



**Feasibility Study  
For  
Generation Interconnection  
Request  
GEN-2007-032**

SPP Tariff Studies  
(#GEN-2007-032)

February, 2008

## Executive Summary

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 150 MW of wind generation within the control area of Western Farmers Electric Cooperative (WFEC) located in Custer County, Oklahoma. The proposed interconnection point is on the existing Clinton Junction (AEPW) – Clinton (WFEC) 138 kV transmission line, owned by WFEC. The proposed in-service date is December, 2010.

Power flow analysis has indicated that for the powerflow cases studied, it is possible to interconnect the 150 MW of generation with transmission system reinforcements within the local transmission system. In order to maintain acceptable reactive power compensation, the customer will be required to pay for the installation of a combined total of at least 25 Mvar of 34.5 kV capacitor bank(s) to be installed in the Customer's collector substation. Dynamic Stability studies performed as part of the System Impact Study will provide additional guidance as to whether the required reactive compensation can be static or a portion must be dynamic (such as a SVC).

The requirement to interconnect the 150 MW of wind generation on the existing Clinton Junction (AEPW) – Clinton (WFEC) 138 kV transmission line consists of adding a new 138 kV three-breaker ring-bus switching station. The new station will be constructed and maintained by WFEC. The Customer did not propose a specific route for the 138 kV line extending to serve its 138/34.5 kV collection facilities. It is assumed that obtaining all necessary right-of-way for the new transmission line to serve its facilities will not be a significant expense.

The total minimum cost for building the required facilities for this 150 MW of generation is \$2,000,000. These costs are shown in Tables 1 and 2. This cost does not include building the 138 kV line from the Customer 138/34.5 kV collector substation into the point of interconnection. This cost also does not include the Customer's 138/34.5 kV collector substation or the 34.5 kV, 25 Mvar capacitor bank(s). Network constraints in the American Electric Power West (AEPW), Kansas City Power & Light (KACP), Oklahoma gas and Electric (OKGE), Southwestern Public Service Company (SPS), Missouri Public Service (MIPU) and WFEC transmission systems that were identified are shown in Table 3. These Network constraints will have to be verified with a Transmission Service Request (TSR) and associated studies. Network Constraints are in the local area of the new generation when this generation is sunk throughout the SPP footprint for the Energy Resource (ER) Interconnection request. With a defined source and sink in a Transmission Service Request, this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer for future analyses including the determination of lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

There are several other proposed generation additions in the general area of the Customer's facility. It was assumed in this preliminary analysis that not all of these other projects within the WFEC control areas will be in service. Those previously queued projects that have advanced to nearly complete phases

were included in this Feasibility Study. In the event that another request for a generation interconnection with a higher priority withdraws, then this request may have to be re-evaluated to determine the local Network Constraints.

The required interconnection costs listed in Tables 1 and 2 and other upgrades associated with Network Constraints do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer submits a Transmission Service Request through Southwest Power Pool's OASIS.

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## Introduction

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 150 MW of wind generation within the control area of Western Farmers Electric Cooperative (WFEC) located in Custer County, Oklahoma. The proposed interconnection point is on the existing Clinton Junction (AEPW) – Clinton (WFEC) 138 kV transmission line, owned by WFEC. The point is near the existing WFEC Arapaho Switch 69kV substation. The proposed in-service date is December, 2010.

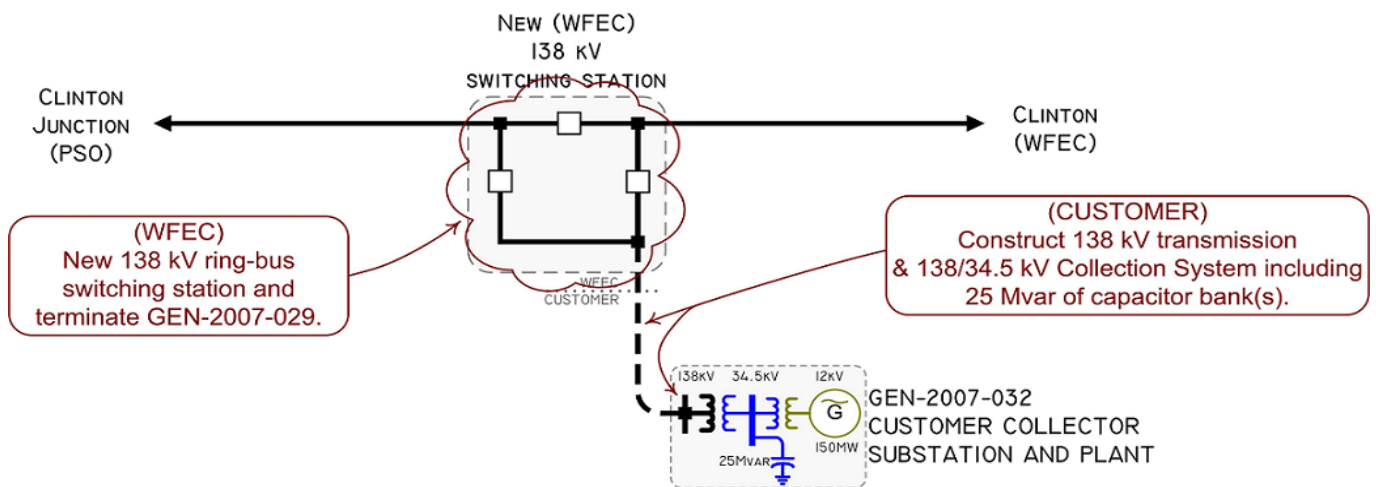
## Interconnection Facilities

The primary objective of this study is to identify the system problems associated with connecting the generation to the area transmission system. The Feasibility and other subsequent Interconnection Studies are designed to identify attachment facilities, Network Upgrades and other Direct Assignment Facilities needed to accept power into the grid at the interconnection receipt point.

The requirement to interconnect the 150 MW of wind generation on the existing Clinton Junction (AEPW) – Clinton (WFEC) 138 kV transmission line consists of adding a new 138 kV three-breaker ring-bus switching station. The new station will be constructed and maintained by WFEC. The Customer did not propose a specific route for the 138 kV line extending to serve its 138/34.5 kV collection facilities. It is assumed that obtaining all necessary right-of-way for the new transmission line to serve its facilities will not be a significant expense.

Other Network Constraints in the American Electric Power West (AEPW), Kansas City Power & Light (KACP), Oklahoma gas and Electric (OKGE), Southwestern Public Service Company (SPS), Missouri Public Service (MIPU) and WFEC transmission systems that were identified are shown in Table 3. With a defined source and sink in a Transmission Service Request (TSR), this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements.

A preliminary one-line drawing of the interconnection and direct assigned facilities are shown in Figure 1.



**Figure 1: Proposed Method of Interconnection**

(Final design to be determined)

## Interconnection Estimated Costs

The minimum cost for adding a new 138 kV three-breaker ring-bus switching station serving GEN-2007-032 facilities is estimated at \$2,000,000. These costs are listed in Tables 1 and 2. These estimates will be refined during the development of the System Impact Study based on the final designs. This cost does not include building the Customer's 138 kV transmission line extending from the point of interconnection to serve its 138/34.5 kV collection facilities. This cost also does not include the Customer's 138/34.5 kV collector substation or the 25 Mvar of capacitor bank(s), all of which should be determined by the Customer. The Customer is responsible for these 138 kV – 34.5 kV facilities up to the point of interconnection.

The costs of interconnecting the facility to the WFEC transmission system are listed in Table 1 & 2. **These costs do not include any cost that might be associated with short circuit study results or dynamic stability study results.** These costs will be determined when and if a System Impact Study is conducted.

**Table 1: Direct Assignment Facilities**

FACILITY	ESTIMATED COST (2008 DOLLARS)
CUSTOMER – 138/34.5 kV substation facilities.	*
CUSTOMER – 138 kV line between Customer substation and new WFEC 138 kV three-breaker ring-bus switching station.	*
CUSTOMER – 34.5 kV, 25 Mvar capacitor bank(s) to be installed in the Customer 138/34.5 kV collector substation.	*
CUSTOMER – Right-of-Way for all Customer facilities.	*
<b>TOTAL</b>	<b>*</b>

\* Estimates of cost to be determined.

**Table 2: Required Interconnection Network Upgrade Facilities**

FACILITY	ESTIMATED COST (2007 DOLLARS)
WFEC – 138 kV three-breaker ring-bus switching station to be built for generation request #GEN-2007-032 on the Clinton Junction (AEPW) – Clinton (WFEC) 138 kV transmission line. Work to include associated switches, control relaying, high speed communications, metering and related equipment and all related structures.	\$2,000,000
<b>TOTAL</b>	<b>\$2,000,000</b>

\* Estimates of cost to be determined.

## Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2012 summer and winter peak models, and the 2017 summer peak model. The output of the Customer's facility was offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ER) Interconnection request. The proposed in-service date of the generation is December, 2010. The available seasonal models used were through the 2017 Summer Peak of which is the end of the current SPP planning horizon.

Following current practice, this analysis was conducted assuming that previous queued requests in the immediate area of this interconnect request were in service. The analysis of the Customer's project indicates that, given the requested generation level of 150 MW and location, additional criteria violations will occur on the existing MIPU, OKGE, KACP, AEPW, SPS and WFEC transmission systems under steady state and contingency conditions in the peak seasons. Table 3 lists these overloaded facilities.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

In order to maintain a zero reactive power flow exchanged at the point of interconnection, additional reactive compensation is required. The Customer will be required to install a combined total of 25 Mvar of capacitor bank(s) in the Customer's 138/34.5 kV collector substation on the 34.5 kV bus. Dynamic Stability studies performed as part of the System Impact Study will provide additional guidance as to whether the reactive compensation can be static or a portion must be dynamic (such as a SVC or STATCOM). It is possible that an SVC or STATCOM device will be required at the Customer facility because of FERC Order 661A Low Voltage Ride-Through Provisions (LVRT) which went into effect January 1, 2006. FERC Order 661A orders that wind farms stay on-line for 3-phase faults at the point of interconnection even if that requires the installation of a SVC or STATCOM device.

There are several other proposed generation additions in the general area of the Customer's facility. Some of the local projects that were previously queued were assumed to be in service in this Feasibility Study. Not all local projects that were previously queued and have advanced to nearly complete phases were included in this Feasibility Study.

## **Powerflow Analysis Methodology**

The Southwest Power Pool (SPP) criteria states that: “The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable NERC Planning Standards for System Adequacy and Security – Transmission System Table I hereafter referred to as NERC Table I) and its applicable standards and measurements”.

Using the created models and the ACCC function of PSS/E, single contingencies in portions or all of the modeled control areas of Sunflower Electric Power Corporation (SUNC), Missouri Public Service (MIPU), Westar Energy (WERE), Kansas City Power & Light (KCPL), West Plains (WEPL), Midwest Energy (MIDW), Oklahoma Gas and Electric (OKGE), American Electric Power West (AEPW), Grand River Dam Authority (GRDA), Southwestern Public Service Company (SPS), Western Farmers Electric Cooperative (WFEC) and other control areas were applied and the resulting scenarios analyzed. This satisfies the ‘more probable’ contingency testing criteria mandated by NERC and the SPP criteria.



## Powerflow Results

**Table 3: Network Constraints**

AREA	OVERLOADED ELEMENT
AEPW	CLINTON CITY - FOSS TAP 69KV CKT 1
AEPW	CLINTON CITY - THOMAS TAP 69KV CKT 1
AEPW	CLINTON JUNCTION - ELK CITY 138KV CKT 1
AEPW	CLINTON JUNCTION - FOSS TAP 69KV CKT 1
AEPW	ELK CITY (ELKCTY-4) 138/69/13.8KV TRANSFORMER CKT 1
AEPW	FLETCHER TAP - LAWTON EASTSIDE 138KV CKT 1
AEPW	HOBART JUNCTION - TAMARAC TAP 138KV CKT 1
AEPW	NORGE ROAD - SOUTHWESTERN STATION 138KV CKT 1
AEPW	THOMAS TAP - WEATHERFORD 69KV CKT 1
AEPW/SPS	2006-02T - GRAPEVINE INTERCHANGE 230KV CKT 1
AEPW/WFEC	CLINTON JUNCTION - 2007-32T 138KV CKT 1
AEPW/WFEC	LAKE PAULINE - RUSSELL 138 KV CKT 1
AEPW/WFEC	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
KACP	WEST GARDNER (WGARD 11) 345/161/13.8KV TRANSFORMER CKT 11
MIPU	LAKE ROAD 161/34.5KV TRANSFORMER CKT 1
MIPU	LAKE ROAD 161/34.5KV TRANSFORMER CKT 2
OKGE	5 TRIBES - HANCOCK 161KV CKT 1
OKGE	CIMARRON - HAYMAKER 138KV CKT 1
OKGE	CLASSEN - SW 5TAP 138KV CKT 1
OKGE	DIVISION AVE - HAYMAKER 138KV CKT 1
OKGE	EL RENO - ROMAN NOSE 138KV CKT 1
OKGE	MUSKOGEE - PECAN CREEK 345KV CKT 1
OKGE/WFEC	GLASS MOUNTAIN - MOORELAND 138KV CKT 1
SPS	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1
WFEC	2007-32T 138.00 - CLINTON 138KV CKT 1
WFEC	ANADARKO - CORN TAP 138KV CKT 1
WFEC	ANADARKO - GRGIAJT4 138.00 138KV CKT 1
WFEC	ANADARKO - WASHITA 138KV CKT 1
AEPW	American Electric Power West
KACP	Kansas City Power and Light
MIPU	Missouri Public Service
OKGE	Oklahoma Gas and Electric
SPS	Southwestern Public Service Company
WFEC	Western Farmers Electric Cooperative

**Table 4: Contingency Analysis**

SEASON	OVERLOADED ELEMENT	RATING (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
12SP	ANADARKO - WASHITA 138KV CKT 1	212	164	0	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
12SP	SOUTHWESTERN STATION - WASHITA 138KV CKT 1	260	153	0	2007-32T 138.00 - CLINTON JUNCTION 138KV CKT 1
12SP	HOBART JUNCTION - TAMARAC TAP 138KV CKT 1	105	128	0	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
12SP	2006-02T - GRAPEVINE INTERCHANGE 230KV CKT 1	351	120	0	OKLAUNION - TUCO INTERCHANGE 345KV CKT 1
12SP	ELK CITY (ELKCTY-4) 138/69/13.8KV TRANSFORMER CKT 1	72	110	0	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
12SP	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1	129	109	0	CHILDRESS - LAKE PAULINE 138KV CKT 1
12SP	CLASSEN - SW 5TAP 138KV CKT 1	191	108	0	COUNCIL - MUSTANG 138KV CKT 1
12SP	ANADARKO - CORN TAP 138KV CKT 1	118	107	0	BASE CASE
12SP	FLETCHER TAP - LAWTON EASTSIDE 138KV CKT 1	143	109	2	ELGIN JUNCTION - SOUTHWESTERN STATION 138KV CKT 1
12SP	CLINTON JUNCTION - FOSS TAP 69KV CKT 1	72	116	64	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12SP	NORGE ROAD - SOUTHWESTERN STATION 138KV CKT 1	143	103	68	SOUTHWESTERN STATION - VERDEN 138KV CKT 1
12SP	CLINTON CITY - THOMAS TAP 69KV CKT 1	48	112	108	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12SP	CLINTON CITY - FOSS TAP 69KV CKT 1	79	105	119	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12SP	CLINTON JUNCTION - 2007-32T 138KV CKT 1	143	115	120	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
12SP	THOMAS TAP - WEATHERFORD 69KV CKT 1	48	105	131	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12SP	CLINTON JUNCTION - ELK CITY 138KV CKT 1	143	104	140	WEATHERFORD JCT. - WEATHERFORD SOUTHEAST 138KV CKT 1
12SP	CIMARRON - HAYMAKER 138KV CKT 1	308	100	145	CIMARRON - CZECH HALL 138KV CKT 1
12SP	2007-32T 138.00 - CLINTON 138KV CKT 1	143	101	148	2007-32T 138.00 - CLINTON JUNCTION 138KV CKT 1
12WP	ANADARKO - WASHITA 138KV CKT 1	212	183	0	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
12WP	SOUTHWESTERN STATION - WASHITA 138KV CKT 1	260	165	0	ANADARKO - WASHITA 138KV CKT 1
12WP	LAKE ROAD 161/34.5KV TRANSFORMER CKT 1	83	121	0	LAKE ROAD 161/34.5KV TRANSFORMER CKT 2
12WP	LAKE ROAD 161/34.5KV TRANSFORMER CKT 2	83	120	0	LAKE ROAD 161/34.5KV TRANSFORMER CKT 1
12WP	DIVISION AVE - HAYMAKER 138KV CKT 1	308	113	0	CIMARRON - CZECH HALL 138KV CKT 1
12WP	EL RENO - ROMAN NOSE 138KV CKT 1	185	109	0	CLEO CORNER - MEN TAP 138KV CKT 1
12WP	GLASS MOUNTAIN - MOORELAND 138KV CKT 1	124	109	0	EL RENO - ROMAN NOSE 138KV CKT 1
12WP	CLINTON JUNCTION - FOSS TAP 69KV CKT 1	72	111	87	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12WP	THOMAS TAP - WEATHERFORD 69KV CKT 1	53	113	97	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12WP	CLINTON CITY - THOMAS TAP 69KV CKT 1	55	112	97	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12WP	HOBART JUNCTION - TAMARAC TAP 138KV CKT 1	105	102	117	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
12WP	CLINTON CITY - FOSS TAP 69KV CKT 1	79	101	142	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
12WP	CLINTON JUNCTION - 2007-32T 138KV CKT 1	143	104	143	2007-32T 138.00 - CLINTON 138KV CKT 1
17SP	ANADARKO - WASHITA 138KV CKT 1	212	162	0	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
17SP	SOUTHWESTERN STATION - WASHITA 138KV CKT 1	260	155	0	2007-32T 138.00 - CLINTON JUNCTION 138KV CKT 1
17SP	HOBART JUNCTION - TAMARAC TAP 138KV CKT 1	105	134	0	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
12WP	2006-02T - GRAPEVINE INTERCHANGE 230KV CKT 1	351	129	0	TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1
17SP	LAKE PAULINE - RUSSELL 138 KV CKT 1	72	117	0	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
17SP	GRAPEVINE INTERCHANGE 230/115KV TRANSFORMER CKT 1	129	116	0	CHILDRESS - LAKE PAULINE 138KV CKT 1
17SP	ELK CITY (ELKCTY-4) 138/69/13.8KV TRANSFORMER CKT 1	72	115	0	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1
17SP	FLETCHER TAP - LAWTON EASTSIDE 138KV CKT 1	143	113	0	ELGIN JUNCTION - SOUTHWESTERN STATION 138KV CKT 1
17SP	ANADARKO - CORN TAP 138KV CKT 1	118	110	0	BASE CASE

**TABLE 4: Contingency Analysis (continued)**

SEASON	OVERLOADED ELEMENT	RATING (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
17SP	ANADARKO - GRGIAJT4 138.00 138KV CKT 1	144	106	0	BASE CASE
17SP	MUSKOGEE - PECAN CREEK 345KV CKT 1	478	103	0	CLARKSVILLE - MUSKOGEE 345KV CKT 1
17SP	WEST GARDNER (WGARD 11) 345/161/13.8KV TRANSFORMER CKT 11	440	103	0	CRAIG - WEST GARDNER 345KV CKT 1
17SP	NORGE ROAD - SOUTHWESTERN STATION 138KV CKT 1	143	103	65	SOUTHWESTERN STATION - VERDEN 138KV CKT 1
17SP	CLINTON JUNCTION - FOSS TAP 69KV CKT 1	72	116	67	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
17SP	2006-02T 230.00 - GRAPEVINE INTERCHANGE 230KV CKT 1	351	105	71	SPP-SWPS-04A
17SP	5 TRIBES - HANCOCK 161KV CKT 1	223	101	110	AGENCY - PECAN CREEK 161KV CKT 1
17SP	CLINTON JUNCTION - 2007-32T 138KV CKT 1	143	118	114	SOUTHWESTERN STATION - WASHITA 138KV CKT 1
17SP	CLINTON CITY - FOSS TAP 69KV CKT 1	79	105	120	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
17SP	CLINTON CITY - THOMAS TAP 69KV CKT 1	48	107	125	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
17SP	CLINTON JUNCTION - ELK CITY 138KV CKT 1	143	106	135	WEATHERFORD JCT. - WEATHERFORD SOUTHEAST 138KV CKT 1
17SP	CIMARRON - HAYMAKER 138KV CKT 1	308	100	140	CIMARRON - CZECH HALL 138KV CKT 1
17SP	THOMAS TAP - WEATHERFORD 69KV CKT 1	48	101	147	WEATHERFORD TAP - WEATHERFORD WIND FARM 138KV CKT 1
17SP	2007-32T 138.00 - CLINTON 138KV CKT 1	143	101	148	2007-32T 138.00 - CLINTON JUNCTION 138KV CKT 1

*Note: When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this Table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.*

## **Conclusion**

The minimum cost of interconnecting the Customer's interconnection request is estimated at \$2,000,000 for Direct Assignment Facilities and Network Upgrades. At this time, the cost estimates for other Direct Assignment facilities including those in Tables 1 and 2 have not been defined by the Customer. In addition to the Customer's proposed interconnection facilities, the Customer will be responsible for installing a total of 25 Mvar of capacitor bank(s) in the Customer's substation for reactive support. As stated earlier, some but not all of the local projects that were previously queued are assumed to be in service in this Feasibility Study. These costs exclude upgrades of other transmission facilities that were listed in Table 3 of which are Network Constraints.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

These interconnection costs do not include any cost that may be associated with short circuit or transient stability analysis. These studies will be performed if the Customer signs a System Impact Study Agreement. At the time of the System Impact Study, a better determination of the interconnection facilities may be available.

The required interconnection costs listed in Tables 1 and 2 and other upgrades associated with Network Constraints do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer submits a Transmission Service Request through Southwest Power Pool's OASIS.

## Appendix A: Point of Interconnection Area Map

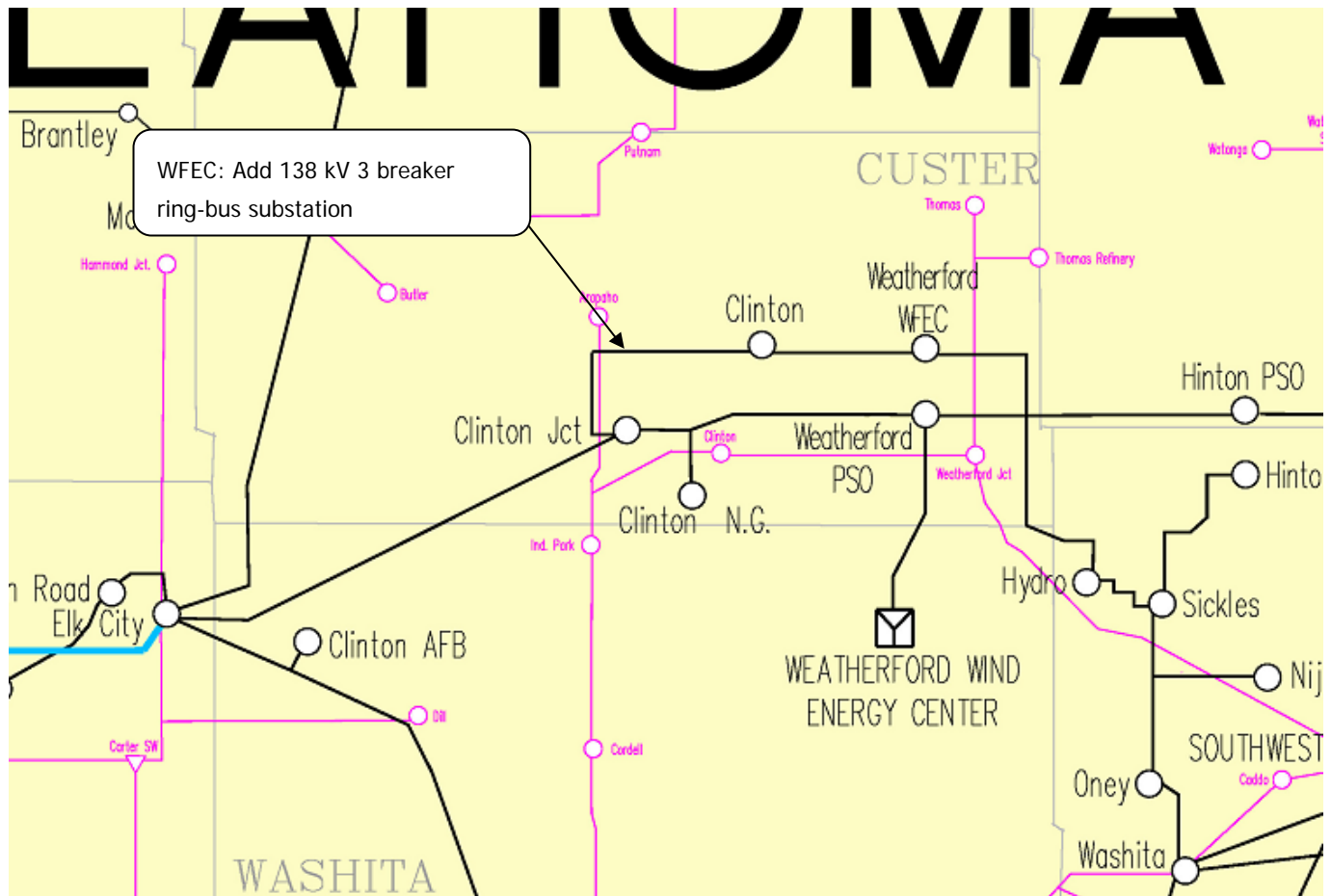


Figure 2: Point of Interconnection Area Map