

Minnesota Department of Transportation Office of Land Management

Source: http://www.olmweb.dot.state.mn.us/tech/Projections.htm

Map Projections and Parameters

Last Updated on April 16, 2009

Notice of Error in Beltrami County North Zone Parameters

Conad83 was originally written in 1986 to run on the HP-310 computer system. In 1988, Conad83 was rewritten to run on IBM-compatible computers. At that time there was a transcription error, and the south parallel parameter for Beltrami County North Zone was mistakenly set one degree too far south, which results in county coordinate positional errors on the order of one to three meters. See below in the Lambert Zones table. The erroneous value persisted in the MnCon program that replaced the functionality of the Conad programs in 1997 and also appeared in some documentation of the Minnesota County Coordinate System, including this page.

This error was repaired in MnCon Version 1.9.3, released on June 7, 2001. Beginning with version 1.9.3, MnCon will include both the correct and erroneous parameters for Beltrami County North Zone. For lack of a better term, they are designated "good" and "bad" on the map projection lists and in the printed and file outputs. The uncorrected (or bad) value appears at the bottom of the lists and is included for the convenience of those who may need to convert from or to the old, erroneous county coordinates.

To summarize, any Beltrami County North Zone coordinate computed by the PC version of Conad83 or by MnCon prior to June 7, 2001 is incorrect with respect to the Minnesota County Coordinate System definition. Any coordinate projections computed from Beltrami County North Zone coordinates are also suspect and should be examined. No other counties, zones, or projections are affected.

Introduction

The following tables and examples provide the data needed to perform conversions of coordinates between map projections used in the State of Minnesota.

Required parameters, examples of usage and methods of parameter calculation are listed for all projections used in Minnesota. Since different conversion packages give the parameters different names, all known aliases have been noted.

For more information, please contact:

Roy Graff Minnesota Department of Transportation, Office of Land Management Surveys Research and Support Unit Transportation Building Mail Stop 643 395 John Ireland Boulevard Saint Paul, MN 55155-1899 (651) 366-3443 roy.graff@dot.state.mn.us

Click on the following links to jump to the associated topic:

NAD83 Universal Transverse Mercator

NAD83 Minnesota State Plane

NAD83 Minnesota County Coordinate System

NAD83 Minnesota County Zones with Lambert Conformal Conic Projection

NAD83 Minnesota County Zones with Transverse Mercator Projection

NAD83 Minnesota County Zones with Oblique Mercator Projection

NAD27 Universal Transverse Mercator

NAD27 Minnesota State Plane

NAD27 Minnesota Project Coordinate System

NAD27 Minnesota Project Zones in North State Plane

NAD27 Minnesota Project Zones in Central State Plane

NAD27 Minnesota Project Zones in South State Plane

NAD27 Minnesota Project Zones Along North Shore of Lake Superior

NAD27 Minnesota Project Coordinate System -- Modified for Counties

Conversions Between Datums

NAD83 Universal Transverse Mercator (UTM)

Zone	False Northing (meters)	False Easting (meters)	Central Meridian	Latitude of Grid Origin	Grid Scale Factor at Central Meridian	West Edge of Zone	East Edge of Zone
UTM 14	0.000	500000.000	-99 00 00	00 00 00	0.99960000000	-102 00 00	-96 00 00
UTM 15	0.000	500000.000	-93 00 00	00 00 00	0.99960000000	-96 00 00	-90 00 00
UTM 16	0.000	500000.000	-87 00 00	00 00 00	0.99960000000	-90 00 00	-84 00 00

NAD83 UTM Parameters

When UTM coordinates are used in Minnesota, Zone 15 is usually extended east and west to encompass the entire state within a single zone, which may be denoted as "Zone 15E" or "Zone 15 Extended." For example, the Mn/DOT Basemap specifies "Universal Transverse Mercator (UTM) Minnesota extended Zone 15, NAD83 coordinates."

The following parameters apply to all NAD83 UTM zones:

Projection = Transverse Mercator Spheroid = GRS 1980

UTM ARC/INFO Example

The parameters needed to convert to or from UTM Zone 15 are shown below. This can become part of a file used in ARC/INFO's PROJECT command. More detailed examples showing complete conversions are shown in the NAD83 Minnesota County Coordinate System section of this document.

Projection UTM Zone 15 Datum NAD83 Zunits NO Units METERS Xshift 0.000000000 Yshift 0.000000000 Parameters

NAD83 Minnesota State Plane

State Plane Zone	,	Semi-minor Axis (meters)	Southern Standard Parallel	Northern Standard Parallel	Longitude of Origin	Latitude of Grid Origin
North	6378137.000	6356752.314	47 02 00	48 38 00	-93 06 00	46 30 00
Central	6378137.000	6356752.314	45 37 00	47 03 00	-94 15 00	45 00 00
South	6378137.000	6356752.314	43 47 00	45 13 00	-94 00 00	43 00 00

NAD83 Minnesota State Plane Parameters

The Semi-major Axis can also be called the Equatorial Radius. It is represented by the letter *a* in equations. The Semi-minor Axis can also be called the Polar Radius. It is represented by the letter *b* in equations.

The Longitude of Origin may also be called the Central Meridian. Within various software packages, the Southern Standard Parallel may be called either Standard Parallel 1 or Standard Parallel 2, making the Northern Standard Parallel either Standard Parallel 2 or Standard Parallel 1. A process of trial and error may be necessary to determine the correct terminology.

The following constants apply for all Minnesota state plane zones:

Projection = Lambert Conformal Conic False Northing = 100000.000 m False Easting = 800000.000 m Eccentricity = e = 0.08181919104283185Flattening = f = 0.003352810681183637Inverse Flattening = 1 / f = 298.2572221008827

State Plane ARC/INFO Example

The parameters needed to convert to or from the Minnesota North State Plane zone are shown below. This can become part of a file used in ARC/INFO's PROJECT command. More detailed examples showing complete conversions are shown in the NAD83 Minnesota County Coordinate System section of this document.

Projection STATEPLANE Datum NAD83 Units METERS Zone 4276 Parameters

NAD83 Minnesota County Coordinate System

Counties in the Minnesota County Coordinate System are defined using Lambert Conformal Conic, Transverse Mercator, or Oblique Mercator mapping projections. For the purpose of listing their parameters, they are separated into tables according to their mapping projections.

NAD83 Lambert Conformal Conic County Zones

NAD83 Lambert Conformal Conic Formulas

The Semi-major Axis, or Equatorial Radius, is represented by the letter *a* in equations. The Semi-minor Axis, or Polar Radius, is represented by the letter *b* in equations.

The Longitude of Origin may also be called the Central Meridian. Within various software packages, the Southern Standard Parallel may be called either Standard Parallel 1 or Standard Parallel 2, making the Northern Standard Parallel either Standard Parallel 2 or Standard Parallel 1. A process of trial and error may be necessary to determine the correct terminology.

The following constants apply for all Minnesota counties defined with the Lambert projection:

False Northing = N_0 = 30480.0610 m False Easting = E_0 = 152400.3048 m Eccentricity = e = 0.08181919104283185 Flattening = f = 0.003352810681183637 Inverse Flattening = 1 / f = 298.2572221008827

Equations for computing both the forward and inverse calculations are available in NOAA Manual NOS NGS 5 titled <u>State Plane Coordinate System of 1983</u> by James E. Stem. One change must be made to make those formulas work for the Minnesota County Coordinate System Lambert Conformal Conic counties. The ellipsoid height must be added to the standard GRS80 semi-major axis.

semi-major_axis = a = 6378137.000 + ellipsoid_height

If you are using a map projection conversion from a commercial software package you will need to create a user defined ellipsoid. This generally requires the lengths of the semi-major axis and the semi-minor axis. Both are available in the table above. The way the length of the semi-minor axis of the ellipsoid was computed is as follows:

semi-minor_axis = b + (ellipsoid_height * (1 - f)) = 6356752.314 + (ellipsoid_height * 0.996647189318816363)

where:

ellipsoid_height = County's ellipsoid height (rarely used in commercial packages) a = GRS80 semi-major axis (equatorial radius) = 6378137.000 m b = GRS80 semi-minor axis (polar radius) = 6356752.314 m f = flattening of the geodetic ellipsoid = 0.003352810681183637

County Semi-main Xis (meters) Semi-mino Xis (meters) Sumdare Parallel Norther Parallel Norther Parallel Longitud of Origin Latturde Legitud Legitud Origin Elitude Height Meters) Scale Factor (PPM)* Anoka 6378418.941 6357033.301 45 04 00 45 22 00 -93 16 00 45 02 07 281 941 44.20428724 Betram/North 6378566.581 6357203.381 45 04 00 47 50 00 -95 41 00 46 31 04 44.9081 70.40782323 Betram/North 6378490.569 6357104.698 45 30 0 47 20 0 -94 03 00 45 03 33 505.59 55.43452579 Big Stone 6378403.701 6357018.121 43 56 00 44 20 0 -94 40 0 44 62 2 29.7181 46.530997 Carton 637843.4181 635704.925 64 28 00 46 40 -94 40 0 44 82 32 265.651 41.3089202 Carton 6378454.907 6357016.88 44 100 44 54 00 -94 28 00 46 13 3 40.378 7.47707050 Cass/South 6378646.957 635716.088 46 16 00							arameter	-	ū .
Becker 6378586.541 6357200.388 46 47 00 47 05 00 95 41 00 46 43 04 44 9.581 70.48782427 Beltrami/North ** 6378505.809 6357119.886 48 07 00 47 28 00 95 01 00 48 01 12 368.809 57.82333824 Bertron 6378490.669 6357104.069 6357104.069 45 31 00 45 32 00 96 03 00 45 30 33 35 055 2.32828959 Big Stone 6378403.701 6357084.921 45 1 30 45 32 00 94 4 00 43 35 05 2.66.771 4.8590970 Carton 6378434.181 6357048.921 64 28 00 46 44 00 92 41 00 44 25 02 31.797 4.85369370 Carton 637840.053 635716.033 44 10 00 44 28 00 93 46 00 44 32 23 283.653 41.383693292 Carton 6378464.907 6357160.886 46 10 00 44 49 00 94 46 00 34 48 10 44 45 10 39.853 5.3280518 Carton 6378476.853 6357101.086 44 100 44 49 100 90 46 10 23	County			Standard	Standard	Longitude	of Grid	Height	(PPM) *
Beltrami/North ** 6378505.800 6367119.886 48 07 00 48 28 00 95 01 00 48 01 12 368.808 57.82393824 Beltrami/South 6378644.823 6357104.698 45 35 00 47 47 00 94 03 00 45 33 33 63.35.69 55.34362579 Big Stone 6378407.077 6357048.492 45 13 00 44 20 94 16 00 43 05 53 266.701 41.81487478 Brown 6378434.181 6357048.499 44 100 44 200 94 44 00 44 06 29 297.181 45.9369970 Cartton 6378470.653 6357015.083 44 41 00 44 200 93 46 00 44 38 23 263.653 41.330378 67.47707050 Cass/South 6378647.376 635716.396 46 15 00 46 400 94 28 00 46 48 13 43.3378 67.47707050 Cass/South 637864.957 635716.369 46 10 00 45 120 95 100 44 45 10 393.853 53.24804584 Chipseva 637847.541 6357261.143 47 50 00 48 100 90 15 00 47 72 02 <td>Anoka</td> <td>6378418.941</td> <td>6357033.310</td> <td>45 04 00</td> <td>45 22 00</td> <td>-93 16 00</td> <td>45 02 07</td> <td>281.941</td> <td>44.20428724</td>	Anoka	6378418.941	6357033.310	45 04 00	45 22 00	-93 16 00	45 02 07	281.941	44.20428724
Beltrami/South 6378544.822 6367158.770 47 30 00 47 50 00 94 51 00 47 24 45 407.823 63.94077142 Benton 6378490.563 6357104.698 45 35 00 45 47 00 -94 03 00 45 33 33 353.569 55.43452579 Big Stone 6378437.0757 6357084.952 45 13 00 45 22 00 -94 16 00 43 50 53 266.701 41.8148778 Brown 6378434.819 6357048.999 44 100 44 28 00 -94 44 00 44 65 29 297.181 46.5936970 Cartton 637840.0653 6357015.083 44 41 00 44 54 00 -94 44 00 44 382.3 263.653 41.33699229 Cass/North 637867.378 6367181.249 46 50 0 47 19 00 -94 13 00 46 44 51 0 39.983 53.2465458 Chisago 637847.541 6357261.143 47 30 00 47 100 -90 15 00 47 17 4 274.31 43.0098610 Cook/North 6378647.541 6357261.143 47 30 00 70 15 00 47 52 00 510.541 80.04547409	Becker	6378586.581	6357200.388	46 47 00	47 05 00	-95 41 00	46 43 04	449.581	70.48782427
Benton 6378490.560 6357104.698 45 35 00 45 47 00 94 03 00 45 33 33 353.569 55.43452579 Big Stone 637840.757 6357084.952 45 13 00 45 32 00 -96 03 00 45 09 08 333.757 52.32828959 Brown 6378434.181 6357049.155 44 100 44 22 00 -94 16 00 43 50 53 266.701 41.81487478 Brown 6378434.181 6357045.053 44 100 44 28 00 -94 44 00 44 06 29 27.81 46.5930970 Carver 6378400.653 6357015.083 44 11 00 44 45 00 -93 46 00 44 38 23 263.6631 41.3309820 Carver 637847.853 635701.028 44 50 0 -93 150 44 45 10 39.853 53.28405458 Chippewa 637841.321 6357261.143 47 30 00 47 40 00 -90 15 00 41 51 03 39.853 53.28405458 Chippewa 6378647.541 6357261.143 47 30 00 47 400 -90 15 00 41 45 0 43.400.44 45 0 43.80 53 <td< td=""><td>Beltrami/North **</td><td>6378505.809</td><td>6357119.886</td><td>48 07 00</td><td>48 28 00</td><td>-95 01 00</td><td>48 01 12</td><td>368.809</td><td>57.82393824</td></td<>	Beltrami/North **	6378505.809	6357119.886	48 07 00	48 28 00	-95 01 00	48 01 12	368.809	57.82393824
Big Stone 6378470.757 6357084.952 45 13 00 45 32 00 -96 03 00 45 09 08 333.757 52.32828959 Blue Earth 6378403.701 6357018.121 43 56 00 44 22 00 -94 16 00 43 50 53 266.701 41.81487478 Brown 6378434.181 6357048.499 44 10 00 44 28 00 -94 44 00 42 02 2 297.181 46.5936970 Cartver 6378040.653 6357015.083 44 41 00 44 44 00 -94 13 00 46 48 13 30.378 67.47707050 Cass/North 6378476.853 6357161.986 44 16 00 -94 13 00 46 48 13 30.378 67.477050 Cass/South 6378476.853 6357101.286 44 100 -94 28 00 46 09 23 40.9957 64.27535188 Chipewa 6378476.853 6357102.5715 45 20 00 45 40 00 -94 13 00 47 45 10 33.9853 53.2405458 Chipewa 637847.541 6357261.143 47 30 00 47 10 0 49 15 00 47 5 30 51.541 80.04547099	Beltrami/South	6378544.823	6357158.770	47 30 00	47 55 00	-94 51 00	47 24 45	407.823	63.94077142
Blue Earth 6378403.701 6357018.121 43 56 00 44 22 00 -94 16 00 43 50 53 266.701 41.81487478 Brown 6378434.181 6357048.493 44 10 00 44 28 00 -94 44 00 44 06 29 297.181 46.59369970 Cartton 6378454.907 6357069.155 46 28 00 46 44 00 -94 44 00 44 52 02 317.907 49.84323792 Carver 6378400.653 6357150.83 44 41 00 44 45 400 -94 48 00 46 09 23 409.957 64.2753188 Cass/South 637846.853 635701.028 46 16 00 46 44 00 -94 28 00 46 09 23 409.957 64.2753188 Chippewa 637841.321 635705.715 45 20 00 45 100 -95 100 44 55 00 38.150 47.321 43.00454749 Cook/North 6378647.541 655761.143 47 53 00 44 10 00 -94 55 00 43 50 53 37.753 59.2676872 Cortonwood 637814.953 6357190.043 47 50 00 43 100 -94 28 00 46 09 23	Benton	6378490.569	6357104.698	45 35 00	45 47 00	-94 03 00	45 33 33	353.569	55.43452579
Brown6378434.1816357048.49944 10 0044 28 0094 44 0044 06 29297.18146.5936970Carlton6378454.9076357069.15646 28 0046 44 00-92 41 0046 25 02317.90749.84323792Carver6378400.6536357015.08344 41 0044 54 0093 46 0044 38 23263.65341.33699229Cass/North6378567.3786357181.24946 55 0047 19 0094 13 0046 48 13430.37867.47707050Cass/South637847.68556357161.28946 16 0046 44 00-94 28 0046 09 23409.95764.27535188Chippewa637847.68556357091.02844 50 0045 100-93 05 0045 17 40339.85353.28405488Chisago637841.3216357261.14347 50 0045 10090 15 0047 53 00510.54180.04547409Cook/South6378647.5416357261.14347 33 0047 49 0090 15 0047 26 20510.54180.04547409Cottonwood6378514.955635719.00043 54044 10 00-94 28 0046 09 2340.96742.7535188Dakota637841.4256357036.34744 31 0044 55 0033 19 0044 28 1928.49844.6216973Dodge637841.426637035.58443 53 0044 08 00-92 55 0043 50 02344.42554.00087831Dodge637841.4266357132.07843 34 0043 48 00-93 57 0043 30 00384.04960.21335070Frieborn	Big Stone	6378470.757	6357084.952	45 13 00	45 32 00	-96 03 00	45 09 08	333.757	52.32828959
Carlton6378454.9076357069.15546 28 0046 44 0092 41 0046 25 02317.90749.84323792Carver6378400.6556357015.06344 41 0044 54 0093 46 0044 38 23263.65341.3699229Cass/North6378567.3786357181.24946 55 0047 19 00-94 13 0046 48 13430.37867.47707050Cass/South6378546.9576357160.89646 16 0046 44 00-94 28 0046 09 23409.95764.27535188Chippewa6378476.8536357091.02844 50 0045 10 0-95 51 0044 45 10339.85353.28405488Chisago6378411.3216357057.71545 20 0045 40 00-90 15 0047 53 00510.54180.04547409Cook/North6378647.5416357261.14347 30 0047 49 00-90 15 0047 56 0337.95559.2578572Crow Wing6378461.4556357160.89646 16 0044 10 00-94 28 0040 923409.95764.2753188Dakata637841.4266357035.58443 50 0044 55 0043 50 02344.621697330.0159.758672Crow Wing637841.4266357035.58443 30 0044 08 0092 55 0043 50 02344.42564.00087831Dodge637841.4266357035.78643 30044 08 0093 57 0043 30 0038.40460.21335070Fillmore637841.426635703.75743 3044 48 0093 57 0043 30 0038.40460.21335070Grant	Blue Earth	6378403.701	6357018.121	43 56 00	44 22 00	-94 16 00	43 50 53	266.701	41.81487478
Carver6378400.6636357015.08344 41 0044 54 0093 46 0044 38 23263.65341.33699229Cass/North6378567.3786357181.24946 55 0047 19 0094 13 0046 48 13430.37867.47707050Cass/South6378464.9576357160.89646 16 0046 44 0094 28 0046 09 23409.95764.27535188Chippewa6378476.8536357091.02844 50 0045 12 0095 51 0044 45 10339.85353.28405458Chisago6378411.3216357025.71545 20 0045 40 0093 05 0045 17 47274.32143.00958101Cook/North6378647.5416357261.14347 33 0047 49 0090 15 0047 26 20510.54180.04547409Cottonwood637841.9586357129.00043 54 0044 10 0094 55 0043 05 03377.95359.2576872Crow Wing6378461.4556357056.34744 31 0044 50092 25 0043 50 02340.95764.2735188Dakota637841.4256357055.58443 53 0044 08 0092 55 0043 000384.04960.21335070Faribault637841.4256357055.58443 53 0044 80093 75 0043 000384.04960.21335070Fillmore637841.425635705.57543 34 0043 48 0093 57 0043 30 00384.04960.21335070Goodhue6378431.418635703.30144 38 0093 63 0045 45 32381.00159.73546821Hennepin63	Brown	6378434.181	6357048.499	44 10 00	44 28 00	-94 44 00	44 06 29	297.181	46.59369970
Cass/North6378567.3786357181.24946 55 0047 19 0094 13 0046 48 1343.0.37867.47707050Cass/South6378546.9576357160.89646 16 0046 44 0094 28 0046 09 23409.95764.27535188Chippewa6378476.8536357091.02844 50 0045 12 0095 51 0044 45 10339.85353.28405458Chisago6378411.3216357025.71545 20 0045 40 0093 05 0045 17 47274.32143.00958101Cook/North6378647.5416357261.14347 33 0047 49 0090 15 0047 52 00510.54180.04547409Cook/South6378647.5416357261.14347 33 0047 49 0090 15 0047 26 20510.54180.04547409Cotonwood6378514.9536357129.00043 54 0044 10 0094 28 0046 09 2340.995764.27535188Dakota637841.425635705.54443 31 0044 55 0093 19 0044 28 19284.98944.68216973Dodge637841.425635705.55443 30 0044 08 0092 55 0043 30 00384.04960.21335070Filmore6378518.0016357132.07843 30 0043 48 0093 57 0043 30 00384.04960.21335070Filmore637841.816357078.87643 30 0043 48 0093 57 0043 30 00384.04960.21335070Grant637843.18635708.52943 34 0043 48 0093 20044 12 02381.00159.73546821He	Carlton	6378454.907	6357069.155	46 28 00	46 44 00	-92 41 00	46 25 02	317.907	49.84323792
Cass/South6378546.9576357160.86646 16 0046 44 00-94 28 0046 09 23409.95764.27535188Chippewa6378476.8536357091.02844 50 0045 12 00-95 51 0044 45 10339.85353.28405458Chisago6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Cook/North6378647.5416357261.14347 56 0048 10 00-90 15 0047 53 00510.54180.04547409Cook/South6378647.5416357261.14347 33 0047 49 00-90 15 0047 26 20510.54180.04547409Cotonwood6378514.9536357129.00043 54 0044 10 00-94 28 0046 09 2340.995764.27535188Dakota637841.9256357160.89646 16 0046 44 00-94 28 0046 09 2340.995764.27535188Dakota637841.4256357036.34744 31 0044 55 00-93 19 0044 28 19284.98944.68216973Dodge6378481.425635705.58443 30044 08 00-92 55 0043 50 02344.42554.0008781Douglas6378518.0016357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Filmore637841.8166357048.49944 18 0044 40 00-93 05 0045 45 32381.00157.752461Freeborn6378434.1816357048.49944 18 0044 00 09-93 57 0043 30 00384.04960.21335070 <td>Carver</td> <td>6378400.653</td> <td>6357015.083</td> <td>44 41 00</td> <td>44 54 00</td> <td>-93 46 00</td> <td>44 38 23</td> <td>263.653</td> <td>41.33699229</td>	Carver	6378400.653	6357015.083	44 41 00	44 54 00	-93 46 00	44 38 23	263.653	41.33699229
Chippewa6378476.8536357091.02844 50 0045 12 0095 51 0044 45 10339.85353.28405488Chisago6378411.3216357025.71545 20 0045 40 0093 05 0045 17 47274.32143.00958101Cook/North6378647.5416357261.14347 56 0048 10 0090 15 0047 26 20510.54180.04547409Cook/South6378647.5416357261.14347 33 0047 49 0090 15 0047 26 20510.54180.04547409Cottonwood6378514.9536357129.00043 54 0044 10 0094 55 0043 50 53377.95359.25758572Crow Wing6378481.4256357065.34744 31 0044 55 0093 19 0044 28 19284.98944.68216973Dodge6378481.4256357095.58443 53 0044 08 0092 55 0043 50 02344.42554.00087831Douglas637851.0006357132.03845 48 0046 03 0096 03 0045 45 32381.00159.73546821Faribault637844.6616357078.87643 33 0043 48 0093 57 0043 30 00384.04960.21335070Goodhue637843.1816357132.07543 34 0043 48 0093 57 0043 30 00384.04960.21335070Goodhue637843.181635703.31044 50 0093 0044 47 28281.94144.2042874Houston637841.894635703.31044 50 0093 30 0045 47 32381.00159.73546821Hennepin637841.391 <td< td=""><td>Cass/North</td><td>6378567.378</td><td>6357181.249</td><td>46 55 00</td><td>47 19 00</td><td>-94 13 00</td><td>46 48 13</td><td>430.378</td><td>67.47707050</td></td<>	Cass/North	6378567.378	6357181.249	46 55 00	47 19 00	-94 13 00	46 48 13	430.378	67.47707050
Chisago6378411.3216357025.71545 20 045 40 00-93 05 0045 17 47274.32143.00958101Cook/North6378647.5416357261.14347 56 0048 10 00-90 15 0047 53 00510.54180.04547499Cook/South6378647.5416357261.14347 33 0047 49 00-90 15 0047 26 20510.54180.04547499Cottonwood6378514.953635712.00043 54 0044 10 00-94 55 0043 50 53377.95359.2578572Crow Wing637846.957635716.089646 16 0046 44 00-94 28 0046 09 2340.95764.27535188Dakota637841.4256357095.58443 50 0044 08 00-92 55 0043 50 02344.42554.0087831Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.7554621Faribault6378521.0496357135.07543 30 0034 800-92 05 0043 30 00384.04960.21335070Goodhue637841.818635703.31044 30 0043 48 00-93 05 0045 45 32381.00159.7554621Freeborn637841.814635703.31044 30 00-93 08 0041 11 41297.18146.5936970Grant637841.824635703.31044 50 0045 00-93 08 0044 11 41297.18145.936970Grant637841.824635705.92843 40 00-93 08 0044 77 28281.94144.20428724Houston637841.83463571	Cass/South	6378546.957	6357160.896	46 16 00	46 44 00	-94 28 00	46 09 23	409.957	64.27535188
Cook/North6378647.5416357261.14347 56 0048 10 00-90 15 0047 53 00510.54180.04547.490Cook/South6378647.5416357261.14347 33 0047 49 00-90 15 0047 26 20510.54180.04547.490Cottonwood6378514.963635712.00043 54 0044 10 00-94 55 0043 50 53377.95359.2578572Crow Wing6378421.989635706.34744 31 0044 50 0-94 28 0046 09 23409.95764.27535188Dakota637841.256357095.58443 50 0044 08 00-92 55 0043 50 02344.42554.0087831Douglas6378518.006357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.7546821Faibault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.4960.21335070Goodhue637843.181635703.5.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue637843.181635703.3.1044 50 00-93 0044 72 8281.94144.2042874Houston637843.619635703.5.71545 20045 000-93 23 0044 77 2029.61144.2042874Houston637843.639635713.2.03845 80 0046 03 00-91 28 0043 30 0029.61946.753488Isanti637843.639635703.5.71543 20 0045 000-93 23 0044 77 28281.94144.2042874Houston6378474	Chippewa	6378476.853	6357091.028	44 50 00	45 12 00	-95 51 00	44 45 10	339.853	53.28405458
Cook/South6378647.5416357261.1434733047909015004726510.54180.04547409Cottonwood6378514.9536357129.00043434044100-945043503377.9359.2578572Crow Wing6378546.9576357160.896461600464400-9428004646.923409.95764.27535188Dakota637841.4256357036.347443100444819284.98944.68216973Dodge6378481.4256357095.58443334448092504350344.42554.00087831Douglas637851.0016357132.0384548480-9370434330384.04960.21335070Filmore637846.6161635778.8764343444093704330384.04960.21335070Goodhue637841.811635703.31044444093936330384.04960.21335070Grant637841.821635703.310444460939330384.04960.21335070Grant637841.821635703.31044446393433029.61946.97594298Isani637841.821635705.92843434043433029.619<	Chisago	6378411.321	6357025.715	45 20 00	45 40 00	-93 05 00	45 17 47	274.321	43.00958101
Cottonwood6378514.9536357129.00043 54 0044 10 0094 55 0043 50 53377.95359.25758572Crow Wing6378546.9576357160.89646 16 0046 44 00-94 28 0046 09 23409.95764.27535188Dakota6378421.9896357036.34744 31 0044 55 00-93 19 0044 28 19284.98944.68216973Dodge6378481.4256357095.58443 53 0044 08 00-92 55 0043 50 02344.42554.00087831Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Faribault6378521.0496357135.07543 34 0043 48 00-92 05 0043 30 00384.04960.21335070Filmore6378464.6616357078.87643 33 0043 48 00-92 05 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.5936970Grant6378418.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 50 0045 000-93 23 0044 47 28281.94144.20428724Houston6378434.181635705.71545 20 0045 40 00-93 57 0043 30 0029.61946.97594298Isanti6378411.3216357050.52843 34 0043 48 00-91 28 0043 30 00347.3968.57629430 <tr< td=""><td>Cook/North</td><td>6378647.541</td><td>6357261.143</td><td>47 56 00</td><td>48 10 00</td><td>-90 15 00</td><td>47 53 00</td><td>510.541</td><td>80.04547409</td></tr<>	Cook/North	6378647.541	6357261.143	47 56 00	48 10 00	-90 15 00	47 53 00	510.541	80.04547409
Crow Wing6378546.9576357160.8964616004644009428004669 23409.95764.27535188Dakota6378421.9896357036.34744 31 0044 55 00-93 19 0044 28 19284.98944.68216973Dodge6378481.4256357095.58443 53 0044 08 00-92 55 0043 50 02344.42554.00087831Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Faribault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Fillmore6378464.6616357078.87643 33 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378518.0016357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378434.181635703.31044 18 0044 40 00-93 08 0044 11 41297.18146.5936970Grant6378418.941635703.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378574.3896357138.23747 34 0047 49 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0047 25 00-93 44 0047 3	Cook/South	6378647.541	6357261.143	47 33 00	47 49 00	-90 15 00	47 26 20	510.541	80.04547409
Dakota6378421.9896357036.34744 31 0044 55 00-93 19 0044 28 19284.98944.68216973Dodge6378481.4256357095.58443 53 0044 08 00-92 55 0043 50 02344.42554.00087831Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Faribault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Filmore6378464.6616357078.87643 33 0043 48 00-92 55 0043 30 00384.04960.21335070Godhue637851.0096357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Godhue6378434.1816357038.7543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Godhue6378434.181635703.31044 53 0046 03 00-96 03 0044 11 41297.18146.59369970Grant6378418.941635703.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378418.941635705.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti637841.3216357135.07543 34 0043 48 00-93 57 0043 30 00437.38968.57629430Itasca/North6378574.3896357182.3747 34 0047 49 00-93 44 0047 03 00437.38968.57629430 <td< td=""><td>Cottonwood</td><td>6378514.953</td><td>6357129.000</td><td>43 54 00</td><td>44 10 00</td><td>-94 55 00</td><td>43 50 53</td><td>377.953</td><td>59.25758572</td></td<>	Cottonwood	6378514.953	6357129.000	43 54 00	44 10 00	-94 55 00	43 50 53	377.953	59.25758572
Dodge6378481.4256357095.58443 53 0044 08 00-92 55 0043 50 02344.42554.00087831Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Faribault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Fillmore6378464.6616357078.87643 33 0043 48 00-92 05 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.5936970Goodhue6378434.1816357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 0029.61946.97594298Isanti6378411.3216357050.92843 34 0043 48 00-93 57 0043 30 0029.61946.97594298Isanti6378411.3216357050.92843 34 0043 48 00-93 23 0044 47 28281.94144.20428724Houston6378574.3896357188.23747 34 0047 49 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357135.07543 34 0047 49 00-93 44 0047 30 00384.04960.21335070Jackson6378472.2816357086.47145 49 0047 20 00-93 44 0047 30 0037.38965.7629430 <td>Crow Wing</td> <td>6378546.957</td> <td>6357160.896</td> <td>46 16 00</td> <td>46 44 00</td> <td>-94 28 00</td> <td>46 09 23</td> <td>409.957</td> <td>64.27535188</td>	Crow Wing	6378546.957	6357160.896	46 16 00	46 44 00	-94 28 00	46 09 23	409.957	64.27535188
Douglas6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Faribault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Fillmore6378464.6616357078.87643 33 0043 48 00-92 05 0043 30 00327.66151.37252461Freeborn6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.5936970Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378411.3216357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378574.3896357188.23747 34 0047 49 00-93 44 0047 01 35437.38968.57629430Itasca/North6378574.3896357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0047 49 00-93 44 0047 01 35437.38968.57629430Itasca/North6378574.3896357135.07543 34 0047 49 00-93 44 0047 01 35437.38968.57629	Dakota	6378421.989	6357036.347	44 31 00	44 55 00	-93 19 00	44 28 19	284.989	44.68216973
Faribault6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Fillmore6378464.6616357078.87643 33 0043 48 00-92 05 0043 30 00327.66151.37252461Freeborn6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.5936970Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357050.92843 34 0047 49 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Jackson6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378572.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357188.23747 34 0047 49 00-93 44 0047 01 35437.38968.57629430Jackson6378574.3896357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070 </td <td>Dodge</td> <td>6378481.425</td> <td>6357095.584</td> <td>43 53 00</td> <td>44 08 00</td> <td>-92 55 00</td> <td>43 50 02</td> <td>344.425</td> <td>54.00087831</td>	Dodge	6378481.425	6357095.584	43 53 00	44 08 00	-92 55 00	43 50 02	344.425	54.00087831
Fillmore6378464.6616357078.87643 33 0043 48 00-92 05 0043 30 00327.66151.37252461Freeborn6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.59369970Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 01 35437.38968.576294300Itasca/South6378574.3896357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Jackson6378472.2816357135.07543 34 0047 49 00-93 44 0047 01 35437.38968.576294300Jackson6378498.18963571132.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kandiyohi6378498.1896357112.29244 58 0045 20 00-93 44 0047 01 35437.38968.576294300Kittson6378498.1896357112.29244 58 0045 20 00-92 54 0045 3 28312.42148.	Douglas	6378518.001	6357132.038	45 48 00	46 03 00	-96 03 00	45 45 32	381.001	59.73546821
Freeborn6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.59369970Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357036.47145 49 0046 20 00-93 57 0043 30 00384.04960.21335070Kandiyohi6378498.1896357112.29244 58 0045 20 00-93 44 0047 01 35437.38968.57629430Kittson6378449.4216357063.68848 36 0048 56 00-93 57 0043 30 00384.04960.21335070Kittson6378452.6216357139.63248 00048 37 00-93 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 37 00-93 45 0044 53 29361.18956.62923202 <td>Faribault</td> <td>6378521.049</td> <td>6357135.075</td> <td>43 34 00</td> <td>43 48 00</td> <td>-93 57 00</td> <td>43 30 00</td> <td>384.049</td> <td>60.21335070</td>	Faribault	6378521.049	6357135.075	43 34 00	43 48 00	-93 57 00	43 30 00	384.049	60.21335070
Goodhue6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.59369970Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Jackson6378571.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378449.4216357063.68848 36 0048 50 0-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 048 37 00-93 45 0047 50 45388.62160.93017444	Fillmore	6378464.661	6357078.876	43 33 00	43 48 00	-92 05 00	43 30 00	327.661	51.37252461
Grant6378518.0016357132.03845 48 0046 03 00-96 03 0045 45 32381.00159.73546821Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 01 35437.38968.57629430Itasca/South6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Freeborn	6378521.049	6357135.075	43 34 00	43 48 00	-93 57 00	43 30 00	384.049	60.21335070
Hennepin6378418.9416357033.31044 53 0045 08 00-93 23 0044 47 28281.94144.20428724Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Itasca/South6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Goodhue	6378434.181	6357048.499	44 18 00	44 40 00	-93 08 00	44 11 41	297.181	46.59369970
Houston6378436.6196357050.92843 34 0043 48 00-91 28 0043 30 00299.61946.97594298Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Itasca/South6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson637849.4216357063.68848 36 0048 37 00-93 45 0047 50 45388.62160.93017444	Grant	6378518.001	6357132.038	45 48 00	46 03 00	-96 03 00	45 45 32	381.001	59.73546821
Isanti6378411.3216357025.71545 20 0045 40 00-93 05 0045 17 47274.32143.00958101Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Itasca/South6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson637849.4216357063.68848 36 0048 37 00-93 45 0047 50 45388.62160.93017444Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Hennepin	6378418.941	6357033.310	44 53 00	45 08 00	-93 23 00	44 47 28	281.941	44.20428724
Itasca/North6378574.3896357188.23747 34 0047 49 00-93 44 0047 30 00437.38968.57629430Itasca/South6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Houston	6378436.619	6357050.928	43 34 00	43 48 00	-91 28 00	43 30 00	299.619	46.97594298
Itasca/South6378574.3896357188.23747 05 0047 25 00-93 44 0047 01 35437.38968.57629430Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Isanti	6378411.321	6357025.715	45 20 00	45 40 00	-93 05 00	45 17 47	274.321	43.00958101
Jackson6378521.0496357135.07543 34 0043 48 00-93 57 0043 30 00384.04960.21335070Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Itasca/North	6378574.389	6357188.237	47 34 00	47 49 00	-93 44 00	47 30 00	437.389	68.57629430
Kanabec6378472.2816357086.47145 49 0046 20 00-92 54 0045 43 48335.28152.56723084Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Itasca/South	6378574.389	6357188.237	47 05 00	47 25 00	-93 44 00	47 01 35	437.389	68.57629430
Kandiyohi6378498.1896357112.29244 58 0045 20 00-94 45 0044 53 29361.18956.62923202Kittson6378449.4216357063.68848 36 0048 56 00-96 09 0048 32 38312.42148.98311215Koochiching6378525.6216357139.63248 00 0048 37 00-93 45 0047 50 45388.62160.93017444	Jackson	6378521.049	6357135.075	43 34 00	43 48 00	-93 57 00	43 30 00	384.049	60.21335070
Kittson 6378449.421 6357063.688 48 36 00 48 56 00 -96 09 00 48 32 38 312.421 48.98311215 Koochiching 6378525.621 6357139.632 48 00 00 48 37 00 -93 45 00 47 50 45 388.621 60.93017444	Kanabec	6378472.281	6357086.471	45 49 00	46 20 00	-92 54 00	45 43 48	335.281	52.56723084
Koochiching 6378525.621 6357139.632 48 00 00 48 37 00 -93 45 00 47 50 45 388.621 60.93017444	Kandiyohi	6378498.189	6357112.292	44 58 00	45 20 00	-94 45 00	44 53 29	361.189	56.62923202
	Kittson	6378449.421	6357063.688	48 36 00	48 56 00	-96 09 00	48 32 38	312.421	48.98311215
Lac Qui Parle 6378476.853 6357091.028 44 50 00 45 12 00 -95 51 00 44 45 10 339.853 53.28405458	Koochiching	6378525.621	6357139.632	48 00 00	48 37 00	-93 45 00	47 50 45	388.621	60.93017444
	Lac Qui Parle	6378476.853	6357091.028	44 50 00	45 12 00	-95 51 00	44 45 10	339.853	53.28405458

NAD83 Lambert Conformal Conic County Parameters

"Map Projections and Parameters" from http://www.olmweb.dot.state.mn.us/

Lake of the Woods/North6378466.1856357080.39549 11 0049 20 00-94 59 0049 09 00329.18551.611Lake of the Woods/South6378496.6656357110.77348 27 0048 53 00-94 53 0048 21 58359.66556.390Le Sueur6378434.1816357048.49944 18 0044 40 00-93 08 0044 11 41297.18146.593	46586
Woods/South 6378496.665 6357110.773 48 27 00 48 53 00 -94 53 00 48 21 58 359.665 56.390	
Le Sueur 6378434.181 6357048.499 44 18 00 44 40 00 -93 08 00 44 11 41 297.181 46.593	29077
	69970
Lincoln 6378643.579 6357257.195 44 17 00 44 37 00 -96 16 00 44 11 48 506.579 79.424	28957
Lyon 6378559.758 6357173.655 44 15 00 44 35 00 -95 51 00 44 11 44 422.758 66.282	36427
McLeod 6378414.369 6357028.753 44 32 00 44 55 00 -94 38 00 44 27 22 277.369 43.487	46350
Mahnomen 6378586.581 6357200.388 47 12 00 47 27 00 -95 49 00 47 09 06 449.581 70.487	82427
Marshall 6378441.801 6357056.093 48 14 00 48 29 00 -96 23 00 48 10 23 304.801 47.788	40592
Martin 6378521.049 6357135.075 43 34 00 43 48 00 -93 57 00 43 30 00 384.049 60.213	35070
Meeker 6378498.189 6357112.292 44 58 00 45 20 00 -94 45 00 44 53 29 361.189 56.629	23202
Morrison 6378502.761 6357116.849 45 51 00 46 16 00 -94 12 00 45 46 26 365.761 57.346	05575
Mower 6378521.049 6357135.075 43 34 00 43 48 00 -93 57 00 43 30 00 384.049 60.213	35070
Murray 6378617.061 6357230.765 43 55 00 44 10 00 -95 46 00 43 50 53 480.061 75.266	64918
Nicollet 6378403.701 6357018.121 43 56 00 44 22 00 -94 16 00 43 50 53 266.701 41.814	87478
Nobles 6378624.681 6357238.360 43 34 00 43 48 00 -95 57 00 43 30 00 487.681 76.461	35541
Norman 6378468.623 6357082.825 47 12 00 47 27 00 -96 27 00 47 09 02 331.623 51.993	370913
Olmsted 6378481.425 6357095.584 43 53 00 44 08 00 -92 55 00 43 50 02 344.425 54.000	87831
Ottertail 6378525.621 6357139.632 46 11 00 46 39 00 -95 43 00 46 06 23 388.621 60.930	17444
Pennington 6378445.763 6357060.042 47 36 00 48 05 00 -96 22 00 47 29 56 308.763 48.409	59045
Pine 6378472.281 6357086.471 45 49 00 46 20 00 -92 54 00 45 43 48 335.281 52.567	23084
Pipestone 6378670.401 6357283.927 43 53 00 44 09 00 -96 15 00 43 50 57 533.401 83.629	59278
Polk 6378445.763 6357060.042 47 36 00 48 05 00 -96 22 00 47 29 56 308.763 48.409	59045
Pope 6378502.761 6357116.849 45 21 00 45 42 00 -95 09 00 45 16 58 365.761 57.346	05575
Ramsey 6378418.941 6357033.310 44 53 00 45 08 00 -93 23 00 44 47 28 281.941 44.204	28724
Red Lake 6378445.763 6357060.042 47 36 00 48 05 00 -96 22 00 47 29 56 308.763 48.409	59045
Redwood 6378438.753 6357053.055 44 16 00 44 34 00 -95 14 00 44 11 41 301.753 47.310	52343
Renville 6378414.369 6357028.753 44 32 00 44 55 00 -94 38 00 44 27 22 277.369 43.487	46350
Rice 6378434.181 6357048.499 44 18 00 44 40 00 -93 08 00 44 11 41 297.181 46.593	69970
Rock 6378624.681 6357238.360 43 34 00 43 48 00 -95 57 00 43 30 00 487.681 76.461	35541
Roseau 6378449.421 6357063.688 48 36 00 48 56 00 -96 09 00 48 32 38 312.421 48.983	311215
St Louis/North 6378543.909 6357157.859 47 59 00 48 32 00 -92 27 00 47 50 00 406.909 63.797	46939
St Louis/ Central 6378605.783 6357219.525 47 20 00 47 45 00 -92 27 00 47 15 00 468.783 73.498	42125
St Louis/South 6378540.861 6357154.821 46 47 00 47 08 00 -92 27 00 46 39 00 403.861 63.319	58690
Scott 6378421.989 6357036.347 44 31 00 44 55 00 -93 19 00 44 28 19 284.989 44.682	16973
Sherburne 6378443.325 6357057.612 45 02 00 45 28 00 -93 53 00 44 58 39 306.325 48.027	34717
Sibley 6378414.369 6357028.753 44 32 00 44 55 00 -94 38 00 44 27 22 277.369 43.487	46350
Stearns 6378502.761 6357116.849 45 21 00 45 42 00 -95 09 00 45 16 58 365.761 57.346	05575
Steele 6378481.425 6357095.584 43 53 00 44 08 00 -92 55 00 43 50 02 344.425 54.000	87831
Stevens 6378502.761 6357116.849 45 21 00 45 42 00 -95 09 00 45 16 58 365.761 57.346	05575

"Map Projections and Parameters" from http://www.olmweb.dot.state.mn.us/

Swift	6378470.757	6357084.952	45 13 00	45 32 00	-96 03 00	45 09 08	333.757	52.32828959
Todd	6378548.481	6357162.415	45 52 00	46 17 00	-94 54 00	45 46 24	411.481	64.51429312
Traverse	6378463.746	6357077.964	45 38 00	45 58 00	-96 33 00	45 35 08	326.746	51.22906579
Wabasha	6378426.561	6357040.904	44 09 00	44 25 00	-92 16 00	44 06 25	289.561	45.39899347
Wadena	6378546.957	6357160.896	46 16 00	46 44 00	-94 28 00	46 09 23	409.957	64.27535188
Waseca	6378481.425	6357095.584	43 53 00	44 08 00	-92 55 00	43 50 02	344.425	54.00087831
Watonwan	6378514.953	6357129.000	43 54 00	44 10 00	-94 55 00	43 50 53	377.953	59.25758572
Winona	6378453.688	6357067.940	43 54 00	44 08 00	-91 37 00	43 50 50	316.688	49.65211628
Wright	6378443.325	6357057.612	45 02 00	45 28 00	-93 53 00	44 58 39	306.325	48.02734717
Yellow Medicine	6378530.193	6357144.189	44 40 00	44 57 00	-95 54 00	44 32 30	393.193	61.64699818

* Entry of a scale factor in commercial software packages may be required to achieve the same results as the **MnCon** program. The scale factor is entered typically as PPM, or parts per million, but a trial-and-error process may be necessary, since some programs expect positive values, while others expect negative values. The scale factor is computed by dividing the number in the "Ellipsoid Height" column by one millionth of the GRS80 semi-major axis length, for example in Anoka County, the scale factor = 281.941/6.378137 = 44.20428724 ppm.

** The latitude of the south parallel for Beltrami County North Zone was incorrectly shown as 47 07 00. The correct value of 48 07 00 is now shown above.

NAD83 Lambert Projection ARC/INFO Example

ARC/INFO cannot convert files from a Lambert county coordinate system directly into UTM or State Plane coordinates. Instead, a two step process must be used with a conversion to latitude/longitude being the extra step. For example, to convert a coverage from Dakota County to UTM, one can run ARC/INFO's PROJECT command twice using these two projection files:

DAKOTA.PRJ

INPUT /* Dakota County to Lat/Long, metric units Projection LAMBERT Zunits NO Units METERS Xshift 0.000000000 Yshift 0.000000000 Parameters 6378421.989 6357036.347 44 31 00 /* 1st standard parallel 44 55 00 /* 2nd standard parallel -93 19 00 /* central meridian 44 28 19 /* latitude of projection's origin 152400.3048 /* false easting (meters) 30480.06096 /* false northing (meters)

OUTPUT Projection GEOGRAPHIC Spheroid GRS1980 Zunits NO Units DD Xshift 0.000000000 Yshift 0.000000000 Parameters END

UTM.PRJ INPUT /* Lat/Long to UTM, metric units Projection GEOGRAPHIC Datum NAD83 Zunits NO Units DD Xshift 0.000000000 Yshift 0.000000000 Parameters OUTPUT Projection UTM Zone 15 Datum NAD83 Zunits NO **Units METERS** Xshift 0.000000000 Yshift 0.0000000000 Parameters FND

The commands needed are:

PROJECT COVER SOURCECOV INTERCOV DAKOTA.PRJ PROJECT COVER INTERCOV TARGETCOV UTM.PRJ

where SOURCECOV = The source (input) coverage INTERCOV = The intermediate latitude/longitude coverage TARGETCOV = The target (output) coverage

ARC/INFO can also convert ASCII files containing one X Y coordinate set per record separated by a space. It uses the same two projection files:

PROJECT FILE SOURCEFIL INTERFIL DAKOTA.PRJ PROJECT FILE INTERFIL TARGETFIL UTM.PRJ

where SOURCEFIL = The source (input) ASCII file INTERFIL = The intermediate latitude/longitude ASCII file TARGETFIL = The target (output) ASCII file

NAD83 Transverse Mercator County Zones

County	False Northing (meters)	False Easting (meters)	Central Meridian	Latitude of Grid Origin	Grid Scale Factor at Central Meridian	Ellipsoid Height (meters)	
Aitkin	30481.8640	152409.3196	-93 25 57	46 09 15	1.000059152669	377.953	
Clay	30481.4423	152407.2110	-96 42 00	46 37 48	1.000045317862	289.561	
Clearwater	30482.2708	152411.3547	-95 22 33	47 09 06	1.000072505661	463.297	
Hubbard	30482.2416	152411.2097	-94 55 14	46 48 13	1.000071553661	457.201	
Lake	30482.3728	152411.8636	-91 24 33	47 04 00	1.000075844621	484.633	
Mille Lacs	30481.7112	152408.5566	-93 37 14	45 33 32	1.000054146138	345.949	
Washington	30481.2751	152406.3759	-92 50 00	44 44 45	1.000039836799	254.509	
Wilkin	30481.5511	152407.7567	-96 31 28	46 01 18	1.000048901066	312.421	

NAD83 Transverse Mercator County Parameters

Note: St. Louis County has developed **St. Louis County Transverse Mercator Coordinate System 96** that provides a single map projection for the entire county. Map scaling error is generally limited to less than one part in 40,000. This projection is included in **MnCon**, and its parameters are provided below:

Central Meridian = 92 27 00 West Latitude of Grid Origin = 46 37 00 North False Northing = 1,000,000 meters False Easting = 1,450,000 meters Semi-Major Axis = 6,378,523 meters Semi-Minor Axis = 6,357,138.3141403 meters Scale Factor = 0.99998529 Inverse Flattening = 298.2752724012354

NAD83 Transverse Mercator Formulas

Equations for computing both the forward and inverse calculations are based on NOAA Manual NOS NGS 5 titled <u>State Plane Coordinate System of 1983</u> by James E. Stem. When the Minnesota County Coordinate System was designed by University of Minnesota surveying professor Gerald Johnson and some graduate students, the only parameters identified for transverse Mercator counties were the central meridian, the latitude of grid origin, and an ellipsoid height. They used the same false northing (30480.0610 m) and false easting (152400.3048 m) as for the Lambert conformal conic counties. They set the grid scale factor at the central meridian to 1.000. Ellipsoid height isn't used in James Stem's manual nor in map projection conversions in commercial software packages.

In the Minnesota County Coordinate System the ellipsoid height is used in some extra steps beyond those shown in Stem's equations. These are the steps that must be added after finishing Stem's equations in the forward direction (latitude/longitude to county coordinate):

 $Y_F = Y_S * ((R + Ellipsoid Height) / R)$ $X_F = X_S * ((R + Ellipsoid Height) / R)$

where: Y_F = Final northing Y_S = Stem's northing X_F = Final easting X_S = Stem's easting R = Radius of curvature in the prime vertical *Ellipsoid Height* = Average ellipsoid height for county

Similarly, when doing the inverse calculations (county to latitude/longitude), these steps must be applied before starting Stem's equations:

 $Y_{s} = Y_{O} / ((R + Ellipsoid Height) / R)$ $X_{s} = X_{O} / ((R + Ellipsoid Height) / R)$

where: $Y_{O} = Original northing$ $X_{O} = Original easting$

NAD83 Transverse Mercator County Zones are based on the GRS80 Ellipsoid.

Obviously, commercial software packages cannot be changed to handle this. Instead you can account for the use of the ellipsoid height by making some minor adjustments to the grid scale factor at the central meridian and the false northing and easting. The method of making these adjustments is shown below. The results from these adjusted parameters give answers that match the original method to the nearest millimeter. The adjusted parameters were listed in the above table of parameters for transverse Mercator zones.

Grid Scale Factor at Central Meridian = (R + ellipsoid_height)/R

where *ellipsoid_height* = County's ellipsoid height R = Radius of curvature of the prime vertical = (k * a) / (1 - e^2 * sin² phi)^{1/2} where k = scale factor = 1.000 a = semi-major axis of the ellipsoid = 6378137 m e = first eccentricity = 0.08181919104283185 phi = latitude at midpoint of county

False Northing and *False Easting* were computed on a trial and error basis to give the best results possible for points at the extreme edges of the county using the following procedure. First, latitudes and longitudes for the corners of each county were converted to true county coordinates to use for comparisons.

Then, using the map projection conversion from a commercial software package, a transverse Mercator projection was defined. The central meridian and latitude of origin were from the above table. The scale factor was computed as shown in the equation above. The false northing was 30480.0610 m and the false easting 152400.3048 m.

Next, the same latitudes and longitudes representing the corners of the counties were entered into the map projection conversion from the commercial package. The difference between the true county coordinates and the commercial software package's results were averaged and added to the false northing and easting. The transverse Mercator projection was redefined using the new false northing and easting. Finally, the conversions were re-run on the commercial software package. In all cases, the results were within 1 mm of the true county coordinates.

NAD83 Transverse Mercator ARC/INFO Example

ARC/INFO can convert files between a transverse Mercator county coordinate system and latitude/longitude, UTM or State Plane coordinates in a one step process. It doesn't require two steps like in the case for the Lambert conformal conic counties because the ellipsoid is not changed. For example, to convert a coverage from Washington County to UTM, one can run ARC/INFO's PROJECT command using this projection file:

WASH2UTM.PRJ INPUT /* Washington County to UTM, metric units Projection TRANSVERSE Datum NAD83 Zunits NO Units METERS Xshift 0.000000000 Yshift 0.000000000 Parameters 1.000039836799 /* scale factor at central meridian -92 50 00.000 /* longitude at central meridian 44 44 45.000 /* latitude of origin 152406.37590 /* false easting (meters) 30481.27510 /* false northing (meters) OUTPUT Projection UTM Zone 15 Datum NAD83 Zunits NO Units METERS Xshift 0.000000000 Yshift 0.000000000 Parameters END

The commands needed are:

PROJECT COVER SOURCECOV TARGETCOV WASH2UTM.PRJ

where SOURCECOV = The source (input) coverage TARGETCOV = The target (output) coverage

ARC/INFO can also convert ASCII files containing one X Y coordinate set per record separated by a space. It uses the same projection file:

PROJECT FILE SOURCEFIL TARGETFIL WASH2UTM.PRJ

where SOURCEFIL = The source (input) ASCII file TARGETFIL = The target (output) ASCII file

NAD83 Oblique Mercator County Zones

The Oblique Mercator parameters for map projection conversions in commercial software packages haven't been determined. Below are the parameters established by Professor Johnson and used by CONAD83 and MnCon.

County	Latitude of Local Origin	Longitude of Local Origin	Azimuth of Positive Skew	Elevation Shift (meters)	Added Northing (meters)	Added Easting (meters)
Cook/ North Shore	46 30 00	89 19 40	62 00 00	-1693.167	-3505207.011	-6187452.376
Lake/ North Shore	46 10 00	89 58 34	46 00 00	-1697.739	-4389128.779	-4206248.413
St.Louis/NorthShore	45 45 00	90 41 30	45 00 00	-1703.835	-4358648.718	-4114808.230

NAD83 Oblique Mercator County Parameters

The following constants apply for all Minnesota county zones defined with the Oblique Mercator projection:

False Northing = $N_0 = 0.0000$ m False Easting = $E_0 = 0.0000$ m Grid scale factor at the local origin = $k_c = 1.0000000000000$ First eccentricity = e = 0.08181919104283185Computed flattening = f = 0.003352810681183637Computed inverse flattening = 1 / f = 298.2572221008827

Oblique Mercator Formulas

Equations for computing both the forward and inverse calculations are based on NOAA Manual NOS NGS 5 titled <u>State Plane Coordinate System of 1983</u> by James E. Stem. When the Minnesota County Coordinate System was designed by University of Minnesota surveying professor Gerald Johnson and some graduate students, they added some extra steps for oblique Mercator formulas to minimize the difference between ground distances and map distances. As stated above, no one has yet determined how to make them work in map projection conversions in commercial software packages.

These are the steps that must be added after finishing Stem's equations in the forward direction (latitude/longitude to county coordinate):

 $\begin{array}{l} Y_F = Y_S * ((R + Elevation Shift) / R) + N_1 \\ X_F = X_S * ((R + Elevation Shift) / R) + E_1 \\ \end{array}$ $\begin{array}{l} \text{where:} \quad Y_F = \text{Final northing} \\ Y_S = \text{Stem's northing} \\ X_F = \text{Final easting} \\ X_S = \text{Stem's easting} \\ N_1 = \text{Added northing} \\ E_1 = \text{Added easting} \\ R = \text{Radius of curvature} \\ \end{array}$

Similarly, when doing the inverse calculations (county to latitude/longitude), these steps must be applied before starting Stem's equations:

$$\begin{split} Y_{S} &= (R * (Y_{O} - N_{1})) / (R + Elevation Shift) \\ X_{S} &= (R * (X_{O} - E_{1})) / (R + Elevation Shift) \\ & \text{where:} \qquad Y_{O} = \text{Original northing} \end{split}$$

 X_{O} = Original easting

NAD83 Oblique Mercator County Zones are based on the GRS80 Ellipsoid.

NAD27 Universal Transverse Mercator

Zone	False Northing (meters)	False Easting (meters)	Central Meridian	Latitude of Grid Origin	Grid Scale Factor at Central Meridian	West Edge of Zone	East Edge of Zone
UTM 14	0.000	500000.000	-99 00 00	00 00 00	0.99960000000	-102 00 00	-96 00 00
UTM 15	0.000	500000.000	-93 00 00	00 00 00	0.999600000000	-96 00 00	-90 00 00
UTM 16	0.000	500000.000	-87 00 00	00 00 00	0.999600000000	-90 00 00	-84 00 00

NAD27 UTM Parameters

When UTM coordinates are used in Minnesota, Zone 15 is usually extended east and west to encompass the entire state within a single zone, which may be denoted as "Zone 15E" or "Zone 15 Extended." For example, the Mn/DOT Basemap specifies "Universal Transverse Mercator (UTM) Minnesota extended Zone 15, NAD83 coordinates."

The following parameters apply to all NAD27 UTM zones:

Projection = Transverse Mercator Spheroid = Clarke 1866

UTM ARC/INFO Example

The parameters needed to convert to or from UTM Zone 15 are shown below. This can become part of a file used in ARC/INFO's PROJECT command. More detailed examples showing complete conversions are shown in the NAD83 Minnesota County Coordinate System section of this document.

Projection UTM Zone 15 Datum NAD27 Zunits NO Units METERS Xshift 0.000000000 Yshift 0.000000000 Parameters

NAD27 Minnesota State Plane

State Plane			Southern Standard		0	Latitude of		
Zone	Axis (meters)	Axis (meters)	Parallel	Parallel	Origin	Grid Origin		
North	6378206.4	6356583.8	47 02 00	48 38 00	-93 06 00	46 30 00		
Central	6378206.4	6356583.8	45 37 00	47 03 00	-94 15 00	45 00 00		
South	6378206.4	6356583.8	43 47 00	45 13 00	-94 00 00	43 00 00		

NAD27 Minnesota State Plane Parameters

The projection definitions under NAD27 are quite similar to those under NAD83. The state plane coordinates from each datum, however, are different by about 100,000 m for Y and 190,380 m for X due to the use of different false northings and false eastings.

Another method for computing to or from NAD27 state plane coordinates used the following set of parameters . The equations that make use of them are listed in Department of Commerce publication 62-4 titled <u>State Plane Coordinates by Automatic Data Processing</u> by Charles N. Claire.

Zone	North	Central	South
L ₁	200000.00	200000.00	200000.00
L ₂	335160.00	339300.00	338400.00
L ₃	18984319.62	20006679.72	21327006.06
L ₄	19471398.75	20493457.15	21874349.14
L ₅	0.9999028166	0.9999220223	0.9999220448
L ₆	0.7412196637	0.7233880702	0.7009277824
L ₇	2861	2771	2661
L ₈	24.63011	20.89747	20.12517
L ₉	3.80362	3.80497	3.80662
L ₁₀	5.01609	4.76197	4.46959
L ₁₁	0	0	0

NAD27 State Plane Parameters for Alternate Computations

NAD27 State Plane ARC/INFO Example

The parameters needed to convert to or from the Minnesota North State Plane zone are shown below. This can become part of a file used in ARC/INFO's PROJECT command. More detailed examples showing complete conversions are shown in the NAD83 Minnesota County Coordinate System section of this document.

Projection STATEPLANE Datum NAD27 Units METERS Zone 4276 Parameters

NAD27 Minnesota Project Coordinate System

In order to achieve a coordinate system in which map distances closely matched ground distances, the Minnesota Department of Highways developed the Minnesota Project Coordinate System. In it, the State of Minnesota was divided into a grid of rectangles measuring 15 minutes of latitude by one degree of longitude. The name for each zone was XX-YYYY where XX is the line of longitude marking the east edge of the rectangle and YYYY is the line of latitude forming the south edge of the rectangle. For example zone 93-4445 is bounded by 94 degrees longitude to the west, 45 degrees latitude to the north, 93 degrees longitude to the east and 44 degrees, 45 minutes latitude to the south. Parameters consisting of a combined factor, X constant and Y constant were established for each project coordinate system zone that was defined by one of these rectangles. More information about this was written by Robert B. Roscoe, P.E., in a paper titled *Project Coordinate System--A Ground Coordinate System for Surveyors and Engineers.*

NAD27 Minnesota Project Coordinate System Formulas

State plane coordinates must always be computed as an intermediate step between the project coordinate system and latitude/longitude and between the project coordinate system and Universal Transverse Mercator. The equations for converting project coordinate system coordinates to state plane are as follows:

 $\begin{array}{l} Y_{s} = CF \ ^{*} \left(\ Y_{p} + Y_{c} \ \right) \\ X_{s} = CF \ ^{*} \left(\ X_{p} + X_{c} \ \right) \end{array}$ where $\begin{array}{l} Y_{s} = State \ \text{Plane Y Coordinate} \\ Y_{p} = \text{Project Y Coordinate} \\ Y_{c} = Y \ \text{Constant} \\ X_{s} = State \ \text{Plane X Coordinate} \\ X_{p} = \text{Project X Coordinate} \\ X_{c} = X \ \text{Constant} \\ CF = \text{Combined Factor} \end{array}$

To convert state plane coordinates to project coordinate system coordinates, these equations are used:

$$Y_p = (Y_s / CF) - Y_c \\ X_p = (X_s / CF) - X_c$$

NAD27 Project Zones Lying in the North State Plane

NAD27 North State Plane Project Zone Parameters						
Project Zone	Y Constant	X Constant	Combined Factor			
96-4845	800000	600000	1.0000272			
96-4830	709000	600000	0.9999524			
96-4815	618000	600000	0.9999016			
96-4800	527000	600000	0.9998700			
96-4745	435000	600000	0.9998568			
96-4730	344000	600000	0.9998639			
96-4715	253000	600000	0.9998893			
96-4700	162000	600000	0.9999335			
95-4845	800000	800000	1.0000177			
95-4830	709000	800000	0.9999477			
95-4815	618000	800000	0.9998969			
95-4800	527000	800000	0.9998605			
95-4745	435000	800000	0.9998521			
95-4730	344000	800000	0.9998449			
95-4715	253000	800000	0.9998703			
95-4700	162000	800000	0.9999097			
94-4900	893000	1100000	1.0001119			
94-4845	800000	1100000	1.0000177			
94-4830	709000	1100000	0.9999477			
94-4815	618000	1100000	0.9998969			
94-4800	527000	1100000	0.9998605			
94-4745	435000	1100000	0.9998425			
94-4730	344000	1100000	0.9998449			
94-4715	253000	1100000	0.9998703			
93-4830	709000	1300000	0.9999477			
93-4815	618000	1300000	0.9998873			
93-4800	527000	1300000	0.9998605			
93-4745	435000	1300000	0.9998425			
93-4730	344000	1300000	0.9998449			
93-4715	253000	1300000	0.9998655			
93-4700	162000	1300000	0.9999097			
93-4645	162000	1300000	0.9999019			
92-4830	709000	1600000	0.9999381			
92-4815	618000	1600000	0.9998873			
92-4800	527000	1600000	0.9998510			

NAD27 North State Plane Project Zone Parameters

"Map Projections and Parameters" from http://www.olmweb.dot.state.mn.us/ © Mn/DOT, 2002-2009

92-4745	435000	1600000	0.9998378
92-4730	344000	1600000	0.9998401
92-4715	253000	1600000	0.9998655
92-4700	162000	1600000	0.9999145
92-4645	162000	1600000	0.9999019
92-4630	162000	1600000	0.9998845
91-4800	527000	1800000	0.9998510
91-4745	435000	1800000	0.9998283
91-4730	344000	1800000	0.9998305
91-4715	253000	1800000	0.9998655
91-4700	162000	1800000	0.9999097
91-4645	162000	1800000	0.9998971
90-4800	527000	2100000	0.9998462
90-4745	435000	2100000	0.9998330
90-4730	344000	2100000	0.9998401

NAD27 Project Zones Lying in the Central State Plane

Project Zone 96-4700 96-4645 96-4630 96-4615 96-4600 96-4545	Y Constant 618000 618000 527000 435000 344000 253000 162000	X Constant 600000 600000 600000 600000 600000	Combined Factor0.99993350.99992090.99988450.99986660.9998783
96-4645 96-4630 96-4615 96-4600 96-4545	618000 527000 435000 344000 253000	600000 600000 600000 600000	0.9999209 0.9998845 0.9998666
96-4630 96-4615 96-4600 96-4545	527000 435000 344000 253000	600000 600000 600000	0.9998845 0.9998666
96-4615 96-4600 96-4545	435000 344000 253000	600000 600000	0.9998666
96-4600 96-4545	344000 253000	600000	
96-4545	253000		0.9998783
		600000	
	162000		0.9999037
96-4530		600000	0.9999479
96-4515	162000	600000	0.9999881
95-4715	618000	800000	0.9998703
95-4700	618000	800000	0.9999097
95-4645	618000	800000	0.9998924
95-4630	527000	800000	0.9998702
95-4615	435000	800000	0.9998571
95-4600	344000	800000	0.9998640
95-4545	253000	800000	0.9998941
95-4530	162000	800000	0.9999431
95-4515	162000	800000	0.9999833
94-4715	618000	1100000	0.9998703
94-4700	618000	1100000	0.9999097
94-4645	618000	1100000	0.9999019
94-4630	527000	1100000	0.9998702
94-4615	435000	1100000	0.9998618
94-4600	344000	1100000	0.9998735
94-4545	253000	1100000	0.9998989
94-4530	162000	1100000	0.9999431
94-4515	162000	1100000	0.9999833
93-4715	618000	1300000	0.9998655
93-4700	618000	1300000	0.9999097
93-4645	618000	1300000	0.9999019
93-4630	527000	1300000	0.9998749
93-4615	435000	1300000	0.9993618
93-4600	344000	1300000	0.9998735
93-4545	253000	1300000	0.9998989
93-4530	162000	1300000	0.9999526

NAD27 Central State Plane Project Zone Parameters

"Map Projections and Parameters" from http://www.olmweb.dot.state.mn.us/

93-4515	162000	1300000	0.9999928
92-4645	618000	1600000	0.9999019
92-4630	527000	1600000	0.9998845
92-4615	435000	1600000	0.9998666
92-4600	344000	1600000	0.9998783
92-4545	253000	1600000	0.9999132
92-4530	162000	1600000	0.9999574
92-4515	162000	1600000	0.9999928

NAD27 Project Zones Lying in the South State Plane

NAD27 South State Plane Project Zone Parameters			
Project Zone	Y Constant	X Constant	Combined Factor
96-4530	800000	600000	0.9999479
96-4515	800000	600000	0.9999881
96-4500	709000	600000	0.9999357
96-4445	618000	600000	0.9998929
96-4430	527000	600000	0.9998598
96-4415	435000	600000	0.9998503
96-4400	344000	600000	0.9998595
96-4345	253000	600000	0.9999072
96-4330	162000	600000	0.9999686
95-4515	800000	800000	0.9999881
95-4500	709000	800000	0.9999310
95-4445	618000	800000	0.9998976
95-4430	527000	800000	0.9998741
95-4415	435000	800000	0.9998693
95-4400	344000	800000	0.9998768
95-4345	253000	800000	0.9999072
95-4330	162000	800000	0.9999686
94-4530	800000	1100000	0.9999431
94-4515	800000	1100000	0.9999833
94-4500	709000	1100000	0.9999310
94-4445	618000	1100000	0.9998976
94-4430	527000	1100000	0.9998788
94-4415	435000	1100000	0.9998788
94-4400	344000	1100000	0.9998978
94-4345	253000	1100000	0.9999262
94-4330	162000	1100000	0.9999829
93-4530	800000	1300000	0.9999526
93-4515	800000	1300000	0.9999928
93-4500	709000	1300000	0.9999357
93-4445	618000	1300000	0.9998976
93-4430	527000	1300000	0.9998836
93-4415	435000	1300000	0.9998788
93-4400	344000	1300000	0.9998978
93-4345	253000	1300000	0.9999262

NAD27 South State Plane Project Zone Parameters

"Map Projections and Parameters" from http://www.olmweb.dot.state.mn.us/

93-4330	162000	1300000	0.9999829
92-4515	800000	1600000	0.9999928
92-4500	709000	1600000	0.9999357
92-4445	618000	1600000	0.9998976
92-4430	527000	1600000	0.9998836
92-4415	435000	1600000	0.9998788
92-4400	344000	1600000	0.9998978
92-4345	253000	1600000	0.9999262
92-4330	162000	1600000	0.9999829
91-4415	435000	1800000	0.9998788
91-4400	344000	1800000	0.9998978
91-4345	253000	1800000	0.9999357
91-4330	162000	1800000	0.9999924

Other Minnesota Project Coordinate Zones

Project Zones Lying Along North Shore of Lake Superior

There are five Project Coordinate System zones that lie along the north shore of Lake Superior. The portions of these zones that have a National Geodetic Vertical Datum of 1929 elevation below 1200 feet have been given different parameters than the rest of those zones to provide better results.

Project Zone	Y Constant	X Constant	Combined Factor
91-4715	253000	1800000	0.9998941
91-4700	162000	1800000	0.9999383
91-4645	162000	2100000	0.9999266
90-4745	435000	2100000	0.9998616
90-4730	344000	2100000	0.9998687

NAD27 North Shore Pro	ject Zone Parameters
-----------------------	----------------------

NAD27 Project Coordinate System -- Modified for Counties

Some counties have defined project zones that cover different, often larger, areas than the original rectangles. This enabled all county mapping to be done in one or two or three zones rather than dealing with many of the rectangular one degree by 15 minute zones. The formulas are identical to those used in the Minnesota Project Coordinate System. The parameters for known project zones created for counties are as follows:

NAD27 County Project Zone Parameters				
County Project Zone	Y Constant	X Constant	Combined Factor	
Anoka, North	700000	1300000	1.0000073	
Anoka, Central	700000	1300000	0.9999644	
Anoka, South	700000	1300000	0.9999321	
Carver	300000	1000000	0.9998906	
Dakota	527000	1300000	0.9998836	
Hennepin	500000	1300000	0.9999129	
Ramsey	500000	1300000	0.9999129	
Scott	527000	1300000	0.9998836	
Washington, North	709000	1600000	0.9999490	
Washington, Central	618000	1600000	0.9999490	
Washington, South	618000	1600000	0.9999064	

_

Conversions Between Datums

Converting data between the North American Datum of 1927 and the North American Datum of 1983 is not a simple task, since no direct mathematic relationship exists between them. There are, however, several ways to convert data. The appropriate method for any situation depends mostly on accuracy requirements. If a high degree of accuracy is required, additional information is necessary. For example, the coordinates of some points in a data set from both datums will be needed. In addition, best results can be achieved if surveying measurements between data set points are available.

The most accurate way to convert data from one datum to the other is not always feasible. It is the case where coordinates are known from both datums for one or more control points that are part of the data set and measurements from those control points(s) are available to all the other points in the data set. In this situation, the way to convert the data set to the other datum is by starting with the other datum's coordinates on the control point(s) and recomputing the coordinates of all the other points based on the measurements from the control points. This method will definitely provide data that is sufficiently accurate for engineering or surveying uses.

The next most accurate method is for the case where coordinates are known from both datums for three or more points in a data set, but measurements are not available. In this situation, a transformation algorithm can be used to compute the relationship between the two datums and apply it to the other points in the data set. This method may provide data that is sufficiently accurate for engineering or surveying uses, depending on the geographic extent of the data set being converted and the statistical results of the transformation.

If accuracy is not as important, there are several tools that can be used to convert between datums. The most famous is the National Geodetic Survey's NADCON, which can convert between NAD27 latitude/longitude and NAD83 latitude/longitude. Mn/DOT's **MNCON** program contains the NADCON functionality. The U.S. Army Corps of Engineers has a similar program called CORPSCON that extends the ability to state plane and Universal Transverse Mercator coordinates. Both of these programs are available from the <u>National Geodetic Survey</u>. ARC/INFO includes the NADCON algorithm in its PROJECT command, which can compute conversions within or between datums.

Datum Conversion ARC/INFO Example

ARC/INFO can convert between datums. In this example, a coverage in NAD27 latitude/longitude will be converted to a coverage in NAD83 latitude/longitude.

DATUM.PRJ INPUT /* NAD27 Lat/Long to NAD83 Lat/Long **Projection GEOGRAPHIC** Datum NAD27 Zunits NO Units DD Xshift 0.000000000 Yshift 0.000000000 Parameters OUTPUT **Projection GEOGRAPHIC** Datum NAD83 Zunits NO Units DD Xshift 0.000000000 Yshift 0.000000000 Parameters END

The command needed is:

PROJECT COVER SOURCECOV TARGETCOV DATUM.PRJ

where SOURCECOV = The source (input) coverage TARGETCOV = The target (output) coverage