

SECTION A

Flow South Study Results, Northern Umbrella Phase 1 Projects

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
215	442	Morgan-White Clay 138	Pulliam-Stiles 138	223	439	Plains-Stiles 138	Plains-Morgan 345
222	424	Stiles-Pioneer 138	Morgan-White Clay 138				
224	431	Plains-Stiles 138	Plains-Morgan 345				
230	424	Highway V-Preble 138	L.Dauphin-R. Maple 138				
232	422	Pulliam-Stiles 138	Pulliam-Stiles 138				
249	403	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138				
293	353	U.P. Voltage	Plains-Morgan 345	300	353	U.P. Voltage	Plains-Morgan 345

- 1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, and Stiles-Amberg 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.
- 2 West Marinette and Pulliam dispatch: Original – West Marinette = 75 MW, Pulliam = 385 MW (138 kV = 254 MW); Emergency – West Marinette = 234 MW, Pulliam = 481 MW.
- 3 The following notes apply to all tables: There are numerous first-contingency overloads of the Chandler-Cornell 69 kV line throughout this study (outage of Dead River-Plains 345 kV is the most severe outage), but these overloads are not listed in any tables. This line is listed with a SN/SE rating of 15/15 MVA and no winter ratings. A rating review of this line will be necessary. There are also overloads of the Sherman St. and Weston 115/46 kV transformers in later cases, but these are ignored due to the fact that they are not ATC facilities. Other overloads were observed subsequent to the outage of Arpin-Eau Claire and Arpin-Rocky Run 345 kV lines (including the North Appleton-Werner West 345 kV line), but they were ignored because of the existing operating guides in this area. Finally, an overload of the Presque Isle-Dead River 138 kV line at very high U.P. import levels in later tables were ignored due to the fact that the limiters are substation equipment.

Table A1: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. Existing System.

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
218	439	Morgan-White Clay 138	Pulliam-Stiles 138	343	316	Stiles-Pioneer 138	Morgan-White Clay 138
227	429	Stiles-Pioneer 138	Morgan-White Clay 138	354	304	Amberg-Stiles 138	Plains-Morgan 345
230	425	Highway V-Preble 138	L.Dauphin-R. Maple 138	360	298	Falls-Morgan 138	Morgan-White Clay 138
232	423	Pulliam-Stiles 138	Pulliam-Stiles 138	363	294	Morgan-White Clay 138	Falls-Pioneer 138
250	403	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	385	270	Falls-Pioneer 138	Morgan-White Clay 138
320	325	Amberg-Stiles 138	Plains-Morgan 345	400	254	Pulliam-Stiles 138	Pulliam-Stiles 138
336	307	Falls-Morgan 138	Morgan-White Clay 138				
346	296	N. App.-Lawn Rd. 138	Badger-W. Shawano 138				
361	280	Falls-Pioneer 138	Morgan-White Clay 138				
374	266	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138				
376	264	U.P. Voltage	Plains-Morgan 345	409	244	U.P. Voltage	Plains-Morgan 345

- 1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A2: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. Existing System, Add Project A – Phase 1 (Plains-Amberg 138 kV 1033 ACSR Rebuild + West Marinette-Amberg 138 kV 795 ACSR Rebuild).

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
220	462	Morgan-White Clay 138	Pulliam-Stiles 138	348	334	Stiles-Pioneer 138	Morgan-White Clay 138
231	448	Highway V-Preble 138	L.Dauphin-R. Maple 138	365	316	Morgan-White Clay 138	Falls-Pioneer 138
232	447	Stiles-Pioneer 138	Morgan-White Clay 138	366	315	Amberg-Stiles 138	Plains-Morgan 345
234	445	Pulliam-Stiles 138	Pulliam-Stiles 138	366	315	Falls-Morgan 138	Morgan-White Clay 138
250	426	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	391	286	Falls-Pioneer 138	Morgan-White Clay 138
330	331	Amberg-Stiles 138	Plains-Morgan 345	402	275	Pulliam-Stiles 138	Pulliam-Stiles 138
344	315	Falls-Morgan 138	Morgan-White Clay 138				
348	311	N. App.-Lawn Rd. 138	Badger-W. Shawano 138				
367	288	Falls-Pioneer 138	Morgan-White Clay 138				
376	278	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138				
391	261	U.P. Voltage	Plains-Morgan 345	429	241	U.P. Voltage	Plains-Morgan 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A3: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Project A – Phase 1, Add Project B (Indian Lake-Hiawatha 69 kV).

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
234	446	Highway V-Preble 138	L.Dauphin-R. Maple 138	367	314	Amberg-Stiles 138	Plains-Morgan 345
240	439	Pulliam-Stiles 138	Pulliam-Stiles 138	408	266	Pulliam-Stiles 138	Pulliam-Stiles 138
253	423	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138				
330	332	Amberg-Stiles 138	Plains-Morgan 345				
347	312	N. App.-Lawn Rd. 138	Badger-W. Shawano 138				
377	278	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138				
397	254	U.P. Voltage	Plains-Morgan 345	433	238	U.P. Voltage	Plains-Morgan 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A4: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Projects A – Phase 1+B, Add Projects C+D (Morgan-Stiles 138 kV + Morgan-White Clay 138 kV).

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
241	436	Highway V-Preble 138	L.Dauphin-R. Maple 138				
260	414	Pulliam-Stiles 138	Pulliam-Stiles 138				
265	407	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138				
267	405	Stiles-Oconto 138	Plains-Morgan 345				
333	326	N. App.-Lawn Rd. 138	Badger-W. Shawano 138				
342	315	U.P. Voltage	Plains-Morgan 345	381	294	U.P. Voltage	Plains-Morgan 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV
All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A5: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Projects A – Phase 1+B+C+D, Amberg-Crivitz-Stiles 138 kV Out-Of-Service During Construction.

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
234	446	Highway V-Preble 138	L.Dauphin-R. Maple 138	408	264	Pulliam-Stiles 138	Pulliam-Stiles 138
241	437	Pulliam-Stiles 138	Pulliam-Stiles 138	464	198	Highway V-Preble 138	L.Dauphin-R. Maple 138
253	423	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	482	176	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138
354	302	N. App.-Lawn Rd. 138	Badger-W. Shawano 138	496	160	N. App.-Lawn Rd. 138	Badger-W. Shawano 138
383	267	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138	522	128	Plains 345/138 T1	Dead River-Plains 345
405	241	Weston-Kelly 115	Hilltop-Sherman St. 115	525	125	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138
416	228	N. App.-Mason St. 138	N. App.-Lawn Rd. 138				
432	210	Morgan-White Clay 138	Pulliam-Stiles 138				
455	182	N. Appleton 345/138 T2	N. Appleton 345/138 T3				
457	180	N. Appleton 345/138 T1	N. Appleton 345/138 T2				
460	176	Badger Area Voltage	N. App.-Lawn Rd. 138				
467	167	U.P. Voltage	Plains-Morgan 345	529	120	U.P. Voltage	Plains-Morgan 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV
All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A6: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Projects A+B+C+D.

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
242	446	Highway V-Preble 138	L.Dauphin-R. Maple 138	411	263	Pulliam-Stiles 138	Pulliam-Stiles 138
245	437	Pulliam-Stiles 138	Pulliam-Stiles 138	469	193	Highway V-Preble 138	L.Dauphin-R. Maple 138
261	423	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	488	171	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138
351	302	N. App.-Lawn Rd. 138	Badger-W. Shawano 138	493	165	N. App.-Lawn Rd. 138	Badger-W. Shawano 138
380	267	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138	522	130	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138
410	228	N. App.-Mason St. 138	N. App.-Lawn Rd. 138				
430	210	Morgan-White Clay 138	Pulliam-Stiles 138				
453	241	Weston-Kelly 115	Hilltop-Sherman St. 115				
459	179	Badger Area Voltage	N. App.-Lawn Rd. 138				
476	158	U.P. Voltage	Plains-Morgan 345	535	116	U.P. Voltage	Plains-Morgan 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, and Grand Rapids-White Rapids 138 kV
All non-voltage import limits are based on the Summer Emergency rating of the limiting element.

Table A7: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Projects A+B+C+D, Add Projects E+F (Werner West & Plains 345/138 kV Transformations).

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
267	411	Highway V-Preble 138	L.Dauphin-R. Maple 138	456	214	Pulliam-Stiles 138	Pulliam-Stiles 138
281	395	Pulliam-Stiles 138	Pulliam-Stiles 138	512	149	Highway V-Preble 138	L.Dauphin-R. Maple 138
290	385	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	513	148	Weston-Kelly 115	Hilltop-Sherman St. 115
355	308	Weston-Kelly 115	Hilltop-Sherman St. 115	533	126	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138
403	253	N. App.-Lawn Rd. 138	Badger-W. Shawano 138	535	123	Highway 8-Clear Lk 115	Venus-Three Lakes 115
423	230	Highway 8-Clear Lk 115	Venus-Three Lakes 115	550	106	N. App.-Lawn Rd. 138	Badger-W. Shawano 138
437	213	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138				
480	163	N. App.-Mason St. 138	N. App.-Lawn Rd. 138				
500	140	Bunker Hl.-Bl. Brook 115	Weston- Bl. Brook 115				
508	131	Morgan-White Clay 138	Pulliam-Stiles 138				
534	102	L. Dauphin-Red Maple 138	Highway V-Preble 138				
545	90	U.P. Voltage	Dead River-Plains 345	564	90	U.P. Voltage	Dead River-Plains 345

1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, Grand Rapids-White Rapids 138 kV , and Conover-Cranberry 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.
2 Voltage limit (Dead River-Plains 345 kV outage) for both original and emergency dispatch are due to low post-contingency voltages in the Empire/Tilden area. The limits of 545 MW (normal dispatch) and 564 MW (emergency dispatch) are with two Presque Isle generators on-line. Voltage collapse is observed as soon as only one Presque Isle unit is on-line.

Table A8: Flow South (U.P. Import) Limits, 2006 Shoulder Peak Case w/Ludington Cycle. With Projects A+B+C+D+E+F, Add Project G (Plains -Iron River-Conover-Cranberry 138 kV).

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
278	408	Highway V-Preble 138	L.Dauphin-R. Maple 138	464	213	Pulliam-Stiles 138	Pulliam-Stiles 138
290	394	Pulliam-Stiles 138	Pulliam-Stiles 138	475	201	Highway 8-Clear Lk 115	Venus-Three Lakes 115
296	386	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138	508	162	Bunker Hl.-Bl. Brook 115	Weston- Bl. Brook 115
358	314	Highway 8-Clear Lk 115	Venus-Three Lakes 115	521	147	Highway V-Preble 138	L.Dauphin-R. Maple 138
376	294	Bunker Hl.-Bl. Brook 115	Weston- Bl. Brook 115	539	127	Tower Dr.-Preble 138	L.Dauphin-R. Maple 138
395	271	N. App.-Lawn Rd. 138	Badger-W. Shawano 138	541	124	N. App.-Lawn Rd. 138	Badger-W. Shawano 138
434	226	Lawn Rd.-W. Clay 138	Badger-W. Shawano 138				
448	210	N. App.-Mason St. 138	N. App.-Lawn Rd. 138				
456	200	Hilltop-Sherman St. 115	Weston-Kelly 115				
487	164	Venus-Three Lakes 115	Highway 8-Clear Lk 115				
497	153	N. App.-L. Dauphin 138	Forest Jct.-L. Dauphin 138				
498	151	Morgan-White Clay 138	Pulliam-Stiles 138				
530	115	Kelly-Whitcomb 115	N. App.-Lawn Rd. 138				
530	115	Badger Area Voltage	N. App.-Lawn Rd. 138				
548	96	U.P. Voltage	Dead River-Plains 345	569	93	U.P. Voltage	Dead River-Plains 345

- 1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, Grand Rapids-White Rapids 138 kV , and Conover-Cranberry 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.
- 2 Voltage limit for the Dead River-Plains 345 kV outage with both original and emergency dispatch are due to low post-contingency voltages in the Empire/Tilden area. The limits of 548 MW (normal dispatch) and 564 MW (emergency dispatch) are with two Presque Isle generators on-line. Voltage collapse is observed as soon as only one Presque Isle unit is on-line.

Table A9: Flow South (U.P. Import) Limits, 2008 Shoulder Peak Case w/Ludington Cycle. With Projects A+B+C+D+E+F+G, Add Arrowhead-Weston 345 kV Project.

Original West Marinette And Pulliam Dispatch				Emergency West Marinette And Pulliam Dispatch			
Flow South Limit	Presque Isle Generation	Limiting Element	Contingency	Flow South Limit	Presque Isle Generation	Limiting Element	Contingency
562	120	Plains-Arnold 138	Dead River-Plains 345	557	139	Plains-Arnold 138	Dead River-Plains 345
583	97	U.P. Voltage	Dead River-Plains 345	592	102	U.P. Voltage	Dead River-Plains 345

- 1 Flow South is calculated by summing the flows on the following lines: Morgan-Plains 345 kV, Stiles-Crivitz 138 kV, Stiles-Amberg 138 kV, Grand Rapids-White Rapids 138 kV , and Conover-Cranberry 138 kV. All non-voltage import limits are based on the Summer Emergency rating of the limiting element.
- 2 Voltage limit (Dead River-Plains 345 kV outage) for both original and emergency dispatch are due to low post-contingency voltages in the Empire/Tilden area. The limits of 583 MW (normal dispatch) and 592 MW (emergency dispatch) are with two Presque Isle generators on-line. Voltage collapse is observed as soon as only one Presque Isle unit is on-line.

Table A10: Flow South (U.P. Import) Limits, 2008 Shoulder Peak Case w/Ludington Cycle. With Projects A+B+C+D+E+F+G, Add Project H (Morgan-Werner West 345 kV + Clintonville -Werner West 138 kV).