CITY OF MILTON
6-YEAR AND 20-YEAR
ELECTRIC SYSTEM PLAN
FINAL

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Section 1
INTRODUCTION, CONCLUSIONS, AND RECOMMENDATIONS

1.1 Introduction

The City of Milton, Washington (the City), owns and operates the 15-kV electric distribution facilities which delivered 58,289 MWh to approximately 3,160 customers in 2003. The system demand was 11.56 MW in 2003. However, the electric distribution system experienced a recent peak in December 1998 at 13.89 MW as taken from Bonneville Power Administration (BPA) historical data. Over the past 10 years the demand for electrical energy has maintained a growth rate of just over 1 percent.

The City's electric distribution system of the City serves the area lying mostly within the Milton city limits, consisting of residential, commercial, municipal, and industrial loads. The electric distribution system includes a 115-12.47/7.2-kV BPA-owned substation (Surprise Lake Substation); three feeder circuits; 12.5-kV primary distribution lines consisting of approximately 19 miles of overhead line and 8 miles of underground line; distribution transformers; street lights; and secondary services with meters.

1.2 Purpose and Scope

The purpose of this electric system plan is to review and analyze the present electric distribution system and to make recommendations to the City for modifying and upgrading the existing system to achieve an efficient, reliable, maintainable system while providing for the projected load growth. The study includes the following elements:

- Data collection methods:
  - Field reviews
  - System map verification
  - Data collection
- Development of planning criteria:
  - Load growth requirements
  - Electric distribution system planning criteria
- An analysis of the existing electric distribution system:
  - Computer modeling of existing system (SynerGEE model)
  - Load allocation
  - Load flow, voltage drop, and short-circuit analysis

- Review of BPA Load Forecast
  - Estimate of future loads and areas of load growth
  - Account for Lloyd's Development Park
- Development of a 6-Year Electric System Plan (6-Year Plan) to provide economical system improvements such as:
  - Power factor improvements
  - Feeder extensions to new customers in growth areas
  - Planning-level cost estimates for required construction
  - Increasing reliability by improving switching options and sectionalizing
- Development a 20-Year Electric System Plan (20-Year Plan) to include:
  - Estimate of future loads and areas of load growth
  - Recommended improvements to meet the planning criteria
  - Planning-level cost estimates for required construction.

1.3 Guidance and Criteria

Work under this study was performed in compliance with applicable National Electric Safety Codes (NESC), the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), the Washington Administration Code (WAC 480), and industry standards.

The study was performed using guidance and planning criteria based on standards typically employed in the electric utility industry, modified to meet the City's standards. For the purpose of the study, the following guidance criteria were used:

- System improvements will be driven by safety considerations, age of equipment, voltage levels, conductor loading, excessive outages, and new loads.
- Construction estimates will use the City's construction standards adopted from Tacoma Power.
- Overhead design will be typical except where underground design is found to be favorable or to comply with the City's standards.
- Load growth will follow BPA's load forecast and known future development.
- Economic factors will be considered in analyzing alternative plans and equipment selection.

1.4 Conclusions

The existing electric distribution system is in good overall condition. The major conclusions of the study can be summarized as follows:

- The existing feeders do not experience low-voltage conditions (more than 5 percent voltage drop) during peak loads under normal operating conditions.
- Conductor loading is below the maximum limits during existing peak load conditions.

- Phase balancing is very good.
- Load balancing between feeders is very good.
- The load factor was 62 percent in 2003 (58,289,502/8,760/10,980 Annual Energy-kWh/hours in year/Peak demand-kW).
- The electric distribution system is a winter-peaking system.
- The system power factor is generally above 97 percent except during summer peaking months.
- The system is using more distribution transformers than necessary. The average transformer in the system is loaded to 27 percent of its capacity. Industry standards call for the use of 60 percent or higher of transformer capacity. Since there are energy losses associated with having transformers on-line regardless of loading, it is beneficial to have as few transformers on-line as possible and have the capacity to meet peak demands.
- The historical electric distribution system peak was 13.9MW in December 1998.
- Computer simulations showed that with either Feeder 2 or Feeder 3 out of service, system improvements will be necessary to meet voltage requirements listed in WAC 480-100-378 under specific switching scenarios.
- The underground cable serving the Surprise Lake Village Shopping Center commercial customers approaches its 30-year life expectancy at the end of the 6-Year Plan and will need to be replaced.
- Sectionalizing of the main feeders is necessary to decrease the restoration time to the majority of customers experiencing an outage and reduce the number of customers impacted by an outage.
- Tacoma Power cannot pick up the entire City's load at higher loads (40 percent of the year) using the existing 12.47-kV tie.
- The Surprise Lake Substation will reach its 40-year expected life and require refurbishing in 2015 (see Section 3.3).
- The electric load in 2024 will reach 90 percent of the top rating for the Surprise Lake Substation power transformer (see Section 3.3).

1.5 Recommendations

Based on reviews and analyses performed as part of this electric system plan, it is recommended that the City:

- Identify fuse sizes for primary lateral taps.
- Increase the loading for new or existing lightly loaded distribution transformers to increase the ratio of connected transformers on the system and the peak load. The connected load ratio should be 60 percent or higher. This will reduce transformer no-load losses on the electric distribution system.

- Purchase the Surprise Lake Substation from BPA in 2006. The BPA delivery charge is expected to increase by 18.3 percent in 2006. The present worth cost saving is estimated to be $415,610 through 2024.
- Rebuild the Surprise Lake Substation in 2015 to replace aging facilities. In 2004 the power transformer and switchgear are at 80 percent of their life expectancy. The rebuild should include a power transformer with a 30MVA top rating, a 115-kV circuit switcher, oil-containment facilities, and a new lineup of 15-kV switchgear with four feeder positions.
- Perform the following system improvements:
  - **Birch Court** – Purpose: To replace a previously faulted direct buried cable with new cable and conduit to Birch Court off of 19th Ave.
  - **AMR Metering System** – Purpose: To continue the established program of replacing all meters in system in order to be capable of Automatic Meter Reading using the same system being used by the City of Milton's Water Department.
  - **900A Gang Switch at Feeder Getaways** – Purpose: To help maintenance operations and improve switching options. Install new 900A gang-operated switch at all three feeder getaways from substation.
  - **23rd Ave Tie** – Purpose: To accommodate proposed development along 23rd Ave, to improve voltage for normal-less-one (N-1) conditions for Feeders 2 and 3, and reduce area of extended outages as a result of faults in certain area of the system. Replace the single phase 1/0 conductor along 23rd Ave from Milton Way to Taylor St with 477 AAC conductor. Selective pole replacement will be required, new framing will be required on all structures, and two overhead gang-operated sectionalizing switches are included.
  - **Lloyd's Development Park, First Stage** – Purpose: To accommodate power needs for the first stages in the development outlined in Lloyd's Development Park Master Plan and for the new pump station. Extend overhead three-phase power lines from 1st St Ct to the northern city limits along 5th Ave.
  - **Lloyd's Development Park, Later Stages** – Purpose: To accommodate power needs for the later stages of the Lloyd's Development Park. Includes establishing Feeder 4 along Porter Way and 5th Ave to service Lloyd's, and a tie between Feeder 1 and the new Feeder 4 crossing Hylebos Creek.
  - **Alder Street Tie** – Purpose: To feed six new residential loads and provide backup power feed and reduce the area of extended outages as a result of faults in the northeast area of the City. The feeder tie uses an existing padmount sectionalizing switch.
  - **Tacoma Power Primary Metering and Second Tie** – Purpose: To enable Tacoma to provide a full backup via two separate 12.47-kV ties and, at the request of Tacoma, to install primary metering at each of the two tie points to reduce the work required by Tacoma to manually adjust loads for BPA billing purposes.

- **Hylebos Creek Boring** – Purpose: This project is only necessary if the Lloyd's Development Park requires a second feed for increased reliability. Have two five-inch conduits installed in Lakehaven sewer-pipe boring under Hylebos Creek. Lakehaven is developing plans to bore under Hylebos Creek in 2006–2007; however, the plans are in the preliminary stages and cost data is not available at the preparation time of this study. The estimated price to piggyback on the project is $100/ft x 1,000 feet = $100,000. The city must stay apprised of the Lakehaven Hylebos Creek sewer line crossing project. Contact Karissa Kawamoto, AICP, Environmental Planner with HDR, Inc., (425-450-6249) or Ken Canfield (253-261-6387) for project coordination.
- **Milton Way Re-conductor** – Purpose: To improve performance of the aging lateral tap along Milton Way southwest of Porter St.
- **28th Ave Court** – Purpose: To replace aging infrastructure and to remove the residential load from the main commercial load at Surprise Lake Village Shopping Center, the lateral circuit to 28th Ave Ct needs to be re-routed to be fed from a new riser pole on Milton Way at the entrance to 28th Ave Ct.
- **Underground Tie to Harland** – Purpose: To provide backup power feed to all commercial businesses on Meridian north of Milton Way.
- **Primary Capacitor Bank Installation** – Purpose: To provide power factor correction on Feeders 1 and 2 and to reduce system losses by 18 kW at 2010 peak loads. Economic analysis indicates payback of 5.5 years.
- **Surprise Lake Village Shopping Center Underground Improvements** – Purpose: To replace aging underground infrastructure, to improve voltage levels for N-1 conditions for Feeders 2 and 3, and to increase system reliability by increasing switching options and increasing capacity of mainline conductor behind the shopping center. Install padmount sectionalizing switches with fused taps.
- **Surprise Lake Village Apartments** – Purpose: To replace aging underground cable at Surprise Lake Village Apartments and increase the cable capacity to provide a second major tie point to the commercial area.
- **New School on 23rd Ave** – Purpose: To provide service to school district land on 23rd Ave. Provide 1,000 circuit feet of primary underground cabling and three-phase transformer on site.
- **Re-conductor Sections of Feeders 1, 2 and 3 to 477 AAC** – Purpose: To bring system voltages within the requirements of WAC 480-100-378 at the end of the 6-Year Plan and in the 20-Year Plan, and to minimize switching operations. The current system has sections that drop under required voltages during N-1 outage conditions in years 2009 and beyond.
- **Re-conductor Milton Way 477 MCM** – Purpose: To accommodate N-1 switching conditions at 20-year load growth forecast. Install new 477 conductor from Switch 1106-2 at Milton Way and 15th Avenue to riser pole at 23rd Ave and Milton Way.

- **Re-conductor 11th Avenue** – Purpose: To accommodate N-1 switching conditions at 20-year load growth forecast. Replace existing 4/0 AWG conductor with 477 MCM conductor on Feeder 1 from Park Way and Fife Way to 11th Ave and Emerald Street.

Section 2
SYSTEM REVIEWS AND DATA COLLECTION

2.1 Introduction

The study required an on-site review of the physical features of the City's 12.5-kV primary electric distribution system. Existing distribution maps were verified for accuracy, and a field review was made of the BPA Surprise Lake Substation and the City's primary electric distribution system. City staff were interviewed about existing conditions and they identified capital improvements and general concerns. Load data was obtained for the largest customers.

2.2 Reviews and Map Verification

A detailed on-site review was made of each of the three primary feeders to verify the accuracy of existing system maps. The existing paper maps were marked up to call out all discrepancies between the maps and the actual physical layout. Existing underground as-built drawings were also field-verified for accuracy. R. W. Beck, Inc., employees inspected equipment at the Surprise Lake Substation.

2.3 Interviews

R. W. Beck personnel interviewed the City's Electric Department staff about existing conditions and future considerations for the electric distribution system. The Electric Department had concerns about switching, tree trimming, vault sizes, tie circuits, crew sizes, and underground labeling.

2.4 Electric Department Staffing

The City's Electric Department has four full time electrical maintenance including three linemen, a helper, and a part time meter reader. Two of the Electric Department staff have been have joined the City in the past year. The Electric Department has been operating with three staff for the past few years and as of June 2004 has all positions filled. With the increase in capital projects over the next six years, the City should consider hiring an additional staff member who has some experience but does not have the full qualifications of a lineman. This additional staff member could be trained over the next few years to become a lineman with the intent that they would remain with the City for many years. This would reduce the City's dependence on outside contractors to perform work that the City would otherwise perform in-house. In the long term, the capital projects are expected to reduce and as staff retires, the City's Electric Department would reduce the full-time staff to only four positions.

Staff training has included in-house training conducted by more experienced staff and by vendors for specific equipment. The Electric Department staff has attended hands-on seminars for the installation, maintenance, and operation of distribution overhead and underground facilities. This training should continue in order to keep the staff's experience current. Monthly safety meetings are conducted in-house in addition to "tailgate" meetings which occur at the job site to coordinate the work at hand to ensure that each person understands the specifics of their assignment and who the lead person is for that project.

2.5 Conservation Efforts

The City's has provided electrical conservation programs in the past, including offering compact fluorescent light bulbs. The Electric Department is using High-Pressure Sodium street lights, which are the current technology for efficient street lighting. Conservation programs should be coordinated with BPA conservation programs and other agencies in the region that offer assistance to customers in order to reduce the overall demand on electric energy. BPA offers several conservation programs, including Conservation Augmentation, Conservation and Renewable, and Residential Load programs. The City should review these programs with BPA and become active in promoting these programs to customers. For more information regarding BPA conservation programs, see http://www.bpa.gov/Energy/N/Projects/Index.cfm.

The Northwest Energy Efficiency Alliance is a non-profit company that offers special programs for residential, commercial, and industrial customers. Currently the Northwest Energy Efficiency Alliance is participating in over 50 programs with the goal of helping Northwest consumers and businesses use electricity more efficiently. Programs include rebates, Energy Star equipment, conservation voltage reduction, industrial motors, efficient lighting, and HVAC controls. To learn more about these programs see http://www.nwalliance.org.

2.6 Basic Data Procurement

R. W. Beck corresponded with the City, BPA, and Tacoma Power to acquire all pertinent data on their equipment to assess the condition of substation. The following data was obtained:

- Recordings from the City's SATEC metering
- Lloyd's Development Park Master Plan
- Previously identified capital improvement projects
- Feeder breaker, relays, and recloser O&M manual, including relay settings
- Schematic drawings for underground distribution
- Paper map of overhead distribution system
- Purchased power information reports

- BPA billing records
- Source impedance from Tacoma Power
- Transformer information from BPA, including age, general condition, grounding, high-side protection, and cooling fan information.

Section 3
DISTRIBUTION SUBSTATION AND FEEDER PLANNING CRITERIA

3.1 Objective

The objective of this section is to provide guidelines for future planning of the electric distribution system to serve the City of Milton's electrical load in a reliable manner and, at the same time, to provide the service at an economical cost to the customer.

It is intended that the electric distribution system be planned to meet these criteria; however, in order to maintain reasonable consumer electrical rates, some exceptions to these criteria may be necessary due to high capital costs for system improvements. These exceptions should be documented in appropriate distribution studies.

These criteria generally cover planning issues related to a 115-12.5-kV substation and 12.47/7.2-kV distribution circuits.

3.2 Substation Planning

3.2.1 Load Projection

Load projections used to plan system additions are based on historical data plus identified future projects relating to potential load growth. The load forecast used for the 6-Year and 20-Year Plans is the BPA load forecast. This forecast was reviewed by City staff before the system analysis was performed for the 6-Year Plan.

The load forecast is also based on a load level with load assigned to specific years. In reality, loads may develop at specific rates differing from those anticipated. If the actual load develops as projected in the load forecast, the year given would match the load levels. To simplify the analyses, system improvements will be addressed in a given year. Prior to actually performing the system improvements, verification of the actual loads as compared to the projected loads will be necessary to be sure the recommended improvements are scheduled appropriately.

3.2.2 Substation Capacity

Loading of power transformers is calculated from the base (OA/FA/FA) nameplate rating at 55°/65°C rise and the metered power factor. For analysis purposes, whenever projected new load growth in a substation service area would overload the existing power transformers above the top rated operating capacity, a study will be performed to determine how to increase the substation capacity. The study would analyze at least one of these three scenarios: replacing the existing transformer and related equipment with higher capacity units, installing a second transformer and related equipment, or constructing a new substation at a different location.

3.2.3 Substation Capacity Additions and New Substations

The existing BPA Surprise Lake Substation is configured for only one power transformer, but has sufficient physical space for two power transformers and a second lineup of switchgear. New substations shall accommodate a minimum of 22 MVA of load and up to four distribution circuits (see Section 3.3.1). When acquiring land for new substations, consideration should be given to the ultimate station service area and projected load as well as the possible need for special types for construction.

3.2.4 Emergency Capacity

If a failure of the substation occurs, the load will be manually transferred to a neighboring utility's distribution circuit(s). Currently, the City has an understanding with Tacoma Power and a single tie point. There are plans for a second tie point in the future. Other neighboring utilities may include Puget Sound Energy, but agreements with PSE will not be explored in this report.

3.3 Power Transformers

3.3.1 Transformer Operating Capacity

Basic transformer operating capacity is 90 percent of the top rating due to the transformer's age of 33 years, which is 80 percent of the life expectancy. The existing Surprise Lake Substation power transformer is rated 12/16/20/22 OA/FA/FA 55°/65°C. BPA has confirmed that the transformer has a second set of cooling fans. Subsequently, the operating capacity is 0.9x22MVA = 19.8MVA.

If transformer loading is projected to exceed the operating capacity, an engineering study will be performed that considers the cost of loading the existing transformer above 90 percent versus the cost of adding a new transformer. Regardless of the study outcome, the maximum allowable continuous loading is 100 percent of the top rating. The study would consider:

- Ability to transfer load to other utilities and the capacity of the other utilities' distribution lines.
- Cost of expanding the existing BPA substation.
- Cost of constructing a new substation.
- Cost of new feeder ties, as necessary.
- Cost of increased watt and VAR losses due to higher loading.
- Cost of modifying existing equipment, such as with extra fans, larger load-tap changer (LTC) units, etc., in order to increase the rating of an existing transformer.

- Impact on customer reliability assuming that load can be picked up via ties to other utilities in six to eight hours and a mobile transformer can be installed in six to seven days depending on the availability of a spare transformer and crews from Tacoma Power.
- Savings resulting from capital deferral of a new transformer based on higher loading of existing equipment.

3.3.2 Single-Transformer Installations

For single-transformer installations, consideration shall be given to the number of customers interrupted in the event of transformer failure. Increasing the loading limit from the basic limit of 90 percent can substantially increase the number of customers affected.

In order to perform transformer maintenance, sufficient ties to backup power sources need to exist. The projected loading limit and available ties should be such that at 50 percent of the projected peak, ALL loads can be transferred from the transformer. This allows maintenance to be performed during approximately 70 percent of the year based on typical transformer load duration curves.

3.3.3 Voltage Regulation

In order to ensure adequate substation bus voltage, each new transformer proposed shall be equipped with an LTC capable of ±10 percent regulation.

Substation regulation shall be set at 124 volts at peak loads for voltage drop and power flow calculations. Corrective action is required for voltages less than 118 volts on a primary distribution line due to voltage variation restraints of WAC 480-100-373. Future system improvements based on calculated voltages shall be verified before being approved for construction.

3.4 Circuit Planning

3.4.1 Circuit Capacity

Each circuit shall be designed to be loaded nominally to 50 percent capacity of the conductor under normal operating conditions, with consideration for the following:

- Continuous rating of the underground getaway as well as the remainder of the circuit.
- Continuous rating for cables calculated based on a 90°C conductor temperature and overhead conductors at 167°F hot curve.
- Adequate ties to other circuits in case of an outage.
- Adequate capacity to receive load following outage of an adjoining circuit.
- Allowable voltage regulation along the circuit.

- New primary conductor will be sized on a case-by-case basis using Economic Conductor Analysis and common conductor sizes used by the City, including 4/0 AAC and 477 AAC.
- Multi-phasing of distribution lines will be recommended in the following situations:
  - Voltage levels do not conform to criteria in Section 3.4.3.
  - The peak load current exceeds 50 amperes (360 kVA) and load transfer is not possible or advantageous to reduce load.
  - The number of consumers exceeds 60 on a single-phase tap.

3.4.2 Continuous Emergency Capacity

Circuits shall be planned such that upon loss of one circuit, sufficient adjacent circuits can be used to restore the lost load by closing tie switches in the field. The number and location of ties should be such that restoration of unfaulted sections can be completed in a timely fashion. Generally, a maximum of four tie-switch operations will be considered. Under these conditions, cable rating shall be based on 100 percent of continuous rating and overhead conductor rating shall be based on 100 percent of the normal rating. However, in no case shall the circuit loading exceed 80 percent of the overcurrent relay minimum trip setting. Additional circuit ties shall be available for use, as necessary, so that backup circuits operate at their respective emergency cable ratings for no more than one 24-hour period of each contingency event.

3.4.3 Voltage Levels

Distribution circuits, distribution transformers, and low-voltage service connections to customers shall be planned such that residential customers' voltage stays within 114–126 volts under normal conditions and within 110–127 volts under "emergency" conditions (usually lasting a few hours) at the customer meter base (WAC 480-100-373). The analysis allows for a drop of 5 volts from the high primary side (high-voltage side) of the distribution to the customers' meters, resulting in a voltage limit on the primary line of 119 volts for normal conditions and 115 volts under emergency or N-1 (normal-less-one-outage) conditions.

3.4.4 Circuit Capacitors

Capacitors are placed on the system based on peak feeder readings. Both light-load and heavy-load conditions are studied. Sufficient capacitors shall be planned for each circuit to maintain the power factor at 98 percent lagging or above to reduce electrical losses. Switched capacitors will be used only if the power factor drops below 98 percent leading light load levels.

Capacitor size shall be limited to cause no more than 2 percent voltage rise on the circuit. Economic analysis will be performed to determine if the cost savings in reducing kW loss will equal the capital investment.

3.4.5 Lateral Fusing

Fusing of laterals should be considered during the study. The instantaneous trip and reclosing relays on the substation circuit breaker should be used on circuits with fusing in order to avoid unnecessarily lengthy outage times for temporary faults. Line fuses should not exceed 75 percent capacity.

3.4.6 Loop-Feed Service

New underground projects shall be designed for eventual loop-feed service. Existing non-loop underground laterals that serve 500 kW or more shall be considered for loop feed. Reliability is to be weighed against the capital cost to complete the loop.

3.4.7 Phase Imbalance

Load balancing on each feeder shall be maintained within 15 percent of the phase current at system peak.

3.5 Reliability of Service

3.5.1 Sectionalizing

All overhead transformers will have a primary fuse to isolate a fault in the event of a transformer failure or faulted condition down-line of the transformer.

All lateral taps smaller than 4/0 will have primary fuses to isolate a down-line fault from the main feeder.

Primary switches including underground elbows that are intended to operate while energized will be designed to be operated in the energized state without having to undergo significant maintenance in order to be operated. Improvement will be recommended to maintain the following:

- Bushes and obstacles shall be kept clear of the “operating envelop” (typically 10 feet from the switching device).
- Equipment should be accessible and not located in the middle of streets.
- Equipment (such as load-break elbows) should not be located in underground vaults or manholes that are prone to water penetration due to safety and operational issues.

3.5.2 Outage Restoration

System improvements will be considered to provide the ability to restore load to customers through the use of switched devices. This will provide restoration of power to areas that are in the faulted section of the distribution lines. Adequate capacity on adjacent feeders will be maintained to allow load switching from the faulted feeder.

Section 4
ANALYSIS OF THE EXISTING SYSTEM

4.1 Introduction

Comprehensive engineering analyses were made of the electric distribution system of the City of Milton. These analyses included reviews of the power supply system consisting of substation sources and detailed computer-aided analyses of the primary electric distribution system.

The City's electric distribution system serves the area lying mostly within the Milton city limits, consisting of residential, commercial, municipal, and industrial loads. The electric distribution system includes a BPA-owned substation (Surprise Lake Substation) with high-side fusing and low-side reclosing circuit breaker; Milton-owned feeder breakers with relays and reclosers; 12.5-kV primary distribution lines consisting of approximately 19 miles of overhead line and 8 miles of underground line; distribution transformers; street lights; and secondary services with meters.

The City has one power delivery point from BPA at Surprise Lake Substation. The substation uses three 12.5-kV feeders to serve all of Milton. For an overview of the City's primary electric distribution system, see Figure 4-2.

The performance of the existing system at peak load under normal conditions is within the acceptable industry parameters. All voltage levels are above the minimum level of 118V on nominal 120V base, and the conductor load for each section of primary conductor and underground cable is below 70 percent of the maximum rating.

4.2 Power Supply and Substation Facilities

The City purchases all of its power and energy from BPA. BPA charges the City for kWh and peak demand, and it charges power factor penalties when the electric load drops below 95 percent power factor. BPA owns and operates the 115-12.5/7.2-kV Surprise Lake Substation located on Fife Way near Porter Way. Tacoma Power's Surprise Lake transmission line is the normal source for the 115-kV bus with one transformer. BPA's Surprise Lake Substation transformer was manufactured by Standard Transformer Company and is a three-phase 12/16/20/22-MVA OA/FA/FA 55/65°C unit. The transformer is protected by high-side fuses and a low-side recloser. The three feeders are protected by 15-kV circuit breakers with GE electro-mechanical overcurrent relays. See Table 4-1 for substation equipment models and settings.

Table 4-1
BPA Surprise Lake Substation Equipment

Equipment	Manufacturer	Model	Date Installed	Rating/Setting
BPA High Side Fuse	S&C	SMD-2B-150 E	2000	Standard
BPA Transformer No. 1	Standard	OA/FA/FA 65°C	1971[1]	12/16/20/22 MVA
BPA Recloser	Unknown		1980[2]	1600 A Phase 560 A Neutral
Feeder Breakers	GE	OR-B L-53	1982	
Phase Overcurrent Relays	GE	121FC77B3A (Extr. Inv.)	1982	560 A Pick-up
Neutral Overcurrent Relays	GE	121FC77B2A (Extr. Inv.)	1982	240 A Pick-up
Reclosure Relays	GE	12NLR21B2A	1982	

1. Purchased by BPA in 1971 and energized at Surprise Lake Substation in 1980. BPA has the transformer listed as OA/FA/FA; however, it appears that only one set of fans is installed.
2. Installation date.

4.3 Primary Distribution Facilities

The primary electric distribution system at the City of Milton includes three 12.5-kV overhead feeders originating from Surprise Lake Substation. The electric distribution system primarily consists of approximately 19 miles of aerial and approximately 8 miles of underground lines serving mostly residential areas. The major underground facilities are located at the east end of the City and serve the commercial business.

All three feeders exit Surprise Lake Substation underground for approximately 100 feet, then continue overhead. Feeder 1 primarily serves residential load on the north and west side of the City. Feeder 2 serves residential, commercial, and industrial load along Milton Way in the northeast corner of the City. Feeder 3 primarily serves residential and commercial loads south of Milton Way, as well as the eastern city limits and the commercial businesses in the southeast area of the City.

An underground system of vaults, transformers, and a single four-inch PVC conduit run was installed in the early 1980s around the perimeter of the Surprise Lake Village Shopping Center. The cable is 4/0 URD 15-kV (one per phase). This system is normally fed from Feeder 3 through Surprise Lake Village Apartments, feeding into the southwest vault in the shopping center.

An underground system of vaults, transformers, padmount switches, and a five-inch PVC conduit run was installed in the late 1990s along 27th Ave from Milton Way to Alder Street. The five-inch conduit is PVC and the cable is 500 MCM URD 15-kV underground cable (one per phase). This system is normally fed from Feeder 2.

The conductor for the main feeder backbone is 477 MCM AAC, 336 MCM AAC, and 4/0 AAC, with primarily 1/0 AAC used as the conductor for three-phase laterals. The single-phase primary lines consist of 1/0 AAC and No. 2 ACSR with some No. 6 and No. 4 copper still in service.

4.4 Load Allocation

The overall electrical distribution load for the analysis of the City's system was derived from a review of BPA records, billing records, and instantaneous feeder recordings. The BPA records were used to determine the most recent coincidental system peak. Instantaneous feeder recordings were used to determine percent loading among individual feeders. Billing records were used to determine whether the feeders peaked during summer months or winter months.

BPA billing records from 2001 to 2004 were analyzed. The most recent peak in January 2004 reached 13.5 MW. Historical records show a peak demand of 13.9 MW in December 1998. Figure 4-1 is a graph of the demand data from October 2001 to August 2004, illustrating a winter peaking trend. Table 4-2 shows the monthly demand data for January 2003 through December 2003.

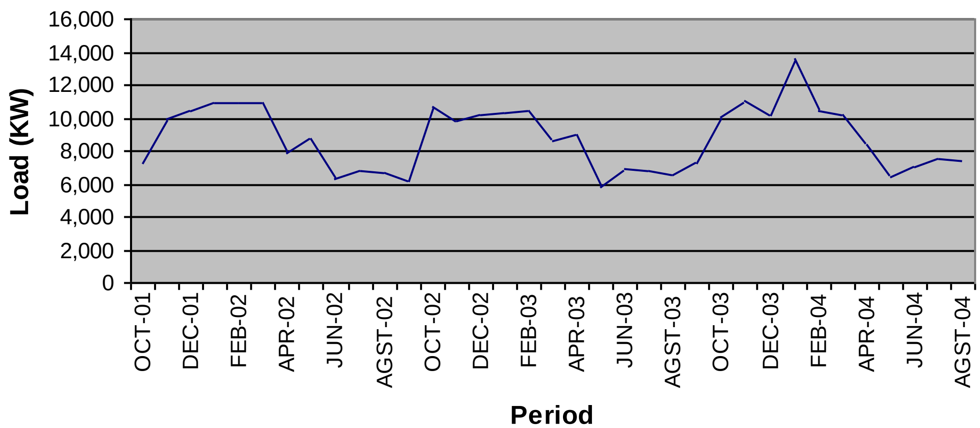

Figure 4-1: City of Milton Load Demand

Table 4-2
Monthly BPA Billing Records
Surprise Lake Substation – 2003

Period	Load Demand (kW)
January	10,270
February	10,470
March	8,570
April	8,950
May	5,760
June	6,860
July	6,830
August	6,500
September	7,290
October	10,080
November	10,980
December	10,220

Analysis of feeder records taken from the City's SATEC meter data from April 5, 2004 to May 26, 2004 was used to establish a percentage for feeder loading. Table 4-3 displays the maximum loading of each feeder in that period and a total of those maximum loads. From this data it was determined that in the existing system the percentage of the total system load breaks down as follows: Feeder 1 – 30 percent, Feeder 2 – 38 percent, and Feeder 3 – 32 percent. BPA historical data was used to determine BPA system peak at 13,890 kW in December 1998. Table 4-4 shows load allocation per feeder at system peak load.

Table 4-3
Maximum Feeder Instantaneous Recordings

Feeder	Peak kW	% kW of Total	Pf at Max kW
1	2,720	30%	98.7
2	3,410	38%	96.1
3	2,821	32%	99.9
Total	**8,951**	**100%**	

Table 4-4
Load Allocation - 1998

Feeder	Peak kW[1]	% kW of Total	Allocated kW
1	13,890	30%	4,221
2	13,890	38%	5,292
3	13,890	32%	4,278

1. Total load for Surprise Lake Substation.

4.5 Load Flow and Voltage Drop Results

Computer-aided analyses using Advantica's SynerGEE 3.6 software were made as part of the study of the City's electric distribution system. After existing paper maps were verified, a distribution model was created in SynerGEE (SynerGEE model). The electric distribution system was divided into electrical sections and nodes. A section starts and ends at a node and contains the electrical data required for the computer-aided distribution system analysis. Data gathered in the field review, including the size and location of distribution transformers and the location of primary switches, were modeled in SynerGEE.

Once the electric distribution system data was entered into the SynerGEE model, the electrical loads were allocated throughout the distribution system by the ratio of the feeder's peak demand load to the feeder's total connected transformer load (the distribution transformer name plate rating). See Table 4-4 for the feeder peak loads used.

A summary of the existing conditions for all three feeders as analyzed at peak loads for extreme weather conditions in the load flow and voltage drop analysis is presented in Table 4-5. The computer printouts of the detailed SynerGEE analysis are included in Appendix A.

Table 4-5
Feeder Conditions – Existing System

		Load			Lowest Voltage		Wire Load Max		Loss	
Feeder	Phase	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
1	ABC	4,189	4,135	803	123	121.0	032	40.89	41.44	46.34
2	ABC	5,563	5,346	1,533	083	120.7	011	62.08	69.69	109.73
3	ABC	4,395	4,390	765	081	121.3	008	55.87	70.74	84.33
Total		**14,147**	**13,871**	**3,101**					**174.3**	**240.3**

Note: For Surprise Lake Substation

4.6 Short-Circuit Analysis

A fault analysis was performed using the existing SynerGEE model and fault duty information provided by BPA and Tacoma Power (Appendix B). The source-, maximum-, and minimum-fault currents at the transformer and on the feeder are summarized in Table 4-6. The detailed SynerGEE fault analysis for all feeder sections is provided in Appendix B.

Table 4-6
Fault Currents – Existing System

	Fault Current From Source (Amps)		Minimum Fault Current (Amps)		Maximum Fault Current (Amps)	
Fault Location	**3 Phase**	**Line-Ground**	**3 Phase**	**Line-Ground**	**3 Phase**	**Line-Ground**
Feeder 1 (12.5-kV)	7,806	7,939	2,299	170	7,806	7,939
Feeder 2 (12.5-kV)	7,808	7,941	2,792	173	7,808	7,942
Feeder 3 (12.5-kV)	7,806	7,938	3,022	173	7,806	7,938
Substation (115-kV)	16,254	10,690	2,299	173	16,254	10,690

Note: For Surprise Lake Substation

(placeholder)

Figure 4-2: Electrical System Map – Existing System

Section 5
ELECTRIC LOAD FORECAST ALLOCATION

To develop the 6-Year and 20-Year Plans it was necessary to have a forecast of the City's power requirements by geographic areas of the City. A BPA forecast of energy requirements and peak demand for the 2004–2024 period was available, and the City requested that this forecast be allocated to three geographic areas within the City that correspond to the City's three electric feeders.

5.1 BPA Wholesale Load Forecast

The BPA load forecast projects the City's wholesale purchases from BPA for 2004–2024 at a single delivery point, on a weather-normalized basis, expressed in both energy and demand. The BPA forecast for the Milton system projects 2004 energy purchases of 61,287 MWh, which is 5.9 percent above the 2003 level of 57,875 MWh. The basis for this large increase in 2004 in the BPA forecast is not known. Energy purchases are projected to grow 2.1 percent annually in 2005 and 2006, and slower growth rates in the 1.2 to 1.9 percent range are projected for the following years.

Development plans (Lloyd's Development Park) of Land Lloyd Development Company are expected to be a major contributor to growth in energy sales in Milton over the next five years. However, Lloyd's representatives indicated that substantial energy requirements are not expected until 2006 and later years. These expectations are inconsistent with the projected energy requirements in the BPA load forecast. After consultation with City management and a BPA representative, it was decided that the projected energy purchases in the BPA load forecast should be adjusted to reflect the difference in timing of expected new loads.

The BPA forecast was adjusted in three steps. First, the BPA forecast for the years 2004–2011 was smoothed to reflect steady annual growth instead of the large projected increase in 2004 followed by slower growth. Second, the projected energy requirements of the Lloyd's Development Park were added to the smoothed forecast. Third, this forecast including Lloyd's Development Park was adjusted so that total energy purchases over the 20-year forecast period were approximately equal to total energy purchases in the BPA load forecast. The net effect of this adjustment process was to shift some of the energy purchases in 2004–2006 to later years (2007–2011) to be more consistent with current projections of Lloyd's Development Park's energy requirements, and to change annual energy sales by a minimal amount. Beginning in 2011, the annual growth rates in purchases are equal to the growth rates reflected in the original BPA forecast. The adjustments to the BPA load forecast are presented on Page 1 of Appendix C.

To determine the City's energy sales and peak demand at the distribution level, actual 2003 and projected 2004–2024 purchases from the adjusted BPA load forecast were reduced by a 5.4 percent loss factor.[1] The 2003 historical energy sales were then allocated to the three feeders based on ratios developed by examining hourly load data for each feeder provided by the City from the City's SATEC meters. For the April to July 2004 period, approximately 27 percent of energy sales were served by Feeder 1, 39 percent were served by Feeder 2, and 34 percent were served by Feeder 3. Projected energy sales for 2004 and 2005 were also allocated to feeders based on these percentages.

For 2006–2024, the plans for Lloyd's Development Park were a major consideration in the allocation of energy sales to the three feeders. The analysis used to estimate the power requirements of Lloyd's is presented on Pages 2 and 3 of Appendix C.

Lloyd's plans to develop a 120-acre parcel of land in the northwest part of the City for residential and assisted-living housing units and commercial and industrial uses. Individuals from Lloyd's and its contractor were contacted as part of the load forecast allocation process to identify the power requirements of the planned development. The master plan prepared by Lloyd's contains plans for a variety of types of development over the next 20 years. A representative of Lloyd's indicated what parts of the master plan are currently slated for construction in the 2005–2010 time frame. The Lloyd's Development Park plans include the following:

- Phase 1: A 100-unit assisted-living facility in combination with a 16-bed Alzheimer's facility, and 20 cottages of 1,200–1,300 square feet each, expected to come on-line during 2006 and 2007
- Phase 2: A 120-unit apartment building, expected to come on-line in 2008
- Phase 3: 70 cottages of 1,200–1,300 square feet each, expected to come on-line in 2009
- Phase 4: Expansion of the assisted-living and Alzheimer's facility to include an additional 25 units for assisted living and 8 units for Alzheimer's patients, expected to come on-line in 2010

Estimates and timing of energy sales and peak demand for the new facilities included in the Lloyd's Development Park plans were developed based on connected load estimates provided by the contractor for Lloyd's. All of the energy requirements of Lloyd's Development Park were assumed to be part of the Feeder 1 load, based on the geographic location of the planned development. These Feeder 1 load estimates were then subtracted from the total projected energy sales from the BPA forecast, and the remaining energy was allocated to Feeders 2 and 3 based on the 2004 ratios discussed above. For the years 2007–2009 the increased energy associated with Lloyd's Development Park was almost as large as the total projected increases in energy for the City. Therefore, most of the growth during that time period was attributed to Feeder 1.

Beginning in 2011, the difference between total energy increases and increases related to Lloyd's Development Park was allocated to Feeders 1, 2, and 3, such that the load on all three feeders was projected to increase at the same rate.

[1] 2003 losses were estimated to be 5.4 percent

The additional components of the Lloyd's Development Park plan beyond Phase 4 were still very speculative and there was no substantial basis for estimating the future power requirements or the timing of load additions. Therefore, they were not examined discretely as part of this load forecast allocation.

For each year, coincident peak demand for each feeder was estimated using energy sales and a 51 percent load factor, based on the assumption that all three feeders have the same load factor. The 51 percent load factor was calculated based on the energy and peak demand purchases in the BPA load forecast.

5.2 Results

Results of the load forecast allocation are summarized in Table 5-1 and a more detailed summary is provided on Page 4 of Appendix C. The adjusted BPA forecast for Milton's total system projects compound annual growth rates of 2.1 percent for the 2003–2013 period and 1.5 percent for the 2013–2024 period, with the largest increases in the 2007–2010 period.

Portions of the Lloyd's Development Park are expected to begin electric service each year between 2006 and 2010. Because the estimated energy requirements of Lloyd's Development Park are very close to the total increase projected by BPA in 2007 and 2008, for these two years virtually all of the increased energy sales projected by BPA were allocated to Feeder 1 as related to the Lloyd's Development Park.

Energy sales on Feeder 1 are projected to increase by 5,712 MWh between 2003 and 2010, an increase of 37 percent. Nearly 90 percent of this increase is related to the Lloyd's Development Park. This increase in energy requirements translates to a 1.5 MW increase in peak demand on Feeder 1 between 2003 and 2010. During this same period, peak demand on Feeder 2 is projected to increase by 840 kW and peak demand on Feeder 3 is projected to increase by 730 kW.

Between 2010 and 2024, energy sales are projected to increase by 15,723 MWh, which represents a 1.6 percent compound annual growth rate. During this period the system peak demand is projected to increase an additional 3.54 MW to 18.17 MW. This increase is spread relatively evenly between the three feeders, with an expected increase of slightly more than 1 MW on each feeder.

Table 5-1
City of Milton Electric Load Forecast Allocation
Summary of Results

					Coincident Peak Demand		
Year	Total Purchases (MWh)	Estimated Sales (MWh)	System Peak (MW)	Distribution Peak (MW)	Feeder 1 (MW)	Feeder 2 (MW)	Feeder 3 (MW)
2003[1]	58,474	55,317	12.17	11.51	3.11	4.49	3.91
2004	59,603	56,384	13.42	12.70	3.43	4.95	4.32
2005	60,624	57,351	13.65	12.91	3.47	5.04	4.40
2006	61,598	58,272	13.87	13.12	3.67	5.05	4.40
2007	63,522	60,092	14.30	13.53	4.08	5.05	4.40
2008	64,879	61,376	14.61	13.82	4.36	5.05	4.41
2009	66,946	63,331	15.07	14.26	4.55	5.19	4.52
2010	68,687	64,978	15.47	14.63	4.65	5.33	4.65
2011	70,097	66,312	15.78	14.93	4.74	5.44	4.74
2012	71,375	67,521	16.07	15.20	4.83	5.54	4.83
2013	72,221	68,321	16.26	15.38	4.89	5.61	4.89
2014	73,410	69,446	16.53	15.64	4.97	5.70	4.97
2015	74,600	70,572	16.80	15.89	5.05	5.79	5.05
2016	75,790	71,697	17.06	16.14	5.13	5.88	5.13
2017	76,979	72,823	17.33	16.40	5.21	5.98	5.21
2018	78,169	73,948	17.60	16.65	5.29	6.07	5.29
2019	79,359	75,073	17.87	16.90	5.37	6.16	5.37
2020	80,549	76,199	18.14	17.16	5.45	6.25	5.45
2021	81,738	77,324	18.40	17.41	5.53	6.35	5.53
2022	82,928	78,450	18.67	17.66	5.61	6.44	5.61
2023	84,118	79,575	18.94	17.92	5.69	6.53	5.69
2024	85,307	80,701	19.21	18.17	5.77	6.62	5.77
Compound Annual Growth Rates:							
2003–2010	2.3%	2.3%	3.5%	3.5%	5.9%	2.5%	2.5%
2003–2013	2.1%	2.1%	2.9%	2.9%	4.6%	2.2%	2.2%
2013–2024	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
2003–2024	1.8%	1.8%	2.2%	2.2%	3.0%	1.9%	1.9%

1. 2003 data is historical.

Section 6
BPA SUBSTATION PURCHASE

6.1 Introduction

The City of Milton receives all of its power from BPA through BPA's Surprise Lake Substation. The City receives service on the low-voltage side of the substation and must pay a Delivery Charge to BPA. If the City owned the substation and took service on the high-voltage side of the substation, then it would not have to pay the Delivery Charge. BPA defines low-voltage delivery facilities as facilities that are used to deliver power to public utility customers at voltages less than 34.5 kV.

Since 1996, as a result of a settlement agreement between BPA and its customers, customers have been allowed to purchase or lease low-voltage substations as an alternative to paying the Delivery Charge. The program has been popular, with many public utilities purchasing the low-voltage substations serving their systems. As evidence of this, BPA's investment in substation delivery facilities has decreased by 60 percent from 1998 to 2003.[1] At the same time, however, the Delivery Charge paid by the remaining delivery facility customers has continued to increase. Table 6-1 shows the increase in the Delivery Charge since 1980.

Table 6-1
BPA Delivery Charge

Date	Delivery Charge ($/kW-month)
1975–1980	0.200
10/1/1996	0.750
10/1/2001	0.932
10/1/2003	0.946
10/1/2006	1.550 (proposed)
10/1/2006	1.119 (settlement)

The current Delivery Charge is equal to $0.946/kW-month. BPA has indicated that the Delivery Charge rate is not recovering costs. In its 2006–2007 Rate Case, BPA proposed increasing the Delivery Charge to $1.550/kW-month. However, the Delivery Charge specified in the settlement agreement is much lower ($1.119/kW-month).

1 BPA Transmission Rate Case Workshop, August 5, 2004, Summary of Segmented Investment as of September 20, 2003.

R. W. Beck conducted a study to evaluate the feasibility of the City purchasing the existing BPA substation serving the City or, alternatively, of constructing a new City-owned substation at an appropriate site. Specific tasks performed in the study include:

- Estimating the value of the BPA Surprise Lake Substation
- Estimating the cost for the City to construct a new substation at an appropriate site
- Reviewing the reasonableness of cost data provided by BPA regarding the Surprise Lake Substation
- Performing financial analyses to evaluate the costs of substation ownership (capital and O&M costs) compared to the projected savings in purchased power costs
- Based on the results of the financial feasibility analyses, recommending whether it makes economic sense for the City to purchase the existing BPA substation or build a new City-owned substation.

6.2 Estimated Value of Surprise Lake Substation

The Original Cost Less Depreciation (OCLD) and Reproduction Cost New Less Depreciation (RCNLD) indicators of value are commonly considered under the cost approach when valuing public utility property. OCLD is defined as the original cost of the property when it was first put into service, less accrued depreciation. The OCLD value is an estimate of the net book value of the property. RCNLD is defined as the cost of constructing an exact replica of the property at current prices with the same or closely related materials, less accrued depreciation.

The calculation of the estimated RCNLD and OCLD values for the Surprise Lake Substation is shown on pages 1 and 2 of Appendix D.

The Surprise Lake Substation was energized in 1980; however, the transformer was manufactured in 1971. The history of the transformer prior to energizing the Surprise Lake Substation is not known. The substation has a single 115-12.47/7.2-kV, 12/22 MVA transformer with no load-tap changer (LTC). The 115-kV and 15-kV bussing is copper tubing with box lattice support structures. In addition, the 115-kV bus has pedestal bus supports, and 115-kV fuses provide protection for the transformer. The 15-kV protection is provided by reclosures with current transformers and voltage transformers. Three sets of three-phase underground cables feed the City's lineup of outdoor switchgear. A small control building houses the relays and metering for the BPA-owned equipment. There is no oil-containment structure around the transformer.

R. W. Beck engineers estimated the inventory of equipment at the substation based on physical observation and one-line diagrams of the substation provided by BPA. Based on this inventory, R. W. Beck estimated the current construction cost, or Reproduction Cost New (RCN) value, of the substation. Average unit costs were developed based on R. W. Beck's experience with design and construction projects for electric utilities, quotations from manufacturers, and industry cost guides. All costs are in 2004 dollars and include labor, materials, and equipment. Overhead percentages were added to the direct costs to account for engineering, construction management, and other indirect costs not specifically identified. The current value of the land on which the substation is located was assumed to be $100,000.

The estimated RCN value for the Surprise Lake Substation, including land, is equal to $1,380,574. The development of the estimated RCN value is shown on page 1 of Appendix D.

The amount of accumulated depreciation was estimated based on the current age and estimated average service life of the substation. The Surprise Lake Substation was energized in 1980, which corresponds to an age of 24 years. Based on an electric industry survey of depreciation data[2], the average service life for the substation is estimated to be 40 years. The resulting depreciation reserve ratio is equal to 60 percent (24-year age/40-year average service life). The amount of depreciation was subtracted from the RCN value to determine the RCNLD value. This is shown on page 2 of Appendix D.

The OCLD value was estimated by trending the current cost figures to the year of installation using the *Handy-Whitman Index of Public Utility Construction Costs*, a semi-annual publication widely used in the utility industry. This is also shown on page 2 of Appendix D.

Table 6-2 shows the estimated OCLD and RCNLD values of BPA's Surprise Lake Substation developed by R. W. Beck. The OCLD and RCNLD values tend to establish the lower and upper range of purchase prices for utility property such as substation facilities.

Table 6-2
Estimated OCLD and RCNLD Values
Surprise Lake Substation

	OCLD Value	RCNLD Value
Value of Substation Facilities	$268,618	$512,229
Value of Land	$100,000	$100,000
Total Estimated Value	**$368,618**	**$612,229**

6.3 Estimated Cost to Construct New Substation

R. W. Beck also estimated the cost for the City to construct a new substation instead of purchasing the existing BPA substation. The new substation would probably be located at Surprise Lake Substation and would replace the existing BPA facilities. Other locations would require transmission-line extensions and interconnections to the distribution feeders. The new substation was assumed to have a single 115-12.47/7.2-

[2] *A Survey of Depreciation Statistics*, published by the Edison Electric Institute Property Accounting & Valuation Committee and the American Gas Association Accounting Services Committee.

kV, 18/30 MVA transformer with LTC and 15-kV outdoor switchgear to support four feeders, relays, and communication. A 115-kV circuit switcher would provide the protection for the new transformer and the 115-kV bussing would connect the circuit switcher to the transformer. The 15-kV bussing would be exposed from the transformer to the new lineup of 15-kV switchgear and three underground feeder getaways would connect to the existing distribution feeders. Provisions for a fourth feeder would be made. The new substation would be constructed to meet current regulations for oil-spill containment.

The cost to construct the new substation was estimated based on R. W. Beck's experience with design and construction projects for electric utilities, quotations from manufacturers, and industry cost guides. All costs are in 2004 dollars and include labor, materials, and equipment. Overhead percentages were added to the direct costs to account for engineering, construction management, and other indirect costs not specifically identified. The value of the land was assumed to be $100,000.

Based on our analysis, the estimated cost to construct a new substation instead of purchasing the existing BPA substation is equal to $1,922,080. The development of the cost estimate is shown on page 3 of Appendix D.

6.4 Review of BPA Preliminary Cost Data

BPA provided the City a preliminary analysis of the City's annual cost associated with purchasing the Surprise Lake Substation versus continuing to pay BPA's Delivery Charge. This one-page analysis prepared by George T. Reich, Power Business Line Executive for BPA, is provided on page 4 of Appendix D.[3]

The preliminary analysis provided by BPA suggests a potential purchase price for the Surprise Lake Substation equal to $525,720. This amount is based on the estimated gross plant investment for the Surprise Lake Substation ($584,133) multiplied by a factor of 0.90. The estimated plant investment is an average investment value based on BPA's plant investment catalog and does not reflect depreciation. BPA's estimated gross investment value ($584,133) is very close to the Original Cost value, excluding land, estimated by R. W. Beck ($586,503). The 0.90 factor reflects Mr. Reich's assessment of what the estimated purchase price might be for the Surprise Lake Substation based on sales of other low-voltage substations.

The suggested purchase price in BPA's preliminary analysis is within the range of the OCLD and RCNLD values shown in Table 6-2. However, it is understood that as a typical benchmark, the average purchase price for low-voltage substation sales is closer to 0.82 times gross investment value, or $479,000.[4] Table 6-3 is a summary of the range of potential purchase prices for the existing BPA substation. The values are also expressed as a multiple of OCLD (i.e., net book value).

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[3] Mr. Reich is familiar with other sales of BPA low-voltage substations, although he explained that he is not a staff member of BPA's Transmission Business Line group which is responsible for the transmission delivery facilities.

[4] Based on conversation with Anne Falcon, Project Manager with EES Consulting, who is performing the Rate Case Study.

Table 6-3
Range of Potential Purchase Prices
BPA Surprise Lake Substation

Indicator of Value	Estimated Value	Multiple of OCLD
RCNLD	$612,200	1.66 times
0.90 x Gross Investment	$525,700	1.43 times
0.82 x Gross Investment	$479,000	1.30 times
OCLD	$368,600	1.00 times

BPA's Transmission Business Line (TBL) group does not view low-voltage delivery as a primary line of business and is interested in selling the low-voltage substations to free up capital for other lines of business. If the City makes an offer to BPA to purchase the substation, we recommend that it be at the lower end of the price range shown in Table 6-3.

The preliminary BPA analysis also provided an estimate of the City's annual cost for operations, maintenance, and administrative and general (A&G) expenses if it were to own and operate the substation. These costs are summarized in Table 6-4.

Table 6-4
BPA Estimate of Annual Substation Costs

	% of Estimated Purchase Price	Annual Cost
Operations Expense	1.00%	$5,257
Maintenance Expense	2.00%	$10,514
Administrative & General	2.50%	$13,143
Total Annual Cost		**$28,914**

Source: BPA preliminary analysis; costs based on purchase price = $525,720.

The dollar amounts of annual operations, maintenance, and A&G expenses shown in Table 6-4 are reasonable estimates of the City's annual cost to operate the substation, although the estimates are not necessarily "linked" to the purchase price paid. R. W. Beck compared the annual costs, expressed as percentage of gross plant investment, to BPA's three-year average O&M costs for Utility Delivery Substations[5] and other electric utility industry data, and found the costs to be reasonable. R. W. Beck also developed a rough budget of the time and materials required to operate and maintain the substation and came up with approximately the same level of costs.

[5] BPA Segmentation Study, Transmission Rate Case Workshop, August 5, 2004.

6.5 Financial Analysis

As part of the substation feasibility study, R. W. Beck developed a 20-year financial model to estimate the projected net savings if the City were to own and operate its own substation compared to the cost of the substation under continued BPA ownership. To estimate the net savings, R. W. Beck first calculated the net present value of operations and maintenance and capital costs under three scenarios. The three scenarios were:

- Scenario 1 – Continued BPA Ownership
- Scenario 2 – City Purchases Existing BPA Substation
- Scenario 3 – City Constructs New Substation

Following is a summary of the assumptions used in developing the model.

1. BPA Delivery Charge – The BPA Delivery Charge in 2005 was $0.946/kW-month, the current rate. For 2006, the BPA Delivery Charge increased to $1.119/kW-month, which is the rate specified in BPA's proposed TBL Rate Case Settlement Agreement. This rate was assumed to stay in effect through 2007. R. W. Beck does not know what BPA's Delivery Charge will be beyond 2007. However, BPA's 2006 Rate Case indicated that the Delivery Charge could be as high as $1.550/kW-month. For the years beyond 2007, it was assumed that the Delivery Charge would increase every two years[6] by 18 percent, the amount of the settlement rate increase, until the rate equals $1.550/kW-month. Thereafter, it was assumed that the Delivery Charge would increase at the annual rate of inflation.
2. Purchase Price – To be conservative, it was assumed that the purchase price for the existing BPA substation is equal to $600,000. As discussed above, this price is at the high end of the range of estimated purchase prices and is also higher than the purchase price estimated in BPA's preliminary analysis.[7] If purchasing the existing substation is found to be feasible at $600,000, then it becomes an even better option at a lower purchase price.
3. Cost to Build New Substation – The estimated cost to build a new substation in Scenario 3 is equal to $1,922,080.
4. Operations, Maintenance, and A&G Expenses – Expense amounts for 2005 were estimated based on the amounts shown in the BPA preliminary analysis. Thereafter, these expenses were assumed to increase each year at the rate of inflation.
5. Renewals and Replacements – Annual renewals and replacements of $10,000 in 2005, increasing annually at the rate of inflation, were assumed in Scenario 2, City Purchases Existing BPA Substation. In Scenario 3, City Constructs New

[6] Two years is the estimated average time period between rate changes due to rate surcharges, adjustments, or changes in base rates.

[7] The BPA preliminary analysis does not represent an offer to sell. If the City decides to purchase the substation, BPA would respond at that time with a formal offer to sell, which could be higher or lower than the price estimated in the preliminary analysis.

Substation, it was assumed that renewals and replacements would be equal to half the amount in Scenario 2, reflecting the lower expenditures associated with the newer substation.

6. Capital Improvements – In 2015 the existing BPA substation will be 35 years old, which is at or near the end of the useful life for transformers. In Scenario 2, it was assumed that in 2015 the City would replace the existing transformers and increase the capacity of the substation at a cost of $1,500,000. These capital improvements are not needed in Scenario 3, in which the City constructs a new substation.
7. Financing Costs – The feasibility analysis was run using different financing assumptions, cash vs. debt financing. Where debt financing is used to finance the substation purchase and/or capital improvements, R. W. Beck assumed 10-year debt at 5 percent annual interest.[8] In addition, where debt financing is used to finance the new substation construction, R. W. Beck assumed 20-year debt at 5 percent annual interest.
8. Inflation – An inflation rate of 2.4 percent was assumed based on the October 2004 Blue Chip Economic Indicators Report.
9. Discount Rate – A 5 percent discount rate was used to calculate the net present value of costs under the different scenarios. The discount rate reflects the City's cost of capital, which is essentially equal to the cost of debt.

Copies of the financial model analyses are provided on pages 5–8 of Appendix D.

6.6 Discussion of Results

Table 6-5 shows the results of the financial model scenarios. Based on the assumptions described in the preceding section, the net present value of costs over the 20-year projection period under Scenario 2, City Purchases BPA Substation, is less than under the status quo, Scenario 1, Continued BPA Ownership of the Substation. The net present value of projected costs in Scenario 3, City Constructs New Substation, is essentially the same as in Scenario 1. Therefore, based on the results of the financial model analyses, it is financially feasible for the City to acquire the existing BPA substation.

8 The use of 10-year debt to finance the substation purchase is based on the estimated remaining life of the existing transformer. Capital improvements in 2015 were financed over 10 years to correspond to the remainder of the projection period (2015–2024).

Table 6-5
Substation Ownership Options
Comparison of Net Present Value Costs

Scenario	Cash Financed	Debt Financed
1 – Continued BPA Ownership[1]	$2,440,434	$2,440,434
2 – City Purchases BPA Substation	$2,024,823	$2,097,245
3 – City Constructs New Substation	$2,372,993	$2,466,616

1. Based on proposed 2006–2007 Transmission Rate Case Settlement Agreement, Delivery Charge equals $1.119/kW-month in 2006 and 2007. Thereafter, the Delivery Charge was assumed to increase 18 percent every two years until the rate equals $1.55/kW-month, and then increase annually with inflation for the remainder of the 20-year projection period.

A key factor in determining the financial feasibility of purchasing the BPA substation or constructing a new substation is how much BPA's Delivery Charge will be in the future. In the 2006 Rate Case, BPA proposed a $1.55/kW-month Delivery Charge, a nearly 63.8 percent increase in the rate. For settlement purposes, BPA lowered the proposed Delivery Charge to $1.119/kW-month, an 18.3 percent increase compared to the current rate. However, based on BPA's rate filing and conversations with BPA representatives, R. W. Beck does not believe that the Delivery Charge will remain at $1.119/kW-month for many years. BPA representatives have also stated that as more public utility customers purchase their low-voltage delivery facilities, the cost will increase even more for remaining customers.

Table 6-6 shows the sensitivity of the financial model results to different assumptions regarding the amount of the Delivery Charge. The Delivery Charge only affects the results of Scenario 1, Continued BPA Ownership of the Substation. In these alternatives, the Delivery Charge is assumed to be at the indicated level in 2006 and increasing annually with inflation, rather than being at the $1.119/kW-month level in 2006 and increasing 18 percent every two years as was assumed in the base case analysis.

Table 6-6
Effect of Delivery Charge Assumption
on Scenario 1 Results

Delivery Charge	NPV of Cost
$1.119/kW-month	$2,056,350
$1.550/kW-month	$2,810,889

Note: Delivery Charge in 2006, increasing annually at the rate of inflation.

If the Delivery Charge proposed in BPA's 2006 Rate Case ($1.550/kW-month) was adopted, the net present value of costs under Scenario 1 would be greater than either Scenario 2 or 3, indicating that either purchasing the BPA substation or constructing a new substation is financially feasible. Even at the lower Delivery Charge ($1.119/kW-month) specified in the proposed Settlement Agreement, the net present value of costs under Scenario 1 is within the range of results shown under Scenario 2 (see Table 6-5). If the Delivery Charge increases in the future at a rate greater than the rate of inflation, which is likely, then purchasing the existing BPA substation becomes more financially feasible.

An element of risk that is not reflected in the financial model analyses is the cost associated with a major failure or catastrophic loss at the substation. As long as BPA owns the Surprise Lake Substation, it is responsible for fixing a major breakdown and restoring power. Under City ownership, the City would be responsible. All of the City's power is delivered through the Surprise Lake Substation, so it is a critical component in the delivery of power to City customers. If the City decides to acquire the substation, we strongly recommend that the City negotiate an arrangement with Tacoma Power or another neighboring utility to provide backup power if there is a failure at the substation. There may be a cost for this service, which is not reflected in the financial model. The proposed capital improvement plan discussed elsewhere in this report includes the construction of new feeders to improve system reliability and provide greater interconnections with Tacoma Power.

6.7 Acquisition Process

The process BPA has established for acquiring low-voltage substations is as follows:

- The City contacts its BPA Transmission Account Executive (Nancy Morgan, 360-619-6008) to request data and a preliminary price offering for the Surprise Lake Substation. (The City already has a preliminary analysis for the Surprise Lake Substation dated August 19, 2004 from George T. Reich, Power Business Line Executive for BPA. See page 4 of Appendix D.)
- If the City decides it is interested in purchasing the substation, it must pay BPA a $5,000 application fee (which will be applied to the purchase price). In return, BPA will provide the following information:
    - detailed inventory and age of the equipment at the substation
    - estimated replacement cost of the substation
    - Phase I environmental assessment
- Negotiations take place between the City and BPA.

As discussed in Section 6.2 of this report, R. W. Beck has already developed an estimate of the replacement cost for the Surprise Lake Substation and based on the age of the substation, has developed a range of purchase prices based on the OCLD and RCNLD values of the substation. We would be happy to assist the City in purchase negotiations with BPA.

Section 7
6-YEAR AND 20-YEAR PLAN

7.1 Introduction

The City's electric distribution system was analyzed for each year in the range 2004–2024, inclusive, in order to develop both a 6-Year and a 20-Year Plan. During the 6-year planned period the system is expected to increase from 13.72 MW to 15.31 MW and at 20 years out is expected to have grown to 18.92 MW. In order to meet the projected load growth, a long-range plan was developed to address the needs of the City. The long-range plan includes detailed computer analysis of the distribution system at 6 years with and without recommended capital improvement projects and again at 20 years with recommended capital improvement projects. A capacitor analysis was performed to determine whether additional capacitors would be cost-effective and improve the performance of the electric distribution system. Detailed switching analysis was also performed to see how the system performed under N-1 contingencies. See Figures 7-6 and 7-8 for the maps showing the recommended system improvements. Figure 7-9 shows current locations of switches referred to in the 6- and 20-year work plans.

7.2 Capacitor Analysis

Analysis was performed using the SynerGEE model to allocate the reactive (kVAR) power flow on all three feeders. Using data collected from the City's SATEC meters, the amount of kVAR flowing into each feeder was determined; see Figures 7-1, 7-2, and 7-3. Feeder 3 already has a capacitor bank installed and has a much lower kVAR flow as compared to Feeders 1 and 2. The benefit of adding capacitors on the primary electric distribution system is that the improvements will reduce kW losses and increase the system voltage levels.

7.2.1 Feeder 1

Analysis of the data shown in Figure 7-1 determined that a 450-kVAR bank could be added without causing a significant leading power factor under light load condition.

A 450-kVAR capacitor bank was modeled in SynerGEE at full load and at 50 percent load to verify acceptable performance under these system conditions. At full load Feeder 1 showed a 97 percent power factor lagging, and at 50 percent load it showed a 99 percent power factor leading.

Feeder 1 minimum section voltage and maximum section loading showed improvements with the addition of the capacitor and, more importantly, the kW was reduced due to the power flowing more efficiently.

7.2.2 Feeder 2

Analysis of the data shown in Figure 7-2 determined that adding a 900-kVAR bank would be the most beneficial to system performance.

A 900-kVAR capacitor bank was modeled in SynerGEE at full load and 50 percent load to verify acceptable performance under these system conditions. At full load Feeder 2 showed a 99.7 percent power factor lagging and at 50 percent load it showed a 99.8 percent power factor leading.

Feeder 2 minimum section voltage and maximum section loading improve with the addition of the capacitor.

7.2.3 Feeder 3

Analysis of the data shown in Figure 7-3 determined that the system would not benefit from additional capacitance.

The feeder was modeled in SynerGEE at full load and 50 percent load to verify acceptable performance under these system conditions. At full load Feeder 3 showed a 99.9 percent power factor lagging and at 50 percent load showed a 99.8 percent power factor leading.

7.2.4 Capacitor Placement Cost Analysis

To determine whether it was cost-beneficial to place the recommended 1,350 kVAR of additional capacitance on the system, kW and kWh savings were determined using the SynerGEE model. These savings are shown in Table 7-1 with BPA costs to illustrate that after six years in service the cost savings is equivalent to $11,329. The cost to place the capacitors in service is estimated at $10,567, making the payback within 5.5 years.

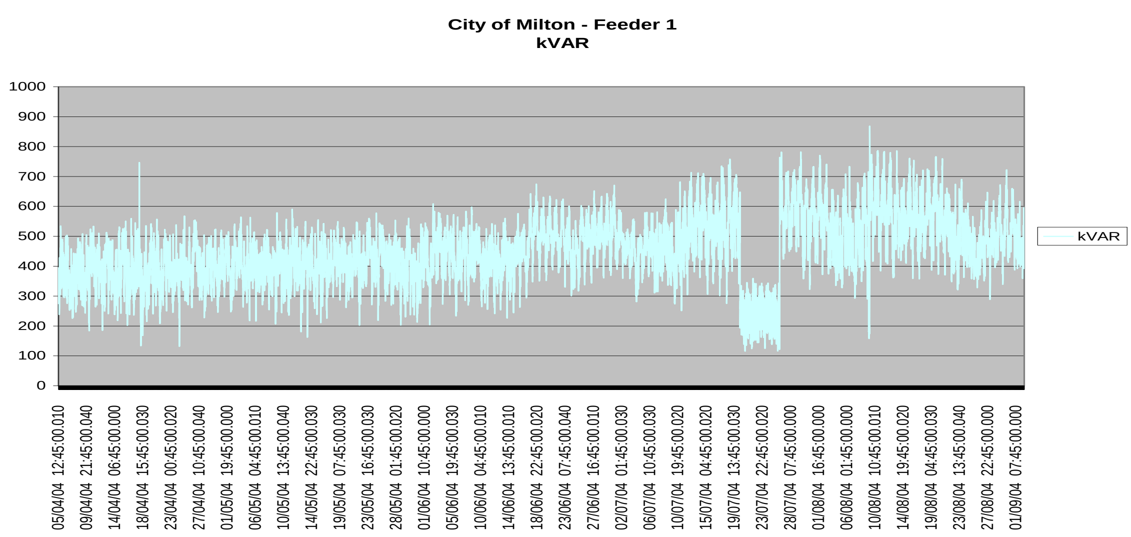

Figure 7-1: Feeder 1 kVAR Flow, City's SATEC Meter Data

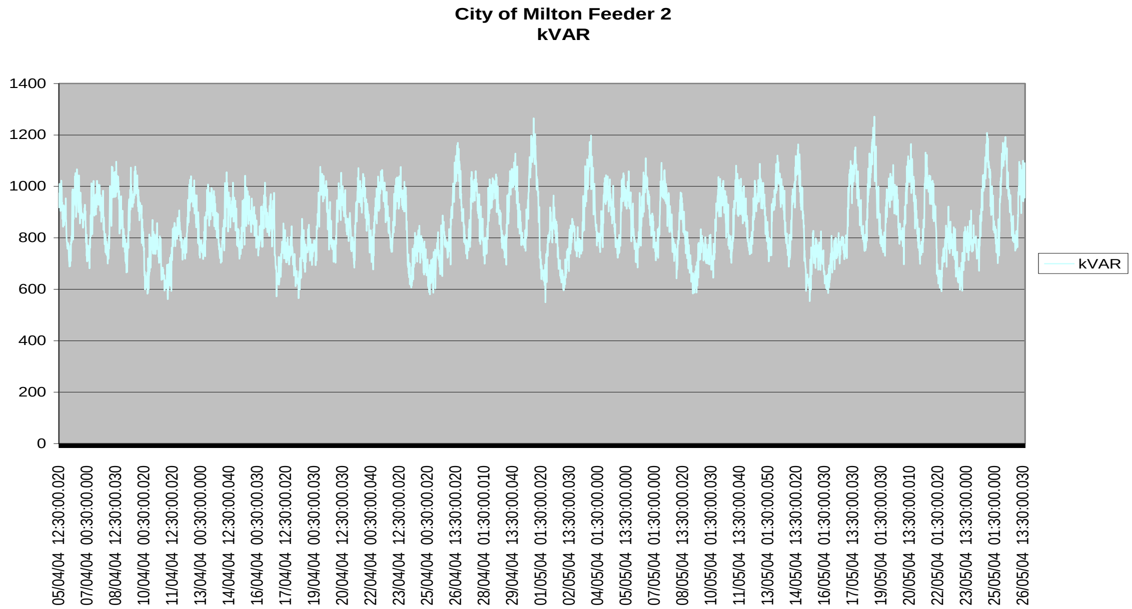

Figure 7-2: Feeder 2 kVAR Flow, City's SATEC Meter Data

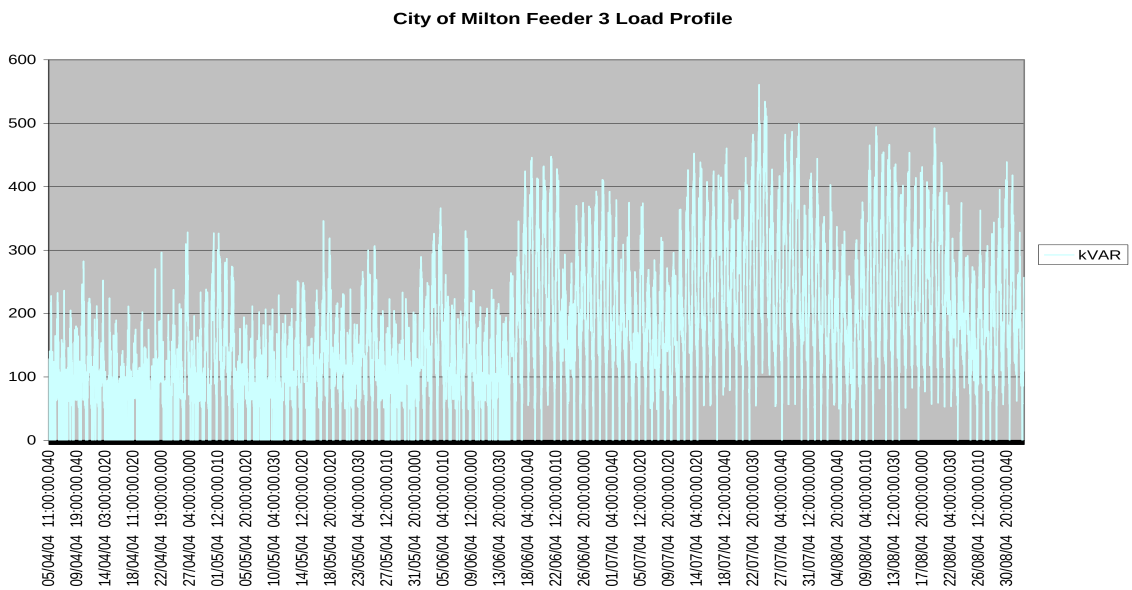

Figure 7-3: Feeder 3 kVAR Flow, City's SATEC Meter Data

Table 7-1
Savings Due to Capacitor Bank Additions

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
kWh Savings	51,104	52,649	54,240	55,880	57,569	59,309
BPA Average Charge per kWh[1]	0.03295	0.03344	0.03394	0.03445	0.03497	0.03550
Cost Savings per year	$1,684	$1,761	$1,841	$1,925	$2,013	$2,105

1. Calculated by dividing the projected power purchase cost, less the delivery charge, by the projected kWh for 2005

7.3 Switching Analysis

Switching analysis was performed with specific sections of the power system out of service in order to determine if the adjacent feeders would be capable of picking up the lost service areas. Specific sections of the power lines were chosen that would impact large areas of the system. The results of the switching analysis have been incorporated into the 6-Year and 20-Year Plans.

7.3.1 Scenario 1

Feeder 3 is disconnected at substation; disconnects are open at 15th Ave and Taylor Street; Switch 728-3 is closed; Switch PM-2400-3 is open – This allows the isolation of Circuit 3 along Taylor Street. Surprise Lake Village Shopping Center and Surprise Lake Village Apartments are backfed from Circuit 2 in this scenario. Circuit 2 is marginally able to support the additional load from Feeder 3 in this outage scenario even at current loading levels.

The minimum section voltage under this scenario is 116.6 volts and the maximum section loading is 105.2 percent. The conductor loading is above the planning criteria.

7.3.2 Scenario 2

Feeder 2 is removed from service at substation; Switch 1106-2 is open at 15th and Milton Way; Switch 728-3 is closed at Milton Way and Meridian – This scenario requires two switching operations to restore large portions of lost service areas. Normal Feeder 2 loads are picked up by Feeder 3.

On the current system the minimum section voltage under this scenario is 116.34 volts and the maximum section loading is 117.9 percent. The conductor loading is above the planning criteria. At 6-year load forecast the condition would worsen with the minimum section voltage going to 115.28 volts and maximum section loading increasing to 127.08 percent.

7.3.3 Scenario 3

Feeder 2 is removed from service at substation; Switch 1106-2 is open at 15th Ave and Milton Way; Switch 803-2 is closed at 19th Ave and Milton Way – This scenario requires two switching operations to restore large portions of lost service area. Normal Feeder 2 loads are picked up by Feeder 1.

On the current system the minimum section voltage under this scenario is 113.7 volts and the maximum section loading is 121.7 percent. The conductor loading is above the planning criteria. At 6-year load forecast the condition would worsen to a minimum section voltage going to 110.8 volts and maximum section loading increasing to 127.08 percent.

7.3.4 Scenario 4

Feeder 2 is removed from service at substation; Switch 1106-2 is open at 15th Ave and Milton Way; Switch 803-2 is closed at 19th Ave and Milton Way; Padmount Switch PM-2748-2 is open at 27th Ave and Milton Way and Switch 728-3 is closed; normal Feeder 2 loads are picked up by both Feeder 1 and Feeder 3 – This scenario requires four switching operations to restore large portion of lost service area.

On the current system the minimum section voltage under this scenario is 119.77 volts and the maximum section loading is 84.85 percent, both acceptable under N-1 contingency design criteria. At 6-year load forecast the minimum section voltage would be 119.9 volts and maximum section loading would increase to 90.76 percent. At 20-year load forecast the minimum section voltage would be 117.8 volts and maximum section loading would increase to 105.4 percent, exceeding the N-1 design requirements under loading.

7.3.5 Scenario 5

Feeder 1 is removed from service from 11th Ave and Emerald Street to 15th Ave and Alder Street; open cut-outs at 11th Ave, close cut-outs at 23rd Ave and Milton Way (see analysis), and open cut-outs at 15th Ave and Alder Street – Under this scenario at 2010 forecasted load growth the minimum system section voltage is 120.3 volts and the maximum feeder section loading is 82.4 percent, both acceptable under switching parameters. At 20-year load forecast the minimum section voltage would be 119.8 volts and maximum section loading would increase to 85.7 percent, both conditions acceptable under the N-1 design criteria.

7.3.6 Scenario 6

Feeder 2 along Milton Way is removed from service from 15th Ave to 28th Ave Court; normally closed Switch 1106-2 and Switch PM 2748-2 are open; normally open Switch 728-3 is closed; services are picked up from Feeder 3 – On the current system the minimum section voltage under this scenario is 119.77 volts and the maximum section loading is 84.85 percent, both acceptable under N-1 contingency design criteria. At 6-year load forecast the minimum section voltage would be 119.35 volts and maximum section loading would increase to 86.36 percent. At 20-year load forecast the minimum section voltage would be 118.8 volts and maximum section loading would increase to 89.71 percent.

7.3.7 Switching Analysis Conclusions

Scenario 1 does not provide for any currently available switching options in order to shift some of the load from Feeder 2 to Feeder 1. The only way to reduce the load on Feeder 3 would be to shed either the underground load north of Milton Way or south of Milton Way along Meridian. Both of those options require disconnecting a large number of commercial customers in order to prevent overloading.

Scenarios 2, 3, and 4 all deal with losing Feeder 2 at the substation and restoring as much of the service as possible. In Scenario 2 the lost load is being picked up by Feeder 3 and is causing overloading on sections even at current load levels. In Scenario 3 the lost load is picked up by Feeder 1 and is causing overloading on sections at current load levels. Scenario 4 has better performance in today's system and would not overload until the 20-year load levels, but requires four switching operations to complete, requiring in turn more time to restore load than Scenarios 2 and 4.

Scenario 5 does not present a problem with loading at any of the forecasted load levels. A problem does arise when load is being closed in from normally open cut-outs and not a gang-operated switch.

Scenario 6 does not present a problem with loading at any of the forecasted load levels. Because there are no switches on this stretch of line, a major three-phase underground lateral tap along 27th Ave would be removed from service, causing a large number of residential customers to be without power.

7.4 Recommended 6-Year Plan

7.4.1 2005 Construction Work Plan

Birch Court – Purpose: To replace an aging direct-buried underground cable that previously experienced a fault with a new cable and conduit Birch Court off of 19th Ave. Approximately 965 feet of trenching, single-phase cabling, installation of two conduits in the trench, backfill, and terminations will be performed for this job.

AMR Metering System – Purpose: To replace all meters in the system in order to be capable of Automatic Meter Reading using the same reading equipment being used by the City of Milton Water Department. It is estimated that one person will work 60 percent of the time in replacing the electric revenue meters with the new AMR meters over a 6-year period.

900A Gang Switch at Feeder Getaways – Purpose: To help maintenance operations and improve switching options. Install new 900A gang-operated switch at all three feeder getaways from substation.

23rd Ave Tie – Purpose: To accommodate proposed development along 23rd Ave, to improve voltage for N-1 conditions for Feeders 2 and 3 (see switching analysis for Scenarios 2 and 3), and reduce exposure of extended outages as a result of faults in the southeast area of the system. The electric load on this section of the single-phase line is approaching the planning criteria limit that can be served by a single-phase line. Construction in 2005 will consist of replacing the single-phase 1/0 conductor along 23rd Ave from Milton Way for five spans to service new load in the area with three-phase 477 AAC conductor. Selective pole replacement and new framing is required on all structures. This project will continue in 2007 and will be completed in 2008. The larger 477 AAC conductor was selected to provide a tie-line between Feeders 2 and 3 in order to maintain proper system voltages for the commercial district under contingency conditions (N-1 scenario).

Lloyd's Development Park – Purpose: To accommodate power needs for the first stages in the development outlined in Lloyd's Development Park Master Plan. Extend overhead three-phase power lines from 1st St Ct to the northern city limits along 5th Ave. Work includes installation of 11 poles, reframing of three existing poles, and installation of 2,600 circuit-feet of conductor. The conductor is 477 MCM for approximately 1,000 circuit feet to the existing lateral tap, where it then becomes 4/0 AWG all the way to the end of the line at the north city limits.

Alder Street Tie – Purpose: To feed six new residential loads, provide backup power feed, and reduce the area of extended outages as a result of faults in certain areas of the system (see switching analysis for Scenario 6). Approximately 965 feet of trenching, three-phase cabling, and installation of two conduits in trench, backfill, and terminations will be performed between 23rd Ave and Heather Hills Mobile Home Park along Alder St. In addition, 700 feet of three-phase 1/0 cabling must be removed and replaced with 4/0 cable between 27th Ave and Heather Hills Mobile Home Park along Alder St. The project will start in 2005 and be completed in 2007.

7.4.2 2006 Construction Work Plan

Continued Work on AMR Meter replacements

Continued Work on distribution line to Lloyd's Development Park

Continued work on Alder Street Tie

Tacoma Power Primary Metering and Second Tie – Purpose: To improve performance of the system while taking service from Tacoma Power and to install primary metering to assist Tacoma Power in cutover.

Hylebos Creek Boring – Purpose: This project is only necessary if the Lloyd's Development Park requires a second feed for increased reliability. Have two 5-inch conduits installed in Lakehaven sewer-pipe boring under Hylebos Creek. Lakehaven is developing plans to bore under Hylebos Creek in 2006; however, the plans are in the preliminary stages and cost data is not available at the preparation time of this study. The estimated price to piggyback on the project is $100/ft x 1,000 feet = $100,000.

7.4.3 2007 Construction Work Plan

Resumed Work on 23rd Ave Tie

Continued Work on AMR Meter replacements

Continued Work on Lloyd's Distribution Line

Continued Work on Hylebos Creek Boring

Milton Way Re-conductor – Purpose: To improve performance of lateral tap and to replace aging poles along Milton Way from Porter Way to Fife Way. Work includes replacing select poles, reframing, a re-conductor with new 1/0 ACSR for phase and neutral, and replacing aging open-wire secondary with triplex cable.

28th Ave Court – Purpose: To replace aging infrastructure and to separate the residential loads from the main commercial load at Surprise Lake Village Shopping Center. The lateral circuit to 28th Ave Ct needs to be re-routed to be fed from a new riser pole on Milton Way at the entrance to 28th Ave Ct. This section of 25-year-old underground cable has already experienced failures. Approximately 1,030 feet of trenching, single-phase underground cabling, installation of two conduits in trench, backfill, one new vault, and terminations will be performed for this job. The existing padmount transformers will be reused.

7.4.4 2008 Construction Work Plan

Continued Work on 23rd Ave Tie

Continued Work on AMR Meter replacements

Underground Tie to Harland – Purpose: To provide backup power feed to commercial business (Harland) on Meridian north of Milton Way. Extend underground 15-kV cable along 28th Ave into vault in existing underground infrastructure in the parking lot at Harland. Approximately 1,610 feet of trenching, 2,010 feet of three-phase 4/0 copper cabling, installation of two conduits in trench, backfill, four new vaults, and terminations will be performed for this job.

Primary Capacitor Bank Installation – Purpose: Power factor correction and cost savings (see Section 7.2). Add 450-kVAR capacitor bank to Feeder 1 at 15th Ave and Emerald St and 900-kVAR capacitor bank to Feeder 2 at 27th Ave and Milton Way. The timing of the installation of the capacitor banks was chosen to be in 2008 to level capital funding and the higher priority of the improvements recommended in earlier years.

7.4.5 2009 Construction Work Plan

Continued Work on AMR Meter replacements

Surprise Lake Village Shopping Center Underground Improvements – Purpose: To replace aging underground infrastructure, to improve voltage levels that are under feeder N-1 conditions for Feeders 2 and 3, to increase system reliability, and to facilitate maintenance.

System reliability will be increased by adding switching options to reduce the number of customers impacted during maintenance or outage conditions, by increasing capacity of mainline conductor behind shopping center, and by replacing nearly 30-year-old aging infrastructure.

Maintenance will be facilitated by increasing vault sizes and relocating load-break connections out of the currently water-filled manholes. The manholes in this area need to be pumped out before any work can be done, possibly increasing outage times. Figure 7-4 depicts the current condition of the connections in this area and Figure 7-5 shows how they would look after improvements.

Install four vaults, three padmount switches with two 600A positions and two fused tap positions, 3,000 feet of trenching behind Safeway, 2,000 circuit feet of mainline 500 MCM AL UG cable, and 500 feet of peripheral 1/0 AL UG cable (see Figure 7-7). Underground 250 feet of existing overhead line along Milton Way just west of Meridian. It is planned that contractors will construct the civil aspects of the project and City crews will install the underground cable and terminate the cable to transformers and switches. This project will begin in 2009 and continue into 2012.

Figure 7-4: Load-Break Connections, Below Grade, Current Conditions

Figure 7-5: Load-Break Connections, Above Grade, Future Conditions

7.4.6 2010 Construction Work Plan

Continued Work on AMR Meter replacements

Continued work on Surprise Lake Village Shopping Center

7.4.7 2010 Analysis

A SynerGEE model of the City's system was used to analyze peak projected 2010 loads with and without the recommended system improvements. Growth on Feeder 1 was determined to be primarily from Lloyd's Development Park and was accounted for in the SynerGEE model (1.2 MW 2010 and additional 1.12 MW in 2024). Feeder 2 and Feeder 3 load growth were modeled using a load growth factor applied to the existing load based on the load growth forecast.

Computer-aided load flows and voltage drop analyses were performed with the load additions and system improvements (without additional capacitors, Tables 7-2 and 7-4; and with additional capacitors, Table 7-3 and Section 7.2). All feeders were within voltage-loading and conductor-loading criteria with system improvements.

Table 7-2
Feeder Conditions 2010 System (Without Added Capacitors)

	Load			Lowest Voltage		Wire Load Max		Loss	
	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	5587	5515	898	123	120.3	032	57.5	54.6	76.1
Feeder 2	5977	5745	1653	154	120.3	011	67.8	85.4	132.9
Feeder 3	4711	4706	211	081	121.0	008	70.8	70.4	95.9

Note: For Surprise Lake Substation

Table 7-3
Feeder Conditions 2010 System (With Added Capacitors)

	Load			Lowest Voltage		Wire Load Max		Loss	
	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	5529	5513	426	123	121.5	032	45.3	52.6	74.2
Feeder 2	5778	5733	721	154	121.9	011	65.7	72.8	123.3
Feeder 3	4711	4706	211	081	122.0	008	70.8	70.4	95.5

Note: For Surprise Lake Substation

Table 7-4
Feeder Conditions 2010 System (Without Improvements)

	Load			Lowest Voltage		Wire Load Max		Loss	
Feeder	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	5589	5516	899	123	119.7	032	66.1	66.8	86.7
Feeder 2	5977	5744	1653	154	120.4	011	66.9	81.3	130.6
Feeder 3	4710	4706	210	081	121.0	008	70.8	71.7	99.0

Note: For Surprise Lake Substation

7.5 Recommended 20-Year Plan

7.5.1 2011 Construction Work Plan

Continued work on Surprise Lake Village Shopping Center.

7.5.2 2012 Construction Work Plan

AMR Meter maintenance and upgrades

Continued work on Surprise Lake Village Shopping Center.

Surprise Lake Village Apartments – Purpose: To replace aging conductors as they surpassed designed life span and to increase cable capacity to provide a second tie point to a commercial area.

7.5.3 2013 Construction Work Plan

Continued work on Surprise Lake Village Shopping Center

Continued work on Surprise Lake Village Cable Replacement

New School on 23rd Ave – Purpose: To provide service to school district land on 23rd Ave. Provide 1,000 circuit feet of primary underground cabling and three-phase transformer on-site.

7.5.4 2014 Construction Work Plan

AMR Meter maintenance and upgrades

Lloyd's Distribution East and Hylebos Creek Crossing – Purpose: To provide a second power feed to future growth in Lloyd's Development Park and to increase reliability by creating a tie between the east and west laterals of Feeder 1. Install approximately 3,500 circuit feet of conductor and eight additional poles. Reframe existing poles and install underground conductor and manholes in 1,000-foot underground creek crossing from previous boring work outline in 2006 Construction Work Plan.

7.5.5 2015 Construction Work Plan

Surprise Lake Substation Upgrade – Purpose: To replace switchgear and transformer from 22 MVA to 30 MVA top rating due to increasing load, addition of Feeder 4, and aging of equipment. Installation of an oil-containment system is included.

7.5.6 2016 Construction Work Plan

AMR Meter maintenance and upgrades

Establish Feeder 4 – Purpose: To split Feeder 1 into two feeders: Feeder 1 and Feeder 4. Install underground portion between substation and Park Way, split existing north load from Feeder 1, and move to new Feeder 4.

7.5.7 2017 Construction Work Plan

AMR Meter maintenance and upgrades

Re-conductor Milton Way 477 MCM – Purpose: To accommodate N-1 switching conditions at 20-year load growth forecast. Install new 477 conductor from Switch 1106-2 to riser pole at 23rd Ave and Milton Way.

Re-conductor 11th Avenue – Purpose: To accommodate N-1 switching conditions at 20-year load growth forecast. Replace existing 4/0 AWG conductor with 477 MCM conductor on Feeder 1 from Park Way and Fife Way to 11th Ave and Emerald Street.

7.5.8 2018 Construction Work Plan

AMR Meter maintenance and upgrades

Re-conductor Taylor Street 477 MCM – Purpose: To accommodate N-1 switching conditions at 20-year load growth forecast. Install new 477 conductor from 15th Ave and Taylor St to end of the existing overhead line, as bounded by the location of padmount Switch PM-2400-3.

7.5.9 2019–2024 Construction Work Plan

Generic projects are identified in the remaining years of the 20-Year Plan to provide capital cost placeholders.

Underground cable replacements for 6th Ave off of Fife Way

Replacement of aging poles, conductors, equipment, and hardware

Install new services to connect new customer loads

7.5.10 2024 Analysis

A SynerGEE model of the City's system was used to analyze peak projected 2024 loads with and without the recommended system improvements. Growth on Feeder 1 was determined to be primarily from the Lloyd's Development Park. That load growth was entered in as a spot load in the SynerGEE model (2.32 MW). Feeder 2 and Feeder 3 load growth were modeled using a load growth factor applied to connected load based on the load growth forecast.

Computer-aided load flows and voltage drop analyses were performed with the load additions and system improvements (without additional capacitors, Tables 7-6 and 7-7; and with additional capacitors, Table 7-5 and Section 7.2).

Table 7-5
Feeder Conditions 2024 System (With Added Capacitors)

	Load			Lowest Voltage		Wire Load Max		Loss	
	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	2888	2859	408	207	122.7	001	42.6	20.2	30.4
Feeder 2	7492	7417	1057	102	121.2	011	84.4	131.6	214.8
Feeder 3	5915	5856	834	081	121.7	103	70.3	82.0	146.4
Feeder 4	4179	4141	563	141	123.7	012	48.7	33.6	65.6

Note: Surprise Lake Substation

Table 7-6
Feeder Conditions 2024 System (Without Added Capacitors)

	Load			Lowest Voltage		Wire Load Max		Loss	
	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	2972	2836	887	207	121.1	001	37.6	20.9	32.6
Feeder 2	7605	7343	1980	102	120.1	011	86.3	138.1	226.8
Feeder 3	5876	5817	833	081	120.9	103	70.4	82.1	146.7
Feeder 4	4147	4109	563	141	122.5	012	55.1	33.6	46.3

Note: Surprise Lake Substation

Table 7-7
Feeder Conditions 2024 System (No System Improvements)

	Load			Lowest Voltage		Wire Load Max		Loss	
	kVA	kW	kVAR	Section	Volts	Section	% Cap	kW	kVAR
Feeder 1	7059	6967	1135	123	119.7	032	77.4	96.4	135.2
Feeder 2	7483	7191	2069	083	120.3	011	67.6	125.8	210.2
Feeder 3	4405	4401	197	081	122.1	008	65.7	62.0	83.6

Note: Surprise Lake Substation

(placeholder)

Figure 7-6: Electrical System Map With 6-Year Improvements

back

(placeholder)

Figure 7-7: Schematic of Underground System Improvements

back

(placeholder)

Figure 7-8: Electrical System Map With 20-Year Improvements

back

(placeholder)

Figure 7-9: Electrical System Map – Switch Locations

back

Section 8
COST ESTIMATE

8.1 Introduction

Cost estimates have been prepared for the proposed system improvements to the City's electric distribution system. The planning-level cost estimates include substation improvements and distribution improvements for the underground and overhead system. The total estimate per improvement was placed in the projected capital improvements spreadsheet, split between years of the project, and weighted by effort per year. The capital improvement spreadsheet is shown in Table 8-2. The details of the planning-level cost estimates are in Appendix E.

General operation and maintenance expenses were projected through 2024 and are detailed in Table 8-3 and summarized by year in Table 8-1.

The planning-level cost estimates are preliminary planning construction cost estimates based upon preliminary layouts. Major material costs are from R. W. Beck's 2004 cost database, RSMeans Electrical cost data, and estimates received from vendors. The costs for removal and relocating of major distribution equipment have been included in the estimates. All costs are in 2004 dollars.

The cost estimates assume all work to be performed by City crews except for substation rebuild, civil work at Surprise Lake Village Shopping Center, and civil work at the Surprise Lake Village Apartments.

8.2 Substation Facilities

The substation and switching equipment are in good condition for the age of equipment. As load increases and the equipment ages the equipment will need to be replaced. For 2015, an upgrade to the substation is planned, which includes replacing switchgear, adding switchgear for new Feeder 4, replacing the transformer with a new 30 MVA top rating unit, and constructing an oil-containment facility.

8.3 Distribution Facilities

The primary electrical distribution facilities are generally in good condition at the current time with the exception of switching options, aging underground conductors, and small vaults. The major overhead improvements are targeted toward system growth and switching options for improved system reliability. The major underground improvements are targeted toward system growth, switching options, and replacement of aging conductors.

8.4 Year-by-Year Capital Improvement Costs

Table 8-1 contains a summary of the total capital improvement costs and estimated operation and maintenance expenses by year. These yearly costs are provided in more detail in Table 8-2 and Table 8-3, respectively.

Table 8-1
Summary of Capital Improvement and O&M Costs

Year	Capital Improvement Cost	Operations and Maintenance Cost	Total
2005	$383,261	$3,593,728	$3,976,989
2006	$746,255	$3,523,921	$4,270,176
2007	$229,367	$3,621,963	$3,851,330
2008	$126,937	$3,704,801	$3,831,738
2009	$248,098	$3,795,408	$4,043,506
2010	$248,098	$3,915,048	$4,163,146
2011	$260,000	$4,034,269	$4,294,269
2012	$547,500	$4,257,184	$4,804,684
2013	$257,690	$4,276,412	$4,534,102
2014	$146,060	$4,613,566	$4,759,626
2015	$1,500,000	$4,685,879	$6,185,879
2016	$210,000	$4,645,697	$4,855,697
2017	$208,131	$4,733,426	$4,941,557
2018	$120,000	$4,915,405	$5,035,405
2019	$50,000	$4,907,705	$4,957,705
2020	$70,000	$5,010,398	$5,080,398
2021	$60,000	$5,107,561	$5,167,561
2022	$100,000	$5,207,271	$5,307,271
2023	$310,000	$5,301,610	$5,611,610
2024	$110,000	$5,406,661	$5,516,661
Totals	$5,931,397	$89,257,913	$95,189,310

Note: All costs in 2004 dollars

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Table 8-2
Revenue and Expense Projections 2004–2024

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Table 8-3
Projected 2004–2024 Capital Expenses

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Table 8-4
Projected 2004–2024 O&M Expenses

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