Washington City

Capital Facilities Plan- Electrical

September 2007

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INTRODUCTION

Intermountain Consumer Professional Engineers (ICPE) has prepared this electrical system study and Five Year Work Plan Update at the request of Washington City. The intent of the work plan is to anticipate future demand for electricity, and evaluate the capacity of the City's electrical system to supply it. Improvements to the system are proposed to insure that capacity is in place to supply power to customers when needed. Where appropriate, improvements to safety, reliability, and efficiency of the electric system are recommended. This report has been prepared to provide Washington City information for budgeting and planning purposes. Detailed design work is not included as part of this study.

General findings and recommendations of the work plan update are presented in the summary section of the work plan. The project summary section lists major projects that are proposed in the work plan, the general timeframe when these projects should be completed, and the estimated cost of the projects in 2007 dollars.

The system load history and forecast section includes tabular data on past load, projected load, and prospective development in the City, and a table showing forecast loads for each substation. The load forecast identifies expected loads for existing substations, as well as the addition of the Green Springs North Substation and the Sienna Hills Substation. Load transfers between substations are projected on the basis of maximizing the utilization of existing substation transformers. Capacity additions are only scheduled when the transfer of load to adjacent substations would result in overloading those facilities. Maximizing the utilization of existing and future resources produces the least cost option. Distribution facilities are planned for construction in the time frames necessary to facilitate the load transfers as dictated by the "Action Plan". Backup capacity for substation transformers/equipment and provisions for improved transmission and distribution reliability are also issues addressed in the study.

Detailed information is provided in the report for each element of the power system evaluated as part of the work plan. Sections are included on transmission, substation, distribution, large known residential and commercial development projects, protection and coordination, and system power factor.

A long term planning map showing prospective distribution line routes is included with the work plan.

SUMMARY

Major projects that are proposed in the work plan are listed in the project summary section with the recommended completion date and the estimated cost of the project in 2007 dollars. Actual timing of these projects may vary depending on the actual load growth of the electrical system. Additional information for each of these projects is included in the work plan.

Load Forecasts

The demand on the City's electrical system has grown at a high rate since 1994. The high rate of commercial and residential growth is expected to continue because of the City's location and the continued interest of developers. The number of requests Washington City has received for project approval supports the expectation of continued rapid growth for the period of time covered by this work plan.

The load forecast assumes a steady rate of growth within the City. Due to the continued high rate of growth in the last few years, a load forecast was developed to define expected growth based on the current growth rate, compared to a full build-out of developable land area per Washington City's General Land Use Plan. Advanced planning is required so facilities will be in place when needed and the financial impact to the City's budget can be identified and incorporated.

Historical and forecast data can be found in Tables 1 and 2. This same data is shown graphically in Graphs 1 and 2.

Transmission

Washington City is served from a 69 kV transmission line originating in the UAMPS River Substation. UAMPS owns the 138 kV transmission line feeding the River Substation and the 69 kV line running from the River Substation to the Millcreek Substation. UAMPS meters the Washington City Power system at Millcreek Substation. (Meters are also located on the 12.5 kV bus at each substation.) Washington owns the 69 kV line that connects the Millcreek Substation to the Staheli, Main Street, and Buena Vista Substations. The City owns these three substations. Washington City also owns the 69 kV line from the Purgatory tap to the Coral Canyon Substation and then along Telegraph Road to approximately 1100 East. The City's 69 kV transmission line is 795 ACSR from the Millcreek Substation to approximately 100 East 200 South and is able to provide up to 80 MVA of electrical power to the City system before approaching a thermal overload condition. The remainder of the transmission line to Staheli and Main Street Substations is 4/0 ACSR. The 4/0 ACSR conductor will reach thermal overload at approximately 28 MVA. The 69 kV line between the Main Street Substation and the Buena Vista Substation is 795 ACSR. The UAMPS Creek 69 kV line (795 ACSR) is able to provide a total of 80 MVA of power to the entities it serves. This UAMPS line also serves the electrical needs of Hurricane City and Twin Cities areas.

When the electrical demand on the 4/0 ACSR line section feeding Staheli and Main Street Substations exceeds 28 MVA, it will have to be replaced or rebuilt. Current load forecast indicates a need to replace the 4/0 ACSR line from 100 East 200 South to the Main Street Substation during 2013 to avoid putting 29.9 MVA on it in 2014. The 4/0 ACSR wire serving Staheli, Sienna Hills, and Coral Canyon Substations will not require replacement until 2016 to avoid an overload of 30.1 MVA during 2017. These projects are beyond the scope of this study and will need to be reviewed as part of future Capital Facilities Plan updates. Limited capacity is available from the Purgatory Tap 69kV line until the proposed Hurricane-Washington 138/69 kV Substation is constructed.

Any UAMPS or countywide plans to upgrade the transmission system is critical for power system planning and should be considered before the City makes major construction commitments.

Service Area

This study considers the electrical load growth within the Washington City Power service area. It does not provide any information or evaluation for the loads on the south side of the Virgin River. Washington City Power serves the area north of the Virgin River and within the City limits. The north side of the I-15 Freeway corridor is also served by Washington City Power. The Tortoise Habitat area provides the northern and western boundaries to this portion of the service area.

Substations

The existing Staheli, Main Street, Coral Canyon, and Buena Vista Substations should be used to supply electrical energy within the City boundaries. These substations are well placed to supply power in the areas around them for many years. As the City continues to expand into undeveloped areas, additional substations, transmission lines, and distribution feeder lines will be required. The new electrical facilities will be connected to the system in such a way that they can provide backup support to adjacent circuits and substations. The existing substations should be maintained and expanded as necessary to handle future load growth within the neighborhoods they serve. The Staheli Substation is located to serve the existing downtown area, the general area between the substation and the Virgin River, and to provide backup to the Wal-Mart/Home Depot commercial area. The Coral Canyon Substation provides electrical service to the Coral Canyon Development Area. The Main Street Substation is located to serve existing commercial businesses and new developments along I-15. The new Buena Vista Substation has been built to deliver power to the Buena Vista residential area and to the expanding commercial area on the west side of Washington City.

The Staheli and Main Street transformers will need to be replaced with larger units or have additional units installed to sustain the rate of growth within their service areas. The new Coral Canyon substation has been constructed to serve the growth in the Coral Canyon Development area. The area surrounding the I-15 exit to State Road #9 (to Hurricane) is expected to fill in with commercial loads, light industrial loads, as well as a significant amount of residential housing. This substation will provide electrical power for these customers.

The construction of the Mile Post 13 interchange has opened additional lands for development. This development includes the construction of the Washington Parkway Boulevard between Telegraph Road and I-15. Development plans for this area include residential, commercial and light industrial customers. A new substation will be required to serve this area. The Sienna Hills Substation will serve customers between the freeway and Telegraph Road and between the Sod Farm and Coral Canyon Development Area. This substation will also serve the loads that develop on the south side of Telegraph Road.

The rapid growth in the Buena Vista area has prompted the building of the Buena Vista Substation to alleviate loading stress on existing electrical facilities Buena Vista Substation will also provide for expected development along the north side of the I-15 corridor and for the area west of the Main Street Substation. Another new substation (Green Springs North) is proposed to support the northern end of the Buena Vista area growth. It will provide for the northward growth of the Buena Vista area and the general area north of I-15. It will also provide interconnection points with the Main Street Substation for maintenance and reliability purposes.

The timetable for substation capacity increase and the construction of new substations is presented in the Washington City Electrical Load Growth Mitigation Plan, (Table 9).

Distribution

General guidelines for main feeder distribution line construction are included in the distribution section. The guidelines emphasize construction of power lines with capacity to handle current and expected future load, provide backup capacity, maintain reliability, and minimize losses.

The long-range planning map included with the work plan shows prospective routes for new main feeder distribution lines. The lines run along existing and future road right-of-ways, as shown on the Washington City Master Transportation Plan. Potential locations for switches to interconnect major feeders are shown on the map.

The distribution routes on the long-range map are intended as a guide to aid in planning new distribution facilities. Line routing will vary from the plan depending on where development occurs and the actual alignment of the roads at the time of construction.

The present 12 kV distribution system has adequate capacity to handle existing load, under normal conditions, with limited backup capacity for contingency situations. Prospective load growth will require changes to the distribution system, including new feeders from the Coral Canyon Substation and construction of new substations at Sienna Hills and Green Springs North. Other modifications and additions will be projected through the term of the study. New distribution feeders to serve growth areas should be engineered to provide for overall distribution feeder system reliability improvement. Ongoing engineering evaluation of the distribution system is recommended to prevent low voltage and overloaded facilities, provide for power factor correction, maintain over-current coordination, and provide backup capacity to maintain reliability. Mapping of facilities serving newly developed areas will be increasingly critical as electrical facilities expand and more complex service configurations are installed.

Power Factor Correction

In power purchase contracts with UAMPS, Washington City has agreed to correct system power factor to at least 95%. No penalties are stipulated in these contracts. During winter and spring, Washington City typically complies with contract power factor requirements at the metering point. Installation of capacitors on Washington City's system allows the City to comply with contract power factor requirements. Since the Washington County transmission system is voltage limited, proper VAR support from each utility is critical. Each utility should correct the distribution power factor as close to unity (100%) as possible. Capacitors that are properly located on distribution feeders will provide the VAR support needed to attain unity power factor on the Washington City Power System. In addition to VAR support, other benefits of power factor correction are:

1. Line losses are reduced resulting in a more efficient system and savings in power purchase costs.
2. Capacity of feeders and substation transformers is increased because electrical current required to serve the load is reduced and the circuit voltage profile is improved.
3. Reduce VAR demand on the transmission system, which improves overall voltage support.

Protective Device Coordination

A review of distribution system coordination should be done as soon as possible for each circuit. A review of all system coordination should be done in 2007-08, after the distribution circuits are reconfigured with the additional feeders from Coral Canyon Substation and Sienna Hills Substation. Any contemplated load transfers between substations to alleviate summer load peaking problems should be completed before this review is implemented. The system coordination study would insure the integrity of protection zones, establish the optimal relay settings and fuse sizes necessary for system protection, and identify the need for any ancillary devices to limit customer exposure during abnormal system operation.

Over-current devices such as fuses, reclosers, and sectionalizers are used to protect substation equipment and power lines from damage. Proper operation of these devices is mandatory to protect equipment and to avoid possible human injury. Coordinated application of the protective devices will reduce the frequency and length of outages, assist response personnel in locating the cause of outages, and will improve protection of lines and equipment. Proper fuse-breaker coordination limits the number of customers affected by a system fault. Cost savings will result from fewer and shorter outages, and a lower frequency of equipment failure. Customer satisfaction will improve and operating cost will be lower as the number of service interruptions/outages is reduced.

Typically, coordination work is done on the electrical system for specific equipment installations, such as the installation of a substation transformer or a piece of switchgear. This approach only insures proper coordination for a limited part of the system and only at the time of installation. Periodically, a review of the entire system should be done to insure that protective devices are still coordinated. Any distribution circuit reconfiguration or new line equipment installation must be reviewed to insure proper coordination with any upstream protective devices. Protective devices (fuses, sectionalizers and reclosers) should be thoroughly reviewed for line extensions or new load additions. In the past, large subdivisions or extensions to commercial developments have relied on overhead fuses for protection. Due to the increasing size of developing loads, consideration should be given to the use of automatic devices, such as vacuum fault interrupters (VFI's) and electronic sectionalizers, to maintain the integrity of protected zones and provide sufficient capacity to serve the load without compromising system coordination.

System Load History and Forecast

Management of an electric utility system requires careful planning. Load forecasts are essential to planning. New facilities must be designed, ordered, and installed in time to meet the needs of new residences and businesses; power resource contracts must be in place to supply growing demand at the most economical rate. In addition, budgetary estimates for new facilities need to be created for short term and long range financial planning.

Washington City peak electrical loads have been projected based on load history, zoning requirements, and applications for subdivision and property development. The forecasts are intended to show growth trends for planning. Many factors may cause variation in the annual kilowatt peak including weather, construction schedules of developers and businesses, annexations, and factors affecting the general economy of the region. The short-term forecasts are most reliable. Longer-term forecasts need to be periodically updated based on current information and forecast trends.

Load history is the obvious indicator of what load to expect in the future. During the eighties, Washington City load growth was low (due to the introduction of natural gas), but began growing at about 5% during the early nineties. In the late nineties, the growth rate increased to about 8%. From 2000 until the present, the rate of growth has remained high, averaging 10-12% per year. A high rate of growth is expected to continue because of Washington City's location, continued interest of developers, favorable interest rates for investment, and the availability of manpower resources.

Urban growth has historically moved along the I-15 Freeway from St. George City northward. As St. George has grown, new customers have become established along the freeway. Washington is now seeing this growth within its boundaries. Many city residents choose to live in Washington City, but commute to St. George to work. Others commute northward to the Cedar City area. The Mile Post 13 project, the Coral Canyon expansion, and the continued expansion in the Buena Vista area support the expectation of a continued high rate of growth.

Historical load data and forecast load data for Washington City are listed in Tables 1 and 2, and shown graphically in Graphs 1, 2, and 3. Data for each substation is included along with the total City load.

The forecast shows a high rate of growth for the next 5-10 years. This appears to be a certainty for the next five years. The following five years are sufficiently far away that an educated guess is the best we can offer. The substation loading forecasts are based on an evaluation of the following criteria and assumptions:

- Washington City General Plan Land Use Map
- Historical data on the area being developed per year; number residential lots, etc. per unit of developable area.
- For each substation service area, the total amount of developable land according to the parameters in the "Land Use Plan"
- That all new developments, loads, etc. within Washington City's corporate city limits and located north of the Virgin River would be served by Washington City Power Department.

In planning for additions to Washington City's electrical system, summer loads are used. Washington City's load has been summer peaking since 1994. Loading of all system equipment, such as transformers and lines, is more critical in summer due to the higher ambient temperatures.

TABLE 1

WASHINGTON CITY
ELECTRICAL DEMAND HISTORY

Year	Summer Peak	% Growth (Summer)	Winter Peak
1987	3,639		6,498
1988	3,840	5.52%	6,146
1989	4,360	13.54%	6,851
1990	4,514	3.53%	6,520
1991	4,433	-1.79%	6,500
1992	5,121	15.52%	5,616
1993	5,615	9.65%	6,083
1994	6,514	16.01%	6,268
1995	6,984	7.22%	6,376
1996	8,112	16.15%	6,436
1997	8,590	5.89%	6,665
1998	9,883	15.05%	6,410
1999	10,646	7.72%	7,154
2000	11,956	12.31%	6,976
2001	14,490	21.19%	8,144
2002	15,638	7.92%	8,930
2003	17,782	13.71%	8,714
2004	19,840	11.57%	9,716
2005	23,971	20.82%	11,302
2006	25,093	4.68%	12,966

GRAPH 1
Washington City Demand History

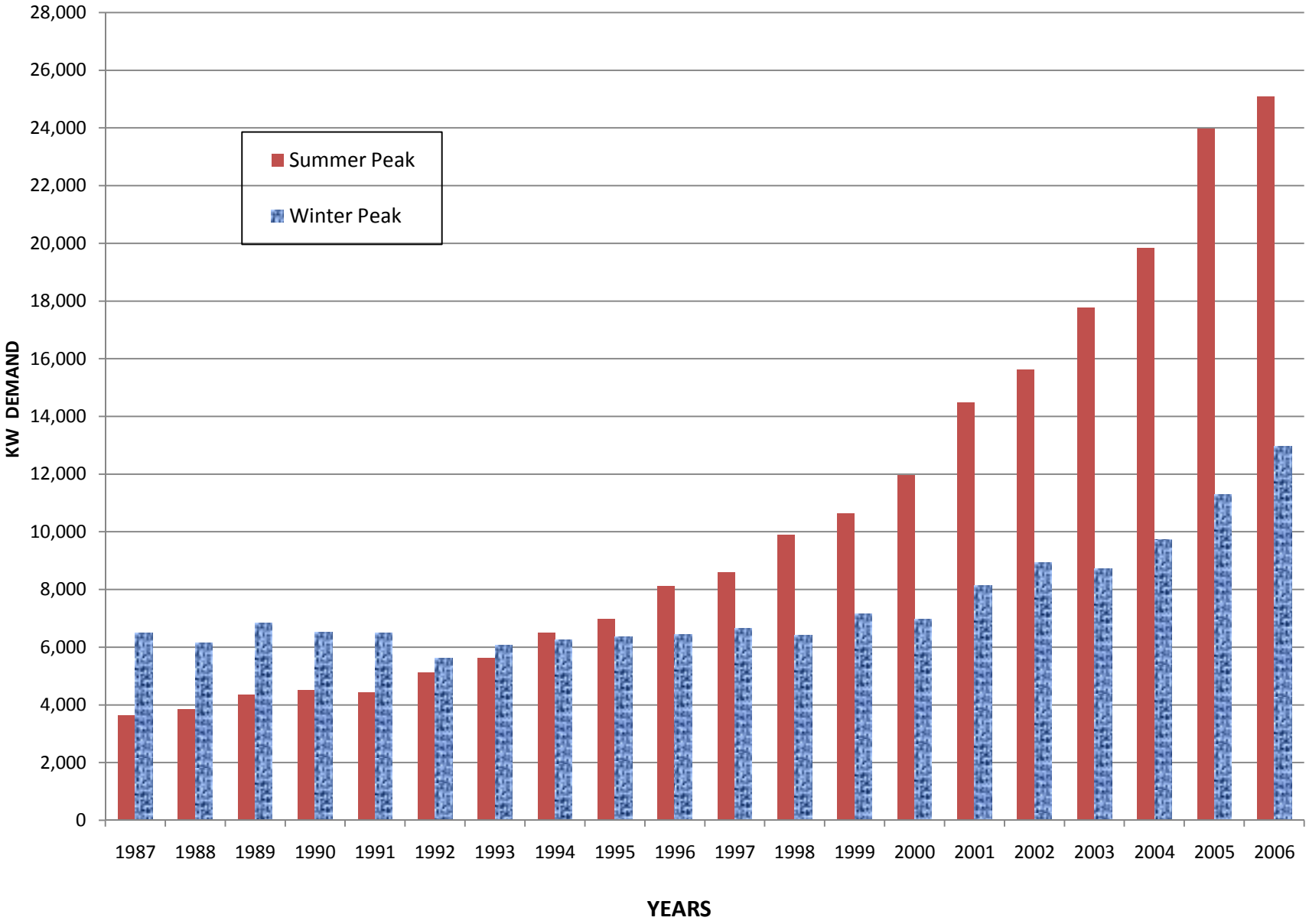


TABLE 2

WASHINGTON CITY
ELECTRICAL LOAD FORECAST

PEAK KW		
Year	Historical	Projected
1991	4,433	
1992	5,121	
1993	5,615	
1994	6,514	
1995	6,984	
1996	8,112	
1997	8,590	
1998	9,883	
1999	10,646	
2000	11,956	
2001	14,490	
2002	15,638	
2003	17,782	
2004	19,840	
2005	23,971	
2006	25,093	25,093
2007		27,602
2008		30,363
2009		33,399
2010		36,739
2011		40,413
2012		44,454
2013		47,788
2014		51,372
2015		55,225
2016		59,367
2017		63,819

GRAPH #2
Washington City Power
Load Growth Projection 2000-2017

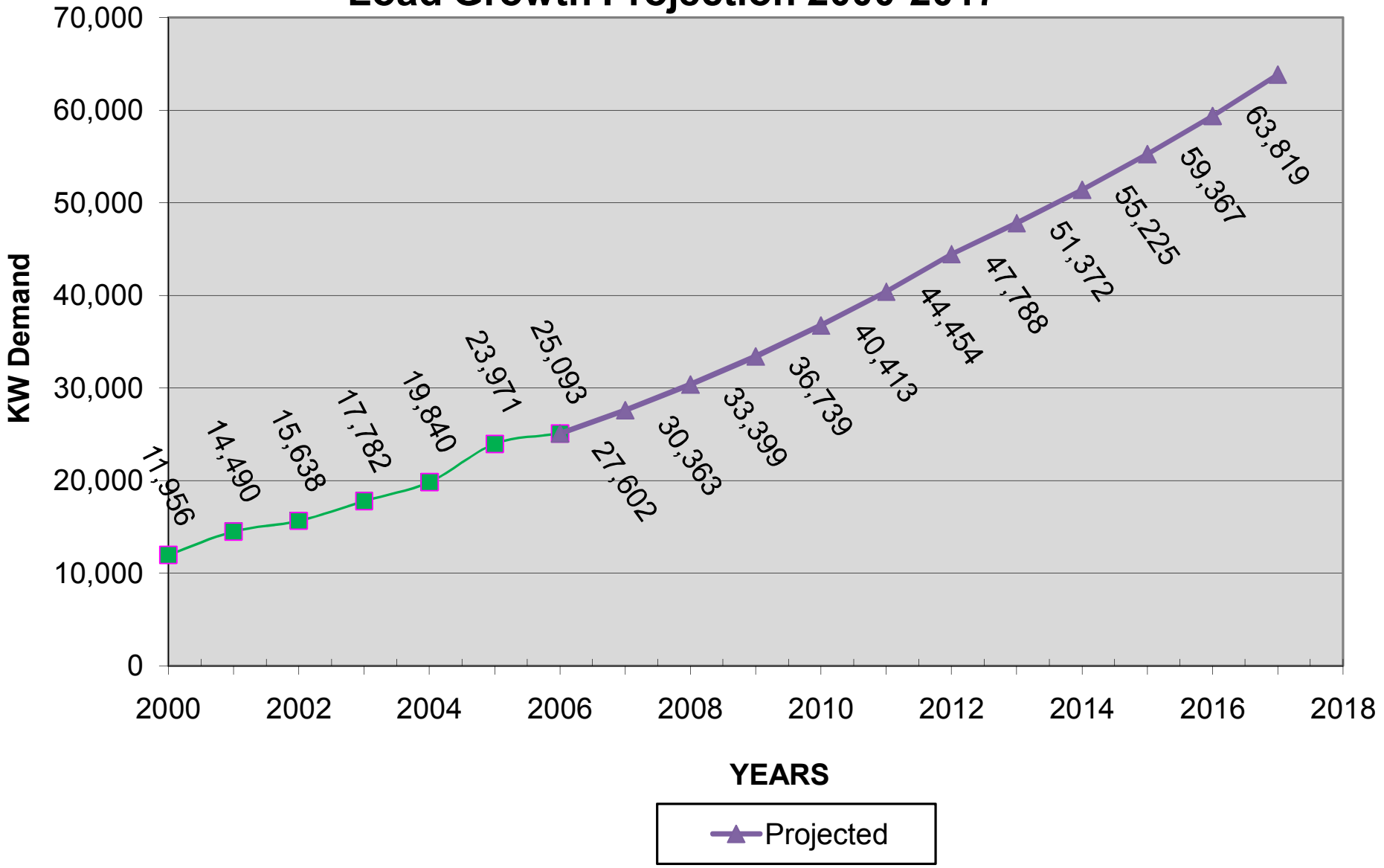


TABLE 3
WASHINGTON CITY
SUBSTATION LOAD FORECAST
Present System -- 10% growth per year 2007-2012 and 7.5% growth per year 2013-2017

No Mitigation Adjustments

Substation	YEAR KW-Demand 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Transformer Base Rating
Staheli															
Bank #1	6,761	8,168	7,172	7,889	8,678	9,546	10,501	11,551	12,706	13,659	14,683	15,784	16,968	18,241	10,000 kVA
Main Street															
Bank #1	7,519	9,086	6,681	7,349	8,084	8,892	9,782	10,760	11,836	12,723	13,678	14,704	15,806	16,992	10,000 kVA
Bank #2	5,560	6,717	2,451	2,696	2,966	3,262	3,589	3,947	4,342	4,668	5,018	5,394	5,799	6,234	10,000 kVA
Coral Canyon															
Bank #1	0	0	4,050	4,455	4,901	5,391	5,930	6,523	7,175	7,713	8,291	8,913	9,582	10,300	12,000 kVA
Buena Vista															
Bank #1	0	0	4,739	5,213	5,734	6,308	6,938	7,632	8,395	9,025	9,702	10,430	11,212	12,053	12,000 kVA
Sienna Hills															
Bank #1															
Green Springs No.															
Bank #1															
Total	19,840	23,971	25,093	27,602	30,363	33,399	36,739	40,413	44,454	47,788	51,372	55,225	59,367	63,819	54,000 kVA

WASHINGTON CITY

SUBSTATION LOAD FORECAST

Proposed Plan -- 10% growth per year 2007-2012 and

7.5% growth per year 2013-2017 with mitigation adjustments (Rev. 7/26/07)

	YEAR														Transformer
	History	History	History	kW-Demand											Base Rating
Substation	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Staheli															
Bank #1	6,761	8,168	7,172	7,889	6,179	6,797	4,476	4,924	5,416	5,822	6,259	6,728	7,233	7,775	10,000 kVA
Main Street															
Bank #1	7,519	9,086	6,681	5,099	5,609	6,170	6,787	7,465	8,212	8,828	9,490	10,202	10,967	11,789	10,000 kVA
Bank #2	5,560	6,717	2,451	4,946	5,441	5,985	6,583	7,241	7,966	8,563	9,205	9,896	10,638	11,436	10,000 kVA
Coral Canyon															
Bank #1	0	0	4,050	4,455	4,901	5,390	5,929	6,522	7,174	7,712	8,291	8,912	9,581	10,299	12,000 kVA
Buena Vista															
Bank #1	0	0	4,739	5,213	5,734	6,308	6,938	7,632	8,395	9,025	9,701	10,429	11,211	12,053	12,000 kVA
Sienna Hills															
Bank #1	0	0	0	0	2,500	2,750	6,026	6,629	7,291	7,838	8,426	9,058	9,738	10,466	12,000 kVA
Green Springs No.															
Bank #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	19,840	23,971	25,093	27,602	30,363	33,399	36,739	40,413	44,454	47,788	51,372	55,225	59,367	63,819	66,000 kVA

2007

1) Transfer 2250 kW from Main St. Bank #1 to Main St. Bank #2.

2008

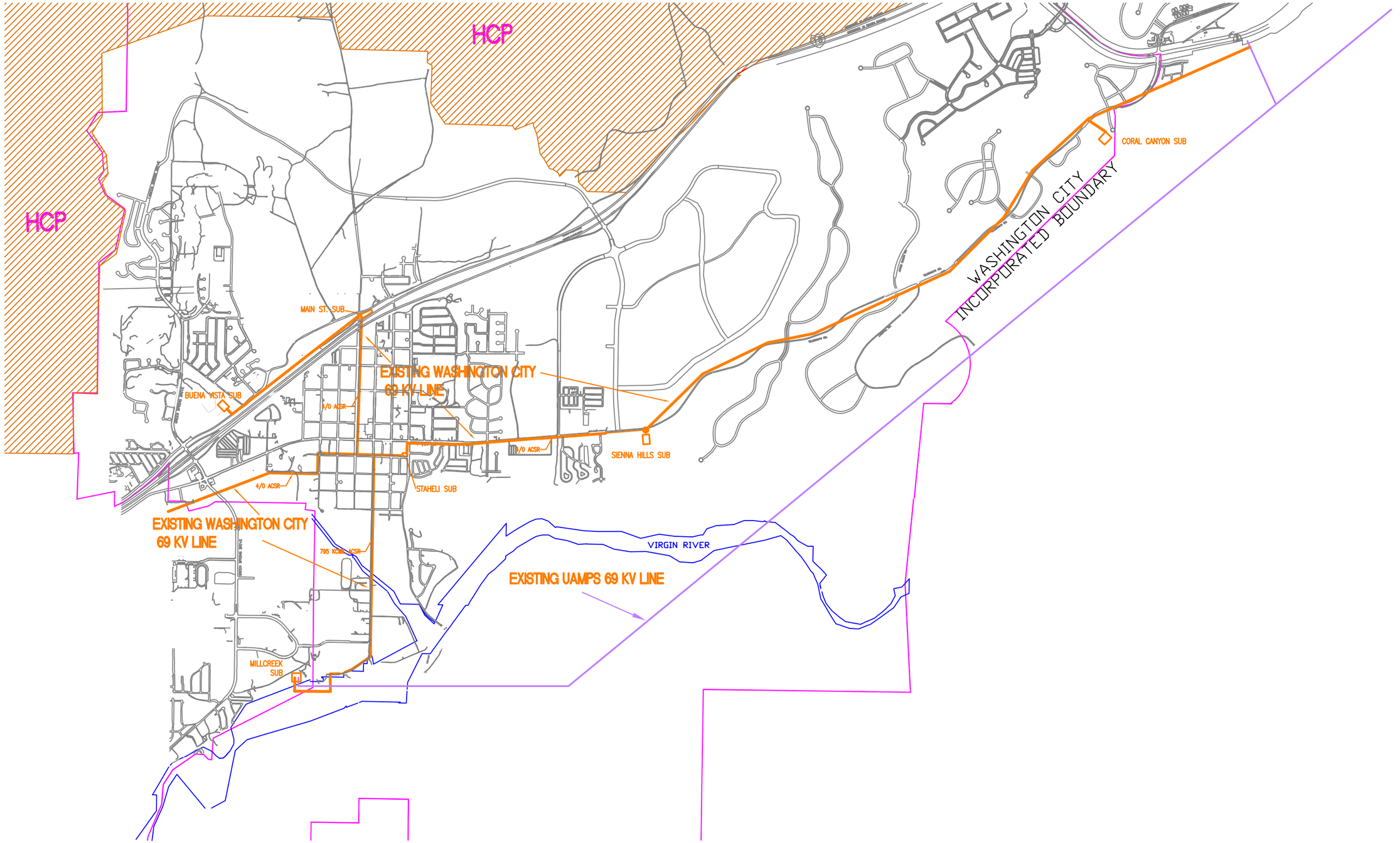
1) After construction of Sienna Hills Substation is completed, transfer 2500 kW from Staheli Bank #1 to Sienna Hills Bank #1.

2010

1) Transfer 3000 kW from Staheli Bank #1 to Sienna Hills Bank #1.

NOTES:

1) This plan has been developed using a standard growth rate of 10% per year for 2007-2012 and 7.5% for 2013-2017.
2) If the rate of growth and electrical usage changes from this rate, this plan will need to be updated accordingly.
3) The attempt has been made to keep bank loading to approximately one-half of the 65 degree rating of the substation transfomer. This will allow load to be tranferred to an adjacent substation or transformer during maintenance of substation equipment or during an emergency situation, without exceeding the design rating of the substation transformer.
4) This plan recognizes that necessary distribution circuits of adequate capacity will have to be built to accommodate proposed load transfers. Appropriate switchgear (VFI's, oil switches, etc.) will need to be included for switching.



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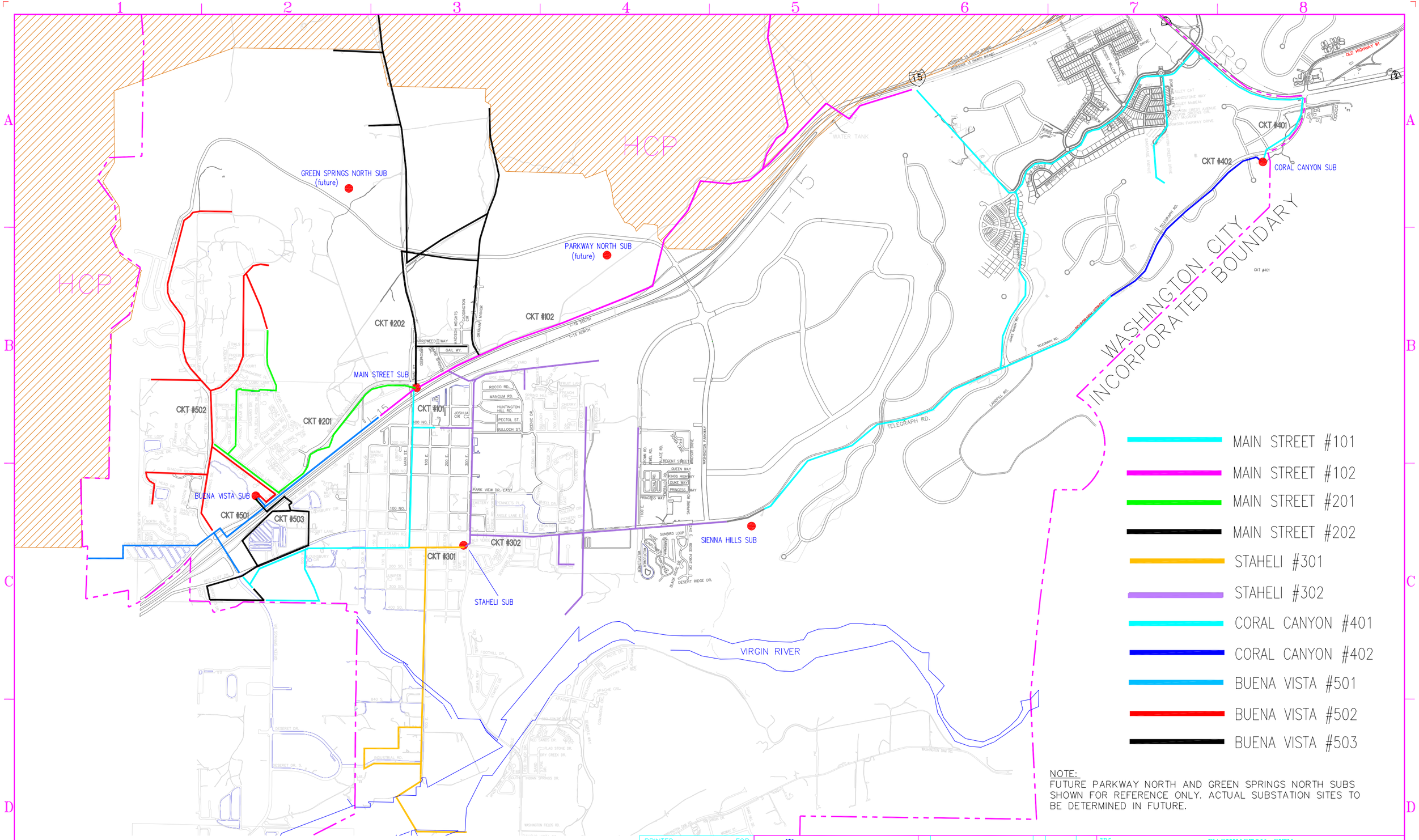
No.	DESCRIPTION	BY	DATE	APPD.

REVISIONS

CONFIDENTIAL

TITLE: WASHINGTON CITY POWER
EXISTING TRANSMISSION LINES (2007)

Drawn By: RKO	Date 7-11-07	ENGR. KCB	Date 7-11-07	DRAWING No.	REVISION
Chk'd. By: KCB	Date 7-12-07	APPD. AJT	Date	MAP #1	B
Project No. 71-047	SCALE NONE				



NOTE:
FUTURE PARKWAY NORTH AND GREEN SPRINGS NORTH SUBS SHOWN FOR REFERENCE ONLY. ACTUAL SUBSTATION SITES TO BE DETERMINED IN FUTURE.

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DATE

- ☐ PRELIMINARY
- ☐ DESIGN DEVELOPMENT
- ☐ BIDDING
- ☐ CONSTRUCTION
- ☐ APPROVAL
- ☐ AS BUILT
- ☐ REVISION

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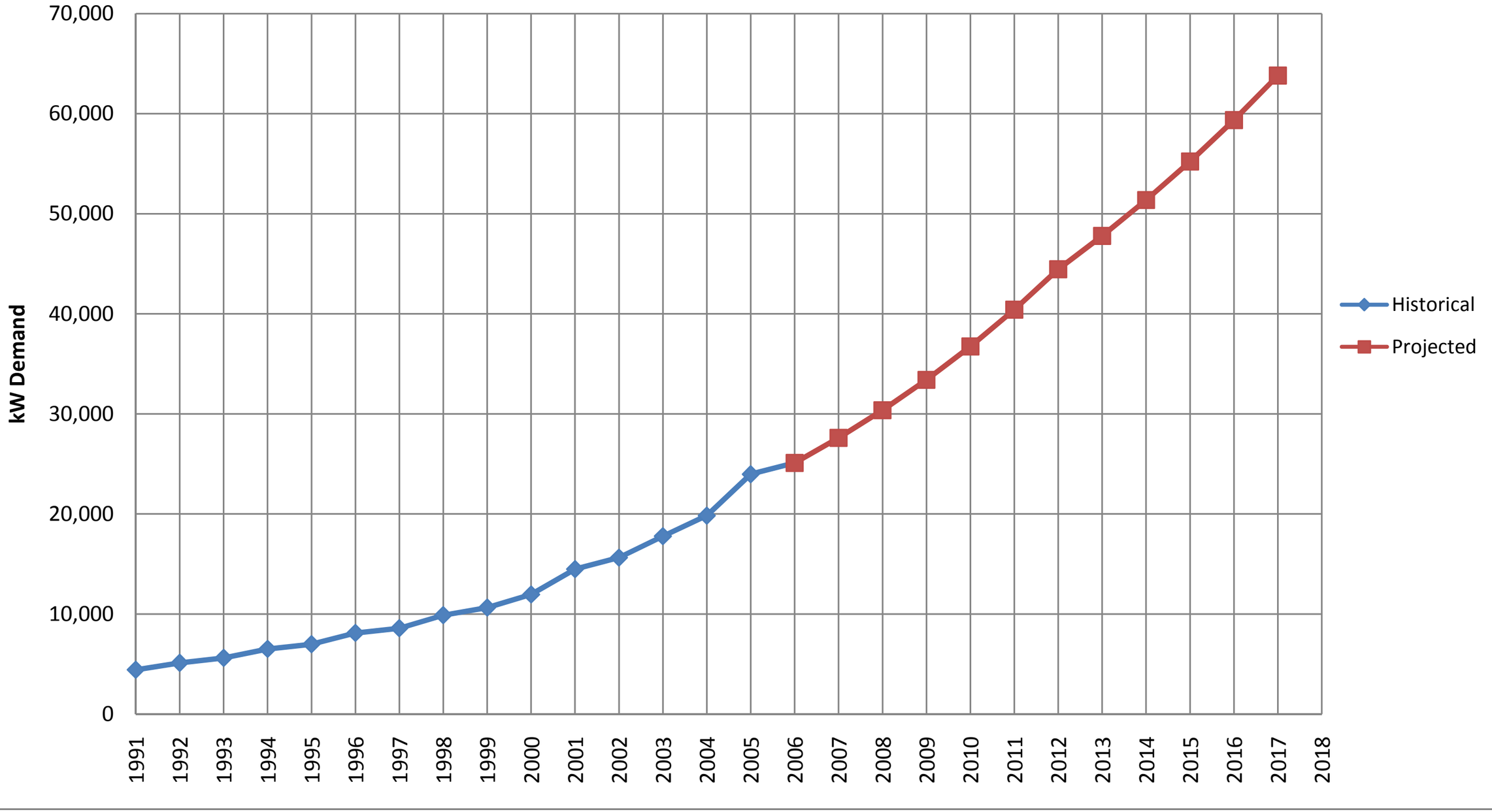
No.	DESCRIPTION	BY	DATE	APPD.
	REVISIONS			

CONFIDENTIAL

TITLE: WASHINGTON CITY
CIRCUIT MAP
2007 EXISTING LINES

Drawn By:	Date 06-11-07	ENGR. KCB	Date 06-13-07	DRAWING No. 2007	REVISION B
Chk'd. By: KCB	Date 06-13-07	APPD. AJT	Date		
Project No. 71-047	SCALE NONE				

GRAPH # 3
Washington City Load Projection



TRANSMISSION EVALUATION

The primary transmission source for Washington City runs from the UAMPS River Substation (138/69 kV) to the Millcreek Substation. Washington City takes metered delivery at 69 kV at this substation and owns the radial feed from Millcreek Substation to Main Street and Staheli Substations. A UAMPS 69 kV line borders Washington City on the east and provides the initial source of power for the Coral Canyon Substation. The radial fed substations are very vulnerable to outage if any abnormal events occur on the 69 kV line between Millcreek Substation and Staheli or Main St. Substations. The Coral Canyon Substation is equally vulnerable to abnormal events on the UAMPS 69 kV line between Millcreek and Coral Canyon Substations. To eliminate this vulnerability, construction of a 69 kV line from the Coral Canyon Substation to the Sienna Hills Substation, to the north side of I-15, to the Main St. Substation, and then to the Green Springs North Substation is recommended. This will create a 69 kV loop between the existing and proposed Washington City substations. With appropriate switching capability at each substation, this loop will allow the City to maintain transmission service to each substation during abnormal operating conditions. These might include line maintenance work or an outage to any segment of the loop. This versatility will enhance the City's ability to operate the electrical system and improve service reliability to all City customers.

Washington does have another existing 69 kV transmission line connection. Before the Millcreek Substation meter point for Washington City was built, Washington City received transmission service from the Skyline to Twin Lakes 69 kV line. In an emergency, this line would be able to support approximately 28 MVA of Washington City load before reaching a thermal overload condition. All of the City's current load could not be supported from this source.

The proposed transmission line construction will be built with 1272 kcmil ACSR at 138 kV or 795 ACSR at 69 kV. At 69,000 volts, the 795 kcmil ACSR wire can supply 80 MVA of power to the City's customers. The 1272 kcmil ACSR wire would be capable of 130 MVA at 69 kV. The implementation of a loop-type transmission system will allow each substation to have an adequate power source for present and future needs. Some of the existing transmission wire is 4/0 AWG ACSR. This wire is limited at a capacity of 28 MVA. In order to provide for the needs of the City, some portions of the 4/0 AWG ACSR conductor may have to be rebuilt with 795 kcmil ACSR.

ICPE is currently working with UAMPS, St. George, Santa Clara, Hurricane, PacifiCorp, and Dixie-Escalante to coordinate Washington County transmission system improvement needs. Capacitors were installed on the transmission system to improve power factor and voltage regulation on the line. As electrical growth continues in the Washington County area, other system improvement projects will be needed to meet electrical power needs. Some of the anticipated projects were identified by a joint system study, conducted by UAMPS and PacifiCorp.

Through these joint system studies it was determined that major system improvements would be necessary on the UAMPS and PacifiCorp systems to support expected loads. The results of the joint studies and recommended system improvements are detailed in two (2) study reports entitled "Southwest Utah – Planning Study" dated May 12, 2003 and (Southwest Utah –Joint Planning Study Report - Part II 138/69 kV Sub Transmission" dated July 08, 2003. In general, the reports indicate that along with system improvements that are necessary on both PacifiCorp and UAMPS primary transmission (345 kV and 138 kV) systems, improvements and system additions are also necessary on UAMPS's 138 kV and 69 kV systems. The addition of a 138/69 kV Substation to be located in the vicinity of the Washington City/Hurricane City boundary will be necessary in the 2010-2012 timeframe. The installation of that substation will necessitate construction of an additional interconnecting 138 kV line.

SUBSTATION EVALUATION

Substations

Washington City receives power delivery from UAMPS through a high voltage metering point in the Millcreek Substation. The billing meter for Washington City is located in this substation. There is a 69 kV circuit breaker on the Washington City 69 kV line within this substation. A 69 kV transmission line, part 795 KCMIL ACSR and part 4/0 AWG ACSR, delivers the power to the City's Staheli, Main Street, and Buena Vista substations. These substations step the voltage from 69 kV to 12.47 kV for distribution delivery. The major equipment ratings and capacities of each substation are listed in Tables 6 and 7. Historical load and forecast load for each substation is listed in Table 2.

Two capacity ratings, normal and maximum are listed for each substation. Normal capacity is used in planning and should match or exceed the forecast substation load. The normal capacity rating is based on the ability to back up loss of a transformer using another transformer within the substation and/or using adjacent substations and distribution lines.

The maximum rating is based on transformer forced air rating at 65° C winding temperature rise. This is the maximum load that should be placed on the substation transformer and should be used only when necessary to back up loss of another transformer or system element.

Good engineering practice requires that the electrical system be able to withstand the loss of a single substation transformer (typically the largest on the system), without leaving any customers out of power. This is most often referred to as the "N-1" condition. The Washington City Power System is currently at the limits of the "N-1" condition. In order to accomplish this, loading of these substation transformers should not exceed the normal capacity of the substation transformer. The remaining capacity is then available to provide power to customers who would otherwise be without power when a substation transformer fails. If any one of the substation transformers in the system fails, the remaining transformers and distribution main feeder lines can continue to serve the entire load. It is critical that adequate ties are created between distribution circuits to allow load transfers from one circuit to another or from one substation to another. These interconnection points on the distribution system are best accomplished with three-phase air break switches for overhead or with pad-mounted three-phase operated switchgear for underground applications.

Growth projections indicate that the new Green Springs North Substation will need to be built during the 2016-2017 time period to relieve loading on the Main Street substation and to provide for the needs of the Buena Vista development as it continues to expand northward. The transmission line to serve this substation would be built from the Main Street 69 kV Substation to the Green Springs North Substation. This is a distance of approximately 1.5 miles.

Load growth projections also dictate that a new substation (Sienna Hills) will be necessary to serve the Mile Post 13 area sometime during the 2007-2008 timeframe. Timing of the installation will be heavily dependent on the type of load that is added by the Mile Post 13 Project. It is anticipated that this substation will be served by extending the 69 kV line built from the UAMPS Purgatory Tap to the Coral Canyon Substation. This is a distance of approximately 3.4 miles. This line segment will be part of the City's 69 kV transmission loop.

Long-range projections indicate a need for the construction of the Parkway North Substation, near the I-15 freeway and on the north end of the new Washington Parkway Boulevard. This substation will be needed to serve customers along the I-15 corridor and to provide load relief to the Main Street and Coral Canyon substations. Distribution circuits need to be built into the area as the load develops. The substation would need to be built when the distribution feeders cannot maintain adequate voltage in the area, when the adjacent substation transformers do not have sufficient capacity to support the load, or when the reliability of the circuit is no longer acceptable.

Note: In cold weather, substation transformers can be temporarily loaded above the maximum rating. ANSI Standard C57.92 provides a guide for loading transformers at various temperatures. The standard indicates that if the average daily temperature is 30° F, a transformer can be loaded to about 120% of nameplate rating with the same life expectancy as if it were loaded to nameplate. If the average daily temperature exceeds 86° F, the transformer loading should be reduced below nameplate rating. Average daily temperature of 86° F is often exceeded in the Washington City area. This demands that the loading on each substation

transformer during the summer peaking time be maintained below the nameplate rating. Recommended summer peak maximum loading guidelines are included in the appendix.

Substation Assessment

The Washington City power system is served by four substations with Staheli Substation in the downtown area, Main Street Substation on the north side of the I-15 Freeway, Buena Vista Substation on the west end, and Coral Canyon on the east end. Transmission service to these substations is provided from the UAMPS Millcreek 69 kV substation. Washington City owns the 69 kV transmission line that connects the City substations to the Millcreek Substation. This 69 kV line is metered at the Millcreek Substation.

The existing Staheli, Main Street, Coral Canyon, and Buena Vista Substations should continue to be used to supply electrical energy within the City boundaries. These substations are well placed to supply power in the areas around them for many years. As the City continues to expand into undeveloped areas, additional substations, transmission lines, and distribution feeder lines will be required. The new electrical facilities will be connected to the system in such a way that they can provide backup support to adjacent circuits and substations. The existing substations should be maintained and expanded as necessary to handle future load growth within the neighborhoods they serve. The Staheli Substation is located to serve the existing downtown area, the general area between the substation and the Virgin River, and to provide backup to the Wal-Mart/Home Depot commercial area. The Coral Canyon Substation provides electrical service to the Coral Canyon Development Area. The Main Street Substation is located to serve existing commercial businesses and new developments along I-15. The new Buena Vista Substation has been built to deliver power to the Buena Vista residential area and to the expanding commercial area on the west side of Washington City.
The recommendation of the work plan is that existing substations be maintained and expanded as necessary to handle future Washington City loads. Substation additions proposed to meet forecast load are described in the following sections of the work plan. These plans may be easily adapted if conditions change in the City, such as construction of a new transmission line or development of a new heavy load center.

Staheli Substation

Staheli Substation consists of one 69/12.5 kV, 10/12.5 MVA transformer. It currently serves two distribution circuits. The Coral Canyon Substation can be utilized to manage some of the projected load increases, with the Sienna Hills Substation serving the remainder of the load growth. This substation provides load relief and backup to the Main Street Substation and to the Coral Canyon Substation.

Projected loading indicates the need to replace the 10/12.5 MVA transformer with a 12/16/20 MVA transformer, or install a second transformer in the substation to share the area load. This would require a second substation bay to be constructed within the existing substation property boundaries. The existing substation site is such that the addition of a second transformer is possible. The timetable for this installation is dependent on the load growth experienced during the next 5-8 years. Current projections suggest that this project would need to be built during the years 2011-2012. (See Proposed Projects and Proposed Projects Map Exhibit for additional information).

Note: The existing transformer was rebuilt in the 1970's and has aluminum windings. There is some concern about how reliable it may be. As the electrical load increases, the internal winding temperature will climb higher than it has been in the past. ICPE recommends that the loading on this transformer be limited to roughly 80% of its nameplate rating to avoid the possibility of damaging the internal components of this transformer. This will avoid the heating and its effects that is associated with loading the transformer to a higher kVA.

Main Street Substation

The Main Street Substation consists of two-69/12.47 kV, 10/12.5 MVA transformers, with a combined rating of 20/25 MVA. Three single-phase substation regulators are connected to each transformer bank to provide voltage regulation on each transformer bus. Each transformer has two circuits in service. This substation provides load relief and backup

to the existing Staheli, Buena Vista, and the future Green Springs North substations. As the load grows, these transformers may need to be upgraded to 12/16/20 MVA units. The timing for the transformer upgrade is beyond the timeframe of this study. The addition of a third transformer at this location is not possible due to space limitations. [See Proposed Projects in Table 10 and Proposed Projects Map in the Appendix for additional information].

Coral Canyon Substation

Residential and commercial developments in the Coral Canyon Development, loads along the I-15 Freeway and growth south of Telegraph Road are served from this substation. This substation provides relief and backup for the Main Street and Staheli Substation transformers and distribution circuits. One circuit serves the Coral Canyon development and provides backup to the city eastside loads served by the Staheli Substation. The other circuit serves north to the I-15 Freeway interchange area. Hurricane City is serving the southeast quadrant of the interchange, while Washington City will be serving the other three quadrants. The northwest and northeast quadrants are currently inside of the HCP (Tortoise Habitat). This may slow the development of new loads within these two quadrants. The load growth around this interchange and on adjacent properties requires the support of a main feeder. A third circuit is anticipated when the area south of Telegraph Road begins to develop.

Buena Vista Substation

Residential and commercial developments in the Buena Vista area, loads developing on the northern end of Main Street, and the need for load relief for the Main Street Substation forced the construction of a new substation named Buena Vista Substation. This substation provides voltage relief in the Buena Vista area and to the commercial district on the south side of the I-15 corridor.

New Sienna Hills Substation

The Sienna Hills Substation is to be located on the south side of Telegraph Road, near the intersection with Washington Parkway Boulevard. Load growth on the east side of the downtown area, new residential and commercial growth south and northwest of Telegraph Road require that this substation be built before the summer peak of 2008. This substation will provide load relief and backup support to the Coral Canyon and Staheli Substations. Initially, three distribution circuits will be installed. They will connect to existing circuits to the east, to the west, and provide a new feeder into the area east of the Washington Parkway Boulevard. The Mile Post 13 development includes low, medium and high-density residential areas, as well as multiple commercial, retail, and light industrial areas.

TABLE 5
WASHINGTON CITY SUBSTATION EQUIPMENT RATINGS

SUBSTATION	TRANSFORMER	REGULATOR	RECLOSERS
Staheli Sub Bank #1	10/12.5 MVA @55°C (OA/FA) 14.4 MVA @ 65°C (OA/FA) 43800 X 67000 –12470Y/7200 X 24940Y /14400 volts	3-509 kVA (15.3 MVA)	**Ckt #301:** Cooper WE w/ 4C control 560 Amp Rating **Ckt #302:** Cooper WE w/ 4C control 560 Amp Rating
Main Street Bank #1	10/12.5 MVA @55°C(OA/FA) 14.4 MVA @ 65°C (OA/FA) 67000 – 12470Y/7200 volts	3-509 kVA (15.3 MVA)	**Ckt #101:** Cooper VWE w/ 4C control 800 Amp Rating **Ckt #102:** Cooper VWE w/ 4C control 800 Amp Rating
Main Street Bank #2	10/12.5 MVA @55°C (OA/FA) 14.4 MVA @ 65°C (OA/FA) 67000 – 12470Y/7200 volts	3-509 kVA (15.3 MVA)	**Ckt #201:** Cooper VWE w/ 4C control 800 Amp Rating **Ckt #202:** Cooper VWE w/ 4C control 800 Amp Rating
Coral Canyon Bank #1	12/16/20 MVA @55°C (OA/FA/FA) 22.4 MVA @ 65°C (OA/FA/FA) 67000 – 12470Y/7200 volts	3-887 kVA (26.6 MVA)	**Ckt #401:** G&W Solid Dielectric Sw. 800 Amp continuous **Ckt #402:** G&W Solid Dielectric Sw. 800 Amp continuous **Ckt: #403:** G&W Solid Dielectric Sw. 800 Amp continuous
Buena Vista Bank #1	12/16/20 MVA @55°C (OA/FA/FA) 22.4 MVA @ 65°C (OA/FA/FA) 67000 – 12470Y/7200 volts	3-887 kVA (26.6 MVA)	**Ckt #501:** G&W Solid Dielectric Sw. 800 Amp continuous **Ckt #502:** G&W Solid Dielectric Sw. 800 Amp continuous **Ckt: #503:** G&W Solid Dielectric Sw. 800 Amp continuous

TABLE 6
SUBSTATION CAPACITY

				CAPACITY OF CIRCUITS LEAVING THE SUBSTATION (AMPS)		
	TOTAL CAPACITY (MVA)[1]					
SUBSTATION	NORMAL	MAXIMUM	LIMITING ELEMENT	CIRCUIT	CONDUCTOR	MAXIMUM[2] AMPS
STAHELI BANK #1	10	14.4 @ 65°C OA/FA Regulators: 15.3 MVA @ 65°C	Transformer-- Alum. Wndgs. or regulators			
				#301	4/0 ACSR	340
				#302	4/0 ACSR	340
MAIN STREET BANK #1 (South Unit)	10	14.4 @ 65°C OA/FA Regulators: 15.3 MVA @ 65°C	Transformer or regulators			
				#101	477 ACSR	670
				#102	4/0 AL CN 15	248
MAIN STREET BANK #2 (North Unit)	10	14.4 @ 65°C OA/FA Regulators: 15.3 MVA @ 65°C	Transformer or regulators			
				#201	750 AL CN 15	497
				#202	750 AL CN 15	497
CORAL CANYON BANK #1	12	22.4 @ 65°C OA/FA/FA Regulators: 26.6 MVA @ 55°C	Transformer			
				#401	750 AL CN 15	497
				#402	750 AL CN 15	497
				#403	750 AL CN 15	497
BUENA VISTA BANK #1	12	22.4 @ 65°C OA/FA/FA Regulators: 26.6 MVA @ 55°C	Transformer			
				#501	750 AL CN 15	497
				#502	750 AL CN 15	497
				#503	750 AL CN 15	497

NOTES:

(1) Normal capacity of the substation should be exceeded only temporarily for emergencies or maintenance. The normal rating is based on the ability to backup loss of a transformer using another transformer within the substation or using adjacent substations and lines. The maximum capacity is based on transformer forced air rating at 65^{o} C rise. This is the maximum load that should be placed on the substation transformer and should be used only when necessary to backup loss of another transformer or system element. In cold weather, maximum rating can be increased in accordance with ANSI Standard C57.92. For example, if average daily temperature is 30^{o} F, the transformer can be loaded to about 120% of the nameplate rating. However, if the average daily temperature is over 100^{o} F, the loading of the transformer should be at or less than the nameplate rating for a 65^{o} C rise above ambient.

(2) Ampacity ratings for overhead lines given are for extreme summer conditions (100^{o} F). Underground cable ampacity ratings given are for earth at 68^{o} F. Conservative loading of underground three phase circuits is recommended where single cables are run in metallic conduits. Circuit MVA ratings assume 10% imbalance of phase currents.

DISTRIBUTION EVALUATION

Distribution: General Recommendations

The existing electrical distribution system will not support future projected loads. New main feeder distribution circuits will be needed to supply power to new customers. General recommendations to be followed as these new feeders are built are listed herein. Following these guidelines will make the operation and maintenance of the expanding system more manageable and cost less to operate.

Distribution lines are used to deliver power from substations to customers throughout the City. Safe, reliable, electrical service is dependent on these lines. To maintain quality service requires engineering, planning, quality construction, and regular maintenance. This work plan will provide input to the planning process. During this period of rapid growth, the City should continue to work closely with engineering. Decisions made now will affect utility operations for many years. Construction depends on trained and experienced line crews, who are well-supported and well-equipped, and with good material and construction specifications. Maintenance requires a commitment in labor and materials to keep facilities in good operating order. All of these measures require funding. However, neglecting or delaying these actions carries a penalty of a less reliable power system, and higher operational and maintenance costs.

Emergency loading capacities of three-phase distribution lines are listed in Table 8. Overhead line ampacities are given for conductors in 77° F in air. These ratings must be reduced when the temperature is above 77° F. Summer ratings for air at 100° F are listed for 477 ACSR and 4/0 ACSR. The table refers to overload ampacities only. Capacity to supply power over specific lines in the City may be restricted by voltage drop or other constraints.

A planning rating is listed in the table for each conductor type. This rating is based on a load level of about 50% of line capacity. The planning rating is recommended as a general guide to maximum line loading for normal conditions. Limiting load to the planning rating has the following benefits: line loss is reduced significantly since loss increases by the square of the current, capacity is available in the line for backing up load or for other contingencies, voltage drop is reduced and is more likely to remain at acceptable levels under a range of conditions, and capacity is available in the line for unanticipated new load.

The planning rating should not be considered as a strict limitation on loading a line. Where line sections are short, losses or voltage drop may not be a significant factor, even at heavy load. On the other hand, where lines are long, voltage drop may be excessive when loaded to the planning rating. More detailed analysis is recommended for these lines.

Recommended general guidelines for new distribution line construction are:

- Use a minimum of 477 kcmil ACSR (overhead) or 750 kcmil Aluminum underground cable for all distribution feeders leaving a substation, for all main feeders supplying heavy load centers, and for feeders in which extra capacity is needed to back up or provide an alternate source for another main feeder. A network of "main feeders" should be developed between substations to allow for needed load transfers between substations.

- Use a minimum of # 4/0 ACSR (overhead) or #4/0 Aluminum underground cable for all three-phase main feeders within the City. If lines extend more than 2 miles or are expected to supply loads in excess of 2000 kW, consult engineering.

- Use a minimum of # 1/0 ACSR (overhead) or #1/0 Aluminum underground cable for all distribution system tap lines and branch segments.

- Use at least two underground cable entries to serve multiple lot subdivisions. Interconnect the cables using pad-mounted switchgear within the subdivision.

The work plan recommends that switches be installed throughout the distribution system to interconnect main three-phase feeders. The switches that interconnect main trunk lines will improve reliability and reduce costs. The ability to quickly restore service to customers when outages occur will be improved by this action. Line sections can be taken out of service or bypassed for maintenance or construction. This will reduce customer outage time and reduce construction costs. Switches should be installed where main trunks from the same or different feeders intersect. Load-break switches, overhead or pad-mounted, should be used where frequent switching is anticipated or where paralleling is required. Taps from the main trunk lines should use over-current protective devices such as fuses and/or Vacuum Fault Interrupters (VFI's) to minimize the area affected by a system fault.

Distribution Evaluation: Staheli Substation

Load flow analysis was done on each circuit previously. This was based on the information provided to ICPE by Washington City. All feeders deliver good quality voltage when supplying existing power levels and with the system switched for normal operation. Circuit #301 supplies power to the west and to the south from the substation location. Circuit #302 provides power to eastern part of the downtown area.

Distribution Evaluation: Main Street Substation

The south transformer bank serves two distribution circuits. Circuit #101 has traditionally served the load on Main Street and much of the City's central and west area. The 477 ACSR conductor makes this feeder an effective backup to the Staheli Substation. Load can be transferred between substations without worry of overloading the conductor.

The north transformer bank has two distribution circuits. Circuit #201 currently serves the loads located to the north, east, along the northern side of the I-15 Freeway. It has some very long lines that serve City wells and water storage tanks. The underground feeder is 750 kcmil Aluminum Concentric Neutral cable. It parallels the Freeway, going east from the substation. The 750 kcmil Aluminum cable terminates in pad-mounted switchgear, where it transitions to overhead construction with 1/0 ACSR conductor. It can provide some limited backup capacity to the Coral Canyon service area. The 750 kcmil Aluminum conductor runs approximately one-fourth of the distance from the Main Street Substation to the new Mile Post 13 interchange. This feeder is not heavily loaded, but a careful watch will be needed to avoid low voltage conditions at its extremities as new load develops along the Freeway frontage road. Circuit #202 leaves the substation underground to the north. There is a planned circuit tie with a circuit from the Green Springs North Substation, when it is built. This circuit is 750 kcmil Aluminum conductor and serves the area developing north of the Main Street Substation.

Distribution Evaluation: Coral Canyon Substation

The load in the Coral Canyon Development is increasing as the remaining undeveloped areas are under construction or will be in the near future. Additional load from this expansion and the established load in the surrounding area are served from the Coral Canyon Substation. The substation site is adjacent to the Washington City Water Treatment Plant, on the south side of Telegraph Road. It has two 12.5 kV distribution circuits, served by a 67,000-12470Y/7200 volt 12/16/20 MVA substation transformer. One circuit connects to the existing 750 Aluminum Concentric Neutral circuit that loops through the developed part of the Coral Canyon area. The second circuit is installed along Telegraph Road to serve the loads on the north side of Telegraph Road, west of the new substation. The planned third circuit will serve the loads located on the south side of Telegraph Road between the Coral Canyon Substation and Washington Parkway Boulevard. This circuit will not be installed until the areas on the south side of Telegraph Road begin construction.

Distribution Evaluation: Buena Vista Substation

Residential and commercial developments in the Buena Vista area, loads developing on the northern end of Main Street, and the need for load relief for the Main Street Substation forced the construction of a new substation named Buena Vista Substation. This substation provides voltage relief in the Buena Vista area. There are three circuits leaving this substation. One serves northward, another serves to the west, and the third supplies power to the Commercial area south of the I-15 Freeway.

Distribution Evaluation: New Sienna Hills Substation

The new Sienna Hills Substation is planned to be on the south side of Telegraph Road, near the Washington Parkway Boulevard. The substation will have provisions for one transformer bay and for three distribution feeders. A 67,000-12,470Y/7200 volt, 12/16/20 MVA substation transformer will be installed. This transformer will serve three distribution circuits. One circuit will serve the area north of the substation (part of the Mile Post 13 project area). The second will serve load on the north side of Telegraph Road and east of the substation. The third circuit will serve load west of the substation. Each of these circuits will provide power to new customers, as well as providing reliability backup connections to the Coral Canyon Substation, the Staheli Substation, and the future Parkway North Substation.

Distribution Evaluation: *Parkway North Substation (Future)*

The Parkway North Substation is planned to be located on the north side of the I-15 Freeway and a little west of the Mile Post 13 Interchange. This substation will be built with one substation transformer (67,000-12,470Y/7200 volts and 12/16/20 MVA) and three distribution circuits. The need for construction of this substation will be determined by the commercial and retail businesses that are built near the interchange. The circuits from this substation are planned to serve (generally) to the north, to the east, and to the south from the substation site. This substation will provide power service to new customers and reliability backup connections with the Coral Canyon Substation, Sienna Hills Substation, Main Street Substation, and the Green Springs North Substation. As the development plans are reviewed and approved for the area on the north side of the freeway at the Mile Post 13 interchange, the City should obtain a site for this substation.

Distribution Evaluation: Green Springs North Substation (Future)

The new Green Springs North Substation is planned to be located approximately one mile north and one-quarter mile west of the Main Street Substation. The City owns property in this area and would like to use a portion of it for this substation. This substation will have one transformer (67,000-12,470Y/7200 volts and 12/16/20 MVA) with three distribution circuits. The three circuits will serve load to the east, west, and south from the substation location. The Buena Vista area is in severe need of support from another source. It is currently fed from the Buena Vista Substation. The circuit to be built to the west is planned to interconnect with the Main St. #102 circuit. This will allow new and existing load to be served without low voltage difficulties. It will also provide a means of reliable backup service between the Green Springs North Substation and the Main Street Substation. The east circuit will serve new customers to the east of the substation and will serve the existing rural load on what is now the Main St. #201 circuit. The south circuit is planned to serve new and existing customers along the extension of Main Street as it expands north from the Freeway. The east circuit is planned to interconnect with the Main St. #202 circuit. This connection will allow load management and provide reliability backup service between the Green Springs North Substation, the Main St. Substation, the Buena Vista Substation, and eventually the Parkway North Substation.

Distribution: Long Term Plans

Long-term distribution plans are intended as a guide to be followed as service is provided for new customers. Most new construction can be delayed until forecasts are certain. However, duplication and waste can be avoided if conformance to the City's master plan is verified before line improvements or extensions are made. The long-term plans are speculative and should be adapted as circumstances change, such as the location of electrical load and routing of streets. The City should use the long-term plans as a guide to assure proper Right-of-Ways are obtained as each development is approved. Another benefit of following the long-term plan is to assure that feeder cables installed will be properly sized to meet the future needs of the area. This will minimize the need to upgrade these cables in the future. Having adequate right-of-ways secured in advance will streamline the construction process for the City Power Department.

Prospective locations for main distribution feeders in Washington City are shown on the Long-term Planning Map. The map also shows existing main feeders, existing interconnection points, and proposed interconnection points between feeders. New feeder routes will need to be selected to supply load in the east and northeast part of the City. As these areas develop, heavy backbone feeders need to be extended along major streets. Main feeders from each substation should intersect to form a looped system. This will permit load to be transferred between substations, and will establish alternate sources of power during outages or for maintenance work.

TABLE 7

DISTRIBUTION LINE CAPACITY RATINGS[1]
THREE PHASE 12.47 kV SERVICE

LINE CONDUCTOR	OVERHEAD LINES[2] (AMPS or MVA)	UNDERGROUND LINES[2]		SUMMER RATING[3] (MVA)	PLANNING RATING[4] (MVA)
		3 Conductors in 1 Duct	3 Conductors in 3 PVC Ducts		
1000 AL CN Cable		574 or 12.3	707 or 15.2	11.0	6.0
750 AL CN Cable		497 or 10.7	601 or 12.9	9.8	5.0
500 AL CN Cable		400 or 8.6	472 or 10.1	8.0	4.0
4/0 AL CN Cable		230 or 5.0	268 or 5.8	4.6	2.5
477 ACSR	670 or 14.4			12.0	7.0
4/0 ACSR	340 or 7.3			6.0	3.5
1/0 ACSR	230 or 4.9			4.0	2.5
2 ACSR	180 or 3.8			3.1	2.0
2/0 Copper	360 or 7.7			6.3	3.5
6 Copper	120 or 2.5			2.0	1.5

NOTES:

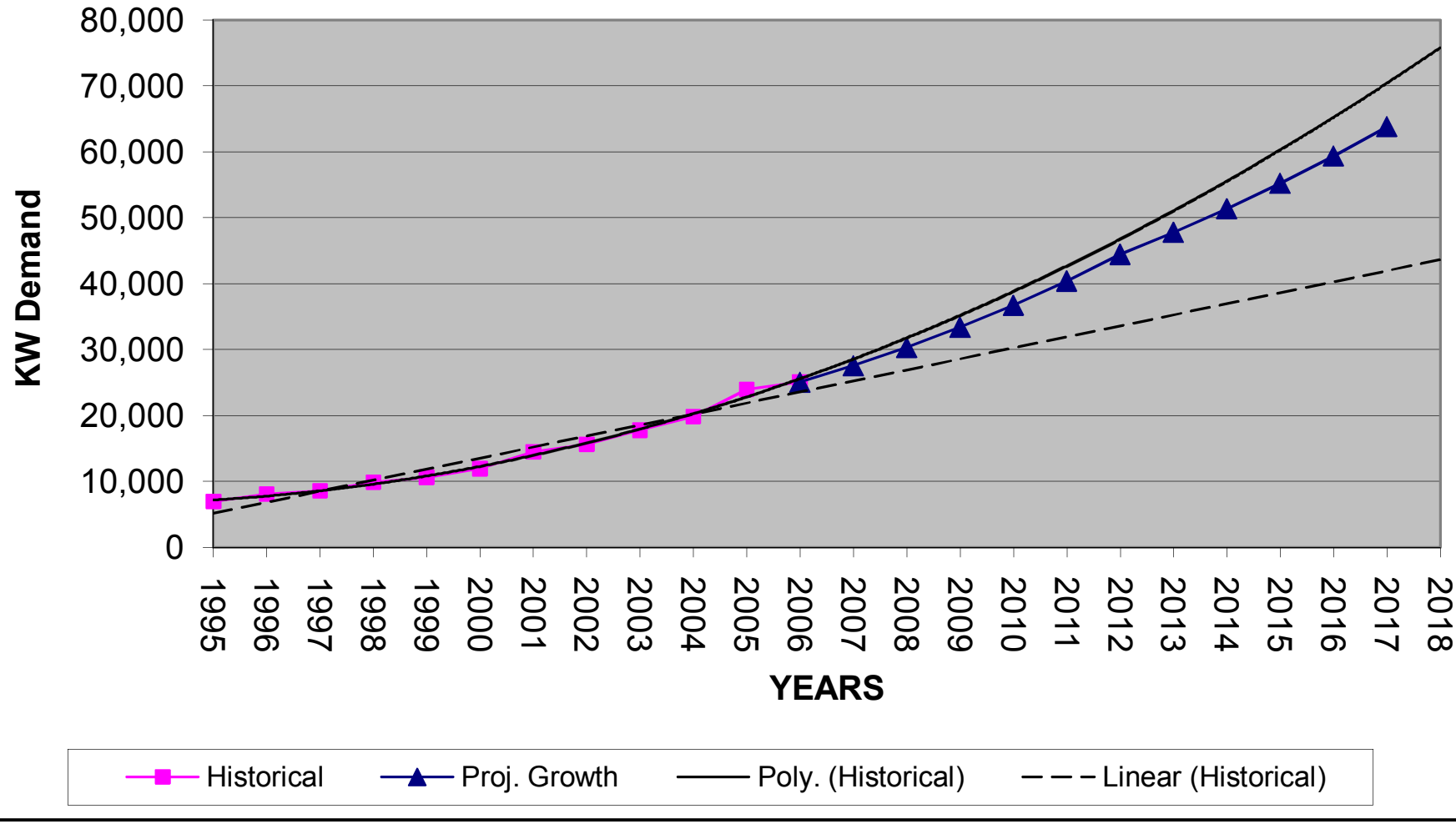
(1) Thermal overload ratings are listed. Capacity to supply power over specific lines in the City may be restricted by voltage drop or other constraints.

(2) Ampacities for underground cable: 194°F conductor, 68°F earth, 75% load factor. From Okonite Engineering data book. Ampacities for overhead conductor: 77°F air, 167°F conductor, wind 1.4 mph.

(3) Summer rating for overhead conductor: 100°F air, 176°F conductor. Wind 1.4 mph. Underground conductor: 3 cables in single direct-buried conduit, 194°F conductor, 68°F earth, 75% load factor.

(4) Planning rating is established at approximately 50% loading.

GRAPH 4
Washington City Demand Vs. Trends



GRAPH 5
Washington City Power Factor History
(Measured at Millcreek Meter Point)

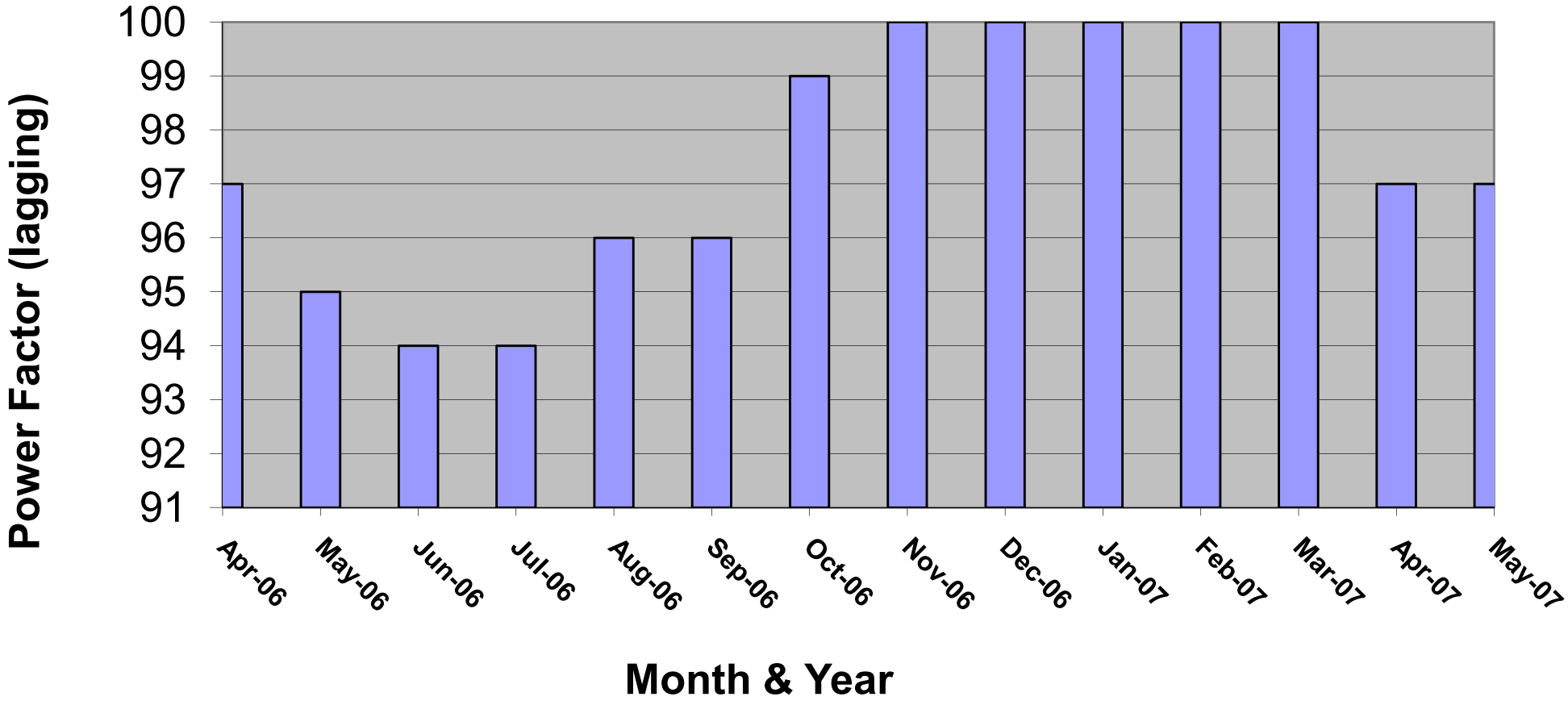


TABLE 8

Washington City
Historical Demand vs. Growth

PEAK KW		
Year	**Historical**	**Projected**
1995	6,984	
1996	8,112	
1997	8,590	
1998	9,883	
1999	10,646	
2000	11,956	
2001	14,490	
2002	15,638	
2003	17,782	
2004	19,840	
2005	23,971	
2006	25,093	25,093
2007		27,602
2008		30,363
2009		33,399
2010		36,739
2011		40,413
2012		44,454
2013		47,788
2014		51,372
2015		55,225
2016		59,367
2017		63,819

TABLE 9

WASHINGTON CITY AREA

Fully Developed Load Projection with HCP restrictions

Section	Dimensions	Total Sq.Ft	Acres in Section	Useable Acres within City *	Estimated Developed Portion	Estimated Undeveloped Portion *	Existing Load	Add'l Expected Load	Expected Total
23	5280' X 5280'	27,878,400	640	384	115	269	1,120	3,228	4,348
24	5280' X 5280'	27,878,400	640	32	0	32	0	384	384
19	5706' X 5280'	30,127,680	692	173	0	173	0	2,076	2,076
18	5706' X 5280'	30,127,680	692	415	0	415	0	4,980	4,980
17	5280' X 5280'	27,878,400	640	64	0	64	0	768	768
8	5280' X 5280'	27,878,400	640	320	16	304	156	3,648	3,804
7	5743' X 4984'	28,623,112	657	329	0	329	0	3,948	3,948
6	5187' X 5280'	27,387,360	629	126	0	126 + HCP	0	1,512	1,512
5	5280' X 5558'	29,346,240	674	404	303	101 + HCP	2,951	1,212	4,163
31	5280' X 5743'	30,323,040	696	0	0	HCP	0	0	0
32	5280' X 5280'	27,878,400	640	0	0	HCP	0	0	0
1	5280' X 5280'	27,878,400	640	0	0	HCP	0	0	0
2	5410' X 5558'	30,038,780	690	173	0	173 + HCP	0	2,076	2,076
3	5336' X 5410'	28,867,760	663	265	0	265 + HCP	0	3,180	3,180
34	5280' X 5280'	27,878,400	640	0	0	HCP	0	0	0
35	5280' X 5280'	27,878,400	640	0	0	HCP	0	0	0
36	5280' X 5280'	27,878,400	640	0	0	HCP	0	0	0
9	5280' X 5280'	27,878,400	640	64	10	54	97	648	745
10	5280' X 5280'	27,878,400	640	576	288	288	2,805	3,456	6,261
11	5280' X 5280'	27,878,400	640	544	54	490	526	5,880	6,406
12	5248' X 5302'	27,824,896	639	383	0	383	0	4,596	4,596
13	5280' X 5373'	28,369,440	651	553	184	369	1,792	4,428	6,220
14	5280' X 5373'	28,369,440	651	586	527	59	5,133	708	5,841
15	5280' X 5373'	28,369,440	651	586	527	59	5,133	708	5,841
16	5280' X 5280'	27,878,400	640	128	13	115	127	1,380	1,507
	TOTALS:	710,194,068 square feet	16,304 acres	6,105 acres * (HCP acres not incl.)	2037 acres	4,068 acres * (HCP acres not incl.)	19,840 kW Demand **(2004 Peak)**	48,816 kW Demand	68,656 kW Demand

TABLE 9 (continued)

NOTE: Overall Average: **11.25 kW /Ac.**

1) 19,840 kW /2037 acres = **9.74 kW/Acre for existing load**
   (a) Low kW per acre may be a result of the cooler weather during the summer of 2004.
   (b) A lower than expected load peak may be caused in part by electric customers who migrate to cooler areas during the summer heat.
   (c) Developed areas may not be fully occupied at the present time.

2) Additional Expected Load calculated at 12 kW per Acre, based on Coral Canyon and Mile Post 13 developments.

3) Application of a general power factor of 90% results in a total expected load of **76,284 kVA.**

4) This load projection only includes the portion of Washington City located north of the Virgin River.

SYSTEM IMPROVEMENT SUMMARY

The following Project Summary details the anticipated projects and expenditures necessary to sustain the projected growth rate for Washington City's electrical system for the next 5 years. There is greater confidence in projecting requirements for 2 to 3 years than there is for a 5-year outlook. However it is necessary to forecast future projects due to the magnitude (and cost) of the modifications necessary should the annual rate of growth established during the last 6 years continue as projected. Substation, distribution, and transmission line requirements need to be addressed to meet future needs of the City in a timely fashion.

The proposed projects will provide a method for Washington City to plan and budget for the facilities necessary to serve the anticipated electrical load growth.

The projects were developed based on the following parameters:

1. Existing Washington City Substations would be served at 69 kV and the proposed new substations would be served at 69kV by a new transmission line to be built from the UAMPS Purgatory Tap to the Coral Canyon Substation, to the Sienna Hills Substation, to the Parkway North Substation site (future), to the Main St. Substation, and finally to the Green Springs North Substation (future). The connection to the UAMPS Purgatory Tap, coupled with the new transmission line to the Main Street Substation, will create a 69 kV loop within the City electrical system. Installation of switches at each substation tap point will allow line segments within the loop to be de-energized for maintenance and repair. This arrangement also provides a significant improvement over the radial 69kV system currently in operation.
2. To minimize expenditures and the capital procurement of new equipment existing substation transformers and equipment would be utilized as long as possible.
3. Backup capacity would have to be built into the distribution system for load transfers between substations in order to defer purchasing additional substation transformers, which would only be required for N–1 contingency.

TABLE 10

Washington City Workstudy Estimates

Substation, Transmission and Distribution Projects

All Estimates Are In 2007 Dollars

Item and Description	Item Cost	Total For Year	Prior Years	Running Total
2007				
2007 Total Estimate	**$0**	**$0**	**$0**	**$0**
2008				
1. Construct 69 kV line with underbuild from 1100 E Telegraph Rd. to Main St. Substation.	949,000	**Increase of estimate used in 2005** 949,000		
2008 Total Estimate	**$949,000**	**$949,000**	**$0**	**$949,000**
2009				
2009 Total Estimate	**$0**	**$0**	**$949,000**	**$949,000**
2010				
2010 Total Estimate	**$0**	**$0**	**$949,000**	**$949,000**
2011				
2011 Total Estimate	**$0**	**$0**	**$949,000**	**$949,000**
2012				
2012 Total Estimate	**$0**	**$0**	**$949,000**	**$949,000**

Assumptions:

1-Basis is Washington City Electrical Load Growth Projection
2-Actual timing will vary depending on system load growth type and timeframe.
3-Cost estimates do not include Right-of-Way acquisition expense.
4-Cost estimates are based on per unit budgetary values only.
No design or engineering work has been done to create these estimates.
5-Substation estimates do not include property purchase.

APPENDIX

TABLE OF CONTENTS

WASHINGTON CITY

SUBSTATION LOAD FORECAST

Present System -- 10% growth per year 2007-2012 and 7.5% growth per year 2013-2017

No Mitigation Adjustments

	YEAR														Transformer
	KW-Demand														Base Rating
Substation	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Staheli															
Bank #1	6,761	8,168	7,172	7,889	8,678	9,546	10,501	11,551	12,706	13,659	14,683	15,784	16,968	18,241	10,000 kVA
Main Street															
Bank #1	7,519	9,086	6,681	7,349	8,084	8,892	9,782	10,760	11,836	12,723	13,678	14,704	15,806	16,992	10,000 kVA
Bank #2	5,560	6,717	2,451	2,696	2,966	3,262	3,589	3,947	4,342	4,668	5,018	5,394	5,799	6,234	10,000 kVA
Coral Canyon															
Bank #1	0	0	4,050	4,455	4,901	5,391	5,930	6,523	7,175	7,713	8,291	8,913	9,582	10,300	12,000 kVA
Buena Vista															
Bank #1	0	0	4,739	5,213	5,734	6,308	6,938	7,632	8,395	9,025	9,702	10,430	11,212	12,053	12,000 kVA
Sienna Hills															
Bank #1															
Green Springs No.															
Bank #1															
Total	19,840	23,971	25,093	27,602	30,363	33,399	36,739	40,413	44,454	47,788	51,372	55,225	59,367	63,819	54,000 kVA

WASHINGTON CITY

SUBSTATION LOAD FORECAST

Proposed Plan -- 10% growth per year 2007-2012 and

7.5% growth per year 2013-2017 with mitigation adjustments (Rev. 7/26/07)

	YEAR														Transformer
	History	History	History	kW-Demand											Base Rating
Substation	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Staheli															
Bank #1	6,761	8,168	7,172	7,889	6,179	6,797	4,476	4,924	5,416	5,822	6,259	6,728	7,233	7,775	10,000 kVA
Main Street															
Bank #1	7,519	9,086	6,681	5,099	5,609	6,170	6,787	7,465	8,212	8,828	9,490	10,202	10,967	11,789	10,000 kVA
Bank #2	5,560	6,717	2,451	4,946	5,441	5,985	6,583	7,241	7,966	8,563	9,205	9,896	10,638	11,436	10,000 kVA
Coral Canyon															
Bank #1	0	0	4,050	4,455	4,901	5,390	5,929	6,522	7,174	7,712	8,291	8,912	9,581	10,299	12,000 kVA
Buena Vista															
Bank #1	0	0	4,739	5,213	5,734	6,308	6,938	7,632	8,395	9,025	9,701	10,429	11,211	12,053	12,000 kVA
Sienna Hills															
Bank #1	0	0	0	0	2,500	2,750	6,026	6,629	7,291	7,838	8,426	9,058	9,738	10,466	12,000 kVA
Green Springs No.															
Bank #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	19,840	23,971	25,093	27,602	30,363	33,399	36,739	40,413	44,454	47,788	51,372	55,225	59,367	63,819	66,000 kVA

2007

1) Transfer 2250 kW from Main St. Bank #1 to Main St. Bank #2.

2008

1) After construction of Sienna Hills Substation is completed, transfer 2500 kW from Staheli Bank #1 to Sienna Hills Bank #1.

2010

1) Transfer 3000 kW from Staheli Bank #1 to Sienna Hills Bank #1.

NOTES:

1) This plan has been developed using a standard growth rate of 10% per year for 2007-2012 and 7.5% for 2013-2017.
2) If the rate of growth and electrical usage changes from this rate, this plan will need to be updated accordingly.
3) The attempt has been made to keep bank loading to approximately one-half of the 65 degree rating of the substation transfomer. This will allow load to be tranferred to an adjacent substation or transformer during maintenance of substation equipment or during an emergency situation, without exceeding the design rating of the substation transformer.
4) This plan recognizes that necessary distribution circuits of adequate capacity will have to be built to accommodate proposed load transfers. Appropriate switchgear (VFI's, oil switches, etc.) will need to be included for switching.

WASHINGTON CITY

1100 EAST/TELEGRAPH ROAD- GREEN SPRINGS 138 KV LINE

Total Cost Estimate Summary

PROJECT: Telegraph Road - Green Springs 138 kV Line						**BASIS OF ESTIMATE:**		
DESCRIPTION: Cost Estimate Summary						CODE A - (Schematic Design) CODE B - (Preliminary Design) CODE C - (Final Design) 100%		
ENGINEER: Les Bell						**OTHER - Conceptual Configuration**		
	ESTIMATOR: Les Bell					**CHECKED:**		
DESCRIPTION	**QUANTITY**		**LABOR**			**MATERIAL $**		
	QTY	**UNIT**	**UNIT MH**	**TOTAL MH**	**TOTAL LABOR $**	**PER UNIT**	**TOTAL MATERIAL**	**TOTAL COST ($)**
Wood Poles	1	LS	356.00	356.00	$25,632.00	$157,150.00	$157,150.00	$182,782.00
Steel Poles	1	LS	1,257.80	1,257.80	$90,561.60	$589,982.50	$589,982.50	$680,544.10
Trans. Tangent PTA 2 1/2"	1	LS	372.00	372.00	$26,784.00	$87,947.00	$87,947.00	$114,731.00
Trans. Tangent PTA 3"	1	LS	264.00	264.00	$19,008.00	$78,254.00	$78,254.00	$97,262.00
Trans. DDE PTA	1	LS	384.00	384.00	$27,648.00	$41,520.00	$41,520.00	$69,168.00
Dist. Tangent PTA	1	LS	672.00	672.00	$48,384.00	$67,200.00	$67,200.00	$115,584.00
Dist. DDE PTA	1	LS	216.00	216.00	$15,552.00	$15,264.00	$15,264.00	$30,816.00
138 kV Switches	1	LS	180.00	180.00	$12,960.00	$105,000.00	$105,000.00	$117,960.00
Install 1272 kcmil ACSR	121,000	Ft.	0.015	1,815.00	$130,680.00	$2.15	$260,150.00	$390,830.00
Install 477 kcmil ACSR	77,500	Ft.	0.015	1,162.50	$83,700.00	$1.35	$104,625.00	$188,325.00
Install 3/8" EHS Steel	20,000	Ft.	0.011	220.00	$15,840.00	$0.35	$7,000.00	$22,840.00
Concrete Foundations	1	LS	1,120.00	1,120.00	$80,640.00	$380,400.00	$380,400.00	$461,040.00
Wood Pole Grounds	31	Ea.	1.50	46.50	$3,348.00	$100.00	$3,100.00	$6,448.00
Access Road Const/Maint	1	LS	350.00	350.00	$25,200.00			$25,200.00
ROW Restoration/Seeding	1	LS	250.00	250.00	$18,000.00	$5,000.00	$5,000.00	$23,000.00
SUBTOTALS				8,665.80	$623,937.60		$1,902,592.50	$2,526,530.10
Average Labor Rate			$72.00					
Subtotal Labor Hours/$				8,665.80	$623,937.60			$623,937.60
Subtotal Material							$1,902,592.50	$1,902,592.50
Contractor Markup On Material								$76,103.70
Sales Tax (7%)								$133,181.48
Special Equipment Rental (Total Labor Hours / 5 x $50.00)								$86,658.00
Contractor Mobilization/Demobilization/Bonding								$56,449.47
TOTAL ESTIMATED CONSTRUCTION COST								**$2,878,922.74**
Engineering								$172,735.36
Construction Period Services								$71,973.07
PacifiCorp Coordination								$35,000.00
Commissioning								$10,000.00
Surveying - Subcontractor								$45,000.00
Geotech - Subcontractor								$30,000.00
TOTAL ESTIMATED ENGINEER'S COST								**$364,708.43**
Contingency								$486,544.68
Right Of Way Acquisition								$96,195.92
Right Of Way Payments								$857,331.21
TOTAL ESTIMATE								**$4,683,702.98**

* Cost estimate excludes right of way costs.

COST ESTIMATE

DATE PREPARED: 1/18/2007

PROJECT:
Green Springs North Substation

DESCRIPTION:
Green Springs North Substation (including Site Prep Work)

ENGINEER : ICPE

BASIS FOR ESTIMATE
CODE A (Schematic Design)
CODE B (Preliminary Design)
CODE C (Final Design) 100%
OTHER--Conceptual Configuration

ESTIMATOR: Craig Michaelis
CHECKED:

Avg. Labor Rate: $60.00

DESCRIPTION	QUANTITY NO. UNITS	QUANTITY UNIT MEAS	LABOR PER UNIT	LABOR TOTAL Man Hr	LABOR TOTAL LABOR ($)	MATERIAL ($) PER UNIT	MATERIAL ($) TOTAL MATERIAL	TOTAL ESTIMATE
Major Equipment								
69kV - 12.47kV Transformer 12/16/20/22.4 MVA	1	EA	80	80.00	$4,800.00	$335,000.00	$335,000.00	$339,800.00
69kV Breaker	1	EA	45	45.00	$2,700.00	$42,000.00	$42,000.00	$44,700.00
69kV Group Operated Switch	2	EA	60	120.00	$7,200.00	$10,500.00	$21,000.00	$28,200.00
15 kV Voltage Regulators 889 kVA	3	EA	32	96.00	$5,760.00	$33,500.00	$100,500.00	$106,260.00
15 kV Reclosers with external CT	3	EA	32	96.00	$5,760.00	$15,750.00	$47,250.00	$53,010.00
15kV Group Operated Switch	1	EA	40	40.00	$2,400.00	$7,750.00	$7,750.00	$10,150.00
15kV Distribution Switchgear PMH-10 With Vault	2	EA	40	80.00	$4,800.00	$25,750.00	$51,500.00	$56,300.00
							Total	**$638,420.00**
Metering / Relaying / SCADA								
15kV Metering (PTs & CTs, Conduit/Cable)	1	LS	40	40.00	$2,400.00	$11,500.00	$11,500.00	$13,900.00
Relay Panels (Installation & Wire Terminations)	1	LS	120	120.00	$7,200.00	$95,000.00	$95,000.00	$102,200.00
SCADA Equipment & Programming	1	LS	320	320.00	$19,200.00	$7,500.00	$7,500.00	$26,700.00
							Total	**$142,800.00**
Steel Structures								
Steel Structures	29950	LBS	0.009	269.55	$16,173.00	$2.30	$68,885.00	$85,058.00
							Total	**$85,058.00**
Concrete Foundations								
Concrete Foundations	195	CUYD	3	585.00	$35,100.00	$450.00	$87,750.00	$122,850.00
							Total	**$122,850.00**
Control Building								
Masonary Building	1	EA	240	240.00	$14,400.00	$24,750.00	$24,750.00	$39,150.00
Control Building Equipment	1	LS	16	16.00	$960.00	$4,750.00	$4,750.00	$5,710.00
125 VDC Battery System	1	EA	32	32.00	$1,920.00	$11,250.00	$11,250.00	$13,170.00
Control Building AC Systems	1	LS	80	80.00	$4,800.00	$11,750.00	$11,750.00	$16,550.00
							Total	**$74,580.00**
Substation Bus & Material								
69kV Bus & Fittings	1	LS	72	72.00	$4,320.00	$7,500.00	$7,500.00	$11,820.00
15kV Bus & Fittings	1	LS	200	200.00	$12,000.00	$35,000.00	$35,000.00	$47,000.00
Regulator Bypass Switches	3	EA	8	24.00	$1,440.00	$3,750.00	$11,250.00	$12,690.00
Recloser Bypass Switches	18	EA	4	72.00	$4,320.00	$675.00	$12,150.00	$16,470.00
Recloser Fused Switches	9	EA	4	36.00	$2,160.00	$1,750.00	$15,750.00	$17,910.00
Station Lightning Protection	1	LS	32	32.00	$1,920.00	$2,125.00	$2,125.00	$4,045.00
69 kV Lightning Arresters	3	EA	4	12.00	$720.00	$1,750.00	$5,250.00	$5,970.00
9kV Lightning Aressters	9	EA	1	9.00	$540.00	$675.00	$6,075.00	$6,615.00
							Total	**$122,520.00**
Substation Conduit & Cable								
600 Volt Conduit & Cable	1	LS	240	240.00	$14,400.00	$32,500.00	$32,500.00	$46,900.00
15kV Conduit & Cable	1	LS	120	160.00	$9,600.00	$17,750.00	$17,750.00	$27,350.00
15 kV Terminations	18	EA	3	54.00	$3,240.00	$475.00	$8,550.00	$11,790.00
15kV Distribution Conduit & Cable (Not Included)	0	LS	0	0.00	$0.00	$0.00	$0.00	$0.00
Station Service (Transformer, Disconnect, Conduit/Cable)	1	LS	32	32.00	$1,920.00	$4,275.00	$4,275.00	$6,195.00
							Total	**$92,235.00**
Substation Grounding								
Station Ground Grid	1	LS	320	320.00	$19,200.00	$34,750.00	$34,750.00	$53,950.00
							Total	**$53,950.00**
Substation Site Work								
Site Grubbing & Fill	1	LS	400	400.00	$24,000.00	$80,000.00	$80,000.00	$104,000.00
Site Surface gravel	1	LS	80	80.00	$4,800.00	$12,500.00	$12,500.00	$17,300.00
Site Roads	1	LS	40	40.00	$2,400.00	$5,750.00	$5,750.00	$8,150.00
Site Curb Gutter & Sidewalk	1	LS	120	120.00	$7,200.00	$12,500.00	$12,500.00	$19,700.00
Substation Fence (Block Fence)	1	LS	400	400.00	$24,000.00	$35,750.00	$35,750.00	$59,750.00
Additional Site Preparation Work	1	LS	10779	10779.00	$646,740.00			$646,740.00
Substation Land	1	LS	0	0.00	$0.00	$37,120.00	$37,120.00	$37,120.00
							Total	**$892,760.00**
Miscellaneous								
Contractor Mobilization	1	LS	0	0.00	$0.00	$20,000.00	$20,000.00	$20,000.00
Contractor Bonding	1	LS	0	0.00	$0.00	$15,000.00	$15,000.00	$15,000.00
Substation Testing & Commisioning	1	LS	0	0.00	$0.00	$25,000.00	$25,000.00	$25,000.00
							Total	**$60,000.00**
	Subtotals			**15,341.6**	**$920,493.00**		**$1,364,680.00**	
Subtotal Labor + Material								**$2,285,173.00**
Equipment				3068.31		70		**$214,781.70**
Contingency (10%)								**$249,995.47**
TOTAL ESTIMATE								**$2,749,950.17**

Notes:
1-Foundation estimate is based on the site having good soil conditions without water.
2-15kV Distribution Circuits are not included
3-Costs shown are as of 1/10/07. Market conditions are volatile and can have an impact on costs shown.

COST ESTIMATE

DATE PREPARED: 1/11/2007 0:00

PROJECT:
Sienna Hills Substation

DESCRIPTION:
Sienna Hills Substation (including Site Prep Work)

ENGINEER : ICPE

BASIS FOR ESTIMATE
CODE A (Schematic Design)
CODE B (Preliminary Design)
CODE C (Final Design) 100%
OTHER--Conceptual Configuration

ESTIMATOR: Craig Michaelis
CHECKED:
Avg. Labor Rate: $60.00

DESCRIPTION	QUANTITY NO. UNITS	UNIT MEAS	LABOR PER UNIT	LABOR TOTAL Man Hr	LABOR TOTAL LABOR ($)	MATERIAL ($) PER UNIT	MATERIAL TOTAL MATERIAL	TOTAL ESTIMATE
Major Equipment								
69kV - 12.47kV Transformer 12/16/20/22.4 MVA	1	EA	80	80.00	$4,800.00	$335,000.00	$335,000.00	$339,800.00
69kV Breaker	1	EA	45	45.00	$2,700.00	$42,000.00	$42,000.00	$44,700.00
69kV Group Operated Switch	2	EA	60	120.00	$7,200.00	$10,500.00	$21,000.00	$28,200.00
15 kV Voltage Regulators 889 kVA	3	EA	32	96.00	$5,760.00	$33,500.00	$100,500.00	$106,260.00
15 kV Reclosers with external CT	3	EA	32	96.00	$5,760.00	$15,750.00	$47,250.00	$53,010.00
15kV Group Operated Switch	1	EA	40	40.00	$2,400.00	$7,750.00	$7,750.00	$10,150.00
15kV Distribution Switchgear PMH-10 With Vault	2	EA	40	80.00	$4,800.00	$25,750.00	$51,500.00	$56,300.00
							Total	**$638,420.00**
Metering / Relaying / SCADA								
15kV Metering (PTs & CTs, Conduit/Cable)	1	LS	40	40.00	$2,400.00	$11,500.00	$11,500.00	$13,900.00
Relay Panels (Installation & Wire Terminations)	1	LS	120	120.00	$7,200.00	$95,000.00	$95,000.00	$102,200.00
SCADA Equipment & Programming	1	LS	320	320.00	$19,200.00	$7,500.00	$7,500.00	$26,700.00
							Total	**$142,800.00**
Steel Structures								
Steel Structures	29950	LBS	0.009	269.55	$16,173.00	$2.30	$68,885.00	$85,058.00
							Total	**$85,058.00**
Concrete Foundations								
Concrete Foundations	195	CUYD	3	585.00	$35,100.00	$450.00	$87,750.00	$122,850.00
							Total	**$122,850.00**
Control Building								
Masonary Building	1	EA	240	240.00	$14,400.00	$24,750.00	$24,750.00	$39,150.00
Control Building Equipment	1	LS	16	16.00	$960.00	$4,750.00	$4,750.00	$5,710.00
125 VDC Battery System	1	EA	32	32.00	$1,920.00	$11,250.00	$11,250.00	$13,170.00
Control Building AC Systems	1	LS	80	80.00	$4,800.00	$11,750.00	$11,750.00	$16,550.00
							Total	**$74,580.00**
Substation Bus & Material								
69kV Bus & Fittings	1	LS	72	72.00	$4,320.00	$7,500.00	$7,500.00	$11,820.00
15kV Bus & Fittings	1	LS	200	200.00	$12,000.00	$35,000.00	$35,000.00	$47,000.00
Regulator Bypass Switches	3	EA	8	24.00	$1,440.00	$3,750.00	$11,250.00	$12,690.00
Recloser Bypass Switches	18	EA	4	72.00	$4,320.00	$675.00	$12,150.00	$16,470.00
Recloser Fused Switches	9	EA	4	36.00	$2,160.00	$1,750.00	$15,750.00	$17,910.00
Station Lightning Protection	1	LS	32	32.00	$1,920.00	$2,125.00	$2,125.00	$4,045.00
69 kV Lightning Arresters	3	EA	4	12.00	$720.00	$1,750.00	$5,250.00	$5,970.00
9kV Lightning Aressters	9	EA	1	9.00	$540.00	$675.00	$6,075.00	$6,615.00
							Total	**$122,520.00**
Substation Conduit & Cable								
600 Volt Conduit & Cable	1	LS	240	240.00	$14,400.00	$32,500.00	$32,500.00	$46,900.00
15kV Conduit & Cable	1	LS	120	160.00	$9,600.00	$17,750.00	$17,750.00	$27,350.00
15 kV Terminations	18	EA	3	54.00	$3,240.00	$475.00	$8,550.00	$11,790.00
15kV Distribution Conduit & Cable (Not Included)	0	LS	0	0.00	$0.00	$0.00	$0.00	$0.00
Station Service (Transformer, Disconnect, Conduit/Cable)	1	LS	32	32.00	$1,920.00	$4,275.00	$4,275.00	$6,195.00
							Total	**$92,235.00**
Substation Grounding								
Station Ground Grid	1	LS	320	320.00	$19,200.00	$34,750.00	$34,750.00	$53,950.00
							Total	**$53,950.00**
Substation Site Work								
Site Grubbing & Fill	1	LS	400	400.00	$24,000.00	$80,000.00	$80,000.00	$104,000.00
Site Surface gravel	1	LS	80	80.00	$4,800.00	$12,500.00	$12,500.00	$17,300.00
Site Roads	1	LS	40	40.00	$2,400.00	$5,750.00	$5,750.00	$8,150.00
Site Curb Gutter & Sidewalk	1	LS	120	120.00	$7,200.00	$12,500.00	$12,500.00	$19,700.00
Substation Fence (Block Fence)	1	LS	400	400.00	$24,000.00	$35,750.00	$35,750.00	$59,750.00
Additional Site Preparation Work	1	LS	7278	7,278.00	$436,680.00			$436,680.00
Substation Land	1	LS	0	0.00	$0.00	$37,120.00	$37,120.00	$37,120.00
							Total	**$682,700.00**
Miscellaneous								
Contractor Mobilization	1	LS	0	0.00	$0.00	$20,000.00	$20,000.00	$20,000.00
Contractor Bonding	1	LS	0	0.00	$0.00	$15,000.00	$15,000.00	$15,000.00
Substation Testing & Commisioning	1	LS	0	0.00	$0.00	$25,000.00	$25,000.00	$25,000.00
							Total	**$60,000.00**
	Subtotals			**11,840.6**	**$710,433.00**		**$1,364,680.00**	
Subtotal Labor + Material								**$2,075,113.00**
Equipment				2368.11		70		**$165,767.70**
Contingency (10%)								**$224,088.07**
TOTAL ESTIMATE								**$2,464,968.77**

Notes:
1-Foundation estimate is based on the site having good soil conditions without water.
2-15kV Distribution Circuits are not included
3-Costs shown are as of 1/10/07. Market conditions are volatile and can have an impact on costs shown.

Substation Transformer Loading Guidelines per ANSI/IEEE C57.92-1981

1. Assumes that the daily average ambient temperature is between 0°C to 30°C and 30°C to 50°C.
2. Temperature rise of transformer oil is assumed to be 65°C.
3. These numbers are usable for daily average ambient temperature range of 0°C to 50°C **(32°F to 122°F)**.

Decrease load rating by 1% for each 1°C rise of average ambient temperature above 30°C.
OA/FA or OA/FA/FA type cooling = 1% deduction

Substation Transformer OA/FA/FA 65°C nameplate rating: **22,400**

Daily Average Ambient Temp.	% Load Reduction	Revised Transformer Rating	°F
		kVA	
30°C	0	22,400	86.0
31°C	1	22,176	87.8
32°C	2	21,952	89.6
33°C	3	21,728	91.4
34°C	4	21,504	93.2
35°C	5	21,280	95.0
40°C	10	20,160	104.0
45°C	15	19,040	113.0
50°C	20	17,920	122.0

Increase Loading by 0.75% for each 1°C drop of average ambient temperature below 30°C .
OA/FA or OA/FA/FA type cooling = 0.75% increase

Substation Transformer OA/FA/FA 65°C nameplate rating: **22,400**

Daily Average Ambient Temp.	% Increase Allowed	Revised Transformer Rating	°F
		kVA	
30°C	0.00	22,400	86.0
29°C	0.75	22,568	84.2
28°C	1.50	22,736	82.4
27°C	2.25	22,904	80.6
26°C	3.00	23,072	78.8
25°C	3.75	23,240	77.0
20°C	7.50	24,080	68.0
15°C	11.25	24,920	59.0
10°C	15.00	25,760	50.0
5°C	18.75	26,600	41.0
0°C	22.50	27,440	32.0

Note:
The Daily Average Ambient Temperature is defined as the high ambient temperature plus the low ambient temperature (on the same day) divided by two for each day of the month. The sum of these daily averages divided by the number of days in the month generates the Average Daily value for the month. The ANSI/IEEE C57.92-1981 standard recommends using this average daily ambient temperature value when applying the above chart to a substation transformer.

Washington City Substation Equipment Information

July 2007

Staheli Transformer:

Serial # H880407
General Electric-Class OA/FA –3 phase
Voltage Rating = 43800 X 67000 – 12470Y/7200 X 24940Y/14400 – 5 tap positions
kVA =10,000/12,500 @ 55C &14,400 @65C
Impedance =7.53%

Staheli Regulators:

Cooper, McGraw Edison VR 32 type A
Voltage Rating = 7620/13200y
Load Amps = 656/668
KVA Rating: 500/509
5 A & 5 C Control Panels

Staheli Reclosers:

Cooper Type WE 15.5 kV
Control: Kyle 4 C
Interrupting Capacity Rating: 10 kA
Continuous Current Rating: 560 Amps

Main Street 1 Transformer:

Serial # AO363V
Waukesha Class OA/FA – 3 phase
Voltage Rating = 67000 55C BIL 350 kV – 12470y/7200 55C BIL 110 kV
MVA = 10/12.5 @ 55C & 14.4 @65C – 5 tap positions.
Impedance = 5.41%

Main Street 1 Regulators

Cooper, McGraw-Edison VR 32 type A
Voltage Rating = 7620/13200Y (Set for 7200/12470Y operation)
Load Amps = 656/668
kVA Rating = 500/509
Bank #1: Type 5A Control Panels

Main Street 1 Reclosers:

Cooper Type VWE 15.5 KV
Control: Kyle 4 C
Interrupting Capacity Rating: 12 kA
Continuous Current Rating: 800 A

Main Street 2 Transformer:

Serial # 47010MAO54
Virginia Class OA/FA – 3 Phase
Voltage Rating = 67000 55 C BIL 350 kV – 12470y/7200 55C BIL 110 kV
MVA = 10/12.5 @ 55C &14.4 @ 65C - 5 tap positions.
Impedance = 5.10%

Main Street 2 Regulators

Cooper, McGraw-Edison VR 32 type A
Voltage Rating = 7620/13200Y (Set for 7200/12470Y operation)
Load Amps = 656/668
kVA Rating = 500/509
Bank #2: Type 5E Control Panels

Washington City Substation Equipment Information

July 2007

Main Street 2 Reclosers:

Cooper Type VWE 15.5 KV
Control: Kyle 4 C
Interrupting Capacity Rating: 12 kA
Continuous Current Rating: 800 A

Coral Canyon Transformer:

Serial # 47012MA071– A655A
Virginia Class OA/FA – 3 Phase
Voltage Rating = 67000 55C BIL 350 kV – 12470y/7200 55C BIL 110 kV
MVA= 12/16/20 @ 55C & 22.4 @ 65C – 5 tap positions.
Impedance = 7.72%

Coral Canyon 69kV Breaker:

Siemens Type SPS2-72.5 – 40.2
Serial # S.O. 54751– 2
Rated Continuous Current 1200 Amp

Coral Canyon Regulators:

Cooper Power Systems VR – 32
Voltage Rating 7200/13200Y
Load Amps: 1164/1303 ONAF
KVA Rating: 887/994 ONAF

Coral Canyon Reclosers:

G&W Recloser Solid Dielectric Switch
Max Volt 15.5
BIL 110kV
Rated Continuous Current: 800 Amp (RMS)

Buena Vista Transformer:

Serial # 47012MA071– A655B
Virginia Class OA/FA – 3 Phase
Voltage Rating = 67000 55C BIL 350 kV – 12470y/7200 55C BIL 110 kV
MVA = 12/16/20 @ 55C & 22.4 @ 65C – 5 tap positions.
Impedance = 7.82%

Buena Vista 69kV Breaker:

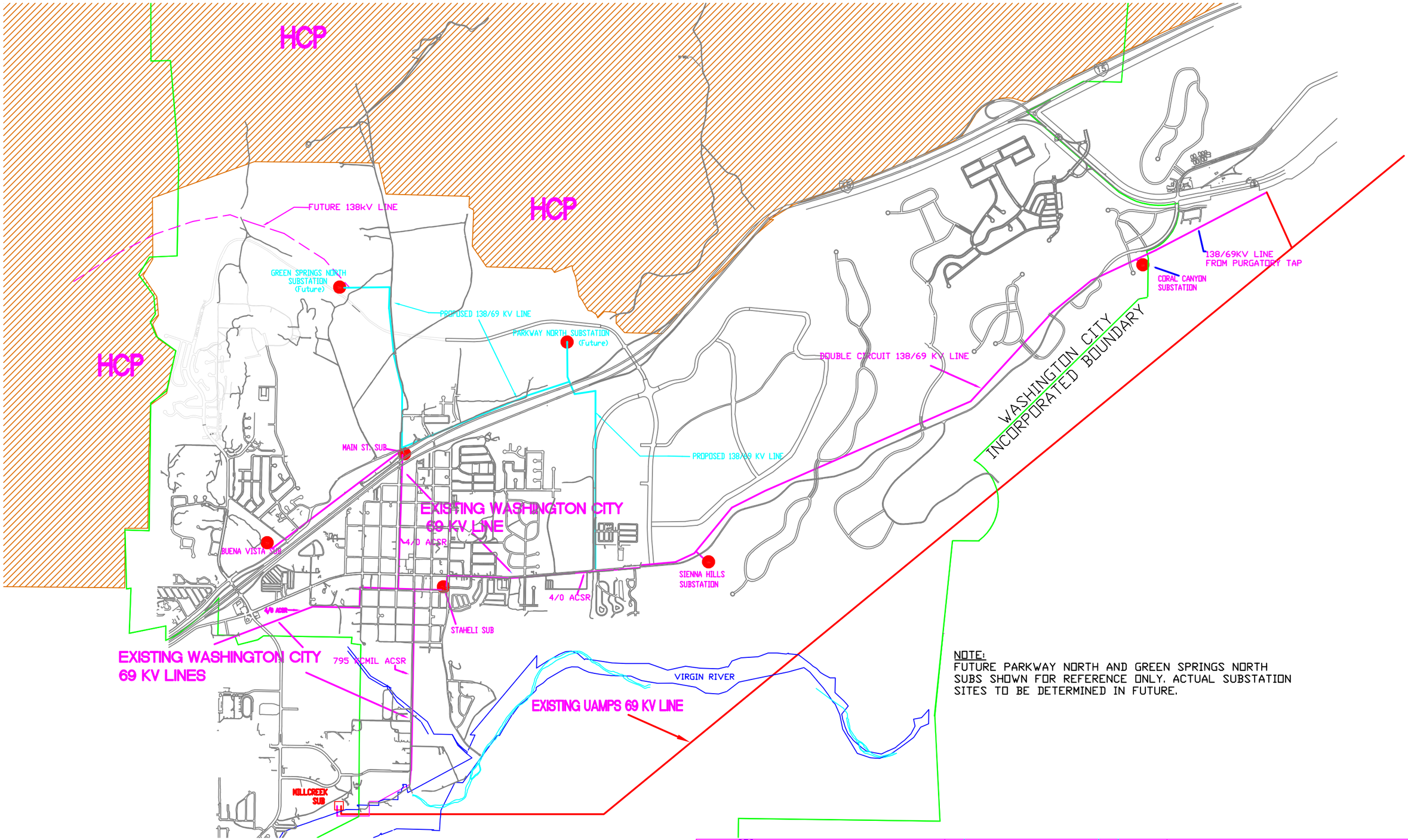
Siemens Type SPS2 –72.5 – 40.2
Serial # S.O. 54751–1
Rated Continuous Current: 1200 Amp

Buena Vista Regulators:

Cooper Power Systems VR –32
Voltage Rating 7200/13200Y
Load Amps 1164/1303 ONAF
KVA Rating 887/994 ONAF

Buena Vista Reclosers:

G&W Recloser Solid Dielectric Switch
Max Volt 15.5kV
BIL 110kV
Rated Continuous Current: 800 Amp (RMS)



NOTE:
FUTURE PARKWAY NORTH AND GREEN SPRINGS NORTH SUBS SHOWN FOR REFERENCE ONLY. ACTUAL SUBSTATION SITES TO BE DETERMINED IN FUTURE.

[redacted]

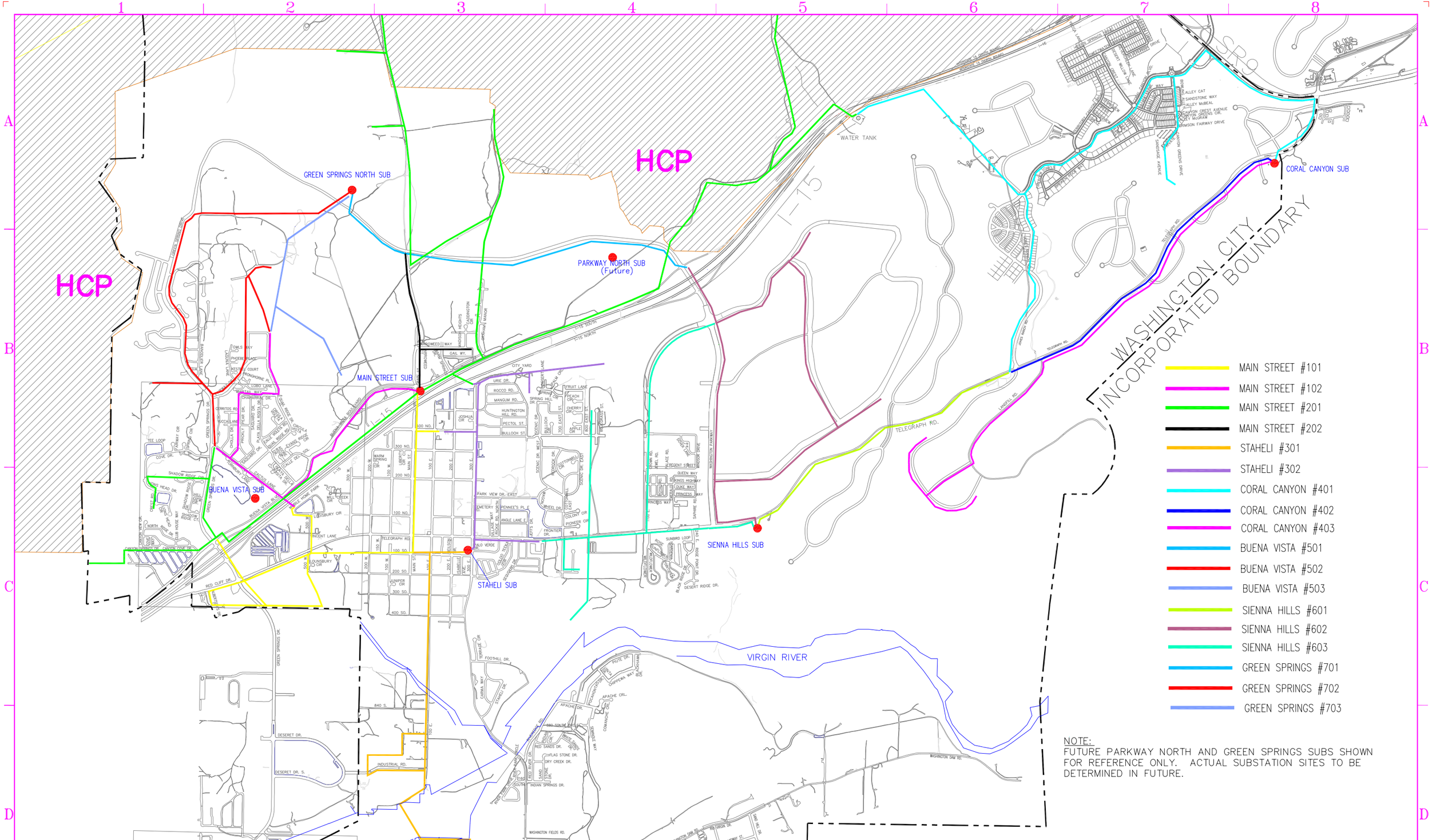
No.	DESCRIPTION	BY	DATE

REVISIONS

CONFIDENTIAL

TITLE: WASHINGTON CITY POWER
EXISTING & PROPOSED
TRANSMISSION LINES

Design By:	Date 6-23-07	SCALE NONE	
ENGR. KCB	Date 6-23-07	DRAWING No. MAP #3	REVISION B
Drafting By: RKO	Project No. 71-047		



NOTE:
FUTURE PARKWAY NORTH AND GREEN SPRINGS SUBS SHOWN FOR REFERENCE ONLY. ACTUAL SUBSTATION SITES TO BE DETERMINED IN FUTURE.

PRINTED _____ FOR
DATE
- ☐ PRELIMINARY
- ☐ DESIGN DEVELOPMENT
- ☐ BIDDING
- ☐ CONSTRUCTION
- ☐ APPROVAL
- ☐ AS BUILT
- ☐ REVISION

Intermountain Consumer Professional Engineers, Inc.
CONSULTING ENGINEERS
1140 E. SOUTH UNION AVE.
MIDVALE, UTAH 84047
BUS. (801) 255-1111 FAX. 566-0086

No.	DESCRIPTION	BY	DATE	APPD.

REVISIONS

CONFIDENTIAL

TITLE: WASHINGTON CITY
PROPOSED CIRCUITS
BY 2012

Drawn By:	RKO	Date	7-11-07	ENGR.	KCB	Date	7-12-07
Chk'd. By:	KCB	Date	7-12-07	APPD.	AJT	Date	
Project No.	71-047	SCALE	NONE				

DRAWING No. 2012 REVISION B