activated sludge processes for treatment, followed by second stage treatment (such as membranes), for final contaminant removal.

More simplified packaged treatment systems are available that are based on providing a growth medium for microbes. The added growth media provides for more efficient growth and treatment than microbes suspended in the wastewater (such as a lagoon). This allows for reduced system footprint. These systems do not require recirculated/activated sludge.

Operational Complexity

The operational complexity varies significantly with the type of packaged plant selected. As such, operational considerations are provided separately for each treatment option.

Wastewater Discharge

A packaged plant system would require a relatively small footprint, which would allow placement in an area near the existing development and the existing wastewater system infrastructure. This could make the continued use of the existing wastewater discharge system possible and minimize any needed reconfiguration of the sewer transmission lines, depending on the site chosen. If the existing discharge system is used, provisions should be included to protect the system from the ongoing threat of erosion.

4.2.1 Membrane Bio-Reactor (MBR)

A membrane bio-reactor (MBR) would consist of an aerobic bio-reactor unit (activated sludge) followed by a low pressure, ultrafiltration membrane. Membrane units would be housed within a heated enclosure. A system schematic for an MBR system showing the proposed treatment processes and potential expansion is provided in Figure 4. The additional processes required in an MBR system include:

- Equalization Basin – to mitigate variations in flow. This could potentially also serve as a dump station for hauled wastes. An associated pump lift station would be needed to transfer the wastewater from the equalization basin to the wastewater treatment system.
- Chemical Feed systems – as needed to aid in treatment.

- Motors/blowers - to provide oxygen for the bioreactor.
- Sludge Management – activated sludge will be generated in the bio-reactor unit, routine waste sludge removal will likely require a sludge treatment process (such as gravity thickener) prior to disposal in the Dillingham landfill.
- Chlorination/dechlorination station – to disinfect, as needed, during emergency events. Disinfection, including chlorination/dechlorination and ultra-violet, is discussed further in Section 4.3.2.
- Laboratory – to verify microbial growth and biologic treatment processes in the bio-reactor and allow for needed management of the wastewater treatment. Lab equipment includes a spectrophotometer and digester.

A high rate MBR wastewater treatment system would provide high quality effluent, with the ability to treat high strength wastewater to stringent permit discharge standards. Treatment processes can handle a wide range of organic loading, and still produce water suitable for reuse. An anoxic process would provide needed nitrification and ammonia removal.

Additional wastewater analysis would be needed to determine treatment processes. Successful microbial treatment is impacted by wastewater quality characteristics, including alkalinity. Alkalinity in the Dillingham area can be high, which could impact the wastewater treatment design.

A modification to the existing solid waste permit may be required to accommodate the increased sludge disposal rates (as compared to the existing wastewater lagoon system). A packaged MBR system could be used to simplify system construction.

Design Criteria

The following design criteria are assumed for a new MBR system:

Table 8 MBR Design Criteria

DESCRIPTION	VALUE/UNIT	NOTES
Max Permitted Flow	273,000 gpd	Assume current permit limit
Estimated Flow	185,000 gpd	Based on population projections
Influent BOD	150 mg/L	Higher levels are possible, for the purposes of this report no changes in wastewater quality was assumed
Influent TSS	140 mg/L	Higher levels are possible, for the purposes of this report no changes in wastewater quality was assumed
Influent Alkalinity	200 mg/L	Max without additional treatment
Total Phosphorous	8 mg/L	Max without additional treatment
Influent TKN	40 mg/L	Total Kjeldahl Nitrogen, a measure of organic nitrogen and ammonia
Minimum Bio-Reactor Temperature	75 F - 85 F	The lower wastewater temperatures decrease the efficiency of the reactor
Max Bio-Reactor Temperature	95 F	
Approximate Heated Footprint	3,000 sq ft	Membranes, lab, sludge systems, anoxic process tank, motors/blowers
Approximate Sludge Generation Rate	50 pounds per day	Assuming current wastewater characteristics
Estimated winter sludge storage volume needed	2,000 gallons	8 months of sludge accumulation
Equalization Basin	150,000 gallons	Min volume is average daily flow
Bio reactor	15,000 gallons	

Wastewater Treatment Sizing

An MBR would require a relatively small area. Locating the system near existing wastewater infrastructure would minimize the required modifications to community sewer lines and the wastewater discharge line.

A heated space, approximately 3,000 sq feet, would be sufficient to house needed treatment equipment and the laboratory. Additional area for an exterior equalization tank (with associated lift station), and a bio-reactor aeration tank would be needed. Sludge treatment, storage, and handling would also require an additional area.

A sampling/dechlorination building would be needed near the outfall. Given the high-quality effluent, ultraviolet light could also be an effective disinfection technique.

Operational Complexity

An activated sludge MBR system requires daily monitoring and process control, including microscopic analysis and onsite laboratory testing. The treatment system is based on microbial growth. If processes become unbalanced, or there is a toxic event, it could take time to re-establish microbial treatment. Offsite technical assistance may be needed to supplement the efforts of the wastewater treatment operator and bring the system back into compliance. Any prolonged exceedance could result in enforcement action including fines and penalties. Wasted sludge would require routine disposal. Sludge disposal using existing processes at the landfill could be limited during winter months due to the difficulty of dewatering in freezing conditions. This could require sludge storage for the duration of the winter.

An MBR system is much more complex, and less forgiving, than an aerated lagoon system. This would particularly be a concern for systems that struggle with high operator turnover. Operator certification estimates for an MBR is included in Appendix D. An MBR system would likely require at least a Level 2 Wastewater Treatment Operator Certification and could easily require a Level 3 Certification with supplemental treatment processes (such as the need for sludge treatment and dewatering). The time needed for treatment oversight could require additional wastewater treatment operators. The increased need for long term, high level operators would result in increased operational costs for the system.

It is anticipated that two (2) operators with Level 3 Wastewater Treatment certifications and two (2) operators with Level 1 Wastewater Treatment certifications will be required to operate the MBR alternatives.

The typical operations for an MBR include:

- Bioreactor System Monitoring – Solids retention time, hydraulic flow, aeration, sludge recycle rates, onsite microbial and chemical analysis, floc formation;
- Membrane System Monitoring – Flux, pressure, permeability, recovery, rejection, membrane aeration rate/, physical/chemical cleaning cycles; and
- Chemical injection systems and injection rates (as needed for water quality adjustments including pH).
- Sludge Management – Sludge treatment/conditioning would be necessary to minimize storage volumes. Periodic removal to the landfill would be necessary.

4.2.2 Moving Bed Bio-Film Reactor (MBBR)

An MBBR wastewater treatment system would provide high quality effluent, including ammonia reduction. The wastewater would be treated in large tanks, filled (approximate 50%) with media, which would be circulated in the tank with the media. A settling tank would be used to clarify the effluent prior to discharge.

Sludge production would be minimal, requiring limited additional sludge treatment. The existing sludge disposal system may meet the sludge disposal needs of an MBBR system.

The MBBR systems provides microbial treatment in a mixed tank with bio-film growth occurring on surfaces submerged or suspended in the wastewater. The growth surfaces decrease the footprint needed for treatment. A settling tank is used to clarify the effluent. MBBR systems have relatively low sludge production and do not utilize sludge recycling. This treatment process is more resilient and less susceptible to upset than activated sludge treatment systems. Similar to the MBR systems, an anoxic process would provide needed nitrification and ammonia removal. A system schematic for an MBBR system showing the proposed treatment processes and potential expansion is provided in Figure 5.

Design Criteria

The following design criteria are assumed for new MBBR system:

Table 9 MBBR Design Criteria

DESCRIPTION	VALUE/UNIT	NOTES
Max Permitted Flow	273,000 gpd	Assume current permit limit
Estimated Flow	185,000 gpd	Based on population projections
Influent BOD	150 mg/L	Higher levels are possible, for the purposes of this report no changes in wastewater quality was assumed
Influent TSS	140 mg/L	Higher levels are possible, for the purposes of this report no changes in wastewater quality was assumed
Minimum Dissolved Oxygen	3 mg/L	
Minimum Water Temperature	40 F	
Approximate Heated Footprint	2,000 sq ft	Workbench, sludge systems, anoxic process tank, motors/blowers
Sludge Generation	15 pounds per day	
Estimated winter sludge storage volume needed	550 gallons/winter	Min 8 months of sludge accumulation
Equalization Basin	150,000 gal	Min volume is average daily
Dissolved Air Flotation Tanks	127,000 gal	Includes floating media

Wastewater Treatment Sizing

An MBBR would require a relatively small area. Locating the system near the existing systems would minimize needed changes to community sewer lines or the wastewater discharge line. Site descriptions are provided in Section 5.

A mechanical building (approximately 2,000 sq ft), to house motors/blowers and pre-treatment components (such as a moving bed filter) would be needed. A limited sludge storage and handling area would also be needed, to store any accumulated sludge until removal is possible at the landfill. This could require storing the sludge for the duration of the winter. A gravity thickener could be incorporated with the sludge storage unit to provide for better sludge disposal at the landfill.

Operational Complexity

An MBBR system is more complex than an aerated lagoon, but less complex than an MBR. Operator certification estimates for an MBBR are included in Appendix D. An MBBR system would likely require at least a Level 1 Wastewater Treatment Operator Certification, and could require a Level 2 Certification with supplemental treatment processes (such as the need for additional sludge treatment).

It is anticipated that two (2) operators with Level 1 Wastewater Treatment certifications and one (1) assistant operator will be required to operate the MBBR alternatives.

The typical operations for an MBBR include:

- Onsite Monitoring – hydraulic flow and aeration
- Sludge Management – periodic sludge removal

4.3 DISINFECTION

The following section presents disinfection techniques that could apply to any of the wastewater treatment alternatives discussed in pervious sections.

4.3.1 Chlorination/Dechlorination

The most commonly used method of wastewater disinfection in rural Alaska is chlorination. Chlorination systems destroy target organisms by oxidizing cellular materials. Chlorine can be supplied in many forms, including chlorine gas (not typically used in Alaska), hypochlorite solutions, and other chlorine compounds in solid or liquid form. The forms most often used in rural Alaska are liquid (hypochlorite solution), granular (calcium hypochlorite), and pellets (hypochlorite tablets). The chlorination system capacity must be adequate to produce an effluent that will meet the applicable bacterial limits of the APDES permit requirements.

For optimum performance, a chlorine disinfection system should display plug flow and be highly turbulent for complete initial mixing in less than three seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer. For a chlorination system, a minimum contact period of 15 minutes at design peak hourly flow or maximum rate of pumpage is typically sufficient after thorough mixing (Great Lakes, 2004). The contact chamber should be designed to have rounded corners to prevent dead flow areas and be baffled to minimize short-circuiting. Depending on the chlorine demand and detention time, chlorinated wastewater may require dechlorination prior to discharge. Sulfur dioxide, sodium bisulfite, and sodium metabisulfite are the most commonly used dechlorination chemicals. By dechlorinating the effluent, the total chlorine residual can be reduced to a level that is not toxic to aquatic life.

Advantages of a chlorination/dechlorination disinfection system include:

- Well-established technology;
- Cost-effectiveness when compared to ultraviolet or ozone techniques;
- Reliability and effectiveness against a wide spectrum of pathogenic organisms; and
- Flexible dosing controls.

Disadvantages include special handling and storage requirements, as all forms of chlorine are highly corrosive and toxic, requiring increased safety regulations for transportation, handling and storage. In addition, some parasitic species have shown resistance to low doses of chlorine and the long-term effect of discharging dechlorinated compounds into the environment are unknown (USEPA, 1999a).

4.3.2 Ultraviolet Light

Another commonly used method of disinfection is to pass the wastewater stream through an ultraviolet (UV) light array. When properly operated, UV disinfection will kill the majority of pathogens present and will not produce regulated byproducts. UV disinfection systems transfer electromagnetic energy from a mercury arc lamp to an organism's genetic material. When UV radiation penetrates the cell wall of an organism, it destroys the cell's ability to reproduce.

The effectiveness of a UV disinfection system depends on the characteristics of the wastewater, the intensity of UV radiation, the amount of time the microorganisms are exposed to the radiation, and the reactor configuration. UV disinfection success is directly related to the concentration of colloidal and particulate constituents in the wastewater. High levels of turbidity and TSS, above 30 mg/L, in the wastewater can render UV disinfection ineffective. Therefore, these systems are best suited to wastewater treatment systems that produce a high quality of wastewater effluent prior to the disinfection process.

Advantages of a UV disinfection system include:

- No chemical handling;
- No regulated byproducts produced;
- Small space requirements for equipment;
- Relatively short contact time; and
- User-friendly operation and maintenance.

Disadvantages include limited effectiveness at inactivating some viruses, requirements for clean power supplies (and associated Uninterruptable Power Supply support systems), and ineffectiveness with high turbidity and TSS solutions. In addition, UV disinfection is not generally as cost-effective due to increased energy requirements when compared to chlorination/dechlorination.

5.0 SITE ALTERNATIVES

This section presents site alternatives for future wastewater treatment systems. The following sites were identified for consideration through coordination with City of Dillingham personnel and operators, and are shown on Exhibit 5:

- Site 1 – Defend Existing Treatment Lagoon in Place
- Site 2 – City Shop Pad
- Site 3 – Kanakanak Road

EXHIBIT 5 – SITE ALTERNATIVES LOCATION MAP

5.1 SITE DESIGN CRITERIA

The following section presents site design criteria that could apply to any of the wastewater treatment site alternatives.

5.1.1 FAA/ADOT&PF

Per FAA Advisory Circular 150/5200-33B – Hazardous Wildlife Attractants on or Near Airports – *"For airports serving turbine-powered aircraft, the FAA recommends a separation distance of 10,000 feet between hazardous wildlife attractants and the nearest air operations area.*

The FAA strongly recommends that airport operators immediately correct any wildlife hazards arising from existing wastewater treatment facilities located on or near the airport. Where required, a Wildlife Hazard Management Plan (WHMP) developed in accordance with Part 139 will outline appropriate wildlife hazard mitigation techniques. Accordingly, airport operators should encourage wastewater treatment facility operators to incorporate measures, developed in consultation with a wildlife damage management biologist, to minimize hazardous wildlife attractants. Airport operators should also encourage those wastewater treatment facility operators to incorporate these mitigation techniques into their standard operating practices."

5.2 SITE 1 – DEFEND EXISTING TREATMENT LAGOON IN PLACE

Site 1 is located at the existing wastewater treatment lagoon. It retains the existing wastewater treatment lagoon in its current configuration, installs necessary improvements to meet treatment objectives and regulatory requirements, and constructs bank armoring to protect the existing lagoon and site infrastructure from failure due to shoreline erosion. The Site 1 site plan is shown on Figure 6.

PHOTOGRAPH 3 – SITE 1 DEFEND EXISTING TREATMENT LAGOON IN PLACE (7/12/19)

This alternative assumes the planned aeration, baffles, and pretreatment pond improvements, discussed in Section 2.1.4, will be constructed prior to, and independently of, any improvements discussed in this Study. The engineer's cost estimate for planned treatment lagoon improvements is $900,000. This cost is omitted from the capital cost estimate for this alternative, as presented in Section 6.

5.2.1 Property Ownership and Land Status (Dillingham Master Plan)

The existing lagoon and potential Site 1 improvements are located on City of Dillingham (USS 4974) and Choggiung Limited property with subsurface rights belonging to Bristol Bay Native Corporation. Per the October 2010 City of Dillingham, Comprehensive Plan Update & Waterfront Plan, Site 1 is located in an area designated for Public Lands and Institutions which includes sewer treatment. See Appendix F for additional information on property ownership and land status.

5.2.2 Geotechnical Considerations

The following information was summarized from Golder's Geotechnical Reconnaissance Findings and Preliminary Engineering Considerations report, presented in Appendix A.

The existing lagoon site (Site 1) was developed by mass excavation of overlying materials to a suitable substrate. The treatment cells were excavated into the exposed bench. Based on a visual assessment by Golder, no significant slope instability issues were noted. The treatment cells are approximately 450 feet from the bay; however, the shoreline at the lagoon is unprotected and is experiencing shoreline erosion.

Previous coastal erosion mitigation measures include a sheetpile wall and armor rock installed along the shoreline within approximately 700 to 800 feet south of the lagoon. The zone with coastal protection measures appears to reduce and possibly stabilize the progressive shoreline loss relative to unprotected areas northward along the shoreline.

Bluff exposures along the unprotected shoreline adjacent to the existing lagoon indicate a several foot-thick organic mat overlying silts with varying organic contents. Sloughing and slope instability along the unprotected areas is prevalent.

Site 1 appears to have adequate area for facility expansion using a similar mass excavation earthwork approach as was used for the existing lagoon. However, shoreline protection is needed to control coastal erosion risks for extended use of this site.

Additional civil, geotechnical, and coastal engineering analysis, as well as permitting, will be required to refine the appropriate armor system for this alternative. However, left unprotected, continued shoreline regression and erosion should be anticipated with the rate and geometry of additional shoreline loss requiring additional costal process assessment and engineering evaluation. There are at least two rock quarries in the Dillingham/Aleknagik area that may be able to produce riprap for shoreline armor material.

5.2.3 Erosion Protection Considerations

No Action

No action assumes that shoreline erosion adjacent to the lagoon, driven by wave action during high tides and Nushagak River channel migration, continues at its current rate which has averaged over 10-feet per year over the past 20 years. See the Dillingham Shoreline Erosion Analysis figure and the desktop Erosion Protection Assessment prepared by Herrera Environmental Consultants, Inc., located in Appendix G. In the short term, the lagoon effluent discharge line could be exposed and damaged during any major storm event. Assuming a consistent erosion rate (10 feet per year), the hillside below the lagoon may be significantly eroded with lagoon integrity becoming a major concern within 15 years.

Sheetpile Wall Revetment

Often used in conjunction with rock revetments, sheetpile walls are a common and effective solution to shoreline protection in a variety of environments. The proposed sheetpile wall revetment alternative includes a 2,600 LF sheet-pile bulkhead that extends along roughly the same alignment as the rock revetment. The preliminary bulkhead design has a capped top at elevation +32 feet MLLW. The southern terminus of the proposed bulkhead connects to the existing USACE sheet-pile bulkhead constructed in 1999. For the concept design, structural components of the sheet-pile system are consistent with those developed by the USACE. The revetment would run northeastward, roughly parallel to the existing shoreline for 2,100 LF where it turns inland following the lower hillside topography east of the lagoon for an additional 500 LF. The revetments northern end would key into the hillside northeast of the lagoon to limit erosion undercutting. This includes a 20' wide construction-maintenance road that extends the length of the bulkhead.

The steel sheetpile bulkhead would consist of coal tar epoxy coated Z or U piles approximately 24 feet in length with anchor rods extending back to anchor piles at 20-foot spacings. A galvanized wale assembly would be continuous along the face. Six-inch weep holes would be placed on a 12-foot spacing to drain water from behind the wall and minimize overburden pressures. Numerous zinc anodes would be installed on the sheet-pile sections and replaced periodically for cathodic protection. Approximately 50,000 CY of pit-run gravel would be required along the inland face of the bulkhead for stabilization and development of the construction/maintenance road. A protective layer of armor rock would be placed along the base of the sheetpile wall to limit undermining caused by wave reflection and scour. See Exhibit 6 for a typical sheetpile wall cross section (armor rock not shown) from the USACE used previously in Dillingham. Additional information is provided in Appendix G, including the desktop Erosion Protection Assessment prepared by Herrera Environmental Consultants, Inc.

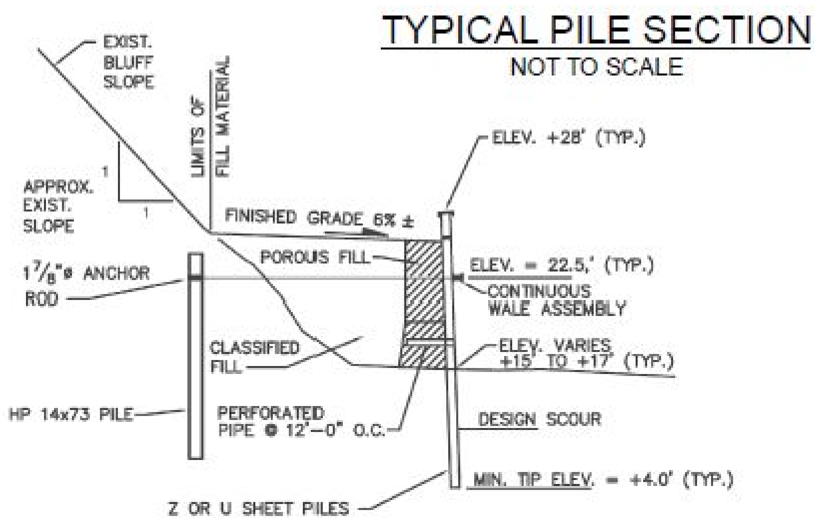

EXHIBIT 6 – SHEETPILE WALL SECTION

The sheet-pile has a 30-year design life. It is assumed that the sheet-pile would need to be replaced at year 30 and that periodic maintenance would have to be performed on the structure at intervals of not more than 10 years. This replacement is expected to be accomplished by driving new sheet-pile in front of the old and possible replacement of the waler and anchor rods. The cathodic protection of the structure would need to be inspected annually. Safety ladders should be included at regular intervals, as well as fish net attachments at 100-foot spacing to accommodate local subsistence fishing. Corrosion protection (coal tar epoxy coating and galvanic anodes) is recommended for sheetpiles, HP-piles, and anchor rods.

Armor Rock Revetment

Rock revetments are a simple and reliable means to protect infrastructure and are widely used around the world. The proposed armor rock revetment alternative consists of a 3-layer system of core, secondary, and armor stone that extends northeastward approximately 2,400 LF from the existing armor rock revetment located at the lagoon effluent outfall line. The revetment would run roughly parallel to the existing shoreline for 1,900 LF where it turns inland following the lower hillside topography east of the lagoon for an additional 500 LF. The revetment's northern end would key into the hillside northeast of the lagoon to limit erosion undercutting. This includes a 20' wide construction-maintenance road that extends the length of the revetment. The seaward side of the proposed revetment is to be placed at a 1V:1.5H slope with a trench at the base extending outward 6 feet laterally. A geotextile fabric would underlie the armor layers in the toe trench. The armor layer is 5.5 feet thick, measured perpendicular to the face of the slope. The rock in the armor layer should be as uniform as possible with a median stone weight of 3,450 pounds. The secondary rock layer beneath the armor rock measures 3 feet thick with a median stone weight of 350 pounds. Armor and secondary rock quantities are estimated at 40,000 CY. The core of the revetment and construction/maintenance road would consist of pit-run gravel requiring an estimated 75,000 CY of material.

The top elevation of the preliminary revetment design is set at +32 feet MLLW. This is based upon 6 feet of wave run-up the rubble slope with a design high water level of 26 feet, which equates to mean higher high water plus 6 feet of storm surge. See Exhibit 7 for a typical rock revetment cross section from the USACE used previously in Dillingham. Additional information is provided in Appendix G, including the desktop Erosion Protection Assessment prepared by Herrera Environmental Consultants, Inc.

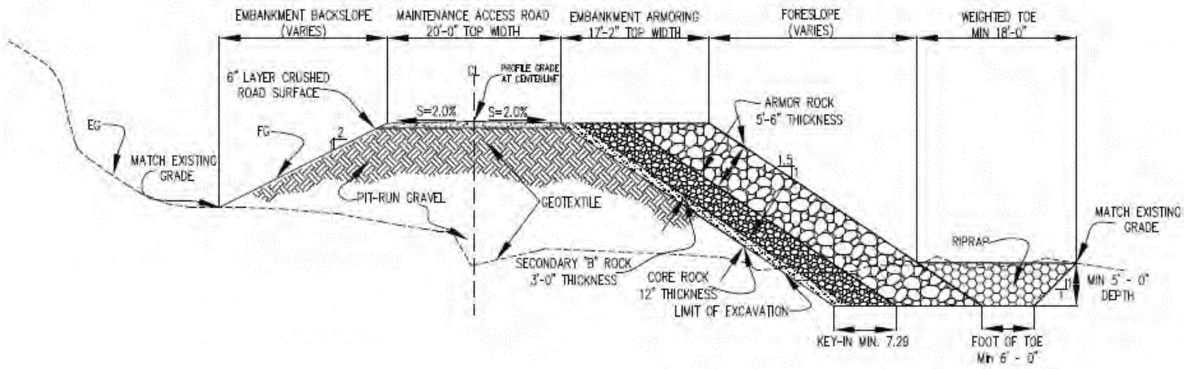

EXHIBIT 7 – ROCK REVETMENT SECTION

Periodic inspection is required to verify whether maintenance on the revetment is warranted. Rock surfaces should be inspected for ice damage and rock sizes should be checked to ensure that freeze-thaw action does not reduce the design gradation. Some maintenance activity is assumed throughout the project life. To account for maintenance activities resulting from the inspections, stone replacement is assumed at 2 percent of the installed armor layer every 25 years.

5.2.4 Environmental/Permitting Considerations

A critical part of project development for wastewater facilities is the consideration of potential environmental impacts. The following environmental/permitting considerations warrant special note.

Wetlands

The U.S. Fish & Wildlife Service – National Wetlands Inventory mapper was used to determine Dillingham's wetland resources. According to the mapper, Site 1 is in an area classified as "Freshwater Emergent Wetland". Coordination with the USACE will be required and it is anticipated that a General Permit and associated wetlands documentation will be necessary prior to construction activities.

Endangered Species/Critical Habitat

The U.S. Fish & Wildlife Service – Information for Planning and Consultation (IPaC) mapper was used to determine if endangered species and/or critical habitat exist in the area of Site 1. According to the mapper, there are no endangered species expected to occur at this location. However, construction activities at Site 1 may result in impacts to migratory birds, eagles, and their habitats, which will likely require the implementation of conservation measures and project scheduling considerations for breeding seasons.

Cultural Resources

The following information was summarized from True North's Cultural Resources Investigation, presented in Appendix B. Site 1 proposes to install treatment improvements at the existing lagoon, construction of a bluff access road, and placement of erosion protection along the bluff embankment. The proposed Area of Potential Effects (APE) for Site 1 is just east of Lil Larry Road at the existing sewer lagoon, and along the shoreline of the Nushagak River. Areas surrounding the proposed APE, as well as a portion of the sewage lagoon access road from Lil Larry Road, were previously surveyed for cultural resources. These surveys resulted in negative findings for cultural resources. Site 1 includes the existing lagoon, which is considered to yield a low probability for containing cultural resources. The proposed lagoon improvements are assessed as unlikely to impact cultural resources that may constitute historic properties pursuant to Section 106 of the NHPA and its implementing regulations (36 CFR §800).

In addition to the treatment improvements at the lagoon, Site 1 will include removal of vegetation and grading for placement of erosion protection along the embankment. It will also involve the construction of a new access road. This particular scope under Site 1 is in a location considered to have moderate-to-high potential for containing cultural resources and has yet to be investigated for such resources. Based on this desktop survey, shorelines along fresh and saltwater sources have the highest density of cultural resources in the Nushagak Region. As such, it is safe to assume prehistoric and historic cultural resources may be discovered in the areas of Site 1 where construction will take place along the shoreline. It is, therefore, recommended these particular areas (erosion protection and access road) within Site 1 be subject to an on-site survey for cultural resources by a professional archaeologist prior to construction.

FAA/ADOT&PF Coordination

The existing lagoon and proposed improvements for this alternative are located approximately 8,500 feet from the Dillingham Airport. Preliminary consultation with the FAA indicates that construction of wastewater treatment improvements within the 10,000-foot separation distance is possible, and not all that uncommon in rural Alaska, provided the project complies with FAA Airport Certification Part 139.337 – Wildlife Hazard Management, including coordination with ADOT&PF and the Wildlife Biologist. In addition, an update to Dillingham's existing WHMP, and the installation of enhanced wildfire deterrents, may be required based on the design of the selected improvements.

ADEC Approval

As presented in Section 3.1 – Minimum Construction Standards, improvements to Dillingham's wastewater treatment system will required coordination with ADEC for Approval to Construct followed by Approval to Operate.

NEPA Approval

Improvements have the potential to be Federally funded, which require adherence with the National Environmental Policy Act (NEPA), and all the regulatory requirements contained within.

ADF&G Fish Habitat

Coordination with the Alaska Department of Fish and Game (ADF&G) will be required prior to the implementation of any improvements to determine if a Fish Habitat Permit is required and what the conditions of the permit entail.

5.2.5 Utility/Infrastructure Considerations

This alternative maintains all existing wastewater utilities and infrastructure at the existing lagoon site and includes planned improvements such as a new settling pond and replacement aeration system and baffles. Continued use of the existing lagoon would mean continued use of existing sewer infrastructure, the blower building and blower systems, and the outfall line. There would be no changes to community sewer lines or the wastewater discharge line.

The original lagoon included provisions (effluent piping and valve) for a future third cell; however, it is assumed these components are inoperable due to their age lack of operation/maintenance. Additional treatment, including the polishing cell (Cell #3) and disinfection system, could be constructed at the existing wastewater treatment site, north of Cell #2, with a sampling/dechlorination building installed adjacent to the existing outfall manhole.

This alternative has the potential benefit of protecting other community infrastructure from erosion such as the AT&T Building, Lil Larry Road, and the Weathering Heights and HUD Subdivisions.

5.3 SITE 2 – CITY SHOP PAD

Site 2 is located adjacent to the City Shop on the north side of the existing pad, northwest of the existing wastewater treatment lagoon. The Site 2 site plan is shown on Figure 7.

PHOTOGRAPH 4 – SITE 2 CITY SHOP PAD (7/12/19)

5.3.1 Property Ownership and Land Status

The City Shop and potential Site 2 improvements are located on City of Dillingham (Tucker Subdivision Plat No. 1997-14) property. The area northeast of the City Shop is owned by Choggiung Limited with subsurface rights belonging to Bristol Bay Native Corporation. Per the October 2010 City of Dillingham, Comprehensive Plan Update & Waterfront Plan, Site 2 is located in an area designated for Public Lands and Institutions which includes sewer treatment. See Appendix F for additional information on property ownership and land status.

5.3.2 Geotechnical Considerations

The following information was summarized from Golder's Geotechnical Reconnaissance Findings and Preliminary Engineering Considerations report, presented in Appendix A.

Site 2 is bounded by the City Shop pad, radio tower/subdivision, and residential development. It is a broad sloping grassland area with a drainage swale along the approximate centerline of the observed area. Brush and shrub vegetation border the south and east margins of area. Water and wastewater pipelines are buried along the margin of the brush and shrub zone roughly parallel to the road. Portions of the area were traversed by foot with noted shallow standing water present thorough the area. The area would not have supported tired or track mounted equipment without mats or other access improvements.

City personnel indicated the buried utility pipelines encountered hard clay, probably over consolidated glacial deposits, along its alignment. One shallow test pit was advanced by the city along the western margin of their fill pad. The test pit was advanced with a Case 580 rubber-tired backhoe.

The US Department of Agriculture, Natural Resources Conservation Service (NRCS) mapped the soils to approximately 6 feet below grade. In the grassland area for this site, the NRCS soil classification was predominately the Weary river Peat, mostly organics over silty loam. This classification is in general accordance with the shallow test pit findings located at the edge of the City Shop fill pad.

The City Shop site (Site 2) may be a potential location for either a new lagoon or a new treatment plant. The lagoon option will need to address nearby existing and planned residential developments as well as current drainages within the grassland area. An embankment berm lagoon geometry can be considered but geotechnical risks including consolidation settlement of the underling cohesive soil from the embankment surcharge pressures will need to be evaluated. If a new treatment facility is being considered structure foundations will need to be determined. This will require additional site-specific geotechnical investigation and analysis. However, the mineral soils, both cohesive (plastic silt and clay) and non-cohesive (sand and gravel) are expected to provide suitable structure foundation support using driven closed end piles or larger dimensioned helical piles seated into an adequate bearing stratum. Conventional shallow foundations may be feasible for load bearing, settlement sensitive structures but additional evaluation to determine the consolidation settlement characteristics for the site soils will need to be determined. Building and embankment geotechnical design will require a more detailed site investigation at the desired structure footprints.

5.3.3 Environmental/Permitting Considerations

A critical part of project development for wastewater facilities is the consideration of potential environmental impacts. The following environmental/permitting considerations warrant special note.

Wetlands

The U.S. Fish & Wildlife Service – National Wetlands Inventory mapper was used to determine Dillingham's wetland resources. According to the mapper, Site 2 is in an area classified as "Freshwater Emergent Wetland". Coordination with the USACE will be required and it is anticipated that a General Permit and associated wetlands documentation will be necessary prior to construction activities.

Endangered Species/Critical Habitat

The U.S. Fish & Wildlife Service – Information for Planning and Consultation (IPaC) mapper was used to determine if endangered species and/or critical habitat exist in the area of Site 2. According to the mapper, there are no endangered species expected to occur at this location. However, construction activities at Site 1 may result in impacts to migratory birds, eagles, and their habitats, which will likely require the implementation of conservation measures and project scheduling considerations for breeding seasons.

Cultural Resources

The following information was summarized from True North's Cultural Resources Investigation, presented in Appendix B. Site 2 proposes the construction of wastewater treatment improvements adjacent to the City Shop and includes significant site development and the installation of sewer and water lines beneath West 2nd Avenue and West E Street. This area has not been subject to any previous cultural resources investigations. The land to the north of the existing City Shop pad proposed for development is a mixed habitat of wetlands consisting of low-lying tundra, grasses, and willow thickets. Small ponds and areas where water is pooling scatter the landscape. Based on the predictive model for identifying cultural resources, Site 2 is assessed as being proposed in an area considered to have low probability for containing cultural resources. Moreover, the installation of utility lines as part of the site development and construction of the wastewater treatment improvements will be serviced from within the confines of the existing roadbed. As would be expected, this roadbed is heavily disturbed from road construction and maintenance, with layers of compacted gravels and soils previously placed onsite during past road improvement activities. The proposed APE for this site is, therefore, assessed as having a very low likelihood for encountering undocumented resources during construction. As such, construction could proceed with no further investigation.

FAA/ADOT&PF Coordination

Alternative 2 is located approximately 6,500 feet from the Dillingham Airport. Preliminary consultation with the FAA indicates that construction of a new wastewater treatment plant within the 10,000-foot separation distance is possible, and not all that uncommon in rural Alaska, provided the project complies with FAA Airport Certification Part 139.337 – Wildlife Hazard Management, including coordination with ADOT&PF and the USDA Wildlife Biologist. In addition, an update to Dillingham's existing Wildlife Hazard Management Plan (WHMP), and enhanced wildfire deterrents, may be required if a new wastewater treatment lagoon is the selected treatment process. A packaged wastewater treatment plant would not be subject to the same FAA regulations as a treatment lagoon system as there would be essentially be no wildlife attractants.

ADEC Approval

As presented in Section 3.1 – Minimum Construction Standards, improvements to Dillingham's wastewater treatment system will required coordination with ADEC for Approval to Construct followed by Approval to Operate.

NEPA Documentation

Improvements have the potential to be Federally funded, which require adherence with the National Environmental Policy Act (NEPA) and all the regulatory requirements contained within.

5.3.4 Utility/Infrastructure Considerations

With the exception of a water distribution main located along West 2nd Ave. and the abandoned forcemain on the east side of the site, there are no sanitation utilities or infrastructure in the proximity of Site 2. The implementation of wastewater treatment improvements at Site 2 would require significant design and construction efforts to reroute the existing wastewater collection system to the new treatment system, including:

- Intercepting the existing forcemain from City Dock lift station at the intersection of East D St. and East 1st Ave. and installing a new forcemain and lift station(s) to Site 2, approximately 2,000 LF.
- Reenergizing the existing forcemain and lift station(s) from the HUD Subdivision and connecting to the new forcemain at the intersection of East D St. and 1st Ave.
- Installing new gravity sewer, forcemain, and lift station(s) from Site 2 to the existing effluent outfall manhole, approximately 3,500 LF.
- Protecting the existing effluent manhole and outfall line.
- Decommissioning the existing treatment lagoon.

A new wastewater treatment system at Site 2 would require substantial development to accommodate new site infrastructure including, but not limited to, roadways, parking lots, electric services, a pumper truck dump station, and security fencing.

5.4 SITE 3 – KANAKANAK ROAD

Site 3 is located on the west side of Kanakanak Road, southwest of the existing lagoon and northwest of the Kanakanak Hospital complex. The Site 3 site plan is shown on Figure 8.

PHOTOGRAPH 5 – SITE 3 KANAKANAK HOSPITAL (7/11/19)

5.4.1 Property Ownership and Land Use

Robert Himschoot is the owner of approximately 150 acres where Site 3 is located. Per email correspondence in July and October of 2019, Mr. Himschoot is willing to entertain the sale of this land, or a portion thereof, to support this critical component of community sanitation infrastructure. According to the City of Dillingham's Mapping website, the land value is $165,000. However, further coordination and negotiations will be required if Site 3 is selected as the proposed alternative.

The potential effluent outfall location, east of the Himshoot property on the east side of Kanakanak Road, is owned by Choggiung Limited (Plat No. 2009-12).

Per the October 2010 City of Dillingham, Comprehensive Plan Update & Waterfront Plan, Site 3 is located in an area designated for Open Space/Watershed/Lower Intensity Use with the area on the east side of Kanakanak Road designated as Residential Focus. See Appendix F for additional information on property ownership and land status.

5.4.2 Geotechnical Considerations

The following information was summarized from Golder's Geotechnical Reconnaissance Findings and Preliminary Engineering Considerations report, presented in Appendix A.

Site 3 is located in a large tract that borders Kanakanak Road and extends westerly for approximately one mile. A series of topographic rises are present along the western margin of the tract. The majority of the area is grass vegetation with defined surface drainages along the margins of the areas. Some standing water was present near the roadway with the majority of the site not accessed. A series of timber power poles borders the southern margin of the site. The power poles appeared to be direct site vertical with minimal leaning or other deflections.

The NRCS mapped the elevated areas as the Nushagak Clarks point Complex, a predominately well-drained silty loam with increasing sand content with depth (to about 6 feet). The lower lying, grassy areas were classified by the NRCS as the Pellernargug Wearyriver Complex and the Pellernargug Mucky Peat. Both classifications infer poorly drained, high organic content soils with some silty loam at depth in some areas. These soil classifications are expected to be in general accord with the glacial depositional environment in the area.

The Site 3 may have similar development considerations as the City Shop site for a lagoon option. The better drained, upland areas within Site 3, if present, may provide better soil conditions for wastewater treatment cells but their distance from existing infrastructure will need to be addressed in the planning phase. As with Site 2, driven or helical piles and possibly conventional shallow foundations may be feasible foundation systems for settlement sensitive load bearing structures, such as treatment plants.

5.4.3 Environmental/Permitting Considerations

A critical part of project development for wastewater facilities is the consideration of potential environmental impacts. The following environmental/permitting considerations warrant special note.

Wetlands

The U.S. Fish & Wildlife Service – National Wetlands Inventory mapper was used to determine Dillingham's wetland resources. According to the mapper, Site 3 is in an area classified as "Freshwater Forested/Shrub Wetland". Coordination with the USACE will be required and it is anticipated that a General Permit and associated wetlands documentation will be necessary prior to construction activities.

Endangered Species/Critical Habitat

The U.S. Fish & Wildlife Service – Information for Planning and Consultation (IPaC) mapper was used to determine if endangered species and/or critical habitat exist in the area of Site 2. According to the mapper, there are no endangered species expected to occur at this location. However, construction activities at Site 1 may result in impacts to migratory birds, eagles, and their habitats, which will likely require the implementation of conservation measures and project scheduling considerations for breeding seasons.

Cultural Resources

The following information was summarized from True North's Cultural Resources Investigation, presented in Appendix B. Site 3 proposes to construct wastewater treatment improvements south of Dillingham, along Kanakanak Road. A new access road will be constructed to extend west of the existing road to the new wastewater treatment system.

An effluent sewer water line will be installed from the lagoon, along the access road, to the east side of the Kanakanak Road, where a new outfall will be placed. Marine outfall is typically a pipeline or tunnel that discharges wastewater to the sea. Additional pipeline installation will be required beneath Kanakanak Road for connecting areas from Dillingham and possibly to the Kanakanak Hospital.

The area for the proposed wastewater treatment improvements and access road was previously surveyed for cultural resources. The area was considered a low probability at that time of the cultural resources investigations and the results from the surveys were negative. These previous cultural resources investigations were associated with Kanakanak Road and a Native allotment. The investigation undertaken on the Native allotment that once comprised what is now the project area was carried out in the early 1980s. More recent surveys at the Kanakanak Hospital suggests the area may yield a more moderate probability for containing cultural resources, particularly unmarked graves. As such, it is recommended this portion of Site 3 be subject to an on-site survey for cultural resources prior to construction by a professional archaeologist.

The area proposed for the new outfall zone is set along the shoreline of the Nushagak River and directly south of a freshwater stream that empties into the river. Site density in the Nushagak Region has been determined to be the highest along fresh and saltwater shorelines. Cultural resource recorded on the Alaska Heritage Resource Survey database for this area are prevalent at the confluences of streams and creeks, particularly along the Nushagak River. As such, the proposed outfall area is considered to have a high potential for containing undocumented cultural resources. More importantly, areas on and adjacent to the Kanakanak Hospital Campus have been known to contain unmarked graves. As such, the outfall installation should be monitored for cultural resources by a professional archaeologist during all construction activities.

FAA/ADOT&PF Coordination

Site 3 is located outside of the 10,000-foot separation distance from the airport. Additional coordination with FAA and ADOT&PF may be required prior to construction of Site 3; however, the level of effort will be significantly less than if the alternative was located within the 10,000-foot separation from wildlife attractants.

ADEC Approval

As presented in Section 3.1 – Minimum Construction Standards, improvements to Dillingham's wastewater treatment system will required coordination with ADEC for Approval to Construct followed by Approval to Operate.

NEPA Documentation

Improvements have the potential to be Federally funded, which require adherence with the National Environmental Policy Act (NEPA) and all the regulatory requirements contained within.

5.4.4 Utility/Infrastructure Considerations

There are no sanitation utilities or infrastructure in the proximity of Site 3. The implementation of wastewater treatment improvements at Site 3 would require significant design and construction efforts to reroute the existing wastewater stream to the new system, including:

- New gravity sewer, forcemain, and lift stations from Dillingham to the Site 3 along Kanakanak Road, approximately 20,000 LF, or HDD beneath the Nushagak River, approximately 15,000 LF.
- A new access road from Kanakanak Road, approximately 2,500 LF.
- A new effluent outfall line from Site 3 to the Nushagak River, approximately 4,000 LF.
- Decommissioning the existing treatment lagoon.

A new wastewater treatment system at Site 3 would require substantial development to accommodate new site infrastructure including, but not limited to, roadways, parking lots, electric services, a pumper truck dump station, and security fencing.

6.0 COST ESTIMATES

Capital, operation and maintenance (O&M), and short-lived asset costs were used to develop the life-cycle costs for eight (8) site and treatment alternative combinations, as presented in Sections 4 and 5 and as shown in the Figures at the end of this Study:

- Site 1/Alt. 1 – Defend In-Place with Sheetpile Revetment
- Site 1/Alt. 2 – Defend In-Place with Armor Rock Revetment
- Site 2/Alt. 1 – City Shop with New Wastewater Lagoon
- Site 2/Alt. 2A – City Shop with New MBR Packaged Treatment Plant
- Site 2/Alt. 2B – City Shop with New MBBR Packaged Treatment Plant
- Site 3/Alt. 1 – Kanakanak Road with New Wastewater Lagoon
- Site 3 /Alt. 2A – Kanakanak Road with New MBR Packaged Treatment Plant
- Site 3/Alt. 2B– Kanakanak Road with New MBBR Packaged Treatment Plant

Life-cycle costs consist of capital costs, O&M costs, short-lived assets converted to present worth for the 25-year planning period. See Appendix E for detailed breakdowns of O&M costs as well as capital cost estimates from HMS.

6.1 SITE 1/ALT. 1 – DEFEND IN-PLACE WITH SHEETPILE REVETMENT

The following summarizes life-cycle costs to defend the existing wastewater treatment lagoon in place at Site 1 using sheetpile wall revetment, as shown on Figures 2 and 6:

SUMMARY DESCRIPTION	PRESENT WORTH	
Capital Costs	$	27,902,017
Salvage Value	$	20,000
O&M Costs	$	9,007,132
Short Lived Assets	$	80,116
TOTAL LIFE-CYCLE COST	**$**	**36,969,265**

The following considerations would impact annual O&M costs:

- The need for blowers will decrease after the construction of the new, more efficient aeration equipment. Since fewer motors/blowers will be needed, there will be decreased electrical costs in the current operation.

The certification requirements for operators will not change. There would be no expected cost changes associated with training and certifications.

6.2 Site 1/Alt. 2 – Defend In-Place with Armor Rock Revetment

The following summarizes life-cycle costs to defend the existing wastewater treatment lagoon in place at Site 1 using armor rock revetment, as shown on Figures 2 and 6:

SUMMARY DESCRIPTION		PRESENT WORTH
Capital Costs	$	33,440,552
Salvage Value	$	20,000
O&M Costs	$	9,386,379
Short Lived Assets	$	80,116
TOTAL LIFE-CYCLE COST	**$**	**42,887,047**

The following considerations would impact annual O&M costs:

- The need for blowers will decrease after the construction of the new, more efficient aeration equipment. Since fewer motors/blowers will be needed, there will be decreased electrical costs in the current operation.

The certification requirements for operators will not change. There would be no expected cost changes associated with training and certifications.

6.3 Site 2/Alt. 1 – City Shop with Wastewater Lagoon

The following summarizes life-cycle costs to construct a new wastewater treatment lagoon at Site 2, as shown on Figures 3 and 7:

SUMMARY DESCRIPTION		PRESENT WORTH
Capital Costs	$	52,342,263
Salvage Value	$	80,000
O&M Costs	$	7,110,893
Short Lived Assets	$	80,116
TOTAL LIFE-CYCLE COST	**$**	**59,453,273**

The following considerations would impact annual O&M costs:

- A new lagoon system would be slightly larger than the existing lagoon, and would require more aeration. The use of efficient aeration equipment would minimize needed motor/blower equipment and any associated electricity costs.
- The certification requirements for operators will not change. There would be no expected cost changes associated with training and certifications.

6.4 Site 2/Alt. 2A – City Shop with MBR Packaged Treatment Plant

The following summarizes life-cycle costs to construct a new MBR packaged treatment plant at Site 2, as shown on Figures 4 and 7:

SUMMARY DESCRIPTION		PRESENT WORTH
Capital Costs	$	19,860,418
Salvage Value	$	250,000
O&M Costs	$	16,438,490
Short Lived Assets	$	379,248
TOTAL LIFE-CYCLE COST	**$**	**36,428,155**

The following considerations would impact annual O&M costs:

- Higher electrical costs would be associated with the additional process equipment.
- The new, larger building would increase heating costs.
- Higher costs would be associated with increased operator certification, higher levels of ongoing training, and the need for more operator hours for system operations.
- Increased level of sludge generation and disposal could impact the landfill operations.

6.5 SITE 2/ALT. 2B – CITY SHOP WITH MBBR PACKAGED TREATMENT PLANT

The following summarizes life-cycle costs to construct a new MBBR packaged treatment plant at Site 2, as shown on Figures 5 and 7:

SUMMARY DESCRIPTION		PRESENT WORTH
Capital Costs	$	24,548,648
Salvage Value	$	200,000
O&M Costs	$	11,388,333
Short Lived Assets	$	91,019
TOTAL LIFE-CYCLE COST	**$**	**35,828,000**

The following considerations would impact annual O&M costs:

- Higher electrical costs would be associated with the additional process equipment.
- The new, larger building would increase heating costs.
- Higher costs would be associated with increased operator certification, higher levels of ongoing training, and the need for more operator hours for system operations.
- Increased level of sludge generation and disposal could impact the landfill operations.

6.6 SITE 3/ALT. 1 – KANAKANAK RD WITH WASTEWATER LAGOON

The following summarizes life-cycle costs to construct a new wastewater treatment lagoon at Site 3, as shown on Figures 3 and 8:

SUMMARY DESCRIPTION		PRESENT WORTH
Capital Costs	$	29,583,440
Salvage Value	$	80,000
O&M Costs	$	7,565,991
Short Lived Assets	$	80,116
TOTAL LIFE-CYCLE COST	**$**	**37,149,547**

The following considerations would impact annual O&M costs:

- A new lagoon system would be slightly larger than the existing lagoon, and would require more aeration. The use of efficient aeration equipment would minimize needed motor/blower equipment and any associated electricity costs.

- The certification requirements for operators will not change. There would be no expected cost changes associated with training and certifications.

6.7 Site 3 / Alt. 2A – Kanakanak Rd with MBR Packaged Treatment Plant

The following summarizes life-cycle costs to construct a new MBR packaged treatment plant at Site 3, as shown on Figures 4 and 8:

SUMMARY DESCRIPTION	PRESENT WORTH	
Capital Costs	$	25,414,528
Salvage Value	$	250,000
O&M Costs	$	16,893,587
Short Lived Assets	$	379,248
TOTAL LIFE-CYCLE COST	**$**	**42,437,362**

The following considerations would impact annual O&M costs:

- Higher electrical costs would be associated with the additional process equipment.
- The new, larger building would increase heating costs.
- Higher costs would be associated with increased operator certification, higher levels of ongoing training, and the need for more operator hours for system operations.
- Increased level of sludge generation and disposal could impact the landfill operations.

6.8 Site 3/Alt. 2B– Kanakanak Rd with MBBR Packaged Treatment Plant

The following summarizes life-cycle costs to construct a new MBBR packaged treatment plant at Site 3, as shown on Figures 5 and 8:

SUMMARY DESCRIPTION	PRESENT WORTH	
Capital Costs	$	29,868,847
Salvage Value	$	200,000
O&M Costs	$	11,843,430
Short Lived Assets	$	91,019
TOTAL LIFE-CYCLE COST	**$**	**41,603,297**

The following considerations would impact annual O&M costs:

- Higher electrical costs would be associated with the additional process equipment.
- The new, larger building would increase heating costs.
- Higher costs would be associated with increased operator certification, higher levels of ongoing training, and the need for more operator hours for system operations.
- Increased level of sludge generation and disposal could impact the landfill operations.

6.9 COST ESTIMATE SUMMARY

The following table summarizes life-cycle costs for each site and treatment alternative combination. See Appendix E for detailed breakdowns of O&M costs, short-lived assets, and salvage values as well as capital cost estimates from HMS.

Table 10 Cost Estimate Summary

DESCRIPTION	CAPITAL COST	SALVAGE VALUE	O&M COSTS		SHORT LIVED ASSETS		TOTAL
			ANNUAL	PRESENT WORTH	ANNUAL	PRESENT WORTH	LIFE-CYCLE COST
Site 1/Alt. 1	$ 27,902,017	$ 20,000	$ 475,000	$ 9,007,132	$ 4,225	$ 80,116	**$ 36,969,265**
Site 1/Alt. 2	$ 33,440,552	$ 20,000	$ 495,000	$ 9,386,379	$ 4,225	$ 80,116	**$ 42,887,047**
Site 2/Alt. 1	$ 52,342,263	$ 80,000	$ 375,000	$ 7,110,893	$ 4,225	$ 80,116	**$ 59,453,273**
Site 2/Alt. 2A	$ 19,860,418	$ 250,000	$ 866,900	$ 16,438,490	$ 20,000	$ 379,248	**$ 36,428,155**
Site 2/Alt. 2B	$ 24,548,648	$ 200,000	$ 600,575	$ 11,388,333	$ 4,800	$ 91,019	**$ 35,828,000**
Site 3/Alt. 1	$ 29,583,440	$ 80,000	$ 399,000	$ 7,565,991	$ 4,225	$ 80,116	**$ 37,149,547**
Site 3/Alt. 2A	$ 25,414,528	$ 250,000	$ 890,900	$ 16,893,587	$ 20,000	$ 379,248	**$ 42,437,362**
Site 3/Alt. 2B	$ 29,868,847	$ 200,000	$ 624,575	$ 11,843,430	$ 4,800	$ 91,019	**$ 41,603,297**

7.0 ALTERNATIVES ANALYSIS AND CONCLUSIONS

This Study considers three treatment alternatives (Lagoon, MBR, and MBBR) and three site alternatives (Existing Lagoon, City Shop Pad, and Kanakanak Road) for wastewater treatment improvements in Dillingham. The advantages and disadvantages of each of the treatment and site alternatives are summarized below, followed by an alternatives analysis matrix which combines the treatment and sites alternatives, and analyzes them to determine the most favorable alternative combination for Dillingham.

7.1 TREATMENT ALTERNATIVES

Treatment alternatives are detailed in Section 4.

7.1.1 Wastewater Treatment Lagoon (Alternative 1)

This treatment alternative includes construction (or protection) of a wastewater treatment lagoon, as shown on Figure 2 and 3.

Advantages

- Aerated, partial mix lagoons have been used successfully throughout Alaska for decades. These systems have the ability to meet current minimum discharge standards with low operational and maintenance complexity.
- Aerated lagoons have long detention times and are not as impacted by daily variations in flow and loading as packaged plants.
- Low operations and maintenance costs.

Disadvantages

- High capital costs (new lagoon only).

7.1.2 MBR Packaged Wastewater Treatment Plant (Alternative 2)

This treatment alternative includes construction of an MBR packaged wastewater treatment plant, as shown on Figure 4.

Advantages

- Low capital costs.

- Wastewater treatment plants have been used throughout Alaska to provide effective wastewater treatment in a relatively small, enclosed area (as compared to lagoons).
- Since the treatment can be located above ground, they can be used in areas where surface or subsurface conditions would preclude the use of a lagoon.

Disadvantages

- High operations and maintenance costs.
- An MBR system is much more complex, and less forgiving, than an aerated lagoon system. This would particularly be a concern for systems that struggle with high operator turnover.

7.1.3 MBBR Packaged Wastewater Treatment Plant (Alternative 3)

This treatment alternative includes construction of an MBBR packaged wastewater treatment plant, as shown on Figure 5.

Advantages

- Low capital costs.
- Wastewater treatment plants have been used throughout Alaska to provide effective wastewater treatment in a relatively small, enclosed area (as compared to lagoons).
- Since the treatment can be located above ground, they can be used in areas where surface or subsurface conditions would preclude the use of a lagoon.

Disadvantages

- High operations and maintenance costs.
- An MBBR system is much more complex, and less forgiving, than an aerated lagoon system. This would particularly be a concern for systems that struggle with high operator turnover.

7.2 SITE ALTERNATIVES

Site alternatives are detailed in Section 5.

7.2.1 Site 1 – Defend Existing Treatment Lagoon in Place

This site alternative defends the existing wastewater treatment lagoon in place at Site 1 using either sheetpile wall or armor rock revetment, as shown on Figure 6.

Advantages

- Lowest site development capital costs (approximately $1.3).
- Maintains all existing wastewater utilities and infrastructure at the existing lagoon site.
- The existing lagoon and potential Site 1 improvements are located on City of Dillingham and Choggiung Limited property, with subsurface rights belonging to Bristol Bay Native Corporation.
- Site 1 is located in an area designated for Public Lands and Institutions including sewer treatment.
- Planned lagoon improvements (aeration, baffles, and pre-treatment pond) have been designed and are awaiting construction funding.
- Located near the City Shop and operations and maintenance staff.
- Potential benefit of protecting other community infrastructure from erosion such as the AT&T Building, Lil Larry Road, and the Weathering Heights and HUD Subdivisions.

Disadvantages

- Shoreline protection is needed to control coastal erosion risks for extended use of this site.
- No permanent offices at Site 1.
- Site 1 is located adjacent to community development areas. This area could have a greater value for commercial and/or residential uses.
- Site 1 includes the existing lagoon, which is considered to yield a low-probability for containing cultural resources. However, it is safe to assume prehistoric and historic cultural resources may be discovered in the areas of Site 1 where construction will take place along the shoreline.

7.2.2 Site 2 – City Shop Pad

This alternative includes construction of wastewater treatment improvements at Site 2, as shown on Figure 7.

Advantages

- Site 2 can support a new lagoon or a new packaged wastewater treatment plant (MBR or MBBR).

- The City Shop and potential Site 2 improvements are located on City of Dillingham property. The area northeast of the City Shop is owned by Choggiung Limited with subsurface rights belonging to Bristol Bay Native Corporation.
- Site 2 is located in an area designated for Public Lands and Institutions including sewer treatment.
- Located inland; with the exception of the outfall, no shoreline erosion concerns at Site 2.
- Easily accessible by operations and maintenance staff.
- This site is assessed as having a very low likelihood for encountering undocumented resources during construction.

Disadvantages

- High site development capital costs (approximately $7.8M). Note that the site development capital costs are independent of the wastewater treatment type (lagoon, packaged treatment plant) and not representative of their respective life-cycle costs (capital, O&M, short-lived assets).
- Site 2 is located adjacent to residential areas; potential for visual, vector, safety, and odor concerns; potential concerns regarding nearby property values.
- Proximity to airport (within 10,000 feet) will likely require FAA coordination including a Wildlife Hazard Management Plan and implementation of mitigation techniques.
- There are no sanitation utilities or infrastructure in the proximity of Site 2. The implementation of wastewater treatment improvements at Site 2 would a require significant design and construction efforts to reroute the existing wastewater collection system to, and from, the new treatment system.
- A new wastewater treatment system at Site 2 would require substantial development to accommodate new site infrastructure including, but not limited to, earthwork (excavation and backfill), road, parking lots, water service, electric service, a pumper truck dump station, and security fencing.
- Requires closure/decommissioning of the existing lagoon site.

7.2.3 Site 3 – Kanakanak Road

This alternative includes construction of wastewater treatment improvements at Site 3, as shown on Figure 8.

Advantages

- Site 3 can support a new lagoon or a new packaged wastewater treatment plant (MBR or MBBR).
- Located inland; with the exception of the outfall, no shoreline erosion concerns at Site 3.
- Promotes expansion of the City's wastewater system to the south west of the community.
- Located near Kanakanak Hospital; potential for future connection from Hospital.
- Located in low density residential area.
- Greater than 10,000 feet from airport; no hazardous wildlife attractant considerations/ coordination with FAA anticipated.

Disadvantages

- Highest site development capital costs (approximately $16M). Note that the site development capital costs are independent of the wastewater treatment type (lagoon, packaged treatment plant) and not representative of their respective life-cycle costs (capital, O&M, short-lived assets).
- Site 3 is located on private property; coordination and negotiations will be required to purchase and/or secure use of the property.
- The outfall area at Site 3 is considered to have a high potential for containing undocumented cultural resources, which will likely require regulatory oversight prior to and during construction.
- There are no sanitation utilities or infrastructure in the proximity of Site 3. The implementation of wastewater treatment improvements at Site 3 would require significant design and construction efforts to reroute the existing wastewater stream to, and from, the new treatment system.
- A new wastewater treatment system at Site 3 would require substantial development to accommodate new site infrastructure including, but not limited to, earthwork (excavation and backfill), road, parking lots, water service (well), electric service, a pumper truck dump station, and security fencing.
- Requires closure/decommissioning of the existing lagoon site.
- Less accessibly by system operations and maintenance staff.
- Recent surveys at the Kanakanak Hospital suggest the area may yield moderate probability for containing cultural resources, particularly unmarked graves. In addition, the proposed outfall area is considered to have a high potential for containing undocumented cultural resources. As such, it is recommended this

portion of Site 3 be subject to an on-site survey for cultural resources prior to construction by a professional archaeologist.

7.3 Alternatives Analysis Matrix

The following Alternatives Analysis Matrix was developed by Bristol and CRW; it summarizes and qualifies the considerations discussed in Sections 4, 5, and 6. Each of the treatment and site alternative combinations were evaluated against a set of analysis criteria and ranked on a scale of 1 to 5, with 5 being the most favorable alternative.

Table 11 Alternatives Analysis Matrix

ALTERNATIVE	LIFE-CYCLE COSTS	OPERATIONAL COMPLEXITY	EXISTING INFRASTRUCTURE	CULTURAL RESOURCES	CONSTRUCT ABILITY	LAND USE	COMMUNITY PREFERENCE	SCORE
WEIGHT FACTOR	0.30	0.20	0.10	0.05	0.10	0.10	0.15	1.00
Site 1/Alt. 1	4	5	5	3	5	5	5	
	1.20	1.00	0.50	0.15	0.50	0.50	0.75	4.60
Site 1/Alt. 2	2	5	5	3	5	5	4	
	0.60	1.00	0.50	0.15	0.50	0.50	0.60	3.85
Site 2/Alt. 1	1	4	2	5	1	4	2	
	0.30	0.80	0.20	0.25	0.10	0.40	0.30	2.35
Site 2/Alt. 2A	5	1	2	5	3	4	1	
	1.50	0.20	0.20	0.25	0.30	0.40	0.15	3.00
Site 2/Alt. 2B	5	2	2	5	3	4	3	
	1.50	0.40	0.20	0.25	0.30	0.40	0.45	3.50
Site 3/Alt. 1	5	4	1	2	3	3	3	
	1.50	0.80	0.10	0.10	0.30	0.30	0.45	3.55
Site 3/Alt. 2A	3	1	1	2	3	3	1	
	0.90	0.20	0.10	0.10	0.30	0.30	0.15	2.05
Site 3/Alt. 2B	3	2	1	2	3	3	2	
	0.90	0.40	0.10	0.10	0.30	0.30	0.30	2.40

Data and input from the City and our subconsultants, Golder, True North, and HMS, helped develop the matrix and guide the analysis for this Study. In addition, the matrix includes weight factors for each of the analysis criteria which are based on Bristol and CRW experience in Dillingham and engineering judgement.

7.4 Conclusions

City of Dillingham officials, community members, and other stakeholders have reviewed this Study throughout its development and have provided valuable input and feedback which aided in the development and analysis of wastewater treatment improvements for Dillingham. As presented in Table 11 – Alternatives Analysis Matrix, the conclusions of this Study are in line with Dillingham's preferences with respect to the four highest ranked alternatives:

1. Site 1/Alt. 1 – Defend In-Place with Sheetpile Wall Revetment
2. Site 1/Alt. 2 – Defend In-Place with Armor Rock Revetment
3. Site 3/Alt. 1 – Kanakanak Road with New Wastewater Lagoon
4. Site 2/Alt. 2B – City Shop with New MBBR Packaged Treatment Plant

Each of these alternatives will provide the City with a means of treating wastewater to permit standards while mitigating the potential impacts of future erosion and accommodating some community growth.

8.0 REFERENCES

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