

## Airborne GPS Processing Report Oneida County LiDAR mission, May 2013

### 1.1 Base Station Network Design

The GPS base station network was designed to maintain consistent and redundant coverage across the Oneida County project area. A combination of WISCORS permanent base stations and temporary GPS base stations were used to collect GPS data during the LiDAR acquisition missions in May 2013. The network was designed such that the aircraft was within 30km of a base station throughout the mission. The majority of the county had redundant coverage from a nearby base or bases, which was used to ensure the mission was successful even if one base station was not recording during flight. No such issues were encountered during the Oneida County flights.

The base layout was done in coordination with the lidar experts at Aerometric (now Quantum Spatial) and Ayres Associates, who determined that the 30km baseline lengths provide more than adequate coverage for the flight block. For example, the Minocqua/Woodruff area has 2 base stations at 30km and 4 base stations at 35km, with 2 of those 4 bases having redundant bases (Rhineland, Eagle River).

Although FEMA standards have recommended 20km baseline lengths in the past for high density lidar, we have found on other county-wide flights that good spatial coverage using 30km spacing is more than robust enough for the accuracy required for this project. The advancement of airborne GPS and IMU systems, such as the one paired with Leica ALS70, has reduced the amount of base stations needed to accurately calibrate the lidar data. The 7 bases used for the Oneida/Vilas LiDAR flight block is the densest network of base control we have used on projects of the same specification.

#### 1.1.1 Oneida County Base Stations and Airport

For the Oneida County LiDAR mission, the flight crew mobilized the aircraft and sensor out of the following airport:

- Rhineland Municipal Airport (RHI)

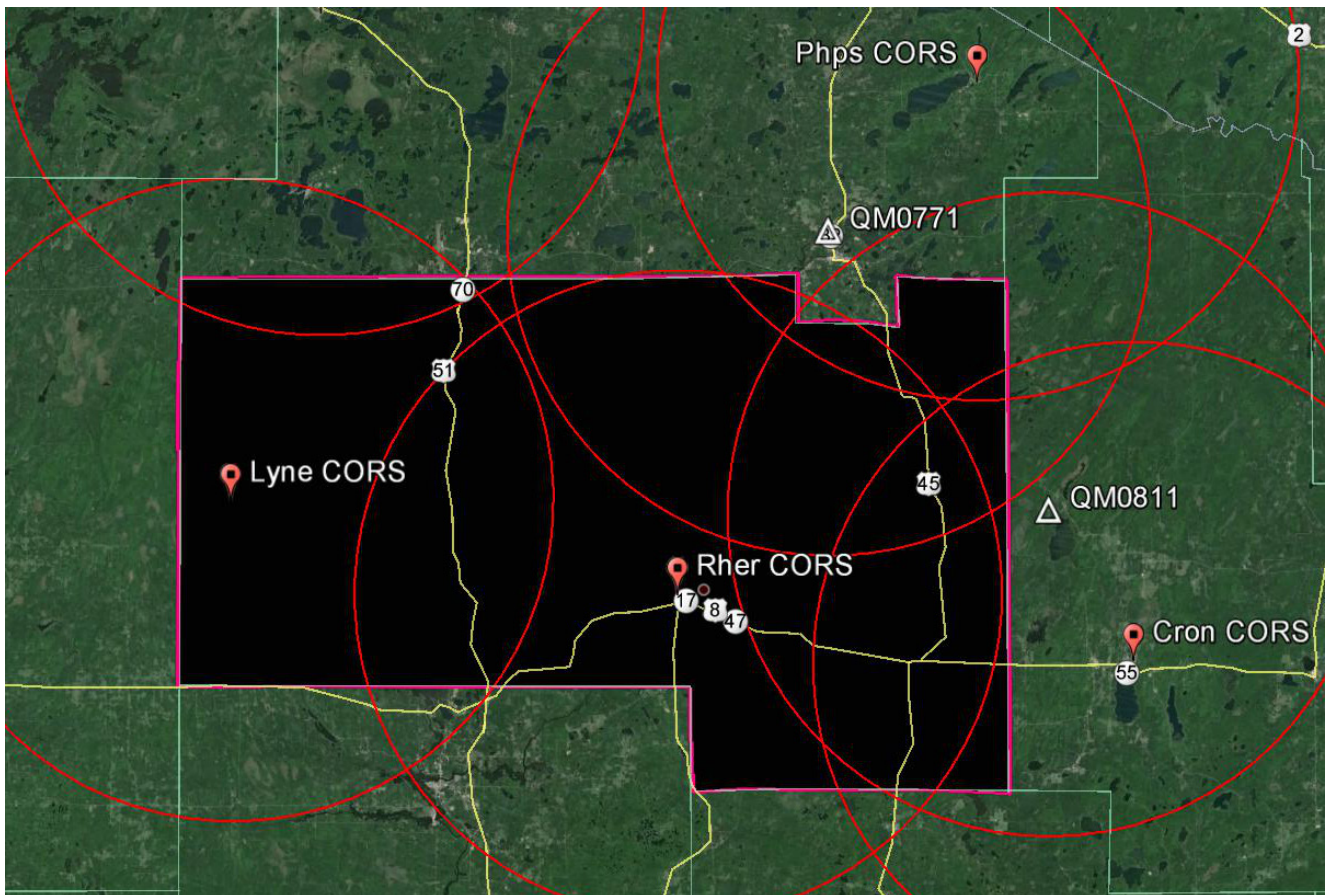
All base station locations for the Oneida County flight were tied into the existing WISCORS/NGS network. In order to provide the highest accuracy Airborne GPS (ABGPS), all airborne processing used the points established on existing NGS Monuments, as well as the CORS Network using Applanix POSMMS “augmented” Smartbase solutions. This allowed the creation of a virtual network over the entire AOI resulting in better GPS locks and more accurate data.

**Table 1: Oneida County LiDAR base station locations**

| Name   | Type             | Location                      |
|--------|------------------|-------------------------------|
| Lyne   | WISCORS          | Willow, WI                    |
| Rher   | WISCORS          | Rhineland, WI                 |
| Phps   | WISCORS          | Phelps, WI                    |
| Mawa   | WISCORS          | Manitowish Water, WI          |
| Cron   | WISCORS          | Crandon, WI                   |
| QM0811 | GPS base station | Hiles, WI                     |
| QM0771 | GPS base station | Eagle River municipal airport |
| QM0779 | GPS base station | Eagle River municipal airport |

Flight crews were responsible for setting base stations at Rhinelander municipal airport. Trained survey crews were responsible for setting and maintaining the mobile base station units at Eagle River municipal airport and near Hiles.

The following graphic depicts the locations of the WISCORS base stations and GPS base stations that were used for the Oneida County flight, along with their associated 30km baseline rings:



The following pages include the listed information for each base station utilized on the flight:

- GPS base station data sheets from May 13-15, 2013 (pages 3-11)
- Field Notes for each GPS base station used (pages 12-14)
- OPUS Reports during flight for GPS base stations (pages 15-21)
- WISCORS data sheets (pages 22-26)

JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Forest Country: USA

OPERATOR: **Jake Jensen**

RECEIVER MODEL: Leica GX1230

RECEIVER S/N: 464602

**APPROXIMATE POSITION (C/A/CODE)**

LATITUDE: 45 42 09.97665(N) 477.818 HGT. MTS

LONGITUDE: 088 59 46.25218(W)

SESSION: 0 DATE: 05/13/13 DAY OF YEAR: 133

START TIME: 07:07 Record Interval: X U.T.C.

END TIME: 18:40 1 sec. LOCAL

**ANTENNA HEIGHT (SLANT)**

MTRS/FT: MEASURED FIXED HGT.

**ANTENNA HEIGHT (VERTICAL)**

MTRS/FT: 1.8 MEASURED X FIXED HGT

**ANTENNA INFO**

RADIUS (M): 0.000

S/N NUMBER: 6380040 0.000

ANTENNA TYPE: Leica AX1202 GG

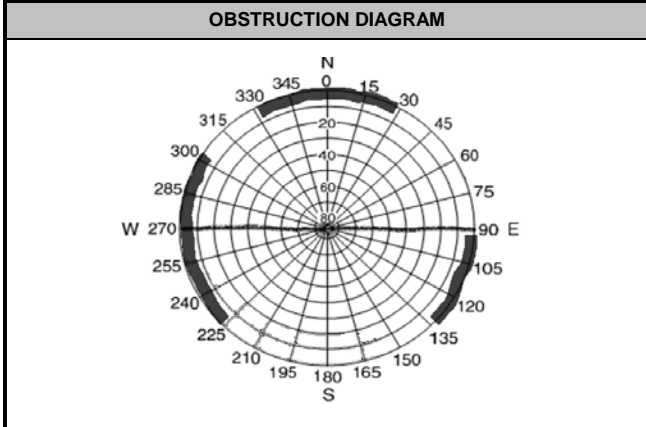
TOP OF MONUMENT IS: X FLUSH

METERS/FEET: ABOVE GROUND

METERS/FEET: BELOW GROUND

|                 |                |
|-----------------|----------------|
| AERIAL TARGET   | PHOTO I.D.     |
| PUB. BENCH MARK | NEW CONTROL    |
| PUB. CONTROL    | X BASE STATION |

Ayres Description: PID= QM0811



JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Forest Country: USA

OPERATOR: **Jake Jensen**

RECEIVER MODEL: Leica GX1230

RECEIVER S/N: 464602

**APPROXIMATE POSITION (C/A/CODE)**

LATITUDE: 45 42 09.97665(N) 477.818 HGT. MTS

LONGITUDE: 088 59 46.25218(W)

SESSION: 0 DATE: 05/14/13 DAY OF YEAR: 134

START TIME: 06:58 Record Interval: X U.T.C.

END TIME: 18:15 1 sec. LOCAL

**ANTENNA HEIGHT (SLANT)**

MTRS/FT: MEASURED FIXED HGT.

**ANTENNA INFO**

RADIUS (M): 0.000

S/N NUMBER: 6380040 0.000

ANTENNA TYPE: Leica AX1202 GG

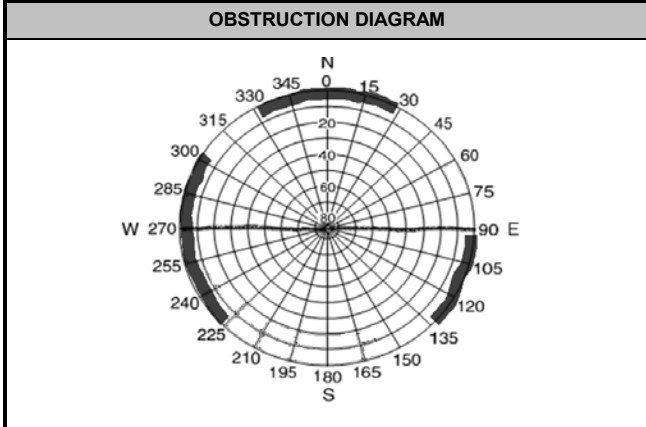
**ANTENNA HEIGHT (VERTICAL)**

MTRS/FT: 1.8 MEASURED X FIXED HGT

TOP OF MONUMENT IS: X FLUSH

METERS/FEET: ABOVE GROUND

METERS/FEET: BELOW GROUND



AERIAL TARGET PHOTO I.D.

PUB. BENCH MARK NEW CONTROL

PUB. CONTROL X BASE STATION

Ayres Description: PID= QM0811

**Photo**



**Sketch**



JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Forest Country: USA

OPERATOR: **Jake Jensen**

RECEIVER MODEL: Leica GX1230

RECEIVER S/N: 464602

**APPROXIMATE POSITION (C/A/CODE)**

|           |                    |         |          |
|-----------|--------------------|---------|----------|
| LATITUDE  | 45 42 09.97665(N)  | 477.818 | HGT. MTS |
| LONGITUDE | 088 59 46.25218(W) |         |          |

SESSION: 0 DATE: 05/15/13  
DAY OF YEAR: 135

|            |       |                 |   |        |
|------------|-------|-----------------|---|--------|
| START TIME | 07:10 | Record Interval | X | U.T.C. |
| END TIME   | 22:18 | 1 sec.          |   | LOCAL  |

**ANTENNA HEIGHT (SLANT)**

|          |            |
|----------|------------|
| MTRS/FT  |            |
| MEASURED | FIXED HGT. |

**ANTENNA INFO**

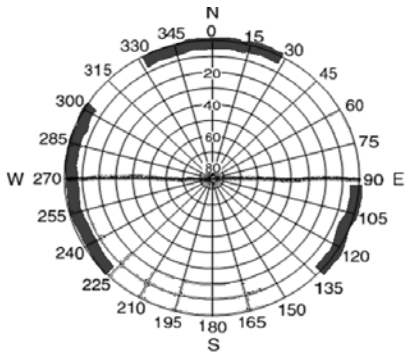
|              |                 |       |
|--------------|-----------------|-------|
| RADIUS (M)   |                 | 0.000 |
| S/N NUMBER   | 6380040         | 0.000 |
| ANTENNA TYPE | Leica AX1202 GG |       |

**ANTENNA HEIGHT (VERTICAL)**

|          |             |
|----------|-------------|
| MTRS/FT  | 1.8         |
| MEASURED | X FIXED HGT |

|                     |   |              |
|---------------------|---|--------------|
| TOP OF MONUMENT IS: | X | FLUSH        |
| METERS/FEET         |   | ABOVE GROUND |
| METERS/FEET         |   | BELOW GROUND |

**OBSTRUCTION DIAGRAM**



|                 |   |              |
|-----------------|---|--------------|
| AERIAL TARGET   |   | PHOTO I.D.   |
| PUB. BENCH MARK |   | NEW CONTROL  |
| PUB. CONTROL    | X | BASE STATION |

Ayres Description: PID= QM0811

**Sketch**



**Photo**



JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Vilas Country: USA

OPERATOR: **Jake Jensen**

APPROXIMATE POSITION (C/A/CODE)

RECEIVER MODEL: Leica GX1210  
RECEIVER S/N: 464398

LATITUDE: 45 56 03.83153(N) 467.505 HGT. MTS  
LONGITUDE: 089 15 48.30885(W)

SESSION: 0 DATE: 05/13/13  
DAY OF YEAR: 133

START TIME: 06:05 Record Interval: X U.T.C.  
END TIME: 19:25 1 sec. LOCAL

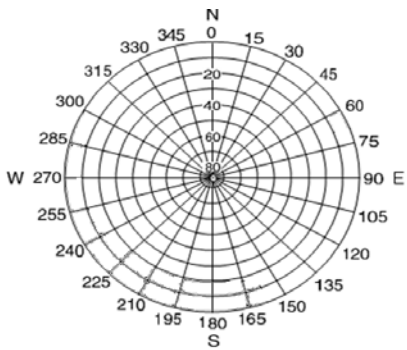
ANTENNA HEIGHT (SLANT)  
MTRS/FT: MEASURED FIXED HGT.

ANTENNA INFO  
RADIUS (M): 0.000  
S/N NUMBER: 6380076  
ANTENNA TYPE: Leica AX1202 GG

ANTENNA HEIGHT (VERTICAL)  
MTRS/FT: 1.8  
MEASURED X FIXED HGT

TOP OF MONUMENT IS: X FLUSH  
METERS/FEET: ABOVE GROUND  
METERS/FEET: BELOW GROUND

**OBSTRUCTION DIAGRAM**



AERIAL TARGET PHOTO I.D.  
PUB. BENCH MARK NEW CONTROL  
PUB. CONTROL X BASE STATION

Ayres Description: PID= QM0779

**Photo**



**Sketch**



JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE WI

COUNTY Vilas

Country USA

OPERATOR **Jake Jensen**

APPROXIMATE POSITION (C/A/CODE)

RECEIVER MODEL Leica GX1230  
RECEIVER S/N 464803

|           |                    |         |          |
|-----------|--------------------|---------|----------|
| LATITUDE  | 45 56 03.83153(N)  | 467.505 | HGT. MTS |
| LONGITUDE | 089 15 48.30885(W) |         |          |

|         |             |          |
|---------|-------------|----------|
| SESSION | DATE:       | 05/14/13 |
| 0       | DAY OF YEAR | 134      |

|            |       |                 |   |        |
|------------|-------|-----------------|---|--------|
| START TIME | 06:05 | Record Interval | X | U.T.C. |
| END TIME   | 19:25 | 1 sec.          |   | LOCAL  |

ANTENNA HEIGHT (SLANT)

|          |            |
|----------|------------|
| MTRS/FT  |            |
| MEASURED | FIXED HGT. |

ANTENNA INFO

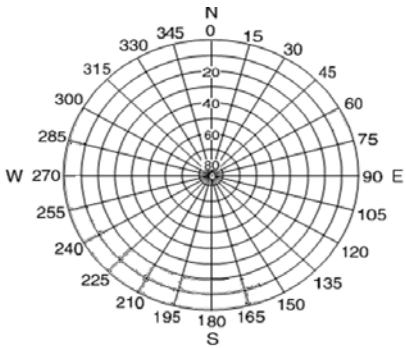
|              |                 |       |
|--------------|-----------------|-------|
| RADIUS (M)   |                 | 0.000 |
| S/N NUMBER   | 6440109         | 0.000 |
| ANTENNA TYPE | Leica AX1202 GG |       |

ANTENNA HEIGHT (VERTICAL)

|          |             |
|----------|-------------|
| MTRS/FT  | 1.8         |
| MEASURED | X FIXED HGT |

|                     |   |              |
|---------------------|---|--------------|
| TOP OF MONUMENT IS: | X | FLUSH        |
| METERS/FEET         |   | ABOVE GROUND |
| METERS/FEET         |   | BELOW GROUND |

**OBSTRUCTION DIAGRAM**



|  |                 |   |              |
|--|-----------------|---|--------------|
|  | AERIAL TARGET   |   | PHOTO I.D.   |
|  | PUB. BENCH MARK |   | NEW CONTROL  |
|  | PUB. CONTROL    | X | BASE STATION |

Ayres Description: PID= QM0779

**Sketch**



**Photo**



**GPS CONTROL SURVEY  
FIELD DATA SHEET**

PAGE:  
1

JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Vilas Country: USA

OPERATOR: **Jake Jensen**

**APPROXIMATE POSITION (C/A/CODE)**

RECEIVER MODEL: Leica GX1210  
RECEIVER S/N: 464398

LATITUDE: 45 56 03.83153(N) 467.505 HGT. MTS  
LONGITUDE: 089 15 48.30885(W)

SESSION: 0 DATE: 05/15/13  
DAY OF YEAR: 135

START TIME: 06:20 Record Interval: X U.T.C.  
END TIME: 00:20 1 sec. LOCAL

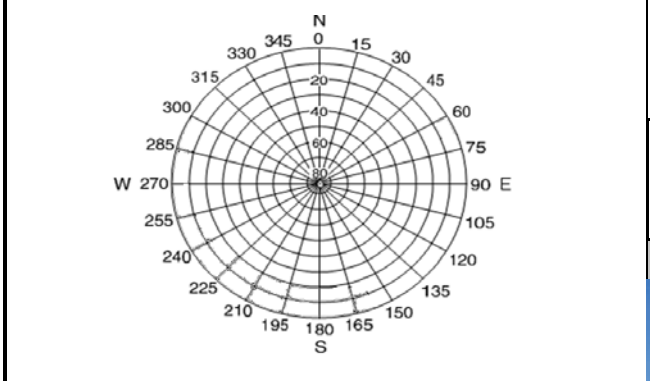
**ANTENNA HEIGHT (SLANT)**  
MTRS/FT: MEASURED FIXED HGT.

**ANTENNA INFO**  
RADIUS (M): 0.000  
S/N NUMBER: 6380076  
ANTENNA TYPE: Leica AX1202 GG

**ANTENNA HEIGHT (VERTICAL)**  
MTRS/FT: 1.8  
MEASURED: X FIXED HGT

TOP OF MONUMENT IS: X FLUSH  
METERS/FEET: ABOVE GROUND  
METERS/FEET: BELOW GROUND

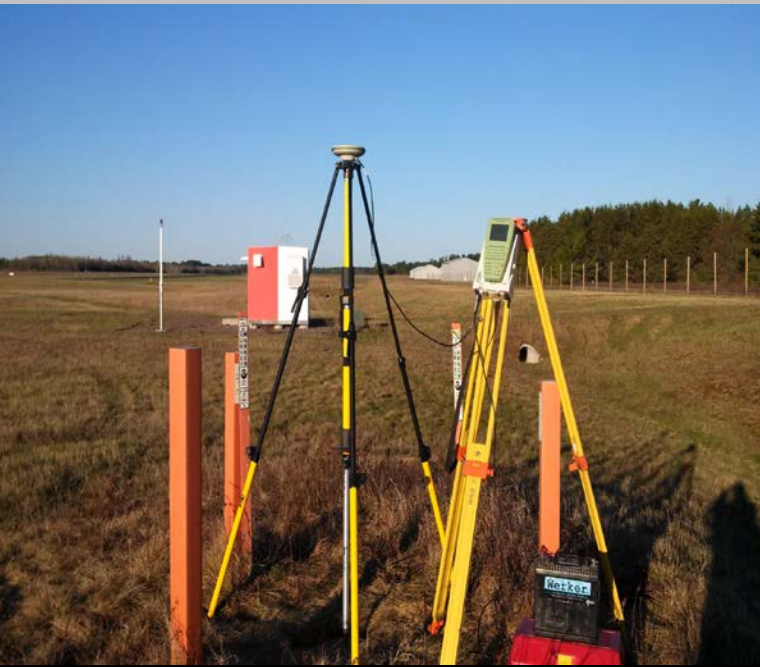
**OBSTRUCTION DIAGRAM**



AERIAL TARGET PHOTO I.D.  
PUB. BENCH MARK NEW CONTROL  
PUB. CONTROL X BASE STATION

Ayres Description: PID= QM0779

**Photo**



**Sketch**





**GPS CONTROL SURVEY  
FIELD DATA SHEET**

PAGE:  
1

JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE: WI COUNTY: Vilas Country: USA

OPERATOR: **Jake Jensen**

**APPROXIMATE POSITION (C/A/CODE)**

RECEIVER MODEL: Leica GX1230  
RECEIVER S/N: 464803

LATITUDE: 45 56 19.14391(N) 467.654 HGT. MTS  
LONGITUDE: 089 15 38.19627(W)

SESSION: 0 DATE: 05/13/13  
DAY OF YEAR: 133

START TIME: 06:22 Record Interval: X U.T.C.  
END TIME: 19:31 1 sec. LOCAL

**ANTENNA HEIGHT (SLANT)**  
MTRS/FT: MEASURED FIXED HGT.

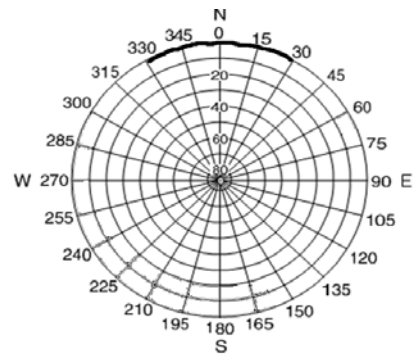
**ANTENNA INFO**  
RADIUS (M): 0.000  
S/N NUMBER: 6440109 0.000  
ANTENNA TYPE: Leica AX1202 GG

**ANTENNA HEIGHT (VERTICAL)**  
MTRS/FT: 1.8  
MEASURED: X FIXED HGT

TOP OF MONUMENT IS: X FLUSH  
METERS/FEET: ABOVE GROUND  
METERS/FEET: BELOW GROUND

**OBSTRUCTION DIAGRAM**

AERIAL TARGET PHOTO I.D.  
PUB. BENCH MARK NEW CONTROL  
PUB. CONTROL X BASE STATION



Ayres Description: PID= QM0771

**Sketch**



**Photo**



JOB REFERENCE  
2013 Lidar

POINT ID: Oneida/Vilas Co Lidar 2013  
Proj. No.:

STATE WI

COUNTY Vilas

Country USA

OPERATOR **Jake Jensen**

APPROXIMATE POSITION (C/A/CODE)

RECEIVER MODEL Leica GX1210

|           |                    |         |          |
|-----------|--------------------|---------|----------|
| LATITUDE  | 45 56 19.14391(N)  | 467.654 | HGT. MTS |
| LONGITUDE | 089 15 38.19627(W) |         |          |

RECEIVER S/N 464398

|         |             |          |
|---------|-------------|----------|
| SESSION | DATE:       | 05/14/13 |
| 0       | DAY OF YEAR | 134      |

|            |       |                 |   |        |
|------------|-------|-----------------|---|--------|
| START TIME | 06:22 | Record Interval | X | U.T.C. |
| END TIME   | 19:31 | 1 sec.          |   | LOCAL  |

ANTENNA HEIGHT (SLANT)

|          |            |
|----------|------------|
| MTRS/FT  |            |
| MEASURED | FIXED HGT. |

ANTENNA INFO

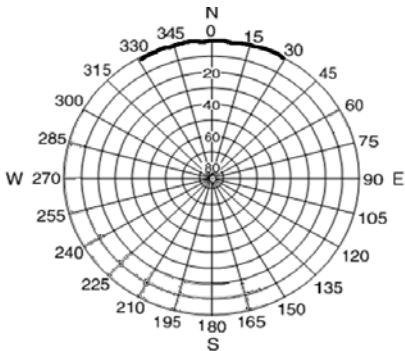
|              |                 |       |
|--------------|-----------------|-------|
| RADIUS (M)   |                 | 0.000 |
| S/N NUMBER   | 6380076         | 0.000 |
| ANTENNA TYPE | Leica AX1202 GG |       |

ANTENNA HEIGHT (VERTICAL)

|          |             |
|----------|-------------|
| MTRS/FT  | 1.8         |
| MEASURED | X FIXED HGT |

|                     |   |              |
|---------------------|---|--------------|
| TOP OF MONUMENT IS: | X | FLUSH        |
| METERS/FEET         |   | ABOVE GROUND |
| METERS/FEET         |   | BELOW GROUND |

**OBSTRUCTION DIAGRAM**



|  |                 |   |              |
|--|-----------------|---|--------------|
|  | AERIAL TARGET   |   | PHOTO I.D.   |
|  | PUB. BENCH MARK |   | NEW CONTROL  |
|  | PUB. CONTROL    | X | BASE STATION |

Ayres Description: PID= QM0771

**Sketch**



**Photo**



**JOB REFERENCE**  
2013 Lidar

**POINT ID:** Oneida/Vilas Co Lidar 2013  
**Proj. No.:**

**STATE** WI      **COUNTY** Vilas      **Country** USA

**OPERATOR** Jake Jensen

**RECEIVER MODEL** Leica GX1230

**RECEIVER S/N** 464803

**APPROXIMATE POSITION (C/A/CODE)**

|                  |                    |         |                 |
|------------------|--------------------|---------|-----------------|
| <b>LATITUDE</b>  | 45 56 19.14391(N)  | 467.654 | <b>HGT. MTS</b> |
| <b>LONGITUDE</b> | 089 15 38.19627(W) |         |                 |

**SESSION** 0      **DATE:** 05/15/13  
**DAY OF YEAR** 135

|                   |       |                        |   |               |
|-------------------|-------|------------------------|---|---------------|
| <b>START TIME</b> | 06:30 | <b>Record Interval</b> | X | <b>U.T.C.</b> |
| <b>END TIME</b>   | 00:27 | 1 sec.                 |   | <b>LOCAL</b>  |

**ANTENNA HEIGHT (SLANT)**

|                 |                   |
|-----------------|-------------------|
| <b>MTRS/FT</b>  |                   |
| <b>MEASURED</b> | <b>FIXED HGT.</b> |

**ANTENNA INFO**

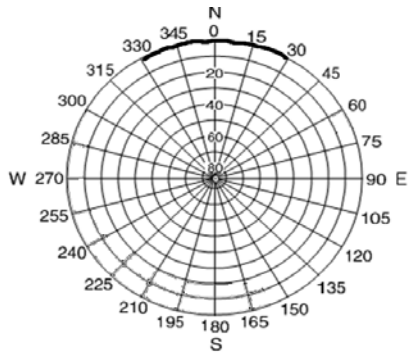
|                     |                 |              |
|---------------------|-----------------|--------------|
| <b>RADIUS (M)</b>   |                 | <b>0.000</b> |
| <b>S/N NUMBER</b>   | 6440109         | <b>0.000</b> |
| <b>ANTENNA TYPE</b> | Leica AX1202 GG |              |

**ANTENNA HEIGHT (VERTICAL)**

|                 |                    |
|-----------------|--------------------|
| <b>MTRS/FT</b>  | 1.8                |
| <b>MEASURED</b> | X <b>FIXED HGT</b> |

|                            |   |                     |
|----------------------------|---|---------------------|
| <b>TOP OF MONUMENT IS:</b> | X | <b>FLUSH</b>        |
| <b>METERS/FEET</b>         |   | <b>ABOVE GROUND</b> |
| <b>METERS/FEET</b>         |   | <b>BELOW GROUND</b> |

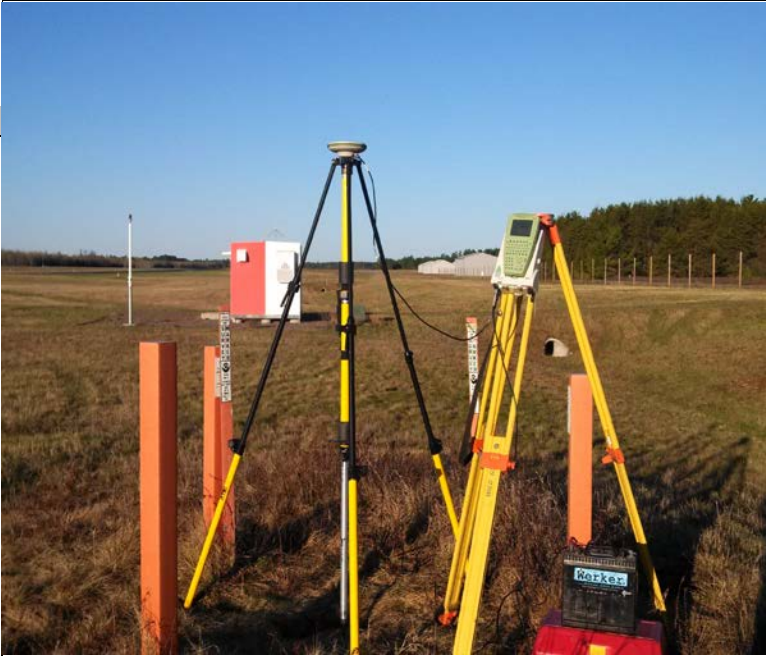
**OBSTRUCTION DIAGRAM**



|                        |   |                     |
|------------------------|---|---------------------|
| <b>AERIAL TARGET</b>   |   | <b>PHOTO I.D.</b>   |
| <b>PUB. BENCH MARK</b> |   | <b>NEW CONTROL</b>  |
| <b>PUB. CONTROL</b>    | X | <b>BASE STATION</b> |

**Ayres Description:** PID= QM0771

**Photo**



**Sketch**



5-13-13

EAGLE RIVER AZI MARK

Receiver GX1210 S# 464398

74.87 ANT. AX120266 S# 06380076

1.8 M TO ARP

6:05 AM - 7:25 PM

5-13-13

EAGLE RIVER GPS

Receiver GX1230 S# 464883

74.95 ANT. AX120266 S# 06440109

1.8 M TO ARP

6:22 AM - 7:31 PM

5-13-13

HILES

74.88 RELIEVER GX1230 S# 464622

ANT AX120266 S# 06380040

1.8 M TO ARP

7:07 AM - 6:40 PM

5-14-13

EAGLE RIVER AZ MK (1)

#74.95

RECEIVER GX1230 S# 464803

100% Point  
Occupation

ANT. 1202 GG S# 06440109

1.8 M TO ARP

6:06 AM - 7:13 PM

5-14-13

#74.87

EAGLE RIVER GPS (2)

RECEIVER GX1210 S# 464398

ANT. AX1202 GG S# 06380076

1.8 M TO ARP

6:17 AM - 7:17 PM

5-14-13

(3)

#74.88

HILES

100% Point  
Occupation

RECEIVER GX1230 S# 464602

ANT. AX1202 GG S# 06380040

1.8 M TO ARP

6:58 AM - 6:15 PM

5-15-13

#7187  
#7195  
001

EAGLE RIVER AZ MARK 001  
1.8 M TO ARP

~~6:07~~ 6:20 AM - 12:20 AM

RECEIVER GX1210 464398  
ANTENNA AX120266 06380076

74.95 GPS EAGLE RIVER GPS  
1.8 M TO ARP

6:30 AM - 12:27 AM 5-16-13

RECEIVER GX1230 464803  
ANTENNA AX120266 06440109

HILES

1.8 M TO ARP

7488

7:10 AM - 10:18 PM

RECEIVER GX1230 464602  
ANTENNA AX120266 06380040

FILE: 00081360.13o OP1369336221290

NGS OPUS SOLUTION REPORT  
=====

All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [tstentz@aerometric.com](mailto:tstentz@aerometric.com) DATE: May 23, 2013  
RINEX FILE: 0008136m.13o TIME: 19:19:47 UTC

SOFTWARE: page5 1209.04 [master2.pl](#) 0821123 START: 2013/05/16 12:17:00  
EPHEMERIS: igr17404.eph [rapid] STOP: 2013/05/17 05:03:30  
NAV FILE: brdc1360.13n OBS USED: 38910 / 40006 : 97%  
ANT NAME: NOV702GG NONE # FIXED AMB: 109 / 161 : 68%  
ARP HEIGHT: 2.00 OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.3722)

|    |                 |          |                 |          |
|----|-----------------|----------|-----------------|----------|
| X: | 42225.683(m)    | 0.004(m) | 42224.851(m)    | 0.004(m) |
| Y: | -4468037.026(m) | 0.007(m) | -4468035.704(m) | 0.007(m) |
| Z: | 4536804.062(m)  | 0.004(m) | 4536804.020(m)  | 0.004(m) |

|            |                 |          |                                    |          |
|------------|-----------------|----------|------------------------------------|----------|
| LAT:       | 45 37 43.09998  | 0.004(m) | 45 37 43.12982                     | 0.004(m) |
| E LON:     | 270 32 29.27056 | 0.004(m) | 270 32 29.23273                    | 0.004(m) |
| W LON:     | 89 27 30.72944  | 0.004(m) | 89 27 30.76727                     | 0.004(m) |
| EL HGT:    | 454.955(m)      | 0.006(m) | 453.995(m)                         | 0.006(m) |
| ORTHO HGT: | 486.847(m)      | 0.012(m) | [NAVD88 (Computed using GEOID12A)] |          |

UTM COORDINATES STATE PLANE COORDINATES

|                       | UTM (Zone 16)               | SPC (4801 WI N) |
|-----------------------|-----------------------------|-----------------|
| Northing (Y) [meters] | <a href="#">5055728.004</a> | 51489.236       |
| Easting (X) [meters]  | 308361.543                  | 642222.527      |
| Convergence [degrees] | -1.75794914                 | 0.39059634      |
| Point Scale           | 1.00005154                  | 0.99998933      |
| Combined Factor       | 0.99998022                  | 0.99991801      |

US NATIONAL GRID DESIGNATOR: 16TCR0836155728(NAD 83)

BASE STATIONS USED

| PID    | DESIGNATION                | LATITUDE    | LONGITUDE    | DISTANCE(m) |
|--------|----------------------------|-------------|--------------|-------------|
| DK4193 | YOU6 YOUNGSTOWN 6 CORS ARP | N431352.479 | W0785811.265 | 875200.4    |
| DF5374 | PARY PARRY SOUND CORS ARP  | N452018.759 | W0800209.179 | 736576.2    |
| DF5367 | KNGS KINGSTON CORS ARP     | N441307.253 | W0763102.142 | 1031420.1   |

NEAREST NGS PUBLISHED CONTROL POINT

|        |                 |             |              |       |
|--------|-----------------|-------------|--------------|-------|
| QM0773 | RHINELANDER GPS | N453739.511 | W0892744.928 | 326.5 |
|--------|-----------------|-------------|--------------|-------|

FILE: GPS\_1330.13o OP1371133428709

NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [tstentz@aerometric.com](mailto:tstentz@aerometric.com) DATE: June 13, 2013  
RINEX FILE: gps\_133l.13o TIME: 14:29:00 UTC

SOFTWARE: page5 1209.04 [master91.pl](#) 082112 START: 2013/05/13 11:25:00  
EPHEMERIS: igs17401.eph [precise] STOP: 2013/05/14 00:33:30  
NAV FILE: brdc1330.13n OBS USED: 33415 / 35690 : 94%  
ANT NAME: LEIATX1230GG NONE # FIXED AMB: 158 / 162 : 98%  
ARP HEIGHT: 1.8 OVERALL RMS: 0.011(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.3637)

|    |                 |          |                 |          |
|----|-----------------|----------|-----------------|----------|
| X: | 57341.457(m)    | 0.005(m) | 57340.624(m)    | 0.005(m) |
| Y: | -4443177.960(m) | 0.007(m) | -4443176.641(m) | 0.007(m) |
| Z: | 4560844.115(m)  | 0.005(m) | 4560844.077(m)  | 0.005(m) |

|            |                 |          |                                    |          |
|------------|-----------------|----------|------------------------------------|----------|
| LAT:       | 45 56 19.14387  | 0.008(m) | 45 56 19.17396                     | 0.008(m) |
| E LON:     | 270 44 21.80379 | 0.005(m) | 270 44 21.76592                    | 0.005(m) |
| W LON:     | 89 15 38.19621  | 0.005(m) | 89 15 38.23408                     | 0.005(m) |
| EL HGT:    | 467.661(m)      | 0.002(m) | 466.709(m)                         | 0.002(m) |
| ORTHO HGT: | 499.399(m)      | 0.007(m) | [NAVD88 (Computed using GEOID12A)] |          |

UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 16) SPC (4801 WI N)

|                       |             |            |
|-----------------------|-------------|------------|
| Northing (Y) [meters] | 5089716.051 | 86068.071  |
| Easting (X) [meters]  | 324763.805  | 657335.346 |
| Convergence [degrees] | -1.62487613 | 0.53337431 |
| Point Scale           | 0.99997752  | 0.99995330 |
| Combined Factor       | 0.99990421  | 0.99987999 |

US NATIONAL GRID DESIGNATOR: 16TCR2476389716(NAD 83)

BASE STATIONS USED

| PID    | DESIGNATION              | LATITUDE    | LONGITUDE    | DISTANCE(m) |
|--------|--------------------------|-------------|--------------|-------------|
| DI0208 | MIIR IRON RIVER CORS ARP | N460449.371 | W0883800.111 | 51074.1     |
| DL6161 | MIOT ONTONAGON CORS ARP  | N465148.570 | W0891758.486 | 102852.7    |
| DH7129 | MINW NORWAY CORS ARP     | N454724.328 | W0875505.747 | 105539.8    |

NEAREST NGS PUBLISHED CONTROL POINT



QM0771 EAGLE RIVER GPS N455619.143 W0891538.196 0.0

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

FILE: AZ\_\_1330.13o OP1371133767661

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [tstentz@aerometric.com](mailto:tstentz@aerometric.com) DATE: June 13, 2013  
RINEX FILE: az\_\_133l.13o TIME: 14:33:49 UTC

SOFTWARE: page5 1209.04 [master13.pl](#) 082112 START: 2013/05/13 11:06:00  
EPHEMERIS: igs17401.eph [precise] STOP: 2013/05/14 00:25:00  
NAV FILE: brdc1330.13n OBS USED: 34182 / 35881 : 95%  
ANT NAME: LEIATX1230GG NONE # FIXED AMB: 148 / 155 : 95%  
ARP HEIGHT: 1.8 OVERALL RMS: 0.011(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.3637)

|    |                 |          |                 |          |
|----|-----------------|----------|-----------------|----------|
| X: | 57128.013(m)    | 0.005(m) | 57127.180(m)    | 0.005(m) |
| Y: | -4443520.359(m) | 0.009(m) | -4443519.040(m) | 0.009(m) |
| Z: | 4560515.143(m)  | 0.002(m) | 4560515.104(m)  | 0.002(m) |

|            |                 |          |                                    |          |
|------------|-----------------|----------|------------------------------------|----------|
| LAT:       | 45 56 3.83078   | 0.008(m) | 45 56 3.86084                      | 0.008(m) |
| E LON:     | 270 44 11.69245 | 0.005(m) | 270 44 11.65457                    | 0.005(m) |
| W LON:     | 89 15 48.30755  | 0.005(m) | 89 15 48.34543                     | 0.005(m) |
| EL HGT:    | 467.463(m)      | 0.005(m) | 466.510(m)                         | 0.005(m) |
| ORTHO HGT: | 499.215(m)      | 0.011(m) | [NAVD88 (Computed using GEOID12A)] |          |

UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 16) SPC (4801 WI N)

|                       |             |            |
|-----------------------|-------------|------------|
| Northing (Y) [meters] | 5089249.639 | 85593.297  |
| Easting (X) [meters]  | 324532.663  | 657121.938 |
| Convergence [degrees] | -1.62677916 | 0.53134819 |
| Point Scale           | 0.99997852  | 0.99995360 |
| Combined Factor       | 0.99990524  | 0.99988032 |

US NATIONAL GRID DESIGNATOR: 16TCR2453289249(NAD 83)

BASE STATIONS USED

| PID    | DESIGNATION              | LATITUDE    | LONGITUDE    | DISTANCE(m) |
|--------|--------------------------|-------------|--------------|-------------|
| DH7129 | MINW NORWAY CORS ARP     | N454724.328 | W0875505.747 | 105686.4    |
| DI0208 | MIIR IRON RIVER CORS ARP | N460449.371 | W0883800.111 | 51430.1     |
| DL6161 | MIOT ONTONAGON CORS ARP  | N465148.570 | W0891758.486 | 103319.3    |

NEAREST NGS PUBLISHED CONTROL POINT

QM0779 EAGLE RIVER GPS AZ MK N455603.831 W0891548.308 0.0

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

8002 The Opus solution for your submitted RINEX file appears to be  
8002 quite close to an NGS published control point. This suggests that  
8002 you may have set your GPS receiver up over an NGS control point.  
8002 Furthermore, our files indicate that this control point has not  
8002 been recovered in the last five years.  
8002 If you did indeed recover an NGS control point, we would  
8002 appreciate receiving this information through our web based  
8002 Mark Recovery Form at  
8002 [http://www.ngs.noaa.gov/products\\_services.shtml#MarkRecoveryForm](http://www.ngs.noaa.gov/products_services.shtml#MarkRecoveryForm).  
8002

FILE: HILE1330.13o OP1371133258063

NGS OPUS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as peak-to-peak values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [tstentz@aerometric.com](mailto:tstentz@aerometric.com) DATE: June 13, 2013  
RINEX FILE: hile133m.13o TIME: 14:24:25 UTC

SOFTWARE: page5 1209.04 [master13.pl](#) 082112 START: 2013/05/13 12:11:00  
EPHEMERIS: igs17401.eph [precise] STOP: 2013/05/13 23:42:30  
NAV FILE: brdc1330.13n OBS USED: 28060 / 30219 : 93%  
ANT NAME: LEIATX1230GG NONE # FIXED AMB: 150 / 159 : 94%  
ARP HEIGHT: 1.8 OVERALL RMS: 0.011(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2013.3637)

X: 78176.277(m) 0.007(m) 78175.445(m) 0.007(m)  
Y: -4461673.840(m) 0.005(m) -4461672.517(m) 0.005(m)  
Z: 4542578.876(m) 0.002(m) 4542578.836(m) 0.002(m)

LAT: 45 42 9.97502 0.005(m) 45 42 10.00512 0.005(m)  
E LON: 271 0 13.74796 0.007(m) 271 0 13.71058 0.007(m)  
W LON: 88 59 46.25204 0.007(m) 88 59 46.28942 0.007(m)  
EL HGT: 477.820(m) 0.002(m) 476.857(m) 0.002(m)  
ORTHO HGT: 510.504(m) 0.008(m) [NAVD88 (Computed using GEOID12A)]

UTM COORDINATES STATE PLANE COORDINATES  
UTM (Zone 16) SPC (4801 WI N)  
Northing (Y) [meters] 5062961.985 60078.542  
Easting (X) [meters] 344606.258 678170.635  
Convergence [degrees] -1.42900451 0.72412562  
Point Scale 0.99989688 0.99997808  
Combined Factor 0.99982198 0.99990318

US NATIONAL GRID DESIGNATOR: 16TCR4460662961(NAD 83)

BASE STATIONS USED  
PID DESIGNATION LATITUDE LONGITUDE DISTANCE(m)

DK6955 MIST STEVENSON CORS ARP            N452518.112 W0873558.603  
113422.8  
DI0208 MIIR IRON RIVER CORS ARP            N460449.371 W0883800.111 50546.0  
DH7129 MINW NORWAY CORS ARP            N454724.328 W0875505.747 84443.1

NEAREST NGS PUBLISHED CONTROL POINT

QM0811    3712E09S GPS 0021            N454209.976 W0885946.252    0.0

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

8002 The Opus solution for your submitted RINEX file appears to be  
8002 quite close to an NGS published control point. This suggests that  
8002 you may have set your GPS receiver up over an NGS control point.  
8002 Furthermore, our files indicate that this control point has not  
8002 been recovered in the last five years.  
8002 If you did indeed recover an NGS control point, we would  
8002 appreciate receiving this information through our web based  
8002 Mark Recovery Form at  
8002 [http://www.ngs.noaa.gov/products\\_services.shtml#MarkRecoveryForm](http://www.ngs.noaa.gov/products_services.shtml#MarkRecoveryForm).  
8002

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**WISCORS Station Control Attributes**

Show N/A

Print

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|            |         |
|------------|---------|
| Point Name | Crandon |
| Point ID   | CRON    |
| County     | FOREST  |
| CORS       | WISCORS |

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|                       |                             |
|-----------------------|-----------------------------|
| Longitude Coordinates | 88 53 30.43937 NAD83 (2011) |
| Latitude Coordinates  | 45 34 35.03906 NAD83 (2011) |
| Lat/Long Format       | dd mm ss.sssss              |
| Ellipsoid Height      | 465.379 meters NAD83 (2011) |

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|                     |                      |
|---------------------|----------------------|
| Online Datasheet(s) | <a href="#">CRON</a> |
|---------------------|----------------------|

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[Report a disturbed or destroyed control station.](#)

**Contacts**


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|                        |  |
|------------------------|--|
| Organization           | Wisconsin Dept. of Transportation  |
| Dataset Inventory Date | 2013-03-22   |
| Name                   | Elliot Smith   |
| Title                  | DOT Geodetic Specialist  |
| Email                  | <a href="mailto:elliott.smith@dot.state.wi.us">elliott.smith@dot.state.wi.us</a> |
| Phone                  | 608-243-5992   |
| Fax                    | 608-245-8959   |
| Address                | 3502 Kinsman Blvd<br>Madison, WI 53704   |
| Website                | <a href="#">Access WISCORS System</a>  |
| Additional Information | <a href="#">Overview of WISCORS</a>  |

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**WISCORS Station Control Attributes**

Show N/A

Print

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|            |         |
|------------|---------|
| Point Name | Lynne   |
| Point ID   | LYNE    |
| County     | ONEIDA  |
| CORS       | WISCORS |

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|                       |                             |
|-----------------------|-----------------------------|
| Longitude Coordinates | 89 58 56.42005 NAD83 (2011) |
| Latitude Coordinates  | 45 42 38.59434 NAD83 (2011) |
| Lat/Long Format       | dd mm ss.sssss              |
| Ellipsoid Height      | 450.209 meters NAD83 (2011) |

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|                     |                      |
|---------------------|----------------------|
| Online Datasheet(s) | <a href="#">LYNE</a> |
|---------------------|----------------------|

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[Report a disturbed or destroyed control station.](#)

**Contacts**


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|                        |  |
|------------------------|--|
| Organization           | Wisconsin Dept. of Transportation  |
| Dataset Inventory Date | 2013-03-22   |
| Name                   | Elliot Smith   |
| Title                  | DOT Geodetic Specialist  |
| Email                  | <a href="mailto:elliott.smith@dot.state.wi.us">elliott.smith@dot.state.wi.us</a> |
| Phone                  | 608-243-5992   |
| Fax                    | 608-245-8959   |
| Address                | 3502 Kinsman Blvd<br>Madison, WI 53704   |
| Website                | <a href="#">Access WISCORS System</a>  |
| Additional Information | <a href="#">Overview of WISCORS</a>  |

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**WISCORS Station Control Attributes**

Show N/A

Print

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|            |                   |
|------------|-------------------|
| Point Name | Manitowish Waters |
| Point ID   | MAWA              |
| County     | VILAS             |
| CORS       | WISCORS           |

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|                       |                             |
|-----------------------|-----------------------------|
| Longitude Coordinates | 89 52 34.90733 NAD83 (2011) |
| Latitude Coordinates  | 46 07 20.41307 NAD83 (2011) |
| Lat/Long Format       | dd mm ss.sssss              |
| Ellipsoid Height      | 462.952 meters NAD83 (2011) |

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|                     |                      |
|---------------------|----------------------|
| Online Datasheet(s) | <a href="#">MAWA</a> |
|---------------------|----------------------|

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[Report a disturbed or destroyed control station.](#)

**Contacts**


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|                        |  |
|------------------------|--|
| Organization           | Wisconsin Dept. of Transportation  |
| Dataset Inventory Date | 2013-03-22   |
| Name                   | Elliot Smith   |
| Title                  | DOT Geodetic Specialist  |
| Email                  | <a href="mailto:elliott.smith@dot.state.wi.us">elliott.smith@dot.state.wi.us</a> |
| Phone                  | 608-243-5992   |
| Fax                    | 608-245-8959   |
| Address                | 3502 Kinsman Blvd<br>Madison, WI 53704   |
| Website                | <a href="#">Access WISCORS System</a>  |
| Additional Information | <a href="#">Overview of WISCORS</a>  |

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**WISCORS Station Control Attributes**

Show N/A

Print

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|            |         |
|------------|---------|
| Point Name | Phelps  |
| Point ID   | PHPS    |
| County     | VILAS   |
| CORS       | WISCORS |

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|                       |                             |
|-----------------------|-----------------------------|
| Longitude Coordinates | 89 04 46.06181 NAD83 (2011) |
| Latitude Coordinates  | 46 03 47.92813 NAD83 (2011) |
| Lat/Long Format       | dd mm ss.sssss              |
| Ellipsoid Height      | 514.381 meters NAD83 (2011) |

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|                     |                      |
|---------------------|----------------------|
| Online Datasheet(s) | <a href="#">PHPS</a> |
|---------------------|----------------------|

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[Report a disturbed or destroyed control station.](#)

**Contacts**


---

|                        |  |
|------------------------|--|
| Organization           | Wisconsin Dept. of Transportation  |
| Dataset Inventory Date | 2013-03-22   |
| Name                   | Elliot Smith   |
| Title                  | DOT Geodetic Specialist  |
| Email                  | <a href="mailto:elliott.smith@dot.state.wi.us">elliott.smith@dot.state.wi.us</a> |
| Phone                  | 608-243-5992   |
| Fax                    | 608-245-8959   |
| Address                | 3502 Kinsman Blvd<br>Madison, WI 53704   |
| Website                | <a href="#">Access WISCORS System</a>  |
| Additional Information | <a href="#">Overview of WISCORS</a>  |

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**WISCORS Station Control Attributes**

Show N/A

Print

---

|            |           |
|------------|-----------|
| Point Name | Rhineland |
| Point ID   | RHER      |
| County     | ONEIDA    |
| CORS       | WISCORS   |

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|                       |                             |
|-----------------------|-----------------------------|
| Longitude Coordinates | 89 26 37.85581 NAD83 (2011) |
| Latitude Coordinates  | 45 37 58.25273 NAD83 (2011) |
| Lat/Long Format       | dd mm ss.sssss              |
| Ellipsoid Height      | 460.834 meters NAD83 (2011) |

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|                     |                      |
|---------------------|----------------------|
| Online Datasheet(s) | <a href="#">RHER</a> |
|---------------------|----------------------|

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[Report a disturbed or destroyed control station.](#)

**Contacts**


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|                        |  |
|------------------------|--|
| Organization           | Wisconsin Dept. of Transportation  |
| Dataset Inventory Date | 2013-03-22   |
| Name                   | Elliot Smith   |
| Title                  | DOT Geodetic Specialist  |
| Email                  | <a href="mailto:elliott.smith@dot.state.wi.us">elliott.smith@dot.state.wi.us</a> |
| Phone                  | 608-243-5992   |
| Fax                    | 608-245-8959   |
| Address                | 3502 Kinsman Blvd<br>Madison, WI 53704   |
| Website                | <a href="#">Access WISCORS System</a>  |
| Additional Information | <a href="#">Overview of WISCORS</a>  |

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