City of Unalaska, Alaska

Electric Utility Master Plan

DPU Project No. 41-133

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Summary of Changes

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1	10/10/2017	Initial Release
2	11/07/2017	Final Draft
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1. Executive Summary

The City of Unalaska has unique design and construction requirements unlike any other in the State of Alaska. The City resides on two islands, Unalaska and Amaknak, only accessible via shipping routes or via small passenger/cargo planes out of Anchorage. Extreme weather conditions present a difficult challenge for construction projects. Coupled with fishing season constraints, engineers and builders need to be aware of how to plan and coordinate construction projects.

The City is home to many large industrial customers including Westward Seafoods, Alyeska Seafoods, UniSea, Horizon Lines, American President Lines (APL), etc. These customers have historically provided their own power generation since the City did not have the generation and distribution capacity necessary to support them. However, the City has recently built up its electrical infrastructure and is now supporting a portion of these large industrial consumers' needs. Additionally, the City desires to increase its infrastructure to provide complete support to every large industrial consumer in Unalaska.

The City of Unalaska's Electric Utility has faced rapid growth with the addition of two large seafood processing facilities to the electrical distribution system within the last two years. While this is a benefit with increased revenues from power sales, it also creates a strain on generation resources and distribution infrastructure. Furthermore, many of the large industrial customers that the City is now serving and plans to serve in the future have unique requirements of their own. These requirements may include large and sudden increase/decrease in loading, voltage support requirements (Horizon Lines undervoltage protection on refrigeration vans and system wide harm to customer equipment), paralleling and load sharing capabilities between City and customer generators (Westward and Alyeska Seafoods), and load shedding schemes/restrictions. Coupled with the fact that each large industrial customer served uses a substantial portion (in some cases 15% to 25%) of the total system demand at any given time, the City will need to have adequate knowledge, planning, and infrastructures in place to continue to adequately serve the community.

The City contracted Electric Power Systems, Inc. (EPS) to provide a Master Plan (MP) to address the future needs of the City's electrical infrastructures, clearly define purposes and needs, estimate costs to implement recommended solutions, prioritize and categorize each solution, and approximate the time needed to execute each solution. The MP identifies challenges and deficiencies in serving the Utility's load as well as presents solutions and recommendations. The plan also identifies items for improvement and projects for the Utility that should be completed over the life of the plan, estimated at 15 years.

The identified projects have been categorized and prioritized in order to address the City's upcoming challenges with system reliability, generation, and distribution systems. The projects that focus on the critical need to safely meet the reliability and power sales requirements for its existing and future customers are ranked the highest. The projects which achieve fewer benefits to the community are ranked lower in comparison.

In order to determine the order in which projects should be implemented by the City, a method of categorizing was developed based on an alphanumeric system. The projects were first divided into Distribution or Generation. Generation is defined as power production at the City Powerhouse or other locations, including non-City owned facilities. Distribution covers the delivery of the electrical energy to the end user. Each identified project was then placed into one of six categories based on the primary objective of the project. Projects can frequently satisfy multiple objectives; therefore, categorization is based on the primary objective of the project. The six categories listed in order of importance are:

Table 1: Project Categories

Project Category	Description
Reliability	• N-1 planning • Replace and upgrade existing infrastructure • Continuation of highly reliable electrical service
Environmental	• Environmental permitting changes or updates
Efficiency	• Reduce costs of providing power • Reduce necessary manpower or infrastructure
Renewables	• Solar, wind, hydroelectric and other “green energy” type projects
Administration	• Benefits operation and maintenance • Minimal benefit to utility customers
Additional	• Projects that have components of other categories • Smaller in size • Typically do not benefit all utility customers • Generally expected to be performed by in-house labor

Safety projects are those which specifically address life safety and involve correcting system safety deficiencies. Some projects were identified that address worker/operator safety, but there were no projects identified which affected public safety. The City has already started on several of the worker safety improvement projects; therefore these projects have not been included in the MP.

After all projects were placed in appropriate categories, further prioritization was still required. In order to achieve this EPS performed an analysis of the City’s electrical system by utilizing various loading scenarios. The resulting complete project list provided in Appendix A, Table A-1 is based on these findings and is presented in the order in which the greatest benefits and improvements for the Electric Utility can be achieved. Rankings have been further developed for those projects found in Table 2. For example, a project ranked “1-a” takes priority over a “1-b” or a “2-a” project. These rankings are intended to assist the City in determining which projects to implement first. Further discussion of the system analysis, findings, and the projects are found within the MP.

Nearly 50 projects were initially identified during the MP development process and the complete list is found in Appendix A, Table A-1. Given the large quantity of projects, each project was assigned a project identification number, indicated by the “Project ID No.” column in Table 2. Table 2 lists only the highest ranked projects. The primary category for all of the projects in Table 2 is Reliability.

Table 2: Master Plan Identified Projects (Reliability Category - Highest Priority)

Project Ranking	Project ID No.	Upgrade Description	Total ROM Estimate	Time to Complete (months)
1-a	D1	NPH Substation T11 Upgrade	$1.1 million	18-24
1-a	D2	35 kV Feeder Replacement (multiple phase project)	$7.9 million	12-24 per phase
1-a	D3	Submarine Cable Replacement at Illiukuk Bay	$1.8 million	12-18
1-a	D4	Install New 4 Way Switch at Town Substation	$150,000	6-9
1-a	D5	Procure Major Equipment (System Wide)	$400,000	6-9
1-a	G1	Powerhouse Sea Water Intake Line Extension	$180,000	9-15
1-a	G2	New Powerhouse Air Permitting Changes (Include Unit 8 & 9)	$1.1 million	12-18
1-a	D6	Breaker Maintenance/Service (Town Sub, New and Old Powerhouse)	Up to $150,000 / yr.	yearly schedule

Project Ranking	Project ID No.	Upgrade Description	Total ROM Estimate	Time to Complete (months)
1-a	D7	Large Transformer Maintenance at Powerhouse and Town Sub	Up to $150,000 / yr.	yearly schedule
1-a	D9	Intermediate Level Protection for 35 kV System	$500,000	9-12
1-a	G3	Wartsila/Caterpillar Major Overhauls	Up to $1.8 million/yr.	yearly schedule
1-b	G4	Modicon PLC Replacement at New Powerhouse	$350,000	9-12
1-b	D8	Town Substation SCADA Upgrade (RTAC/HMI)	$90,000	6-9
1-b	G5	Utility Flywheel Energy Storage System (FESS)	$1.2 million	12-18
1-c	G6	Utility Battery Energy Storage System (BESS) (Study)	$30,000	6-9

For planning purposes, cost estimates for completed projects and estimated time to complete have been provided in Table 2. The cost estimates are rough order of magnitude (ROM) and include construction phase and complete project duration. The required engineering cost and time associated with each of these projects are also included.

2. Distribution System Overview

The City of Unalaska faces many unique challenges in the daily operation of the Electric Utility. Increased generation capacity reserves are required to cover both scheduled and unscheduled outages. Faults on the distribution system are felt throughout the electrical system. The absence of adjoining electrical systems forces the Utility to cover contingency planning and react to unplanned outages without relying on help from adjacent systems. The large number of processors served by the electrical system requires a higher degree of reliability than would typically be found with residential or small commercial loads.

The City of Unalaska has 35 kilovolt (kV) subtransmission and 12 kV distribution system. The City's 35 kV system was originally installed in 1983 and 1984. The majority of the line is original and beyond its design life. It is also limited in its capacity to 200 amps due to cable size and termination limitations within switches and junction boxes. EPS understands the 35 kV system was installed using 4/0 aluminum conductors. The City's entire distribution system consists of 12 kV and 35 kV buried cables in PVC conduit.

The 35 kV system consists of a looped backbone, 200 amp padmounted junction cabinets (every 500 to 1,000 feet), padmounted 4 way switches, and padmounted transformers. The 35 kV is sourced from the New Powerhouse (NPH) on Amaknak Island and serves many nearby large industrial loads such as seafood processing, shipping, and harbor facilities. The NPH is also used to provide power to the Town Substation, located on Unalaska Island. There are two main 35 kV backbone extensions that connect the Amaknak Island distribution system to the Unalaska Island distribution system, one is a 1,200 foot submarine cable channel crossing and the other is a town bridge crossing.

The 35 kV subtransmission system originates at the NPH substation. Two main feeders, E1 and S1, create a loop starting at a common point of connection/separation via a 5 way Switch E-1 and have another point of common coupling/separation at the Margaret Bay Switch (also 5 way), which sources the bridge crossing extension to Unalaska Island. The substation getaway conductors are limited to a capacity of 10 MVA for each of the two feeders, matching the maximum output capacity of 20 mega volt amp (MVA) powerhouse. The 35 kV conductors along the looped backbone of the system have a 12 MVA capacity. These feeder conductors are inadequately sized for N-1 loading events.

The majority of the 12 kV distribution system is sourced from the Town Substation. The 12 kV system is primarily used to serve the residential and light commercial facilities in town. A single 12 kV feeder is sourced from the NPH substation transformer T11 and serves the residential and light commercial loads in the Standard Oil Hill area.

The Town Substation was built in the early 1990's and is the primary center of transformation from the 35 kV system to the 12 kV system. The Town Substation serves the town residential and small commercial/industrial load through four feeders. It has two matched 3750 kVA power transformers. A small metal building serves as a control building and contains two sets of medium voltage switchgear consisting of three 35 kV and seven 12 kV sections. In addition, the building houses communications equipment and a station battery bank system. The substation and control building appeared to be clean and well secured.

Known existing distribution system deficiencies include the following:

1. Currently, there is no intermediate level distribution system protection (i.e. fusing, interrupters, reclosers, etc.). There is only protection at the powerhouse substation main feeder breakers, town substation feeder breakers, and customer transformer high side fusing. Refer to section 2.1.1 for further details.
2. Inadequate N-1 coverage for key switches, main transformers, main breakers, main backbone feeder conductors, etc. as further outlined in section 2.1.2.

The load fluctuates dramatically depending on the time of day, and fishing and processing seasons. During peak system demands, the City is approaching limitations in generation and distribution capabilities. The City has recently added two seafood processing facilities and has plans to add another to its distribution system. The City added one seafood processing facility in 2015 to its distribution system. A second facility was added in late 2017. The addition of this second facility will require more infrastructure to ensure service can be maintained following an outage of critical line sections. For further loading information refer to Section 3.

2.1 Reliability and N-1

i. Protection

Currently, the distribution does not have any intermediate level protective devices that would minimize power disruptions to customers. The system is protected from faults via two main 35 kV reclosers at the powerhouse, two main 35 kV town substation breakers, and four main 12 kV town substation breakers. Other than primary fusing on customer transformers, there is no coordinated protection scheme currently employed. Some underfrequency and undervoltage load shed schemes are currently employed in the system but are limited in their ability to isolate the system in manageable pieces that would minimize disturbances to as few customers as possible. The lack of adequate coordinated protection schemes and apparatus has resulted in system wide outages during a fault or disturbance event, most often induced by a single large industrial customer. Further recommendations and solutions are outlined in Section 2.7.

ii. N-1 Planning

A type of contingency planning called "N-1" is commonly used by utilities in order to ensure that they can continue to serve its firm loads in the event of the removal from the system of any one piece of equipment, transmission line or distribution line. A specific example of N-1 planning is the failure of one section of switchgear bus at the NPH that would also result in the unavailability of the generation and transformers connected to this bus. N-1 planning studies typically will remove the largest piece of equipment or transmission line in order to verify the system load can still be served.

N-1 considerations for electrical distribution systems often contribute to the construction of feeders in looped configurations to the greatest extent that is economically feasible. This configuration allows a utility to isolate a fault in the middle of the loop before a repair is done, keeping service interruptions to the fewest customers during repairs. In contrast, a radial feeder does not allow reconfiguration to keep customers on line in the event of a problem with the line. All customers downstream from a fault are affected until the circuit can be repaired.

Customers such as UniSea, Alyeska Seafoods, APL, and Westward Seafoods are not considered in the N-1 planning portion of this report as they have full generation capabilities to accommodate their own loads in the event of a distribution failure. <u>However, it should be noted that if any major industrial customer removes its own backup generation capabilities to support their own loads, the N-1 system review results may change substantially. It is critical that the City keep in correspondence with major industrial customers regarding load additions and/or backup generation needs.</u>

N-1 planning also extends to individual pieces of equipment in a system. In the case of the Unalaska distribution system, there are many examples where the loss of a single piece of equipment will cause an extended outage to one or many customers.

Table 3 displays some specific examples of critical equipment in the Unalaska system and possible affected customers in the event of an equipment failure.

Table 3: N-1 Equipment Failure Impacts

Equipment Failure	Location	Affected Customers
Transformer T4 at NPH	NPH Substation	Entire City (limited service)
Transformer T5 at NPH	NPH Substation	Entire City (limited service)
Transformer T12 at NPH	NPH Substation	Entire City (limited service)
Switch E-1	Across street from NPH Substation	Entire City
Switch S-1	Near NPH	All Ballyhoo Road, airport maintenance, and FAA customers
VCR E1	NPH Substation	Limited service to entire City

Equipment Failure	Location	Affected Customers
VCR S1	NPH Substation	Limited service to entire City
Switch T-12	Town Substation	All Unalaska Island 12 kV customers
Margaret Bay Switch		Limited service to Town Sub Customers, Westward Seafoods and Alyeska Seafoods
S-2 Radial Tap from Switch S-1	Airport	Airport Maintenance, FAA, Ballyhoo Road Customers
Town Sub 12 kV "Town" Feeder Breaker	Town Substation	All Town feeder customers including senior center, city park, office, sewer, etc.
Town Sub 12 kV "Valley" Feeder Breaker	Town Substation	All Valley feeder customers including Dutton Road, Church circuit, Loop Road circuit, Public Works circuit, Lear Road circuit, East Broadway
Town Sub 12 kV "School" Feeder Breaker	Town Substation	All School feeder customers
Town Sub 12 kV "Captains Bay" Feeder Breaker	Town Substation	All Captains Bay feeder customers including Public Safety, Water Department, Clinic, City Hall, etc.
Large VA Transformers (>300 kVA) whose customers do not have adequate backup generation on site	Throughout	Customer served by their transformer.
Loss of channel or bridge crossings		Limited service to Alyeska and Westward Seafoods and Town Substation

EPS has recommended a project to verify current spare equipment and order any missing items in order to improve the City's distribution N-1 scenario readiness. See Appendix B for details.

iii. Personnel Needs

The distribution system is operated and maintained by the City Line crew. The Line crew is responsible for all daily distribution system operations and modifications, from connecting residential services to 35kV system changes. They also perform maintenance on equipment, read all revenue meters monthly and respond to outages.

The line crew has typically been staffed with up to three journeyman level workers. In early 2017, the City had a single journeyman and two apprentices. The current lead journeyman has approximately 10 years of experience, including two years at the City. At the time of the site visit, there were advertised open positions for a line crew General Foreman and a journeyman lineman. One of the City's apprentices recently became a journeyman lineman.

The City Line crew needs two journeymen at a minimum to ensure State of Alaska labor laws are met. Per the State of Alaska's 8 Alaska Administrative Code (AAC) 90.165(c), the state allows a two-to-one ratio of apprentices to journeymen. The City is able to meet this as long as one journeyman is available, even when the second one is not available for work. The City must also follow the requirements of their Alaska Department of Labor Apprenticeship program. This program requires a one to one ratio of journeyman to apprentice linemen. The City must limit its number of trainees in order to meet the program requirements. It would be preferred if the remaining line crew position could be filled with an experienced journeyman who could take over the General Foreman duties. The addition of an experienced person will also provide better training for the less experienced linemen. This staffing approach would ensure the City is always able to satisfy the State of Alaska requirements.

Until the line crew is better staffed, a term services contract with a line construction contractor is recommended to fill in for staff when planned absences occur. The fill-in position may include having a contractor on notice when City staff is unavailable to perform their job duties and they may be called if problems arise. If workloads dictate, the City may require one or two contractor lineman to temporarily work in Unalaska. This type of term contract should also address emergency assistance and support. Task specific training opportunities may also be available from a contractor line shop.

Recommendations Summary:

- Hire one full time experienced journeyman to fill General Foreman position
- Term service contract for emergency support and staffing support

Additional comments on staffing for the Electric Utility are found in Generation Section 3.3.

2.2 Capacity Now and Needed

i. Existing System

Feeder E1 is the normal 35 kV source for loads along East Point Drive, including Horizon and APL. It serves as the main service point (Feeder T1) for the channel crossing. Feeder T1 serves Alyeska Seafoods and ends at the Town Substation. The channel crossing of Iliuliuk Bay originates just south of APL and crosses over near Alyeska Seafoods and ends at the Town Substation. Alyeska Seafoods is the only 35 kV service on Feeder E1 between the channel crossing and the Town Substation. The feeder has a capacity of 12 MVA and experiences loading between 60% and 80% of its rated capacity in the normal system switch configuration. Refer to Section 4 for further feeder loading information.

Feeder S1 serves 35 kV loads along Airport Beach Road (ABR) as well as Ballyhoo Road. Ballyhoo Road is served via a radial tap at Junction Box S-2. Feeder S1 can be connected to E1 near the intersection of ABR and East Point Drive. This feeder continues along ABR to a 5 way switch near Margaret Bay where E1 and S1 feeders can also be joined together, if needed. A radial feeder to UniSea's 2.5 MVA transformer originates at this switch. Feeder S1 also has a capacity of 12 MVA and experiences loading between 40% and 60% of its capacity.

Feeder T1 consists of the section of 35 kV line between Margaret Bay switch and the Town Substation and has a capacity of 12 MVA. The circuit crosses the channel using the bridge rather than submarine cable. Under normal operating conditions, this feeder currently carries all of the Unalaska Island loads while the channel crossing is energized on standby but not loaded. This line then extends out along Captain Bay Road and provides the 35 kV source for Westward Seafoods Captains Bay plant, which is expected to add 4 - 5 MW to the system load during peak seasons. The radial segment of line starting at the tap point from the main looped 12 MVA backbone has a capacity to 10 MVA.

ii. Expected Short and Long Term Needs

The 35 kV system was originally designed as a looped configuration that would allow the loss of either the channel or bridge crossing and still retain the ability to serve all loads. However, once the Westward Captains Bay plant is on line, both the channel and bridge crossing circuits will be needed to serve loads during peak demands, as indicated in Table 3. The channel crossing needs to be upgraded due to age and because it does not meet N-1 planning needs.

UniSea represents the last known major processing facility in Dutch Harbor/Unalaska to not have a full capacity utility tie in place. The UniSea campus includes a powerhouse, processing facilities, and support facilities such as employee housing, restaurants and hotels. UniSea currently provides all of their power with their own generation, although an existing 2.5 MVA 34.5/4.16 kV padmount transformer served by the City's UT tap is available for use. It is understood that UniSea's generation plant is aging and they are reviewing their options for power generation or purchase.

The City should start a planning group with UniSea to discuss the feasibility of and interest in a larger utility service. Discussions should include long-term power requirements, possible sales arrangements and other cost sharing options. If UniSea expresses interest in a power purchase agreement, the City must undertake additional system improvements. Since the City does not currently have the available generation to support the UniSea plant, they must include in their plans additional diesel units as well as 35 kV distribution system upgrades. The power purchase agreement should address topics such as interruptible service terms, communications infrastructure requirements, protective relaying and coordination requirements, as well as financial topics such as demand charges and kWh charges.

The remainder of the City is provided power with the lightly loaded 12 kV radial distribution system. The 12 kV conductor type is understood to be 1/0 aluminum conductor, which is nominally rated at 3.7 MVA peak loading. The 12 kV feeders are normally loaded between 20% and 30% of this capacity.

2.3 Environmental

At this time the only environmental concern for the distribution system is maintaining oil spill containment facilities at the NPH and Town Substations, and maintaining a current Spill Prevention, Control, and Countermeasure (SPCC) document for all oil filled apparatus (i.e. transformers and switch cabinets) in the system per the United States Environmental Protection Agency (USEPA) 40 CFR 112.7.

2.4 Efficiencies

Transformers are located throughout the system and represent a location where electrical losses occur during the voltage transformation process. In most cases, these electrical losses translate to energy costs that the City must bear. Since these losses are most significant on larger customers, the City has installed metering at Alyeska Seafoods, APL, and Westward Seafoods. In the future, all large industrial customer connections should be made through the use of primary metering.

During the procurement process of a large (1 MVA or greater) transformer, the City should require losses be provided with the bid. Transformer manufacturers are able to provide the expected losses prior to construction of the unit. Therefore, the City can include a simple economic analysis in their transformer purchasing process in order to choose the best long-term value. Such evaluations have been performed recently for the Alyeska Seafoods transformer upgrade and can be referred as a guideline for future large transformer purchases.

With the high cost of energy compared to the national average, the City should employ and maintain a standard of procuring only energy efficient transformers, complying with the latest United States Department of Energy (USDOE) energy regulations for transformers smaller than 1 MVA.

2.5 Renewables

As renewable energy sources are added to the system, special conditions should be taken into consideration. Engineering studies will be required in order to determine and evaluate the availability of energy, geographic considerations, system capacity, and power flow onto the existing distribution system. Part of developing any such project should always include a power system study and analysis for system stability, power flow, fault and protection evaluation, voltage profiling, and capacity.

Generally, the distribution system is minimally affected by the addition of renewable energy generation sources. The renewables added to the system to date, such as the Organic Rankine Cycle (ORC) units at the Powerhouse, have typically just offset local facility power consumption.

2.6 Spare Parts, Maintenance, Procurement, and Administration

i. Spare Parts

Critical spare parts for the 35 kV and 15 kV systems are needed and should include transformers, switches, junction boxes, cable and terminations. Where it is not economically feasible to convert a radial feeder to a looped feeder, additional spare materials should also be procured to restore critical line sections. If new loads are added in the Unalaska City area, then feeder upgrades should be considered as part of that project. Should a failure occur the damaged equipment can often be replaced within a matter of hours if the proper parts and personnel are available. If the Utility does not have the proper spare parts, the loss of a single pad mounted switch or transformer could result in lengthy outages.

It is imperative that the City create and maintain a written list of critical spare transformers, switches, cable, terminations and any other components that are in their system. These items must be available for emergency use at all times. Critical spare parts are needed for radial customers who do not have the benefit of being on a looped system and it is not economical to install infrastructures to upgrade them into a looped configuration.

Additional spare parts may also be needed to replace specific purpose apparatus such as those outlined in Table 4. Project D5 should also have spare parts unless adequate redundancies are in place.

ii. Maintenance

Much of the distribution equipment in the Unalaska system is not unique or specialized and is generally reliable when maintained properly. However, a substation maintenance program should be implemented. Following an industry recommended schedule, such as indicated in National Fire Protection Association (NFPA) 70B, Recommended Practice

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<u>for Electrical Equipment Maintenance</u>, of testing and maintenance for all substation components will ensure that the substation operates safely throughout its life span. A substation replacement will eventually be necessary, but with correct maintenance practices will not be necessary during the time frame of these Master Plan projections. It should be noted that projects to update communications, protective relays and control equipment will be required periodically to extend the substation lifespan.

iii. Procurement

Some distribution equipment (reclosers with relays, programmable logic controls (PLC) driven equipment, switches with controllers, etc.) have unique software and/or programming language that the City has standardized to (in some cases also used in the City water and sewer departments - for example automatic meter reading (AMR) systems and/or motor drives, PLCs and relays). Therefore, the City's procurement policy will need to be revised to allow the City to seek sole source bids for specific purpose equipment, materials, or services.

The procurement policy must also address the identification process by which the City will determine specialized equipment or service needs. It is recommended that an approved specialized equipment list along with their associated vendors be developed and maintained.

When the City needs to select a new single source vendor and/or manufacturer of specialized equipment, local support services, reputation, and availability should be main factors in the selection process. Unfortunately, there are many good products that don't have local support services. The lack of availability of replacement parts can cripple the City's ability to maintain a well-supported system.

The procurement and management of materials can be more easily and cost effectively facilitated by the City's existing Munis software system. Munis, a public municipal management software with inventory and work packages, is currently supported and already in use by the City. This software requires all departments have a single separate department to check and modify inventory.

The capabilities and suitability of existing inventory software packages should be examined and compared to the City's existing Munis inventory control system. In addition to inventory control, the City should explore the capability of Munis to improved procurement, work order tracking, and inventory control. Such effort would fall in line with the 2017 Operating and Capital Budget's fiscal goal to examine ways to reduce expenditures and inventory without significantly impacting the level and quality of services to the public.

The Electric Utility Line Crew Chief and Powerhouse Superintendent should be given the authority and responsibility to determine, document and maintain inventory. Availability of critical spare parts is of vital importance to an electric utility. Customer outages due to failed equipment are rarely, if ever, permissible.

iv. Administration

Any large services (above 750 kilovolt-ampere [kVA]) to be added into the system should be studied from a technical and economic feasibility basis prior to agreement for connection. Understanding the complete impact of the added service to the system is crucial to the proper implementation of the added services in the future. The cost impacts should be evaluated and negotiated with the new customer to bear some or all of the costs associated with needed infrastructure upgrades. This will assist the City to meet new customer needs while minimizing or eliminating the potential cost impact to all rate payers.

To provide the needed service reliably, power sales agreements (PSA) should be used and enforced to ensure a clear understanding of what stipulations, terms, and arrangements must be met by both the City and the customer. PSAs should be based on the findings from technical and economic feasibility studies for new large loads and should include details such as service interruption tolerances, customer backup power, load sharing and system paralleling arrangements, customer load calculations, pay rates (including demand, power factor and energy sales), maintenance and operation costs of their service equipment, etc. All future large service connections should be governed by PSAs.

The City has experienced uncertainty in power sales issues and has been forced to plan for the worst case load scenario due to the lack of PSAs. Without the implementation of PSAs, the City may find that industrial customers purchase power irregularly or unpredictably. Significant infrastructure costs have been and will continue to be incurred to provide power sales. PSAs are instrumental in forecasting of regular and predictable industrial power sales.

The City should obtain a written PSA with their existing large industrial customers. This is especially critical in the case of Westward Seafoods and Alyeska Seafoods. These facilities have sufficient generation that could be left operational to assist the City with N-1 planning. An agreement about the responsibilities of each party will aid in ensuring power is always available for the industrial facilities as well as the rest of Unalaska.

2.7 Solutions

This section outlines all; recommended projects for the distribution system. Table 4 describes each project solution and its priority level. Refer to Tables 1 and 2 for associated ROM costs and estimated timeframe to complete. Refer to the Project Summary Descriptions in Appendix B for additional details regarding the project justification, scope and project end goals for the Electric Utility.

Table 4: Distribution Upgrade Solution Descriptions Identified

Project ID No.	Upgrade Description
D1	Upgrade NPH Substation Transformer T11 to 34.5 kV, install new 35 kV recloser, install new 34.5/12 kV Standard Oil Hill transformer, and install new 5 way switch to bypass switches E-1 and/or S-1 (this satisfies N-1 planning for switch E-1, S-1, VCR E-1, VCR S-1, and Transformers T4, T5, and T12). This includes study, design, and construction.
D2	Replace aged 35 kV distribution system and upgrade to higher ampacity construction. This includes all main backbone looped junctions, terminations, cable/conduit, and switches. This satisfies N-1 planning and aging infrastructure issues to support increased 35 kV industrial demand increases recently and into the future. This includes study, design, and construction.
D3	Channel crossing (submarine cable) replacement. This satisfies N-1 planning for the two intra-island cable crossings to support Alyeska, Westward, and Town Substations.
D4	Install new 4 way switch as redundant supply to Town Substation adjacent to existing switch T-12. This satisfies the N-1 planning for a switch T-12 failure. Includes study, design, and construction
D5	Procure major spare equipment including one spare 5 way padmounted switch cabinet (to replace E-1 or Mag Bay switch), two spare 4 way padmounted switches (to replace T-12, S-1, E7-S1, T-10, C-9_1), two 35 kV 200 amp recloser (to replace Alyeska, Westward, or NPH Sub VCRs), three 35 kV 600 amp padmounted 4 way junction cabinets, three 35 kV 200 amp 4 way junction cabinets, three 12 kV 200 amp junction cabinets, one 12 kV Town Substation breaker. This satisfies the N-1 planning for these pieces of equipment. This includes engineered specification preparations, procurement, and shipping.
D6	Breaker Maintenance (Town Substation, NPH Generation and Substation, Old Powerhouse Generation)
D7	Large Padmount Transformer Maintenance
D8	Town Substation SCADA Upgrade
D9	Install intermediate Level Protection (5 strategically located 35 kV reclosers at taps and large industry services; i.e. Ballyhoo tap, APL, Horizon, channel crossing, bridge crossing)

3. Generation System

The City of Unalaska operates two power plants co-located near the airport. The NPH was constructed in 2011 and contains four diesel generators, Units 10 through 13. The Old Powerhouse (OPH) contains Units 8 and 9, which are two smaller diesel generator units that are currently tagged out of service due to air permitting limitations. The OPH also houses three existing ORC generators, seawater cooling systems for both plants, and plant maintenance parts storage.

The City has an additional diesel generator, Unit 7, which is located at the Department of Public Works complex. This emergency generator is functional, but is rarely run due to noise, age, and condition. This unit is also infrequently used due to the lack of Supervisory Control and Data Acquisition (SCADA) for remote operational control and monitoring capability. An additional staff person would be needed to perform checks during operation. This unit is located several miles from the Powerhouse so a quick visit is not feasible for the plant personnel given current staffing levels. The capital cost to add the level of engine and generator remote monitoring and controls needed for safe and reliable remote operation is not justified due to the age and condition of the unit.

3.1 Safety

The City operates the powerhouse with a single operator for the second and third shift. This can present a safety concern. Inspection rounds require that the operators leave the NPH and walk to the OPH. During winter or inclement weather, the walkway can be slippery. If a "Man Down" incident was to occur during one of the single operator shifts, then there is nothing in place to immediately alert the City. EPS was told this has occurred. While "Man Down" alarms may be of some use, a second person on site at all times is safer.

The operators are surrounded by rotating machinery, electrical equipment, pumps and other devices which are in constant operation. If any of these devices fails, the operator must deal with the situation while simultaneously keeping everything else running.

3.2 Reliability & N-1

i. Electrical Protection

Currently, the system does employ an underfrequency load shed scheme that protects the system from complete blackouts in the event of the sudden loss of a generation unit or a large customer load increase. Shedding load should be a last resort measure taken to help offset any sudden disparity between available generation and the load to which it is connected. Such events, though infrequent, can cause nuisance outages and, in some cases, jeopardize life safety if critical loads such as emergency services, life support systems, or a sudden halt in industrial processes occur. To improve system reliability and avoid sudden load shed events energy storage systems (ESS) should be considered.

Two main types of ESS's exist on the market 1) Battery Energy Storage Systems (BESS) and 2) Flywheel Energy Storage Systems (FESS). BESS is most commonly used to provide large infrequent power swing surge protection and short term (several minutes) uninterruptible power system sourcing. The BESS as a short term power source would be crucial in the sudden loss or gain of a major industrial customer service or the sudden loss of a City generator unit. FESS is most commonly used to provide frequent power swing surge protection and short term (several seconds) uninterruptible power system sourcing. A FESS would be crucial to employ for frequent and substantial load changes such as the APL electric crane (up and down lifting operations when unloading barges).

It is recommended that the City design and install a FESS to manage its exposure to the fluctuating loads of the APL electric crane. As previously recommended, the costs to implement a FESS should be borne at least in part by APL, as this project is directly attributable to the nature of their service. In the future, the City, through a PSA process, should carefully evaluate the addition of any substantial customer loads to determine potential connection issues, such as frequently fluctuation, power factor, etc., and then stipulate what infrastructure should be employed and by whom.

Serving large fluctuating loads will compromise the City's ability to provide reliable support to the rest of the system. The APL electric crane has created stress on the City powerhouse generation units which it cannot support for long periods of time. The addition of new load without a FESS may provide some benefits in additional revenues and the ability to more fully load generation units. Along with these benefits, the City must also consider that without the implementation of a FESS to mitigate crane loading, the City will experience higher than expected maintenance costs and generator unavailability. At this time, certain loading levels exist that prohibit the most economic dispatch of engines. Instead, an additional engine must be run with fewer loads per generator in order to allow for proper frequency response when the crane is operating.

The City may benefit with the design and installation of a BESS but should conduct a study to establish the need.

ii. Electrical N-1

With Westward Seafoods' anticipated load of approximately 5 MVA, the City does not have adequate generation N-1 planning for peak loading events. With the largest unit unavailable (Unit 10 or Unit 11 around 5 MVA), it is anticipated that the City will not be able to fully support the system load during peak seasons. Refer to Section 3.4 for further discussion. During off-peak time(s) of the year, the City does have adequate N-1 coverage. Therefore, it will be critical that all yearly maintenance scheduling for the 4 main NPH units be completed during the lower/off-peak time(s) of the year. Additionally, there may be occasions where the City will need to notify both Alyeska and Westward to support a small portion of their loads in the event that a City unit needs to be removed from the system during peak loading events. Both Alyeska Seafoods and Westward Seafood plants both have full back-up diesel generation capabilities with paralleling and load sharing equipment in place to facilitate any loss of a City unit.

If the City desires to eventually have complete N-1 planning in place for all loading events without the use of outside plant support infrastructures (i.e. Westward and Alyeska load sharing), then additional generation capacity needs to be installed on the system. With units 8 and 9 redeployed, some of these additional generation needs may be deferred. However, to address the long-term generation capacity needs, the City may need to explore expanding its generation system including upgrade of Unit 7, adding generation near or at the Town Substation (if property is available), expanding the NPH (if possible), or other possibilities. Things that should be considered are that any such upgrades will also increase operating costs, plant personnel additions, land acquisition(s), permitting, and design/construction costs. Since adding generation can take months to years to implement, the City should also take into account future load additions (i.e. UniSea, APL, Horizon, Alyeska and Westward Seafoods expansion projects, etc.) that may further impact the sizing of any new generation facilities.

Another long term solution is to take possession of and operate the Alyeska and Westward Seafoods plants, as they are already permitted and ready to export power onto the City grid. This solution may be more cost effective since the infrastructure is already in place. At a minimum, an economic, environmental, and technical feasibility study should be conducted to explore this option. The study should take into consideration age, maintenance, operation personnel needs, appraised value, ownership transfer, etc. If this is explored, Westward and Alyeska will need to be contacted to see if they are first interested in this option. The seafood plants may be considering expansion concepts that could include removal of its generation facilities to facilitate more processing equipment. If this is the case, the study could still explore the purchase of the seafood plant units and install them into a new building facility rather than purchasing brand new units.

iii. Mechanical N-1

Neither the OPH nor NPH prime generating electric mechanical equipment or their associated auxiliaries were identified with N-1 equipment issues at the time of this report. However, due to changing ambient environmental temperature and load increases, a significant operational N-1 issue has come to light.

Both the NPH (partially) and OPH (completely) utilize seawater cooling for power generation equipment cooling. The NPH also utilizes ambient air cooling radiators for engine cooling needs. The NPH requires both ambient air and seawater cooling if all 4 generators are producing power when operated simultaneously. The existing radiators and the seawater system are only capable of cooling two (50% of plant load each) of the existing generators at peak summertime water and ambient temperatures.

Since 2007, Dutch Harbor has seen a significant rise in seawater temperatures. Original seawater design maximum inlet temperature was 50 degrees Fahrenheit (°F) maximum. At the time, typical summertime seawater temperatures were between 45 and 48°F. In 2013, the design was completed for seawater cooling of the OPH Electrotherm ORC's. The maximum design temperature at this time had risen to 55°F.

During the summer of 2017, seawater temperatures peaked at 58°F according to powerhouse seawater inlet temperature sensors. Many factors have contributed to the rise in seawater temperatures, such as ambient air temperature increases thus increasing engine cooling demands, other industrial seawater utilization in the area, and especially the modification/change of the shoreline around the powerhouse seawater intake by other commercial entities around the powerhouse. This modification appears to be causing warmer surface water, both from the powerhouse and elsewhere, to be drawn into (recirculated) the existing intake.

Ambient air temperature increases do not appear to be as severe as the seawater temperature increases. However, reduction in radiator capacity during the 2017 summer was evident with the outage of two of the radiator fans. The fans require maintenance, but a detailed maintenance plan to remove the fans safely is required prior to their repair.

The rise in water temperature is now impacting the cooling of plant electric/mechanical systems. Reduced system cooling capacity coupled with any mechanical failure (such as the loss of a couple of radiator fans) and increase in power production would impact peak summer operating loads. The installation of a third remote radiator would provide better N-1 operation of the plant. Additionally, the extension of the seawater intake water line to deeper, cooler, and more stable temperature water would also ensure N-1 operating scenarios are achieved.

Due to the importance of the OPH seawater intake and discharge lines, a new city ordinance should be created to protect the City's interests at this location. The ordinance would include platting a clear zone around the new intake (which would also encompass the discharge system) to protect the intake and discharge from being impacted by future developments. Platting record map(s), along with building stipulations, would then be available and more easily enforced. This modification would be similar to Water Utilities source protection requirements around City water wells. This effort would be conducted as part of and in parallel with the sea water line extension project.

3.3 Personnel Needs

Skilled personnel should also be considered in N-1 planning, especially in a remote location. The Powerhouse currently operates with one Supervisor, one Engineering Technician, and six Operators when all positions are filled. The City staffs its plant with a single operator during the second (4PM - 12AM) and third (12AM - 8 AM) shifts. As mentioned previously, this can present a safety problem. If an operator were to be injured during their shift, they may not be able to get help in a timely manner. The operators were wearing a "Man Down" alarm which was supposed to assist in providing notification, but these alarms were unreliable and did not function in every location in the plant. It is understood that the operators are currently not using this system.

There are plant operators that will also be retiring within the next several months, or just before the final issue of this plan. The power plant should start planning on filling roles that are not only vacant now but also those that will be vacated soon. In the past year, the City has lost two long term people to retirement. Rather than continuing to lose the institutional knowledge that the more experienced operators have, the City should look into hiring people earlier and training more operators. One possible option would be to start an apprenticeship for a plant operator. This person could learn the operator job, mechanic job and also fill in on the lesser skilled tasks around the plant. An apprenticeship program could be a way to start younger people in a career path that may keep them living in Unalaska.

Multiple plant operators mentioned to EPS that they often work extra shifts and it is difficult to schedule time away from work. While the reality of this has not been detailed for this report, comments such as this can be indicative of understaffing.

One example of an alternative staffing plan is to hire a mechanic and an electrical technician. These positions would fill some of the voids already mentioned and could also serve as back-up operators in the event of problems or sickness. Additionally, if these additional positions worked the second or third shifts, it would greatly alleviate the hazards of working alone that the operators currently are exposed.

The key factors that should be considered for staffing the Powerhouse are:

- Safety and Health
- Worker retention/job satisfaction
- Worker training and cross training
- Knowledge and skill retention and growth
- Proper on-site support to deal with outages or other emergencies
- Timely completion of plant maintenance tasks

An in-depth study of the appropriate staffing level of operators is recommended. This effort could also be expanded to the rest of the Electric Utility or further if the City chooses. The study should further detail safety concerns, position requirements (such as licenses, degrees, supervisory responsibilities, etc.), worker training levels and plans, personnel retention and costs of employees. It should also present viable options for filling recommended positions, ideally from the community or Alaska. This will aid in worker retention, which is especially important in locations such as Unalaska where skilled labor is difficult to find.

A Powerhouse Mechanic position is important to reliable plant operation. This position would be responsible for performing and tracking general maintenance and repairs throughout the Powerhouse. The existing Electrical Engineering Technician position is also critical to plant operations and should have additional support by adding a second technician. This new position should focus directly on the technical aspects of the power plant, including electrical maintenance, communications and protective relaying as well as provide occasional technical support for the distribution system operations.

A System Electrical Engineer is also recommended. This position should be tasked with planning, project identification, load growth forecasting and working with potential new customers to determine their requirements. The City's generation capabilities are reaching maximum capacity and continual long-term planning is especially necessary in order to successfully meet their customers' requirements. The System Electrical Engineer position would also be responsible for the scheduling and oversight of all electrical equipment maintenance. The City system has gotten larger and more complicated with the recent expansions. Further deferring of recommended maintenance will start to create reliability issues. The Engineer would determine which tasks can be performed by in-house labor and which tasks are to be contracted out.

Recommendations Summary:

- Hire additional Powerhouse staff. Two positions suggested.
- Perform detailed Personnel Staffing Study to further evaluate Powerhouse and Utility staffing levels
- Hire System Electrical Engineer

i. Technical and Specialty Expertise (Term Services)

The City may not be able to financially support full time employment of all the necessary technical and specialty expertise staff that is commonly required in a typical utility. To ensure timely response to the City's Utility needs (such as feasibility studies, economic studies, small works engineering, troubleshooting, SCADA technicians, etc.), it is recommended that on-call/term services contracts be established annually. These contracts would be executed on a task basis, time and materials not-to-exceed budget work order system. Such services for the Utility could include:

- Air permitting
- Right of Way
- SCADA and Instrumentation Technicians
- Electrical/Mechanical Engineering
- Generator Service (Wartsila/Caterpillar/Electrotherm)

Recommendations Summary:

- Term service contract(s) for various technical support

3.4 Capacities Now and Needed

i. Existing Generation

The City operates two co-located power plants and one remote mobile power module. The primary facility, NPH, was built in 2011 and contains four diesel 4.16kV generators. These units comprise the only power generation the City operates to meet its current demand. The four generating units consist of two Wartsila 12V32 units rated at 5.2 megawatt (MW) each and two Caterpillar C280-16 units rated at 4.4 MW each, for a total nominal output of 19.2 MW.

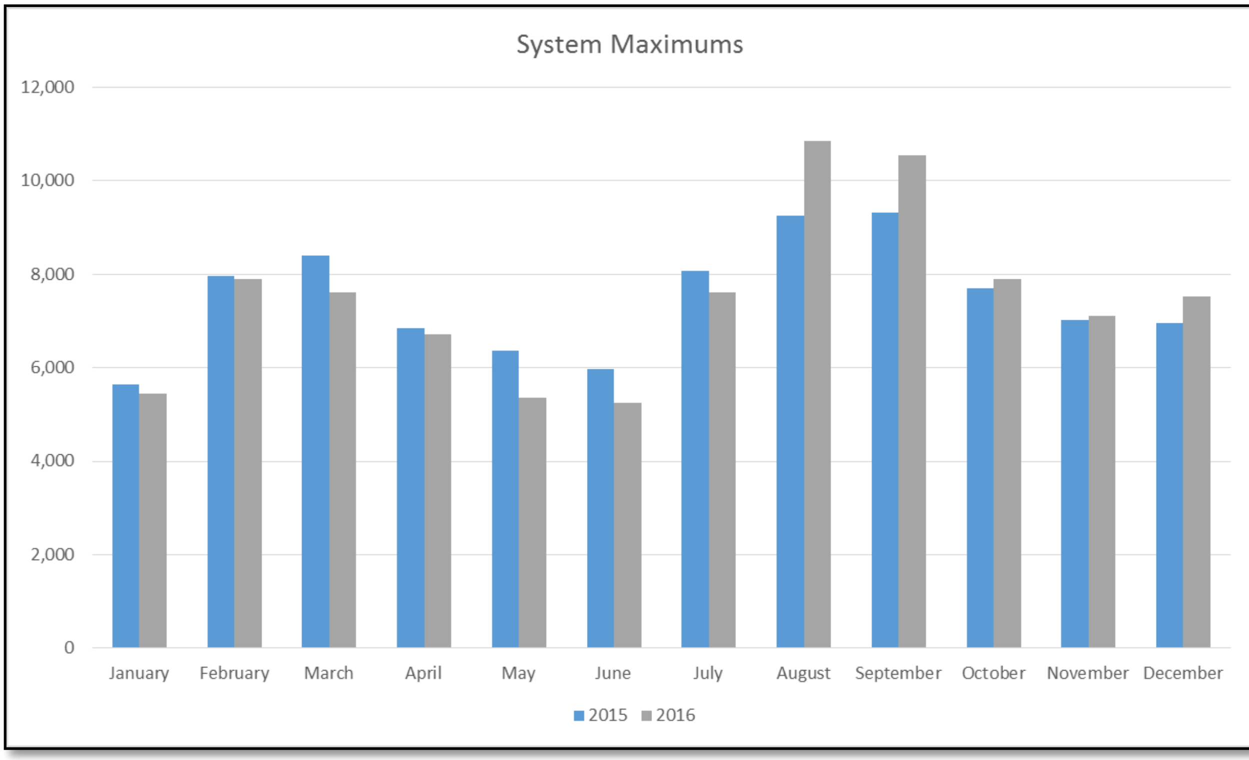
The Powerhouse also serves as the system dispatch center. Monitoring and control of the City generation (both plants), distribution system, and visibility of their major loads, such as the seafood processors or the shipping companies, are available via a SCADA system, which is monitored by plant operators within the NPH control room. This enables the plant operators to have an informed perspective of the system which assists them making decisions regarding unit scheduling, dispatching and feeder outages.

Plant operators are also responsible for the operation of the remote power module, Unit 7. Unit 7 is an older Caterpillar diesel generator which is located in a tractor trailer type of enclosure. However, due to the age and poor condition (primarily due to the enclosure construction), Unit 7 is rarely operated. It requires significant operating maintenance and, therefore, is the Utility's least reliable unit. Unit 7 is also lacking proper spill containment. For the purposes of this study, Unit 7 is considered unavailable for normal operations.

ii. Expected Short Term Needs

The Electric Utility experiences substantial seasonal variation in the load demand. The fishing industry has periods of high activity that will cause the normal load to increase from 5 MW up to nearly 11 MW. Figure 1 shows the maximum system load by month for the last two years.

Figure 1: System Maximum Load in MW



The industrial load has also grown recently with the addition of Alyeska Seafoods plant to the system. An additional increase is planned for late fall of 2017 with the addition of Westward Seafoods Captains Bay plant to the system. This plant has an existing 1 MW utility tie that will increase up to 5 MW. Therefore, the City will see up to an additional 4 MW of load demand after this project is completed. In 2016, Westward Seafoods' peak loads were during July (4.88 MW), August (4.78 MW) and September (4.64 MW). Table 5 shows peak energy usage with three of five existing major customers (including Westward) using their maximums during August.

Table 5: Megawatt Hour Usage by Customer for 2016

	APL	Alyeska	Coast Guard	Matson	Westward
Average	818.2	313.9	50.3	455.0	63.3
Peak	1,115.2	1,743.4	82.1	932.8	183.8
Peak Month	March	August	March	August	August

This demonstrates that the system load can expect to reach an overall new peak in the upcoming 2018 summer season.

As with Alyeska Seafoods, the controls for the new upgraded Westward Seafoods 5 MVA service will include import and export control to enable the Westward Plant generators to pick up a portion of its own entire load during emergency conditions. While Westward has limited excess capacity during peak processing times, the Westward demands can be satisfied within its own facilities if needed.

With the ability for both Westward and Alyeska Seafood plants to parallel and load share onto the City power system, there may be some economic advantages for the City to facilitate power wheeling sales agreements between Alyeska and Westward and/or other large industrial customers. Such an option may serve as a short term and possibly part of a longer term solution to meeting all system demands at all times. However, if the City desires meeting these demands independently then new generation facilities will need to be built which could be more costly and will come with additional challenges, time commitments, and may adversely impact ratepayers.

iii. Expected Long Term Needs

Recent load growth for the City's Electric Utility has been in large increments and occurring with little or no advance notice to the City. Since the EPS site visit in April 2017, the City received one request from an existing customer to add a 1.5 MVA service. Additionally, a new customer requested a service that is approximately 2 MVA. These spikes in growth represent approximately 10% of the nominal generation capacity.

The load growth is not typically predictable or linear over time. The industrial loads that have been added recently are in the several megawatt ranges. This is problematic for the City since its recent historic customer base represents only 7 MW on average. EPS contacted the known industrial facilities on the island that were not already City Electric Utility customers. While not all parties provided information or responded to queries, the following information was obtained:

- APL is planning on expansion at their site in the near future, including a new shop/warehouse and adding to their temporary refrigeration (plug load) capacity. APL stated that load growth on site will require some infrastructure improvements. APL is progressing with their expansion in the fall/winter of 2017 and 2018 with the addition of a 2.0 MVA service.

- Interest in power for those at the end of Captains Bay Road was mixed. Alaska Marine Lines (AML) expressed interest but Offshore Systems, Inc. (OSI) said their needs were covered for the near future due to recent expansions. The City should still plan for load growth at the end of Captains Bay Road as OSI's or other customers' power requirements are subject to change. In November of 2017, City staff reported that OSI may now be reconsidering options for connection to the City grid.

- UniSea Seafoods has had preliminary discussions with City regarding upgraded services. The existing generation at UniSea is aging and they are considering options for renewal of their power plant or possibly purchasing power from the City. No concrete information was obtained at this time.

- The City is in the process of the Unalaska Marine Center dock expansion project which will allow larger vessels to load and unload. An electric crane has been planned although not included during this phase of the project. Any new crane in Dutch Harbor must include a FESS. The new FESS is recommended to be owned and operated by the Electric Utility. It will be able to provide system frequency support for the overall Unalaska grid, benefiting all utility customers.

- Icicle Seafoods recently approached the City with a preliminary request for electric service for a processing vessel. Their power requirements are not detailed clearly at this time, but the request was reportedly for a 2.5 MVA service. It is understood that this is a 2 year old request for power. It's recommended that the City work closely with customers, perform necessary feasibility study and system analysis, develop cost estimations, negotiate PSA terms and conditions, and work towards full implementation. This will ensure a unified power grid under the complete and singular control of the utility. If these requests go unanswered for extended periods of time, customers will be inclined to once again move toward self-generation.

As stated earlier, the Electric Utility has been adding industrial customers to the system and seeks to continue to add others. This continued growth has reached the limit of the existing infrastructure and the City must take care in adding new large customers.

It is recommended that a formal process for the connection of large industrial loads be implemented. This process would include a PSA, which would detail the customer's power requirements such as kilowatts (KW) and KW demand, power factor, KW hours (KWH), guaranteed sales amounts and financial requirements for any needed infrastructure improvements. It should also address power quality and include the requirement for appropriately sized capacitor banks or FESS for dynamic loads such as a new large electric crane. The agreement should include provisions for notification requirements in the event of the customer seeking to add more load in the future.

3.5 Environmental

i. Current Air Permitting Effort Underway

The NPH is classified as a major stationary source under the Titles I and V of the Clean Air Act (Act). NPH's diesel electric generator sets are governed by the terms of three air quality permits issued by the Alaska Department of Environmental Conservation (ADEC) implementing the requirements of the Act and the state's permitting rules. The Operating Permit AQ0215TVP03P is the guiding permit as it incorporates all of the applicable air related performance requirements of the other two permits. The Operating Permit was last amended in January of 2015 to incorporate the new requirements associated with installing the second Caterpillar C-280 engine (Generator 16).

Prior to installing any new engine, an initial construction permit satisfying the requirements of Title I of the Act is required. A 2007 Construction Permit (AQ0215CPT02P) authorized the construction and installation of the two Wartsila engines and a Caterpillar C-280 engine. This was followed in late 2014 with the Minor Source Specific Permit AQ0215MSS04P to authorize the installation of Generator 16 (also known as Unit 12), the second Caterpillar C-280 engine. Generator 16 could only be permitted as a minor source because baseline air quality monitoring data was not available and required to obtain a major source permit. Consequently, the City accepted a permit whereby Generator 16 was operationally restricted and the new air emissions of Generator 16 were largely offset by shutting down Generators 8 and 9.

Since NPH is already a major stationary source, any permitting changes to add a new source, re-install Generator 8 or 9, or release other current operating restrictions will most likely invoke two primary reviews that are required under the Prevention of Significant Deterioration (PSD) permit program found in Title I of the Act. Those reviews are: 1) a pollution control technology review to implement Best Available Control Technology (BACT); and 2) an air quality demonstration that relies upon measured baseline conditions and then uses computer based simulations of out-of-stack emissions to test if the summation of new emissions with existing emissions will meet ground level ambient air quality standards.

The current NPH permits carry several operating restrictions for the purpose of avoiding some technical reviews. This was primarily due to the fact that during the initial permit review timeframe, the City did not possess the necessary baseline air quality measurements. The City is now well staged to seek permit changes for the NPH as the prerequisite baseline air quality monitoring project concluded in September 2017.

The City also maintains a back-up Caterpillar engine/generator (Unit #7) at the separate valley location for the Public Works Department. This unit is authorized under an ADEC Pre-Approved Emission Limit (PAEL) which limits the annual fuel use to 330,000 gallons per year.

Construction of a new physically distinct power plant (Town Substation) is evaluated as part of this Master Plan. From an air quality permitting perspective, a separate plant containing one or two generator sets would require a less rigorous permitting process as compared to adding the same new generators at NPH. There are two reasons for this. First, a new plant has a higher emission threshold for triggering a PSD permit review, and, second, demonstrating compliance with ground level ambient air quality standards will be more straightforward in a greenfield situation where existing baseline emissions are far less than the addition of new generators at the existing plant.

ii. Pivotal Permitting Issues for Re-installing Generators 8 and 9

Generators 8 and 9 were removed from service in early 2015 due to permitting complications with installing Generator 16. Successfully re-permitting Generators 8 and 9 will likely entail the following substantive issues. Under the permitting rules, these engines will not benefit from any grandfather rights. Rather, ADEC will view these as if they are entirely new air emitting sources. The re-installation will almost certainly be subject to the PSD permitting process. Other federal emission control rules in 40 Code of Federal Regulations (CFR) 60 or 40 CFR 63 applicable to compression ignition internal combustion engines will likely also apply.

The BACT pollution control technology assessment will require an assessment of the cost, feasibility and emission reduction potential of alternative pollution reduction technologies that could be retrofitted to these engines. NPH has argued successfully in prior permit reviews that installing a Selective Catalytic Reduction (SCR) system to reduce engine emissions of nitrogen oxides was an excessive cost impact to rate paying customers and did not warrant the marginal air quality benefit derived. However, the City should not anticipate a similar outcome in an upcoming agency decision for re-installing these engines.

The application of SCR to diesel engines has become commonplace and more cost effective in the recent years. As a result, the cost argument is less persuasive if the utility growth demand is largely due to an increase of commercial and industrial customers. However, any BACT and cost benefit analysis should consider and evaluate distributed generation with heat recovery operations coupled with the reduction/mitigation of other island emission sources, such as City converting existing island generation units to emergency standby and providing combined heat and power generation options. Depending on the results of the BACT and resulting cost benefit analysis (including Combined Heat and Power (CHP) options), the City may need to consider more than short term operating, maintenance, and installation costs with future operating (cost reductions and increased efficiencies) and construction permitting.

Depending upon the extent of improvements made when re-installing Generators 8 and 9, it is possible that the re-installation project could trigger the requirements of the New Source Performance Standards for compression ignition engines in 40 CFR 60, Subpart IIII. Most likely this can be avoided, provided the cost of the re-installation project with its improvements remains below 50% of the costs of a hypothetical new “facility” of the same size. This issue warrants attention when detailed plans for the re-installation are developed. Should the project qualify as a "reconstruction", the engines would have to be retrofitted to meet the same emission performance as new engines.

If the engines are re-installed, some requirements in Subpart ZZZZ of 40 CFR 63 will apply. However, due to the site location in rural Alaska where it is not accessible to the federal aid highway system, many features of the rule will not apply. The applicable requirements are expected to be limited to engine maintenance and record keeping. These requirements are identical or nearly identical to the requirements that applied prior to their de-commissioning in 2015 and similar to those required for the other existing NPH engines. It is also noteworthy that the "reconstruction" feature mentioned above for the Subpart IIII rule is also contained in the Subpart ZZZZ rule.

With the conclusion of the baseline monitoring project in late September 2017, the City has the requisite information to support the air quality modeling assessment for a PSD permit application. The modeling effort will be a technically complex task as the greatest challenge will be to demonstrate compliance with the most restrictive air quality standard. The most restrictive standard is the one hour health standard for exposure to nitrogen dioxide. The modeling assessment must include not only the emissions of nitrogen oxides (NOx) from Generators 8 and 9, but those of all other NPH generators and other nearby NOx emitting sources. Because the PSD rules require that the agency's decision must be protective of the health based standards, the one-hour NO_2 modeling results may become the governing factor limiting the quantity of new NOx emissions that will be permitted for NPH. This applies to Generators 8 and 9 and any other changes to NPH operations

iii. Pivotal Permitting Issues for Releasing NPH Operating Restrictions

The City accepted several operating restrictions at NPH for the purpose of previously avoiding PSD review for pollutants of sulfur dioxide, particulate matter and ozone and nitrogen oxides. Specifically, these restrictions are a plant-wide annual power production cap, tracking monthly emissions of particulate matter on all engines so as to stay within an annual limit for this pollutant; and for Generator 16, individually tracking and constraining emissions of particulate matter and nitrogen oxides within annual caps.

Seeking a permit change to remove these restrictions will largely follow the same PSD permitting process as described above for Generators 8 and 9. The PSD rules are often complex with respect to reaching back to prior decisions from which the operating limits originated. For example, the permit record indicates that the plant-wide power production limit was based on limiting the emissions of sulfur dioxide, particulate matter, carbon monoxide and volatile organic compounds. The feasibility of releasing those restrictions will depend to some degree on the quantity of emission increase for each pollutant. For example the sulfur content of fuel has decreased in recent years, so the permit application will likely show a decrease for that pollutant.

Perhaps the most pivotal aspect will be the results of the modeling demonstration which will show the potential changes in ground level concentrations for each pollutant. It will be necessary to show that releasing the restrictions will still comply with air quality health standards and PSD growth increment standards. A BACT review to evaluate retrofit feasibility for particulate emissions of carbon monoxide may or may not be required. Much depends upon the quantity of emissions increases, the record for previous permit decisions and a close review of the federal rules.

Generator 16 was permitted as a minor source with accepted engine specific limits to avoid PSD review for emissions of nitrogen oxides and particulate matter. Releasing the operational restrictions on this engine will likely invoke a BACT review, as well as a modeling demonstration. For a BACT review, it would be necessary to assess the feasibility and cost of retrofitting a SCR system or installing another NOx control system for Generator 16.

A suggested project approach would be for the City to first evaluate which operational limits are the most problematic and thus most important to be released. Consideration should be given to actual unit dispatching based on various load levels to ensure the freedom to operate engines such that the most efficient fuel use is maintained which would reduce overall yearly emissions. Operating large diesel engines at low lows (currently as permitted) is not efficient and often see more fuel consumption overall. Then a more in- depth review of the complexity of the permit change could be assessed and the likelihood of success can be evaluated. This will focus the scope of the permitting project prior to undertaking most of the in-depth technical work of preparing the permit application and its associated dispersion modeling and pollution control technology assessments.

In light of the common technical work involved for permitting both projects: the releasing of operating restrictions; and the re-permitting of Generators 8 and 9, it may be wise to manage these as one consolidated re-permitting project.

iv. Pivotal Permitting Issues for a New Power Plant

Should a new power plant be constructed at a site some distance from the NPH, its generator set(s) will need to acquire a new separate air quality permit. Furthermore, the new engine(s) will most likely be subject to the New Source Performance rules in 40 CFR 60, Subpart IIII for compression ignition engines. A construction permit – either a minor source permit or a PSD major source permit - will be needed prior to purchasing the generator(s) and site construction. The generator size, number and emission rates will largely determine whether a minor permit or a major PSD permit will be required. With the lower emitting technology of new engines, it may be possible to install several megawatts of capacity while staying within the minor source category. For a new plant site, the demarcation is whether emissions of NOx will be below 250 tons per year. The NPH plant is subject to a PSD major source review for a NOx emission increase of 40 tons per year.

Obtaining a minor source permit is more simplistic, quicker and would be accomplished at a lower cost. While air quality modeling would still be required, applicants for minor source permits are not required to show compliance with the most restrictive one hour standard for nitrogen dioxide.

The City has a year of wind data from a recent weather monitoring system. This data should be modeled to determine how wind may be best integrated into the overall energy portfolio.

v. Sea Water Discharge Permitting

By mid-summer of 2017 the City of Unalaska had completed a six month effort of converting their existing ADEC individual discharge permit to a general permit. This effort was undertaken to help simplify discharge permit requirements for the City as a whole.

The City Utility has brought on additional and significant electric load since the beginning of the permitting effort. With the general discharge permit in place, the permit requirement limitation were found to limit the ability of the plant cooling capacity which in turns limits the total generating capacity of the electro-mechanical equipment. Currently, this limitation is not immediate as the more restrictive ADEC Title V air permit limits the total generating capacity of the plant. However, once the air permit has been revised, the limiting factor will be the general discharge permit.

Changing the general water discharge permit so soon after its recent implementation would be extremely difficult. However, as the operating capacity of the power plant will be changing with the revisions in the power plant Title V operating permit, changing to an individual permit is made much easier as it is a change in service for the power plant. As part of the Title V permitting effort the City have a parallel effort to provide changes to the ADEC discharge water permit back to an individual permit.

3.6 Efficiencies

Due to the fact that Units 8 and 9 are unavailable, there are some system loading scenarios that create inefficient unit dispatch issues. The loading ranges where the larger units do not operate efficiently occur when they are loaded to less than 60% of their ratings. As such, when the system load is between 0 to 2.5 MW and 4.7 to 5.3 MW, and near 10 MW the plant loses efficiency. Economic unit dispatch can be optimized with the redeployment of Units 8 and 9 as they are only 1 MW units that could cover those load ranges where the larger units do not cover as effectively. Other benefits that would be reaped from the redeployment of Units 8 and 9 are cleaner and hotter running of the larger units and delivering hotter jacket water temperatures used to run the ORC units in the OPH more efficiently.

Currently, the ORC project runs at 6.5% efficiency (lower end) to 8% efficiency (higher end) depending on the temperature differential (hot water temp less the cold water seawater temp side of the units).

The fuel economy of the larger units operates in the range of 15 kWh/gal to nearly 16 kWh/gal, depending on loading levels.

i. Renewables

The more typical renewable energy sources such as solar or wind are not currently used by the Electric Utility to provide power to the City. There is some renewed interest in use of these in Unalaska, and further studies with economic analysis should be pursued. The high cost of diesel energy will facilitate a more rapid payback than would be seen in locations with more economic power sources.

Unalaska has sought out other renewables technology that has been successful. The ORC units in the OPH are considered successful. Since their commissioning in October 2015, the three Electrotherm units have saved the City 88,048 gallons of fuel and recouped 30% of their installation cost. As of June 2017, there is sufficient daily load to warrant the installation of a 4th ORC (Electrotherm) which a position and infrastructure are currently in place to support. The City has recently been exploring projects that help the overall efficiency of the power generation and delivery systems. Examples of these include the ORC project at the Powerhouse (including utilization of exhaust gas boiler system), seawater cooling system, the planned micro turbine at Pyramid Valley, and the progression of wind power feasibility studies.

Regardless of renewable energy options that the City pursues, it must carefully consider the implications of distributed generation sources that may contribute to the frequency issues seen already. Proper engineering studies and design of the renewables additions can alleviate much of these concerns. Additional personnel and/or training may be required to operate and maintain new equipment.

3.7 Spare Parts, Maintenance, Procurement, and Administration

i. Spare Parts

Currently, the NPH is operating with outdated, unsupported, and proprietary software platformed PLC. These PLCs are a critical part of everyday plant operation, reporting, trending, plant function, and automation control. The City should consider replacing these PLCs with modern supported PLCs, software, and carry recommended spare parts to support.

ii. Maintenance

The NPH is now approaching a major maintenance engine overhaul of its large generation units in order to continue the economic and reliable operation of the NPH.

iii. Procurement & Administration

The NPH is supported by the City's procurement and administrative departments. The type of support needed by the Powerhouse is much the same as for the distribution system. The Powerhouse has the same need for standardization of equipment and the ability to purchase specialty equipment which may only be offered by a single vendor. The Powerhouse should also have a standard equipment list with vendor(s) for each item. As with the distribution system, local support or Alaska support should weigh very heavily when selecting new equipment and vendors. While the current procurement rules may be acceptable for most situations, they should be reviewed and revised in those instances where the Powerhouse is required to purchase specific types of materials or equipment which could ultimately affect their ability to provide highly reliable power to the City.

3.8 Solutions

This section outlines all of the generation system recommended solutions. Table 6 describes each solution and assigns a unique identifying label that will be referred to in the project summary sheets (Appendix B) and Table 2. See Table 2 for ROM costs and estimated timeframe to complete.

Table 6: Generation Upgrade Solution Descriptions Identified

Project ID No	Upgrade Description
G1	Sea Water Intake Line Extension to colder and deeper waters to provide sufficient cooling capacity satisfying N-1 cooling needs during peaking loading events. Establish sea water intake/discharge clear zone to protect powerhouse cooling system performance/operations.
G2	New Powerhouse Air Permitting Changes (Include Unit 8 & 9)
G3	Wartsila/Caterpillar Major Overhauls (Units 10, 11, 12, 13)
G4	Modicon PLC Replacement
G5	Utility Flywheel Energy Storage System (FESS)
G6	Utility Battery Energy Storage System (BESS)

4. Summary of Load Flow Analysis

A load flow analysis was performed by EPS with SKM software. This software allows a system model to be developed and then manipulated in order to test various scenarios and conceptual changes. This is helpful in order to verify assumptions and to quantify expected values of current and voltage throughout the electrical system. The simulations that were performed for this report included base loads, various N-1 contingencies and load growth simulations. The following beginning assumptions were included for the base loading scenario:

- Units 10, 11, 12 and 13 available at the NPH and operating up to maximum rated output,
- Units 7, 8 and 9 off-line,
- All powerhouse transformers available,
- System switches normally configured,
- System power factor of 0.93 for the majority of loads,
- Power factor of 0.95 for Alyeska Seafoods and Westward Seafoods,
- Larger loads modeled as 80% constant impedance, 20% constant kVA, and
- Base load of 15.5 MVA.

The base load value is the expected normal high loads for 2018, not the system record maximums. See Table 7 for details

Table 7: System Loading Levels for SKM Simulations

Location	Load in kVA
Westward Seafoods Captains Bay	4,800
Alyeska Seafoods	3,250
APL	3,000
Captains Bay Road	269
Spit Loads (Dock, Lighting and Misc.)	1,250
SC-10, SC-11, Eagles	1,000
School, Town and Valley Feeders	1,935

The base load simulation resulted in the following observations at several key locations in the City's system. The calculated voltage drop is predicated on the percent below nominal that is found. EPS worked to keep voltages at the main power plant at around 4,200 volts (V) as this is what the generation plant is typically operated at. In some scenarios, the voltage at the units was brought above this, but no more than +5% of nominal for heavier loaded simulations.

Table 8: Base Load Flow Results

Location	Voltage Drop %	Load Flow Amps at 35kV	Rated Ampacity	% of Rated Ampacity
Alyeska Seafoods	2.74	52.73	*	*
APL	2.07	48.88	*	*
E-3 FDR	0.03	48.88	200.0	24.44
Generator 10	-2.45	496.04	722.0	68.70
Generator 11	-2.47	495.00	722.0	68.55
Generator 12	-2.51	559.54	611.0	91.58
Generator 13	-2.54	544.77	611.0	89.16
Margaret Bay Tie	0.29	166.07	200.0	83.04
S-1 FDR	0.05	24.21	210.0	11.53
Transformer T11 (12 kV Sec)	0.63	46.99	231.5	20.30
Transformer T12 (Sec)	2.90	78.74	104.6	75.28
Transformer T4 (Sec)	2.88	78.48	104.6	75.04
Transformer T5 (Sec)	2.88	78.44	104.6	75.00

Location	Voltage Drop %	Load Flow Amps at 35kV	Rated Ampacity	% of Rated Ampacity
WW Capt. Bay	3.40	77.58	*	*

Observations and recommendations

- Loads were simulated at the full rating of the service as shown in Table 7. Ampacity ratings are not provided by the software for loads. These are noted in Table 8 with an asterisk.
- The three industrial loads show 2 to 3.4% voltage drop. Industry standard is to remain below 3% voltage drop from nominal. Voltage levels at services can often be adjusted with transformer taps. Actual voltages should be verified by the City during peak loading times.
- The transformers and generators are all loaded within reasonable levels in the base load scenario. Note that all units are considered available in this scenario.
- The feeders are understood to have 200A terminations, which will be the limiting factor as the 4/0 conductor ampacity is approximate 320A. Terminations for a backbone or main feeder typically should be 600A.

Multiple simulations were then performed on the base load flow in order to examine N-1 scenarios and the resulting system performance. All loads were left in place for all N-1 simulations. The following simulations were performed:

- Switch E-1 #1 opened
- Switch E-1 #2 opened
- Unit 10 generator removed
- Powerhouse transformer T-4 removed
- Channel crossing feeder removed
- Recloser VCR S-1 removed

Key observations from the N-1 simulations include:

- The N-1 scenario with Transformer T4 resulted in both remaining transformers overloaded to approximately 112% which equates to approximately 7 MVA each. An additional power transformer at the NPH is recommended.
- The N-1 scenario with system configuration changes resulting in cables picking up more than 200A were found. As stated earlier, this is above the ratings of the terminations. Cable replacement for ampacity in N-1 scenarios is recommended.

- Switching reconfigurations from the current normal configuration may be beneficial to balance the loads better between the two channel crossings. These were not part of the load flow simulations in this report. Further study and simulations are recommended in order to more fully evaluate the effect of switching changes.
- The N-1 scenario with Generator 10 off-line was not successful. Each remaining unit was loaded to approximately 100% of full load rating. Additional generation is recommended for future load growth and economic dispatch.

System load growth was also considered in the SKM studies. Several step loads were chosen because they represent known future load growth possibility and were added in order to better document what the system is and is not capable. The following step loads were used:

- 5 MVA added at UniSea Seafoods. This assumed an upgraded service at the facility as well.
- 2.5 MVA more added at UniSea (total of 7.5 MW)
- 2.5 MVA added at APL

Even without software simulations, it is clear that the City will run out of generation if the load continues to grow as in recent years. For the City to add more load, a new powerhouse or other paralleling/load sharing arrangements with industrial power customers to assure sufficient available generation is strongly recommended. The following observations are key points of the load growth portion of the study:

- Additional load growth puts the City's ability to serve the peak demand in question, especially in an N-1 scenario with a Wartsila unit off line.
- An additional power transformer is required to accommodate any new load growth (in addition to the additional power transformer already required to satisfy N-1 planning as previously mentioned). In the simulations, the three existing transformers were each loaded to 100% of their maximum in order to complete the 5 MVA load growth test. The 10 MVA load addition overloads the units to 130% each.
- The 34.5 kV system between the NPH and the simulated loads must be upgraded for load growth to be accommodated. The feeder between the NPH and UniSea picks up 290A which is nearly 150% of the 200A termination ratings. The load on the E-1 feeder is approximately 90A. Therefore a new backbone conductor should be at least capable of carrying 400A safely to cover an N-1 scenario.

Note that EPS conducted the simulations with an existing SKM model and made minimal modifications to conduct this study. EPS also assumed that line, switch, transformer, and generators could all be run at their full ratings for extended periods of time. In a couple instances, individual equipment ratings were modified in order for the particular simulation to work in the software. The overall results should be used for general planning and are not deemed to be recommendations to run the system to the limits of the generators or transformers, or are a guarantee that the existing system and all N-1 scenarios can be achieved long term.

Appendix A – Project Listing

Table A-1 lists all projects that were identified during the MP process. The list includes several identified projects which are now underway. The projects are generally listed in order of importance. However, many projects may be executed concurrently or may change priorities based on other circumstances. See report body for details.

Table A-1: Identified Project List

ID Number	Distribution or Generation	Category (Highest ranked if multiple apply)	Project Name
1	Distribution	Reliability	Powerhouse 34.5 kV Transformer
2	Distribution	Reliability	35 kV Feeder Replacement (includes system study, feeder rebuild of existing 35 kV backbone
3	Distribution	Reliability	Submarine Cable Replacement
4	Generation	Reliability	Sea Water Intake Line Extension
5	Generation	Reliability	Large Unit Installation
6	Generation	Reliability	New Powerhouse Air Permitting Changes (Include Unit 8 & 9)
7	Distribution	Reliability	Breaker Maintenance/Service (Town Sub, New and Old Powerhouse)
8	Distribution	Reliability	Large Pad Mount Transformer Maintenance Program
9	Generation	Reliability	Wartsila/Caterpillar Major Overhauls
10	Generation	Reliability	Modicon PLC Replacement
11	Distribution	Reliability	Town Substation SCADA Upgrade (RTAC/HMI)
12	Generation	Reliability	Utility Flywheel Energy Storage System (FESS) OR Interruptible APL Service plan (employ old Viper Design that interrupts APL on an UF or UV event)
13	Generation	Reliability	Utility Battery Energy Storage System (BESS)
14	Generation	Environmental	Unit 13 Tier 3 Conversion, depending on new powerhouse permitting requirements and potential integration of Units 8 & 9
15	Distribution	Environmental	Powerhouse Waste Heat Utilization (Heat Sales Loop, High Temperature Exhaust Gas Heat Recovery and ORC Project)
16	Generation	Environmental	New and Old Powerhouse Site Drainage, Soil PCB, and Road Access Paving
17	Generation	Efficiency	Unit 10 and 11 waste heat exchanger modification

ID Number	Distribution or Generation	Category (Highest ranked if multiple apply)	Project Name
18	Generation	Efficiency	Sea Water System Hellain Strainer Relocation
19	Generation	Renewables	Micro Turbine - City Water system
20	Generation	Renewables	Solar Photovoltaics (Phase I - Study (determine size/locations), Phase 2 - Installation)
21	Generation	Renewables	Hydro Study - Pyramid creek/water shed
22	Generation	Administrative	New and Old Powerhouse Exterior Painting
23	Distribution	Administration	AMR - Automatic Meter Reading
24	Generation	Administration	Old Powerhouse Third Floor Access Road Revision
25	Generation	Administration	Old Powerhouse exterior stairs
26	Distribution	Administration	Utility Line Shop
27	Generation	Administration	Old Powerhouse Second Floor Bridge Crane Replacement
28	Distribution	Additional	Distribution Equipment Replacement Program
29	Distribution	Additional	12 kV Feeder replacement (feeder rebuild of 12kv, upgrades to loop feed any critical loads)
30	Generation	Additional	Seawater Sump Clean Out
31	Distribution	Additional	35 kV Circuits upgrades (includes potential UniSea loop, others as needed if new loads are added)
32	Distribution	Additional	Broadway/Foot Bridge 15 kV Line Replacement
33	Distribution	Additional	Above Grade 15KVA Transformer Relocation Below-grade
34	Distribution	Additional	Captains Bay Road and Utility Improvements
35	Generation	Additional	Radiator Maintenance Crane/Lift
36	Generation	Underway	Utility Wind Turbines (Phase 1 - Request for Interest/Capabilities, Phase 2 - Study (determine unit size/location), phase 3 - Installation)
37	Generation	Underway	4th ORC
38	Generation	Underway	Radiator Maintenance Crane/Lift
39	Generation	Underway	Utility Wind Turbines (Phase 1 - Request for Interest/Capabilities, Phase 2 - Study (determine unit size/location), phase 3 - Installation)
40	Generation	Underway	OPH Plumbing Code Violation
42	Generation	Underway	OPH Fuel System SCADA Integration

Appendix B – Project Summary Sheets

1. New Powerhouse Substation T11 Upgrade

Project Name: New Powerhouse Substation T11 Upgrade

Project ID: D1

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18/19

Project Description:
The Electric Utility relies on the 34.5 kV subtransmission system to deliver power to major industrial loads and to the Town Substation. There are currently three 34.5 kV transformers rated at 5 MW each. A fourth transformer serves the 12 kV feeder for Standard Oil Hill. This project will provide engineering and installation of a fourth matched 5 MW 34.5 kV transformer. This unit will replace the 12 kV transformer and will pick up that feeder, as well as provide additional capacity for the 34. 5 kV system. The project will also include feeder reconfigurations near the NPH and OPH which are recommended in order to deliver power to the system, improve N-1 contingency and improve equipment protection for Switch E-1, the most critical switch in the City system.

Note that this project only covers N-1 transformer needs to match the current NPH N-1 generation capacity. If additional loading is needed, beyond what is already anticipated through the summer of 2018, then consider load support from other sources such as Westward Seafoods and/or Alyeska Seafoods.

The NPH transformers were originally sized to cover the normal town load and keep one 5 MW transformer as a spare. Due to recent increased customer load, all three of the 5 MW transformers will be required at all times.

Project Need:
With the addition of the Westward Alyeska Seafood plant the City increased their load from a peak of 9 MW in 2015 to 11 MW in 2016. The load growth will continue in the fall of 2017 with the addition of Westward Captains Bay Seafood plant. The Captains Bay facility will add as much as 4 to 5 MW, which equates to an increase of over 60% in two years. During the peak processing season, the plant may be required to output over 100% of its current transformer capacity. Additionally, the Electric Utility typically plans to have a minimum of one spare of each critical item to ensure service will not be lost in the event of the failure of a piece of equipment. In the current situation, the Utility could not provide power to all of its customers with the loss of a power transformer.

The 34.5 kV subtransmission system needs capacity added in order to reliably cover the total town load, especially with the addition of Westward Captains Bay Plant. In the current configuration, both 34.5 kV feeders are required to deliver the power needed during processing seasons. This project adds a new connection to Feeder S-1 and to Feeder E-1, which would allow for improved reliability and would provide much needed redundancy for emergency operations. It would also allow for reduced loading of existing transformers during normal operating scenarios.

The project engineering should start as soon as the funding can be made available. The preliminary engineering effort will involve the design and specification of the power transformer, requiring a lead time of 6 to 9 months after it is ordered. With the design and procurement process included, a power transformer will not be on the island until 12 to 15 months after the project begins. The project design phase must also include the distribution system changes to allow the additional power to be delivered on the system. These changes include a 34.5 kV express feeder from the new transformer to a switch outside the power plant yard and the relocation of the 12.47 transformer that serves Standard Oil Hill. Optimum locations for these changes will be part of the preliminary design process. Better physical protection for Switch E-1 across the street from the NPH is also planned for this project. Switch E-1 is a single point of failure for the 34.5 kV system and is located in an area that experiences heavy truck traffic.

This project will require excavation in the vicinity of East Point Road and Biorka Road. Additional environmental review and permitting may be required due to known polychlorinated biphenyls (PCBs) in the vicinity. Additionally, any excavation in the area must be coordinated with the City's plans to pave East Point Road in the future.

Estimated Year Maintenance Required: Transformer inspections are recommended to occur weekly to monthly. Oil samples are recommended on an annual basis. More comprehensive testing is recommended every 3 - 6 years. Refer to NFPA 72B Annex K for details.

Estimated Cost: $1,250,000

2. 34.5 kV Feeder Replacement

Project Name: 35 kV Feeder Replacement

Project ID: D2

Project Recommended Timeline:
Engineering/Design: FY18

Project Description:
The City electrical distribution system utilizes both 34.5 kV and 12.47 kV circuits throughout the island. This project will address the 34.5kV feeders that serve the greatest amount of the town load and serve as a "backbone" for the City's electrical system. It is understood that the majority of the cable and conduit system was primarily installed in 1982. It is assumed that a complete replacement of the two main feeders between the NPH and Town Substation will be needed in the near future.

The project will start with an engineering and design effort to better plan for removal and replacement of the lines. A phased construction approach will be needed in order to allow the City to continue to support the load during peak times. The following phases are recommended for planning. It may be necessary to further break down the work in order to achieve completion during periods of lower loads. This will be determined during the earlier design phases of the project.

- Phase 1: Switch S-1 at NPH to Margaret Bay Switch
- Phase 2: Margaret Bay Switch to Bridge Crossing
- Phase 3: Bridge Crossing to Substation
- Phase 4: Switch E-1 at NPH to APL
- Phase 5: APL to Switch E-7 (at channel crossing)
- Phase 6: Submarine Cable (see separate project summary)
- Phase 7: TL-1 (near Alyeska Seafoods to Substation)

The 34.5 kV replacement projects will require substantial excavation in certain areas and must be coordinated with the City's paving projects.

Project Need:
The 34.5 kV system provides power to the majority of the City via two feeders in a loop configuration between the NPH and the Town Substation. The feeders have a maximum capacity of approximately 9 MW each. During peak loading periods, the City needs both feeders to serve all load. If one of the two 34.5 kV circuits is out of service due to maintenance or damage, the City will not be able to meet the system demand.

The original conductor is XLP type insulation that has a history of beginning to fail at 15 to 20 years of age. The City's conductor is as old as 35 years. Fortunately, the City system has seen fairly low loads for much of the cable's lifetime, but with the recent addition of several megawatts, a replacement plan and program is now highly recommended.

In order to better determine the actual requirements, cable testing is also an option that should be incorporated into this project's early planning stages. It may be possible to expand the project timeline significantly by conducting tests. A few cables were tested by the City in 2009, and satisfactory results were returned. The testing company recommended repeating the test within 5 to 7 years. A distribution cable assessment will provide guidance if the sampled cable is in need of replacement soon or if more service life remains. Cable testing in one location was performed again in 2016 with passing results again. The sampled cable was starting to experience microscopic insulation failures but was stated to be workable for the next five years. With increased loads causing additional stresses on this conductor, it is expected that this time frame may decrease.

Conductor selection for proper ampacity will be part of the early engineering effort. However, it is recommended that the backbone be built with 600 amp rated terminations. The next smaller size available is 200 amp. This smaller size of termination does not allow the City to support all load on a single feeder during higher loading times; 200 amps equates to just under 12 MW, which is less than today's current peak loads. This type of loading is only recommended for an emergency situation. Normal long term loading should be planned for 50% to 60% of nominal ratings

Since most of the distribution system is existing, the project assumes environmental permitting requirements will be negligible.

Estimated Year Maintenance Required: Inspections are recommended to occur annually consistent with NFPA 72B Annex K. More detailed tests are also recommended on a less frequent basis.

Estimated Cost:

It is understood that certain sections within the areas listed below are newer than the rest of the system and may not need any improvements during the project. Estimates reflect the best known condition of the system at this time. The phase sequence listed below is a suggested incremental approach and should be reevaluated during the preliminary engineering phase:

- Phase 1: Switch S-1 at NPH to Margaret Bay Switch - $1,700,000
- Phase 2: Margaret Bay Switch to Bridge Crossing - $2,300,000
- Phase 3: Bridge Crossing to Substation - $950,000
- Phase 4: Switch E-1 at NPH to APL - $1,900,000
- Phase 5: APL to Switch E-7 (at channel crossing) - $500,000
- Phase 6: Submarine Cable - see separate project summary
- Phase 7: TL-1 (near Alyeska Seafoods to Substation) - $1,100,000

3. 34.5 kV Submarine Cable Replacement

Project Name: 34.5 kV Submarine Cable Replacement

Project ID: D3

Project Recommended Timeline:
Engineering/Design: FY19
Construction: FY20

Project Description:
The Electric Utility relies on the 34.5 kV subtransmission system to deliver power to major industrial loads and to the Town Substation using two existing feeders. One of these feeders crosses Iliukiuk Bay between East Point Road and Bay View Avenue. This feeder is nearing the end of its lifespan and replacement will be required.

Project Need:
The submarine cable crossing is understood to be approximately 30 years old and was originally installed by the City line crew. At the East Point Road entrance point, the cable is no longer buried completely and is easily approachable at low tide. Furthermore, large rocks have been moved by waves over the years and are now sitting directly on the cable. While undersea cable has a durable outer jacketing and is more protected by its construction than a typical 15 kV cable, the current condition does represent a safety problem and should be corrected as soon as feasible.

Once a preliminary design is completed, the Section 10 permit package can be developed and filed with the Army Corps of Engineers. The project assumes the Corps will determine that the cable project will qualify for a Nationwide permit, a streamlined version of an individual permit. The Corps will coordinate with federal and state resource agencies during the review process. The agencies will consider project impacts to endangered species, impaired waterbodies, and fish habitats. The Corps usually issue a Nationwide Section 10 permit within three months of receiving a completed application.

It is assumed that the new submarine cable will be installed in the same location and with the same points of connection as the existing line. However, the capacity of this line should be updated during the engineering planning phase of this project in order to better serve the current and future loads. Engineering coordination with the express feeder project will be required. Additionally, a cable condition assessment and inspection should occur very soon. The results of this inspection may affect the replacement schedule of the submarine cable. The project scoping phase must also consider including options such as communications or spare conduit(s). Proper protective devices on both ends of the undersea cable in order to allow for system coordination and sectionalizing are recommended for the project as well

Estimated Year Maintenance Required: Submarine cable maintenance includes visual inspections of cable terminals and entry points on an annual basis. Oil filled cable will require monitoring of pressure. Additionally, Very Low Frequency (VLF) with Tan Delta (Power Factor) test measurements are typically recommended on a 5 year cycle. Follow additional recommendations as provided by specific cable manufacturer.

Estimated Cost: $1,800,000

4. Install New 4 Way Switch at Town Substation

Project Name: Install New 4 Way Switch at Town Substation

Project ID: D4

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18/19

Project Description:
The Electric Utility relies on the 34.5 kV subtransmission system to deliver power to major industrial loads and to the Town Substation. Both feeders that end at Town Substation pass through a single 4 way switch, T12. This project adds a redundant switch for T12 at the substation. The project will provide switching to allow transformer T-1 or T-2 to be taken out of service more readily and without an outage. The project also includes reworking of the 34.5 kV cable/conduit system within the substation to incorporate a new switch in this location. Switches with remote visibility and operation capabilities should be considered during the planning and engineering stages.

Project Need:
All of the town's 12 kV loads in Unalaska are fed from Town Substation. Switch T12 is the point where both 34.5 kV feeders can be joined to the substation and is a single point of failure for the subtransmission system. The loss of this switch results in an outage for all facilities served by the Town Substation, including the school, clinic, and police station, as well as all residential loads on Unalaska Island.

Estimated Year Maintenance Required: Visual inspections are recommended on a yearly basis. Refer to NFPA 72B Annex K for details.

Estimated Cost: $500,000

5. Procure Major Spare Equipment

Project Name: Procure Major Spare Equipment

Project ID: D5

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18/19

Project Description:
The Electric Utility stocks replacement equipment and parts in order to fix any part of their system in the event of damage or failure. This project verifies existing stock, determines what is missing and procures those missing items. The following major items are recommended:

- One 35kV 5 way switch (for E-1 and Margaret Bay)
- Two 35 kV 4 way switches (for T-12, S-1, E7-S1, T-10, C-9-1)
- Two 35kV 200A reclosers
- Three 35 kV 600A 4 way junction cabinets
- Three 35 kV 200A 4 way junction cabinets
- Three 12 kV 200A 4 way junction cabinets
- One 12 kV breaker at Town Substation
- Padmounted transformers (sizes to be determined during this project)

Project Need:
The procurement of the any equipment in the City system is not a fast process due to the remote location of Unalaska and long lead times from manufacturers. A new recloser or large padmount transformer can take up to 9 months from ordering to arrival. This project will ensure that the City is prepared for any sudden equipment problems that might occur anywhere in their system

Estimated Year Maintenance Required: The list of critical spares list and equipment will require ongoing upkeep. Equipment must be stored per manufacturer's recommendations.

Estimated Cost: $400,000

6. Sea Water Intake Line Extension

Project Name: Sea Water Intake Line Extension

Project ID: G1

Project Recommended Timeline:
Construction: FY18

Project Description:

Around 1995 was the first time Magone cleared the intake pipe at the OPH. This was the first time it had been cleared since military times. This was a big project where the contractor utilized divers, a hydraulic dredge pump and a 10" submersible to pump out the sump.

By May of 2010, it was choked off with marine growth and proved to be an even bigger job to clear than the previous one. The project report recommended annual inspections and a cleanout a minimum of every five years.

In September of 2013, a maintenance cleanout was performed utilizing a fabricated steel pig that was drawn through the pipe. This went relatively well.

In May of 2016, the water flow was again restricted so an emergency cleanout was required. This time there was a new problem. Instead of marine growth, the pipe had filled with heavy silt which provided challenging to pull the steel pig through. The source of the silt was apparently road runoff that is being diverted into the intake by the new seawall that was constructed/developed by Delta Western. Previously, when it rained the muddy water from the runoff would run along near shore with the powerhouse intake being out beyond muddy water influence. However, the new seawall extends out, within 20 feet of the powerhouse seawater intake. Therefore, the extension of the intake line will also include the platting of a clear zone around the line in order to prevent future impacts from other development in the area.

Water temperature is an additional issue powerhouse personnel have identified. The summer of 2016 set new records for surface water temperatures in Unalaska Bay, with temperatures noted as high as 53°F in late September 2016. Getting down to -20 mean lower low water (MLLW) should get the temperature down at least a couple of degrees. It would be significantly colder at -30' MLLW but the expense may not be justifiable.

The existing pipe runs inside a square concrete utilidor that terminates with a concrete gate support structure. The gate was actually a strainer grate that could be raised and lowered from the support structure for maintenance and cleaning. Only the concrete guides for the gate remain of this system. It is suggested that the gate be replaced at the end of a 200 linear foot pipe extension out into Unalaska Bay. The pipe would be 30 inch pipe and terminate at a -20 foot MLLW.

The gate would be constructed of 316 stainless steel and the pipe extension would be constructed of SDR 32.5 (.923 inch wall) HDPE pipe to eliminate the need for corrosion maintenance. The extension would be attached to the gate with a 45° elbow to swing the direction of the pipeline to the north, away from the fuel dock and in the shortest direction to deeper water. The terminus would be connected to a steel box, the top of which would have a removable grate. There would be a flanged connection at the 45° elbow and another flange connection 20 feet from the elbow to allow a removable section for cleaning and maintenance. There would be another flange connection 100 feet from the terminus to facilitate handling in construction. To prevent any movement of the extension pipe or suction box, pairs of short wide flange beam anchors would be driven into the bay. The first set just out from the 20' section, the second pair would be to one side of the center connection, the third pair would be 50 feet from the box and the fourth pair would be driven through guide bars welded to the side of the box. These anchor beams would be 10 feet long of 12" 53 lb./ft. WFB that would be driven approximately 6 feet into the gravel substrate. A heavy chain going over the pipe would be shackled to the beam flanges to prevent excessive vertical movement in the event that air would be trapped in the pipeline.

Prior to installation the existing intake pipe would be cleaned again by drawing the cleanout pig through the line, pumping the mud and any debris from the sump and scraping the marine growth from the inside of the concrete gate support structure.

In addition to the line extension, this project would create a new City ordinance. The ordinance would create a platting map to establish a "clear zone" around the newly extended seawater intake and discharge lines to prevent future area land/seawater projects from affecting the clear zone seawater area used by the NPH and the OPH. This ordinance would be similar to the City's Water Utilities source protection requirements for public wells.

This project could be expanded to include the specific cleanout of the powerhouse intake/discharge sumps instead of a specific/isolated project for cleanout of the seawater intake/outfall sumps. It should also be expanded to include paving of East Point Road near the intersection of Ballyhoo Road up to Delta Way. There are known PCBs in the soil in this location and an ADEC approved contaminated soils plan and associated permitting will be required in order to perform any excavation in this area.

Estimated Year Maintenance Required: Annual inspection and cleaning every 5 years.

Estimated Cost: $200,000

7. New Powerhouse Re-Permitting (ADEC - Air)

Project Name: New Powerhouse Re-Permitting (ADEC – Air)

Project ID: G2

Project Recommended Timeline:

Engineering/Design: FY18
Permitting: FY 18
Construction: N/A

Project Description:
The City's electrical power production from the NPH is not limited by generating equipment alone, but also by owner requested limits (ORLs) imbedded in the permit so as to avoid other permitting and technology reviews at the time the existing engines were installed.

The current restrictions place a cap on annual power production while also more specifically restricting full operation of Unit 16. The lack of baseline air quality monitoring data has been a barrier in recent past to achieving a permit that allows full capacity use of all generators. The monitoring data gap will be remedied by late September 2017 allowing the City to make a new permit application that could increase operational flexibility by releasing some or all of the restrictions.

Revising the Operating Permit must be accomplished in a two-step process: first by seeking a new Clean Air Act I construction permit to change or eliminate the current restrictions, then followed by an Operating Permit change. The changes can be made once the construction permit is issued.

The application will require considerable work for which a large portion of the analysis will be to perform multiple runs of the air quality dispersion model to assess which restrictions are most achievable to release while remaining to comply with ground level ambient air quality standards.

The modeling results will indicate what emission levels of each pollutant will be permissible (e.g. compliant with the standards) and will create the basis to decide which restrictions could be released or what new generators can be added. The most telling information will be the results of meeting the one-hour health standard for nitrogen dioxide as this is the most restrictive standard. This will be a primary benchmark indicator. With modeling results available, more finite choices can be made about potential control technology choices, potential for releasing, or increasing the annual power production limit and consider allocating the NOx among respective emissions sources should that present any advantages from a permitting perspective. Consequently, we suggest that it will be far more efficient to combine this project with the project to permit the re-installation of Generators 8 and 9 as the work tasks are identical.

Once the initial modeling work has been accomplished to help fine tune the scope for the permit application, the other supporting work including federal rule review and preparing any BACT analyses will be performed.

In addition to the permitting effort, the effects on island emissions of a distributed combined heat and power (CHP) plan at three of the largest fish processor locations were evaluated. There is a significant potential for CHP plants at the three facilities. The new CHP systems would provide both the power and heat generation to the processors and allow existing older infrastructure (generators and boilers) to be converted to emergency standby. CHP would increase island energy efficiency and reduce, if not remove, older heat and power emissions technology and reduce island emissions.

Preparing the permit application is anticipated to require four to six months. Actual permit issuance is expected to take six to nine months thereafter.

Project Need:
The ORL provisions of the permits limit the ability of the existing power generation equipment from delivering the plants total available power. The City of Unalaska has continued to take on additional loads from various different area customers in Unalaska and Dutch Harbor. Primarily, new customers have consisted of fish and crab processors. The increase in loads has steadily pushed the required generating capacity up.

This project fulfills the need for the City to meet the growing load demand on the Island. The 2016 and 2017 addition of two large seafood processing facilities has resulted in 8 to 9 MW of load added to the system during processing seasons. The 2017 plant maximum output is approximately 16 MW assuming each unit is operated at 80% of full load. Any N-1 scenario involving the NPH generators results in the inability for the Utility to completely meet its customers' needs. The result is that the large industrial customers must be required to remain "interruptible" type loads that can support their own electrical loads when required.

Estimated Year Maintenance Required: None

Estimated Cost: $15,000. (Quoted as the add-on costs if this project is combined to re-permitting project for Generators 8 and 9)
$25,000 additional for CHP Analysis

8. Units 8 & 9 Permitting and Update

Project Name: 8 & 9 Permitting and Update

Project ID: G2

Project Recommended Timeline:
Engineering/Design: FY2018
Permitting: FY 18
Construction: FY19

Project Description:
Generator Units 8 and 9 (Air Permit EU ID's 7 and 8, respectively) are Caterpillar 3516 and 3512B were installed around 1994. Units were removed from service late 2014/early 2015 with the installation of Unit 12 (EU ID 16). Units were removed from service and locked out and have not been operated.

This project would re-permit Units 8 and 9 for continuous operation for dispatching to assist with plant load and system stability. The return of Units 8 and 9 would be accomplished in three parts:

A. Permitting – A Clean Air Act Title I construction permit would be acquired to authorize re-installation. The Powerhouse Title V Operating Permit would then be amended to include units 8 and 9.

   The application will require considerable work for which a large portion of the analysis will be to perform multiple runs of the air quality dispersion model to assess what emission levels of each pollutant will be compliant with the ground level air quality standards. The most telling information will be the results for meeting the one-hour health standard for nitrogen dioxide as this is the most restrictive standard.

   This will be a primary benchmark indicator to assess if Generators 8 and 9 can be installed and operated unrestricted or if additional pollution control technology is necessary to achieve compliance with air quality standards. Even if additional controls are not necessary to achieve ground level standards, a BACT analysis needs to be prepared. The BACT review is an analysis primarily looking at the cost and feasibility of reducing emissions and independent of a need to show compliance with the ambient health standard.

   The terms of a Title I construction permit would guide what, if any, technology upgrades would be necessary to reduce air emissions. The approximate financial magnitude of the re-installation project with associated upgrades must be estimated so as to determine if a "reconstruction" is occurring that will stimulate required emission control upgrades under the 40 CFR 60 Subpart IIII, and the 40 CFR 63, Subpart ZZZZ rules.

B. Suitability for Service Study (SSS) and Integration Design - This portion of the project would provide inspections and design services for both units to determine required repairs, reconditioning and maintenance required for continuous operation.

The concrete building generator auxiliary systems have undergone several modifications since Unit 8 and 9 removal from service. Design services for Unit 8 and 9 would be to integrate both units into the newer systems. Modifications/integration scope would include: incorporation of units into the new combined seawater cooling system to reduce station operating service, provide heat recovery from Units 8 and 9 jacket water system to the existing heat recovery system to support building heating, and ORC operation, etc.

C. Permitting and SSS Construction/Implementation - This phase of the project includes the construction services to implement permitting requirements and work identified under the SSS and integration Design work. Work in this part could include implementation of new emission control systems, seawater system integration, heat recovery integration, Caterpillar maintenance services, switchgear cleaning and breaker testing/maintenance, generator alternator cleaning, area HVAC improvements.

Project Need:
This project fulfills the need for the City to meet the growing load demand on the Island. The 2016 and 2017 addition of two large seafood processing facilities has resulted in 8 to 9 MW of load added to the system during processing seasons. The 2017 plant maximum output is approximately 16 MW, assuming each unit is operated at 80% of full load. Any N-1 scenario involving the NPH generators results in the inability for the Utility to completely meet its customers' needs. The result is that the large industrial customers must be required to remain “interruptible” type loads that can support their own electrical loads when required.

Although these units are not large, they are installed and near ready for operation. New larger generators are at least 2 years out at a minimum.

In addition, Units 8 and 9 can provide voltage and volt-ampere reactive (VAR) support during the operation of APL crane. Units 8 and 9 are high speed (1200 rotations per minute [rpm] and 1600 rpm) and respond faster to system disturbances than the slower speed Wartsila and Cat C280 generators.

Estimated Year Maintenance Required:

Estimated Cost:

Air Permitting -	$90,000
SSS & Integration -	$60,000*
Construction -	$950,000
Total Project -	$1,100,000

*Final Integration and Construction and subsequently total project costs are subject to final ADEC/USEPA Air Permitting effort.

9. Breaker Maintenance/Service

Project Name: Breaker Maintenance/Service (Town Sub, New and Old Powerhouse)

Project ID: D6

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18

Project Description:
All Generation and distribution/feeder breakers at the New and Old Powerhouse and Town Substation will be serviced by a qualified industry service company who specializes in in the maintenance of utility electrical equipment.

Breakers will be assessed and serviced. A detailed report indicating condition of the specific breakers would be provided along with recommended service maintenance intervals per the relevant industry codes.

Project Need:
The City operates two powerhouses, New and Old Powerhouse, and one substation. Each of these facilities has at least one if not two primary electrical switchgear line-ups within each. Electrical switchgear require maintenance and cleaning to ensure proper operation. Safe operation switchgear reduces risks of arc-flash issues and improves operator's safety.

In the last five years, there has been very little major maintenance and testing activities performed at either powerhouses or Town Substation switchgear line-ups. Only general visual maintenance has been performed with one exception. During the installation of the Unit 12 (CAT C280) project, a modification at the Town Substation was made as part of the project. During the implementation of the modification, the Contractor found that one of the substation breakers would not open/close properly. EPC onsite technician working with EPC electrical maintenance leads in Anchorage were able to provide repairs to the breaker so that it could function properly. However, no other maintenance on this breaker or others was performed.

Breaker maintenance recommendations are listed in the NFPA 70B, Recommended Practice for Maintaining Safe Electrical Equipment, Annex L.

Estimated Yearly Maintenance Required: This project catches up on deferred system maintenance. Some maintenance tasks, after this project condition assessment, will be required yearly and other additional maintenance will be required on a three and five year cycle.

Estimated Cost: $150,000

10. Large Transformer Maintenance/Service

Project Name: Large Transformer Maintenance/Service (Town Sub and New Powerhouse)

Project ID: D7

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18

Project Description:
All power transformers at the NPH and Town Substation will be serviced by a qualified industry service company who specializes in in the maintenance of utility electrical equipment.

Transformers will be assessed and serviced, as required. Transformer assessment includes insulation testing, dissolved gas analysis, sweep frequency response analysis and other tests. After testing is completed, a detailed report indicating condition and test results would be provided along with recommended service maintenance intervals per the relevant industry codes. It is also understood that components on the transformers are failing due to long term exposure to the corrosive environment due to the marine atmosphere. This will necessitate a more thorough repair in order to ensure long term reliability of the power transformers.

Project Need:
The City owns four power transformers at the NPH and two at the Town Substation. Three of the NPH transformers are approximately 12 years old, with the fourth only 3 years old. The transformers at the Town Substation are original from the substation construction approximately 20 years ago. While these transformers should have many more years of service, proper and timely maintenance will help prolong their lives. Testing transformers over a period of many years also allows a utility to develop a baseline for each unit, which in turn can identify a developing problem that may not otherwise be discovered until the transformer fails. Replacement of failing monitoring devices is also critical as these are often the utility's first indication of a problem. The devices can also operate to quickly deenergize a transformer should a more serious condition become present. Without operating protective devices, the utility experiences a higher risk of significant damage if a transformer fails

It is understood that in the last five years there has been minimal maintenance and testing activities performed at either powerhouses or Town Substation. Only general visual maintenance has been performed.

Estimated Yearly Maintenance Required: This project catches up on deferred system maintenance. Some maintenance tasks, after this project condition assessment, will be required yearly and other additional maintenance will be required on a less frequent interval. Examples of recommendations include weekly to monthly current, voltage, temperature, pressure and vacuum readings, yearly liquid analysis and testing. Every three to five years insulation and turns ratio testing are also recommended. Complete recommendations are found in NFPA 70B.

Estimated Cost: $150,000

11. Intermediate Level Protection

Project Name: Intermediate Level Protection

Project ID: D9

Project Recommended Timeline:
Engineering/Design: FY19
Construction: FY19

Project Description:

This project adds protective devices at the major industrial services, including APL and Horizon and at radial taps in the 35 kV system. Vacuum circuit reclosers will be used in order to properly coordinate clearing times in the event of a system disturbance. This will enable the rest of the system to stay on line and remove only the faulted service or radial feeder. Each location will require one recloser with dedicated relay control. The recloser will also require provisions for communications back to the NPH either via radio link or fiber optic cable if feasible. An updated short circuit study and new protective relay settings will be required in order to properly complete the system coordination work. Engineering and installation of reclosers at five locations are assumed for this project.

Project Need:

The 35 kV system does not have any intermediate level protective devices that would minimize power disruptions to customers. The system is only protected from faults via two main 35 kV reclosers at the powerhouse, two main 35 kV town substation breakers, Alyeska Seafoods recloser, Westward Seafoods recloser, Captains Bay Road tap recloser, and four main 12 kV town substation breakers. Other than primary fusing on customer transformers, there is no coordinated protection scheme currently employed. Some underfrequency and undervoltage load shed schemes are currently employed in the system but still are limited in their ability to isolate the system in smaller manageable pieces that would minimize disturbances to as few customers as possible. The lack of adequate coordinated protection schemes and apparatus has resulted system wide outages during to a fault or disturbance event most often induced by a single large industrial customer.

Areas where intermediate level protection apparatus should be incorporated are as follows:

1. Ballyhoo Tap
2. APL
3. Horizon
4. Submarine Crossing
5. Bridge Crossing

Estimated Year Maintenance Required: Annual inspections and component testing every three years per NFPA 70 B.

Estimated Cost: $500,000

12. Wartsila/Caterpillar Major Maintenance Contracts

Project Name: Wartsila/Caterpillar Major Maintenance Contracts

Project ID: G3

Project Recommended Timeline:

Wartsila Unit 10 and 11: FY17
Caterpillar Unit 12 (C280-16): FY19
Caterpillar Unit 13 (C280-16): FY19
Caterpillar Unit 8 (3516): FY18 (Pending Re-permitting)
Caterpillar Unit 9 (3512B): FY20 (Pending Re-Permitting)

Project Description:

Recurring funding request for major contracted top-end, overhaul, and in frame overhaul non-powerhouse personnel work efforts with Wartsila and Caterpillar for maintenance of the above referenced generators.

Project Need:

Units 8 through 13 are the backbone power generation equipment for the City's Dutch Harbor Power Plant (concrete and steel buildings). This recurring effort ensures each of the above referenced units are ensure to have maximum unit availability for dispatch for the City's power generation needs all year.

Estimated Year Maintenance Required: Contracted Maintenance

Estimated Cost:

FY17 - $1,500,000
FY18 - $ 657,000
FY19 - $ 542,000
FY20 - $1,360,000
FY21 - $ 108,000
FY22 - $1,767,000
FY23 - $ 489,000
FY24 - $1,043,000
FY25 - $ 987,000
FY26 - $ 553,900

13. Modicon PLC Replacement

Project Name: Modicon PLC Replacement

Project ID: G4

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18

Project Description: The Wartsila generators (Units 10 and 11) at the NPH are controlled by Schneider Electric's Modicon Quantum PLCs. The PLC models installed are no longer produced and difficult to find the same replacement parts. The Concept PLC software, used to program the Quantum PLCs, is not supported on newer operating systems and the logic in the PLC programs are proprietary and locked, which makes it very difficult to troubleshoot and modify.

Project Need:
The Modicon PLCs need to be upgraded for several reasons. The main reason is the end of production on May 2015 for many of the Quantum PLC modules including the CPU 434, which are installed on the Wartsila generators and Common PLC (handles miscellaneous station I/O and communications to relays and meters). Schneider Electric also ended support for the PLC software, Concept, in May of 2015 and is not able to run on operating systems beyond Windows XP (Microsoft support for Windows XP ended in 2014). Wartsila used proprietary function blocks in the PLC code. This is difficult to troubleshoot when there is a control issue, and adjustments to the PLC logic are very difficult with the locked function blocks.

The PLC will be upgraded to the GE PACS RX3i controllers, which are the majority of the PLCs on the Utility's electrical SCADA system. Because the new PLCs will be on the same platform, no new PLC software licenses will need to be purchased and additional spare PLC hardware will not be necessary. When the PLCs are reprogrammed, all of the logic shall be unlocked and become the property of the Utility so that modifications can be made by Utility personnel. The SCADA system human machine interface (HMI) screens will be updated with the new screens and points for the generators.

All of the drawings provided by Wartsila for the original controllers shall be updated with the new controllers and I/O modules. AutoCAD files of the as-built drawings were not provided by Wartsila after the construction of the new power plant. All of the Wartsila drawings affecting the PLC's will be converted to AutoCAD.

Estimated Year Maintenance Required: The PLC software will need to be kept up to date with current versions on an annual basis or when updates are released. This will be required for the other PLC's regardless of this upgrade, so costs can be spread between Wartsila PLCs and other GE PLCs at the two power plants.

Estimated Cost: $350,000

14. Town Substation SCADA Upgrade (RTAC/HMI)

Project Name: Town Substation SCADA Upgrade (RTAC/HMI)

Project ID: D8

Project Recommended Timeline:
Engineering/Design: FY18
Construction: FY18

Project Description:

This project would improve the Town Substation efficiency and reliability. To accomplish this effort, the Town Substation would be updated with the following:

- Addition of a station PLC to replace the Real Time Automation Controller (RTAC) and collect SCADA data from all meters and relays. The PLC will calculate metering data.
- Addition of a small server which includes VM Ware for development and interfacing with existing substation equipment controls such that substation operation would not rely on the existing wireless communication system. The server will also run the power plant SCADA system Wonderware Intouch application so the HMI will display data from the power plant.
- Addition of a thin client (HMI) for local connection and system overview.
- Adding port servers and network switches for engineering access to relays and meters to reliably collect event reports and settings.

Project Need:
In the past, the Utility has known there have been many issues with the substation communications and moving data, data resolution, lost commands to breakers, and lag in reported data between the powerhouse and the Town Substation. The existing SEL Embedded PC and RTAC at the Town substation are one of the first generation made, and the PC is running a standalone HMI application displaying the substation breakers and transformer data along with control of the breakers. However, these components are nearing the end of their useful life and will be soon unsupported. Communication between the Powerhouse and the Town Substation is paramount for safe operations and to know the condition and status of the entire utility system for accurate reporting.

With the addition of the PLC, metering data for the relay and meters will be calculated and stored in the PLC and will hold all metering data from the transformer and feeders in the event the substation loses communications with the SCADA system servers at the power plant. With the new server running the same HMI application utilized for the power plant control room HMI's, programming and maintenance time is reduced when the HMI applications are updated. Once the application is updated, it can be copied to all of the servers at the power plant and substation instead of updating the power plant application and substation application separately. The local server will store the historical data for the substation devices, so historical data is not lost when the communications link to the power plant is unavailable. The server will allow multiple users (locally and remotely) to connect to devices at the substation while the existing PC only allows a single user at a time. The thin client will allow users at the substation to see data at the power plant and rest of the electrical system.

Reliability of the engineering access will be upgraded with dedicated connections to the relays and meters. In the current configuration, multiple devices connect to the network.

Estimated Year Maintenance Required: Reduced current maintenance activities with replacing/updating equipment with new more readily available hardware/software. SCADA software will be upgraded as new updates are released with power plant software. Server shall be replaced every 5 years and other hardware every 10-15 years.

Estimated Cost: $90,000

15. Utility Flywheel Energy Storage System (FESS)

Project Name: Utility Flywheel Energy Storage System (FESS)

Project ID: G5

Project Recommended Timeline:

Phase 1 - Study: Completed November 23, 2015 (Recommended for Installation)
Phase 2 - Engineering/Design: FY18
Phase 3 - Construction: FY19

Project Description:
The flywheel system would be utilized to reduce the frequency fluctuations to the City system that are caused by existing electrical crane load at American President Lines. The electrical connection of the new FESS should be in close proximity to the City NPH since it is recommended this be maintained and operated by the City. Additionally, the FESS will need to have communication infrastructure in place for City SCADA monitoring purposes. This approach will provide for a more efficient system, maintain good communications to the City, and improve the metering and constructability. Flywheels are available from manufacturers in modular units that will facilitate installation and not require additional floor space inside the existing powerhouses.

Project Need:
The results of the study and analysis completed in November 2015 indicated that adding a flywheel system will greatly reduce the frequency fluctuations caused by the crane load. This reduction will allow the City to commit the most economical units (two Wartsila units) in place of running a faster responding Caterpillar unit when the crane is operational. The flywheel system will also prevent outages during certain low frequency events. Refer to the previously completed study for additional details. The cost estimate below is based on the study's preliminary size recommendation of 650 kW. The study also recommends that field data be gathered prior to final sizing of the FESS. The data may necessitate a change in FESS sizing.

The City needs to require any customers requesting to add new crane loads to include and provide a properly sized FESS to mitigate the frequency fluctuations. The FESS must be installed and commissioned at the same time as the new crane. Special considerations should also be incorporated within a PSA address demand charges cost sharing to assist with financially supporting the project in an equitable fashion.

Estimated Year Maintenance Required: Flywheel maintenance tasks include vibration measurements, auto greaser evaluation, helium pressure monitoring and other tasks per the manufacturer's recommendations.

Estimated Cost: Project cost estimated at $1,200,000.

16. Utility Battery Energy Storage System (BESS)

Project Name: Utility Battery Energy Storage System (BESS)

Project ID: G6

Project Recommended Timeline:
Engineering/Design: FY19
Construction: FY20

Project Description:
A BESS would consist of multiple banks of high capacity batteries which would be sized to provide power to the system. It would function as outage prevention and system stabilization as well as energy storage that may assist with economic dispatch of the power plant as a whole. Space requirements, battery size and type, and optimum location for the BESS would be determined by engineering studies and preliminary design. The economics of various BESS options will need to be considered as well. A study is recommended to further explore and define the project scope, economics and feasibility.

Project Need:
The battery energy storage system would be utilized to provide short term outage prevention or reduction by providing an alternate power source for the City Powerhouse in the event of the sudden loss of a generator. A properly sized battery bank can act as spinning reserve and may allow a more economic dispatch of the generators at certain system loading levels. A BESS can also be utilized to assist with system frequency stabilization by charging and discharging in response to frequency changes. A flywheel energy storage system should be considered at the same time as a BESS, because the FESS will assist in absorbing/providing energy and extend the lifespan of the BESS batteries.

As the City continues to explore renewable energy options such as wind turbines, a BESS should be considered further and included in the preliminary engineering studies that would accompany wind energy planning.

Estimated Year Maintenance Required: Recommended maintenance intervals include monthly visual inspections and measurements, annual infrared scans, and capacity tests every 1 to 5 years. Refer to NFPA 70B Annex L for details.

Estimated Cost: The engineering study is estimated at $30,000. Project cost estimated at $1.2 million to $1.4 million per MW.