Exhibit F: Buffalo Ridge Incremental Generational Outlet Study, Volume 1 (June 15, 2008)

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Buffalo Ridge Incremental Generation Outlet
Electric Transmission Study

Transmission Outlet Analysis
for
Southwest Minnesota/Eastern South Dakota
(Buffalo Ridge Area)
Generation Additions

(0 – 600 MW beyond "825 MW")

Volume 1

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Prepared by:
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Prepared by:
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Transmission Reliability & Assessment

Principal Contributors:

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0.0 Certification

I hereby certify that this plan, specification, or report
was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer
under the Laws of the State of Minnesota

Richard Gonzalez
Registration Number 18938
June 15, 2005

1.0 Background & Scope of Study

This electric transmission study addresses the development of transmission outlet capacity for additional electric generation capacity which may be constructed on the Buffalo Ridge in Southwestern Minnesota or adjacent South Dakota and Iowa portions of the 'Ridge. The study effort concentrated on developing and evaluating transmission options that could

- provide several hundred MW of incremental outlet capacity
- be implemented by the 2008-2009 timeframe.

It is recognized that continued generation development on the Buffalo Ridge will ultimately require addition of major transmission facilities to enable reliable and efficient transport of large blocks of power to the load centers located to the east. This Study is for the purpose of identifying smaller-scale improvements that can be implemented while those larger transmission plans are developed.

The existing transmission system and several transmission system improvement options were evaluated to identify the steady-state (thermal and voltage) limitations which would be successively encountered if additional increments of generation capacity were installed on the Buffalo Ridge, subject to the following principal assumptions:

- a total of 825 MW of generation (nameplate rating) has already been installed prior to the period of interest;
- the pre-existing 825 MW of generation has been integrated into the power system by construction of the Southwest Minnesota "825 MW" transmission facilities:
  - -- Split Rock-Nobles Co-Lakefield Jct 345 kV
  - -- Nobles Co 345/115 kV substation
  - -- Nobles Co-Fenton-Chanarambie 115 kV
  - -- Lakefield Jct-Fox Lk 161 kV #2
  - -- Troy 69 kV Switching Station
  - -- Buffalo Ridge-Yankee-White 115 kV
  - -- 60% series compensation of Wilmarth-Lakefield Gen 345 kV
  - -- various 161, 115 & 69 kV line reconductors & rebuilds
  - -- various substation upgrades

- it is desired to identify the limiters which would be incrementally encountered with additions ultimately aggregating to several hundred MW of additional nameplate generation capacity.
- under both system intact and first-contingency (n-1) conditions, facility loadings and bus voltage levels will be maintained within applicable established performance criteria, for both peak and off-peak load conditions, without resorting to tripping of generation or curtailment of deliveries to load.
- all new generation located on the Buffalo Ridge will have dynamic and steady-state reactive power control characteristics (power factor controllable in range of .90 lead to .90 lag) in conformance with the 1999-vintage NSP reactive power/voltage control standard.
- Present MAPP and MISO standards and policies will continue to apply with respect to constrained interface impacts, non-degradation of existing transfer capabilities, and generation accreditation procedures.

This study's analysis does not address transient or dynamic stability. Parallel studies (MISO "Buffalo Ridge Group II Interconnection") have identified local and regional stability limitations associated with installations of additional generation in this area. The local stability limitations identified by MISO are actually of a voltage collapse nature, and are addressed in this analysis (Section 5.2 & Appendix E). The regional stability limitations identified by the MISO studies appear to only require reactive power supply facility additions remote from the Buffalo Ridge to mitigate dynamic voltage dip violations. Consequently, these dynamic stability considerations are not considered critical with respect to selection of transmission options under evaluation in this Buffalo Ridge Incremental Generation Outlet Study.

This study's analysis also does not address mitigation of all remote interface impacts. Although interfaces traditionally of relevance to the Buffalo Ridge area were monitored, it is possible that incremental loading of remote interfaces, (either existing or defined in the future) may require mitigation. In this study, it has been noted that all transmission options studied exhibit 8 - 10% incremental flow ("circulating", "inadvertent", or "loop" flow) through the Manitoba Hydro system, from west to east; this increases loading on the Winnipeg-Twin Cities 500 kV interconnection.

The technical and economic analyses were performed for the purpose of identifying a preferred plan to achieve the specific goal of providing generation outlet capacity for several hundred MW of additional generation development on the Buffalo Ridge. It is recognized that many other potential generation developments--possibly aggregating to thousands of MW--are in preliminary stages of study by various entities; these may significantly affect overall future transmission requirements in this region. Many of these hypothetical generation projects are in the Dakotas, distant from the Ridge, but would in most cases require transmission to the Twin Cities or locations beyond, and therefore may involve transmission developments passing near the Ridge. Other postulated developments are within 100 - 150 miles of the Ridge, and therefore may offer opportunities for joint outlet development. In either case, however, although those projects could involve new or upgraded transmission through or near the Ridge, those hypothetical generation proposals would be implemented after the time period of interest for the increment of Buffalo Ridge generation outlet capacity addressed in this study.

Two specific generation proposed developments are electrically close to the Buffalo Ridge, or are located between the Ridge and the Twin Cities load center. These are

- Big Stone II (600 MW)
- Mankato Calpine Phase 2 (341 MW; 667 MW total)

Big Stone 2 is proposed to be a 600 MW coal-fired addition at the existing Big Stone site. MISO has completed the "Interconnection" Study for this unit, but not a "Delivery" (Transmission Service) study. The MISO interconnection study has concluded that there are two feasible interconnection options, each of which involves developing two 230 kV outlet lines to the east. Both options involve rebuilding the Big Stone-Canby-Granite Falls 115 kV circuit to 230 kV. For the second 230 kV outlet, one option establishes a Big Stone-Morris circuit (via rebuild or double-circuiting on existing 115 kV route), while the other option establishes a new Big Stone-Willmar 230 kV circuit.

The Big Stone-Canby-Granite Falls 230 kV development would affect the performance of Buffalo Ridge Option 6 (Yankee-White-Toronto) and related options (61A and 31A6) because Toronto is connected to Canby. A significant portion of the incremental Buffalo Ridge generation outlet achieved by Option 6's connection to Toronto is by virtue of increased loading which it causes on the Canby-Granite Falls 115 kV. If this line were rebuilt to 230 kV capability, the Buffalo Ridge outlet limit arising from overload of the Canby-Granite Falls line (1490 MW for Option 6 and 1430 MW for Option 61A) would almost certainly be relaxed. However, transmission system power flow patterns would change due the

- changes in network impedance arising from the Big Stone interconnection facility improvements, and
- the addition of the Big Stone generation output.

Consequently, it is not possible to determine the degree to which the Big Stone generation addition would affect Buffalo Ridge generation outlet capability until the outlet plans for Big Stone 2 are identified in greater detail.

The outlet plans for Big Stone 2 will not be finalized until after completion of the "delivery" study later in 2005; that study will likely identify the need for significant additional transmission system improvements (beyond those identified in the interconnection study) to accommodate delivery of the output of the Big Stone 2 generation addition.

Mankato Calpine is a multi-unit gas-fired plant proposed to be connected to the Wilmarth 345 and 115 kV buses. The first stage (326 MW) is proposed for a 2006 in-service date, while the timing of the second stage is unknown. This Buffalo Ridge study presumed the Stage 1 installation is in service, and it is further presumed that the transmission outlet improvement for this facility consists of a 115 kV line from Wilmarth to Carver Co, anticipated to consist of rebuild to double circuit 115/69 kV of an existing 69 kV line. The Stage 2 development is not modeled in this study. Stage 2, if it should ever be constructed, will require significant transmission improvements, the characteristics of which are not known at this time.

Other than the Big Stone 2 and Mankato Calpine Stage 1 projects, it is not possible to accurately predict the timing, size, and number of generation projects which may actually be implemented in the region. Accordingly, this Buffalo Ridge generation outlet study was performed presuming that transmission requirements for any such additional projects will be addressed by other power system improvements, the characteristics of which would be determined through future transmission studies.

2.0 Conclusions & Preferred Plan

The Preferred Plan is Option 31A, which adds the following facilities:

- Nobles Co-Fenton 115 kV line #2
- Nobles Co 345/115 transformer #2
- Lake Yankton-Marshall SW 115 kV line
- Shunt capacitors at Panther, Lk Yankton, and Winnebago Jct.

This option appears to offer the best overall results with respect to

power system performance	(system intact & contingent loadings & voltages)
power and energy losses	(MW and MWh)
practicality	(logistics of construction and operation)
price	(cumulative present worth cost)

This study further identified that it may also be advantageous to add the Option 6 facilities (Yankee-White 115 kV line #2 and White-Toronto 115 kV line), particularly if more than 400 MW of incremental outlet were desired. These Option 6 facilities create additional Buffalo Ridge outlet capability, and also

- effectively address the Yankee voltage stability limitation;
- yield a beneficial reduction in power system losses;
- "open up" more of the northern portion of the Buffalo Ridge to generation development;
- provide some incidental load-serving benefit to the Toronto/Hetland Jct area
- reduce Buffalo Ridge area generation power injection into the WAPA 345 kV system.

If the Option 6 facilities are not implemented, a separate "Yankee fix" is needed if the total demand for Yankee generation outlet exceeds approximately 250 MW.

3.0 Study History & Participants

Following a kick-off meeting in October, 2004, progress review meetings were held periodically during the study's progress:

October 28, 2004	Sioux Falls, SD	MRES Offices	(kickoff meeting)
November 23, 2004	Minneapolis, MN	Xcel Energy Offices	
December 20, 2004	Sioux Falls, SD	MRES Offices	
January 14, 2005	Sioux Falls, SD	MRES Offices	(adjacent to MAPP MB SPG meeting)
March 3, 2005	Sioux Falls, SD	MRES Offices	(adjacent to MAPP MB SPG meeting)

In addition to the Study Group meetings, updates were also presented to the MAPP Missouri Basin (MB) and Northern MAPP (NM) Sub-regional Planning Groups (SPGs) during their regularly-scheduled meetings.

The Buffalo Ridge Incremental Generation Outlet study group benefited from participation of technical staff of the following transmission entities:

ALT	Alliant Energy	Dubuque, IA
BEPC	Basin Electric Power Coop	Bismarck, ND
EREPC	East River Electric Power Coop	Madison, SD
GRE	Great River Energy	Elk River, MN
HCPD	Heartland Consumers Power District	Madison, SD
MDU	Montana-Dakota Utilities	Bismarck, ND
MRES	Missouri River Energy Services	Sioux Falls, SD
NWPS	Northwestern Public Service	Huron, SD
OTP	Otter Tail Power Co	Fergus Falls, MN
WAPA	Western Area Power Administration	Billings, MT
XEL	Xcel Energy	Minneapolis, MN

Participation was also solicited and received from state (Minnesota, North Dakota, and South Dakota) regulatory bodies and interested environmental and energy policy advocacy groups. Also in attendance at some meetings were representatives of generation development entities, trade groups, and representatives or consultants for transmission service customers.

Xcel Energy technical staff and consultants performed the powerflow simulations, economic analyses, and tabulation of results. These results were presented and reviewed at the study group's meetings, at which comments, conclusions, and recommendations were developed to guide each successive stage of analysis.

The first draft of this study report (dated February 28, 2005) was reviewed at the March 3, 2005 meeting; based on the comments received at that meeting and at the MAPP Missouri Basin Sub-Regional Planning Group meeting also held on March 3, 2005 a second draft (dated May 9, 2005) was distributed to the Study Group and reviewed at the May 17, 2005 MB SPG meeting.

4.0 Analysis

4.1 Models Employed

The powerflow models employed were developed by the SW MN/SE South Dakota transmission study group. The models are based on the 2001 Series MAPP models, as updated

1) by MISO for the Buffalo Ridge Combined Study Group II (CS-2) interconnection evaluation studies;
2) by the Study Group to reflect any additional system improvements (primarily reconductors, shunt capacitors additions, and station equipment upgrades) which have either already been completed, or are planned to be in service by 2007 summer.

Appendix M provides a detailed listing of modeling assumptions employed.

4.2 Conditions Studied

The technical analysis was performed based upon Year 2007 powerflow models. The base models were adjusted to represent the latest available forecast data for summer season peak (100%) and off-peak (70%) load conditions. The off-peak model simulates a high transfer condition corresponding to approximately 90 - 95% of the presently-recognized simultaneous North Dakota/Manitoba transfer limit as established by the Northern MAPP Operating Review Working Group (NMORWG), while the on-peak model represents only identified firm power transactions.

Table 1

					Net generation, MW					
Condition	load level	NDEX[1]	MHEX[2]	MWSI[3]	Wind	Anson	Path-finder	Minn Valley	Lake-field	Fibrominn
Peak	100 %	1167	1681	1058	918	232	0	0	550	50
Off-peak	70 %	1850	1982	1051	918	232	0	0	550	50
NMORWG Limit:		1950	2175	1480						

Powerflow diagrams for the base cases and relevant contingencies are provided in Appendix C.

Some sensitivity analysis was also performed with Anson generation at the 232 + 170 MW level, to investigate incremental effect of the Year 2005 addition of Anson Unit 4. Although this is a peaking unit, the Anson site is sufficiently near the Buffalo Ridge generation locations to warrant an examination of simultaneous operation during off-peak "pool emergency" conditions when Anson may be called upon to operate at full capacity, to "deliver reserves to the pool". This Anson sensitivity analysis is provided in Section 5.7.

Notes

1) NDEX = sum of flows on the 18 lines comprising the "North Dakota Export" Boundary;
2) MHEX = sum of flows on the 4 Manitoba Hydro-U.S. 230 & 500 kV tie lines;
3) MWSI = sum of flows on Minnesota-Wisconsin Stability Interface (Prairie Island-Byron, Eau Claire Arpin 345 kV)

10 options

4.3 Options Evaluated (Maps in Appendix A)

The following transmission improvement options were evaluated:

Option 1 "Nobles Co-Chanarambie 115 kV #2"
This option establishes a second Nobles Co-Chanarambie 115 kV line and installs a second 345/115 kV transformer at the Nobles Co Substation.

Option 1A "Nobles Co-Fenton 115 kV #2"
This option establishes a second Nobles Co-Fenton 115 kV line and installs a second 345/115 kV transformer at the Nobles Co Substation.

Option 2 "Lyon Co-Minn Valley 115 kV #2"
This option establishes a second 115 kV line from Lyon Co Sub to Minn Valley. This is achieved by rebuilding the existing Lyon Co-Yellow Medicine-Minn Valley 69 kV line at 115 kV.

Option 3 "Lake Yankton-Marshall 115 kV"
This option establishes a new Lake Yankton-Marshall SW 115 kV line.

"Marshall SW" is a new 115 kV substation proposed to be added in southwest Marshall by Marshall Municipal to address future distribution system supply needs. It is envisioned to be connected to an extension of the existing Marshall 115 kV loop between the existing Saratoga and "Southeast" substations.

Option 4 "Lyon Co-Franklin 115 kV"
This option establishes a new outlet line from the Marshall area eastward to the Redwood Falls/New Ulm vicinity by constructing a new Lyon Co-Franklin 115 kV circuit. All but 8 miles of this 44-mile route would consist of rebuild of existing 69 kV to 115 kV or double-circuit 115/69 kV configuration.

Option 5 "Chanarambie-Watonwan Jct 115 kV"
This option constructs a new Chanarambie-Watonwan Jct 115 kV line. This development presumes the Lakefield Gen-Watonwan Jct 115 kV line (presently proposed for 2007 in service) has already been installed for load-serving purposes. If not already installed, it would need to be added (at additional cost) to this option's facilities.

Option 6 "Yankee-White-Toronto 115 kV"
This option upgrades establishes a second Yankee-White 115 kV line, and adds a White-Toronto 115 kV line.

Option 7 "Yankee-Lyon Co 115 kV"
This option establishes a new Yankee-Marshall SW-Lyon Co 115 kV line.

Option 8 "Yankee-Lyon Co-Franklin 115 kV"
This option establishes a new Yankee-Marshall SW-Lyon Co-Franklin 115 kV line.

Option 9 "Reconductors only"
This option upgrades all existing facilities as necessary to alleviate overload conditions. This tactic consists of reconductoring any overloaded lines and addressing any transformer overloads by replacement with a higher-capacity unit, or installation of an additional unit.

For Options 1 – 8, any overloads still observed following addition of the new facilities are generally addressed by upgrading the affected lines or transformers as required. In one case (Option 3) an additional 115 kV circuit (Nobles Co-Fenton 115 kV #2) and an additional transformer (Nobles Co 345/115 #2) were added because such an addition economically eliminates the need for multiple other projects.

For Option 9, all overload conditions are addressed by reconductoring the affected lines and replacing/augmenting overloaded transformers.

The above transmission Options were designed to be representative of a broad range of theoretically possible power system improvement strategies within the range of the "modest, quickly implementable" concept. In addition to these "simple" options, several "combination" options were also developed, following the "first cut" evaluation of the above Options. The combination options were developed and examined to determine whether it may be advantageous to implement more than one of the originally-identified transmission options.

Although a large number of other combinations of improvements could be concocted, their individual performance characteristics would not differ substantially from that of one of the of the representative options studied.

Note on "White Substation".

Throughout this report, reference is made to the White 345/115 kV substation. During the course of this study, engineering work was begun on design of the Buffalo Ridge-Yankee-White 115 kV facilities which are part of the "825 MW" Buffalo Ridge outlet development plan. Due to certain WAPA concerns and MISO suggestions, it was decided to install a separate 345/115 kV transformer at "White" as a dedicated step-up for the Yankee-White 115 kV line. Subsequent site investigation led to the conclusion that these new 345/115 kV facilities would best be accommodated in a separate Xcel Energy substation adjacent to the existing WAPA White Substation. This new Xcel Energy 345/115 kV substation has been named *Brookings County Substation* ("Brookings Co").

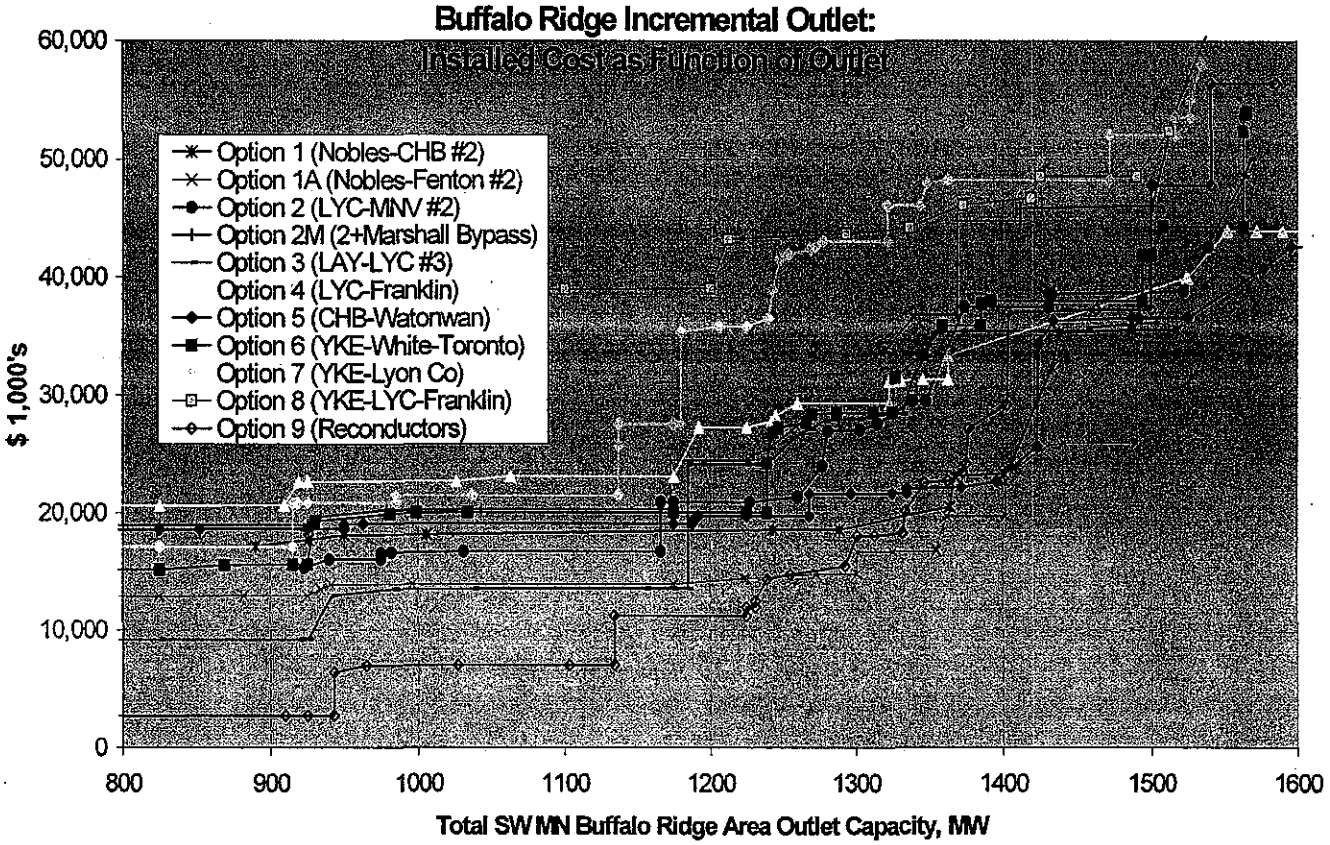
Accordingly, all references in this Report to new lines or transformers connecting to "White" should be interpreted as referring to the proposed new Brookings Co Substation.

4.4 "First Cut" Screening

To keep the amount of technical analysis required at a manageable level, a "first cut" screening analysis was undertaken in an attempt to identify any facility addition Options which were technically or economically significantly weaker than the others, and for which further detailed analysis would not be warranted. Graphs 1, 2, and 3 show the results of the initial screening analysis.

Graph 1 shows each Option's installed cost as a function of total Buffalo Ridge outlet capacity achieved.

Graph 1

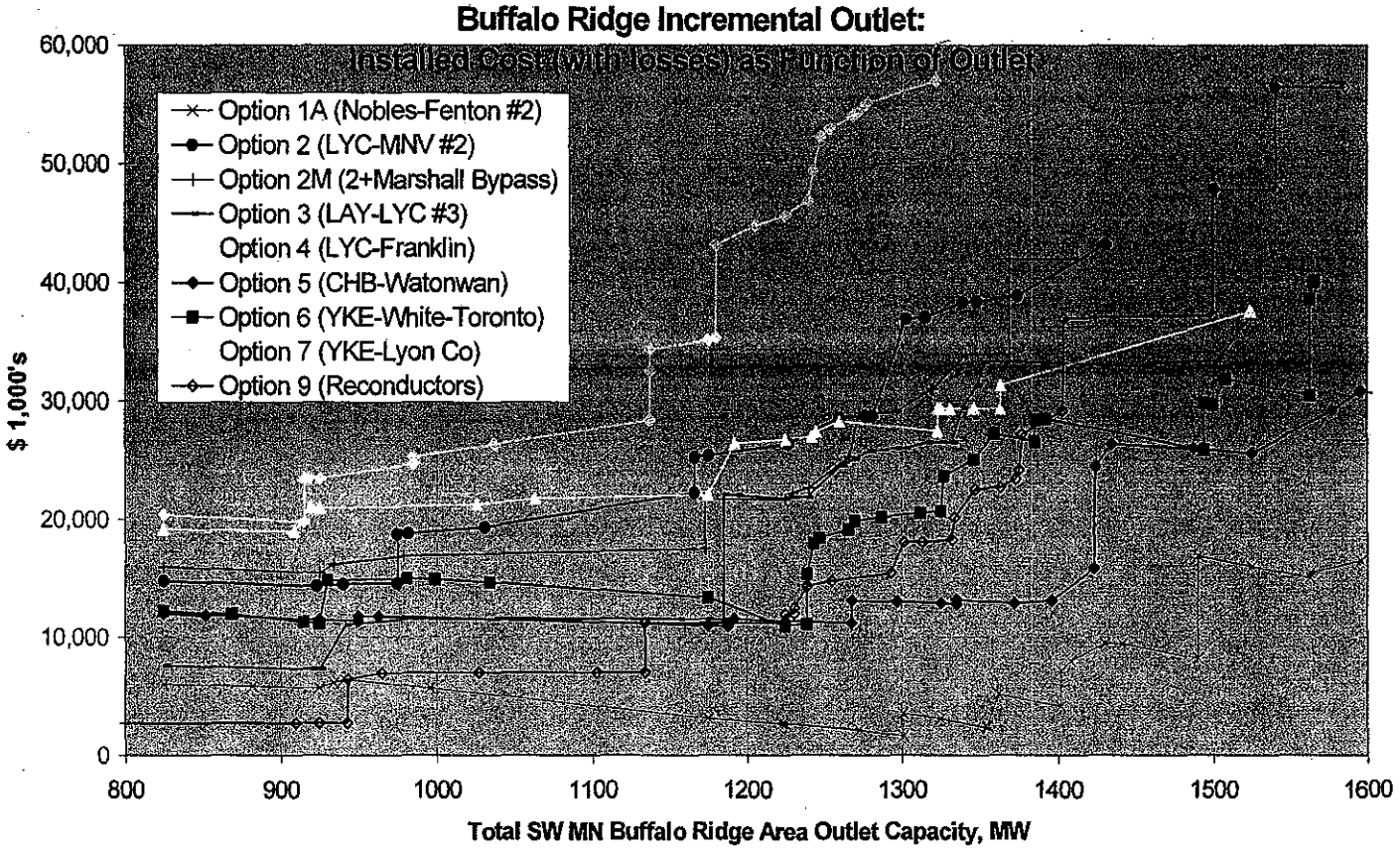


Graph 1 shows that

- Option 9 (Reconductors) is least-cost until approximately 1240 MW of Buffalo Ridge total outlet; Option 1A is least-cost beyond this level;
- Options 7 and 8 are highest-cost;
- Option 3 is relatively economical until approximately 1180 MW, at which point it suffers a large step increase in cost.

A more revealing comparison is achieved if one also takes into consideration the economic value of energy and capacity loss differences between the Options. Graph 2 shows each Option's evaluated cost, taking into account installed cost and losses. (Refer to Section 5.6 for details of loss value derivation).

Graph 2

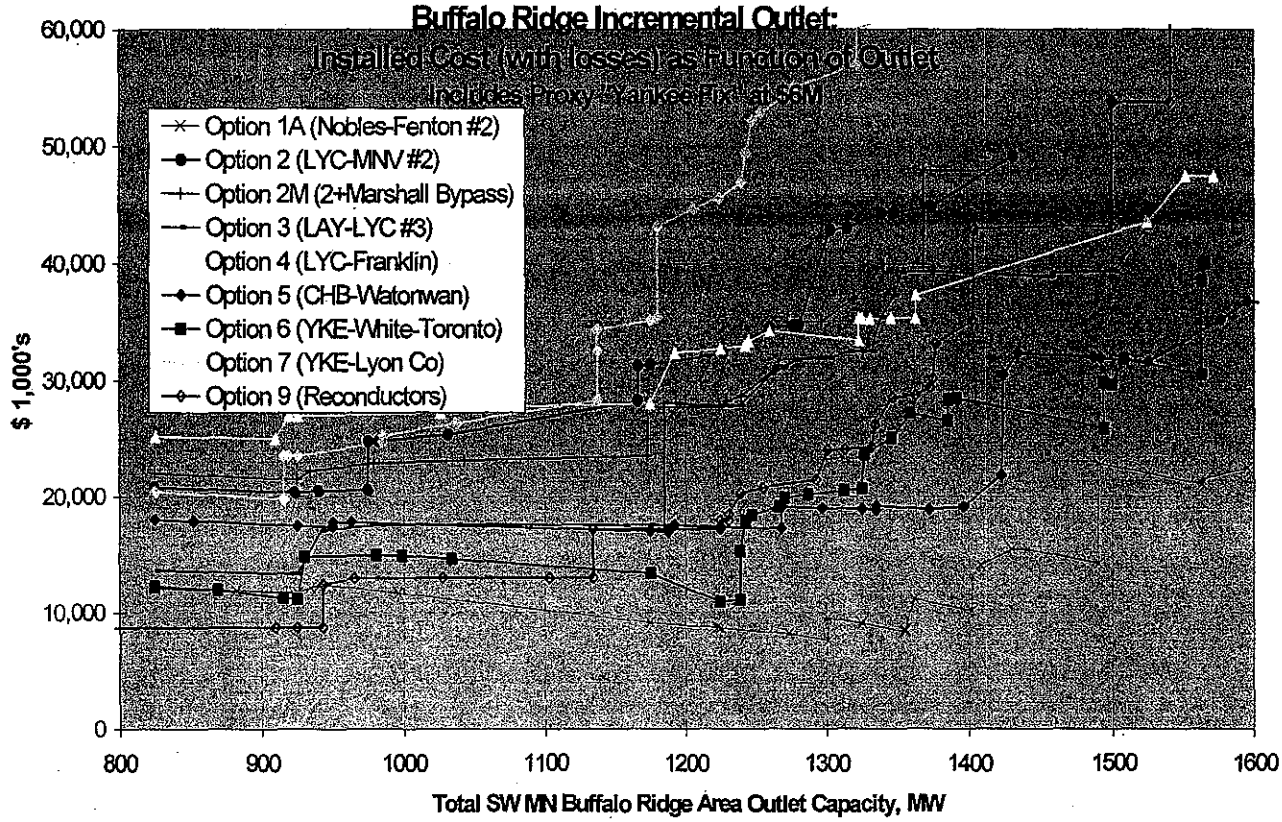


Graph 2 shows that adjusting for losses,

- Option 1A becomes least-cost at approximately 940 MW;
- Option 5 is more economical than Option 9 at outlet levels greater than 1240 MW;

Graph 3 shows the effect of taking into account also the cost of "Yankee" and "Marshall" fixes. (Refer to Sections 5.2 and 7.11 for details of Yankee and Marshall considerations.)

Graph 3



Graph 3 shows that considering installed cost, losses, and Yankee fix:

- Option 1A is least-cost at all levels beyond approximately 940 MW;
- Options 2, 2M, 7, and 8 are substantially more costly than the other Options

It was also observed that Option 1 (Nobles Co-Chanarambie) is always higher-cost than Option 1A Nobles Co-Fenton). Since 1A could later be extended from Fenton to Chanarambie if desired, it was decided that Option 1 should be dropped from further explicit analysis.

Accordingly, it was decided to drop Options 1, 2, 2M, 3, 4, 7, 8 from further consideration.

The remaining Options retained for further evaluation were 1A, 3, 5, 6, and 9.

4.5 Performance Evaluation Methods

Power system performance simulation was performed with the aid of the PSS/E digital computer powerflow program (Version 29) as supplied by Power Technologies, Inc. System intact and first-contingency analysis was performed primarily via the PSS/E activity TLTG ("Transfer Limit Table Generator"). TLTG performs automated contingency analysis while progressively incrementing power transfer between a defined "source" and "sink" location.

For both the TLTG analyses, the following apply:

Monitored facilities:

All transmission lines and transformers 69 kV and above in the model areas:

NSP (Xcel)	WAPA
Alliant	OTP
MEC	SMMPA
GRE	

Study area (facilities subject to outage):

All transmission lines and transformers 69 kV and above in the model zones:

NSP (Xcel) SW Minnesota/SD & NW Region	WAPA
Alliant	OTP
MEC	SMMPA
GRE (SW Minnesota)	

Appendix G contains the input data file describing the above facilities.

Activity TLTG achieves computational efficiency by extensive use of Power Transfer Distribution Factors (PTDFs) and Line Outage Distribution Factors (LODFs), concepts applicable to linear, time-invariant systems. These methods are appropriate for power system analysis, provided it is recognized their accuracy is constrained by their inherent limitations arising from non-linear effects such as exhaustion of reactive power supply and LTC transformer range limits. Consequently, the resultant reported transfer limits from TLTG are thus approximate.

Facilities identified in the TLTG outputs are considered valid limiters if they...

- have a PTDF of 2.0% or greater (system intact) or
- have an OTDF of 2.0% or greater (outage condition).

This 2.0% criterion was selected in accord with the MAPP Design Review Subcommittee (DRS) preliminary selection of this cutoff level for system impact analyses, and also independently in recognition that at PTDFs or OTDFs lower than 2%, very large reductions in generation (over 50:1) are required in order to achieve a perceptible amount of loading relief. Consequently, PTDFs/OTDFs lower than 2% strongly indicate that other power system adjustments are likely to be much more effective in producing the desired ameliorative effect than would generation adjustments in the study area. Refer to Section 5.3 for further discussion on evaluation of incremental loadings on constrained interfaces ("flowgates") and non-flowgate facilities.

5.0 Results of Detailed Analyses

5.1 Powerflow (System Intact & Contingency)

Appendix C provides the "raw" TLTG outputs for the transmission Options.

Appendix B contains summary tables derived from the "raw" TLTG output tables in Appendix C. These tables in Appendix B list only limiting facilities exceeding the 2% PTDF/OTDF cutoff.

For each limiting facility identified, the proposed corrective action is listed in the "Remedy" column. In most instances, an overloaded line is proposed to be reconductored and an overloaded transformer is proposed to be replaced with a larger unit. However, in some cases rather than upgrade the overloading facility, it was determined advantageous to instead neutralize the contingency causing the overload. This is accomplished by constructing another circuit either directly in parallel with the circuit whose outage is the limiting condition, or by adding a new transmission path which provides loading relief to the affected line or transformer.

For example, in Option 3 from the raw TLTG output it was observed that outage of the new 345/115 kV transformer at the Nobles Co substation, or the 115 kV line from Nobles Co to Fenton would result in overload of the Marshall East River-Granite Falls 115 kV line at the 918 +238 = 1156 MW level, Pipestone-Pathfinder 115 kV line at 918 + 267 = 1185 MW, and Erie Rd-S3 115 kV at 918 + 313 = 1231 MW. Furthermore, overload of the Nobles Co 345/115 kV transformer is possible during system intact conditions at the 918 +321 = 1239 MW level. To address all these overload potentials in the most economical manner, rather than reconductor all the potentially affected circuits, it is logical to instead install a second Nobles Co-Fenton 115 kV line and a second Nobles Co 345/115 kV transformer at the 1156 MW level.

5.2 Yankee Voltage Stability Analysis

The "825 MW" set of Buffalo Ridge area transmission improvements presently being implemented are designed to increase generation outlet capability from the Southwest Minnesota portion of the Buffalo Ridge to 825 MW. Recent MISO generation interconnection study reports ("Buffalo Ridge Group 2") have confirmed that if additional increments of generation in excess of this 825 MW design level were to be installed, several power system performance limitations would be encountered. One of the limiting conditions is voltage collapse (or dynamic instability) in the Yankee/Buffalo Ridge Substation vicinity following tripout of either the Brookings Co 345/115 kV transformer or the Yankee-White (Brookings Co) 115 kV line.

A similar voltage collapse potential also exists (at Fenton generation levels beyond 200 MW) on the southern portion of the Buffalo Ridge, at Fenton/Chanarambie following outage of either the Nobles Co 345/115 kV transformer or the Nobles Co-Fenton 115 kV line. Option 1A and related "combination" Options (31A, 61A, 71A, 31A6) directly address this limitation by adding a second Nobles Co 345/115 kv transformer and by establishing a second Nobles Co-Fenton 115 kV line, while Option 5 creates an additional Chanarambie outlet line (Chanarambie-Watonwan Jct 115 kV).

The analysis provided in Appendix L provides an evaluation of three transmission options formulated to address the Yankee voltage stability limitation. In addition to the three "add wires" options, another option that may be feasible is the installation of a Static VAR Compensator (SVC) at the Buffalo Ridge Substation. Confirming the feasibility of the SVC solution would require additional technical analysis; however, based on the reactive study work summarized in Appendix L, it is already known that an SVC designed to permit installation of at least 100 MW of additional generation at Yankee (total of 300 MW) would need to have to have a rating of approximately $\pm$ 80 - 100 MVAR and would likely have an installed cost of 5 - $6 million. This is comparable to the estimated cost of the least-cost "wires" option, which is addition of a second Buffalo Ridge-Lk Yankton 115 kV line.

Identification of the preferred "Yankee fix" is not necessary during the initial comparison of the Buffalo Ridge Area transmission Options; rather, it is only necessary to add a $6 million cost assessment to any Buffalo Ridge area generation outlet options that do not provide a "Yankee fix" by dint of establishing an additional Yankee 115 kV outlet line (to White/Toronto as in Options 6, 61A, and 31A6, or to Marshall as in Options 7 and 71A). This $6 million cost assessment is a proxy for the cost of implementing a Yankee fix (of undetermined type; either "wires" or SVC) for those Options requiring it.

It is important to note that for Yankee outlet levels over 300 MW, the SVC option would quickly become more expensive than a "wires" option, and for levels significantly beyond 300 MW, the addition of a second Buffalo Ridge-Lk Yankton 115 kV line is also not adequate. Consequently, for very high levels of Yankee generation outlet (approximately 350 MW or more) it is necessary to construct a second Yankee-White 115 kV line, plus either a second White 345/115 kV transformer (option 31AB), or a White-Toronto 115 kV line (Option 31A6).

5.3 Constrained Interface Analysis

5.30 General

Presently the MAPP criteria relating to constrained interfaces are:

1. Increased loading of identified interfaces is permitted, provided adequate ATC (Available Transmission Capacity) exists to accommodate the incremental interface loading.
2. If the ATC is already zero or negative, or would become negative due to the transaction, incremental loading is permitted, provided that
   - the incremental loading is less than 5% of the transaction amount (PTDF less than 0.05) for PTDF flowgates, and less than 3% for OTDF flowgates,

   --or--
   - the incremental impact is 1.0 MW or less,

   --or--
   - a mitigation plan is provided.
3. For facility additions (no incremental generation or power transfers) the incremental loading must not exceed 1.0% of the interface's TTC (Total Transfer Capability).

MISO Criteria are similar, but different; a comparison of applicable MISO and MAPP criteria for power transfers is provided in the table below.

Table 2
Impact Assessment Criteria for Incremental Power Transfers

Affected Facility type		Distribution Factor, %		Threshold	
		MAPP	MISO	MAPP	MISO
Line or Transformer (non-flowgate)	system intact	2.0	5.0	1 MW	0 MW
Line or Transformer (non-flowgate)	outage	2.0	3.0	1 MW	0 MW
Flowgate (PTDF type)		5.0	5.0	1 MW or 2% of TTC	0 MW
Flowgate (OTDF type)		3.0	3.0	1 MW or 2% of TTC	0 MW

The above criteria apply to new power transactions, and generation additions, or more precisely, the deliveries of power from such generation additions.

Different criteria apply to addition of transmission facilities without associated new transactions or generation additions. Since there is no power transfer involved, it is not possible to compute a distribution factor (PTDF or OTDF). Rather, only the MW incremental facility loading is examined. MAPP's criterion is 2.0% of a non-flowgate's rating, and 1% of a flowgate's TTC, each with a 1 MW threshold.

Appendix F provides tables summarizing

- the incremental system-intact interface flows (MW) for the line additions, and
- the resultant PTDFs for the generation additions, presuming the line additions to have already been completed.

The entries in Table F include the effect of the addition of 60% series compensation to the Wilmarth-Lakefield 345 kV line, as this is a component of the "825 MW" SW Minnesota transmission upgrades, and is incorporated in all the powerflow models used in this Buffalo Ridge Incremental Generation Outlet Study.

From these tables it is concluded that the transmission Options are not expected to create any new concerns with regard to incremental loading of constrained interfaces in the MAPP region. All incremental flows and distribution factors are below the applicable acceptance criteria. This result was anticipated because none of the Options involves addition of major transmission facilities; consequently, the power flow patterns through the transmission network are not significantly affected. All the Options yield reduced loading on the MWSI interface, due to the presumed Twin Cities "sink".

Despite the above review of incremental loadings, two interfaces must nevertheless be given special consideration: NDEX and MHEX.

5.31 NDEX (North Dakota Export)

The North Dakota Export interface (NDEX) consists of eighteen 345, 230, and 115 kV lines. The NDEX Total Transfer Capability (TTC) MW loading limit is based on dynamic stability considerations.

Option 6: White-Toronto 115 kV line
The White-Toronto 115 kV line, which is a feature of Option 6 and the related "combination" Options (61A and 31A6) creates a new North Dakota Export (NDEX) tie line. No significant change in total NDEX loading occurs, as all incremental flows into NDEX on the new tie line have compensating flows out of NDEX, since all incremental generation is modeled as delivered to the Twin Cities. The small changes observed in NDEX are due to changes in system losses; any noted increase (decrease) in NDEX loading is caused by reduced (increased) losses within the NDEX boundary.

The addition of a new NDEX tie line does not imply or guarantee achievement of any increase in NDEX capability. NDEX is a stability-constrained interface; accordingly, dynamic stability analysis is required in order to evaluate whether any NDEX increment might have been achieved. Any such improvement is apt to be relatively small, as addition of a 115 kV tie line will not significantly affect bulk system loadings and resultant power system dynamic performance for the regional EHV disturbances which presently establish the NDEX limit.

Impact of recent NDEX increase to 2080 MW
Section 5.8 addresses the principal incremental impacts of the recently-approved (by MAPP DRS) 130 MW increase in North Dakota Export limit (from 1950 MW to 2080 MW). The effect of the increased NDEX limit is to accelerate the need for the Granite Falls-Minn Valley-Panther 230 kV reconductors. A more subtle effect is increased post-contingent loading on the Paynesville-Roscoe Tp-Munson Tp-Farm Tp 69 kV line, which has already been identified as in need of upgrade due to the considerations covered in Section 5.9 and Appendix N.

5.32 MHEX (Manitoba Hydro Export)

The Manitoba-U.S. transmission interface (MHEX) consists of one 500 kV and three 230 kV lines:

- Dorsey-Roseau Co-Forbes 500 kV
- Letellier-Drayton 230 kV
- Glenboro-Rugby 230 kV
- Richer-Roseau Co-Moranville 230 kV

The permissible interface MW loading in the southward direction is limited by the thermal ratings of the various circuits, and also by power system dynamic stability considerations.

Referring to Table 3, it is observed that regardless of which Buffalo Ridge "incremental" outlet improvement plan is implemented, approximately 8 - 10% of the Buffalo Ridge-->Twin Cities power delivery flows northward to Manitoba on the Rugby-Glenboro and Letellier-Drayton 230 kV lines, and then southward on the Dorsey-Roseau Co-Forbes-Chisago Co 500 kV.

Although this throughflow does not increase the measured MHEX value (since the flow is measured both incoming and outgoing), it does increase loading on the Dorsey-Roseau Co-Forbes-Chisago 500 kV line segments. This increased loading is a concern because the existing 2175 MW TTC value for the MHEX interface loadability limit is based, in part, on the loading limit of the 500 kV interconnection, which is presently dictated by the 2000 amp (1732 MVA) continuous rating of the Roseau Co series capacitors.

Table 3
Incremental flows on Winipeg-Twin Cities 500 kV System
(PTDFs for Buffalo Ridge-->Twin Cities Power Transfers)

	% of Buffalo Ridge-->Twin Cities delivery	
Option	Dorsey-Forbes	Forbes-Chisago
0	8.1	9.9
1A	8.0	9.7
2	8.1	9.9
3	8.1	9.9
4	7.9	9.7
5	7.8	9.5
6	8.2	10.1
7	8.0	9.9
31A	8.0	9.8
61A	8.1	9.9
71A	7.9	9.7
31A6	8.1	9.9

During periods of high NDEX loading, the MHEX interface flows are biased more heavily onto the Dorsey-Forbes 500 kV line. Incremental Buffalo Ridge--> Twin Cities power deliveries cause further loading of the Dorsey-Forbes 500 kV line, and also the Forbes-Chisago 500 kV line. Since the present 2175 MHEX TTC value is based upon the series capacitors being at their 2000 amp loading limit, any incremental loading due to throughflows would be expected to result in a reduction in MHEX TTC value, unless provision were made for accommodating such incremental loadings.

Preventing deterioration of MHEX TTC would require either prevention of the Buffalo Ridge throughflow, or increase in 500 kV system loadability; these options are discussed in the following paragraphs.

Prevention of Buffalo Ridge-instigated throughflow

This option would involve installation of phase shifting transformers on the Glenboro-Rugby and Letellier-Drayton 230 kV lines. These transformers would have the ability to prevent the incremental northward flows on these two 230 kV circuits which combine to form the incremental southward flow on Dorsey-Forbes 500 kV. To coordinate with the lines' winter ratings, these transformers would each need to have a continuous rating of approximately 550 MVA; installed cost would be approximately $5 - 7 million each, for a total cost of approximately $10 - 14 million.

Increase 500 kV loadability

This option would accommodate increased loading on the Winnipeg-Twin Cities 500 kV system. This involves

- upgrading the Roseau Co and Chisago Co 500 kV series capacitors. The 500 kV series capacitor banks were designed to facilitate future upgrade from 2000 to 2500 amps; this upgrade would increase their MVA "through" rating from 1732 to 2165 MVA.
- Installing additional shunt capacitors on or adjacent to the 500 kV system to compensate for the incremental reactive power consumption on the 500 kV system.

Upgrade of the three series capacitor banks (2 at Roseau Co, 1 at Chisago Co) would cost a total of $3 - 6 million. Provision of additional shunt capacitors would cost $3 - 5 million, depending on the amount of MVAR required, and the voltage at which it would be installed (500 vs. 345, 230, or 115 kV). In addition to facilitating Buffalo Ridge generation outlet, there would likely be some relatively minor incidental benefits achieved with regard to MHEX and NDEX capabilities.

5.33 Constrained interface considerations for Yankee Fix

In addition to the principal transmission options under evaluation in this study, the Tables in Appendix F also have entries for a version of Option 31A which incorporates a "Yankee fix" option proposed by MISO. This "Option 31AB" is based on Option 31A, with the addition of a second Yankee-White 115 kV line and a second White (Brookings Co) 345/115 kV transformer. Consequently, this Option is similar to Option 31A6, but with a second White 345/115 kV transformer instead of the White-Toronto 115 kV line.

The distribution factor table in Appendix F shows that Option 31AB causes increased loading on the Ft Cal S flowgate but that the resultant distribution factor of 3.2%, although the highest of all Options studied, is still below the applicable 5.0% criterion. In contrast, Option 31A has a distribution factor of 2.9% and Option 31A6 has a distribution factor of 3.0%. Considering variability in results which can result from differing modeling assumptions and future generation and transmission facility additions, Option 31AB presents more risk of exceeding the 5.0% criterion (or any future replacement value for the present 5.0% cutoff) than the other "Yankee fixes" studied.

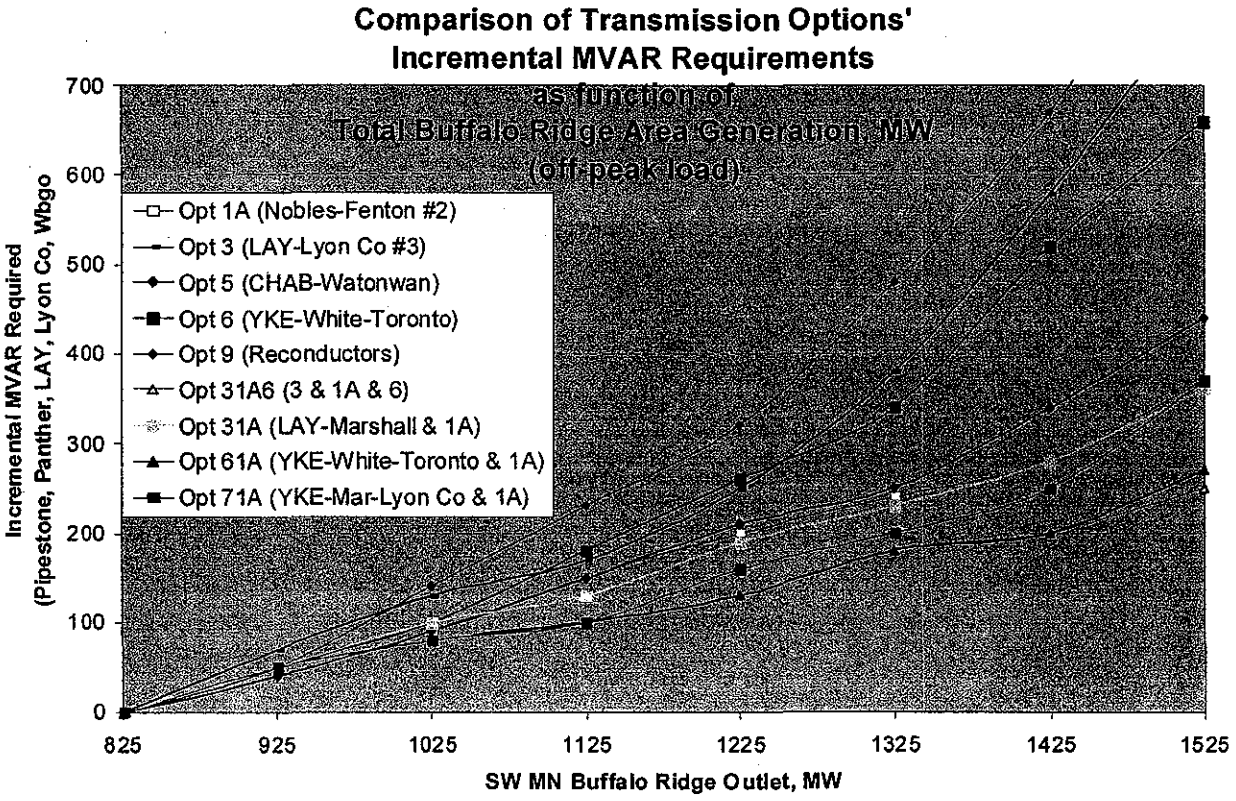
5.4 Reactive Power Requirements

Individual powerflow simulations were performed at the 925, 1225, and 1425 MW outlet levels to determine reactive requirements for each Option. The four most-severe Buffalo Ridge outlet contingencies were examined:

- Nobles Co 345/115 transformer
- White (Brookings Co) 345/115 kV transformer
- Lakefield Gen-Wilmarth 345 kV
- Wilmarth-Blue Lk 345 kV

A full tabulation of the reactive results is provided in Appendix D. Graph 4 summarizes these results; it shows that the transmission Options under evaluation exhibit significant differences with respect to reactive power requirements.

Graph 4



The options which rely principally on increased loading of existing or upgraded circuits (Options 9, 3, and 6) have relatively high incremental reactive requirements due to the lines' and transformers' I^2X reactive power consumption, whereas lower reactive requirements are noted for the Options which establish a new (Option 5) or reinforced 115 kV path (Option 1A) from the Buffalo Ridge area. The "combination" Options, which add two or three new 115 kV circuits, have the lowest reactive requirements.

Table 4 provides detail of the reactive requirements summarized on Graph 4, for the 1425 MW outlet level. Further detail is provided in the tabulation in Appendix D.

Table 4
Incremental Reactive Power Requirements
(Evaluated at 825 + 600 = 1425 MW)

		Reactive Requirement, MVAR					
Option	Buffalo Ridge Generation (MW)	Pipestone	Panther	Lake Yankton	Lyon Co	Winnebago Jct	Total
0 (existing system)	825	0	0	0	0	0	0
1A (Nobles Co-Fenton #2)	1425	0	120	80	0	80	280
3 (Lk Yankton-Lyon Co #3)	1425	240	120	100	60	60	580
5 (CHB-Watonwan Jct)	1425	40	120	100	0	80	340
6 (Yankee-White-Toronto)	1425	180	150	100	30	60	520
9 (Reconductors)	1425	300	120	100	90	60	670
31A	1425	0	120	100	0	60	280
61A	1425	0	120	20	0	60	200
71A	1425	0	150	40	0	60	250
31A6	1425	0	120	20	0	60	200

Notes:
1. Post-contingent reactive requirements based on holding post-contingent bus voltages to 0.95 pu.
2. Lk Yankton requirements listed are MVAR in excess of the existing 4 x 20 MVAR capacitor banks.
3. Lyon Co requirements listed are MVAR in excess of the existing 2 x 30 MVAR capacitor banks.

Regardless of which transmission option is selected for implementation, additional shunt capacitive compensation must be provided. Selecting Option 31A or Option 31A6 requires 100 MVAR of shunt compensation in order to achieve the 1125 MW level of Buffalo Ridge outlet, and at least 200 MVAR to achieve the 1425 MW level. All other Options require yet-higher levels, as shown on Graph 4.

A further conclusion is that it is highly desirable that generation additions have dynamic and steady-state voltage regulating capability similar to that previously required by NSP's ".90 lead/lag power factor" technical specification, as assumed in this analysis, per discussion in Section 1.0. Absent this feature, an equivalent amount of supplemental reactive power supply equipment must be provided in order to ensure adequate transmission system voltage regulation.

Regardless of which transmission option is implemented, the design of the reactive compensation installations will require further detailed analysis, taking into consideration factors such as flicker, switching transients, ratings of existing equipments, capacitor bank availabilities, and operational margins required to guard against voltage collapse conditions. The numbers and sizes of capacitor banks required to satisfy the reactive requirements identified in Table 4 therefore are subject to further adjustment. Table 4 should therefore be used as a comparative guide as to the relative quantities of reactive compensation required, rather than a definitive statement of the exact characteristics of the installations involved.

5.5 Losses: technical evaluation

Table 5 compares the predicted incremental MW losses for the Options, under off-peak load conditions, for the 1325 MW generation scenario, which represents a 500 MW Buffalo ridge area generation increment over the existing 825 MW. The "normalized" column shows the losses relative to Option 1A (2nd Nobles Co-Fenton 115 kV), which was chosen as the reference. More-detailed information on losses is provided in Appendix G.

Table 5
Power System Losses, MW (2007 Summer)
at 1325 MW Buffalo Ridge Area Generation Level compared to
825 MW generation level
(off-peak load condition)

Option	Description	Buffalo Ridge area Generation, MW	Losses, MW	Incremental Losses MW	%	Normalized
0	Existing System	825	13171.0	--	--	--
1A	2nd Nobles Co-Fenton 115	1325	13308.2	137.2	27.4	1.00
3	Lk Yankton-Marshall SW 115	1325	13320.7	149.7	29.9	1.09
5	Chanarambie-Watonwan Jct 115	1325	13313.4	142.4	28.5	1.04
6	Yankee-White-Toronto 115	1325	13314.4	143.4	28.7	1.05
9	Reconductors	1325	13322.7	151.7	30.3	1.11
31A	3 + 1A	1325	13307.4	136.4	27.3	1.00
61A	6 + 1A	1325	13301.5	130.5	26.1	0.95
71A	7 + 1A	1325	13308.4	137.4	27.5	1.00
31A6	3 + 1A + 6	1325	13299.0	128.0	25.6	0.93
345 kV	(White-Lyon Co-Franklin-Twin Cities)	1325	13259.0	88.0	17.6	0.64

From Table 5 it is concluded the 115 kV transmission Options studied have noticeably different loss characteristics. The loss difference between the most efficient Option (31A6) and the lossiest (9) is

nearly 24 MW. All options, however, have relatively high losses (25 -30%) due to lack of new transmission between the generation and the presumed Twin Cities "sink".

The "345 kV" entry shows what the incremental losses would be if a new 345 kV single-circuit line were constructed from the Buffalo Ridge area to the Twin Cities. Its resultant losses are 40 MW (128.0 - 88.0) lower than the most efficient 115 kV Option under study. Further loss reductions could be achieved via optimization studies, which would examine double-circuit construction, different conductor sizes, series compensation, etc. Additional loss reduction would also be achieved if the 345 kV development were combined with one of the 115 kV Options presently under study. A 345 kV development is beyond the scope of this Incremental study, but its performance is shown here for comparison purposes.

From Table 5 it is seen that during the off-peak condition analyzed, the most efficient 115 kV transmission options are 1A and the "combination" options which include 1A. The worst performance is offered by Option 9 (Reconductors).

Regardless of which 115 kV transmission Option is chosen, the incremental losses will be high--approximately 25 - 30%. This is because all the Options (by design) make only relatively modest, local, transmission improvements. Achieving better incremental loss results will require construction of higher-voltage transmission between the Buffalo Ridge area and the Twin Cities load center, as demonstrated by the "345 kV" example.

5.6 Losses: Economic Evaluation

Losses were taken into account in the economic evaluation of the Options by computing an "equivalent capitalized value" of the loss differences between each option and the least-loss option. This equivalent capitalized value of the loss differences was then applied as an adjustment to the installed cost of each option to arrive at a loss-adjusted or "evaluated cost" for each option. The capitalized value of the losses has two components: Demand Losses, and Energy Losses. The following paragraphs describe

- the method by which cumulative present worth of each of these components was computed;
- how the resultant sum was converted to an equivalent capitalized value;
- the financial parameters applied (discount rate, energy & capacity values, fixed charge rates, etc.).

The economic value of losses was evaluated presuming a 20-year period for the duration of the loss differences, and a discount rate of 8.0%/yr. Transmission system economic analyses are ordinarily conducted with longer study periods, typically 30 to 50 years. A 20-year study period was selected in this instance because loss differences change over time as transmission system additions are made and as use of the transmission system is modified due to both changes in generation pattern and changes in load levels and locations.

Demand losses (MW) were determined by performing powerflow simulations at various Buffalo Ridge generation levels between 825 and 1525 MW. These values are provided in Table 1 of Appendix G, and displayed in Graph 1.

The demand loss differences computed from the powerflow simulations were then multiplied by a factor of 1.15 to account for the 15% generation reserve requirement which all MAPP members must maintain in excess of their total system demand (load + losses). It is these adjusted MW figures whose economic value was determined.

The demand losses' value was computed presuming that 50% of the capacity would consist of base-load capacity with an installed cost of $1,000/kW and the remaining 50% would consist of peaking capacity with an installed cost of $400/kW. These values are considered representative, respectively, of contemporary costs for a coal-fired steam plant and a gas-fired combustion turbine installation.

Referring to Table 5, the 20-year cumulative present value of the demand losses is $1,185,500 per MW.

Energy losses were evaluated based upon the off-peak MW loss figures, presuming a 30% annual loss factor (load factor of the losses). The resultant annual MWh figures were then converted to dollar values by multiplying by a presumed average annual energy cost of $22/MWh. This $22/MWh energy cost is based on an estimated cost of replacement energy from the "pool"; if the replacement energy were instead priced against purchasing additional wind-derived energy to compensate for the losses, the per-MWh cost would be considerably higher (up to approximately $50 - 55/MWh).

Referring to Table 5, the 20-year cumulative present value of the energy losses resulting from each (off-peak) MW loss difference is $567,600.

Table 5

Computation of Equivalent Capitalized value for losses
(based on 1.00 MW loss on -peak)
(pool reserve requirement of 15%)

Term of loss reduction	20 yrs	Present Value of annuity factor		9.82			
Assumed life, xmsn	35 yrs			11.65			
Discount rate	8 %/yr						
Energy value	$22 MWh						
Loss Factor	0.30						
FCR, xmsn	0.16						
						Levelized Annual	Cum PW
Capacity value:				FCR		Revenue Rqmt	
	50 % peaking @		$400 /kW	0.15		$30,000	
	50 % baseload @		$1,000 /kW	0.15		$75,000	
					$	105,000	$
	add 15% reserve requirement:					120,750	1,185,541
Energy Value:	1.00	8760 hr/yr	0.30	$22 /MWh		57,816	$ 567,646
			Total annual cost, capacity & energy:		$	178,566	1,753,187
				Present Value factor		9.82	
				Cum PV	$	1,753,187	
				Equivalent investment	$	940,182	

For each option, the cumulative present value of the demand and energy losses was computed for the six Buffalo Ridge area generation levels for which powerflow simulations were performed (825, 925, 1175, 1225, 1325, and 1525 MW). The composite demand (MW) + energy loss (MWh) cost values were then converted to an equivalent capitalized value by the method described in the following paragraphs and in Table 5.

In order to determine the equivalent capitalized value of the losses, it is necessary to determine the amount of transmission investment which would cause a cumulative present worth cost (cumulative present worth of revenue requirements) equivalent to the cumulative present worth costs computed from the "pricing of the losses" exercise described in the preceding paragraphs. The following is a step-by-step example of the derivation of the equivalent capitalized value of losses.

Applying a 16% fixed charge rate, a $1,000,000 investment in transmission facilities yields a levelized annual revenue requirement of $160,000. Next applying a discount rate of 8.0% and a 35-year assumed life for transmission facilities, the "present value of annuity" factor is 11.65.

A $1,000,000 transmission investment, whose annual revenue requirement is $160,000 therefore has a 35-year cumulative present worth of revenue requirements of ($160,000)(11.65) = $1,864,000. Consequently, it can be observed that for transmission facilities the ratio between "cumulative present worth of annual revenue requirements" and "installed cost" is $1,864,000/$1,000,000 = 1.864. The

reciprocal of this number (0.5365) is therefore the factor by which to multiply the "cumulative present worth of the losses" to obtain the "equivalent capitalized value of the losses".

Example: At the 1325 MW generation level, Option 1A has losses that are lower than Option 9 by 14.5 MW.

Cumulative present value of the capacity is	(14.5 MW) ($1,185,500) =	$ 17,190,000
Cumulative present value of the energy is	(14.5 MW) ($567,600) =	8,230,000
Total cumulative present value of losses is	=	$ 25,420,000

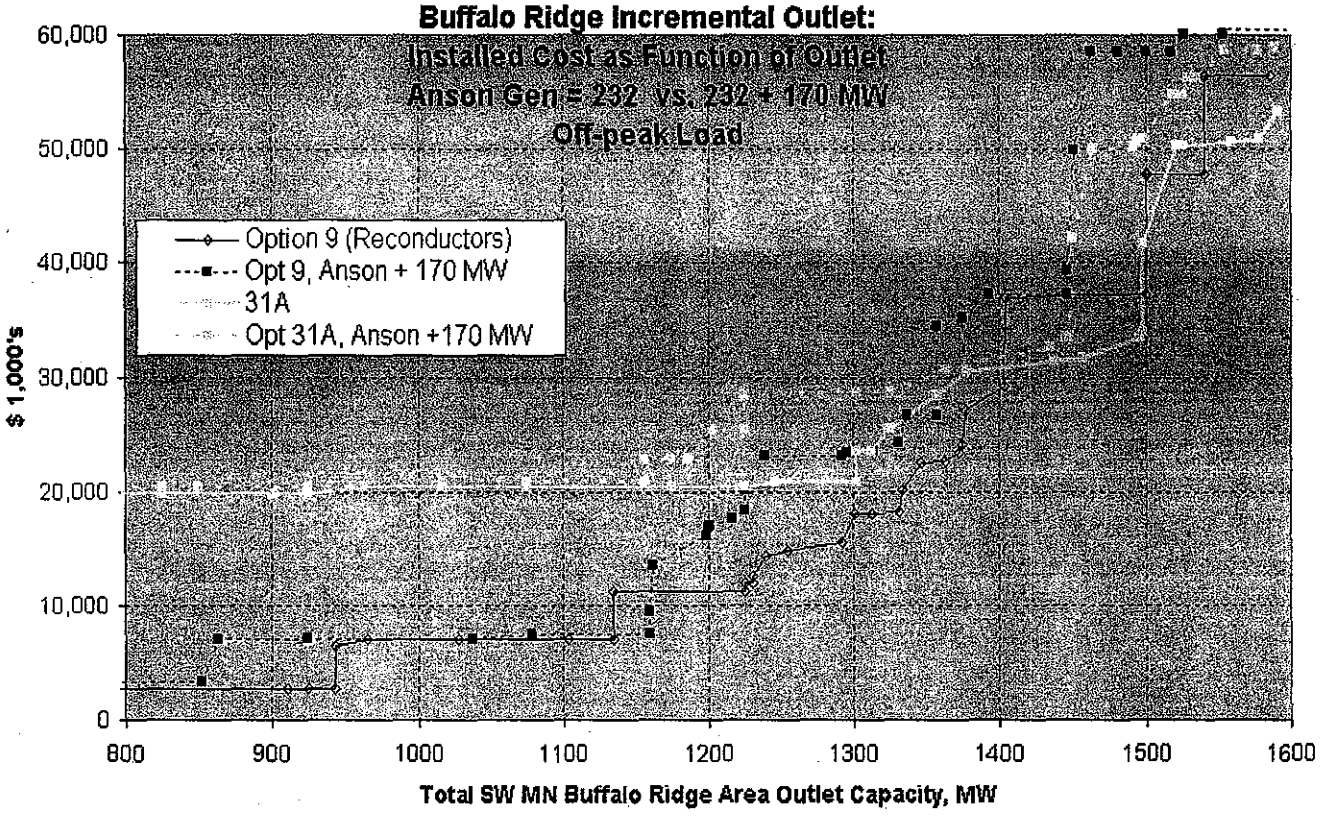
Installed cost of Option 1A at the 1325 MW level (value displayed on Graph 1)	$ 16,660,000
Equivalent capitalized value of loss reduction: - ($25,420,000) (0.5365) =	$ -13,630,000
Evaluated cost of Option 1A at the 825 MW level (value displayed on Graph 2)	$ 3,030,000

5.7 Anson Generation Sensitivity

The analysis described in the balance of this Report presents results obtained from TLTG simulations performed on powerflow base case models which represent Anson generation at 232 MW (existing two units of 116 MW each). This Sensitivity Analysis examines the 170 MW Unit 4 addition scheduled for Summer 2005, to determine whether the new Anson unit (connected to Split Rock Sub) would have any effect on the outlet capabilities achieved by the various transmission Options being studied for Buffalo Ridge generation outlet.

Graph 5 addresses this question. For Options 9 (reconductors) and 31A (2nd Nobles Co-Fenton 115 kV & Lk Yankton-Marshall 115 kV), additional simulations were run with the new Anson generation on line (total of 232 + 170 MW Anson generation). This graph shows the effect on installed cost; no adjustments for losses or other considerations.

Graph 5



Comparing the "before" (solid line) and "after" (dashed line) results, it is seen that for the off-peak condition studied, adding the 170 MW of Anson generation affects both Options in a roughly similar manner. Several conclusions can be made:

- There is no effect at Buffalo Ridge outlet levels below approximately 1130 MW;
- Anson generally causes limiting facilities to be encountered at Buffalo Ridge outlet levels 50 - 150 MW lower than in the base (232 MW Anson gen) case.
- Within the range 1200 -1400 MW total Buffalo Ridge output, the incremental effect of the new Anson generation is to increase the cost of achieving any given output level by $4 -9 million for Option 9, and $0 - 8 million for Option 31A.
- The general relationship between the Options' costs is not affected, but the crossover point where Option 31A becomes the less expensive option (considering only installed cost) occurs approximately 50 MW earlier (1360 vs. 1405 MW).

5.8 Big Stone #1/NDEX Sensitivity

The technical and economic evaluations of the transmission options presented in the balance of this report are based upon results from an extensive set of powerflow simulations, focusing on the off-peak load condition. These simulations represent one set of possible flow patterns resulting from the selected combination of load level, power transfers, and generation pattern.

Following completion of most of the technical analysis, it was noted that the base case models employed inadvertently had the existing Big Stone Unit 1 at only 122 MW net output. Although this is a possible "minimum load" scenario, operation of Big Stone at or near full output is more common, and must be accommodated. Increased generation at Big Stone will tend to increase loading on the Granite Falls-Minn Valley-Panther-McLeod-Blue Lk 230 kV line. Since this line is also an important outlet path for Buffalo Ridge area generation, incremental loading on this path is of concern.

Another matter of interest is that in recent months the MAPP Design Review Subcommittee (DRS) has accepted technical studies supporting an increase in NDEX limit of 130 MW (from 1950 to 2080 MW). This increase has been shown to be achievable with the combination of a capacitor addition proposed for Watertown, SD (by WAPA) and a generator addition at Groton, SD (by Basin Electric). The powerflow models used in the balance of this Report's analyses have NDEX at 1850 MW. Similar to Big Stone, increased NDEX loading also contributes to increased power flow on the Granite Falls-Minn Valley-Panther-McLeod-Blue Lk 230 kV line.

The sensitivity analysis provided in Appendix J evaluates the incremental effect of Big Stone generation level and the planned increase in NDEX operating limit. The powerflow modeling also reflects an update to the 69 kV system configuration in the Troy, MN vicinity; this affects Panther area 69 and 230 kV loadings.

Based on the analysis in Appendix J, the effect of the Big Stone #1/NDEX increase is to accelerate the need for the Granite Falls-Minn Valley and Minn Valley-Panther 230 kV reconductors. Increased loadings on these 230 kV line segments leave less capacity for accommodating incremental loadings

arising from Buffalo Ridge generation increases. Most transmission options studied suffer relatively similar impacts due to this change in base case conditions.

The exception to this general rule is Option 31A6. Presuming at least 1200 MW of total Buffalo Ridge outlet capability is desired (825 + 375 MW), Option 31A6 would incur the significant cost (approximately $10 million) for the Canby-Granite Falls 115 kV rebuild if it (Option 31A6) were implemented prior to the Big Stone Unit 2 interconnection facility improvements. If this Option were implemented later, (such as by initially implementing Option 31A and later--after Big Stone #2 addition--adding the White-Toronto 115 kV line segment) no such penalty is suffered.

Except for the Option 31A6 considerations discussed above, the differences in incremental impact observed among the Options are not significant, and therefore do not affect the conclusion that Option 31A is the Preferred Plan. Similarly, the conclusion that the addition of the White-Toronto 115 kV line also appears to be advantageous--particularly if a relatively large increment of Buffalo Ridge area generation outlet capacity is desired--remains correct, but tempered by the timing considerations described above.

5.9 Paynesville 69 kV Sensitivity

The existing Paynesville-Roscoe Tap-Munson Tap-Farm Tap 69 kV line is equipped with 4/0 ACSR conductor having a nominal Summer rating of 47 MVA. Based upon the results of the Southwest Minnesota/Southeast South Dakota Electric Transmission Study (November, 2001), the resultant "825 MW" Buffalo Ridge series of projects originally included the rebuild of this line to higher capacity.

At a later date, it was determined that this particular rebuild did not appear to be necessary for achieving the 825 MW target outlet capability, but would likely be needed at a somewhat higher outlet level. Consequently, it was removed from the list of "825 MW projects".

During the time between the initial identification of this project and its later de-listing, it was reported during the normal powerflow model building process, as among the "planned facilities". Consequently, in recent years some powerflow models have been issued which represent the Paynesville-Roscoe Tp-Munson Tp-Farm Tp 69 kV as having been rebuilt to higher capacity. This includes the base case models used for the powerflow simulations performed for this Buffalo Ridge Incremental study.

To address the possible impact of this modeling discrepancy, a sensitivity analysis was performed with the correct (existing) Paynesville-Roscoe Tp-Munson Tp-Farm Tp 69 kV impedances and ratings. This analysis, which is provided in Appendix N, shows that regardless of which transmission option is implemented, the Paynesville-Roscoe Tp-Munson TP-Farm Tp 69 kV line upgrade is required in order to achieve Buffalo Ridge area total generation outlet levels of over 1200 MW.

Since the need for (and cost of) the Paynesville-Farm Tp 69 kV upgrade is common to all transmission options studied, this consideration will not affect selection of the Preferred Plan.

6.0 Economic Analysis

For the transmission Options which survived the "first cut", economic analyses were performed

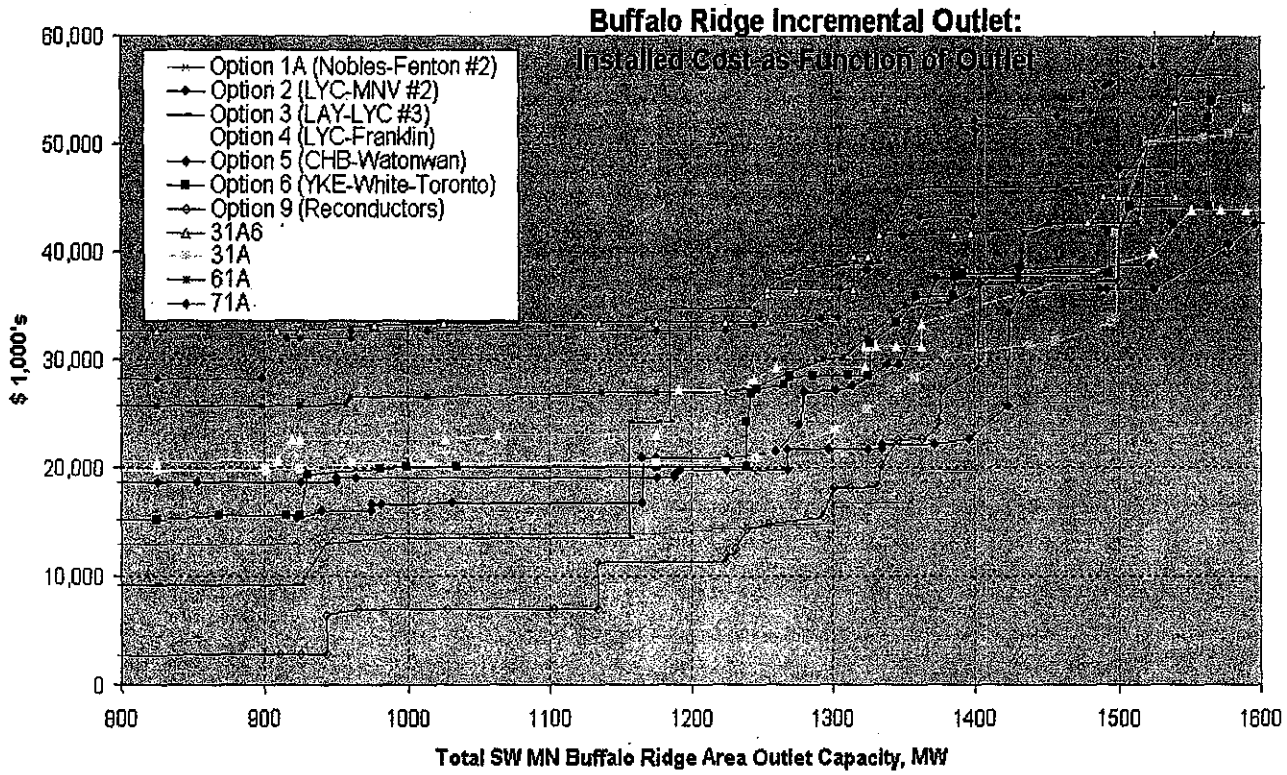
1) on the basis of installed cost of required facilities;
2) also considering the effect of power and energy losses;
3) also considering the cost of Yankee and Marshall "fixes"
4) also considering the cost of satisfying reactive power requirements.

Except for the economic evaluation of the electrical losses, present value analysis was not necessary, as it is presumed that the in-service dates (and hence expenditure patterns) do not vary significantly (more than 1 year) amongst the options.

6.1 Installed Cost

Graph 6 shows the estimated installed cost of each option as a function of incremental outlet capacity desired beyond the pre-existing 825 MW of outlet capacity. This graph was developed based on the data in Appendix B; as each successive power system limitation is encountered, the cost of the required "remedy" (reconductor, replace transformer, build new line, etc.) is added to the running total. These incremental investments are denoted by the individual data points displayed in Graph 6. No consideration of losses is represented in this graph.

Graph 6



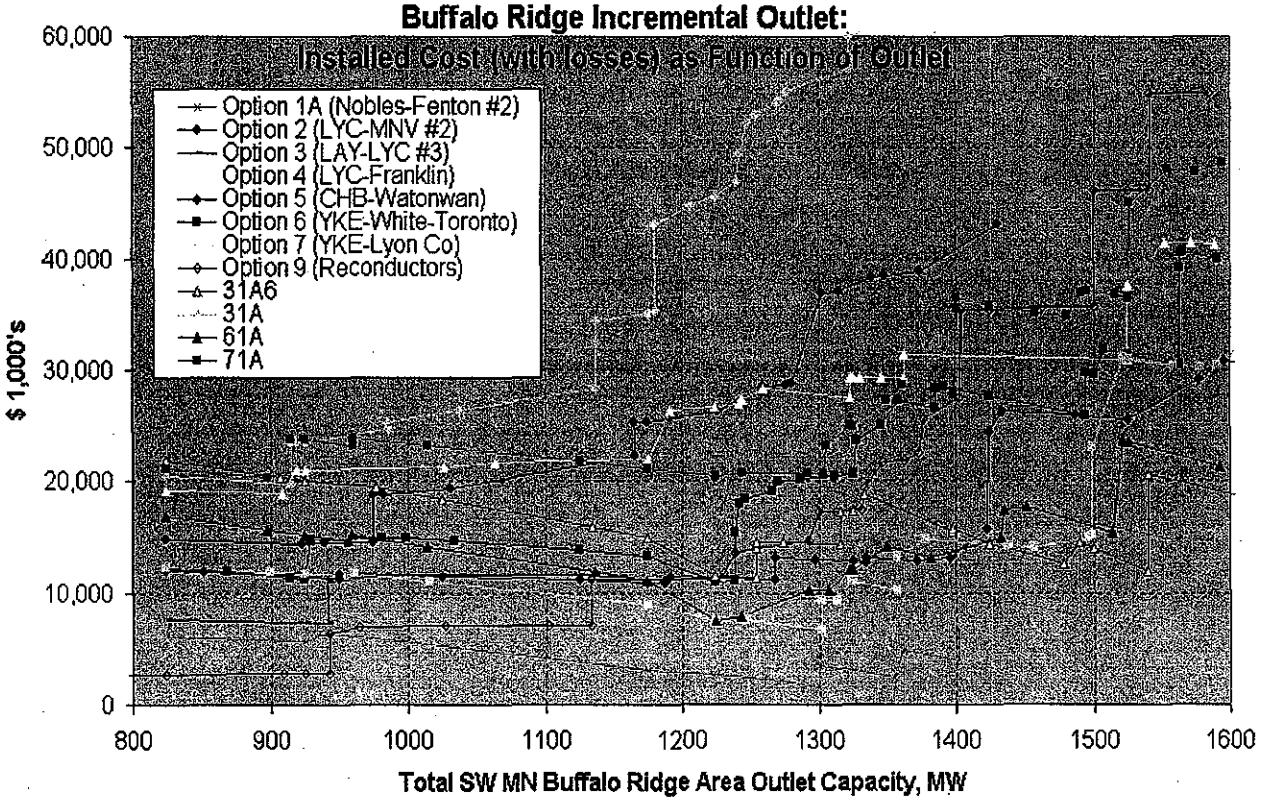
From Graph 6, it is observed that

- Option 9 ("reconductor only") is the least expensive if less than 1240 MW of outlet is required.
- Options 1A and 3 ("2nd Nobles Co-Fenton 115 kV" and "Lk Yankton-Lyon Co 115 #3") have essentially identical installed cost throughout the range of 950 –1150 MW of Buffalo Ridge area outlet capacity. At higher levels, 1A is significantly lower cost;
- At outlet levels beyond 1250 MW, Option 1A has the lowest installed cost.

6.2 Evaluated Cost (Adjusted for Losses)

Graph 7 is based on the installed cost data from Graph 5, with the data for all Options adjusted for each option's higher power and energy losses relative to Option 1A. Section 5.5 contains detailed information regarding the computation of the equivalent capitalized value of the loss differences.

Graph 7



From Graph 7 it is observed that

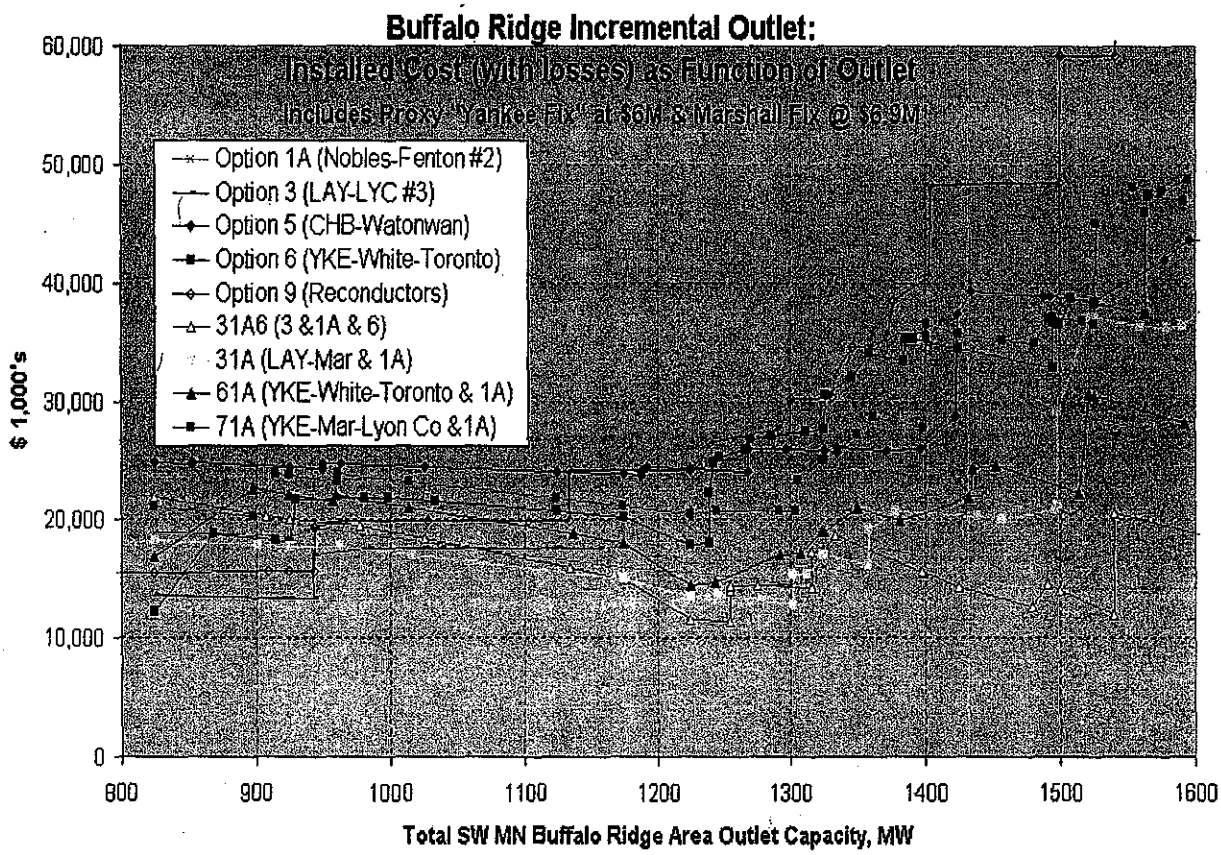
- Beyond 950 MW, Option 1A ("2nd Nobles Co-Fenton 115 kV") is consistently the least-cost option.
- In the range 1200 - 1400 MW, the next-lowest-cost options are 31A, 61A, and 5.

Note: Option 3 is graphed only up to the 1156 MW level because beyond this point, it is most economical to implement the Option 1A facilities rather than individually address the Option 3 overloads directly.

6.3 Evaluated Cost (Adjusted for Losses, Yankee, and Marshall fixes)

Graph 8 shows the effect of taking into consideration the need for addressing the Yankee voltage stability limitation (described in Section 5.2), and the need for an additional transmission supply to Marshall (Section 7.11).

Graph 8

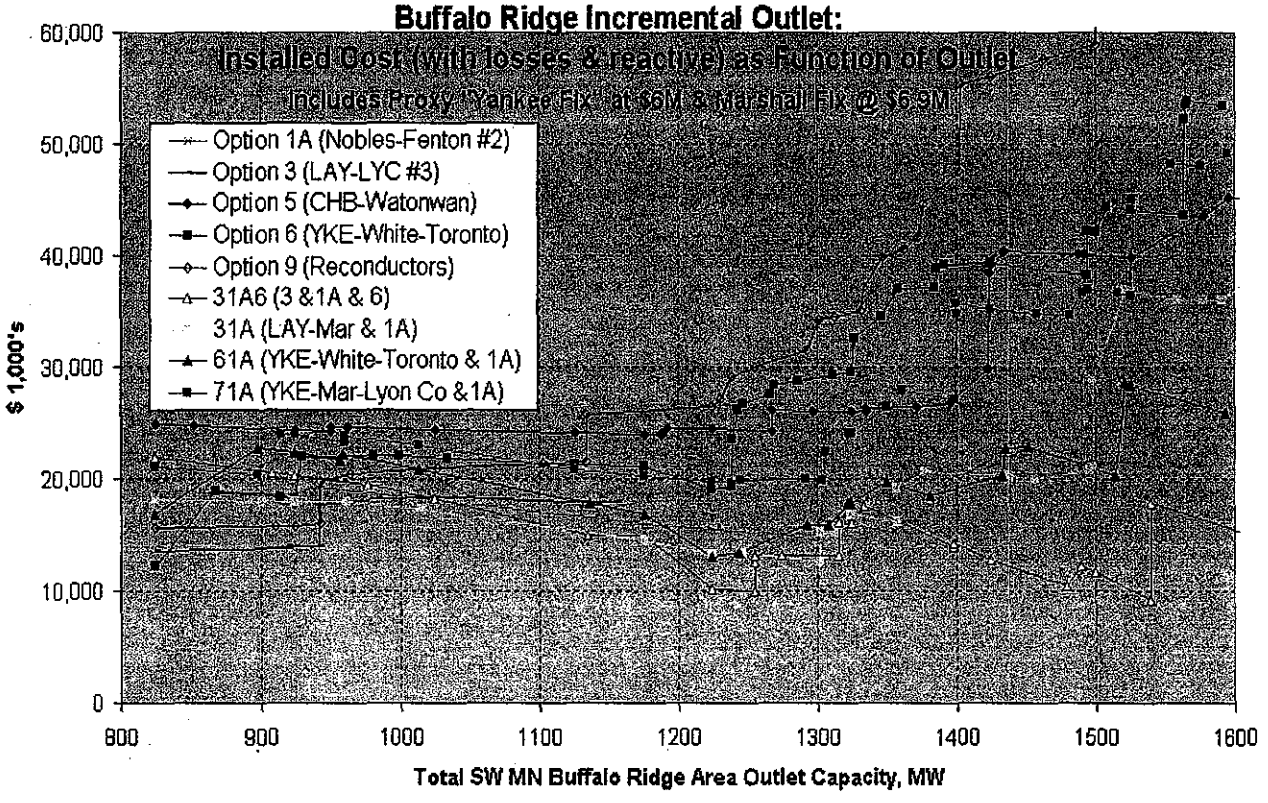


As expected, the Options which lack Yankee or Marshall "fixes" become higher cost than was previously observed in Graph 7. Beginning at approximately 1200 MW, a separation or "break" is developing between most of the "1A" options (1A, 31A, 61A, 31A6) and the remaining options (5, 6, 9, 71A).

6.4 Evaluated Cost (Adjusted for Losses, Yankee/Marshall fixes, & Reactive)

Graph 9 shows the effect of taking into consideration the Options' differences with respect to reactive power requirements. The evaluation of reactive power needs is described in Section 5.4, and further documented in Appendix D.

Graph 9



As expected, the Options which have the highest incremental reactive requirements become comparatively less economical than those which need fewer capacitor additions. Specifically, the "break" between the "1A" group of options and the others becomes more noticeable, while Option 9 (reconductors) becomes distinctly more expensive than all other options at all Buffalo Ridge outlet levels above 1130 MW.

From Graph 9 the following observations can be made:

- Option 9 (Reconductors) is never the most economical, and is the most expensive option at all Buffalo Ridge Area generation outlet levels beyond 1130 MW.
- Beyond 1130 MW, there is a group of four transmission options (1A, 61A, 31A, 31A6) which have total evaluated cost consistently lower than the other five options.
- The group of four lowest-cost options all include the "1A" transmission facilities.
- Option 5 (Chanarambie-Watonwan Jct 115 kV) is the most expensive option up to the 1130 MW level. Beyond that level, it is in the "middle of the pack". However, it is never among the "lowest-cost" group.
- Option 71A (Yankee-Marshall-Lyon Co 115 kV & 1A) is the only "combination" option studied that does not fall within the "lowest-cost" group.
- Option 6 (Yankee-White-Toronto 115 kV) is a mid-cost option up to approximately 1230 MW. Beyond this level, its cost escalates rapidly.
- Option 31A6 becomes least-cost at approximately 1180 MW, but there are several cross-overs with Option 31A between 1255 and 1360 MW, at which point 31A6 breaks away from the pack.
- At levels above 1360 MW, Option 31A6 is consistently the lowest-cost option.

Based on the above observations, the following conclusions can logically be drawn:

- The Option 1A facilities will be part of the optimal transmission development.
- Addition of the Option 3 facilities (this creates Option 31A) generally does not impose any additional net cost on Buffalo Ridge outlet development, yet provides the Marshall load-serving benefits desired. Consequently, the Option 3 facilities (as part of Option 31A) also appear to be a desirable component of the Buffalo Ridge outlet plan.
- Addition of the Option 6 facilities to the Option 31A development (Option 31A6) generally reduces the total cost of Buffalo Ridge outlet beyond the 1180 MW level, provides the required "Yankee fix", and offers some incidental load-serving benefits. However, the benefit of adding the Option 6 facilities is most evident at Buffalo Ridge outlet levels beyond 1360 MW.

7.0 Relevant Concerns

7.1 Load serving issues

Several load serving issues exist or are imminent in southwestern Minnesota and eastern South Dakota. These are summarized below and described in the following paragraphs.

Load center	Critical Contingencies
Marshall, MN	Lyon Co-Marshall Switching Station 115 kV
New Ulm/Redwood Falls	Minn Valley-Redwood Falls-Franklin 115 kV or Wilmarth-Franklin 115 kV
Olivia/Bird Island	Minn Valley-Sacred Heart 69 kV or Panther 230/69 kV source (Panther 230/69 kV transformer or Panther-Bird Island 69 kV line)
Dotson/Lamberton	Heron Lk-Storden 69 kV
Toronto/Hetland Jct	Burr Jct-Toronto 115 kV

Detailed examination of these load-serving issues is beyond the scope of this study; however, some comparative performance characteristics can already be divined based on results of previous studies and consideration of the transmission system topology.

7.11 Marshall, MN

During periods of low (or zero) wind generation, the Marshall area load center is reliant on deliveries from

- the north via the two 30-mile 115 kV lines originating from the WAPA Granite Falls and the Xcel Energy Minn Valley 230/115 kV transformations;
- the south via the two Lk Yankton-Lyon Co lines from the Split Rk and future Nobles Co 345/115 kV transformations (distances of approximately 80 - 100 miles).

Only one of these transmission sources connects directly to the Marshall 115 kV load-serving loop; the other three are connected to the Lyon Co Substation, whose only connection to the Marshall 115 kV loop is the Lyon Co-Marshall Switching Station 115 kV line. Consequently, presently there are only two transmission sources to the Marshall 115 kV loop. Continued load growth at Marshall has rendered the existing two 115 kV sources inadequate for first-contingency conditions. Any Option which constructs a new 115 kV line into the Marshall 115 kV loop would provide additional load-serving capability.

Option 3 establishes a new Lake Yankton-Marshall Southwest ("Marshall SW") 115 kV line. The Lk Yankton-Marshall SW line establishes a new path into Marshall from the south, thereby providing loading relief for the existing two Lk Yankton-Lyon Co 115 kV lines; this is relevant

because with increased Buffalo Ridge generation, loss of the newer Lk Yankton-Lyon Co 115 kV circuit can cause overload of the older circuit, which has smaller conductor.

A special benefit of the Lk Yankton-Marshall 115 kV line addition is that the Lk Yankton SVS is brought electrically closer to the Marshall load center. This results in improved voltage regulation for the Marshall area, in addition to increased load-serving capability.

A future extension of this new Lk Yankton-Marshall SW 115 kV line, from Marshall SW approximately 12 - 15 miles to Lyon Co Substation, could also provide further load-serving capacity and assist in establishing additional wind outlet capacity, particularly if a future EHV transmission development were implemented connecting to the Lyon Co Substation. This is consistent with results of MISO "exploratory" studies which have indicated the need for higher-voltage transmission development from the Buffalo Ridge to the Twin Cities, and with this Incremental study's losses analysis, which indicates that incremental power and energy losses will be rather high until a higher-voltage development is implemented.

The potential future Marshall SW-Lyon Co 115 kV line section also would provide a second connection from Lyon Co Substation to the Marshall 115 kV load-serving loop, thereby minimizing any "prior outage" Buffalo Ridge outlet limitations associated with the Marshall 115 kV loop segments.

"Combination" Options 31A & 31A6 include Option 3's Lk Yankton-Marshall 115 kV line.

Option 2 establishes a second Lyon Co-Minn Valley 115 kV line, while Option 4 establishes a new Lyon Co-Franklin 115 kV line. With either option, to fully address the Marshall load-serving need it would be necessary to add another 115 kV line from Lyon Co to the Marshall 115 kV loop.

Options 7 and 71A establish a Yankee-Marshall SW-Lyon Co 115 kV line. Option 8 extends this line from Lyon Co eastward to the Franklin 115 kV station. Any of these Options would yield a new 115 kV transmission source to Marshall, although significant amounts of future shunt capacitor additions would likely eventually be required with these options to ensure adequate post-contingent Marshall 115 kV voltage.

7.12 <u>New Ulm/Redwood Falls, MN & Olivia/Bird Island</u>

Options 4 and 8 establish a new Lyon Co-Franklin 115 kV circuit. This partially addresses the New Ulm/Redwood Falls load-serving issues because the present load-serving limitation is due to loss of either end of the Minn Valley-Redwood Falls-Franklin-Swan Lk-Wilmarth 115 kV line. The Lyon Co-Franklin line segment brings a new 115 kV source into the center of this line (Franklin). With a future extension of the new 115 kV to Ft Ridgely, this would likely be adequate for the foreseeable future load serving needs in the Redwood Falls/New Ulm area.

The improved Franklin 115 kV situation would also benefit the Olivia/Bird Island area due to the resultant stronger 69 kV source at Franklin, and the recently-rebuilt Franklin-Bird Island 69 kV line. However, additional load serving improvements would still be required for the Olivia/Bird

Island area because this improved Franklin 69 kV source cannot fully mitigate the two most critical Olivia/Bird Island area transmission contingencies:

- Outage of Panther 230/69 kV transformer
- Outage of Panther-Bird Island 69 kV line

7.13 Dotson/Lamberton

Options 4 and 8 establish a Lyon Co-Franklin 115 kV line. This creates the opportunity for addition of a 115/69 kV substation approximately midway, in Sheridan Township. Such a station would provide a new 69 kV source approximately 20 miles closer to the Dotson/Lamberton area than the existing Franklin 115/69 kV source.

7.14 Toronto/Hetland Jct

The Toronto and Hetland Jct 115/41 kV substations are supplied radially by the Burr Jct-Toronto 115 kV line. Option 6 and the related "combination" options 61A and 31A6 establish a White (Brookings Co)-Toronto 115 kV line. This provides a second 115 kV supply to the Toronto Substation, thereby immunizing Toronto and Hetland Jct substations against the Burr Jct-Toronto 115 kV outage contingency. Presently, this line outage causes interruption of supply to all load normally served from the Toronto and Hetland Jct 41 kV sub-transmission systems, requiring that recovery be effected by use of an emergency 69/41 kV connection to East River Electric Power Coop near Lake Preston and start-up of Otter Tail Power's Lake Preston diesel plant.

The new Brookings Co-Toronto 115 kV line established by Option 6 (and the related "combination" options 61A and 31A6) also facilitates routine maintenance or future upgrades and rebuilds of the Toronto/Burr/Canby area 115 kV transmission lines.

7.2 Constructability & Schedule Considerations

The transmission Options under evaluation differ significantly with respect to the number and type of construction activities required. These differences have ramifications with respect to the lead times involved in implementing the series of improvements required. Simpler Options are easier to build.

Options which require large amounts of reconductoring and rebuilding require disproportionately more time. This arises because power system reliability considerations limit the number of circuits within a geographical sub-area that can be simultaneously out of service for upgrade or replacement, since many of the circuits involved are to some degree electrically in parallel. This dictates that construction cannot be undertaken simultaneously on more than a few existing circuits per season; rather, sequential construction is required. In contrast, Options which rely less heavily on reconductors and rebuilds encounter fewer construction outage constraints.

Table 8 summarizes the types of transmission line work involved and gives an estimated duration of work, based on a January, 2007 start date.

Table 8
Constructability & Schedule Considerations
For achieving 500 MW Buffalo Ridge Area Generation Outlet Increment
(825-->1325 MW total outlet)

		miles of transmission						
Option	Description	New	Recond	Rebuild	YKE/Marsh	Total	Capacitors	Years
1A	Nobles Co-Fenton 115 kV #2	18	32	19	25	94	10	2.0
3	Lk Yankton-Marshall-Lyon Co 115 kV	48	9	48	10	115	17	2.0
5	Chanarambie-Watonwan Jct 115	50	28	19	25	122	11	2.5
6	Yankee-White-Toronto 115	30	48	49	15	142	15	3.5
9	Reconductors	0	51	60	25	136	21	4.0
31A	3 + 1A	48	24	19	10	101	10	2.5
61A	6 + 1A	48	29	19	15	111	7	2.5
71A	7 + 1A	73	24	49	0	146	7	3.0
31A6	3 + 1A + 6	78	36	19	0	133	6	2.5

Notes:

1. Options that do not include Option 6 or Option 7 facilities need to address Yankee voltage collapse condition; presumed to be 10-mile Yankee-White 115 kV #2.
2. Options that do not include Option 3, 4, or 7 facilities will need to address Marshall load-serving requirements; presumed to be 15-mile Lk Yankton-Marshall SW 115 kV.
3. "Option 3" has Option 1A facilities added at 1150 MW (refer to Sections 5.1 & 6.2).

The extreme is Option 9, which relies exclusively on the reconductoring or rebuilding of existing lines, except for the Yankee and Marshall fixes. The construction time for these line projects and associated substation projects is estimated to be approximately 4 years. Similarly, Options 6 and 71A are nearly as laggard, at 3.5 and 3 years, respectively; again due to the large number of reconductor and rebuild miles involved.

The 4 years' implementation time indicated in Table 9 for Option 9 presumes all circuits to be reconductored can be taken out of service when requested. Although some preliminary effort has been made to take into consideration the logistics of implementation, it is anticipated a more-detailed construction scheduling analysis would indicate a somewhat longer implementation time likely is required, due to outage scheduling constraints.

The other Options (1A, 3, 5, and the "combinations" other than 71A) are characterized by a more balanced blend of new facility additions and upgrades to existing lines and transformers. Accordingly, although significant coordination of construction outages is still required, implementation times are shorter than for Options 9, 6, and 71A. Consequently, the remaining Options (1A, 3, 5, and the "combinations" other than 71A) are predicted to be capable of implementation in under 3 years.

7.3 Double-Circuit Line Considerations

Option 31A, which has been identified as the "Preferred Plan", involves addition of a second Nobles Co-Fenton 115 kV line, and possibly also a second White-Yankee 115 kV line, depending which "Yankee fix" option is selected. Implementation of the second Nobles Co-Fenton and White-Yankee 115 kV circuits requires consideration of whether it is desirable or acceptable to construct these pairs of circuits on double-circuit structures.

Appendix K provides a detailed analysis of the "double circuit" issue. The conclusion is that in the case of Nobles Co-Fenton 115 kV #2 and White-Yankee 115 kV #2, it is inappropriate to have these circuits on the same structures as the #1 circuit. This conclusion arises because the second circuit in each case is being installed for the purpose of providing back-up (redundancy) for failure of the first circuit. Consequently, the second circuit must be constructed in a manner that minimizes exposure to "common-mode" failures which would simultaneously render both circuits unusable.

Common-mode failure mechanisms for double-circuit lines include

- electrical failure of line insulation due to lightning strike;
- mechanical failure of one or more structures;
- broken shield wire falling into power conductors;
- wind-blown debris causing conductor-conductor short circuits;
- insulator contamination due to road salt, soot, or agricultural chemicals;
- wind/sleet/ice conditions
- contact with aircraft or construction equipment (crane, dump truck)
- protective relaying malfunction ("sympathetic tripping" due to fault on adjacent circuit)

These common-mode failure mechanisms have all been experienced on the Xcel Energy/NSP transmission system, on double-circuit lines at all voltage levels from 69 kV to 345 kV.

In consideration of these common-mode outage mechanisms, the NERC Planning Standards recognize double-circuit line outages as a "single-contingency" type of event ("Category C-5"). Consequently, evaluation of electric transmission system capability is performed considering failure of both circuits of a double-circuit line as being a single-contingency event. Double-circuit lines therefore are not appropriate in situations where two independent circuits are required for reliability purposes.

Double-circuit construction is acceptable if the power system can reliably withstand simultaneous failure of both circuits. Double circuit construction therefore can be appropriate in situations where the two circuits serve different functions, connect different pairs of substations, split away and proceed in different directions, or where high capacity (but not redundancy) is required.

In the case of the Nobles Co-Fenton and White-Yankee 115 kV #2 circuits, the second circuit is needed to provide back-up for the first circuit. Consequently, logic dictates that to achieve the intended benefit to be derived from adding the second circuit, the #1 and #2 circuits cannot be constructed as a double-circuit line.

7.4 Tariff Considerations

The technical and economic analyses described in this Report were performed without regard to transmission tariff considerations. This procedure is appropriate for determining the least-cost transmission solutions with respect to installed cost and future electrical losses, but is somewhat simplistic (if not Pollyannaish and Panglossian) due to its ignorance of possible transmission tariff implications and costs.

The northwestern section of the Buffalo Ridge is on the MISO-WAPA interface. The White (Brookings Co) 345/115 kV facilities now being installed as part of the Buffalo Ridge "825 MW" series of improvements establish a new WAPA-MISO interconnection. This section describes some pertinent tariff considerations that should be recognized when assessing the Buffalo Ridge "incremental" transmission Options' overall performance.

Northern Section of the Buffalo Ridge (South Dakota): access to MISO market

Transmission Options which include the White-Toronto 115 kV line (6, 61A, 31A6) "open up" the Toronto section of the Ridge for wind developments whose intended market would be within MISO. The only existing MISO facility in the area is the radial OTP 115 kV system at Toronto; in addition to voltage control challenges, it has the significant strategic disadvantage of being "trapped" inside the NDEX boundary. The remaining transmission in the immediate area is non-MISO.

Absent a new Brookings Co-Toronto 115 kV line, generation developments in the Toronto area need to pay a transmission service charge for use of the WAPA/Basin/Heartland Integrated System ("IS") for delivery of their output to the WAPA-MISO interface, in addition to any local transmission upgrade costs. This situation keeps potential eastern South Dakota wind generation developments at an economic disadvantage relative to their "inside MISO" competitors in Minnesota and elsewhere.

Reliance on White (Brookings Co) 345/115 kV substation

The transmission Options which include the White-Toronto 115 kV line (6, 61A, 31A6) result in less power injection into the WAPA 345 kV system at White than is the case for the Options lacking this 115 kV line segment. WAPA, which is not a MISO member, has already signaled their expectation that they should receive some significant type of compensation for power injections at White, regardless of whether such injections cause any adverse (or favorable) incremental loading conditions on the WAPA system. Consequently, with respect to MISO participants, it is evident that there is likely some non-trivial value to minimization of inflows onto the 345 kV system at White.

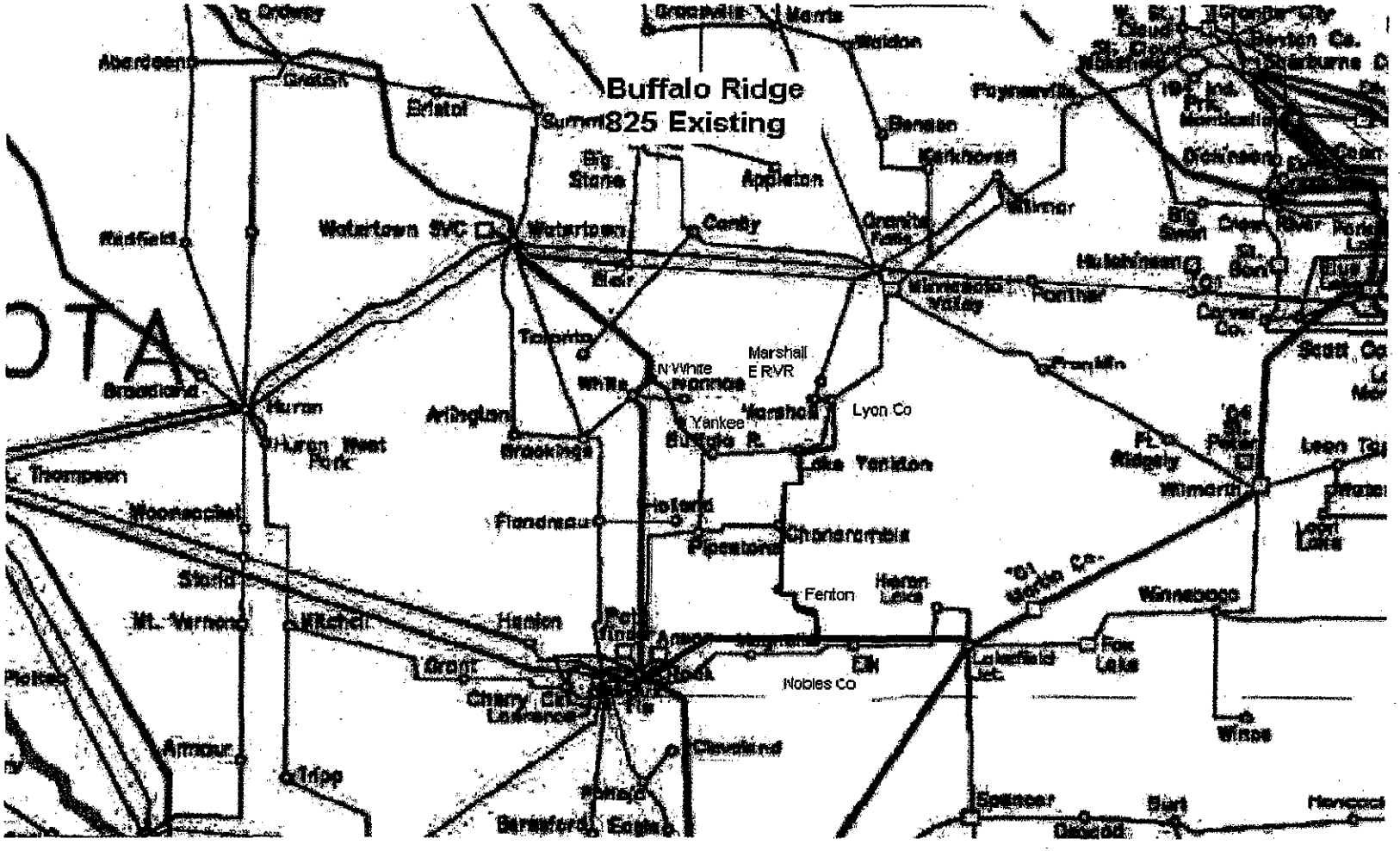
Selection of "Yankee Fix"

The "White 345 kV inflow" matter is also relevant to the selection of the "Yankee Fix" (Section 5.2). In addition to the constrained interface considerations described in Section 5.3, another relevant factor is the effect on White 345 kV inflow levels. The "Yankee fix" option of installing a second 345/115 kV transformer at the new Brookings Co Substation will increase slightly the inflows to the 345 kV system, while the alternate option of adding the Brookings Co-Toronto 115 kV line will reduce such inflows.

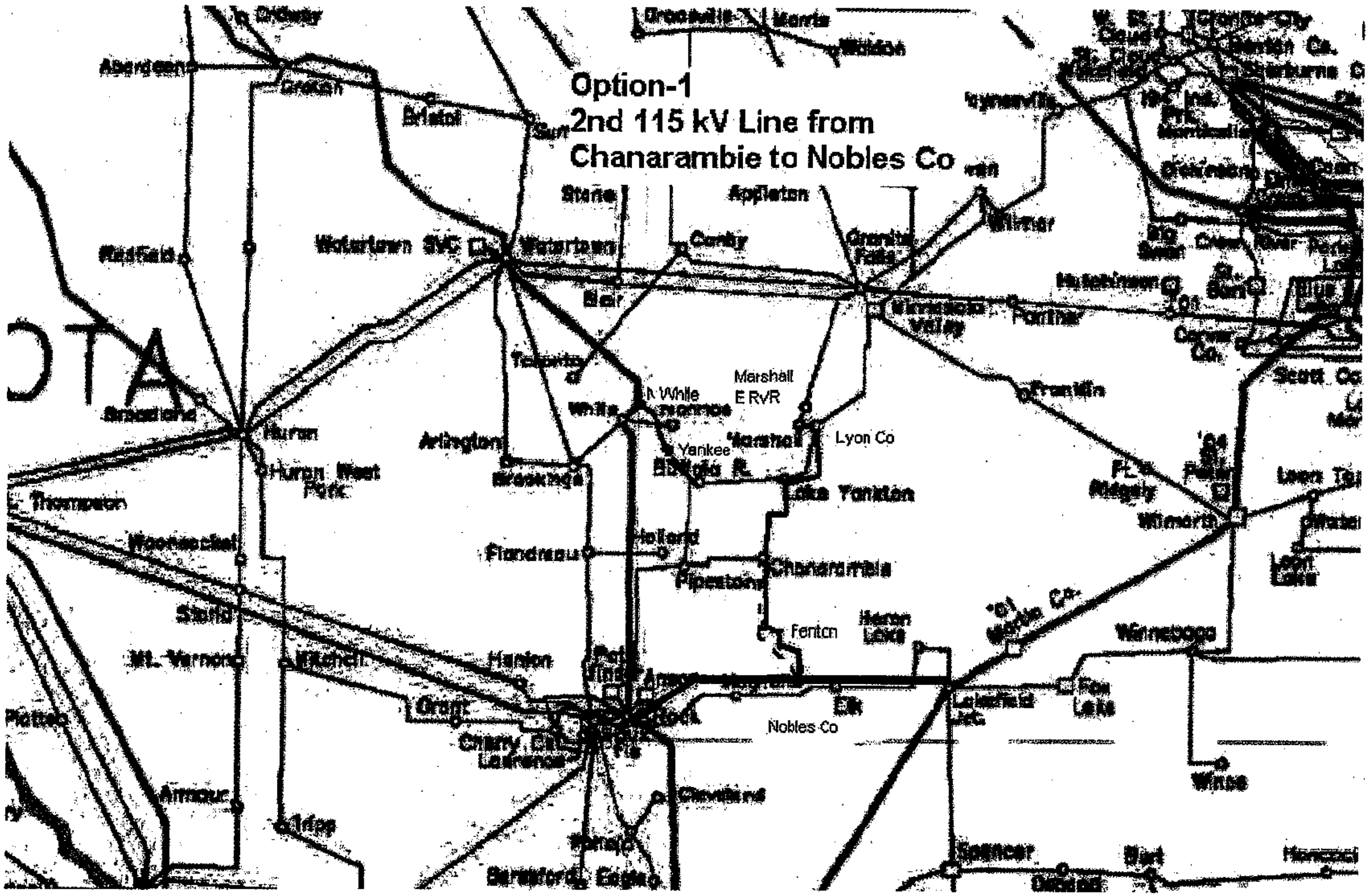
Appendix A

Maps

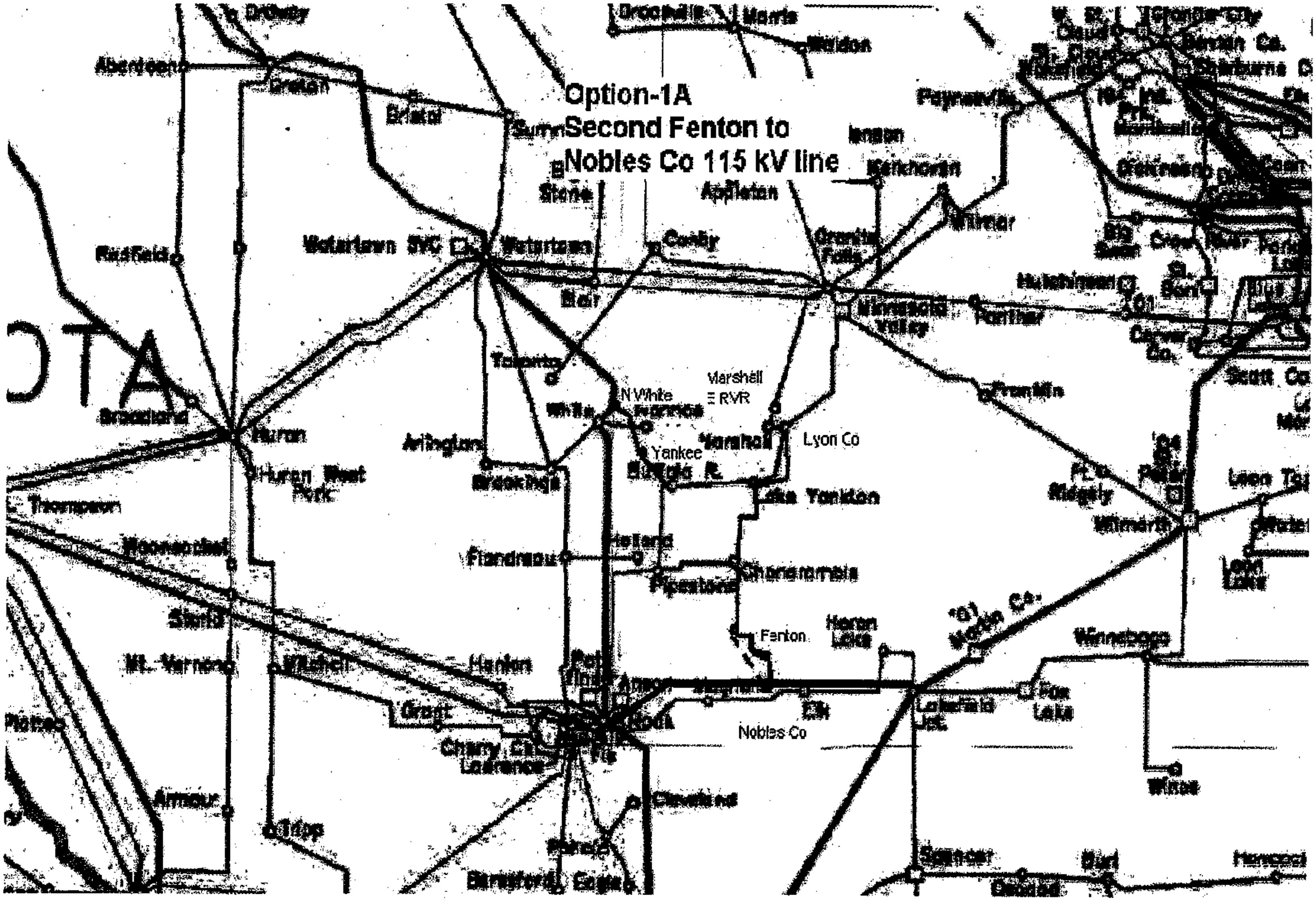
Option 0 (Existing System)



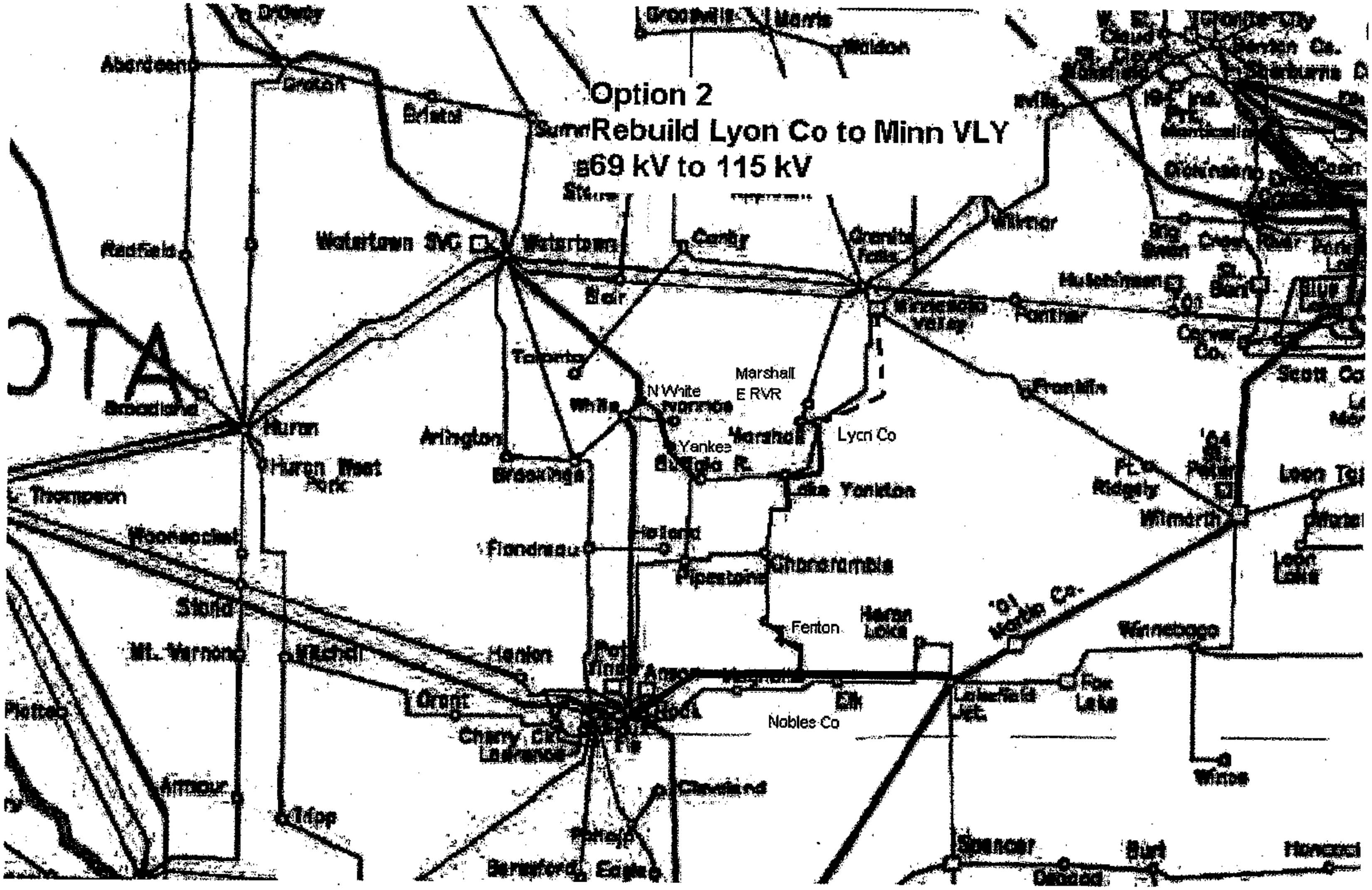
Option 1


Option-1
2nd 115 kV Line from
Chanarambie to Nobles Co
Aberdeen
Redfield
Watertown SVC
Watertown
Bristol
Appleton
Granite Falls
Huron
Brookings
Arlington
Marshall
E RvR
Lyon Co
Yankee
Lake Yankton
Flandreau
Chanarambie
Pipestone
Fenton
Heron Lake
Nobles Co
Winnebago
Spencer
Franklin
Wilmarth
Mitchell
Hanlon
Armour

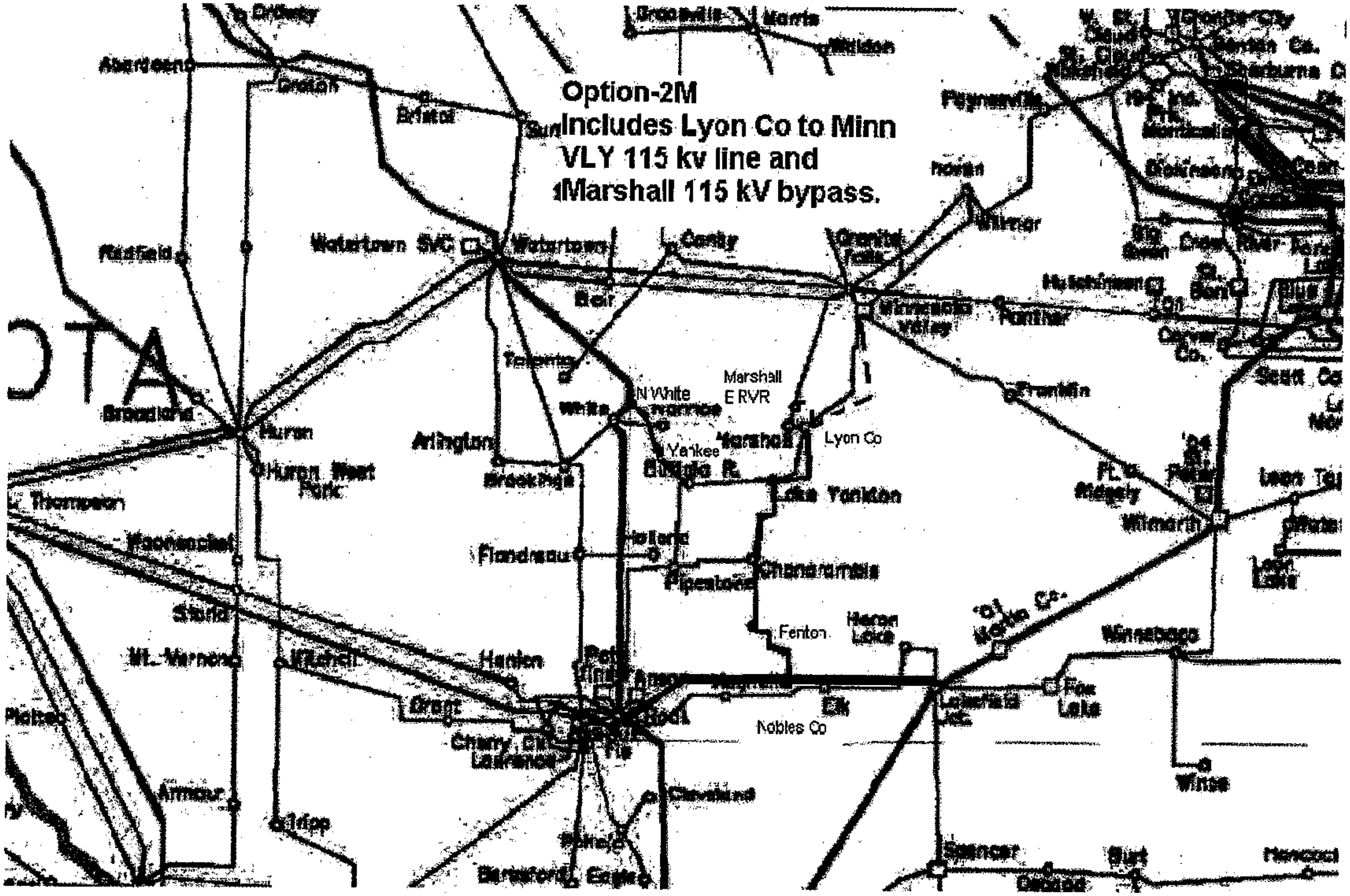
Option 1A


Option-1A
Second Fenton to
Nobles Co 115 kV line
Marshall
= RVR
N White
Yankee
Lyon Co
Fenton
Nobles Co

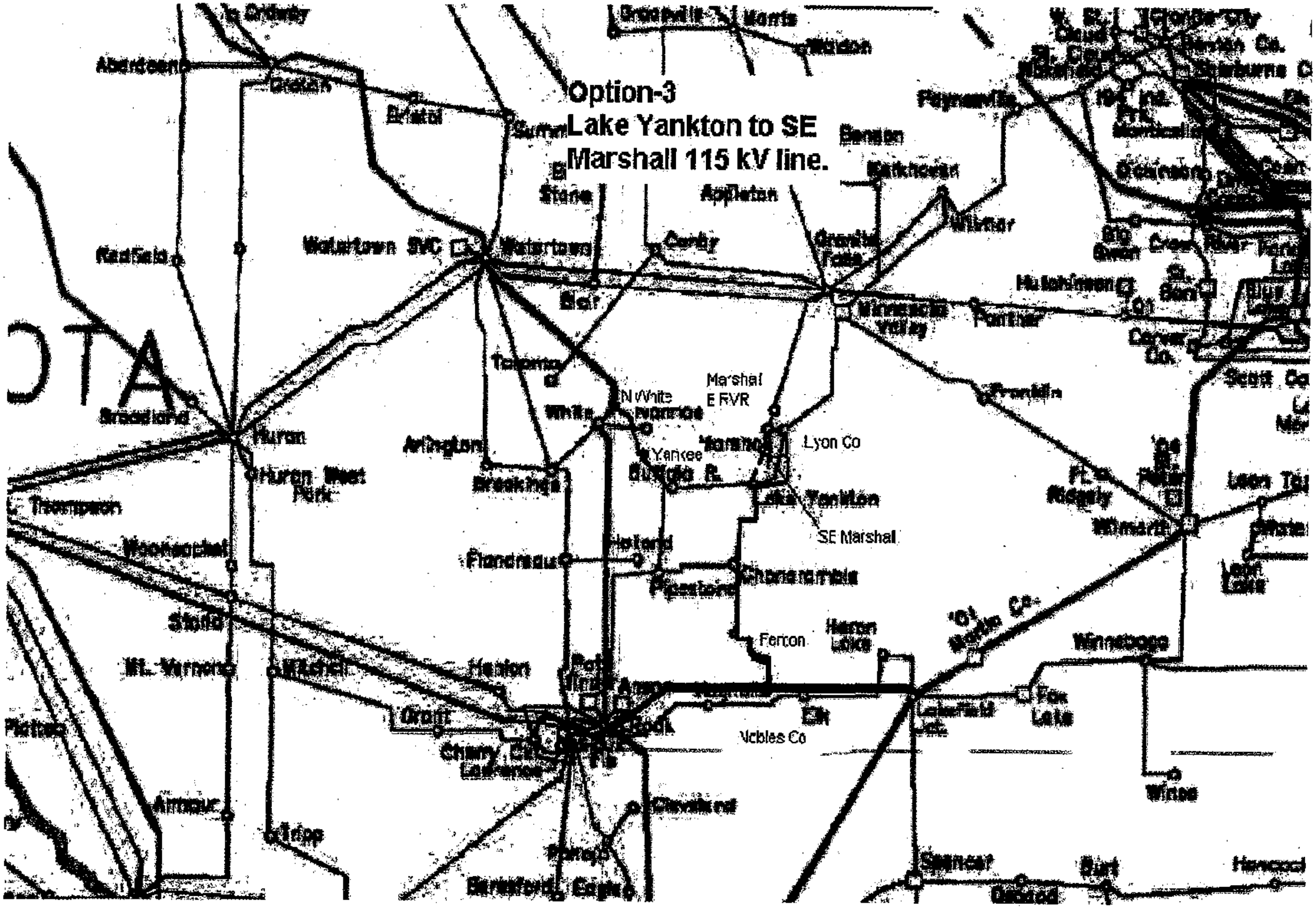
Option 2


Option 2
Rebuild Lyon Co to Minn VLY
69 kV to 115 kV
Marshall
E RVR
N White
Yankee
Lyon Co
Fenton
Nobles Co
Aberdeen
Watertown
Huron
Arlington
Brookings
Flandreau
Wilmarth
Winnebago

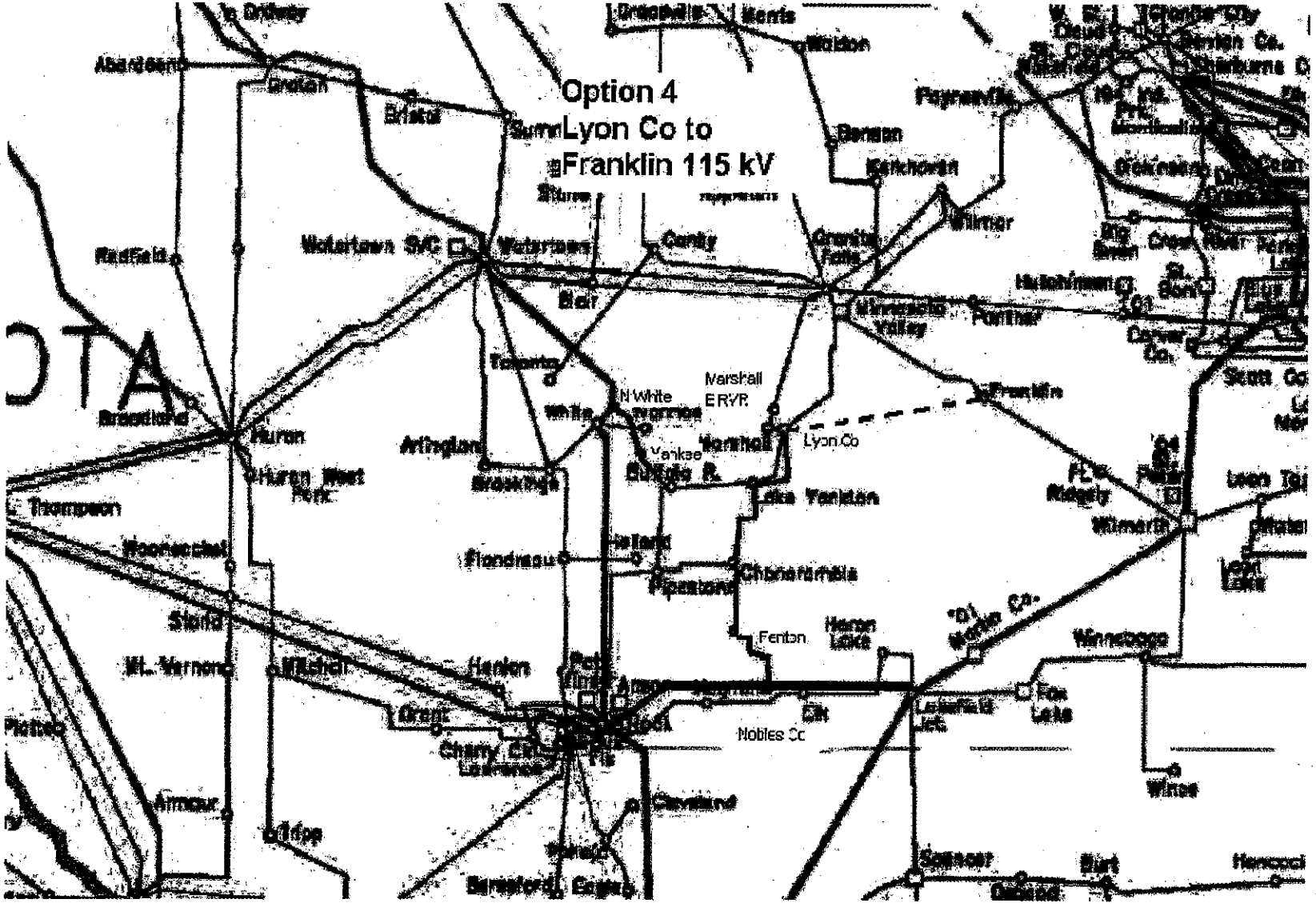
Option 2M


Option-2M
Includes Lyon Co to Minn VLY 115 kv line and Marshall 115 kV bypass.
Aberdeen
Groton
Bristol
Redfield
Watertown SVC
Watertown
Huron
Huron West Park
Thompson
Arlington
Brookings
N White
Marshall
E RVR
Yankee
Lyon Co
Lake Yankton
Minnesota Valley
Granite Falls
Franklin
Flandreau
Pipestone
Fenton
Heron Lake
Nobles Co
Elk
Lakefield Jct.
Fox Lake
Winnebago
Wilmarth
Armour
Tripp
Mt. Vernon
Hanlon
Cleveland
Spencer
Burt

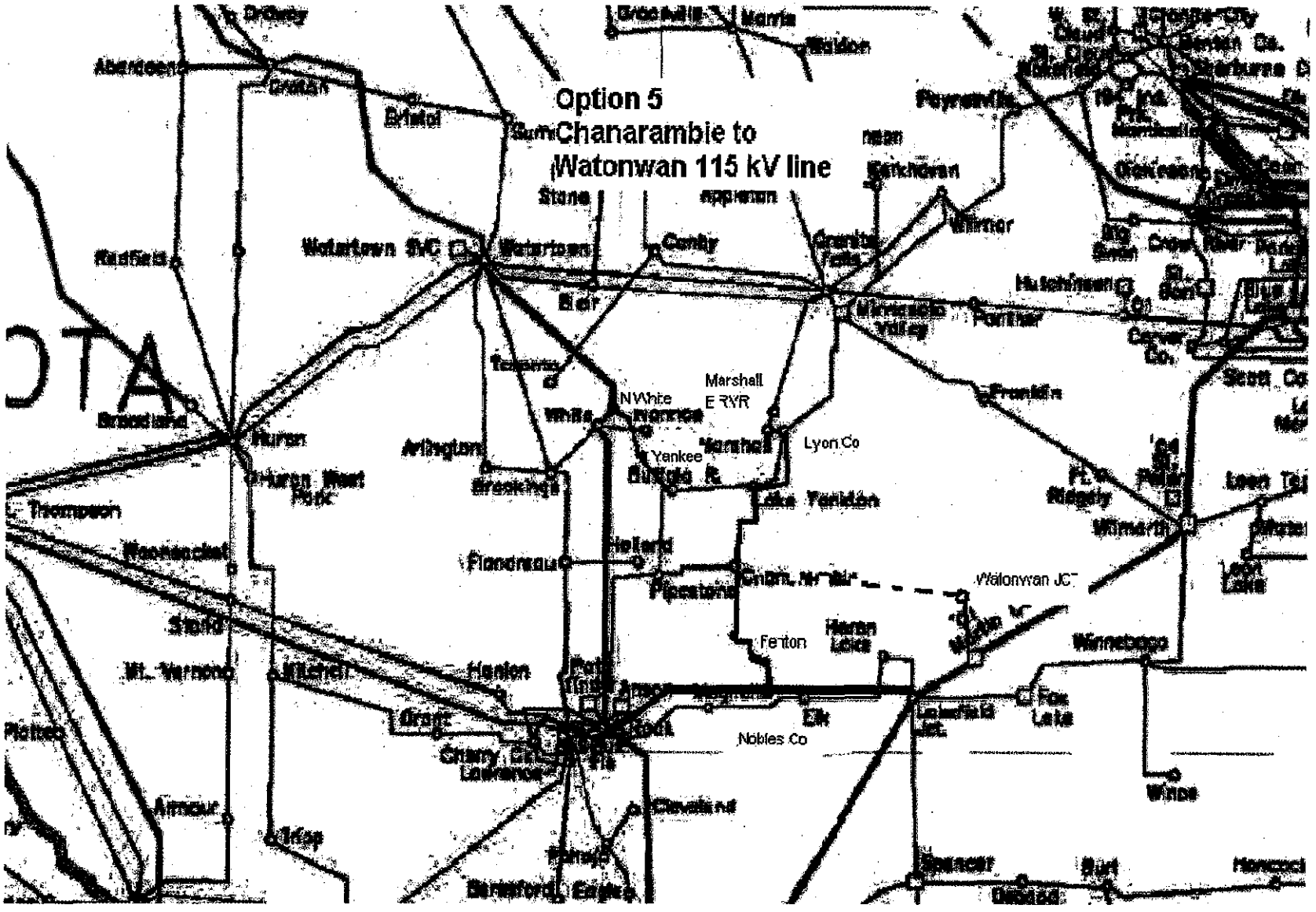
Option 3


Option-3
Lake Yankton to SE
Marshall 115 kV line.
Aberdeen
Bristol
Benson
Appleton
Waterfown SVC
Watertown
Granite Falls
Minnesota Valley
Willmar
Hutchinson
Franklin
Huron
Huron West Park
Thompson
Arlington
Brookings
N White
Marshal
E RVR
Lyon Co
Yankee
Lake Yankton
SE Marshal
Flandreau
Pipestone
Fenton
Heron Lake
Nobles Co
Winnebago
Fox Lake
Mt. Vernon
Mitchell
Armour
Tripp
Cleveland
Spencer
Burt
Winnebago
Ft. Ridgely

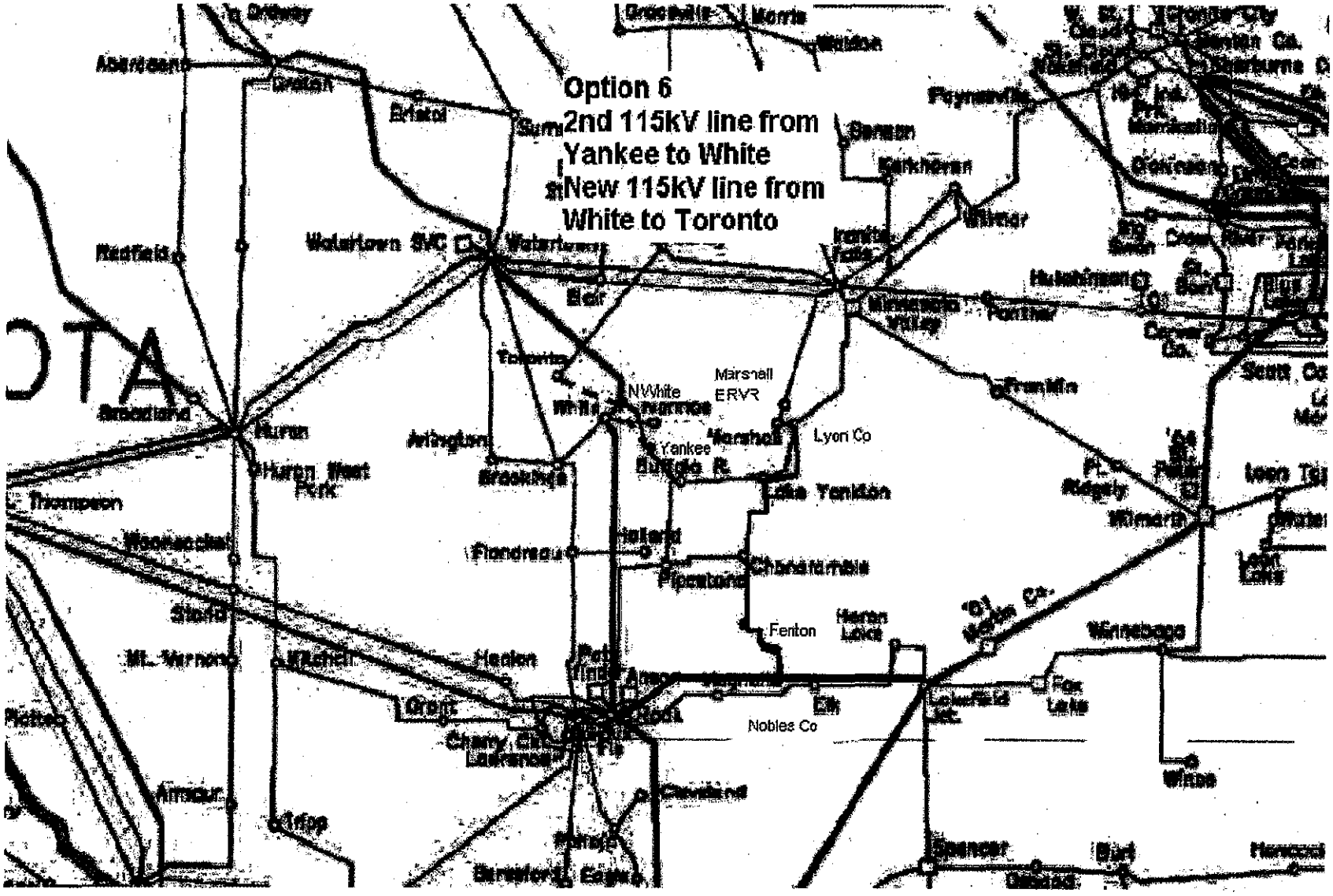
Option 4


Option 4
Lyon Co to
Franklin 115 kV
Marshall
ERVR
N White
Lyon Co
Yankee
Nobles Co

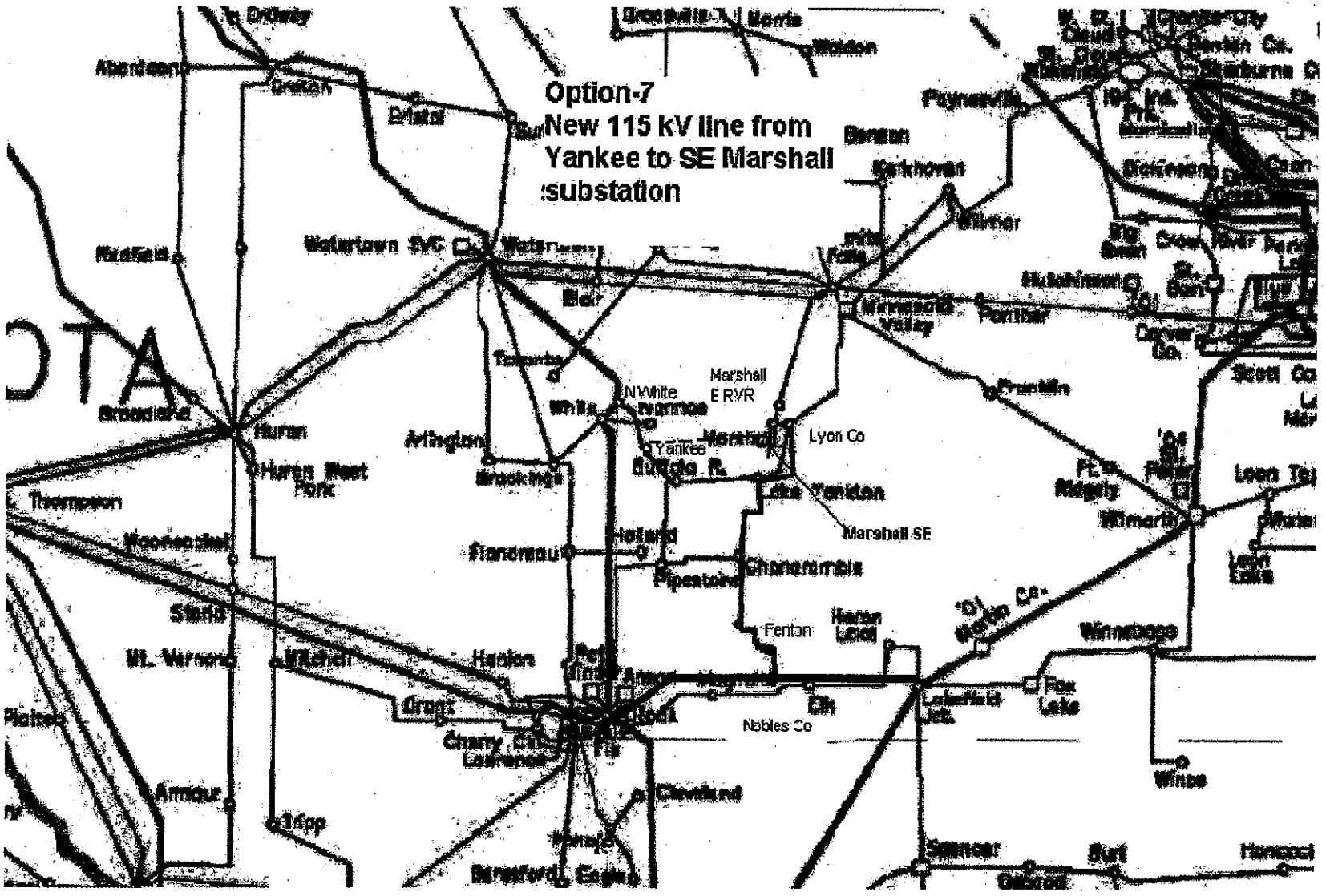
Option 5


Option 5
Chanarambie to
Watonwan 115 kV line
Watertown SVC
Watertown
Stone
Canby
Granite Falls
Hutchinson
Marshall
N White
E RYR
Lyon Co
Yankee
Franklin
Arlington
Brookings
Lake Yankton
Thompson
Flandreau
Pipestone
Watonwan JCT
Fenton
Huron
Mt. Vernon
Hanlon
Winnebago
Fox Lake
Nobles Co
Armour
Wilmarth

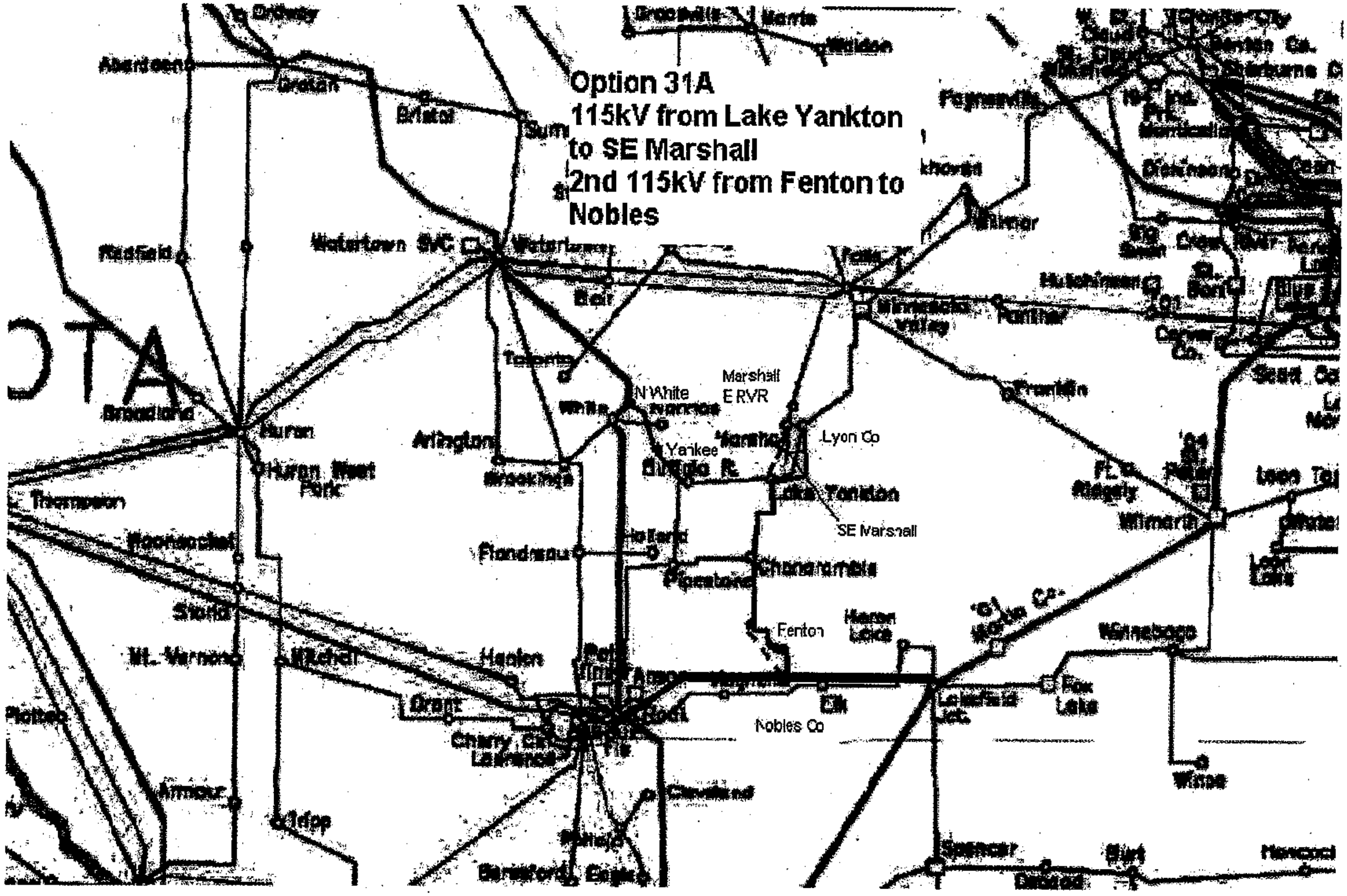
Option 6


Option 6
2nd 115kV line from Yankee to White
New 115kV line from White to Toronto
Watertown SVC
Watertown
Toronto
NWhite
Marshall
ERVR
Yankee
Lyon Co
Fenton
Nobles Co

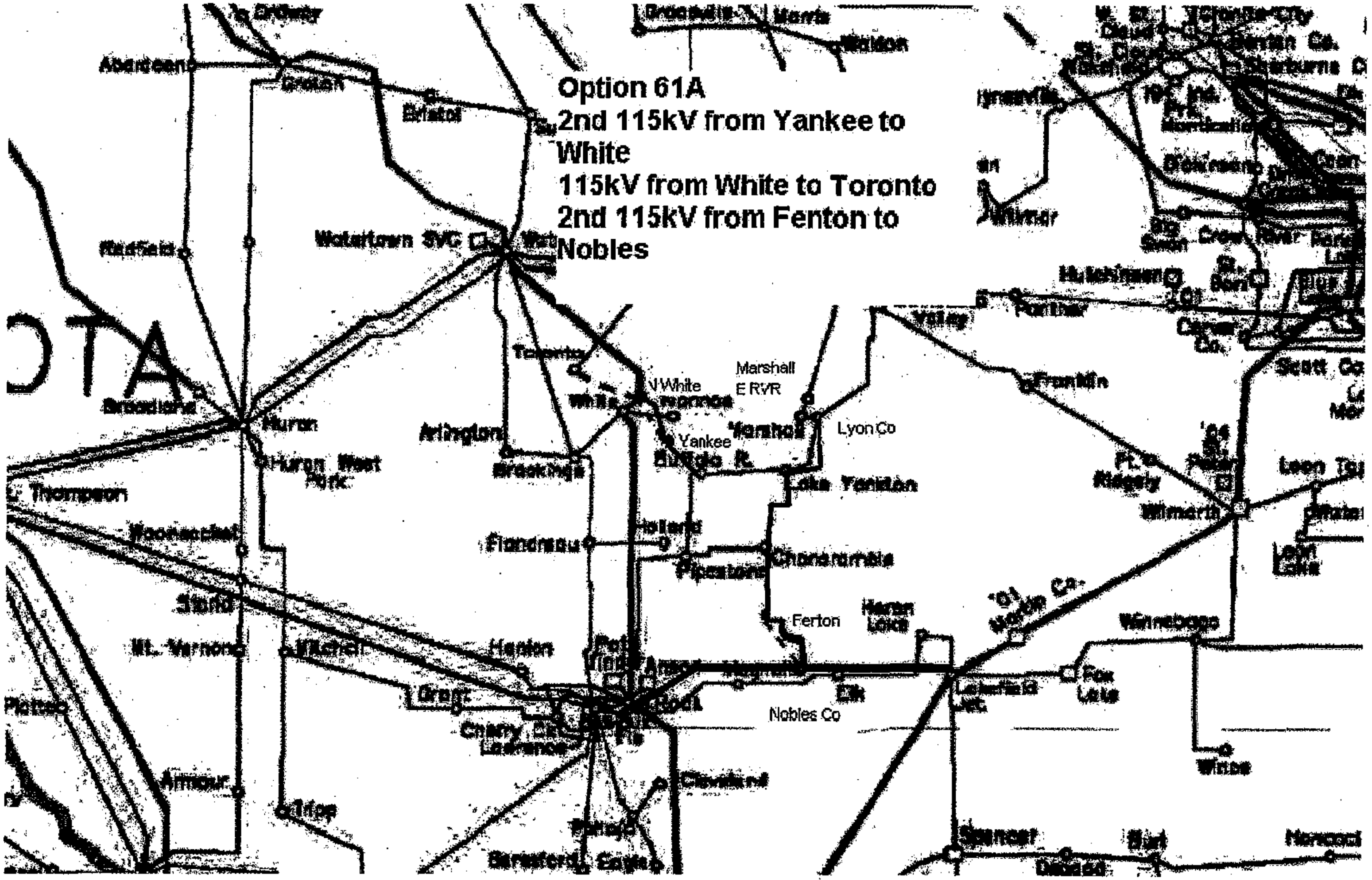
Option 7


Option-7
New 115 kV line from
Yankee to SE Marshall
substation
Marshall
E RVR
NWhite
Yankee
Lyon Co
Marshall SE
Nobles Co

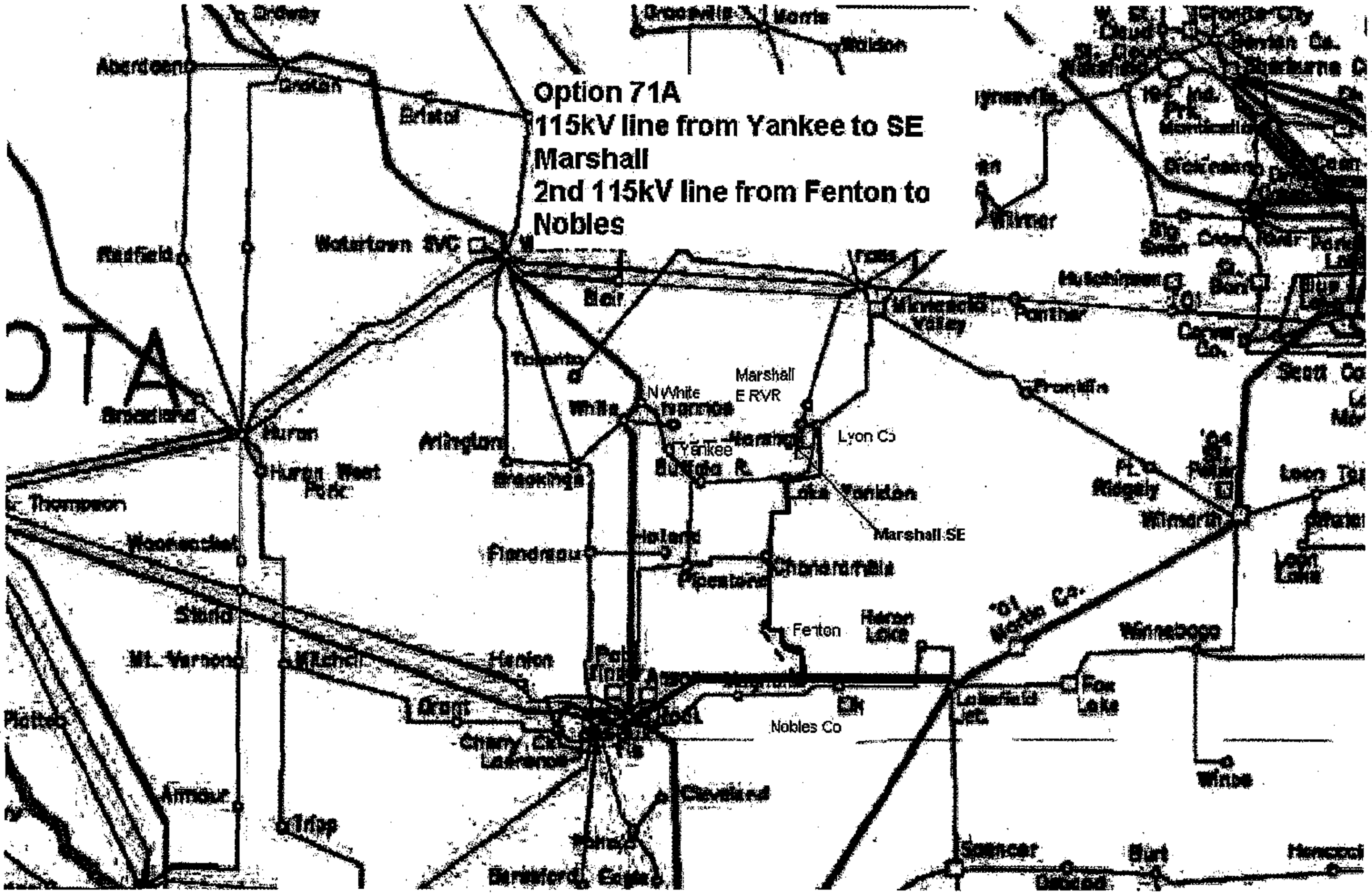
Option 31A


Option 31A
115kV from Lake Yankton
to SE Marshall
2nd 115kV from Fenton to
Nobles
Aberdeen
Groton
Bristol
Redfield
Watertown SVC
Huron
Huron West Park
Thompson
Arlington
Brookings
Toronto
White
N White
Marshall
E RVR
Lyon Co
Yankee
Lake Yankton
SE Marshall
Flandreau
Pipestone
Fenton
Nobles Co
Elk
Mitchell
Armour
Hanlon
Cleveland
Beresford
Franklin
Wilmarth
Winnebago
Fox Lake
Lakefield Jct.
Spencer
Burt
Willmar
Hutchinson
Minnesota Valley
Blair
Winne

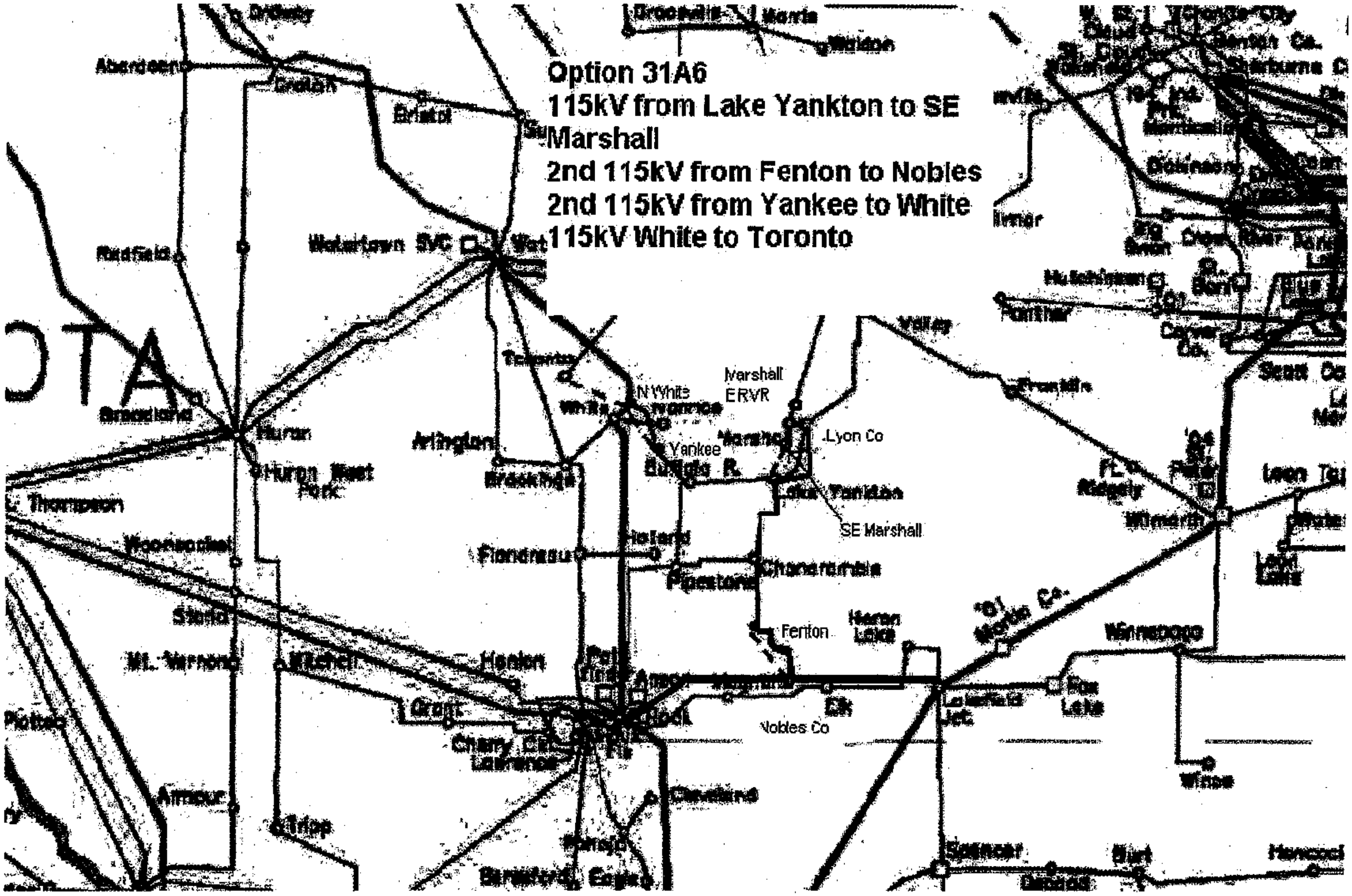
Option 61A


Option 61A
2nd 115kV from Yankee to White
115kV from White to Toronto
2nd 115kV from Fenton to Nobles
Aberdeen
Bristol
Watertown SVC
Redfield
Huron
Huron West Park
Broadland
Thompson
Arlington
Brookings
Toronto
White
N White
Yankee
Marshall
E RVR
Lyon Co
Buffalo R.
Lake Yankton
Flandreau
Holland
Pipestone
Chanarambie
Fenton
Heron Lake
Nobles Co
Elk
Lakefield Jct.
Fox Lake
Winnebago
Franklin
Wilmarth
Panther
Hutchinson
Willmar
Spencer
Armour
Mt. Vernon
Mitchell
Hanlon
Cherry
Lawrence
Cleveland
Beresford
Scott Co
Witte

Option 71A


Option 71A
115kV line from Yankee to SE Marshall
2nd 115kV line from Fenton to Nobles
Aberdeen
Bristol
Redfield
Watertown SVC
Huron
Huron West Park
Thompson
Arlington
Brookings
Toronto
White
N White
Marshall E RVR
Marshall
Lyon Co
Yankee
Marshall SE
Flandreau
Pipestone
Fenton
Heron Lake
Nobles Co
Mt. Vernon
Mitchell
Armour
Cleveland
Minnesota Valley
Franklin
Winnebago
Spencer
Burt
Hancock

Option 31A6


Option 31A6
115kV from Lake Yankton to SE Marshall
2nd 115kV from Fenton to Nobles
2nd 115kV from Yankee to White
115kV White to Toronto
Aberdeen
Bristol
Watertown SVC
Redfield
Huron
Huron West Park
Thompson
Woonsocket
Mt. Vernon
Armour
Arlington
Brookings
Toronto
White
N White
Yankee
Buffalo R.
Marshall ERVR
Lyon Co
Lake Yankton
SE Marshall
Flandreau
Pipestone
Fenton
Heron Lake
Nobles Co
Elk
Lakefield Jct.
Fox Lake
Winnebago
Spencer
Franklin
Wilmarth
Scott Co
Hutchinson
Valley
Winco

Appendix B

TLTG Summaries

Option	Description
0	Existing system
1	Add Chanarambie-Nobles Co 115 kV #2 & 2nd Nobles Co 345/115 tx
1A	Add Fenton-Nobles Co 115 kV #2 & 2nd Nobles Co 345/115 kV tx
2	Add Lyon Co-Minn Valley 115 kV #2 (Rebuild 69 kV)
2M	Add Lyon Co-Minn Valley 115 kV #2 & Lyon Co-Marshall East River 115
3	Establish Lk Yankton-Lyon Co 115 kV #3 (Add Lk Yankton-Marshall SW 115 kV)
4	Add Lyon Co-Franklin 115 kV
5	Add Chanarambie-Watonwan Jct 115 kV
6	Add Yankee-White-Toronto 115 kV
7	Add Yankee-Marshall SW-Lyon Co 115 kV
8	Add White-Lyon Co-Franklin 115
31A	Combination: 3 & 1A
61A	Combination: 6 & 1A
71A	Combination: 7 & 1A
31A6	Combination: 3 & 1A & 6

Buffalo Ridge Incremental Generation Outlet Study

Option 0: Existing System
("Post-825 MW" improvements)

SW MN Buffalo Ridge Area Generation

Key	TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's Item	cumulative
1	-609	918	309	Madelia J-Tienstra Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0209	Conductor	Rebuild	3.5	mi	525	525
2	278	918	640	Madelia VI. Buttemut Tp 69 @ 110% of 37	Wilmarth-Lakefield 345	0.0209	Conductor	Rebuild	11.7	mi	1,755	2,280
3	-144	918	774	Lyon Co-Marshall 115 @ 110% of 128 MVA	Nobles Co 345/115 tx or Nobles-Fenton 115	0.1095	Conductor	Reconductor	4	mi	400	2,680
			825									2,680
4	-8	918	910	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk Dean Lk 115	0.0220	switches	replace switches	2	ea	40	2,720
5			925								0	2,720
6			943								0	2,720
7	25	918	943	SveaTp-Litch Tp 69 @ 110% of 42	Minn Valley-Panther 230	0.0200	Conductor	Rebuild	24.7	mi	3,705	6,425
8	47	918	965	Madolia J-Madolia VI 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0200	Conductor	Rebuild	3.6	mi	540	6,965
9	109	918	1027	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk Dean Lk 115	0.0220	switches	replace switches	2	ea	40	7,005
			1103									7,005
10	185	918	1103	Lyon Co Marshall 115 @ 100% of 128	(system intact)	0.0580	(already addressed)				0	7,005
			1134								0	7,005
11	216	918	1134	Pipestone-Pathfindor 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-Fenton 115	0.2231	Conductor	Reconductor	42	mi	4,200	11,205
			1225								0	11,205
12	313	918	1231	Nobles Co 345/115 tx @ 100% of 448	(system intact)	0.4140	Transformer	Install larger tx	1	ea	500	11,705
13	321	918	1239	Lyon Co-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0405	Conductor	Rebuild	12.3	mi	1,845	13,550
14	337	918	1255	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0592	Conductor	Reconductor	4.6	mi	460	14,010
15	375	918	1293	Willmar-Svea Tp 69 @ 110% of 53	Minn Valley-Panther 230	0.0200	Conductor	Rebuild	4.6	mi	690	14,700
16	383	918	1301	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0215	Transformer	Add 2nd tx	1	ea	2,600	17,300
17	395	918	1313	Nobles Co 345/115 tx @ 130% of 448	White 345/115 tx or White-Yankee 115	0.5287	(already addressed)				0	17,300
18	414	918	1332	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1237	Term equip	Upgrade term equip	1	ea	100	17,400
19	416	918	1334	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0592	Conductor	Reconductor	19.0	mi	1,900	19,300
20	429	918	1347	Minn Valley-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0405	Conductor	Rebuild	16.9	mi	2,385	21,685
21	445	918	1303	Marshall-Erie Rd 115 @ 110% of 128	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0855	Conductor	Reconductor	1.7	mi	170	21,855
22	455	918	1373	Chandler Tp2-Chandler Tp 69 @ 110% of 42	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0208	Conductor	Reconductor	7.1	mi	710	22,565
23	459	918	1377	Minn Valley Tp-Panther 230 @ 110% of 388	Wilmarth-Lakefield 345	0.1333	Conductor	Reconductor	30	mi	3,000	25,565
24	485	918	1403	Lk Yankton-Buffalo Ridge 115 @ 110% of 202	White 345/115 tx or White-Yankee 115	0.2665	Conductor	Reconductor	20	mi	2,000	27,565
25	480	918	1404	S3-Granite Falls 115 @ 110% of 120	Nobles Co 345/115 tx or Nobles-Fenton 115	0.1095	Conductor	Rebuild	30.0	mi	7,800	35,365
			1425									35,365
26	545	918	1463	Granite Falls-Minn Valley Tp 230 @ 110% of 3	Wilmarth-Lakefield Gen 345	0.0920	Conductor	Reconductor	2.5	mi	250	35,615
			1500								0	35,615
27	582	918	1500	Erie Rd-S3 @ 110% of 140	Nobles Co 345/115 tx or Nobles-Fenton 115	0.1095	Conductor	Build 2nd NOB-FNT 115			10,600	46,215
28	583	918	1501	Nobles Co-Fenton 115 @ 110% of 620	White 345/115 tx or White-Yankee 115	0.5287	Conductor	(already addressed)			0	46,215
			1525									46,215
			1541								0	46,215
29	623	918	1541	Wilmarth-Lakefield 345 @ 110% of 1165	Sherco #3 gen	0.3268	Conductor	Reconductor	54	mi	8,640	54,855
30	668	918	1586	Pipestone-Chanerambie 115 @ 110% of 384	Nobles Co 345/115 tx or Nobles-Fenton 115	0.2738	Conductor	(already addressed)			0	54,855
31	676	918	1594	Maynard-Kerkhoven 115 @ 110% of 78	Granite Falls-Willmar 230	0.0302	Conductor	Rebuild				

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections. Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: (none).
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Limo Ck-Emory 161, Wilmarth-Johnson-Ponclopo-Travorso 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

Buffalo Ridge Incremental Generation Outlet Study

Option 1

Add Chanaramble-Nobles Co 115 kV #2 & Nobles Co 345/115 tx #2

Key	SW MN Buffalo Ridge Area Generation TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's incremental	cumulative
0			285					(Base Plan)			14,800	14,800
1	-633	918	285	Madelia - Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0204	Conductor	Rebuild	3.5	mi	525	15,325
2	-305	918	613	Madelia-Butternut Tp 69 @ 110% of 37	Wilmarth-Lakefield 345	0.0274	Conductor	Rebuild	11.7	mi	1,755	17,080
3	-28	918	890	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0223	switches	Replace sw	2.0	es	40	17,120
4	8	918	926	Madelia - Madelia vl 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0274	Conductor	Rebuild	3.6	mi	540	17,660
5	32	918	950	Lyon Co-Marshall 115 @ 110% of 128	Watertown-Granite Falls 230 & Watertown-Blair 230	0.0674	Conductor	Reconductor	4.0	mi	400	18,060
6	85	918	1006	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0223	switches	Replace sw	2.0	es	40	18,100
7	325	918	1243	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0595	Conductor	Reconductor	4.6	mi	460	18,560
8	371	918	1289	Lyon Co-Marshall 115 @ 110% of 128	System Intact	0.0552	Conductor	(already addressed)			0	18,560
9	446	918	1364	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0597	Conductor	Reconductor	19.0	mi	1,900	20,460
10	449	918	1367	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0207	transformer	add 2nd tx	1.0		2,600	23,060
11	483	918	1401	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.0154	terminal	Upgrade term equip	1	es	200	23,260
12	486	918	1406	Nobles 345/115 tx 1 or 2 @ 130% of 448	Nobles 345/115 tx 2 or 1	0.4335	transformer	order larger txs	2	es	1,000	24,260
13	515	918	1433	Lk Yankton-Buffalo Ridge 115 @ 110% of 294	White 345/115 tx or White-Yankee 115	0.2617	Conductor	Build Buff R-Lk Yankton 115 #2	20.0	mi	8,000	32,260
14	520	918	1438	Minn Valley Tp-Panther 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0258	Conductor	Reconductor	30	mi	3,000	35,260
15	569	918	1487	Granite Fals-Minn Valley 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0952	Conductor	Reconductor	2.5	mi	250	35,510
16	600	918	1518	(none)							0	35,510

Notes

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102I_07s.pk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice
3. Improvements modeled: Chanarambie-Nobles Co 115 kV #2 (2 x 795 kcm ACSS), Nobles Co 345/115 tx #2 (448 MVA)
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Ger 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 1A

Add Fenton-Nobles Co 115 kV #2 & Nobles Co 345/115 tx #2

	SW MN Buffalo Ridge Area Generation										
	TLTG	Base	System							Installed Cost, $1,000's	
Key	Limit MW	Case MW	Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty	incremental	cumulative
0			293					(Base Plan)		10,600	10,600
1	-625	918	293	Madelia J-Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0214	Conductor	Rebuild	3.5 mi	525	11,125
2	-297	918	621	Madelia-Buttemut Tp 69 @ 110% of 37	Wilmarth-Lakefield 345	0.0214	Conductor	Rebuild	11.7 mi	1,755	12,880
			825							0	12,880
3	-36	918	882	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0224	switches	replace switches	2 ea	40	12,920
5			925								12,920
6	16	918	934	Madelia J-Madelia Vl 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0214	Conductor	Rebuild	3.6 mi	540	13,460
7	23	918	941	Lyon Co-Marshall 115 @ 110% of 128	Watertown-Granite Falls 230 & Watertown-Blair 230	0.0601	Conductor	Reconductor	4.0 mi	400	13,860
8	78	918	996	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0224	switches	replace switches	2 ea	40	13,900
			1175							0	13,900
9	305	918	1223	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0602	Conductor	Reconductor	4.6 mi	460	14,360
			1225							0	14,360
10	355	918	1273	Lyon Co-Marshall 115 @ 100% of 128	System Intact	0.0501	Conductor	Reconductor	4.0 mi	400	14,760
11			1301								14,760
12	383	918	1301	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0602	Conductor	Reconductor	19.0 mi	1,900	16,660
			1325							0	16,660
13			1355								16,660
14	437	918	1355	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1207	term equip	upgrade term equip	1.0 ea	100	16,760
15	444	918	1362	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0205	transformer	add 2nd tx	1.0	2,600	19,360
16			1402								19,360
17	484	918	1402	Minn Valley Tp-Panther 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1253	Conductor	Reconductor	30.0 mi	3,000	22,360
18	490	918	1408	Nobles 345/115 tx 1 or 2 @ 130% of 448	Nobles 345/115 tx 2 or 1	0.4451	transformer	order larger txs	2.0 ea	1,000	23,360
19	512	918	1430	Lk Yankton-Buffalo Ridge 115 @ 110% of 294	White 345/115 tx or White-Yankee115	0.2618	Conductor	Reconductor	20.0 mi	2,000	25,360
20	523	918	1441	Granite Falls-Minn Valley 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0998	Conductor	Reconductor	2.5 mi	250	25,610
			1490							0	25,610
	572	918	1490	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco # 3 gen	0.3357	Conductor	Reconductor	54.0 mi	8,640	34,250
			1525							0	34,250
			1563							0	34,250
21	645	918	1563	Triboji-Spencer 161 @ 110% of 167	Wilmarth-Lakefield 345	0.0288	Conductor	Reconductor	4.0 mi	400	34,650
22	678	918	1596	Lyon Co-Yellow Medicine 69 @ 110% of 47	Lyon Co-Minn Valley 115 kV	0.0296	Conductor	Rebuild	12.3 mi	1,845	36,495

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Fenton-Nobles Co 115 kV #2 (2 x 795 kcm ACSS), Nobles Co 345/115 tx #2 (448 MVA)
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 2: Add Lyon Co-Minn Valley 115 kV #2

(Rebuild existing LYC-MNV 69 kV to 115 kV)

SW MN Buffalo Ridge Area Generation

Key	TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's incremental	cumulative
0			316					(Base plan)				13,000
1	-610	918	308	Madelia J-Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0206	Conductor	Rebuild	3.5	mi	525	13,525
2	-268	918	650	Madelia VL-Butternut Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0206	Conductor	Rebuild	11.7	mi	1,755	15,280
			825									
3	5	918	923	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0218	switches	Replace switches	2	ea	40	15,320
4	22	918	940	Svea-Litchfield 69 @ 110% of 42	Minn Valley Tp- Panther 230	0.0204	Conductor	Rebuild	4.6	mi	690	16,010
5			975									16,010
6	57	918	975	Madelia J-Madelia VL 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0206		Rebuild	3.6	mi	540	16,550
7	64	918	982	Lyon Co-Marshall 115 @ 110% of 128 MVA	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0852		Reconductor	2	ea	40	16,590
8	113	918	1031	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0218	600 A line sw	Replace switches	1.0		100	16,690
9			1166								0	16,690
10	248	918	1100	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-Fenton 115	0.2159	Conductor	Reconductor	42.0	mi	4,200	20,890
			1175						0.0		0	20,890
11	309	918	1227	Nobles 345/115 tx @ 100% of 448	System intact	0.4030	transformer	Already addressed			0	20,890
12	342	918	1260	W Faribault-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0587	Conductor	Reconductor	4.6	mi	460	21,350
13	359	918	1277	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0219	transformer	add 2nd tx	1.0	ea	2,600	23,950
14	363	918	1281	Willmar-Svea Tp 69 @ 110% of 53	Minn Valley Tp- Panther 230	0.0204	Conductor	Reconductor	30.0	mi	3,000	26,950
15	385	918	1303	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1260	terminal equip	upgrade term equip	1.0	ea	100	27,050
16	397	918	1315	Nobles 345/115 tx @ 130% of 448	White 345/115 tx or White-Yank 115	0.5179	transformer	install larger tx	1	ea	500	27,550
17	421	918	1339	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0587	Conductor	Reconductor	19.0		1,900	29,450
18	430	918	1348	Minn Valley-Panther 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1355						29,450
19	456	918	1374	Lk Yankton-Buffalo Ridge 115 @ 110% of 294	White 345/115 tx or White-Yank 115	0.2760	Conductor	Add 2nd Buff R-Lk Y	20	mi	8,000	37,450
			1431									37,450
20	513	918	1431	Chandler Tp2-Chandler 69 @ 110% of 42	Nobles Co 345/115 tx or Nobles-Fenton 115	0.0200	conductor	Rebuild	7.1	mi	1,065	38,515
21	515	918	1433	Lyon Co-Marshall 115 @ 110% of 128 MVA	(system intact)	0.0460	(already addressed)				0	38,515
22	604	918	1522	Granite Falls-Minn Valley 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0949	Conductor	Reconductor	2.5	mi	250	38,765
23	621	918	1539	Maynard-Kerkhoven 115 @ 110% of 78	Granite Falls-Willmar 230	0.0311	Conductor	Rebuild	14.6	mi	3,796	42,561

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Rebuild Lyon Co-Yellow Medicine 69 kV to 115 kV (795 kcm ACSS).
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV.

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 2M: Add Lyon Co-Minn Valley 115 kV #2 & Lyon Co-Marshal East River 115 kV

(Rebuilc existing Lycn Co-MNV 69 kV tc 115 kV & add Marshall bypass)

	SW MN Buffalc Ridge Area Generation											
	TLTG Limit	Base Case	System Limt			distribution	Limitirg				Installed Cost $1,000's	
Key	MW	MW	MW	Limiting Facility	Contingency	factcr	factcr	Remedy	qty		incremertal	cumulative
0			312					(Base p an)			15690	16690
1	-606	918	312	Macelia ..-Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield Ger 345	0.0206	Conductor	Rebuild	3.5	mi	525	17215
2	-265	918	653	Macelia VL-Butternut Tp 69 @ 110% of 36	Wilmarth-Lakefield Ger 345	0.0208	Conductor	Rebuild	11.7	mi	1755	18970
			825								0	18970
2	7	918	925	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345	0.0216	switches	Replace switches	2	ea	40	19010
3	16	918	934	Svea-..itchfield 69 @ 110% of 42	Mnn Valley Tp- Panther 230	0.0205	Conductor	Rebuild	4.6	mi	690	19700
5	61	918	979	Macelia ..-Madelia VL 69 @ 110% of 36	Wilmarth-Lakefield Ger 345	0.0206	Conductor	Rebuild	3.6	mi	540	20240
6	125	918	1043	Eagle Lk-Eagle Lk 69 @ 1 0% of 72	Blue Lk-Wilmarth 345	0.0216	switches	Replace switches	2	ea	40	20280
7	125	918	1173								0	20280
8	255	918	1173	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx	0.2149	Conductor	Reconductor	42.0	mi	4200	24480
			1225								0	24480
9	312	918	1230	Nobles 345/115 tx @ 100% of 448	System Intact	0.4030	transformer	Order larger tx	1.0	ea	500	24980
10	322	918	1240	W Faribault-Airtech 1 5 @ 110% of 139	Blue Lk-Wilmarth 345	0.0590	Conductor	Reconductor	4.6	mi	460	25440
11	348	918	1266	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0220	transformer	acd 2nd tx	1.0	ea	2600	28040
12	355	918	1273	Willmar-Svea Tp 69 @ 110% of 53	Mnn Valley Tp- Panther 230	0.0205	Conductor	Rebuild	24.7	mi	3705	31745
13	379	918	1297	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield Ger 345	0.1262	term nal equip	upgrade term equip	1.0	ea	100	31845
14	401	918	1319	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345	0.0590	Conductor	Reconductor	19.0	mi	1900	33745
15	402	918	1320	Nobles 345/115 tx @ 130% of 448	White 345/115 tx or White-Yank	0.5182	transformer	(already addressed)			0	33745
16	423	918	1341	Minn Valley-Panther 230 @ 110% of 382	Wilmarth-Lakefield Ger 345	0.1358	Conductor	Reconductor	30	mi	3000	36745
17			1369								0	36745
18	451	918	1369	Lk Yankton-Buffalo Ridge 115 @ 110% of 294	White 345/115 tx or White-Yank	0.2748	Conductor	Add 2nd Buff R-Lk Yank	20.0	mi	8000	44745
19	451	918	1412								0	44745
20	494	918	1412	Chandler Tp2-Chandler 69 @ 110% of 42	Nobles Co 345/115 tx	0.0203	Conductor	Rebuild	7.1	mi	1065	45810
21	588	918	1501	Granite Fals-Minn Valley Tp 230 @ 1 0% of 382	Wilmarth-Lakefield Ger 345	0.0956	Conductor	Reconductor	2.5	mi	250	46060
22	595	918	1513	Nobles-Fenton 115 @ 110% of 620	White 345/115 tx or White-Yank	0.5162	Conductor	Add 2nd Nobles-Fenton 115			6600	52660
23	607	918	1525	Marshall Eas: River-Granite Fals 115 @ 10% of 20	Nobles Co 345/115 tx	0.0972	Conductor	Add 2nd Nobles Co 34	1	ea	4000	56660
24	620	918	1538	Maynard-Ker-hoven Tp 115 @ 110% of 78	Granite Fals-Willmar 230	0.0311	Conductor	Rebuild	14.6	mi	3796	60456
25	635	918	1553	Wilmarth-Lakefielc Gen 345 @ 110% of 1165	Sherco # 3 gen	0.3225	Conductor	Reconductor	54	mi	8640	69096

Notes:

1. TLTG analys s run on off-pk (70% load) powerflow case derved from A102li_07s.pk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo R dge area line ratings adjusted per NSP wind rat ng practice.
3. Improvements modeled: Rebuild Lyon Co-Yellow Medicine 69 kV to 115 kV (795 kcm ACSS), adc Lyor Co-Marshall Eas: River 1 5 kV
4. Limters l sted have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limters not l sted: Lekefe d Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE
1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 3: Establish Lk Yankton-Lyon Co 115 kV #3

	SW MN Buffalo Ridge Area Generation											
	TLTC Limit	Base Case	System Limit			distribution	Limiting				Installed Cost, $1,000's	
Key	MW	MW	MW	Limiting Facility	MVA	factor	factor	Remedy	qty		incremental	cumulative
0			815					(Base plan)				6,900
1	-603	918	815	Medella J-Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0205	Conductor	Rebuild	3.5	mi	525	7,425
2	-261	918	857	Medella-Buttemut Tp 69 @ 110% of 57	Wilmarth-Lakefield 345	0.0205	Conductor	Rebuild	11.7	mi	1,755	9,180
3			825								0	9,180
4			920								0	9,180
5	2	918	920	Eastwood Eagle Lk 69 @ 110% of 72	Blue Lk Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0217	switches	Replace switches	2	ea	40	9,220
6			925								0	9,220
			942									9,220
7	24	918	942	Svea Tp Litch Tp 69 @ 110% of 42	Minn Valley Tp Panther 230	0.0200	Conductor	Rebuild	25	mi	3,705	12,925
8	86	918	904	Medella J-Medella VI 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0205		Rebuild	3.6	mi	540	13,465
9			1025									13,465
10	120	918	1038	Fegio Lk-Fegio Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0217	switches	Replace switches	2	ea	40	13,505
			1125									13,505
			1156								0	13,505
11	238	918	1156	S3 Granite Falls 115 @ 110% of 120	Nobles Co 345/115 tx or Nobles Co	0.1288	Conductor	Add Plan 1A facilities	1.0	ea	10,600	24,105
			1176								0	24,105
11			1185								0	24,105
12	267	918	1185	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles Co	0.2138	Conductor	Addressed by 1A facilities			0	24,105
13	276	918	1194	Lyon Co Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles Co	0.0410	Conductor	Addressed by 1A facilities			0	24,105
			1225								0	24,105
15	313	918	1231	Erie Rd S3 115 @ 110% of 110	Nobles Co 345/115 tx or Nobles Co	0.1288		Addressed by 1A facilities			0	24,105
16	321	918	1239	Nobles 345/115 tx @ 100% of 448	System Intact	0.402	transformer	Addressed by 1A facilities			0	24,105
17	343	918	1261	Pipestone 230/69 tx @ 130% of 70	Pipestone-Mid-cont 230	0.0222	transformer	add 2nd tx	1.0	ea	2,600	26,705
18	351	918	1269	W Fairbault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0585	Conductor	Reconductor	4.6	mi	460	27,165
19	361	918	1279	Willmar-Svea TP 69 @ 110% of 53	Minn Valley Tp-Panther 230	0.0206	Conductor	Rebuild	4.6	mi	690	27,855
20	378	918	1296	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1269	term equip	upgrade term equip	1	ea	100	27,955
21	384	918	1302	Yellow Medicine-Minn Valley 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles Co	0.0416	Conductor	Addressed by 1A facilities			0	27,955
22	398	918	1316	Lyon Co-Marshall 115 @ 110% of 128	Lk Yankton-Southeast 115	0.0590	Conductor	Reconductor	4.0	mi	400	28,355
			1325								0	28,355
23	414	918	1332	Nobles 345/115 tx @ 130% of 448	White 345/115 tx or White Yankee 115	0.5137	transformer	Addressed by 1A facilities			0	28,355
24	421	918	1339	Minn Valley Tp-Panther 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1362	Conductor	Reconductor	30	mi	3,000	31,355
25	430	918	1348	Lk Marion Airtech 115 @ 110% of 139	Blue Lk Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0585	Conductor	Reconductor	19	mi	1,900	33,255
26	435	918	1353	Lk Yankton Buffalo Ridge 115 @ 110% of 291	White 345/115 tx or White Yank 115	0.2773	Conductor	Reconductor	20.0	mi	2,000	35,255
27	455	918	1373	Marshall-Erie Rd 115 @ 110% of 128	Saratoga-Southeast 115	0.0892	Conductor	Reconductor	1.7	mi	170	35,425
			1425								0	35,425
			1457									35,425
28	539	918	1457	Saratoga-SE 115 @ 110 % of 128	Marshall-Erie Rd	0.0665	Conductor	Reconductor	2.7	mi	270	35,695
29	502	918	1460	Granite Falls Minn Valley Tp 230 @ 110% of 3	Wilmarth Lakefield 345	0.0992	Conductor	Reconductor	2.5	mi	250	35,945
30	594	918	1502	Marshall-SE @ 110% of 128	Saratoga-SE 115	0.0747	Conductor	Reconductor	1.7	mi	170	36,115
31	606	918	1524	Maynard-Korkhowen 115 @ 110% of 78	Granite Falls-Willmar 230	0.0316	Conductor	Rebuild	14.6	mi	3,796	39,911
			1525								0	39,911
32	608	918	1526	Nobles Co Fenton 115 @ 110% of 020	White 345/115 tx or White Yank 115	0.0137	Conductor	Addressed by 1A facilities			0	39,911
33	646	918	1564	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco Gen #3	0.3220	Conductor	Reconductor	54	mi	8,640	48,551
34	650	918	1568	Minn Valley 230/115 tx @ 130% of 187	Granite Falls-Minn Valley Tp 230	0.0821	transformer	Replace with 336 MVA	1	ea	1,500	50,051

Notes:

1. TLTC analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Add Lake Yankton-Marshall SE 115 kV (795 kcm ACSS).
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 101 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 09.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV.

R Gonzalez, PE
1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 4: Add Lyon Co-Franklin 115 kV

Key	SW MN Buffalo Ridge Area Generation TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's incremental	cumulative
			600					(base plan)				20,600
			825								0	20,600
0	-9	918	909	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0220	switches	Replace switches	2	ea	40	20,640
1	1	918	919	Franklin 115/69 tx 1 & 2 @ 130% of 47	Minn Valley Tp-Panther 230	0.0229	transformers	Replace txs 47-->70	2.0	ea	2,000	22,640
			925								0	22,640
2	108	918	1026	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0218	switches	Replace switches	2	ea	40	22,680
3	145	918	1063	Lyon Co-Marshall 115 @ 110% of 128 MVA	Nobles Co 345/115 tx or Nobles Co-Fenton 115	0.0864	Conductor	Reconductor	4.0	mi	400	23,080
			1175								0	23,080
4	274	918	1192	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-FNT 115	0.2131	Conductor	Reconductor	42.0	mi	4,200	27,280
			1225								0	27,280
5	324	918	1242	Nobles Co 345/115 tx @ 100% of 448	(System Intact)	0.3810	transformer	order larger tx	1.0	ea	500	27,780
6	327	918	1245	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0596	Conductor	Reconductor	4.6	mi	460	28,240
7	342	918	1260	Chandler Tp2-Chandler Tp 69 @ 110% of 42	Nobles Co 345/115 tx or Nobles-FNT 115	0.0225	Conductor	Rebuild	7.1	mi	1,065	29,305
8			1323								0	29,305
9	405	918	1323	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0596	Conductor	Reconductor	19.0	mi	1,900	31,205
			1325								0	31,205
10	413	918	1331	Nobles Co 345/115 tx @ 130% of 448	White 345/115 tx or White-Yankee 115	0.4849	transformer	(already addressed)			0	31,205
11	428	918	1346	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1231	terminal equip	upgrade term equip	1.0	ea	100	31,305
12			1363									31,305
13	445	918	1363	Lk Yankton-Buffalo Ridge 115 @ 110% of 292	White 345/115 tx or White-Yankee 115	0.2745	Conductor	Reconductor	20.0	mi	2,000	33,305
			1524								0	33,305
14	606	918	1524	Nobles Co-Fenton 115 @ 110% of 620	White 345/115 tx or White-Yankee 115		Conductor	Add 2nd Nobles-Fenton 115			6600	39,905
			1525								0	39,905
15	634	918	1552	Chandler Tp-Lk Wilson 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115		Conductor	Add 2nd Nobles Co 345	1	ea	4000	43,905
16	654	918	1572	Slayton-Hadley 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115							43,905
18	672	918	1590	Lyon Co-Marshall 115 @ 100% of 128	(System Intact)	0.0460	Conductor	(already addressed)			0	43,905
17	685	918	1603	Lk Wilson-Hadley 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0225	Conductor	(already addressed)			0	43,905
19	685	918	1603	Lyon Co-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0326	Conductor	(already addressed)			0	43,905
20	689	918	1607	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco # 3 gen	0.3164	Conductor	Reconductor	54	mi	8640	52,545

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Add Lyon Co-Franklin 115 kV (795 kcm ACSS).
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 6: Add Chanaramble-Watonwan Jct 115 kV

Key	SW MN Buffalo Ridge Area Generation: TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's: incremental	cumulative
0			131					(Base plan)				15,700
1	-787	918	131	Madelia J-Hanska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0243	Conductor	Rebuild	3.5	mi	525	16,225
2	-497	918	421	Madelia VL-Butternut Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0243	Conductor	Rebuild	11.7	mi	1,755	17,980
3	-221	918	697	Madelia VL-Madelia Jct 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0243	Conductor	Rebuild	4.0	mi	600	18,580
			825								0	18,580
			852								0	18,580
4	-66	918	852	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0231	switches	Replace switches	2.0	ea	40	18,620
			925								0	18,620
			950									18,620
5	32	918	950	Lyon Co-Marshall 115 @ 110% of 128 MVA	Watertown-Granite Falls 230 & Watertown-Blair 230	0.0537	Conductor	Reconductor	4.0	mi	400	19,020
6	45	918	963	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0231	switches	Replace switches	2.0	ea	40	19,060
			1025									19,060
			1125									19,060
			1175								0	19,060
			1188									19,060
7	270	918	1188	Watonwan Jct 115/69 tx @ 130% of 70	Watonwan Jct-Lakefield Gen 115	0.0502	transformer	order larger tx (112 MVA	1.0	ea	200	19,260
8	274	918	1192	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0616	Conductor	Reconductor	4.6	mi	460	19,720
			1225								0	19,720
			1268								0	19,720
9	350	918	1268	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0616	Conductor	Reconductor	19.0	mi	1,900	21,620
10	379	918	1297	Lyon Co-Marshall 115 @ 100% of 128	(system intact)	0.0530	Conductor	(already addressed)			0	21,620
			1325								0	21,620
			1335								0	21,620
11	417	918	1335	Triboji-Spencer 161 @ 110% of 433	Wilmarth-Lakefield 345	0.0323	Conductor	Reconductor	4.0	mi	400	22,020
12	454	918	1372	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1207	term equip	Upgrade term equip	1.0	ea	100	22,120
13	478	918	1390	Nobles Co 345/115 tx @ 100% of 446	(system intact)	0.3600	transformer	install larger tx	1	ea	500	22,620
14	505	918	1423	Minn Valley-Panther 230 @ 110% of 360	Wilmarth-Lakefield 345	0.1300	Conductor	Reconductor	30.2	mi	3,020	25,640
15	506	918	1424	Wilmarth-Lakefield 345 @ 110% of 1165	Sherco #3 gen	0.3480	Conductor	Reconductor	54	mi	8640	34,280
16	516	918	1434	Lk Yankton-Buffalo Ridge 115 @ 110% of 292	White 345/115 tx or White-Yankee 115	0.2621	Conductor	Reconductor	20.0	mi	2,000	36,280
17	569	918	1487	Granite Falls-Minn Valley 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0980	Conductor	Reconductor	2.5	mi	250	36,530
18	574	918	1492	Nobles Co 345/115 tx @ 130% of 448	White 345/115 tx or White-Yankee 115	0.4647	transformer	(already addressed)			0	36,530
			1525								0	36,530
18	659	918	1577	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-FNT	0.1663	Conductor	Reconductor	42	mi	4,200	40,730
19	678	918	1596	Lyon Co-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT	0.0317	Conductor	Rebuild	12.3	mi	1845	42,575
20	693	918	1611	Wilmarth Lakefield 345 @ 100% of 1165	(system intact)	0.3480	Conductor	(already addressed)			0	42,575

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice
3. Improvements modeled: Chanaramble-Watonwan Jct 115 kV 795 kcm ACSS
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 6: Add Yankee-White-Toronto 115 kV

	SW MN Buffalo Ridge Area Generation												
	TLTG Limit	Base Case	System Limit			distribution	Limiting				Installed Cost, $1,000's	
Key	MW	MW	MW	Limiting Facility	Contingency	factor	factor	Remedy	qty		incremental	cumulative
0			310					(Base plan)				12,040
1	-608	918	310	Madelia J-Hanska Tp 69 @ 110% of 42	Wilmarth-Lakefield 345	0.0204	Conductor	Rebuild	3.5	mi	525	13,365
2	-264	918	654	Madelia VI -Butternut Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0204	Conductor	Rebuild	11.7	mi	1,755	15,120
			825								0	15,120
3	-49	918	869	Lyon Co-Marshall 115 @ 100% of 128	Nobles Co 345/115 tx or Nobles-FNT 115	0.0925	Conductor	Reconductor	4.0	mi	400	15,520
4	-3	918	915	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0216	switches	Replace switches	2	ea	40	15,560
			925								0	15,560
5	12	918	930	Svea-Litchfield 69 @ 110% of 42	Minn Valley Tp- Panther 230	0.0204	Conductor	Rebuild	24.7	mi	3,705	19,265
6	63	918	981	Madelia VL-Madelia Jct 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0204	Conductor	Rebuild	4.0	mi	600	19,865
7	81	918	999	Canby-Burr Jct 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0308	Conductor	Reconductor	1.1	mi	110	19,975
8	116	918	1034	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0216	switches	Replace switches	2	ea	40	20,015
			1125									20,015
			1175								0	20,015
			1225								0	20,015
			1229								0	20,015
9	321	918	1239	Pipestone-Pembinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-FNT 115	0.1947	Conductor	Reconductor	42.0	mi	4,200	24,215
10	325	918	1243	Panther 230/69 tx @ 130% of 70	McLeod-Panther 230	0.0223	transformer	Add 2nd tx	1.0	ea	2,600	26,815
11	329	918	1247	Nobles Co 345/115 tx @ 100% of 448	(system intact)	0.3890	transformer	order larger tx	1.0	ea	400	27,215
12	348	918	1266	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0582	Conductor	Reconductor	4.6	mi	460	27,675
13	352	918	1270	Willmar Svea Tp 69 @ 110% of 53	Minn Valley Tp- Panther 230	0.0201	Conductor	Rebuild	4.6	mi	690	28,365
14	309	918	1287	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1259	Term equip	Upgrade term equip	1	ea	100	28,465
15	394	918	1312	Lyon Co-Marshall 115 @ 100% of 128	(system intact)	0.0480	Conductor	(already addressed)			0	28,465
			1325								0	28,465
16	409	918	1327	Minn Valley-Panther 230 @ 110% of 388	Wilmarth-Lakefield 345	0.1358	Conductor	Reconductor	30.0	mi	3,000	31,465
17	428	918	1346	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0582	Conductor	Reconductor	19.0	mi	1,900	33,365
18	441	918	1359	Toronto-Burr 115 @ 110% of 144	White NSP 345/115 tx	0.1618	Conductor	Reconductor	24.7	mi	2,470	35,835
21	467	918	1385	Nobles Co 345/115 tx @ 130% of 448	White NSP 345/115 tx	0.4816	transformer	(already addressed)			0	35,835
20	468	918	1386	Lyon Co-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0348	Conductor	Rebuild	12.3	mi	1,845	37,680
21	474	918	1392	Granite Falls-Min Vall Tp 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1035	Conductor	Reconductor	2.5	mi	250	37,930
			1425									37,930
			1494								0	37,930
22	576	918	1494	Canby-Granite Falls 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0308	Conductor	Reconductor	30.2	mi	3,920	41,850
			1500								0	41,850
23	590	918	1508	Minn Valley-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0348	Conductor	Rebuild	15.9	mi	2,385	44,235
			1525									44,235
			1563								0	44,235
24	645	918	1563	Wilmarth-Lakefield Gen 345 @ 110% of 1105	Sherco #3 gen	0.3208	Conductor	Reconductor	54	mi	8,640	52,875
25	647	918	1565	Pipestone-Chanarambie 115 @ 110% of 384	Nobles Co 345/115 tx or Nobles-FNT 115	0.2767	Conductor	Reconductor	15	mi	1,500	54,375
26	648	918	1566	Marshall SS-Lyne Rd 115 @ 110% of 120	Nobles Co 345/115 tx or Nobles-FNT 115	0.0722	Conductor	Reconductor	1.7	mi	170	54,545
			1592								0	54,545
27	674	918	1592	Nobles Co-Fenton 115 @ 110% of 620	White NSP 345/115 tx	0.4816	Conductor	???				
28	677	918	1595	Minn Valley 230/115 tx @ 130% of 187	Granite Falls-Minn Valley 230	0.0799						

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD reprocessing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Yankee-White 115 kV #2 (2 x 795 kcm), White-Toronto 115 kV (795 kcm ACSS).
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 2/16/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 7: Add Yankee-(Marshall SE)-Lyon Co 115 kV

	SW MN Buffalo Ridge Area Generation													
	TLTG Limit	Base Case	System Limit									Installed Cost, $1,000's		
Key	MW	MW	MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy (Base Plan)	qty			incremental	cumulative	
0			655									15,360	15,360	
1	263	918	655	Madelia VL Butternut Tp 69 @ 110% of 36	Wilmarth Lakefield 345	0.0203	Conductor	Rebuild	11.7	mi		1,755	17,115	
			825									0	17,115	
			915									0	17,115	
2	3	918	915	Svea Litchfield 69 @ 110% of 42	Minn Valley Tp Panther 230	0.0213	Conductor	Rebuild	21.7	mi		3,705	20,820	
3	0	918	918	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0215	switches	Replace switches	2	ea		40	20,860	
			925									0	20,860	
			985									0	20,860	
4	67	918	985	Madelia VL Madelia Jct 69 @ 110% of 36	Wilmarth Lakefield 345	0.0203	Conductor	Rebuild	1.0	mi		600	21,460	
5	119	918	1037	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyend Lk-Dean Lk 115	0.0215	switches	Replace switches	2	ea		40	21,500	
			1137									0	21,500	
6	219	918	1137	Pipestone-Pathfinder 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-FNT 115	0.2213	Conductor	Reconductor	42.0	mi		4,200	25,700	
7	219	918	1137	Lyon Co Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles FNT 115	0.0139	Conductor	Rebuild	12.3	mi		1,845	27,545	
			1175									0	27,545	
			1180									0	27,545	
8	262	918	1180	S3 Granite Falls 115 @ 110% of 120	Nobles Co 345/115 tx or Nobles FNT 115	0.1300	Conductor	Rebuild	30.0	mi		7,800	35,345	
9	200	918	1206	Nobles Co 345/115 tx @ 100% of 448	(system intact)	0.4100	transformer	order larger tx	1.0	ea		500	35,845	
			1225									0	35,845	
10	322	918	1240	Willmar Svea Tp 69 @ 110% of 53	Minn Valley Tp Panther 230	0.0213	Conductor	Rebuild	4.6	ea		690	36,535	
11	325	918	1243	Minn Valley-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0439	Conductor	Rebuild	15.9	mi		2,385	38,920	
12	330	918	1248	Panthor 230/69 tx @ 130% of 70	McLeod-Panthor 230	0.0227	transformer	Install 2nd tx	1.0	ea		2,600	41,520	
13	330	918	1254	Erie Rd-S3 @ 110% of 140	Nobles Co 345/115 tx or Nobles-FNT 115	0.1300	Conductor	Reconductor	4.3	mi		430	41,950	
14	351	918	1269	WI Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk Dean Lk 115	0.0582	Conductor	Reconductor	4.6	ea		460	42,410	
15	354	918	1272	Marshall SS-Erie Rd 115 @ 110% of 120	Saratoga-SC 115	0.0790	Conductor	Reconductor	1.7	ea		170	42,580	
16	350	918	1277	Lyon Co-Marshall 115 @ 110% of 128 MVA	Yankee-SE 115	0.0500	Conductor	Roconductor	4.0	mi		400	42,980	
17	360	918	1278	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1290	Tem equip	upgrade tem equip	1.0	ea		100	43,080	
18			1322									0	43,080	
19	401	918	1322	Minn Valley Tp Panther 230 @ 110% of 388	Wilmarth Lakefield 345	0.1387	Conductor	Reconductor	30	mi		3,000	46,080	
20	426	918	1344	Nobles Co 345/115 tx @ 130% of 448	White 345/115 tx or White-Yankee115	0.5027	transformer	(already addressed)				0	46,080	
21	431	918	1349	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0582	Conductor	Reconductor	19	mi		1,900	47,980	
22	445	918	1363	Saratoga-SE @ 110% of 128	Marshall SS-Erie Rd 115	0.0758	Conductor	Reconductor	2.7	mi		270	48,250	
			1472										48,250	
23	554	918	1472	Maynard-Kerkhoven Tp @ 110% of 78	Granite Falls-Willmar 230	0.0334	Conductor	Rebuild	14.7	mi		3,822	52,072	
			1517										52,072	
24	599	918	1517	Minn Valley 230/115 tx @ 130% of 187	Granite Falls Minn Valley 230	0.0857	transformer	Replace with 336 MVA	1	ea		1,500	53,572	
25	609	918	1527	Pipestone-Chanaranbie 115 2 110% of 384	Nobles Co 345/115 tx or Nobles-FNT 115	0.2830							53,572	
26	609	918	1527	Granite Falls-Minn Valley 230 @ 110% of 362	Wilmarth-Lakefield 345	0.0952	Conductor	Reconductor	15	mi		1,500	55,072	
27	617	918	1535	Minn Valley-Lyon Co 115 @ 110% of 225	Nobles Co 345/115 tx or Nobles-FNT 115	0.1675	Conductor	Reconductor	29.4	mi		2,940	58,012	
28	624	918	1542	Nobles Co-Fenton 115 @ 110% of 620	White 345/115 tx or White-Yankee115	0.5027	Conductor	???						
29	639	918	1557	Erie Rd Saratoga 115 @ 110% of 128	Marshall SS Erie Rd 115	0.0758	Conductor							
30	653	918	1571	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco #3 gen	0.3187	Conductor	Reconductor	54	mi		8,640		0

Notes:

1. TLTG analysis run on off pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Yankee-Marshall SE-Lyon Co 115 kV (795 kcm ACSS).
4. Limiters listed have distribution factor (DFAX or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct Fox Lk 161 #1, Lime Ck Emery 161, Wilmarth Johnson Penelope Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV.

R Gonzalez, PE 1/12/2006

Buffalo Ridge Incremental Outlet Study

Option 8: Add Yankee-(Marshall SE)-Lyon Co-Franklin 115 kV

Key	SW MN Buffalo Ridge Area Generation TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	Qty		Nominal Installed Cost, $1,000's incremental	next cumulative
0			879					(Base Plan)			35960	35960
1	39	918	879	Lyon Co-Marshall 115 @ 100% of 128 MVA	Nobles Co 345/115 tx or Nobles-FNT 115	0.0931	Conductor	Reconductor	4	mi	480	36360
2	19	918	937	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0215	switches	Replace switches	2	ea	40	36400
3	41	918	959	Franklin 115/69 tx 1 & 2 @ 130% of 47	Minn Valley Tp-Panther 230	0.0275	Transformers	Replace with 70 MVA	1.0	ea	2500	38900
4	138	918	1056	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0215	switches	Replace switches	2	ea	40	38940
5	182	918	1100	Lyon Co-Marshall 115 @ 100% of 128 MVA	(system intact)	0.0583	Conductor	(already addressed)			0	38940
6	282	918	1200	Winthrop-Heartland 69 @ 100% of 47	Wilmarth-Lakefield 345	0.0220	Conductor	Reconductor	1.0	mi	100	39040
7	294	918	1212	Pleasant-Pathfinder 115 @ 100% of 225	Nobles Co 345/115 tx or Nobles-FNT 115	0.2388	Conductor	Reconductor	42	mi	4200	43240
8	376	918	1294	W Fairbault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0583	Conductor	Reconductor	4.6	mi	460	43700
9	418	918	1336	Nobles Co 345/115 tx @ 100% of 448	(system intact)	0.3520	Transformer	order ergater tx	1.0	ea	400	44100
10	419	918	1337	McLeod-Panther 230 @ 100% of 319	Wilmarth-Lakefield 345	0.1219	Term equip	upgrade term equip	1.0	ea	100	44200
11	455	918	1373	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0583	Conductor	(already addressed)	19.0	mi	1900	46100
12	501	918	1419	Gaylord-Heartland 69 @ 110% of 47	Wilmarth-Lakefield 345	0.0220	Conductor	Reconductor	6.1	ea	610	46710
13	507	918	1425	Lyon Co-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0942	Conductor	Reduc	12.3	mi	1845	48555
14	572	918	1490	Nobles Co 345/115 tx @ 130% of 448	White 345/115 tx or White-Yankee 115	0.4572	transformer	(already addressed)			0	48555
15	594	918	1512	Maynard-Kerkhoven 115 @ 110% of	Granite Falls-Wilmar 230	0.0525	Conductor	Reduc	14.7	mi	3822	52377

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102I_07pk_C1.1_NEW_DKD representing MISO 'Group 2' Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Yankee-Marshall SE-Lyon Co-Franklin 115 kV (795 kcm ACSS)
4. Limiters listed have a distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Crk-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69
6. Includes 30% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 31A

Establish Lk Yankton-Lyon Co 115 kV #3 & Nobles Co-Fenton 115 #2 + 2nd Nobles Co 345/115 tx

Key	SW MN Buffalo Ridge Area Generation: TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	Distribution factor	Limiting factor	Remedy (Basis plan)	qty		Installed Cost, $1,000's: Incremental	cumulative
0			312									17,500
1	-606	918	312	Madelia-Henska Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0211	Conductor	Rebuild	3.5	mi	525	18,025
2	-273	918	645	Madelia-Butternut Tp 69 @ 110% of 37	Wilmarth-Lakefield 345	0.0211	Conductor	Rebuild	11.7	mi	1,755	19,780
3			825								0	19,780
4			901								0	19,780
5	17	918	901	Eastwood Eagle Lk 69 @ 110% of 72	Blue Lk Wilmarth 345 & Hyland Lk Dean Lk 115	0.0217	switches	Replace switches	2	ea	40	19,820
6			925								0	19,820
7	44	918	962	Madelia-Madelia VI 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0211	Conductor	Rebuild	3.6	mi	540	20,360
8			1016									20,360
9	98	918	1016	Lagle Lk-Lagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0222	switches	Replace switches	2	ea	40	20,400
			1175								0	20,400
			1225								0	20,400
10	328	918	1246	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0598	Conductor	Reconductor	4.6	mi	460	20,860
			1302								0	20,860
11	384	918	1302	Panther 230/69 tx @ 130% of 70	Panther-McLeod 230	0.0210	transformer	add 2nd tx	1.0	ea	2,600	23,460
21	395	918	1313	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1229	term equip	upgrade term equip	1	ea	100	23,560
12	406	918	1324	Lk Marion Airtech 115 @ 110% of 139	Blue Lk Wilmarth 345 & Hyland Lk Dean Lk 115	0.0596	Conductor	Reconductor	19	mi	1,900	25,460
			1325								0	25,460
			1358								0	25,460
13	440	918	1358	Minn Valley Tp-Panther 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1324	Conductor	Reconductor	30	mi	3,000	28,460
14	460	918	1378	Lk Yankton-Buffalo Ridge 115 @ 110% of 294	White 345/115 tx or White-Yank 115	0.2715	Conductor	Reconductor	20.0	mi	2,000	30,460
15	520	918	1438	Nobles 345/115 tx #1 or 2 @ 130% of 448	Nobles 345/115 tx #2 or 1	0.4409	transformer	install larger bs	2	ea	1,000	31,460
16	539	918	1457	Granite Falls Minn Valley Tp 230 @ 110% of 38	Wilmarth-Lakefield 345	0.0990	Conductor	Reconductor	2.5	mi	250	31,710
17	578	918	1496	Lyon Co Yellow Medicine 69 @ 110% of 47	Lyon Co Minn Valley 115	0.0309	Conductor	Rebuild	12.3	mi	1,845	33,555
18	580	918	1498	Lyon Co-Marshall 115 @ 110% of 128	Lk Yankton-Southeast 115	0.0512	Conductor	Reconductor	4.0	mi	400	33,955
19	580	918	1498	S3-Granite Falls 115 @ 110% of 120	White 345/115 tx or White-Yank 115	0.1089	Conductor	Rebuild	30.0	mi	7,800	41,755
20	603	918	1521	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco Gen #3	0.3821	Conductor	Reconductor	54	mi	8,640	50,395
			1525								0	50,395
22	641	918	1559	Marshall-Erie Rd 115 @ 110% of 128	Saratoga-Southeast 115	0.0002	Conductor	Reconductor	1.7	mi	170	50,565
23	660	918	1578	Triboji-Spencer 101 @ 110% of 167	Wilmarth-Lakefield 345	0.0284	Conductor	Reconductor	4.0	mi	400	50,965
24	673	918	1591	Erie Rd S3 115 @ 110% of 140	White 345/115 tx or White Yank 115	0.1089	Conductor	Reconductor	1.3	mi	130	51,395
25	704	918	1622	Maynard Kerkhoven 115 @ 110% of 78	Granite Falls Willmar 230	0.0295	Conductor	Rebuild	14.7	mi	3,822	55,217
26	718	918	1636	Yellow Medicine-Minn Valley 69 @ 110% of 47	Lyon Co-Minn Valley 115	0.0309	Conductor	Rebuild	15.0	mi	2,385	57,602
27	723	918	1641	Minn Valley 230/115 tx @ 130% of 187	Granite Falls-Minn Valley Tp 230	0.0772	transformer	Replace with 336 MVA	1	ea	1,500	59,102
28	738	918	1656	Saratoga-SE 115 @ 110 % of 128	Marshall-Erie Rd	0.0578	Conductor	Reconductor	2.7	mi	270	59,372
29	755	918	1673	Elk-Heron Lk 161 @ 110% of 112	Nobles Co-Lakefield Jct 161	0.0582	Conductor	Reconductor	21	mi	2,100	61,472
30	780	918	1705	Marshall-SL @ 110% of 128	Saratoga-SL 115	0.0747	Conductor	Reconductor	1.7	mi	170	61,642
31	792	918	1710	Wilmarth-Lakefield Gen 345 @ 100% of 1165	(System Intact)	0.3920						

Notes:

1. TLTG analysis run on powerflow case A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Fenton-Nobles Co 115 kV #2 (2 x 795 kcm ACSR), Nobles Co 345/115 tx #2 (448 MVA), Lk Yankton-Marshall SE 115 (795 kcm ACSR)
4. Limiters listed have distribution factor (DTDF or OTDF) of 0.0200 or higher
5. Incremental source: 50% Yankee, 50% Fenton
6. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Clk-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
7. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

RG
1/5/2006

Buffalo Ridge Incremental Generation Outlet Study

Option 61A

Add Yankee-White-Toronto 115 kV & 2nd Nobles Co-Fenton 115 kV & 2nd Nobles Co 345/115 tx

	SW MN Buffalo Ridge Area Generation												
	TLTG Limit	Base Case	System Limit			distribution	Limiting				Installed Cost, $1,000's	
Key	MW	MW	MW	Limiting Facility	Contingency	factor	factor	Remedy	qty		incremental	cumulative
0			310					(Base plan)				23,440
1	-612	918	306	Madelia J-Hanska Tp 69 @ 110% of 27 MVA	Wilmarth-Lakefield 345	0.0210	Conductor	Rebuild	3.5	mi	525	23,965
2	-277	918	641	Madelia VL-Butternut Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0210	Conductor	Rebuild	11.7	mi	1,755	25,720
			825								0	25,720
3	-20	918	898	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0221	switches	Replace switches	2	ea	40	25,760
			925								0	25,760
5	40	918	958	Canby-Burr Jct 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0322	Conductor	Reconductor	1.1	mi	110	25,870
4	42	918	960	Madelia VL-Madelia Jct 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0210	Conductor	Rebuild	4.0	mi	600	26,470
6	96	918	1014	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0221	switches	Replace switches	2	ea	40	26,510
7				Lyon Co-Marshall 115 @ 100% of 128	Granite Falls-Watertown 230 & Granite Falls-Blair 230		Conductor	Reconductor	4.0	mi	400	26,910
	219	918	1137			0.0469						
8	219	918	1137	Lyon Co-Marshall 115 @ 100% of 128	Lyon Co-Minn Valley 115 kV	0.0647						26,910
			1175								0	26,910
			1225								0	26,910
10	326	918	1244	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0594	Conductor	Reconductor	4.6	mi	460	27,370
9	375	918	1293	Panther 230/69 tx @ 130% of 70	McLeod-Panther 230	0.0223	transformer	Add 2nd tx	1.0	ea	2,600	29,970
10	390	918	1308	McLeod-Panther 230 @ 110% of 310	Wilmarth-Lakefield 345	0.1227	Term equip	Upgrade term equip	1	ea	100	30,070
11	405	918	1323	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0594	Conductor	Reconductor	19.0	mi	1,900	31,970
			1325								0	31,970
12	432	918	1350	Minn Valley-Panther 230 @ 110% of 300	Wilmarth-Lakefield 345	0.1324	Conductor	Reconductor	30.0	mi	3,000	34,970
13	464	918	1382	Granite Falls-Min Vall Tp 230 @ 110% of 382	Wilmarth-Lakefield 345	0.1041	Conductor	Reconductor	2.5	mi	250	35,220
14	515	918	1433	Canby-Granite Falls 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0322	Conductor	Reconductor	39.2	mi	3,920	39,140
15	517	918	1435	Toronto-Burr 115 @ 110% of 144	White NSP 345/115 tx	0.1519	Conductor	Reconductor	24.7	mi	2,470	41,610
16	534	918	1452	Nobles Co 345/115 tx #1 or 2 @ 130% of 448	Nobles Co 345/115 tx #2 or 1	0.4271	transformer	install larger txs	2	ea	1,000	42,610
17	596	918	1514	Lyon Co-Marshall 115 @ 100% of 128	(system intact)	0.0410	Conductor	(already addressed)			0	42,610
18	603	918	1521	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco #3 gen	0.3302	Conductor	Reconductor	54	mi	8,640	51,250
			1525								0	51,250
19	675	918	1593	Triboji Spencer 161 @ 110% of 160	Wilmarth Lakefield 345	0.0279	Conductor	Reconductor	1	mi	400	51,650

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Fenton-Nobles Co 115 kV #2 (2 x 795 kcm ACSS), Nobles Co 345/115 tx #2 (448 MVA), Yankee-White 115 #2 (2 x 795 kcm ACSS), White-Toronto 115 kV (795 kcm ACSS)
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

R Gonzalez, PE 1/12/2005

Buffalo Ridge Incremental Generation Outlet Study

Option 71A:

Add Yankee-(Marshall SE)-Lyon Co 115 kV & Nobles Co-Fenton 115 kV #2 & 2nd Nobles Co 345/115 tx

		SW MN Buffalo Ridge Area Generation										
	TLTC Limit	Base Case	System Limit			distribution	Limiting				Installed Cost, $1,000's	
Key	MW	MW	MW	Limiting Facility	Contingency	factor	factor	Remedy	qty		incremental	cumulative
0			903					(Base Plan)			25,960	25,960
1	-615	918	303	Madelia-Lafayette Tp 69 @ 110% opf 27	Wilmarth-Lakefield 345	0.0209	Conductor	Rebuild	3.5	mi	525	26,485
2	-278	918	640	Madelia VL-Butternut Tp 69 @ 110% of 30	Wilmarth-Lakefield 345	0.0209	Conductor	Rebuild	11.7	mi	1,755	28,240
			825								0	28,240
			898								0	28,240
4	-20	918	898	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & I Mand Lk-Dean Lk 115	0.0221	switches	Replace switches	2	ea	40	28,280
3	-3	918	915	Svea-Litchfield 69 @ 110% of 42	Minn Valley Tp- Panther 230	0.0203	Conductor	Rebuild	24.7	mi	3,705	31,985
			925								0	31,985
			961								0	31,985
5	43	918	961	Madota VL-Madota Jct 69 @ 110% of 38	Wilmarth-Lakefield 345	0.0200	Conductor	Rebuild	4.0	mi	600	32,585
6	96	918	1014	Eagle Lk-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & I Mand Lk-Dean Lk 115	0.0221	switches	Replace switches	2	ea	40	32,625
			1125									32,625
			1175								0	32,625
			1225								0	32,625
7	327	918	1245	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0594	Conductor	Reconductor	4.6	ea	460	33,085
8	374	918	1292	Willmar-Svea Tp 69 @ 110% of 53	Minn Valley Tp- Panther 230	0.0203	Conductor	Rebuild	4.8	ea	690	33,775
9	386	918	1304	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1256	Term equip	upgrade term equip	1.0	ea	100	33,875
10	388	918	1306	Panther 230/69 tx @ 130% of 70	McLeod Panther 230	0.0216	transformer	Install 2nd tx	1.0	ea	2,600	36,475
11	405	918	1323	Lk Manon-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0594	Conductor	Reconductor	19	mi	1,900	38,375
			1325								0	38,375
12	432	918	1350	Minn Valley Tp-Panther 230 @ 110% of 388	Wilmarth-Lakefield 345	0.1351	Conductor	Reconductor	30	mi	3,000	41,375
13	444	918	1362	Lyon Co-Yellow Medicine 69 @ 110% of 47	Lyon Co-Minn Valley 115	0.0349	Conductor	Rebuild	12.3	mi	1,845	43,220
14	481	918	1399	Marshall SS-Erie Rd 115 @ 110% of 126	Saratoga-SE 115	0.0714	Conductor	Reconductor	1.7	ea	170	43,390
15	483	918	1401	S3-Granite Falls 115 @ 110% of 120	White 345/115 tx or White-Yankee115	0.1245	Conductor	Rebuild	30.0	mi	7,800	51,190
16	483	918	1401	Nobles Co 345/115 tx #1 or 2 @ 130% of 448	Nobles Co 345/115 tx #2 or 1	0.4491	transformer	order larger txs	2.0	ea	1,000	52,190
			1425									52,190
17	540	918	1458	Lyon Co-Marshall 115 @ 110% of 128 MVA	Yankee-SE 115	0.0512	Conductor	Reconductor	4.0	mi	400	52,590
18	563	918	1481	Erie Rd-S3 @ 110% of 140	Nobles Co 345/115 tx or Nobles-FNT 115	0.1245	Conductor	Reconductor	4.3	mi	430	53,020
19	573	918	1491	Minn Valley-Yellow Medicine 69 @ 110% of 47	Nobles Co 345/115 tx or Nobles-FNT 115	0.0349	Conductor	Rebuild	15.9	mi	2,385	55,405
20	577	918	1495	Saratoga-SE @ 110% of 128	Marshall SS-Erie Rd 115	0.0697	Conductor	Reconductor	2.7	mi	270	55,675
21	598	918	1516	Granite Falls-Minn Valley 230 @ 110% of 382	Wilmarth-Lakefield 345	0.0959	Conductor	Reconductor	2.5	mi	250	55,925
			1525								0	55,925
22	608	918	1526	Wilmarth-Lakefield Gen 345 @ 110% of 1165	Sherco #3 gen	0.3284	Conductor	Reconductor	54	mi	8,640	64,565
23	636	918	1554	Maynard-Kerkhoven Tp @ 110% of 78	Granite Falls-Willmar 230	0.0314	Conductor	Rebuild	14.7	mi	3,822	68,387
24	657	918	1575	Tribolt Spencer 161 @ 110% of 167	Wilmarth Lakefield 345	0.0283	Conductor	Reconductor	4.0	mi	400	68,787
25	677	918	1595	Minn Valley 230/115 tx @ 130% of 187	Granite Falls-Minn Valley 230	0.0811	transformer	Replace with 336 MVA	1	ea	1,500	70,287

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NFW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen – 878 + 40 – 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice.
3. Improvements modeled: Fenton-Nobles Co 115 kV #2 (2 x 795 kcm ACSS), Nobles Co 345/115 tx #2 (448 MVA), Yankee Marshall SE Lyon Co 115 kV (795 kcm ACSS)
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth-Johnson-Penelope-Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

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Buffalo Ridge Incremental Generation Outlet Study

Option 31A6
Opt 3 + Opt 1A + Opt 6

Key	SW MN Buffalo Ridge Area Generation: TLTG Limit MW	Base Case MW	System Limit MW	Limiting Facility	Contingency	distribution factor	Limiting factor	Remedy	qty		Installed Cost, $1,000's: incremental	cumulative
0			310					(Base plan)				30,340
1	-802	918	316	Madelia J-Hanska Tp 69 @ 110% of 42	Wilmarth-Lakefield 345	0.0208	Conductor	Rebuild	3.5	mi	525	30,865
2	-263	918	655	Madelia VL-Buttemut Tp 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0208	Conductor	Rebuild	11.7	mi	1,755	32,620
			825								0	32,620
3	-10	918	908	Eastwood-Eagle Lk 69 @ 110% of 72	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0219	switches	Replace switches	2	ea	40	32,660
			925								0	32,660
4	59	918	977	Madelia VL-Madelia Jct 69 @ 110% of 36	Wilmarth-Lakefield 345	0.0208	Conductor	Rebuild	4.0	mi	600	33,260
5	107	918	1025	Eagle Lk Eagle Lk 69 @ 110% of 72	Blue Lk Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0216	switches	Replace switches	2	ea	40	33,300
6	217	918	1135	Canby-Burr Jct 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0298	Conductor	Reconductor	1.1	mi	110	33,410
			1175								0	33,410
			1220								0	33,410
			1255								0	33,410
8	337	918	1255	Panther 230/69 tx @ 130% of 70	McLeod Panther 230	0.0216	transformer	Add 2nd tx	1.0	ea	2,600	36,010
9	337	918	1255	W Faribault-Airtech Pk 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0590	Conductor	Reconductor	4.6	mi	460	36,470
10	357	918	1275	McLeod-Panther 230 @ 110% of 319	Wilmarth-Lakefield 345	0.1244	Term equip	Upgrade term equip	1	ea	100	36,570
			1316								0	36,570
11	398	918	1310	Minn Valley-Panther 230 @ 110% of 368	Wilmarth-Lakefield 345	0.1342	Conductor	Reconductor	30.0	mi	3,000	39,570
			1325								0	39,570
12	416	918	1334	Lk Marion-Airtech 115 @ 110% of 139	Blue Lk-Wilmarth 345 & Hyland Lk-Dean Lk 115	0.0590	Conductor	Reconductor	19.0	mi	1,900	41,470
			1390								0	41,470
13	480	918	1398	Granite Falls Min Vall Tp 230 @ 110% of 382	Wilmarth Lakefield 345	0.1033	Conductor	Reconductor	2.5	mi	250	41,720
			1425									41,720
14	561	918	1479	Nobles Co 345/115 tx #1 or 2 @ 130% of 448	Nobles Co 345/115 tx # 2 or 1	0.4218	transformer	Install larger txs	2	ea	1,000	42,720
15	572	918	1490	Toronto-Burr 115 @ 110% of 144	White NSP 345/115 tx	0.1472	Conductor	Reconductor	24.7	mi	2,470	45,190
			1500								0	45,190
			1540								0	45,190
16	622	918	1510	Wilmarth Lakefield Gen 345 @ 110% of 1165	Sherco #3 gen	0.3271	Conductor	Reconductor	51	mi	8,640	53,830
17	668	918	1600	Minn Valley 230/115 tx @ 130% of 187	Granite Falls-Minn Valley 230	0.0775	Transformer	Replace tx with 336	1	ea	1,500	55,330
18	698	918	1616	Inbop-Sponcor 161 @ 110% of 167	Wilmarth-Lakefield 345	0.0276	Conductor	Reconductor	4.0	mi	400	55,730
19	713	918	1631	Maynard-Kerkhoven 115 @ 110% of 78	Granite Falls-Willmar 230	0.0287	Conductor	Rebuild	14.7	mi	3,822	59,552
20	723	918	1641	Canby-Granite Falls 115 @ 110% of 96	Granite Falls-Watertown 230 & Granite Falls-Blair 230	0.0298	Conductor	Reconductor	39.2	mi	3,920	63,472

Notes:

1. TLTG analysis run on off-pk (70% load) powerflow case derived from A102ll_07supk_C1.1_NEW_DKD representing MISO "Group 2" Buffalo Ridge area gen interconnections.
   Total SW MN Buffalo Ridge area gen = 878 + 40 = 918 MW.
2. NSP Buffalo Ridge area line ratings adjusted per NSP wind rating practice
3. Improvements modeled: Fenton-Nobles Co 115 kV #2 (2 x 795 kcm ACSS), Nobles Co 345/115 tx#2 (448 MVA), Lk Yankton-Marshall SE 115 (795 kcm ACSS), Yankee-White 115 #2 (2 x 795 kcm ACSS), White-Toronto 115 kV (795 kcm ACSS)
4. Limiters listed have distribution factor (PTDF or OTDF) of 0.0200 or higher.
5. Limiters not listed: Lakefield Jct-Fox Lk 161 #1, Lime Ck-Emery 161, Wilmarth Johnson-Penelope Traverse 69.
6. Includes 60% series compensation of Wilmarth-Lakefield Gen 345 kV

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