced pump rate results in leachate backing up into the baler building during storm events. We were told the leachate force main was constructed with an undulating profile due to encountered bedrock along the pipeline alignment. It is suspected that the high points along the force main are allowing air to accumulate at the pipe's crown, thereby reducing the flow area and creating an impediment to efficient pipe flow. Additionally, it is suspected that in the pipe's lower sections of the undulating profile solids could be accumulating over time, thereby creating an impediment to efficient pipe flow. Taken together, the suspected accumulated air and settled leachate solids could be creating considerable headloss that is preventing the leachate pumps from producing flow at their rated capacity.

In order to address the problem, several actions are recommended:

1. Conduct a carefully planned leachate force main pigging operation to remove air and settled solids. This may be required several times each year.

2. Add air/vacuum valves housed in valve vaults at the force main high points to prevent accumulation of air in the pipe.

3. Unless substantial pumping flow rate increase is achieved from pipe pigging and high-point air release the leachate storage tank should be kept at a low level so there is plenty of volume available to store leachate during storm events.

If the first three recommended actions do not solve the problem, additional analysis will be required. Possible solutions include relocating the pipe to provide a more even grade (eliminate high points), or installing additional air/vacuum valves. Note that installing a larger diameter pipe is not the solution because the much lower flow velocity in a larger diameter pipe could encourage leachate solids accumulation in the pipe.

The estimated cost to install three air/vacuum valves and their vaults is approximately $66,000 (Attachment 5).

5.2 Check Valve and Vault Replacement

The existing check valve in the 8-inch diameter HDPE pipe connecting the baler facility floor drain to the landfill lift station has failed and needs cleaning or replacement. This is needed to prevent flooding during high rain events when water backs up into the Baler Facility. The work scope includes relocating the vault out of the roadway for access, replacement of check valve internals, installation of a cleanout, concrete pad, and bollards for protection from snow plow. The estimated cost of this repair is $85,000 (Attachment 5).

5.3 Landfill Lift Station Pump Servicing

The leachate pumping system feeding the leachate storage tank and pretreatment system cannot keep up with leachate flows into the treatment system during significant rain events. Using pump test data provided by the City, we have determined that the influent pumps in the landfill lift station (LFLS) are operating at only 30% efficiency. There are several factors that could be reducing the efficiency of these pumps. These include: buildup of leachate precipitate or scale inside the pumps, increased head loss from trapped air in the piping, and increased head loss from scale or solids in the piping.

We recommend that the City start the analysis of this problem by:

1. Servicing the air/vacuum valve(s) in the piping to make sure they are functional and will release any accumulated air, then retest the pumps.
2. Exchanging one of the pumps with the spare, then retest the pumps.
3. Opening the piping in the leachate building to inspect the inside of the piping for leachate precipitate or scale, then address the scale as needed via chemicals, pigging, or select replacement of piping.

As a starting point, and assuming that both existing pumps are impacted, we have included costs for shipping and servicing the both influent pumps in Anchorage. These costs, a total of $12,000, will cover replacement of the pumps if required.

5.4 Baler Building Insulation

As noted in Section 3.1.1, the baler building insulation has been damaged from the inside by birds. Repair/replacement of the insulation, and the installation of a protective PVC liner have already been programmed into the City's budget for FY 2019. The programmed cost of the repairs is $537,000.

5.5 Composting System

CH2M's estimate for full-scale compost system design, permitting and construction, $3.4 million, has been added to the CIP list for FY2020 (design and permitting) and FY2021 (construction). Engineering services during construction has also been added to the CIP list for FY2021 at 15% of the construction cost. Components of this system are described in the Composting Conceptual Technical Memorandum in Attachment 3. To confirm system details and costs, preliminary design and cost estimate, and a pilot test have also been added to the CIP for FY2019. The preliminary design will include site layout, evaluation of geotechnical conditions for building, site utilities, and Association for the Advancement of Cost Engineering Class 3 cost estimate. The preliminary design task includes a site visit for City personnel to visit the Kodiak composting system to visualize the system we are costing and ask the Kodiak operators questions about facilities, equipment, operations, raw materials, and finished compost. The pilot test will be used to evaluate the availability and feasibility of separating food waste and providing a sufficient mix of bulking agent. The preliminary design and pilot test are estimated at $97,000 and $184,000, respectively. The pilot test estimate includes labor and pilot test equipment.

5.6 Gasification Detailed Analysis

Based on the analyses in this Master Plan, the economic case for switching from landfilling to gasification appears solid, even without including the potential for waste heat recovery that should also be evaluated through further analysis. Further analysis should be conducted to confirm feedstock types and properties, waste feed rate requirements and variability, infrastructure requirements including emissions controls and costs, potential for waste heat recovery, and to develop and implement a community communication plan. We have included a ROM cost of $100,000 for further analysis including waste characterization. The waste characterization would ideally include sampling and analysis once per month for a year. Minimum, average, and maximum waste feed rates need to be confirmed for use as the design basis for the gasification system.

Alternatives Evaluation Financial Model

Unalaska Disposal Alternatives Evaluation																							
Alternatives Evaluation																							
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Present Value	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**FY 2029**	**FY 2030**	**FY 2031**	**FY 2032**	**FY 2033**	**FY 2034**	**FY 2035**	**FY 2036**	**FY 2037**	**FY 2038**
Annual Tons	161,629	7,159	7,374	7,595	7,823	8,058	8,299	8,548	8,805	9,069	9,341	9,621	9,910	10,207	10,513	10,829	11,154	11,488	11,833	12,188	12,553	12,930	13,318
Alternative 1 - Landfill																							
Baler and landfill operations	$66,126,000	$3,138,359	$3,291,000	$3,370,000	$3,451,000	$3,533,000	$3,618,000	$3,705,000	$3,794,000	$3,885,000	$3,978,000	$4,074,000	$4,172,000	$4,272,000	$4,374,000	$4,479,000	$4,587,000	$4,697,000	$4,810,000	$4,925,000	$5,043,000	$5,164,000	$5,288,000
Landfill cell construction	$13,071,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,295,000	$0	$0	$0	$0	$0	$0	$9,658,000	$0	$0	$0	$10,464,000	$0
Baler building insulation	$487,000	$0	$0	$537,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,407,000	$0	$0	$0	$0	$0	$1,118,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Leachate tank and force main	$5,823,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,033,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill Closure/Post-Closure contribution	$3,989,000	$0	$140,702	$148,401	$156,521	$165,086	$174,120	$183,647	$193,697	$204,296	$215,475	$227,266	$239,701	$252,818	$266,652	$281,243	$296,633	$312,865	$329,985	$348,041	$367,086	$387,173	$408,359
Total Expenditures	**$90,903,000**	**$3,138,359**	**$3,431,702**	**$4,055,421**	**$3,607,521**	**$3,698,086**	**$4,910,120**	**$3,888,647**	**$3,987,697**	**$4,089,296**	**$20,521,475**	**$4,301,266**	**$4,411,701**	**$4,524,818**	**$4,640,652**	**$4,760,243**	**$4,883,633**	**$14,667,865**	**$5,139,985**	**$5,273,041**	**$5,410,086**	**$16,015,173**	**$5,696,359**
Levelized $/ton	**$562**																						
Alternative 2 - Landfill with Composting																							
Baler and landfill operations	$61,782,000	$2,932,248	$3,075,000	$3,148,000	$3,224,000	$3,301,000	$3,381,000	$3,462,000	$3,545,000	$3,630,000	$3,717,000	$3,806,000	$3,898,000	$3,991,000	$4,087,000	$4,185,000	$4,285,000	$4,388,000	$4,494,000	$4,602,000	$4,712,000	$4,825,000	$4,941,000
Landfill cell construction	$12,033,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,833,000	$0	$0	$0	$0	$0	$0	$10,370,000	$0	$0
Baler building insulation	$487,000	$0	$0	$537,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,338,000	$0	$0	$0	$0	$0	$0	$0	$1,172,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Leachate tank and force main	$5,401,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,699,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Composting	$10,902,000	$0	$0	$3,687,000	$429,497	$439,805	$450,360	$461,169	$472,237	$483,570	$495,176	$507,060	$519,230	$531,691	$544,452	$557,519	$570,899	$584,601	$598,631	$612,998	$627,710	$642,775	$658,202
Landfill Closure/Post-Closure contribution	$3,615,000	$0	$118,484	$124,967	$131,805	$139,018	$146,625	$154,648	$163,111	$172,036	$181,450	$191,379	$201,851	$212,896	$224,546	$236,833	$249,793	$263,461	$277,878	$293,083	$309,121	$326,036	$343,877
Total Expenditures	**$95,558,000**	**$2,932,248**	**$3,193,484**	**$7,496,987**	**$3,785,302**	**$3,879,823**	**$3,977,985**	**$4,077,817**	**$5,352,347**	**$4,285,606**	**$4,393,626**	**$4,504,439**	**$4,619,081**	**$22,267,588**	**$4,855,998**	**$4,979,352**	**$5,105,692**	**$5,236,062**	**$5,370,509**	**$5,508,082**	**$16,018,831**	**$5,793,811**	**$5,943,079**
Levelized $/ton	**$591**																						
Alternative 3 - Bale and Barge																							
Baler and landfill operations	$14,913,000	$3,138,359	$3,291,000	$3,370,000	$3,451,000	$3,533,000	$3,618,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$537,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,407,000	$0	$0	$0	$0	$0	$1,118,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bale and Barge Loading Operation	$25,606,000	$0	$0	$0	$0	$0	$0	$1,852,500	$1,897,000	$1,942,500	$1,989,000	$2,037,000	$2,086,000	$2,136,000	$2,187,000	$2,239,500	$2,293,500	$2,348,500	$2,405,000	$2,462,500	$2,521,500	$2,582,000	$2,644,000
Barge and Dispose at ($550/ton)	$106,770,000	$0	$0	$0	$0	$0	$0	$5,420,524	$5,717,135	$6,029,977	$6,359,937	$6,707,953	$7,075,012	$7,462,157	$7,870,486	$8,301,159	$8,755,398	$9,234,494	$9,739,805	$10,272,767	$10,834,893	$11,427,779	$12,053,107
Landfill Closure/Post-Closure contribution	$320,000	$0	$66,604	$70,249	$74,093	$78,147	$82,423	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$149,503,000**	**$3,138,359**	**$3,357,604**	**$3,977,269**	**$3,525,093**	**$3,611,147**	**$4,818,423**	**$7,273,024**	**$7,614,135**	**$7,972,477**	**$8,348,937**	**$8,744,953**	**$9,161,012**	**$9,598,157**	**$10,057,486**	**$10,540,659**	**$11,048,898**	**$11,582,994**	**$12,144,805**	**$12,735,267**	**$13,356,393**	**$14,009,779**	**$14,697,107**
Levelized $/ton	**$925**																						
Alternative 4 - Gasification																							
Baler and landfill operations	$14,913,000	$3,138,359	$3,291,000	$3,370,000	$3,451,000	$3,533,000	$3,618,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$537,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier unit and replacement	$4,859,000	$0	$0	$0	$0	$0	$4,846,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,819,000	$0
Gasifier operations	$51,736,000	$0	$0	$0	$0	$0	$0	$3,555,071	$3,650,384	$3,748,531	$3,849,610	$3,953,723	$4,060,976	$4,171,481	$4,285,350	$4,402,706	$4,523,671	$4,648,377	$4,776,959	$4,909,559	$5,046,323	$5,187,406	$5,332,967
Landfill Closure/Post-Closure contribution	$500,000	$0	$104,033	$109,726	$115,730	$122,062	$128,742	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$72,495,000**	**$3,138,359**	**$3,395,033**	**$4,016,746**	**$3,566,730**	**$3,655,062**	**$8,592,742**	**$3,555,071**	**$3,650,384**	**$3,748,531**	**$3,849,610**	**$3,953,723**	**$4,060,976**	**$4,171,481**	**$4,285,350**	**$4,402,706**	**$4,523,671**	**$4,648,377**	**$4,776,959**	**$4,909,559**	**$5,046,323**	**$8,006,406**	**$5,332,967**
Levelized $/ton	**$449**																						
Alternative 5 - Gasification with Composting																							
Baler and landfill operations	$14,913,000	$3,138,359	$3,291,000	$3,370,000	$3,451,000	$3,533,000	$3,618,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$537,020	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier unit and replacement	$4,859,000	$0	$0	$0	$0	$0	$4,846,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,819,000	$0
Gasifier operations	$51,736,000	$0	$0	$0	$0	$0	$0	$3,555,071	$3,650,384	$3,748,531	$3,849,610	$3,953,723	$4,060,976	$4,171,481	$4,285,350	$4,402,706	$4,523,671	$4,648,377	$4,776,959	$4,909,559	$5,046,323	$5,187,406	$5,332,967
Composting	$10,902,000	$0	$0	$3,687,000	$429,497	$439,805	$450,360	$461,169	$472,237	$483,570	$495,176	$507,060	$519,230	$531,691	$544,452	$557,519	$570,899	$584,601	$598,631	$612,998	$627,710	$642,775	$658,202
Landfill Closure/Post-Closure contribution	$500,000	$0	$104,033	$109,726	$115,730	$122,062	$128,742	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$83,397,000**	**$3,138,359**	**$3,395,033**	**$7,703,746**	**$3,996,226**	**$4,094,867**	**$9,043,102**	**$4,016,239**	**$4,122,620**	**$4,232,101**	**$4,344,786**	**$4,460,783**	**$4,580,206**	**$4,703,172**	**$4,829,802**	**$4,960,224**	**$5,094,570**	**$5,232,978**	**$5,375,590**	**$5,522,557**	**$5,674,033**	**$8,649,181**	**$5,991,169**
Levelized $/ton	**$516**																						

Unalaska Disposal Alternatives Evaluation

Alternatives Evaluation

		22	23	24	25	26	27	28	29	30
	Present Value	**FY 2039**	**FY 2040**	**FY 2041**	**FY 2042**	**FY 2043**	**FY 2044**	**FY 2045**	**FY 2046**	**FY 2047**
Annual Tons	161,629	13,717	14,129	14,553	14,989	15,439	15,902	16,379	16,871	17,377
Alternative 1 - Landfill										
Baler and landfill operations	$66,126,000	$5,415,000	$5,545,000	$5,678,000	$5,814,000	$5,954,000	$6,097,000	$6,243,000	$6,393,000	$3,138,000
Landfill cell construction	$13,071,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,407,000	$0	$0	$0	$1,797,000	$0	$0	$0	$0	$0
Leachate tank and force main	$5,823,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill Closure/Post-Closure contribution	$3,989,000	$430,705	$454,273	$479,131	$505,349	$533,002	$562,167	$592,929	$0	$0
Total Expenditures	**$90,903,000**	**$5,845,705**	**$5,999,273**	**$6,157,131**	**$8,116,349**	**$6,487,002**	**$6,659,167**	**$6,835,929**	**$6,393,000**	**$3,138,000**
Levelized $/ton	**$562**									
Alternative 2 - Landfill with Composting										
Baler and landfill operations	$61,782,000	$5,059,000	$5,181,000	$5,305,000	$5,432,000	$5,563,000	$5,696,000	$5,833,000	$5,973,000	$2,932,000
Landfill cell construction	$12,033,000	$0	$0	$11,506,000	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,338,000	$0	$0	$0	$0	$0	$1,884,000	$0	$0	$0
Leachate tank and force main	$5,401,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Composting	$10,902,000	$673,999	$690,175	$706,739	$723,701	$741,069	$758,855	$777,068	$795,717	$814,814
Landfill Closure/Post-Closure contribution	$3,615,000	$362,694	$382,540	$403,473	$425,551	$448,837	$473,397	$499,302	$526,624	$555,440
Total Expenditures	**$95,558,000**	**$6,095,692**	**$6,253,715**	**$17,921,212**	**$6,581,251**	**$6,752,906**	**$8,812,252**	**$7,109,369**	**$7,295,341**	**$4,302,255**
Levelized $/ton	**$591**									
Alternative 3 - Bale and Barge										
Baler and landfill operations	$14,913,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replace baler (20 yrs, with shipping, demo, insta	$1,407,000	$0	$0	$0	$1,797,000	$0	$0	$0	$0	$0
Bale and Barge Loading Operation	$25,606,000	$2,707,500	$2,772,500	$2,839,000	$2,907,000	$2,977,000	$3,048,500	$3,121,500	$3,196,500	$1,569,000
Barge and Dispose at ($550/ton)	$106,770,000	$12,712,653	$13,408,289	$14,141,991	$14,915,840	$15,732,035	$16,592,892	$17,500,855	$18,458,502	$19,468,551
Landfill Closure/Post-Closure contribution	$320,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$149,503,000**	**$15,420,153**	**$16,180,789**	**$16,980,991**	**$19,619,840**	**$18,709,035**	**$19,641,392**	**$20,622,355**	**$21,655,002**	**$21,037,551**
Levelized $/ton	**$925**									
Alternative 4 - Gasification										
Baler and landfill operations	$14,913,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier unit and replacement	$4,859,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier operations	$51,736,000	$5,483,175	$5,638,203	$5,798,234	$5,963,458	$6,134,074	$6,310,289	$6,492,320	$6,680,393	$6,874,745
Landfill Closure/Post-Closure contribution	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$72,495,000**	**$5,483,175**	**$5,638,203**	**$5,798,234**	**$5,963,458**	**$6,134,074**	**$6,310,289**	**$6,492,320**	**$6,680,393**	**$6,874,745**
Levelized $/ton	**$449**									
Alternative 5 - Gasification with Composting										
Baler and landfill operations	$14,913,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Landfill cell construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Baler building insulation	$487,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier unit and replacement	$4,859,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Gasifier operations	$51,736,000	$5,483,175	$5,638,203	$5,798,234	$5,963,458	$6,134,074	$6,310,289	$6,492,320	$6,680,393	$6,874,745
Composting	$10,902,000	$673,999	$690,175	$706,739	$723,701	$741,069	$758,855	$777,068	$795,717	$814,814
Landfill Closure/Post-Closure contribution	$500,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenditures	**$83,397,000**	**$6,157,173**	**$6,328,377**	**$6,504,973**	**$6,687,158**	**$6,875,143**	**$7,069,144**	**$7,269,387**	**$7,476,110**	**$7,689,559**
Levelized $/ton	**$516**									

Cost Estimates from CostPerTon_Alts.xlsx

All costs in 2017$

Baling and landfill operations	Landfill	Composting	Barging	Gasification	Gas/Compost	Source
Annual cost	$3,138,359	$2,932,248	$3,138,359	$3,138,359	$3,138,359	FY2016 operations cost $2,776,439 (J.R. Pearson, Solid Waste Management Plan)
Number of years	All	All	5	5	5	
Replace baler	$2,000,000	$2,000,000	$0	$0	$0	Estimate
Yrs between replacements	20	20	n.a.	n.a.	n.a.	
Cell construction						Cells II-1/2 are actual costs (design and construct); other costs from Unalaska LF Expansion, Estimate of Costs, BEESC, 2006
Cells II-1/2	$0	$0	$0	$0	$0	
Cell II-3	$5,893,000	$5,893,000	$0	$0	$0	
Cell II-5	$6,608,000	$6,608,000	$0	$0	$0	
Cell II-4	$6,512,000	$6,512,000	$0	$0	$0	
Year of Construction						CH2M Estimate
Cell II-3	2026	2029	n.a.	n.a.	n.a.	
Cell II-5	2033	2036	n.a.	n.a.	n.a.	
Cell II-4	2037	2041	n.a.	n.a.	n.a.	
Closure						Unalaska LF Expansion, Estimate of Costs, BEESC, 2006
Area 2	$336,000	$336,000	$336,000	$336,000	$336,000	
Area 3 (Cells II-1/2)	$628,000	$628,000	$628,000	$628,000	$628,000	
Area 4 (Cells II-1/2)	$1,022,000	$1,022,000	$1,022,000	$1,022,000	$1,022,000	
Area 5 (Cell II-3)	$1,171,000	$1,171,000	$0	$0	$0	
Area 6 (Cell II-5)	$1,189,000	$1,189,000	$0	$0	$0	
Area 7 (Cell II-4)	$1,875,000	$1,875,000	$0	$0	$0	
Year of Closure						CH2M Estimate
Area 2	2018	2018	2018	2018	2018	
Area 3 (Cells II-1/2)	2028	2030	2023	2053	2053	
Area 4 (Cells II-1/2)	2028	2030	2023	2023	2023	
Area 5 (Cell II-3)	2034	2037	n.a.	n.a.	n.a.	
Area 6 (Cell II-5)	2039	2042	n.a.	n.a.	n.a.	
Area 7 (Cell II-4)	2045	2049	n.a.	n.a.	n.a.	
Post-Closure Care (Annual $ for 30 years)	$113,000	$113,000	$103,000	$103,000	$103,000	

Landfill Capital Costs	Landfill	Composting				Jun-17	2012/06	Escalation	
Second leachate tank	$6,172,000	$6,172,000		$6,600,000	2012$	178.7	191.1	0.94	1072 Metal Tanks
Force main upgrade	$1,300,000	$1,300,000		$520,000	2006$	228.2	91.3	2.50	0729 Other plastic products
Year costs incurred	2026	2029							

Source: BLS, Table 6 (or 9). Producer price indexes and percent changes for commodity and service groupings and individual items, not seasonally adjusted

Composting Cost	Composting	
Biosolids	$2,034,000	
Food	$1,400,000	
Annual O&M	$400,000	Includes additional $120,000 for full time operator for addition of food waste

	Barging	Gasification	Source
Bale and Barge			
Annual cost - City operations	$1,569,180		Estimate 50% of FY2016 operations cost, professional judgement, $2,776,439 (J.R. Pearson, Solid Waste Management Plan)
Annual cost - Long-haul	$550		Per ton cost to load, transport, and dispose: turnkey estimate provided by Waste Management Inc
Initial year	6		
Gasifier capital			
Original unit		$1,754,000	Assume double the Dillingham actual costs. Assume one full replacement during 30yr life
Building		$2,500,000	Assume new building per City of Unalaska comment on draft Master Plan
Scrubber TBD		$0	Potential future requirement, estimated at $100K for PM scrubber if it were installed today
Tire shredder		$50,000	Internet search, 1 ton/day needed. Most units shred 1 ton/hr
Total Capital Cost		$4,304,000	
Year capital $ spent		5	
Gasifier operations			
Annual cost		$2,776,439	Sort waste, operate gasifier, landfill ash (assume 100% of current operations, per discussion with City of Unalaska)
Diesel fuel ($/ton)		$33	13.9 gal/ton (Jenkins) x $3.00/gal (Pacific Fuels verbal quote $2.60, 4/11/17)
Annual cost of replacement parts		$25,000	Assume $25,000/yr, from Dillingham actuals and professional judgement
Year operations start		6	
		11.0	gal/ton (estimate based on higher heating value with tires and nets)
		$3.0	$/gallon
		$33	$/ton

Dillingham Gasifier Unit	$850,000	2014 dollars
CPI-U, US City Average https://www.bls.gov/regions/mid-atlantic/data/ConsumerPriceIndexHistorical_US_Table.htm		
Mar-14	236.293	
Mar-17	243.801	
Escalation	1.032	
Gasifier Unit in 2017$	$877,000	

FY 2016 Landfill Operations Cost	$1,374,073
15% reduction if composting	$206,111

Closure / Post-Closure Fund Contribution Calculation

Alternative No. 1 Landfilling

Rates:
Rate of Inflation = 2.4%
Interest Rate Earned = 1.5%

To Estimate Closure Fund Contribution	
- Select: Data, What-If Analysis, Goal Seek.	
- Set Cell: H9 ----------------------------->	$0
- To Value: 0	
- By Changing Cell: G18	

Year	Closure Costs	Post-Closure Costs	Fund Contribution	Fund Balance	Notes	
2017	$0		$0	$5,467,661	Estimated based on balance from City	
2018	$344,000		$140,702	$5,347,432	Consolidated Balance Sheet for Mar, 2017	
2019	$0		$148,401	$5,577,158		
2020	$0		$156,521	$5,818,510		
2021	$0		$165,086	$6,072,112		
2022	$0		$174,120	$6,338,619		
2023	$0		$183,647	$6,618,723		
2024	$0		$193,697	$6,913,153	**Closure Years**	
2025	$0		$204,296	$7,222,679	Area 2	2018
2026	$0		$215,475	$7,548,110	Area 3	2028
2027	$0		$227,266	$7,890,301	Area 4	2028
2028	$2,142,000		$239,701	$6,108,155	Area 5	2034
2029	$0		$252,818	$6,454,491	Area 6	2039
2030	$0		$266,652	$6,819,961	Area 7	2045
2031	$0		$281,243	$7,205,613		
2032	$0		$296,633	$7,612,555		
2033	$0		$312,865	$8,041,954		
2034	$1,752,000		$329,985	$6,743,043		
2035	$0		$348,041	$7,194,841		
2036	$0		$367,086	$7,672,603		
2037	$0		$387,173	$8,177,769		
2038	$0		$408,359	$8,711,857		
2039	$2,003,000		$430,705	$7,273,470		
2040	$0		$454,273	$7,840,253		
2041	$0		$479,131	$8,440,581		
2042	$0		$505,349	$9,076,328		
2043	$0		$533,002	$9,749,472		
2044	$0		$562,167	$10,462,098		
2045	$3,643,000		$592,929	$7,573,406		
2046	$0	$224,790	$0	$7,462,216		
2047	$0	$230,185	$0	$7,343,965		
2048	$0	$235,710	$0	$7,218,415		
2049	$0	$241,367	$0	$7,085,324		
2050	$0	$247,159	$0	$6,944,445		
2051	$0	$253,091	$0	$6,795,520		
2052	$0	$259,165	$0	$6,638,288		
2053	$0	$265,385	$0	$6,472,477		
2054	$0	$271,755	$0	$6,297,809		
2055	$0	$278,277	$0	$6,114,000		
2056	$0	$284,955	$0	$5,920,755		
2057	$0	$291,794	$0	$5,717,772		
2058	$0	$298,797	$0	$5,504,741		
2059	$0	$305,968	$0	$5,281,344		
2060	$0	$313,312	$0	$5,047,252		
2061	$0	$320,831	$0	$4,802,130		
2062	$0	$328,531	$0	$4,545,631		
2063	$0	$336,416	$0	$4,277,399		
2064	$0	$344,490	$0	$3,997,070		
2065	$0	$352,758	$0	$3,704,269		
2066	$0	$361,224	$0	$3,398,609		
2067	$0	$369,893	$0	$3,079,695		
2068	$0	$378,771	$0	$2,747,120		
2069	$0	$387,861	$0	$2,400,466		
2070	$0	$397,170	$0	$2,039,303		
2071	$0	$406,702	$0	$1,663,191		
2072	$0	$416,463	$0	$1,271,676		
2073	$0	$426,458	$0	$864,293		
2074	$0	$436,693	$0	$440,565		
2075	$0	$447,173	$0	**$0**		

Closure / Post-Closure Fund Contribution Calculation

Alternative No. 2 Landfilling with Composting

Rates:
Rate of Inflation = 2.4%
Interest Rate Earned = 1.5%

To Estimate Closure Fund Contribution	
- Select: Data, What-If Analysis, Goal Seek.	
- Set Cell: H9 ----------------------------->	$0
- To Value: 0	
- By Changing Cell: G18	

Year	Closure Costs	Post-Closure Costs	Fund Contribution	Fund Balance	Notes	
2017	$0		$0	$5,467,661	Estimated based on balance from City	
2018	$344,000		$118,484	$5,325,048	Consolidated Balance Sheet for Mar, 2017	
2019	$0		$124,967	$5,530,828		
2020	$0		$131,805	$5,746,585		
2021	$0		$139,018	$5,972,844		
2022	$0		$146,625	$6,210,161		
2023	$0		$154,648	$6,459,122		
2024	$0		$163,111	$6,720,343	**Closure Years**	
2025	$0		$172,036	$6,994,474	Area 2	2018
2026	$0		$181,450	$7,282,202	Area 3	2030
2027	$0		$191,379	$7,584,249	Area 4	2030
2028	$0		$201,851	$7,901,378	Area 5	2037
2029	$0		$212,896	$8,234,391	Area 6	2042
2030	$2,246,000		$224,546	$6,338,137	Area 7	2049
2031	$0		$236,833	$6,671,819		
2032	$0		$249,793	$7,023,562		
2033	$0		$263,461	$7,394,353		
2034	$0		$277,878	$7,785,230		
2035	$0		$293,083	$8,197,290		
2036	$0		$309,121	$8,631,689		
2037	$1,882,000		$326,036	$7,207,646		
2038	$0		$343,877	$7,662,216		
2039	$0		$362,694	$8,142,563		
2040	$0		$382,540	$8,650,111		
2041	$0		$403,473	$9,186,362		
2042	$2,151,000		$425,551	$7,601,900		
2043	$0		$448,837	$8,168,132		
2044	$0		$473,397	$8,767,601		
2045	$0		$499,302	$9,402,162		
2046	$0		$526,624	$10,073,768		
2047	$0		$555,440	$10,784,480		
2048	$0		$585,834	$11,536,475		
2049	$4,005,000		$617,891	$8,327,047		
2050	$0	$247,159	$0	$8,204,794		
2051	$0	$253,091	$0	$8,074,775		
2052	$0	$259,165	$0	$7,936,731		
2053	$0	$265,385	$0	$7,790,396		
2054	$0	$271,755	$0	$7,635,498		
2055	$0	$278,277	$0	$7,471,754		
2056	$0	$284,955	$0	$7,298,875		
2057	$0	$291,794	$0	$7,116,564		
2058	$0	$298,797	$0	$6,924,515		
2059	$0	$305,968	$0	$6,722,414		
2060	$0	$313,312	$0	$6,509,939		
2061	$0	$320,831	$0	$6,286,756		
2062	$0	$328,531	$0	$6,052,527		
2063	$0	$336,416	$0	$5,806,899		
2064	$0	$344,490	$0	$5,549,512		
2065	$0	$352,758	$0	$5,279,997		
2066	$0	$361,224	$0	$4,997,974		
2067	$0	$369,893	$0	$4,703,050		
2068	$0	$378,771	$0	$4,394,825		
2069	$0	$387,861	$0	$4,072,887		
2070	$0	$397,170	$0	$3,736,810		
2071	$0	$406,702	$0	$3,386,161		
2072	$0	$416,463	$0	$3,020,490		
2073	$0	$426,458	$0	$2,639,340		
2074	$0	$436,693	$0	$2,242,237		
2075	$0	$447,173	$0	$1,828,697		
2076	$0	$457,906	$0	$1,398,222		
2077	$0	$468,895	$0	$950,300		
2078	$0	$480,149	$0	$484,406		
2079	$0	$491,672	$0	**$0**		

Alternative No. 3 Bale and Barge

Rates:
Rate of Inflation = 2.4%
Interest Rate Earned = 1.5%

To Estimate Closure Fund Contribution	
- Select: Data, What-If Analysis, Goal Seek.	
- Set Cell: H9 ----------------------------->	($0)
- To Value: 0	
- By Changing Cell: G18	

Year	Closure Costs	Post-Closure Costs	Fund Contribution	Fund Balance	Notes	
2017	$0		$0	$5,467,661	Estimated based on balance from City	
2018	$344,000		$66,604	$5,272,779	Consolidated Balance Sheet for Mar, 2017	
2019	$0		$70,249	$5,422,647		
2020	$0		$74,093	$5,578,635		
2021	$0		$78,147	$5,741,048		
2022	$0		$82,423	$5,910,205		
2023	$1,902,000		$0	$4,096,858		
2024	$0	$121,601	$0	$4,036,710	Closure Years	
2025	$0	$124,519	$0	$3,972,742	Area 2	2018
2026	$0	$127,508	$0	$3,904,825	Area 3	2023
2027	$0	$130,568	$0	$3,832,829	Area 4	2023
2028	$0	$133,702	$0	$3,756,620		
2029	$0	$136,910	$0	$3,676,059		
2030	$0	$140,196	$0	$3,591,003		
2031	$0	$143,561	$0	$3,501,307		
2032	$0	$147,007	$0	$3,406,820		
2033	$0	$150,535	$0	$3,307,388		
2034	$0	$154,148	$0	$3,202,851		
2035	$0	$157,847	$0	$3,093,047		
2036	$0	$161,635	$0	$2,977,808		
2037	$0	$165,515	$0	$2,856,960		
2038	$0	$169,487	$0	$2,730,327		
2039	$0	$173,555	$0	$2,597,728		
2040	$0	$177,720	$0	$2,458,974		
2041	$0	$181,985	$0	$2,313,873		
2042	$0	$186,353	$0	$2,162,228		
2043	$0	$190,825	$0	$2,003,836		
2044	$0	$195,405	$0	$1,838,489		
2045	$0	$200,095	$0	$1,665,971		
2046	$0	$204,897	$0	$1,486,063		
2047	$0	$209,815	$0	$1,298,540		
2048	$0	$214,850	$0	$1,103,168		
2049	$0	$220,007	$0	$899,708		
2050	$0	$225,287	$0	$687,917		
2051	$0	$230,694	$0	$467,542		
2052	$0	$236,230	$0	$238,325		
2053	$0	$241,900	$0	**($0)**		

Alternatives 4 and 5 Gasification and Gasification with Composting

Rates:
Rate of Inflation = 2.4%
Interest Rate Earned = 1.5%

To Estimate Closure Fund Contribution	
- Select: Data, What-If Analysis, Goal Seek.	
- Set Cell: H9 ----------------------------->	($0)
- To Value: 0	
- By Changing Cell: G18	

Year	Closure Costs	Post-Closure Costs	Fund Contribution	Fund Balance	Notes
2017	$0		$0	$5,467,661	Estimated based on balance from City Consolidated
2018	$344,000		$104,033	$5,310,489	Balance Sheet for Mar, 2017
2019	$0		$109,726	$5,500,694	
2020	$0		$115,730	$5,699,802	
2021	$0		$122,062	$5,908,277	
2022	$0		$128,742	$6,126,609	
2023	$1,178,000		$0	$5,040,508	
2024	$0	$121,601	$0	$4,994,515	Closure Years
2025	$0	$124,519	$0	$4,944,913	Area 2 2018
2026	$0	$127,508	$0	$4,891,579	Area 3 2053 Area 3 closure date is
2027	$0	$130,568	$0	$4,834,384	Area 4 2023 2053, the final year of
2028	$0	$133,702	$0	$4,773,199	the analysis.
2029	$0	$136,910	$0	$4,707,886	
2030	$0	$140,196	$0	$4,638,308	
2031	$0	$143,561	$0	$4,564,322	
2032	$0	$147,007	$0	$4,485,780	
2033	$0	$150,535	$0	$4,402,532	
2034	$0	$154,148	$0	$4,314,422	
2035	$0	$157,847	$0	$4,221,292	
2036	$0	$161,635	$0	$4,122,976	
2037	$0	$165,515	$0	$4,019,306	
2038	$0	$169,487	$0	$3,910,108	
2039	$0	$173,555	$0	$3,795,205	
2040	$0	$177,720	$0	$3,674,413	
2041	$0	$181,985	$0	$3,547,544	
2042	$0	$186,353	$0	$3,414,405	
2043	$0	$190,825	$0	$3,274,795	
2044	$0	$195,405	$0	$3,128,512	
2045	$0	$200,095	$0	$2,975,345	
2046	$0	$204,897	$0	$2,815,078	
2047	$0	$209,815	$0	$2,647,489	
2048	$0	$214,850	$0	$2,472,352	
2049	$0	$220,007	$0	$2,289,430	
2050	$0	$225,287	$0	$2,098,485	
2051	$0	$230,694	$0	$1,899,268	
2052	$0	$236,230	$0	$1,691,527	
2053	$1,475,000	$241,900	$0	**($0)**	

Figures

FIGURE 5-1
Leachate Force Main
City of Unalaska
Landfill Master Plan

Attachment 1
Wastewater & Landfill Master Plan
Site Visit Summary

MEETING SUMMARY

Wastewater & Landfill Master Plan Site Visit Summary

ATTENDEES:	Rebecca Venot/CH2M Karla Kasick/CH2M Cory Hinds/CH2M	J.R. Pearson/City of Unalaska Don Lane/City of Unalaska BJ Cross/City of Unalaska Robert Lund/City of Unalaska
COPY TO:	Floyd Damron/CH2M	
PREPARED BY:	Rebecca Venot, Karla Kasick, and Cory Hinds	
DATE:	February 20-23, 2017	
PROJECT:	690297 (Solid Waste) and 690823 (Wastewater)	

Monday February 20

The CH2M team arrived at 12:30 pm on Monday February 20, 2017. They met with J.R. Pearson in the afternoon to discuss his vision for the plan, and the details of the kickoff meeting and schedule for the site visits.

HDR is not yet under contract for the water master plan, but will be soon and can provide population and flow data. Since FY 2001, Landfilled solid waste growth has averaged 3.8% per year; a 61% increase of baled landfilled material. The population has not changed significantly in many years, but analysis of electrical utility residential customers, all of whom are metered, shows that the average growth rate from 2004 through 2016 is 0.6%.

The master plans should consider labor needs. The landfill is dramatically understaffed, the wastewater plant received funding for new staff during the WWTP improvements.

Note: In the discussion about labor, it should be noted that over the past 12 plus years, Landfill personnel have been required to do virtually all mechanical repairs and maintenance of the baler, and more recently the leachate facility. Prior to that, the Public Works Department (we are Public Utilities) provided skilled welders for nearly all the maintenance on the baler. The Landfill is now baling tires and have more cells and roads to upkeep.

Tuesday February 21

Notes from meeting at DPW:

Tuesday morning, the team met with J.R. (Deputy Director of Public Utilities), Don Lane (WWTP Manager), BJ Cross (Landfill Manager), and Robert Lund (City Engineer) at the Department of Public Works building to discuss the two plans, the landfill and wastewater supervisors and city engineer's desires for the planning documents, and the data needs.

Plan Goals

The goal of the plans is for it to be a tool for management to communicate to Council effectively. The capital improvements should be easy to follow and clearly justifiable. The Plans will be a tool for securing funding from City Council, so needs to justify improvements using regulations, industry standards, operational improvements, and cost savings.

Executive summary needs to be clear and concise to help with funding requests.

CH2M staff will be sensitive to operator wish lists; justification needs to be provided.

Schedule driver for the Master Plans is the need to have the content for inclusion in the Capital Major Maintenance Program (CMMP), which needs to be ready by October 1, then finalized before Christmas.

Notes from site visits to WWTP and Landfill:

Baler Facility

City would like a weather station (to be used to record data for future design changes) to be included at the landfill. They feel that the weather at the landfill is sufficiently different from other locations like the airport.

Waste is handled at the baler facility as follows: Incoming waste from commercial clients arrives in steel bins on trucks. Trucks are weighed in and out. Waste is dumped onto the tipping floor in the baler building and materials that are not acceptable for the baler are removed and segregated (e.g., scrap metal, rope/nets, large scrap wood/pallets, tires, etc.). Waste that is removed from the tipping floor is aggregated, weighed, then transported to the landfill for segregated storage. Remaining waste is pushed with a loader to the steel conveyor which feeds the baler.

The baler is a Mosely Badger (Badger is the model, their smallest unit), purchased in 1997. The baler has a 100-hp electric motor driving two hydraulic rams. The first ram is horizontal, compressing the waste, and the second is horizontal to eject the bale. Bales are ejected into woven poly bags (Enviro Bale system), tied by hand, then pushed directly onto the City's flatbed truck. When the truck has 5 bales, it is driven across the scale to record total landfilled weight then out to the landfill and the bags are dumped near the working face. Bales are stacked with a loader.

Residential waste is self-hauled and dumped in bins inside the baler doors. This waste is not weighed, but is estimated as the difference between the incoming commercial and the total weight of bales outgoing to the landfill.

BJ Cross and his crew rebuilt various plates and components of the baler and conveyor recently. The baler is currently beyond its expected lifespan. BJ expects the baler/conveyor will run for another 5 years at least.Bale Placement in Landfill

Bales are stacked in the landfill to required side slopes. Soil cover is placed on side slopes and between lifts. One lift is 4 bales high. Fine-grained soil is placed on the side slopes to minimize leachate breakout on the side slopes. Coarse-grained soil (3" minus) is placed on top of each lift for infiltration and driving surface. Stockpiles of the fine-grained soil and coarse-grained soil are maintained at the landfill.

Dewatered, lime-treated solids from the WWTP (approximately 42% solids) is transported in Supersacks® and stacked with bales in the landfill. Sometimes the solids bags are cut open to fill voids. Mostly they remain intact.

Inerts

Stockpiles of inert wastes, including scrap metal, nets and ropes, junk cars, tires (loose and baled) and construction/demolition (C&D) wastes are maintained at the landfill. Scrap metal and junk cars are removed via contract periodically. Baled tires are made available for local construction projects.

Cell Leachate Pumping

Leachate from the closed landfill (Phase 1 Cells 1-4) flows via gravity to the Landfill Lift Station (LLS). It is then pumped into the leachate storage/equalization tank (Storage Tank). Leachate from Phase 2 Cells 2-1 and 2-2 (aka Cells 5 and 6) is pumped (Cell 6 is active), or will be pumped (Cell 5 is not yet active) directly to the Leachate Equipment Building and to the Storage Tank. Leachate from Cell 6 is pumped via submersible side slope pump from within the cell.

Leachate Pumping/Treatment

Leachate in the Storage Tank is aerated to remove volatiles and decrease BOD. Leachate is recirculated to keep the solids in suspension till it reaches the WWTP. Citric acid is used as a descaling agent in the leachate piping between the Leachate Equipment Treatment Building and the Storage Tank.

DO is controlled in semi-auto by timer on aeration. Older DO probes have not worked well due to clogging. During initial filling of Cell 5, leachate was found to be highly concentrated (high BOD). As more bales are stacked in Cell 5, the concentration of BOD has decreased somewhat. This may be due to natural filtration through the bales. It is possible that use of the DO probes could be restarted for better DO control and less energy consumption now that the BOD concentration has decreased.

A significant problem with the leachate collection and pretreatment system is that leachate pumping system cannot keep up with leachate flows into the treatment system during significant rain events. Reason for this is that flow into the Storage Tank is restricted to one 4” diameter pipe. As a consequence, during these significant rain events, leachate backs up into the baler facility and floods the baler loading lock. A check-valve in the line from the baler facility is broken or clogged with fats, oils and grease (FOG). There is no easy access to this check valve.

Liquid waste from the baler (rain/snowmelt, squeezings, and restrooms) flow to the leachate treatment system.

Pretreated leachate is discharged via 4” diameter force main to a manhole near the cemetery, where it is combined with domestic wastewater routed to the WWTP. The leachate pumps run at only 30-40% efficiency, one at a time, and pumping rates are lower than anticipated.

The LLS needs to be replaced/upgraded. Potentially upgrade pumps or review hydraulics so the pumps run more efficiently. It will be a significant project to upsize the force main from the landfill to town.

The LLS does need an upgrade, but the pumps in the lift station only pump into the leachate tank. These pumps are not 100 % efficient, but it is the leachate pumps in the leachate bldg. that are pumping at only 30 – 40% efficiency. Prolonged rain events will cause overflow into the Baler bldg. The check valve needs to be repaired or replaced immediately.

LLS needs to be included in SCADA so WWTP operators can view it. [Capabilities for this may exist; programming or configuration adjustment may be a solution here.]

The LLS needs upgraded before it can be viewed on SCADA. Capability exists today for the WWTP to view the leachate SCADA screens.

WWTP Regulations

2004 NPDES permit + interim permits on fecal coliforms (200/400 monthly/weekly average)

City used to be on an Alaska Native Village Waiver and only had screening. Current permits have become more restrictive than even a 301H waiver.

During 1999 and 2000 the City constructed a new WWTP with both screening and a UV disinfection system to comply with the 1997 NPDES permit requiring fecal coliform to meet 10,000 maximum daily limit. The 1997 NPDES permit had BOD maximum daily limits of 2,343 lbs/day and 468 mg/L. The permit neglected to specify TSS limits, but the City believes it was assumed.

In the 2004 NPDES permit fecal coliform limit was changed to 10,000 / 15,000 monthly average/daily max limits in the 2004 NPDES permit. The 2004 NPDES permit decreased BOD and TSS limits to 140/200 mg/L and 700/1501 lbs/day (Average monthly/Daily Max); which ADEC had acknowledged later that this was a mistake. The 2004 NPDES permit also enforced the 30 percent removal requirement for primary treatment from the Clean Water Act.

The US Department of Justice consent decree established a number of interim limits during design and construction of the new CEPT WWTP and upon completion, the new facility would be required to meet the 2004 NPDES permit limits. However, they changed the 2004 NPDES permit limits for fecal coliform limitations. The new facility must meet 200/400 monthly/weekly average limits,.

The future status of the AK Native Village waiver is in question, and 301H waiver applications are no longer being accepted, so it is unclear of future regulatory situation.

Applied for new permit in 2008, still waiting for DEC/EPA.

Trickling filters were depicted in the preliminary design site plan for the new CEPT WWTP as a potential future upgrade. With this in mind, stub-outs were installed to accommodate a future upgrade.

Operating costs have doubled with new plant, rates have not yet caught up. Chemical costs and landfill tipping fees for sludge account for much of the added costs followed by electricity, heating fuel and water.

Influent Lift Station

Flygt submersible installed. Wet well gets build up because of polymer from belt filter press filtrate. Have to use fire hose to break up.

Headworks

Screening – wish it was finer to get more solids removal. Screens generally work ok though. Gate on one screen and overall geometry limits the ability to rotate screens out of trough for maintenance.

Influent troughs/gates not ideal for how flow is equalized between the two screens. They do not turn on quickly enough with changes in flow/level.

Backup floats in channels do not work.

Washer/compactor is good. Use lime for odor control of screenings.

Grit removal system (Eutek) is offline. It is oversized for the typically observed flows; settlement was causing operational issues.

Flocculation & Mixing

Plant design was for cationic polymer for primary treatment. Caused significant problems when mixed with anionic polymer in sludge handling, so switched to the same anionic polymer. Typically dosed at approximately 2 mg/L.

Aluminum Chlorohydrate (ACH) dosed as coagulant. Typically dosed at approximately 35 mg/L.

ACH lines clog with ACH and have to be cleaned with hot water and high pressure water weekly. Polymer injection line cleaned, though it is not subject to as much clogging.

Primary Clarification

Clarification basins have a "clear" area in the middle, and a baffle wall or other issue is causing water quality degradation at the end of the clarifier that flows over the launder.

Scum removal – wet well Scum Tank is too small, scum overflows into other side.

Tank Drain Pump Station

This pump station is located on the north side of the WWTP. City staff have indicated that maintenance on this pump station is difficult due to the height (approximately 6 feet above grade) and size of the access hatch. The access hatch includes a majority of the top of pump station. This LS needs a work platform built around it and a socket for a davit crane installed. This a huge fall safety concern standing on an 18” concrete ring 6’ off the ground over an open wetwell 18’ deep with no way to access pumps other than pull them by hand.

Chlorination/Dechlorination

Foaming in CT tank, can change significantly with ACH dose.

Significant foaming in channel at times.

Currently dosing 8-9 mg/L of chlorine to get a residual of close to 4 mg/L to control coliforms. Higher doses than designed for, but needed or otherwise coliforms are not completely killed.

Bisulfite pumps may be too small to work with this level of required dechlorination. Occasional high chlorine hits in the discharge, potentially due to bad mixing.

Perhaps change the location of the chlorine residual sampling point to be sure that bisulfite is fully mixed and has time to react prior to sampling

Plant Water

Plant water seems to be pulpy from toilet paper not settling. City staff indicated that solids and quality of process water may be adding to issues realized at the WWTP.

Plant water filters seem undersized, frequent backwashing to process drain sump

Plant water has high chlorine because it is collected before dechlorination. Signification corrosion in lines due to high chlorine levels.

Chlorine Generation

Equipment seems to run well and is in good condition.

Some HDPE tank leakage at low elevation bulkhead fittings

Solids

Storage tank sized for 65,000 gallons of storage. Overflow returns to influent pump station.

Storage tank (constructed of glass lined steel) is occasionally struck by rocks from hillside above it. Consider building a shield to protect it for breaking.

Process solids 5 days/week. 8 hrs on Monday, and 4 hours other days.

If solids sit in tank for too long, they get too thick, and flows through press feed pump drop, and they aren’t able to keep up with solids production.

Flocculator start-up requires drain (which returns to influent pump station), if valves are not set correctly, can gravity drain the entire solids storage tank to the pump station.

2” Flocculator drain needs to be tied into 6” filtrate drain.

Solids Press/Pumps

Press has space for a third press unit, and they have a spare on site.

Operators speak highly of the press and find that it works very well.

Lime Addition

Lime feed equipment is ok.

Lime mixing in solids conveyor is poor. The design calls for the trough to be approximately ½ full. It currently is about 10% full, so there is not good mixing within the conveyor.

Typically dose 7% wt/wt of lime.

Lime dust fouls the odor control system due to not getting well mixed with the solids.

Solids Conveyors

Conveyors designed for 60 gpm of sludge pumping (typically good day is 30-40 gpm, if sludge too thick from sitting, only 20 gpm).

Solids Bagger

Bagging system is designed for grain. Auger at top pushes solids into space between bottom of trough and top of knife gate. Solids solidify and clog opening, and do not fall into bag when knife-gate opens.

Typically send 7 to 8 bags of solids to the landfill on Monday. The WWTP sends 2 to 3 bags per day Tuesday through Friday.

Bagging system is designed for 6 bag operation. With system running as is we can use only 2 bagging chutes.

Laboratory

Lab manager going through training to get the lab certified to do fecal coliform testing in house.

Will eventually be doing total coliform testing for water side as well.

No problems in lab.

Landfill/WWTP Relationships

Typically try to maintain not more than 5% of plant flow as leachate. Control by shutting down leachate LS, and using the tank as storage.

Lift Station 5

Lift station 5 was installed in 1986, seeing some corrosion in piping inside wetwell (will be replaced in 2017). Lift station 2'

Collection system upstream of LS has some reverse grades and leaking MH's.

City staff have indiated that this lift station does operate three times more during a storm event compared to under average conditions. This lift station receives the flow from the older part of the town.

Lift Station 4

Has existing standby generator. Largest wetwell in system.

Leachate Lift Station

Lift Station located at the landfill site. Wet well has three gravity lines that discharge leachate from cells 1, 2 and 3; leachate from cells 5 and 6; bathrooms and trench drain from the building.

Other Lift Station Notes

Most lift stations have been upgraded in the last 5 years to have the electrical/controls in fiberglass huts, and to integrate controls and alarms into SCADA.

The Leachate Lift station needs the same upgrades that the other lift stations received – New electrical controls, 2 junction boxes outside wetwell for punp & float wiring, and a fiberglass hut to house controls and SCADA equipment.

USCG lift station also needs the same upgrades for SCADA access.

Outfitted with portable generator plug to pump out lift stations as needed. Generally power is available and does not go out since the new power house was installed recently.

LS 2 will have wetwell piping replaced in 2017 because of corrosion.

In general, City staff believe lift stations are in good shape.

Collection System

Most of the collection system is made of Class 52 ductile that is in good condition.

Potentially some cement mortar lining is corroding from the pipes. Generally grit is not too bad at WWTP. Suspected that some road construction work on Ballyhoo may have lead to more cement in the line in that area.

City flushes 1/3 of collection system every year as maintenance.

City staff expressed concerns of collection system infiltration and inflow in the Steward Rd/ Generals Hill area.

City staff have installed rain seals on manhole lids to limit the amount of inflow to the collection system. J.R. indicated that he did notice a reduction in influent flow to the lift stations and WWTP after City staff increased efforts to replace rain seals when damaged.

Wednesday February 22

Meeting with J.R. in the morning to review and understand landfill data spreadsheets. Additional visit to City Hall and Landfill to obtain specs and available information on the baler.

Flash drives provided by City to CH2M with wastewater and landfill files, reports, and documents.

Attachment 2
Unalaska Regulations Summary

Unalaska Regulations Summary

PREPARED FOR:	City of Unalaska
PREPARED BY:	Katie Winter
DATE:	August 9, 2017
APPROVED BY:	Cory Hinds

The Unalaska Landfill is a Class I Municipal Landfill. It is permitted to operate under Alaska Department of Environmental Conservation (ADEC) permit SW1A009-18 which expires in May 2018. Disposal of municipal solid waste and construction and demolition waste is authorized. Wastewater screenings are accepted at the Unalaska Landfill but biosolids are not specifically mentioned in the landfill permit. The City of Unalaska (the City) currently conducts surface water sampling quarterly for solid waste permit compliance and stormwater sampling semi-annually. Approximately 8,500 tons of solid waste are accepted at the Unalaska Landfill each year. (Unalaska, 2017)

Solid Waste Permitting Requirements

Solid waste disposal is regulated at the state level. State agencies must ensure that federal requirements for operating municipal landfills are met, and may also impose stricter requirements. In Alaska, the ADEC is the permitting authority and the solid waste regulations are defined in the Alaska Administrative Code (AAC), Title 18, Chapter 60. These regulations are based on the Code of Federal Regulations (CFR), Title 40, Chapter I, Subchapter I, Part 258 – Criteria for Municipal Solid Waste Landfills, adopted in many sections of the ADEC regulations by reference. The Environmental Protection Agency (EPA) administers CFR Title 40 and sets criteria for the following aspects of municipal landfills:

- Location restrictions
- Liner requirements
- Leachate management
- Operating practices
- Groundwater monitoring
- Closure and post-closure care
- Financial assurance

ADEC regulates three classes of municipal solid waste (MSW) facilities. Class I landfills accept more than 20 tons per day on average, must be lined, and are required to manage leachate and monitor groundwater and/or surface water to detect impacts from the landfill. Gas and visual monitoring are also required.

Water monitoring

Class I landfills must follow an approved water monitoring program that establishes background data upgradient of the landfill and a map of groundwater flow. Surface water may also be monitored identify possible impacts. Only surface water is monitored at the Unalaska landfill. Quality assurance and quality control of data and sampling techniques will be verified by ADEC. A statistical analysis of data results must be performed to ensure that a release of contaminants is not occurring that could affect the surrounding environment over time.

Monitoring includes sampling for contaminants listed in Appendix I to Part 258—Constituents for Detection Monitoring. Alaska also requires monitoring of diesel and gasoline range organics. Monitoring at this level is performed at least annually unless a constituent exceeds a background or baseline level that has been defined in the monitoring plan. If an exceedance due to a landfill impact is noted, the landfill must establish an Assessment Monitoring Program. Assessment monitoring, at a minimum, would include additional sampling for contaminants listed in Appendix II to Part 258 – Hazardous Inorganic and Organic Constituents. Regular sampling for other contaminants may be added by ADEC based on historical data.

Visual monitoring

Visual monitoring of the landfill is required monthly to look for any issues or failures of control measures that could result in permit violations or impacts to the environment or human health. Landfill owners must create a site-specific visual monitoring checklist so that varying inspectors provide consistent reporting. All inspections must be documented. Areas to be inspected include but are not limited to: site access control and signage, waste management equipment, retaining structures, liner integrity, monitoring devices, stormwater controls, leachate collection system, blowing trash or litter, and wildlife controls.

Gas monitoring

Methane monitoring is required at landfills to determine if explosive or hazardous gases are present. Methane must be sampled monthly at the Unalaska landfill. Samples will be taken inside all landfill buildings and at other sites designated by ADEC which are no more than 1, 500 feet apart.

New solid waste regulations

Analytical Method Requirements for Surface Water Monitoring

For MSW facilities performing surface water monitoring and comparing to surface water quality standards, ADEC is proposing that they use EPA analytical methods listed in 40 CFR Part 136, not the Solid Waste SW-846 methods. Unalaska should verify what methods are currently used by their chosen laboratory in upcoming sampling events.

Lining of C&D cells

Construction and demolition (C&D) cells currently require no liner in the State of Alaska. ADEC regulators have recently recommended that new C&D cells be lined. If this recommendation is adopted into regulation, it would apply only to new construction of independent C&D cells. (Aldrich, 2017) Existing cells or expansions of existing cells would not need to be lined. New lining regulations are also not expected to be promulgated any sooner than 2022.

Methane

The EPA has recently promulgated new regulations aimed at capturing a greater percentage of methane emissions from MSW facilities producing over 34 megagrams per year of methane. Smaller facilities such as Unalaska may find that annual reporting requirements will include submission of a Tier 4 surface emissions report verifying that no surface emissions readings of 500 parts per million methane or greater have been found on site.

Regulatory impacts of treatment options

Biosolids acceptance

Co-disposal of sewage solids with landfill waste is widely accepted in the State of Alaska but may require a permit modification for the Unalaska landfill for continued disposal. To date, ADEC has not required a permit for biosolids acceptance of less than five tons per day. As upcoming solid waste permits are renewed, however, ADEC will now require permit coverage for any amount of biosolids accepted at a landfill. (Aldrich, 2017) Future water sampling requirements may be modified to include metals, polychlorinated biphenyls (PCBs), and ammonia if the City opts to continue accepting biosolids at the landfill. Biosolids disposed in a MSW landfill must be non-hazardous and pass the Paint Filter Test. An estimated volume of biosolids to be accepted at the Unalaska will likely be required at the next permit cycle. If disposal of large quantities at a time are necessary, a separate cell design for biosolid-only disposal would be submitted to ADEC for approval.

If biosolids are treated at the landfill for some use other than co-disposal, federal requirements 40 CFR Part 503 would apply. These regulations outline specific pathogen and vector reduction requirements based on the ultimate disposal or use of the treated material. Treated biosolids fall under one of two classifications. Biosolids that meet the *Class A* pathogen requirements and pollutant limits are referred to as "Exceptional Quality." As such, these biosolids have minimal regulatory requirements. Biosolids that are *Class B* with respect to pathogen requirements are restricted to bulk application to agricultural land, forest, or reclamation sites. Additional site restrictions, such as food crop, grazing, and public access restrictions, are specific to Class B biosolids.

Composting

To achieve Class A biosolids through composting, a full design review of an engineered composting facility must be performed by ADEC. Based on CH2M's experience in Kodiak, Alaska, ADEC would issue a permit for operation of the compost facility that includes testing requirements for pathogens such as fecal coliform or *Salmonella*, metals, and PCBs.

Transfer/Barging

Shipping of biosolids is not specifically regulated, unless testing reveals that they fall into a hazardous waste category. Acceptance of biosolids for shipment would be at the discretion of the shipping company. Specialized containers may be required to prevent leaks or methane gas build up. The biosolids could also be subject to any testing requirements of the destination landfill.

Gasification

Gasification is not the same as incineration, with its associated emissions and discharges. Since a gasification facility burns syn gas and not the MSW itself, ADEC would generally only require a minor permit, such as those required for gas-fired boilers or generators. However, since the Unalaska landfill is a Class I landfill, an Operating or Title V permit may be required by ADEC for a gasifier.

Stormwater Permitting Requirements

The Clean Water Act, signed into law in 1972, prohibits any discharge of pollutants into waters of the United States through a point source. Stormwater associated with industrial activity such as a landfill has the potential to negatively impact nearby water quality and must be regulated by a permit under the National Pollutant Discharge Elimination System. As with the solid waste permits, ADEC is the permitting authority for the Alaska Pollutant Discharge Elimination System (APDES).

The most recent Multi-Sector General Permit (MSGP) was released in 2015 and regulates stormwater from industrial activities. Landfills are subject to the requirements found in subcategory L. The MSGP requires that each facility create a site-specific Storm Water Pollution Prevention Plan (SWPPP). The SWPPP outlines the plan for complying with regulations by listing responsible parties, potential pollutant sources, current stormwater control measures, and monitoring and inspection schedules. The SWPPP must be updated regularly to reflect any changes in landfill operations or stormwater control measures. Staff must be trained at least annually on the specific control measures used to achieve the effluent limits specified in the permit, as well as the monitoring, inspection, planning, reporting, and documentation requirements.

Regular inspections of the stormwater controls are required to ensure that they are operating as designed. Quarterly visual inspections of the area must be documented and must also include the visual examination of a stormwater sample taken within the first 30 minutes of discharge from storm event to check for obvious indicators of stormwater pollution. An annual comprehensive inspection must be conducted and documentation sent to ADEC with an annual report on operations.

Four benchmark water samples are required in the first year of operation under the MSGP. If no water quality standard exceedences are found, yearly laboratory analysis of samples for BOD, TSS, Ammonia, Alpha Terpineol, Benzoic Acid, p-Cresol, Phenol, Total Zinc, and pH are all that is required. Documentation from the sampling is also submitted to ADEC with the annual report.

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Attachment 3
Composting Conceptual TM

TECHNICAL MEMORANDUM

Composting Conceptual TM

PREPARED FOR:	City of Unalaska
PREPARED BY:	Todd Williams
REVIEWED BY:	Cory Hinds
DATE:	May 15, 2017

The purpose of this TM is to provide a conceptual overview of potentially composting biosolids and other organics such as source separated food wastes generated by the City of Unalaska that are currently landfilled. While there are many types of composting technologies available, this analysis is based on the use of covered aerated static pile (ASP) composting technology, which is the most commonly used and flexible technology to manage these materials in a cold, wet and windy environment such as exists at Unalaska. This technology when properly applied readily achieves time and temperature requirements to achieve a Class A material according to the US EPA and ADEC. This memo provides a basic overview of the waste quantities generated, presents mass balance and process flow assumptions, and from this information, a preliminary capital cost estimate is provided as well as next step recommendations. A brief discussion of an alternative technology approach to managing source separated food wastes through anaerobic digestion is also provided.

Waste Quantities

As part of the landfilling option, CH2M was tasked to evaluate and provide recommendations for composting organics from the City waste stream. City provided data as requested by CH2M, including quantities and characteristics of biosolids, fish wastes, pre-consumer and post-consumer food wastes, and other organics desired to be composted, and bulking agents (e.g., pallets, cardboard, waste wood products). This section summarizes the information provided.

WWTP Biosolids Quantities

With the addition of chemical enhanced primary treatment at the City's WWTP in late 2015, the amount of primary solids being generated significantly increased from previous years. Therefore, only 2016 operating data provided by the City was reviewed. The current practice is dewatering using Fournier presses to an average of 31%TS and then adding approximately 20% lime on a dry weight basis to produce an average 41%TS cake that is then placed in super sacks and landfilled. Although the weekly quantity of sludge (minus lime) produced in 2016 averaged 15.3 wet tons, this quantity doubled to 30 wet tons per week in June and was halved to only 7.6 wet tons per week in December revealing a significant seasonal fluctuation in wastewater biosolids produced. Table 1 shows the month by month quantities produced with and without lime.

Table 1. WWTP Biosolids Production Quantities in 2016

2016	Processed Sludge, Gallons	%TS	Dry Pounds	Processed Sludge Lime, Lbs	Lime Dose, lb /lb DS	Dry lbs lime + sludge
JAN	171285	2.22	31,666	8000	0.25	39,666
FEB	208367	2.22	38,522	5843	0.15	44,365
MAR	216912	2.22	40,102	5595	0.14	45,697
APR	230700	2.22	42,651	7184	0.17	49,835
MAY	188847	2.22	34,913	7200	0.21	42,113
JUN	378427	2.22	69,962	13600	0.19	83,562
JUL	207299	2.22	38,325	6400	0.17	44,725
AUG	206260	2.22	38,133	6800	0.18	44,933
SEP	210881	2.22	38,987	7200	0.18	46,187
OCT	174850	2.22	32,326	6800	0.21	39,126
NOV	157847	2.22	29,182	8000	0.27	37,182
DEC	160171	2.22	29,612	8100	0.27	37,712
TOTAL	2511846		464,380	90722	2.40	555,102
MAX	378427		69962	13600	0.27	83562
AVE	209321		38698	7560	0.20	46259

Potential Food Waste Quantities

Source generated food waste quantities were estimated by the City based on rough percentages of total tonnages received at the landfill in 2016 for several institutions as listed below.

60% - Unisea Galley

60% - Safeway

60% - Alaska Ship Supply

50% - Westward Seafoods

50% - Alyeska Seafoods

30% - Unisea Inn

30% - Grand Aleutian

There may be other compostable materials in these waste streams, but quantities are not readily available. No characterization data was provided. Our experience indicates the moisture content of the food waste material is likely between 65% and 75%. Table 2 shows the estimated monthly quantities. On a weekly basis, this amounts to 16 wet tons per week on average. The biggest challenge with source segregated food wastes is to ensure contaminants such as plastics, metals and glass are not co-mingled with these materials as they all can have a severely detrimental effect on the quality of a finished compost.

Table 2. Food Waste Quantity Production Estimates for 2016

Month	Estimated Food Waste Tons
JAN	74.4
FEB	86.1
MAR	82.6
APR	73.6
MAY	47.5
JUN	72.9
JUL	76.0
AUG	80.0
SEP	75.0
OCT	73.7
NOV	48.2
DEC	48.4
TOTAL	**838.0**
MAX	86.0
AVE	70.0

Composting Facility Sizing and Process Flow

Appropriately sizing the composting facility and establishing a required process flow is necessary for determining spatial needs, equipment sizing and operational impacts. This section provides the information necessary from which capital estimates can be generated.

While most ASP compost operations provide three weeks processing time followed by at least three weeks of curing time, since a good portion of the finished compost may be used as landfill cover, that material only needs to meet Class A and Vector Attraction Reduction standards which can be achieved in about two weeks in the primary stage, then followed by curing as needed. Rather than sizing for the maximum month production of 30 wet tons per week (biosolids only), a better approach is to size for the annual average at the recommended process time of 21 days in primary composting and then switch to a 14 day processing time in high flow weeks which effectively increases the capacity of the composting system by 50% during the peak months. Therefore, the design basis for the wastewater biosolids composting system, sized for year 2027, is shown in Table 3.

Table 3. Suggested Compost Facility Design Criteria – Biosolids Only

Suggested Weekly Design	2016 Average	2027 Projected
%Total Solids (%TS)	31	31
Dry Pounds	9455	10098
Wet Pounds	30188	32243
Wet Tons	15	16.1
Cubic Yards	20	21.5

Using this design basis, a materials balance (Table 4) and process flow diagram (Figure 1) for the WWTP biosolids only is provided below.

Table 4. Weekly Materials Balance to Process WWTP Biosolids at Unalaska

WEEKLY MATERIALS BALANCE FOR: Unalaska - Design Year 2027

FOR SCREEN AFTER CURE

BASED ON:

OPERATING DAYS PER WEEK:	1
BIOSOLIDS DRY TONS PER DAY:	5.0
PERCENT TOTAL SOLIDS (TS):	31.0%

Material	Volume (CY)	Total Weight (Tons)	Dry Weight (Tons)	Volatile Solids (Tons)	Bulk Density (lbs/CY)	Solids Content (%)	Volatile Solids (%)
Biosolids	21.7	16	5.0	4.0	1,500	31.0%	80.0%
Wood Chips	15.2	4.2	2.5	2.4	550	60.0%	95.0%
Screened Recyled Bulking Agent	28.6	10.0	6.0	5.4	700	60.0%	90.0%
Primary Compost Mixture	60.8	30.4	13.5	11.8	1,000	44.5%	87.2%
Base (Recycled BA)	3.4	1.2	0.7	0.6	700	60.0%	90.0%
Cover (Unscreened)	6.8	2.9	1.7	1.4	850	60.0%	80.0%
Primary Composting Losses			1.2	1.2			
Cover (Unscreened)	6.8	2.9	1.7	1.4	850	60.0%	80.0%
Secondary Compost Feed	55.9	23.8	13.1	11.3	850	55.0%	86.2%
Secondary Composting Losses		0.6	0.4	0.4			
Screen Feed	51.5	23.2	12.7	10.9	900	60.0%	85.8%
Recycled Bulking Agent	37.5	13.1	7.9	7.1	700	60.0%	90.0%
Compost to Storage	17.9	8.1	4.8	3.8	900	60.0%	79.0%
Bulking Agent to Biosolids Ratio:	*2.02*	*(Volumetric)*	-				
	0.87	*(Gravimetric)*					

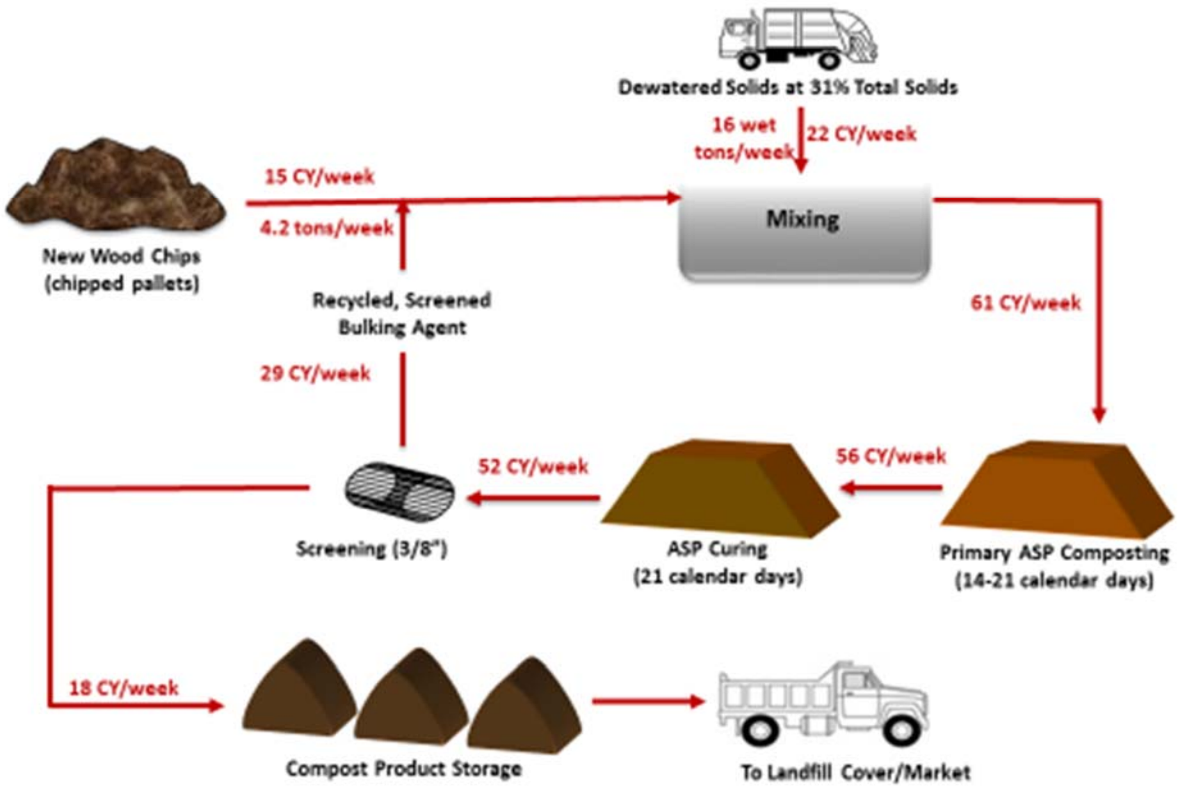

Figure 1. City of Unalaska Aerated Static Pile Composting Facility Process Flow Diagram – Biosolids Only

What this mass balance and process flow diagram show is that slightly more than 4 tons or 15 cubic yards of chipped pallets or other wood chip material will be needed to process all the wwtp biosolids. Further, screening will need to be performed to recycle most of the bulking agent needed for the initial mix, and about 18 CY per week of compost will be produced. This compost will be suitable for use in landfill operations or other landscaping activities on the island. Pilot testing of the process using Unalaska materials will allow for further refinement of the mass balance and process flow requirements. The next section will discuss in detail the assumptions used in the equipment and facilities for development of a preliminary budgetary compost facility cost for this size operation.

The City is also interested in potentially diverting source segregated food wastes into a composting operation. Assuming the estimated SSO quantities provided in Table 3 are accurate, the quantities of all materials in the above process flow diagram would double. In other words, instead of 15 CY per week of chipped pallets, 30 CY would be needed. Instead of sizing the composting operation for 61 CY of mix a week, roughly 120 CY of mix will need to be processed and the 18 CY/week of compost will increase to roughly 36 CY/week of compost produced. There are very many more challenges with processing food wastes instead of wastewater biosolids. First of all, food waste materials are heterogeneous and generally need to be ground up to decrease their particle size prior to composting. Control of contaminants is a major issue requiring extensive reorganizing of how wastes are contained at the point of generation and collected. This also requires training and cooperation of staff at all participating enterprises. Odor and vermin control is of great importance with managing these materials as well. The possibility of digesting food waste materials could also be considered and will be discussed separately later in this TM.

The following section provides a description of the assumed composting process features used to generate a preliminary budgetary capital cost estimate.

Composting Facility System Basis for Capital Cost Estimate

To provide for processing in all weather conditions, it is assumed that all processes would occur under cover. It is assumed that damaged pallets and other wood material are received and processed through grinding equipment at the landfill for use a bulking agent. Dewatered WWTP biosolids would be trucked to an enclosed fabric sprung building roughly 50’ by 70’ in size as shown in Figure 2.

Figure 2. Sprung Fabric Structure

This building would house a three sided bunker where biosolids would be received and another three sided bunker for bulking agent. Mixing would be performed using a front end loader inside this building. Bunker walls would be constructed of vertical I-Beams with used railroad ties placed in-between them as shown in Figure 2.

Figure 3. Biosolids Receiving Bunker with Wooden Walls

This construction method has proven to be much less costly than reinforced concrete based on experience gained in building the Kodiak Composting facility. If food wastes are to be composted, a batch mixer must be added to provide the necessary homogeneous mixture. A front end loader will be used to move materials on the site. Key features of the compost system are as follows:

- One 5 CY capacity front end wheel loader with ejector bucket is required. This is assumed to be a leased piece of equipment and not purchased.
- 1-2 days per week mixing, pile building, pile tear down and screening operations.
- Individual aerated static pile bins for primary composting and curing with above grade aeration piping. Six bins will be provided, each 16' wide by 24 feet deep. Bins will be covered by a metal roof to keep precipitation off the process. Three sides will be enclosed with only the front access open.
- The compost aeration system consists of 6 aerations stations, 3 for primary composting and three for curing. Each aeration station has a dedicated corrosion resistant 1 Hp fan that will service one operating weeks' worth of mix. Temperature control feedback from two temperature probes per primary composting pile to SCADA will allow monitoring and manual control of variable frequency drive fans.
- Screening after composting and curing processes using 3/8" trommel screen opening to recycle bulking agent with oversized material recycled to mixing. One small unit will be required and sized to process a week's worth of material in less than 4 hours.
- Asphalt access pads and building pads.
- Condensate discharged to the City's WWTP via sewer.
- The solids receiving and mixing operation is to be located within a pre-engineered fabric structure suitable for hurricane wind loads. Wall to wall ventilation is provided for dissipation of localized fugitive odors and general air circulation.
- The compost storage area is open asphalt pad.
- Exhaust gases from the active composting and curing processes would be collected with negative aeration and treated through an open organic (wood chip based) media biofiltration system.
- One biofilter booster fan to mix process and cooling air prior to biofiltration system
- Biofilter design residence time = 60 seconds normal, 45 seconds minimum (during fan or media servicing). Expected odor removal (D/T) performance is 90 percent.
- One 40' X 20' biofilter will be required to treat roughly 5,000 cfm of exhaust and cooling air.
- Fugitive odors from the compost mixing, pile formation and pile breakdown operations are assumed to be minimal. These odors typically comprise less than 5 percent of ASP facility odors that treat Class B biosolids, are localized and tend not to migrate offsite. Collection and treatment of these odors is not included.

Costing Basis

The composting facility is comprised of graded asphalt pads and buildings that house the mixing and composting process. A 3500 square foot receiving and mixing fabric building and a 2500 square foot composting and curing building will be required. It is assumed no office building would be provided as the landfill facilities would be available for that purpose. Major stationary equipment includes the following:

- Six 1-Hp aeration fans for servicing 6 compost and curing bays, 420 SCFM capacity each.
- One 15-Hp blower for servicing odor control biofiltration system to treat all compost and cure process exhaust. 5,000 SCFM capacity.
- Eight 1-Hp wall (4 supply and 4 exhaust) fans to provide supplemental ventilation in the receiving and mixing building. 7500 SCFM each

- Wireless temperature probes and data acquisition and control for compost and cure operations
- One 5-cubic yard capacity wheeled front end loaders with push-out bucket (assumed to be leased and not included in capital cost)
- One 40-cubic yard per hour capacity trommel screen (included)
- One grinder for processing pallets and wood wastes into chips (assumed to be leased and not including in capital cost)

The capital cost estimate provided is based on the guidelines provided by the Association for the Advancement of Cost Engineering (AACE) International and adopted by the American National Standards Institute for a Class 4 level estimate. Class 4 estimates are based on conceptual design when the engineering effort is from 1 to 5 percent complete and includes a 30% contingency. Unit costing information from RS Means, vendor quotes and construction experience in other Alaska communities were used in developing concept level cost estimate. The expected accuracy ranges for this class estimate are –30 percent on the low side and +50 percent on the high side.

The preliminary Class 4 estimated capital cost for the wwtp solids only compost facility as described above is:

Low (-30%)	Mean Cost Estimate	High (+50%)
$1,424,000	$2,034,000	$3,051,000

If food waste is added to the system and the capacity of the composting facility is increased to also manage the average load of food waste, a batch mixer will be required and all components of the composting, curing, aeration, and odor control will need to be doubled in size. If food waste is added, the projected Mean cost would increase by approximately $1,400,000.

The O&M cost will consist of labor, electricity, fuel, bulking agent processing, and maintenance. This size facility will require one operator full time for 2 days per week and then up to 2 hours per day the other three days. As such, this person could be devoted half time to composting and half time to other task work at the landfill or WWTP. Assuming bulking agent is available at no cost (lease a grinder to process pallets into chips) and assuming no revenue from the compost produced, the annual cost to process biosolids only is expected to range from $250,000 – $280,000. If food waste is added, a full time operator will be required and the estimated O&M cost would increase by another $120,000 - $150,000 annually.

Follow-On Evaluations Required – Composting System

The following items are identified for follow-on evaluation:

- Development of a full scale facility layout taking into account available site conditions, slope, configuration, etc.
- Geotechnical evaluation of the site soil conditions will be required to allow development of suitable structural support for roadways, buildings and process area pads. Approximately 1 acre is required to house the entire composting operation.
- Site Utilities: Sufficient electrical service (100 kW Minimum) is required to run operational equipment, and to provide site lighting. Water supply is required for irrigation of the biofiltration odor control system, and for fire supply. Condensate from the composting process is assumed to be discharged to nearby leachate collection system. Odor fence line goals should be established and odor dispersion modeling performed, if deemed necessary, to confirm the unit process odors that

require treatment and the biofilter design criteria. The need to treat fugitive odors from mixing and pile formation and breakdown should be considered in this evaluation.

- A pilot composting operation is recommended for further evaluation of blending the waste materials and producing a product for testing. Such a pilot can be easily constructed and operated by City personnel to familiarize them with the process. Composting of various potential feedstock materials can be tested to evaluate WWTP biosolids, different bulking agent materials, and potentially available food wastes. Simple equipment can be used such as front end loader, a small blower, a small pad and simple screening equipment to gather field data for better design of a full scale system and to provide information to the ADEC and the community.
- Determine costs and viability of leasing vs. purchasing equipment such as front end loader, grinder and screen for a full scale system.
- Visit other similar composting operations such as the City of Kodiak.

Attachment 4
Gasification of Potential Feedstocks from Unalaska

TECHNICAL MEMORANDUM

Gasification of Potential Feedstocks from Unalaska

PREPARED FOR: City of Unalaska

PREPARED BY: Steve Jenkins, Gasification Lead, CH2M HILL, INC.

REVIEWED BY: Cory Hinds

DATE: August 8, 2017

Summary

CH2M HILL, Inc. (CH2M) has evaluated the technical feasibility and estimated the costs for gasifying wastes generated by the City of Unalaska (the City), evaluated the potential for beneficial use of the synthesis gas (syngas) generated in a waste gasification facility, and developed production values for the resulting ash that would need to be disposed of in a landfill. As described below in this Technical Memorandum, utilizing gasification technology to convert the City's wastes is technically feasible. The type of technology proposed for use by the City would convert the wastes to syngas, which would then be combusted in a separate chamber with the hot exhaust gases released via a stack. The efficiency of such a facility is very dependent on the specific wastes and blends of such wastes used as the feedstock for a gasification facility. As described in detail below, the City would need to determine whether specific waste streams would be disposed of by using them as a gasification feedstock, or via other treatment methods such as composting.

The economic feasibility would have to be further investigated, as application of gasification technology is very site-specific and waste-specific. Beneficial use of the syngas for energy recovery may be both technically and economically feasible for the City to pursue. Primary beneficial uses include combustion of the syngas for steam generation for industrial use and/or district heating, as well as utilizing the Organic Rankine Cycle for low-level power generation (approximately 250 kW). A more detailed evaluation of the technical and economic feasibility of these energy recovery and power generation options would be required.

Introduction

This memorandum evaluates the feasibility and expected costs for gasifying wastes, beneficial use of the syngas (e.g., power generation), and landfilling of the resulting ash. Based on waste characterization data provided by the City, quantities of waste that could be gasified were determined. An appropriate waste gasification system and associated equipment for the process was then determined. The system and equipment evaluation considered handling the waste prior to gasification, gasifying the waste, and disposal of waste ash, as well as possible uses for the generated syngas. An order of magnitude cost estimate was developed to include the equipment and facility, fuel, and operations costs based on similarly sized projects.

Data Provided by the City

CH2M requested the City provide the following information on its wastes:

- Composition (i.e. % paper, %metals, % glass, % plastics, % organics, % organics)
- Tons/day (minimum, average and maximum) of each type of waste
- Moisture content of each type of waste

The City provided CH2M with spreadsheets titled "Monthly Totals – Active Landfill" and "Monthly Totals – Inerts-Batteries-Wood" for years 2013-2016. For the purposes of implementing this scope of work, CH2M used the most recent data in the spreadsheets, primarily data from 2016.

Table 1 below provides a summary of the data from the spreadsheets obtained from the City. Note that the minimum and maximum values for each of the components do not necessarily occur during the same month, so it is not appropriate to add them together to develop total values.

Table 1. Waste Components and Quantities – City of Unalaska

	Tons/day Minimum	Tons/day Average	Tons/day Maximum
Total MSW to Landfill	10.6	17.6	44.3
Tires - separated	0	0.3	1.0
Fishing nets and lines - separated	3.41	10.88	24.6

The City also provided overall composition data for their MSW. Column 2 in Table 2 below provides this % composition. Since no detailed waste characterization data was provided by the City (as requested), CH2M used industry data for % moisture, % ash, and heating value (Btu/lb) of MSW components. CH2M then calculated detailed composition data for the waste components. Table 2 provides this more detailed information.

Table 2. Composition of MSW

Component	%	% Moisture	% Ash	Btu/lb (as received basis)	Weighted Fraction % Moisture	Weighted Fraction % Ash	Weighted Fraction Btu/lb (as received basis)
Organic	54.0	44.03	3.74	4,909	23.78	2.02	2,651
Cardboard	21.4	5.20	5.0	7,042	1.11	1.07	1,507
Metal	7.8	0.0	100.0	0	0.00	7.80	0
Plastic	15.8	2.0	2.0	14,101	0.32	0.32	2,228
Total	**99.0**				**25.21**	**11.21**	**6,386**

The Unalaska MSW has a higher moisture content than typical urban MSW, partially due to the high local rainfall. The ash content is lower than typical MSW; this may be due to the use of more paper and plastic than metal for food containers. The high plastics content also results in a higher heating value (Btu/lb) than typical urban MSW.

Gasifiable Feedstocks

In addition to the MSW, the City also produces the quantities of tires, fishing nets and lines as noted above in Table 1. The tires, fishing nets and lines are separated from the general MSW. For the purposes of efficient gasification, feedstocks with low moisture and ash content, and high heating value, are preferred. The MSW by itself, as shown in Table 2, has an estimated heating value of 6,386 Btu/lb (as received basis). As noted above, this is somewhat higher than typical urban MSW. Tires have a heating value of approximately 15,000 Btu/lb, with the plastic-based nets and lines at approximately 14,000 Btu/lb. The tires would need to be chipped prior to being fed into a gasifier. These feedstocks increase the overall quality/heating value of the waste blend that would be used as the feedstock for a gasification facility.

Table 3 below shows the impacts of using these other waste materials on the quality and heating value of the gasifier feedstock.

Table 3. Impacts of Adding Other Wastes to MSW for Gasifier Feedstock

	Average Tons/day	Weighted % Moisture	Weighted % Ash	Weighted Heating Value (Btu/lb)
MSW only	17.6	25.21	11.21	6,386
MSW + Tires + Nets/Lines	18.3	24.3	10.98	6,700

Adding the tires and plastic nets/lines to the MSW increases the heating value, and reduces the overall moisture and ash content. This would provide for higher efficiency and energy recovery in a gasification facility.

Summary Description of Gasification Technology

Gasification is a thermo-chemical process that converts solid organic materials (referred to as feedstocks, not fuels, in gasification processes) into a syngas that contains primarily hydrogen and carbon monoxide. The syngas has a heating value about 1/8 to ¼ that of natural gas, and can easily be combusted. It is important to note that the solid material (i.e. MSW) itself is not combusted, as with incineration, but converted to syngas which can then be more easily combusted. The inorganic materials (glass, metals, construction debris) in the feedstock are converted to ash, which then requires disposal or may be able to be re-used in industry due to its mineral content.

As an example, using the feedstock blend of “MSW + Tires + Nets/Lines” listed in Table 3, the average input of 18.3 tons/day would include 4.44 tons/day of moisture (which would be evaporated and/or converted to hydrogen in the gasification process) and 2 tons/day of ash. Therefore, the inlet feed mass (18.3 tons/day) would be reduced to only 2 tons/day of ash for disposal, a reduction in mass of approximately 89%.

Gasification Facility

For the purposes of the analysis provided in this Technical Memorandum, the “MSW + Tires + Nets/Lines” case shown in Table 3 will be used.

CH2M has worked with similar feedstocks/feedstock blends on other gasification facility projects. As an example, in 2013-14, CH2M prepared a Request for Proposal for an Alaskan city to acquire a waste gasification system. Previously, that city had disposed of its wastes in an open outdoor burn box; the Alaska Department of Environmental Conservation had notified that city that such disposal was no longer to be allowed.

The feedstock was a blend of MSW with seasonal fish wastes, at a daily throughput rate of 20.4 tons/day. This included the capability to process up to 500 gallons/day (approximately 1.7 tons/day) of fish wastes during the summer months. Following a detailed technical and economic evaluation, the client acquired the gasification facility. The overall facility included an enclosed building with a tipping floor to store the delivered wastes, an automated bin loading/tipping/feeding system to load the wastes into the gasification facility, and the waste gasification system.

The waste gasification system was designed so that it could either be operated on a continuous basis during high seasonal waste generation periods, or be operated on a batch schedule with the waste loaded each day, processed/gasified over two work shifts, then stopped and allowed to cool overnight. A continuous ash removal system allowed the ash to be removed and sent to landfill on either continuous or batch operating schedules. The syngas produced in the gasifier was combusted in an adjacent chamber, with the exhaust gases routed to a stack (which penetrated the building roof).

In order to bring the gasifier chamber up to operating temperature for batch operation, diesel oil was required as a supplementary fuel. Once the gasifier was at operating temperature, it utilized the energy in the feedstock to maintain temperature and complete the conversion of the solid MSW to the gaseous syngas product. When the high moisture fish wastes are added during the summer months, additional diesel oil is required for startup and operation.

Due to the similarities of the City's waste stream quantity and quality data with those of the other CH2M client's facility described above, CH2M estimates that a waste gasification facility for the City would be similar. Estimated cost and performance data for such a facility, based on the similar facility, is provided below.

Gasification Facility Cost and Performance

The capital cost of the referenced facility was as follows (2014):

- Waste gasification facility - included complete automated waste gasification system, transportation and delivery to Alaska, diesel oil storage tank, installation assistance, emission testing, performance bond, and spare parts for five years' operation = $850,000
- Pre-engineered building with concrete slab = $753,000
- TOTAL = $1,603,000

The facility is frequently operated 24 hours per day, 5 days per week in the summer. In the winter, when waste production is reduced, the facility is operated only 30 hours per week. The average annual throughput is 14.4 tons/day. Due to the high moisture and ash content of the waste, they require approximately 200 gallons/day of diesel oil to start up, maintain temperature, and shut down. Therefore, the average diesel oil requirement is approximately 13.9 gallons/ton of MSW feedstock. Based on the lower moisture content of the City's proposed blend of MSW + tires + nets/lines, the diesel consumption is estimated to be approximately 11 gallons/ton of feedstock.

With an ash content of approximately 15% (metal, construction and demolition waste, and glass), they generate approximately 2.2 tons/day of ash that is disposed of in their landfill. Based on the City's waste blend characterization, as shown in Table 3, the ash generation would be 18.3 tons/day waste @10.98% ash = 2.00 tons/day for disposal.

Beneficial Use of the Syngas

Due to the moderate heating value of the syngas, it may be feasible to combust it for energy recovery purposes, instead of exhausting the hot gases via a stack as described above. When combusted in a boiler or thermal oxidizer/heat recovery steam generator combination, steam can be produced for use in industrial processes or for district heating. This may be technically feasible and economically attractive for the City. Prior to evaluating the feasibility of this case, it would be important for the City to determine whether such potential steam users are currently available, and if so, what the steam loads would be.

Steam may also be utilized for power generation in a steam turbine-generator. The exhaust gases from the boiler must then be treated for removal of sulfur dioxide, nitrogen oxides, particulate matter, and heavy metals. When using a steam turbine-generator, cooling water is required for condensing the steam back to condensate for re-use in the thermal cycle. Steam turbine-generator configurations are more technically and economically viable for much larger gasification systems than the potential 18.3 tons/day feedstock throughput system evaluated in this Technical Memorandum. Therefore, this configuration is not considered as technically and economically feasible for the City.

Another power generation option is to cool and clean the syngas so that it can be combusted in an engine-generator. When using MSW, tires and nets/lines as the feedstocks, removal of heavy metals and other contaminants is required, so that the syngas can be clean enough to be used in engines without causing corrosion and fouling. Such systems are typically complex and costly. Therefore, this configuration is not considered as technically and economically feasible for the City.

One potentially viable configuration for power generation is to use the Organic Rankine Cycle, or ORC (see figure below). ORC is a thermodynamic process where heat is transferred to a fluid at a constant pressure. The fluid is then vaporized and expanded in a turbine that drives a generator, producing electricity. The spent vapor is condensed to liquid and recycled back through the cycle. Since ORC makes uses of an organic fluid (thermal oil) with a boiling point lower than water, the configuration enables recovery of heat from lower temperature sources such as from combustion of moderate heating value syngas. Further, the exhaust gases (after they have transferred most of their heat to the thermal oil) may still be hot enough to be used for drying the incoming feedstock, increasing the overall system efficiency. The ORC configuration has been successfully used in small gasification systems.

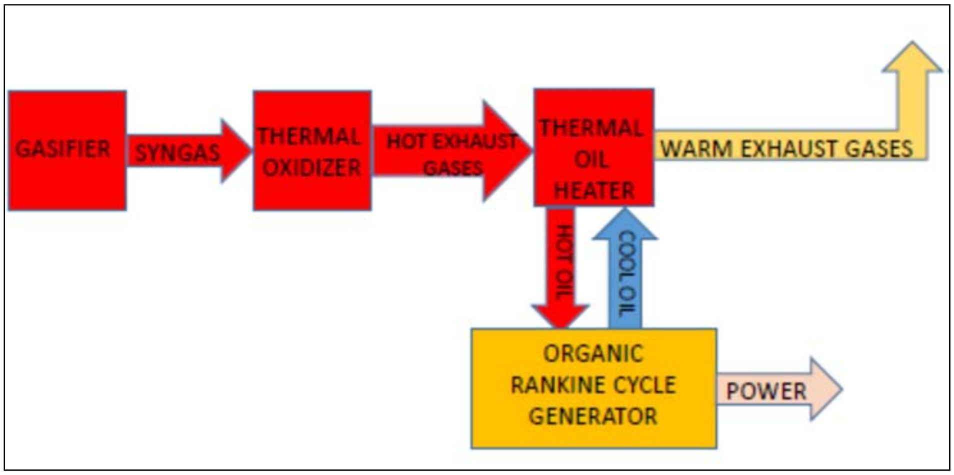

Figure 1. Organic Rankine Cycle for Power Generation

Based on technical and cost data from another CH2M project, the ORC configuration could be used to generate approximately 250 kW of power using the City's blended waste stream described above. The capital cost of the system is estimated to be approximately $5 million (+/- 40%). A much more detailed technical and economic analysis would be required, with the actual feedstock quantities and qualities specified.

Attachment 5
CIP Cost Estimates

Summary Report

Job Size:
Duration:

Project: Unalaska Manhole Check Va
Project No.: 690297
Design Stage: Preliminary

Estimator: Nick Cavalleri/RDD
Revision / Date: 1 / Aug. 4, 2017
Estimate Class: 3

Fac	Description	Takeoff Quantity	Labor Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Equip Cost/Unit	Other Cost/Unit	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
100	Unalaska Manhole Check Valve										
	Utilities										
	Utility Structures										
	Demolition of Existing Check Valve Vault										
	Manhole Demolition and Backfill	1.00 EA	1,867.75 /EA	500.00 /EA	/EA	565.47 /EA	/EA	2,933.22 /EA	2,933	6,593.85 /EA	6,594
	Demolition of Existing Check Valve Vault	1.00 EA	1,867.75 /EA	500.00 /EA	/EA	565.47 /EA	/EA	2,933.22 /EA	2,933	6,593.85 /EA	6,594
	Haul and Disposal of Demolished Materials										
	Demolition - Removal, Haul and Tip Fee	1.00 LD	202.46 /LD	250.00 /LD	/LD	143.71 /LD	/LD	596.17 /LD	596	1,340.19 /LD	1,340
	Haul and Disposal of Demolished Materials	1.00 LD	202.46 /LD	250.00 /LD	/LD	143.71 /LD	/LD	596.17 /LD	596	1,340.19 /LD	1,340
	Traffic Control										
	Temporary Works, Traffic Control	1.00 LS	6,624.77 /LS	2,000.00 /LS	/LS	2,400.00 /LS	/LS	11,024.77 /LS	11,025	24,783.62 /LS	24,784
	Traffic Control	1.00 LS	6,624.77 /LS	2,000.00 /LS	/LS	2,400.00 /LS	/LS	11,024.77 /LS	11,025	24,783.62 /LS	24,784
	Temporary Bypass Pumping										
	Site Preparation, Bypass Pumping, 6" to 10" Pipe	3.00 DAY	300.00 /DAY	200.00 /DAY	/DAY	500.00 /DAY	/DAY	1,000.00 /DAY	3,000	2,247.99 /DAY	6,744
	Temporary Bypass Pumping	1.00 LS	900.00 /LS	600.00 /LS	/LS	1,500.00 /LS	/LS	3,000.00 /LS	3,000	6,743.98 /LS	6,744
	Street Surface Restoration										
	Site Improvements, Paving, Gravel Road	7.11 SY	21.72 /SY	14.07 /SY	/SY	5.25 /SY	/SY	41.03 /SY	292	92.24 /SY	656
	Street Surface Restoration	64.00 SF	2.41 /SF	1.56 /SF	/SF	0.58 /SF	/SF	4.56 /SF	292	10.25 /SF	656
	Patch Piping at Valve Removal Site										
	Buried Pipe, HDPE, 8"	6.00 LF	141.40 /LF	65.83 /LF	/LF	30.62 /LF	/LF	237.86 /LF	1,427	534.70 /LF	3,208
	Patch Piping at Valve Removal Site	1.00 LS	848.42 /LS	395.00 /LS	/LS	183.73 /LS	/LS	1,427.15 /LS	1,427	3,208.22 /LS	3,208
	New Check Valve Manhole										
	Site Improvements, Paving, Concrete	7.11 SY	21.53 /SY	39.38 /SY	/SY	0.91 /SY	/SY	61.82 /SY	440	138.97 /SY	988
	Site Improvements, Bollards	6.00 EA	134.75 /EA	840.00 /EA	/EA	39.78 /EA	/EA	1,014.53 /EA	6,087	2,280.65 /EA	13,684
	Buried Pipe, HDPE, 8"	4.00 LF	478.77 /LF	810.00 /LF	/LF	66.43 /LF	/LF	1,355.20 /LF	5,421	3,046.49 /LF	12,186
	Buried Structures, Manholes, 48" Dia	1.00 EA	2,534.58 /EA	3,454.00 /EA	/EA	659.09 /EA	/EA	6,647.67 /EA	6,648	14,943.92 /EA	14,944
	New Check Valve Manhole	1.00 EA	5,411.25 /EA	12,014.01 /EA	/EA	1,169.93 /EA	/EA	18,595.19 /EA	18,595	41,801.87 /EA	41,802
	Utility Structures	1.00 EA	16,009.08 /EA	15,859.01 /EA	/EA	6,000.15 /EA	/EA	37,868.24 /EA	37,868	85,127.58 /EA	85,128
	Utilities	1.00 LS	16,009.08 /LS	15,859.01 /LS	/LS	6,000.15 /LS	/LS	37,868.24 /LS	37,868	85,127.58 /LS	85,128
	100 Unalaska Manhole Check Valve	1.00 LS	16,009.08 /LS	15,859.01 /LS	/LS	6,000.15 /LS	/LS	37,868.24 /LS	37,868	85,127.58 /LS	85,128

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	35,988			42.28%
Material	35,651			41.88%
Subcontract				
Equipment	13,488			15.84%
Other				
Total Construction Costs	**85,127**	**85,127**		**100.00**

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Equip Cost/Unit	Other Cost/Unit	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
100			**Unalaska Manhole Check Valve**										
	33.0		**Utilities**										
		33.56	**Utility Structures**										
			Demolition of Existing Check Valve Vault										
			Manhole Demolition and Backfill										
			Excavate pit, common earth, hyd backhoe, 3/4 CY bucket	9.00 cy	18.17 /cy	-	-	13.62 /cy	-	31.79 /cy	286	71.47 /cy	643
			Sawcut and Revove Check Valve	1.00 ea	151.88 /ea	100.00 /ea	-	3.70 /ea	-	255.58 /ea	256	574.53 /ea	575
			Demolish Existing Valve Vault	1.00 ea	490.65 /ea	-	-	183.87 /ea	-	674.52 /ea	675	1,516.32 /ea	1,516
			Import Backfill Material	5.00 cy		80.00 /cy	-		-	80.00 /cy	400	179.84 /cy	899
			Backfill, trench, air tamped compaction, add	14.00 cy	11.67 /cy	-	-	4.03 /cy	-	15.70 /cy	220	35.29 /cy	494
			Backfill, Native and Import Material	14.00 cy	64.17 /cy	-	-	14.21 /cy	-	78.37 /cy	1,097	176.18 /cy	2,466
			Manhole Demolition and Backfill	**1.00 EA**	**1,867.75 /EA**	**500.00 /EA**	**/EA**	**565.47 /EA**	**/EA**	**2,933.22 /EA**	**2,933**	**6,593.85 /EA**	**6,594**
			Demolition of Existing Check Valve Vault	**1.00 EA**	**1,867.75 /EA**	**500.00 /EA**	**/EA**	**565.47 /EA**	**/EA**	**2,933.22 /EA**	**2,933**	**6,593.85 /EA**	**6,594**
			Haul and Disposal of Demolished Materials										
			Demolition - Removal, Haul and Tip Fee										
			Load Demolished Materials	1.00 ls	84.21 /ls		-	24.86 /ls	-	109.07 /ls	109	245.20 /ls	245
			Haul and Disposal of Demolished Materials	1.00 Ld	118.25 /Ld	250.00 /Ld	-	118.85 /Ld	-	487.10 /Ld	487	1,094.99 /Ld	1,095
			Demolition - Removal, Haul and Tip Fee	**1.00 LD**	**202.46 /LD**	**250.00 /LD**	**/LD**	**143.71 /LD**	**/LD**	**596.17 /LD**	**596**	**1,340.19 /LD**	**1,340**
			Haul and Disposal of Demolished Materials	**1.00 LD**	**202.46 /LD**	**250.00 /LD**	**/LD**	**143.71 /LD**	**/LD**	**596.17 /LD**	**596**	**1,340.19 /LD**	**1,340**
			Traffic Control										
			Temporary Works, Traffic Control										
			Traffic Control Allowance	4.00 day	1,656.19 /day	500.00 /day	-	600.00 /day	-	2,756.19 /day	11,025	6,195.91 /day	24,784
			Temporary Works, Traffic Control	**1.00 LS**	**6,624.77 /LS**	**2,000.00 /LS**	**/LS**	**2,400.00 /LS**	**/LS**	**11,024.77 /LS**	**11,025**	**24,783.62 /LS**	**24,784**
			Traffic Control	**1.00 LS**	**6,624.77 /LS**	**2,000.00 /LS**	**/LS**	**2,400.00 /LS**	**/LS**	**11,024.77 /LS**	**11,025**	**24,783.62 /LS**	**24,784**
			Temporary Bypass Pumping										
			Site Preparation, Bypass Pumping, 6" to 10" Pipe										
			Bypass Pumping for Removal and Re-installation of Check Valve, Assumes 3 Days	3.00 day	300.00 /day	200.00 /day	-	500.00 /day	-	1,000.00 /day	3,000	2,247.99 /day	6,744
			Site Preparation, Bypass Pumping, 6" to 10" Pipe	**3.00 DAY**	**300.00 /DAY**	**200.00 /DAY**	**/DAY**	**500.00 /DAY**	**/DAY**	**1,000.00 /DAY**	**3,000**	**2,247.99 /DAY**	**6,744**
			Temporary Bypass Pumping	**1.00 LS**	**900.00 /LS**	**600.00 /LS**	**/LS**	**1,500.00 /LS**	**/LS**	**3,000.00 /LS**	**3,000**	**6,743.98 /LS**	**6,744**
			Street Surface Restoration										
			Site Improvements, Paving, Gravel Road										
			Fine grading, for roadway, base or leveling course, large area, 6,000 S.Y. or more	7.11 sy	5.92 /sy	-	-	1.75 /sy	-	7.67 /sy	55	17.25 /sy	123
			Base course drainage layers,aggregate base course for roadways and large paved areas,crushed stone base,compacted,crushed 1-1/2"stone base,8"deep	7.11 sy	15.79 /sy	14.06 /sy	-	3.50 /sy	-	33.35 /sy	237	74.98 /sy	533
			Site Improvements, Paving, Gravel Road	**7.11 SY**	**21.72 /SY**	**14.07 /SY**	**/SY**	**5.25 /SY**	**/SY**	**41.03 /SY**	**292**	**92.24 /SY**	**656**
			Street Surface Restoration	**64.00 SF**	**2.41 /SF**	**1.56 /SF**	**/SF**	**0.58 /SF**	**/SF**	**4.56 /SF**	**292**	**10.25 /SF**	**656**
			Patch Piping at Valve Removal Site										
			Buried Pipe, HDPE, 8"										
			Electrofusion Couplings, 8" HDPE	2.00 ea	65.54 /ea	90.00 /ea	-	64.86 /ea	-	220.40 /ea	441	495.45 /ea	991
			Piping, piping HDPE, butt fusion joints, 8" diameter	6.00 lf	98.72 /lf	15.00 /lf	-	9.00 /lf	-	122.73 /lf	736	275.89 /lf	1,655
			MIscellaneous Items Allowance	1.00 ls	125.00 /ls	125.00 /ls	-		-	250.00 /ls	250	562.01 /ls	562
			Buried Pipe, HDPE, 8"	**6.00 LF**	**141.40 /LF**	**65.83 /LF**	**/LF**	**30.62 /LF**	**/LF**	**237.86 /LF**	**1,427**	**534.70 /LF**	**3,208**
			Patch Piping at Valve Removal Site	**1.00 LS**	**848.42 /LS**	**395.00 /LS**	**/LS**	**183.73 /LS**	**/LS**	**1,427.15 /LS**	**1,427**	**3,208.22 /LS**	**3,208**
			New Check Valve Manhole										
			Site Improvements, Paving, Concrete										
			Aggregate, stone, 3/4" to 1-1/2", prices per C.Y., includes material only	1.25 cy	-	37.50 /cy	-	-	-	37.50 /cy	47	84.31 /cy	105
			Concrete, ready mix, regular weight, slabs/mats, 4000 psi	1.50 cy	-	150.00 /cy	-	-	-	150.00 /cy	225	337.19 /cy	506
			Structural concrete, placing, slab on grade, direct chute, over 6" thick, includes strike off & consolidation, excludes material	1.25 cy	21.42 /cy	-	-	0.86 /cy	-	22.28 /cy	28	50.09 /cy	63
			Concrt fnshng,floors,basic fnshng for unspcf fltwrk,bull float,manual float&broom finish,inclds edging and joints,excluds placing,strikng off&cnsldtng	64.00 sf	1.78 /sf	-	-	-	-	1.78 /sf	114	4.01 /sf	257
			Curing, sprayed membrane curing compound	0.64 csf	8.72 /csf	12.70 /csf	-	-	-	21.42 /csf	14	48.16 /csf	31
			Fine grading, fine grade for slab on grade, machine	7.11 sy	0.92 /sy	-	-	0.76 /sy	-	1.68 /sy	12	3.77 /sy	27
			Site Improvements, Paving, Concrete	**7.11 SY**	**21.53 /SY**	**39.38 /SY**	**/SY**	**0.91 /SY**	**/SY**	**61.82 /SY**	**440**	**138.97 /SY**	**988**
			Site Improvements, Bollards										
			Security vehicle barriers, pipe bollards, steel, concrete filled/painted, 8' L x 4' D hole, 8" diam.	6.00 ea	134.75 /ea	840.00 /ea	-	39.78 /ea	-	1,014.53 /ea	6,087	2,280.65 /ea	13,684
			Site Improvements, Bollards	**6.00 EA**	**134.75 /EA**	**840.00 /EA**	**/EA**	**39.78 /EA**	**/EA**	**1,014.53 /EA**	**6,087**	**2,280.65 /EA**	**13,684**
			Buried Pipe, HDPE, 8"										
			Electrofusion Couplings, 8" HDPE	2.00 ea	65.54 /ea	90.00 /ea	-	64.86 /ea	-	220.40 /ea	441	495.46 /ea	991
			Piping, piping HDPE, butt fusion joints, 8" diameter	4.00 lf	98.72 /lf	15.00 /lf	-	9.00 /lf	-	122.73 /lf	491	275.89 /lf	1,104
			Rebuild Removed Check Valve	1.00 ea	607.51 /ea	2,500.00 /ea	-	0.00 /ea	-	3,107.51 /ea	3,108	6,985.68 /ea	6,986
			Install Rebuilt Check Valve	1.00 ea	303.76 /ea		-	100.00 /ea	-	403.76 /ea	404	907.64 /ea	908
			Cleanout	1.00 ea	227.84 /ea	250.00 /ea	-	0.00 /ea	-	477.84 /ea	478	1,074.19 /ea	1,074
			MIscellaneous Items Allowance	1.00 ls	250.00 /ls	250.00 /ls	-		-	500.00 /ls	500	1,123.99 /ls	1,124
			Buried Pipe, HDPE, 8"	**4.00 LF**	**478.77 /LF**	**810.00 /LF**	**/LF**	**66.43 /LF**	**/LF**	**1,355.20 /LF**	**5,421**	**3,046.49 /LF**	**12,186**
			Buried Structures, Manholes, 48" Dia										
			Excavate pit, common earth, hyd backhoe, 3/4 CY bucket	13.50 cy	18.17 /cy	-	-	13.62 /cy	-	31.79 /cy	429	71.47 /cy	965
			Backfill, trench, air tamped compaction, add	9.00 cy	11.67 /cy	-	-	4.03 /cy	-	15.70 /cy	141	35.30 /cy	318
			Backfill, Around Manhole, Native Material	9.00 cy	37.43 /cy	-	-	11.05 /cy	-	48.48 /cy	436	108.98 /cy	981

Fac	Work Pkg	Trade Pkg	Description	Takeoff Quantity	Labor Cost/Unit	Material Cost/Unit	Sub Cost/Unit	Equip Cost/Unit	Other Cost/Unit	Direct Cost/Unit	Direct Amount	Grand Total Unit Price	Grand Total w/Markups
			Buried Structures, Manholes, 48" Dia										
			Hauling, excavated or borrow material, loose cubic yards, 4 mile round trip, 1.8 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading	4.50 cy	6.76 /cy	-	-	6.79 /cy	-	13.55 /cy	61	30.46 /cy	137
			Base slab; form, resteel and concrete to 8" thick, avg cost per CY	1.00 cy	179.26 /cy	214.00 /cy	-	0.89 /cy	-	394.15 /cy	394	886.05 /cy	886
			Utilty area drains,catch basins manhls catch basins manhls frames and covers,cast iron,heavy traffc,36"dm,1150lb, excluds footing,excavtn,and backfill	1.00 ea	449.16 /ea	860.00 /ea	-	132.59 /ea	-	1,441.75 /ea	1,442	3,241.04 /ea	3,241
			Storm Drainage Manholes, Frames, and Covers, concrete, precast, 4' I.D., 8' deep, excludes footing, excavation, backfill, frame and cover	1.00 ea	906.74 /ea	1,950.00 /ea	-	111.77 /ea	-	2,968.51 /ea	2,969	6,673.20 /ea	6,673
			Storm drainage manholes,frames,and covers,concrete,precast,4'id, excludes footing,excavation,backfill,frame and cover,add for depths over 8'	1.00 vlf	113.34 /vlf	175.00 /vlf	-	13.97 /vlf	-	302.31 /vlf	302	679.59 /vlf	680
			Storm Drainage Manholes, Frames, and Covers, precast concrete, 4' diameter manhole, 8" thick top	1.00 ea	168.44 /ea	255.00 /ea	-	49.72 /ea	-	473.16 /ea	473	1,063.66 /ea	1,064
			Buried Structures, Manholes, 48" Dia	**1.00 EA**	**2,534.58 /EA**	**3,454.00 /EA**	**/EA**	**659.09 /EA**	**/EA**	**6,647.67 /EA**	**6,648**	**14,943.92 /EA**	**14,944**
			New Check Valve Manhole	**1.00 EA**	**5,411.25 /EA**	**12,014.01 /EA**	**/EA**	**1,169.93 /EA**	**/EA**	**18,595.19 /EA**	**18,595**	**41,801.87 /EA**	**41,802**
			33.56 Utility Structures	**1.00 EA**	**16,009.08 /EA**	**15,859.01 /EA**	**/EA**	**6,000.15 /EA**	**/EA**	**37,868.24 /EA**	**37,868**	**85,127.58 /EA**	**85,128**
			33.0 Utilities	**1.00 LS**	**16,009.08 /LS**	**15,859.01 /LS**	**/LS**	**6,000.15 /LS**	**/LS**	**37,868.24 /LS**	**37,868**	**85,127.58 /LS**	**85,128**
			100 Unalaska Manhole Check Valve	**1.00 LS**	**16,009.08 /LS**	**15,859.01 /LS**	**/LS**	**6,000.15 /LS**	**/LS**	**37,868.24 /LS**	**37,868**	**85,127.58 /LS**	**85,128**

Estimate Totals

Construction Costs	Amount	Totals	Rate	% of Total
Labor	16,009			18.81%
Material	15,859			18.63%
Subcontract				
Equipment	6,000			7.05%
Other				
Subtotal Direct Costs	**37,868**	**37,868**		**44.48**
Location Adj. Factor	7,574		20.000 %	8.90%
Subtotal W/ Adj. Factors	**7,574**	**45,442**		**8.90**
General Conditions	4,544		10.000 %	5.34%
Subtotal W/ General Conditions	**4,544**	**49,986**		**5.34**
Mobilization/Demobilization	3,999		8.000 %	4.70%
Prime Contractor Overhead	6,478		12.000 %	7.61%
Prime Contractor Profit	3,628		6.000 %	4.26%
Blder's Risk & Gen Liab Ins -%	641		1.000 %	0.75%
Payment & Performance Bonds	751		1.160 %	0.88%
Subtotal W/ Prime Markups	**15,497**	**65,483**		**18.20**
Contingency	19,645		30.000 %	23.08%
Subtotal W/ Contingency	**19,645**	**85,128**		23.08
Total Construction Costs		**85,128**		

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2017-250 Air Release Valves Unalaska Alaska-ROM
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BID TOTALS

Biditem	**Description**	**Status - Rnd**	**Quantity**	**Units**	**Unit Price**	**Bid Total**
5	Bonds & Insurance		1.000	LS	1,365.00	1,365.00
10	Preconstruction Submittals & Final Report		1.000	LS	3,271.17	3,271.17
20	Mobilize and Demobilize		1.000	LS	7,704.59	7,704.59
25	Permits		1.000	LS	638.26	638.26
30	Survey		1.000	LS	1,316.01	1,316.01
50	Utility Locate		1.000	LS	598.19	598.19
70	Traffic Control		1.000	LS	2,236.00	2,236.00
80	Excavate Pipeline and Manhole(3 ea)		150.000	CY	84.49	12,673.50
90	Tapped 4" HDPE Pipeline		3.000	EA	1,625.28	4,875.84
100	Set Manhole		3.000	EA	5,855.58	17,566.74
110	Set Up Air Release Valves		3.000	EA	1,680.50	5,041.50
120	Backfill Trench and Manhole		3.000	EA	1,861.74	5,585.22
130	Repair Roadway		3.000	EA	1,147.76	3,443.28
			Bid Total	========>		$66,315.30