WISCRS
(Wisconsin Coordinate Reference Systems)

Redesign of the WCCS
(Wisconsin County Coordinate System)

FINAL REPORT

Submitted to the Jackson County, Wisconsin
Land Information Office

Prepared by

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Author's Biographical Sketch

Alan P. Vonderohe is a Professor of Civil and Environmental Engineering at the University of Wisconsin – Madison where he has served on the faculty since 1979. Dr. Vonderohe received his undergraduate and graduate degrees, in civil engineering with emphasis on photogrammetry and geodetic science, from the University of Illinois – Urbana / Champaign. He teaches and conducts research in spatial reference systems, analysis and design of spatial measurement systems, analytical and digital photogrammetry, and theory and applications of GIS. Dr. Vonderohe is a licensed land surveyor in Wisconsin. For many years, he was active in the Wisconsin Land Information Association, the Wisconsin Society of Land Surveyors, and numerous national professional organizations such as the American Society for Photogrammetry and Remote Sensing, and the American Congress on Surveying and Mapping.

Introduction

The Wisconsin County Coordinate System (WCCS), published in 1995 (SCO, 1995), has been redesigned to improve ease of use by eliminating the need for "enlarged" or "raised" reference ellipsoids for the 59 individual coordinate systems. The redesigned systems, WISCRS (Wisconsin Coordinate Reference Systems), use a single reference ellipsoid, the Geodetic Reference System 1980 (GRS 80), for all coordinate systems. The GRS 80 ellipsoid is incorporated in the national horizontal geodetic datum, referred to as "North American Datum of 1983" or "NAD 83."

WCCS has been widely adopted by state and local agencies for use in GIS, infrastructure design and stake out, and geodetic control systems. Its popularity is driven by the fact that distances measured on the ground are, for most applications, negligibly different from distances on the corresponding coordinate grid. During design of WCCS, the "ground-to-grid" distance ratio was made very nearly equal to one by causing the map projection surface to approach the mean terrain surface across the extents of each of the coordinate systems. This was done by enlarging the reference ellipsoid to approach mean terrain and then selecting a map projection surface that closely fit the enlarged ellipsoid. Since geodetic datums are associated with specific ellipsoids, this approach led to each county coordinate system, effectively, having its own geodetic datum. This nuance introduced a level of complexity in use of WCCS that led to the need for redesign.

The new WISCRS are designed to (1) retain GRS 80 as the single reference ellipsoid for all 59 individual coordinate systems and (2) produce negligible coordinate differences when compared to WCCS. Criterion 2 was developed so legacy GIS databases and other spatial data could be merged with newly-acquired data without need for any transformation. That is, data referenced to either WCCS or WISCRS can be integrated without concern for coordinate discrepancies. The largest differences in coordinates, between WCCS and WISCRS, are between 4 and 5 millimeters, and these occur in only four counties around the State. In many other counties, maximum differences between the two sets of coordinates are less than 3 millimeters.

Horizontal Positions

The most fundamental mathematical method for describing the horizontal position of a point is latitude (Φ) and longitude (λ). Φ and λ are referenced to a three-

dimensional ellipsoid (see Figure 1), are expressed in angular units, and are referred to as “geodetic” or “geographic” coordinates. A line of constant latitude on the ellipsoid surface is referred to as a “parallel” of latitude, while a line of constant longitude is referred to as a “meridian” of longitude.

The reference ellipsoid is generated by rotating a two-dimensional ellipse (see Figure 2) about its minor axis. The parameters that describe the reference ellipsoid are its semimajor axis (a) and its semiminor axis (b).

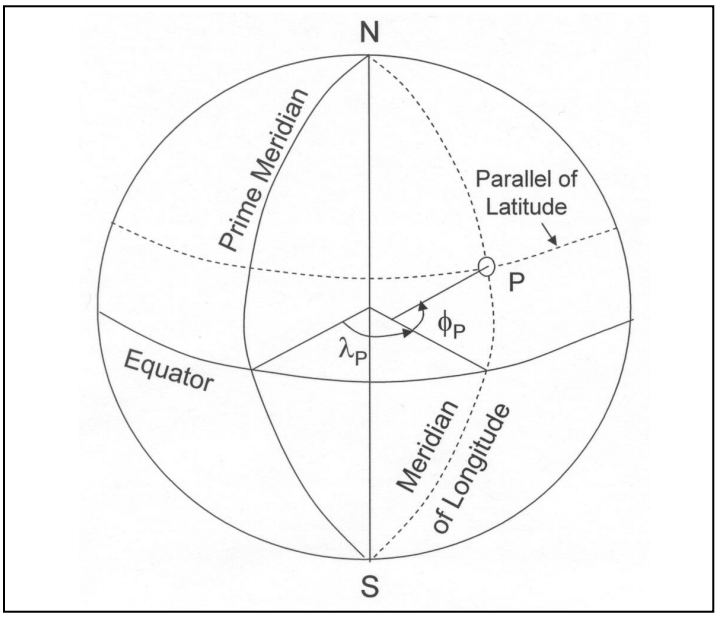

Figure 1.
Latitude (Φ_p) and Longitude (λ_p) of Point P

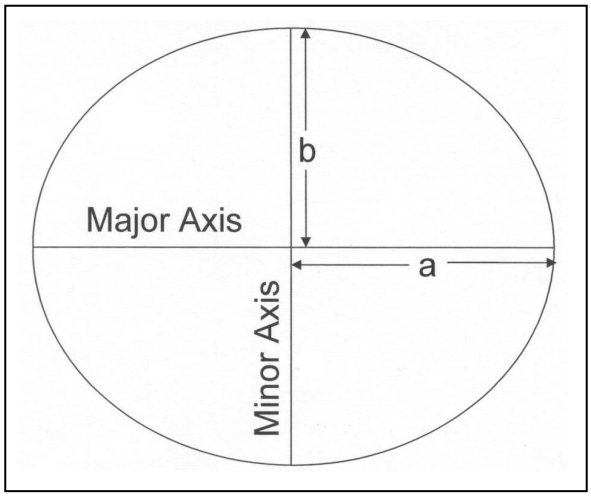

Figure 2.
Parameters of an Ellipse:
a = Semimajor Axis; b = Semiminor Axis

When a reference ellipsoid is positioned in space with respect to the surface of the Earth, we have a *horizontal geodetic datum*. Such a datum is realized by publishing the geodetic coordinates of an interconnected set of permanently marked points that can be recovered and used to control mapping and other measurement activities. The current national horizontal geodetic datum was published in 1986. It is referred to as "NAD 83" because it was originally expected to become available in 1983. NAD 83 uses GRS 80 as the reference ellipsoid. The semimajor axis (a) of GRS 80 is equal to 6378137 meters (exactly) and its semiminor axis (b) is equal to 6356752.31414 meters.

Since 1986, the measurements that connect the permanently-marked points in the horizontal geodetic control network in Wisconsin have been readjusted twice; in 1991 and 1997. This is because major advances (i.e., the Global Positioning System) in measurement technology have been achieved in the past 20 years. We now have very accurate measurements, among widely-separated points, that were not included in the original calculations for NAD 83. Each new adjustment resulted in somewhat different latitudes and longitudes for the monumented control points. Thus, the three sets of published geodetic coordinates for horizontal control points in Wisconsin are referred to as "NAD 83 (1986)," "NAD 83 (1991)," and "NAD 83 (1997)."

Map Projections and Two-Dimensional Rectangular Coordinate Systems

Geodetic coordinates, being expressed in angular units, do not lend themselves to easy computation of, for example, distance and area, or to meaningful display in two-dimensional media such as hardcopy maps and computer screens. Therefore, we usually transform latitudes and longitudes into rectangular coordinates (e.g., northings and eastings) that are expressed in distance units (e.g., meters or U.S. survey feet). These transformations involve projecting points of interest from the ellipsoid surface to a "developable" surface, or "map projection" surface, that can be laid out flat in a plane. We then impose a rectangular coordinate system on the plane so that rectangular coordinates can be obtained for the points of interest.

WCCS used two different map projection surfaces (see Figure 3). The conical surface, used for "Lambert Conformal Conic" systems, can be sliced from apex to base and laid flat. Similarly, the cylindrical surface, used for "Transverse Mercator" systems, can be sliced from end to end, unrolled and laid flat.

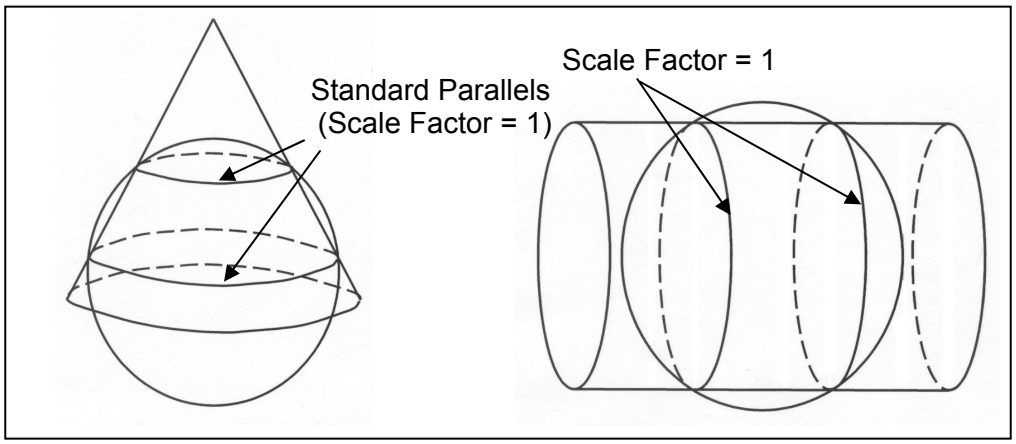

Figure 3.
Conic (Lambert) and Cylindrical (Transverse Mercator) Map
Projection Surfaces

Figure 4 shows a slice through the ellipsoid and conical projection surfaces from Figure 3. The figure indicates that when distances on the ellipsoid surface are projected onto the map projection surface, their values change. Moreover, the ratio of projected distance to ellipsoid distance varies with position. This ratio is referred to as the "scale factor." Every map projection has a place, or places, where the scale factor is a minimum. In Figure 4, the point of minimum scale factor lies near the center of the projection. Since Figure 4 shows a two-dimensional slice through three-dimensional objects, the point of minimum scale lies on a parallel of latitude coming out of, and going into, the plane of the figure. In three-dimensional space, the scale factor is constant, and at a minimum, all along that parallel of latitude.

For Lambert Conformal Conic projections, the parallel of latitude with minimum scale factor is referred to as the "central parallel." The value of its latitude (Φ_0) and the value of its scale factor (k_0) are two of the parameters that describe a Lambert Conformal Conic projection. For cones that slice through, or are secant to, the ellipsoid, as in Figure 3, the latitude of the central parallel and its scale factor are usually computed from the latitudes of the two "standard parallels," which are specified. The standard parallels are the lines of intersection between the cone and the ellipsoid. The scale factor is equal to one along these lines. In Figure 4, points "c" and "f" lie on the two standard parallels that come out of, and go into, the plane of the figure. The third parameter that describes a Lambert Conformal Conic projection is the longitude (λ_0) of the "central meridian" which is chosen to be central to the area covered by the projection.

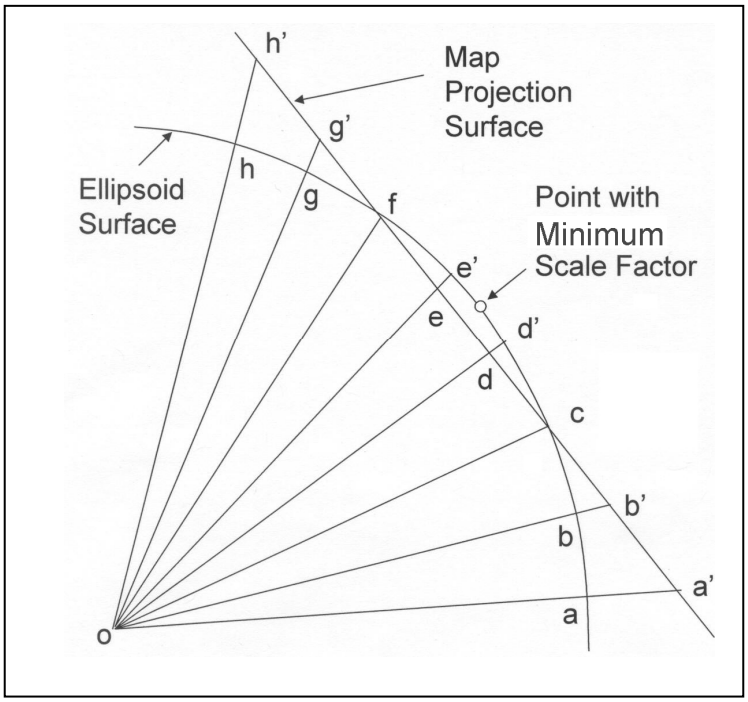

Figure 4.
A Slice through the Ellipsoid and Conical Surfaces

To impose a rectangular coordinate system on a Lambert Conformal Conic projection, we specify the longitude of the true origin to be that of the central meridian. For secant projections, the latitude of the true origin is arbitrary but must be specified. For cones that do not intersect the ellipsoid, the latitude of the true origin is the latitude of the central parallel. In addition, we assign large coordinate values, called the "false northing" (N_0) and the "false easting" (E_0), to the true origin. These values are selected such that no coordinates, within the extents covered by the system, will have negative values. Figure 5 illustrates the five parameters for a rectangular coordinate system based upon a Lambert Conformal Conic projection.

For Lambert Conformal Conic projections, the scale factor varies more rapidly in the north-south direction than in the east-west direction. Therefore, these projections are usually preferred for areas with greater east-west extents, such as Marathon County and Columbia County.

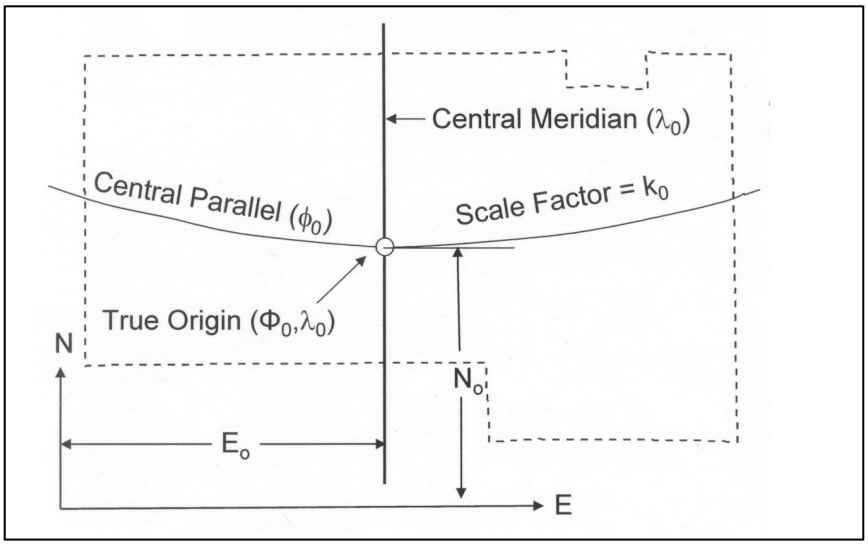

Figure 5.
The Five Parameters of a Rectangular Coordinate System
Based upon a Lambert Conformal Conic Projection

For Transverse Mercator projections, the scale factor is minimum along the central meridian. Its longitude (λ_0) and its scale factor (k_0) describe the projection. To impose a rectangular coordinate system on a Transverse Mercator projection, we specify the true origin to lie on the central meridian. We also specify the latitude (Φ_0) of the true origin which is arbitrary and is usually chosen for convenience. In addition, we assign a false northing (N_0) and a false easting (E_0) to the true origin, as with Lambert-based coordinate systems. Figure 6 illustrates the five parameters for a rectangular coordinate system based upon a Transverse Mercator projection.

For Transverse Mercator projections, the scale factor varies more rapidly in the east-west direction than in the north-south direction. Therefore, these projections are usually preferred for areas with greater north-south extents, such as Brown County and Douglas County.

Transformations among Coordinate Systems

A transformation from geodetic to rectangular coordinates is referred to as a "direct transformation" and a transformation from rectangular to geodetic coordinates is referred to as an "inverse transformation." Direct and inverse transformations involve a series of equations that express the mathematical relationships between the two sets of coordinates, the reference ellipsoid, and the map projection surface (see Appendices B and C). The equations use the starting coordinates, the semimajor and semiminor axes

of the reference ellipsoid, and the parameters of the map projection and rectangular coordinate system to compute the ending coordinates.

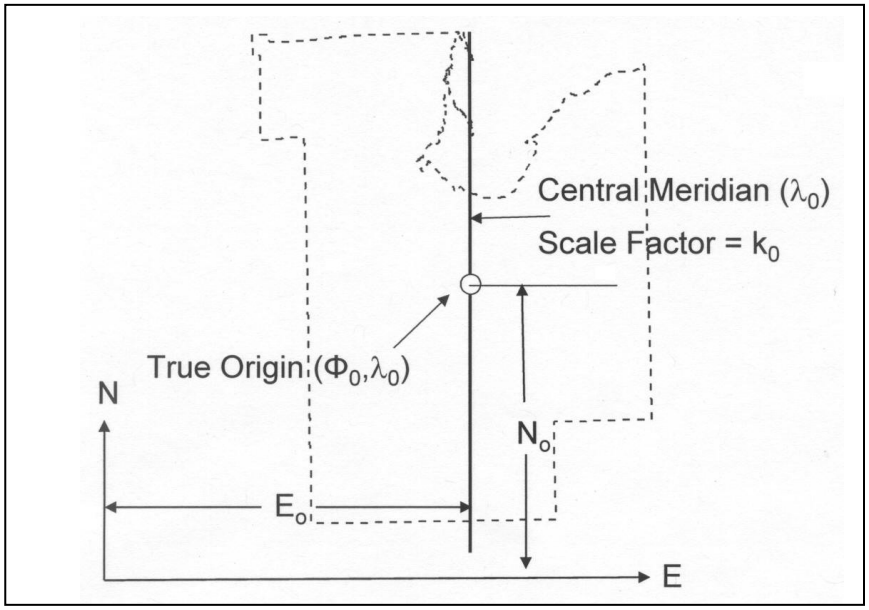

Figure 6.
The Five Parameters of a Rectangular Coordinate System
Based upon a Transverse Mercator Projection

It is also possible to transform coordinates from one rectangular coordinate system into another rectangular coordinate system. For example, state plane coordinates can be transformed into county coordinates, and vice versa. This is done by an inverse transformation to obtain geodetic coordinates from state plane coordinates, followed by a direct transformation to obtain county coordinates from the geodetic coordinates. To simplify the process, most software hides these two steps from us and requires us to specify only the starting and ending rectangular coordinate systems.

In addition, it is possible to transform geodetic coordinates from one datum to another or from one adjustment of a datum to another adjustment of the same datum (e.g., NAD 83 (1986) to NAD 83 (1991)). The methods for doing this are not as exact as the direct and inverse transformations described above. Some, usually tolerable, error is introduced during datum and adjustment transformation.

By combining coordinate transformations and datum transformations, it is possible to transform from a rectangular coordinate system on one datum and adjustment to the same or a different rectangular coordinate system on another datum

and adjustment. For example, it is possible to transform from state plane coordinates on NAD 83 (1986) to county coordinates on NAD 83 (1991). This involves a three-step process: (1) state plane coordinates to geodetic coordinates; (2) geodetic coordinates on NAD 83 (1986) to geodetic coordinates on NAD 83 (1991); and (3) geodetic coordinates to county coordinates. Once again, we are fortunate in that most software requires only that we specify the starting and ending coordinate systems and datums.

Ground-to-Grid

We have seen that distances on a rectangular coordinate grid differ from corresponding distances on the surface of the reference ellipsoid by a multiplier (i.e., the scale factor). However, distances recorded on survey plats, and those used to stake out infrastructure, are measured on the ground. So, how are ground distances related to distances on the surface of the reference ellipsoid? Another multiplier, referred to as the "elevation factor," is used. The elevation factor includes the elevation of the terrain and something called "geoid height." Added together, they yield the distance from the surface of the Earth to the surface of the reference ellipsoid (see Figure 7).

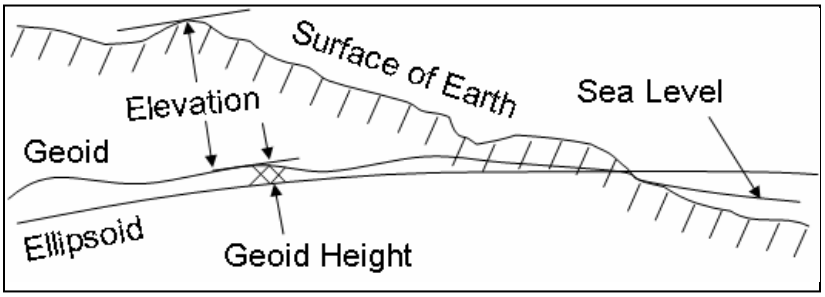

Figure 7.
Elevation and Geoid Height

Elevations, sometimes referred to as "heights above mean sea level," are measured with respect to the geoid. The geoid and ellipsoid surfaces do not coincide. In Wisconsin, the average distance between them (i.e., the geoid height) is approximately minus 32 meters. The geoid height is negative because, in Wisconsin, the geoid is below the surface of the ellipsoid. Of course, the larger the sum of elevation and geoid height, the greater the difference between a ground distance and the corresponding ellipsoid distance.

In Wisconsin, grid distances and corresponding ground distances can vary by as much as 1 foot per mile when using the State Plane Coordinate System, and more than

twice that amount when using the Wisconsin Transverse Mercator (WTM) Coordinate System. The necessity for ground-to-grid conversion of distances, involving two steps (ground-to-ellipsoid and ellipsoid-to-grid), was the reason for development of WCCS.

WCCS and WISCRS

Original Design

For most applications, WCCS eliminated the need for ground-to-grid conversion of distances, thus making it possible to develop GIS spatial databases directly from survey plats and to stake out infrastructure directly from design plans. Firstly, the design of WCCS made the scale factor negligible by limiting the geographic extents of any one coordinate system. Most of the coordinate systems are limited to single counties. A few of them encompass more than one county without violating the original design criteria of errors no larger than 1:50,000 in urban areas and 1:30,000 in rural areas (see Figure 8).

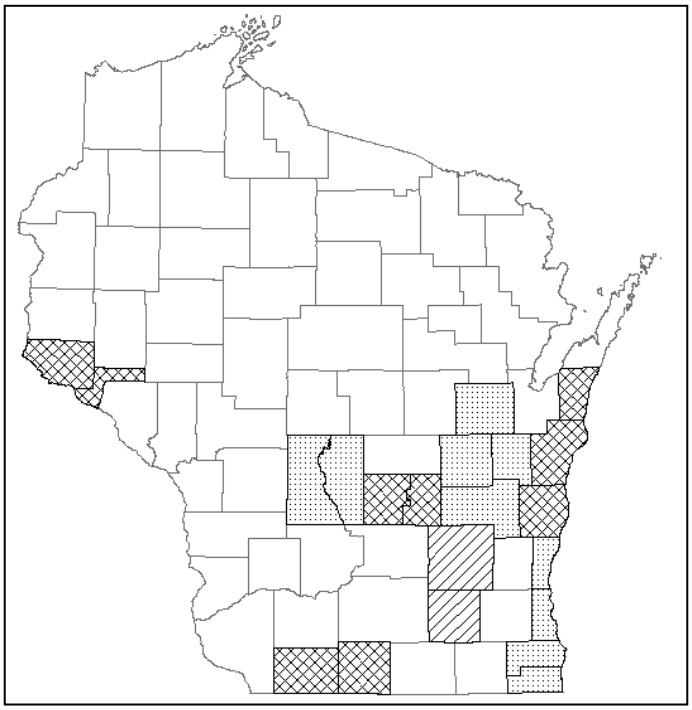

Figure 8.
The Wisconsin County Coordinate System (Adjacent Counties with Shared Symbols Share a Single Coordinate System – There are 72 Counties and 59 Coordinate Systems (24 Lambert and 35 Transverse Mercator))

Secondly, the design of WCCS made the ground-to-ellipsoid conversion factor negligible by enlarging the GRS 80 ellipsoid to an optimal terrain elevation for each coordinate system. In that way, elevation and geoid height cancelled one another when added together.

Different Datums and Redesign

Enlarging the GRS 80 ellipsoid for each coordinate system effectively caused each coordinate system to be on a different horizontal geodetic datum, all of which differed from the national datum. People unfamiliar with geodetic datums, map projections, and coordinate systems experienced difficulty in understanding and applying the design of WCCS. The difficulty grew as WCCS was more widely adopted. Eventually, in 2004, the State Cartographer brought together interested parties and leading expertise and, later, the Wisconsin Land Information Association charged this new Task Force on Wisconsin Coordinate Systems with addressing the issue. After considerable gathering of information, analysis, and deliberation, the Task Force recommended redesign of WCCS under the following criteria:

1. For 58 of the coordinate systems, the type (i.e., Lambert or Transverse Mercator), and geographic extents of the original coordinate system are to be retained. For the 59th coordinate system, in Jackson County, the Jackson County Official Coordinate System is to be adopted, as is, into WISCRS. The Jackson County Official Coordinate System is based upon a Transverse Mercator projection, using the GRS 80 ellipsoid directly, while WCCS uses a Lambert Conformal Conic projection and an enlarged ellipsoid in Jackson County.
2. All coordinate systems are to use the GRS 80 ellipsoid, without need for enlargement. Thus all coordinate systems are based upon the same horizontal geodetic datum.
3. All coordinate differences, between WCCS and the redesigned systems, are to be less than or equal to 5 millimeters in magnitude. The Task Force deemed such a difference negligible, meaning that legacy data (based on the original design) and newly-acquired data (based on the redesign) can be integrated without the need for transformation. The 5-millimeter tolerance arose from initial testing of the redesign methodology. A 5-millimeter ground

distance cannot be plotted on any large-scale map. In addition, 5 millimeters is smaller than the expected error in high-precision geodetic surveys using the Global Positioning System.

Naming Conventions

The Task Force recognized a need for names for the original and redesigned systems that (1) distinguished between the two and (2) did not require changes in names that had already been widely adopted. Therefore, the name "WCCS (Wisconsin County Coordinate System)" is retained for the original and the name "WISCRS (Wisconsin Coordinate Reference Systems)" is designated for the redesigned. It is suggested that individual coordinate systems within WISCRS be referred to as "WISCRS, *county_name* County" (for example, "WISCRS, Langlade County").

Redesign

The methodology for redesign is described in Vonderohe (2005). All 58 redesigned coordinate systems met the 5-millimeter coordinate difference tolerance. Only four coordinate systems had coordinate differences larger than 4 millimeters. Many had maximum differences of 3 millimeters or less.

Appendix A contains coordinate system information for each Wisconsin county. Included are WISCRS parameters, notes pertinent to use of the parameters, and isoline (contour) maps of differences in northing and easting between WCCS and WISCRS coordinates. The coordinate system for plotting of the isoline maps is Wisconsin Transverse Mercator (WTM 83 (1991)). The mapping angles across WTM 83 (1991) cause some county boundaries to appear rotated slightly from their cardinal directions.

For Lambert-based coordinate systems, the WCCS longitude (central meridian) of the true origin is retained in WISCRS. Other parameters are subject to change. For Transverse-Mercator-based coordinate systems, the WCCS longitude (central meridian) of the true origin and the WCCS latitude of the true origin are retained in WISCRS. Other parameters are subject to change.

WISCRS is simpler than WCCS because:

1. All coordinate systems use the same reference ellipsoid.

2. The number of parameters for a Lambert-based system is reduced from eight to five by (1) eliminating the design elevation and geoid height and (2) moving the true origin to the intersection of the central parallel and central meridian.
3. The number of parameters for a Transverse-Mercator-based system is reduced from seven to five by eliminating the design elevation and geoid height.

NAD 83 (1991) is the *de facto* horizontal geodetic datum and adjustment for WISCRS. However, ground-to-grid ratios are, for most applications, also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)). Since WISCRS is mathematically relatable to NAD 83 (the national horizontal geodetic datum), its use is permitted under Chapter 236 of the Wisconsin Statutes. Chapter 236 covers subdivision platting and is the statute in which the use of coordinate systems and datums is mentioned.

Geographic Extents and Ground-to-Grid Ratio

The geographic extents of each individual WISCRS coordinate system were determined during design of WCCS in such a way that ground and grid distances differed by no more than 1:50,000 in urban areas and no more than 1:30,000 in rural areas, with only a few exceptions around the State (SCO, 1995). 1:50,000 is a little more than 1 foot in 10 miles and 1:30,000 is a little more than 1 foot in 6 miles.

Some current and future applications might require extending any given WISCRS coordinate system beyond the boundaries of its county or counties. Most Lambert-based WISCRS coordinate systems can be extended 30 miles north or south of their central parallels before encountering differences larger than 1:20,000 between ground distances and grid distances. Similarly, most Transverse-Mercator-based WISCRS coordinate systems can be extended 30 miles east or west of their central meridians before encountering differences larger than 1:20,000 between ground distances and grid distances. 1:20,000 is a little more than 1 foot in 4 miles. Throughout the State, there are some exceptions to this rule-of-thumb. If there are large elevation differences in adjacent counties, especially if an adjacent county has much lower elevations, the differences between ground and grid distances can exceed 1:20,000 at 30 miles.

Units of Distance Measure

There is one internationally accepted definition for the meter. It is based upon the speed of light in a vacuum, which is known very precisely. However, in the United States, there are two definitions for the foot, both of which are based upon the meter (Stem, 1989). One "international" foot is equal to 0.3048 meters (exactly). One "U.S. survey" foot is equal to 1200 / 3937 meters (exactly). These two definitions differ by approximately 2 parts in 1,000,000, which does not seem like much but can make significant differences in long distances and coordinate values that include large false northings or false eastings.

We have two definitions of the foot because, when the international foot was adopted in 1959, it was not practical to revise all maps and published coordinates that were based upon the older definition of the foot. Thus, the older definition was retained for surveying and mapping purposes and became known as the "U.S. survey foot." Chapter 236 of the Wisconsin Statutes designates the U.S. survey foot or the meter as the units of distance measure for coordinate systems in Wisconsin.

Acknowledgements

The redesign effort was funded by a Wisconsin Land Information Program grant, approved by the Wisconsin Land Information Board. The redesign contract was administered by the Jackson County Land Information Office (Jackson County, Wisconsin). The Wisconsin Department of Natural Resources provided their data sharing CD. The WLIA Task Force on Wisconsin Coordinate Systems provided advice, guidance, and independent validation of results.

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Appendix A

WISCRS Parameters

(Wisconsin Coordinate Reference Systems Parameters)

Adams County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

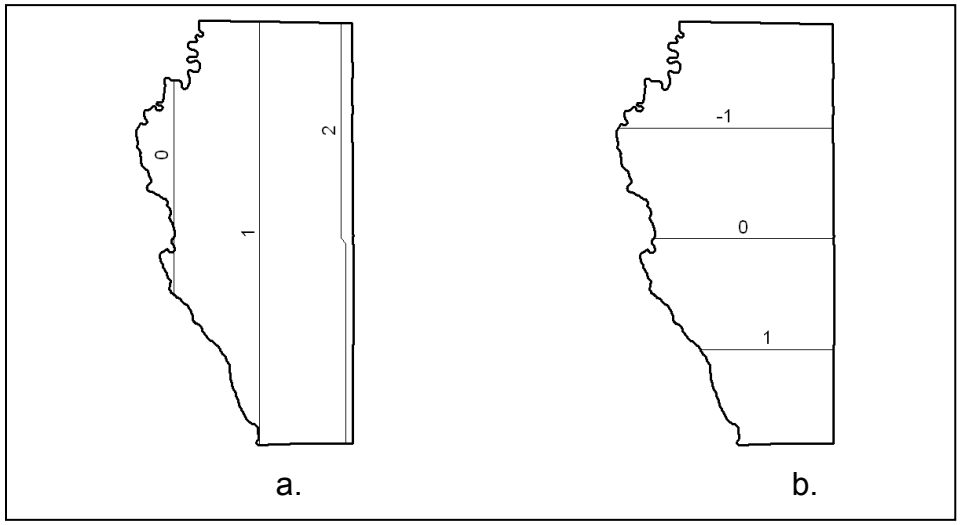
Note: Adams and Juneau Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 90°00'00.000000"
2. Origin Latitude (Φ_o): 43°22'00.000000"
3. False Easting (E_o): 147218.6942 meters (482999.999 U.S. survey feet)
4. False Northing (N_o): 0.0037 meters (0.012 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000365285

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Adams County

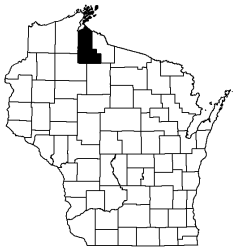
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Ashland County



WISCRS (Wisconsin Coordinate Reference Systems)

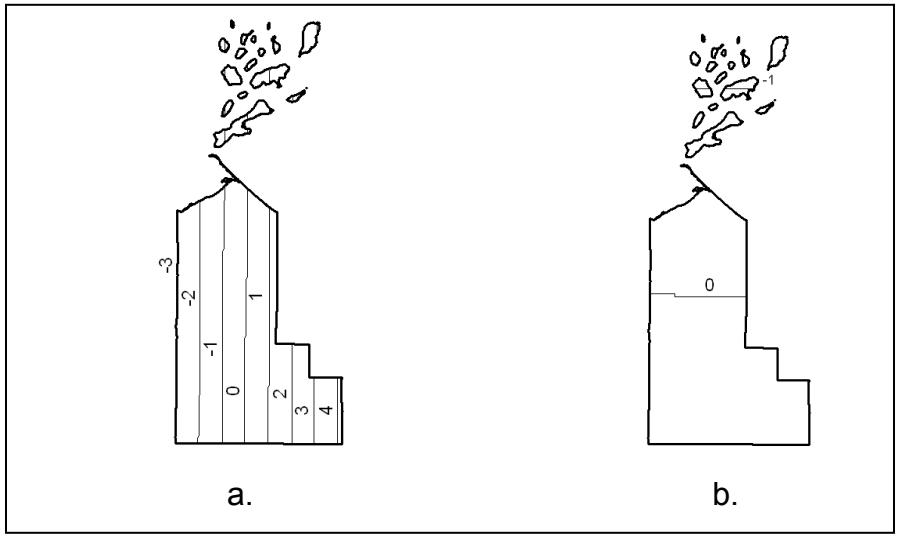
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°37’20.000000”
2. Origin Latitude (Φ_o): 45°42’22.000000”
3. False Easting (E_o): 172821.9461 meters (567000.001 U.S. survey feet)
4. False Northing (N_o): 0.0017 meters (0.006 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000495683

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Ashland County

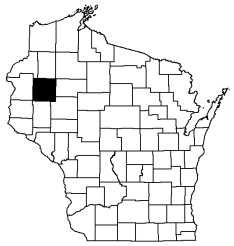
The maximum absolute value in any easting shift is less than 5 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Barron County



WISCRS (Wisconsin Coordinate Reference Systems)

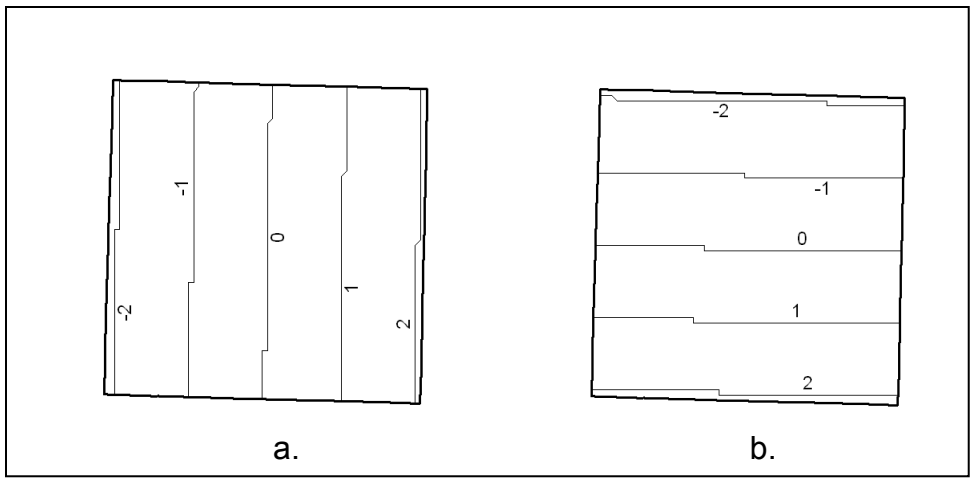
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°51'00.000000"
2. Origin Latitude (Φ_o): 45°08'00.000000"
3. False Easting (E_o): 93150.0000 meters (305609.625 U.S. survey feet)
4. False Northing (N_o): 0.0029 meters (0.010 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000486665

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Barron County

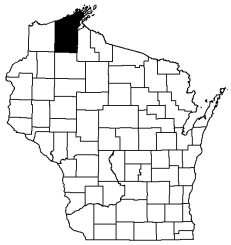
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Bayfield County



WISCRS (Wisconsin Coordinate Reference Systems)

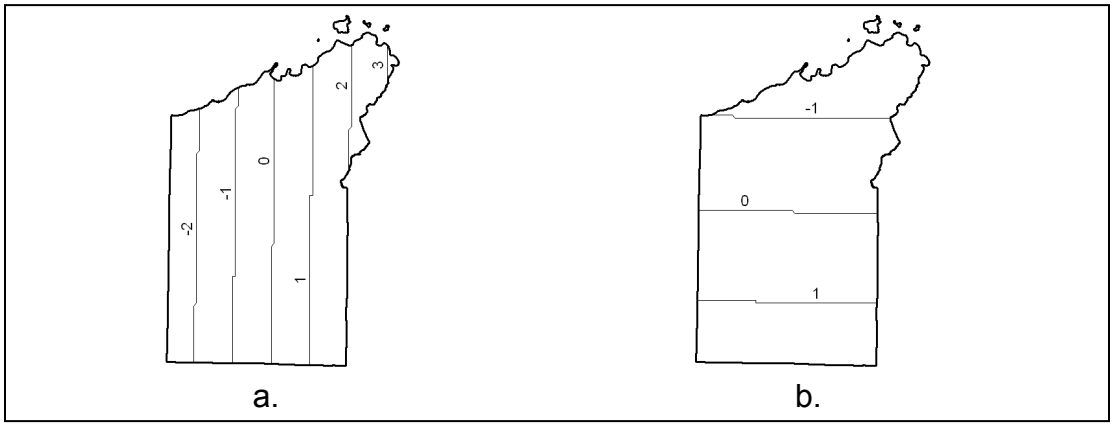
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 91°09'10.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   46°40'10.734158"
3. False Easting (E_o): 228600.4575 meters (750000.001 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   148551.4837 meters (487372.659 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000331195

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Bayfield County

The maximum absolute value in any easting shift is less than 4 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Brown County

WISCRS (Wisconsin Coordinate Reference Systems)

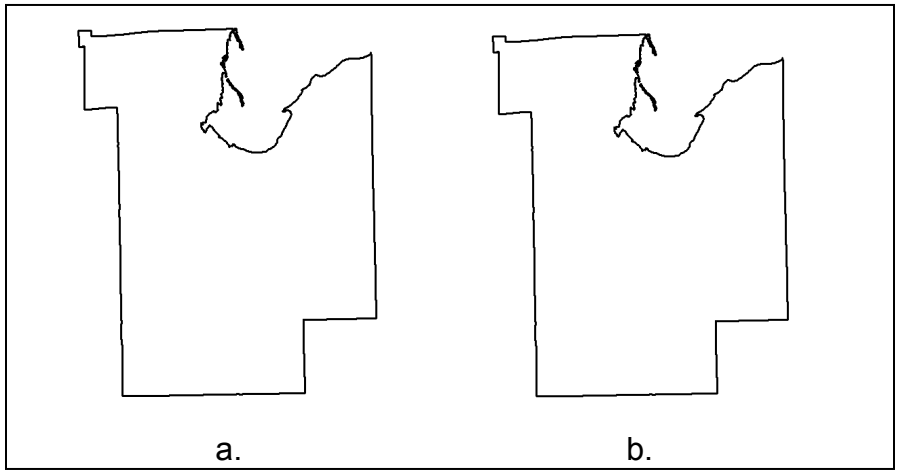
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°00'00.000000"
2. Origin Latitude (Φ_o): 43°00'00.000000"
3. False Easting (E_o): 31600.0000 meters (103674.333 U.S. survey feet)
4. False Northing (N_o): 4600.0000 meters (15091.833 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000200000

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



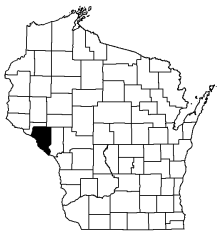
Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Brown County

There are no coordinate shifts in Brown County.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Buffalo County



WISCRS (Wisconsin Coordinate Reference Systems)

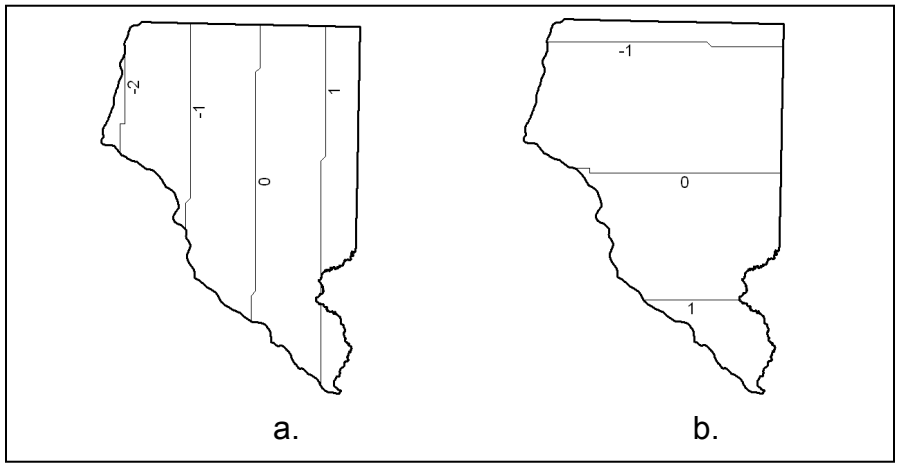
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°47'50.000000"
2. Origin Latitude (Φ_o): 43°28'53.000000"
3. False Easting (E_o): 175260.3502 meters (574999.999 U.S. survey feet)
4. False Northing (N_o): 0.0048 meters (0.016 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000382778

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Buffalo County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Burnett County

WISCRS (Wisconsin Coordinate Reference Systems)

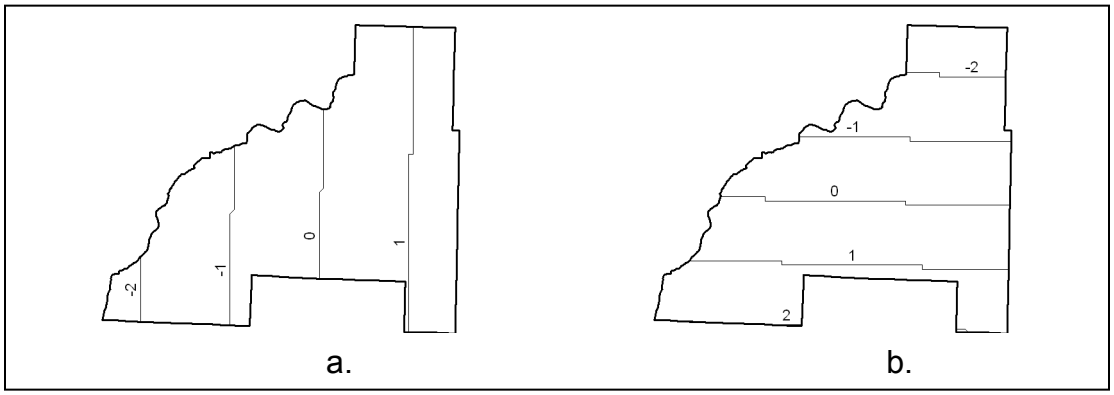
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 92°27'28.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   45°53'55.373517"
3. False Easting (E_o): 64008.1276 meters (209999.999 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   59445.9043 meters (195032.104 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000383841

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Burnett County

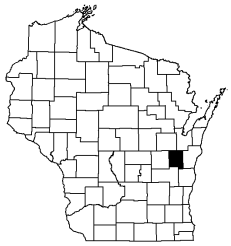
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Calumet County



WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

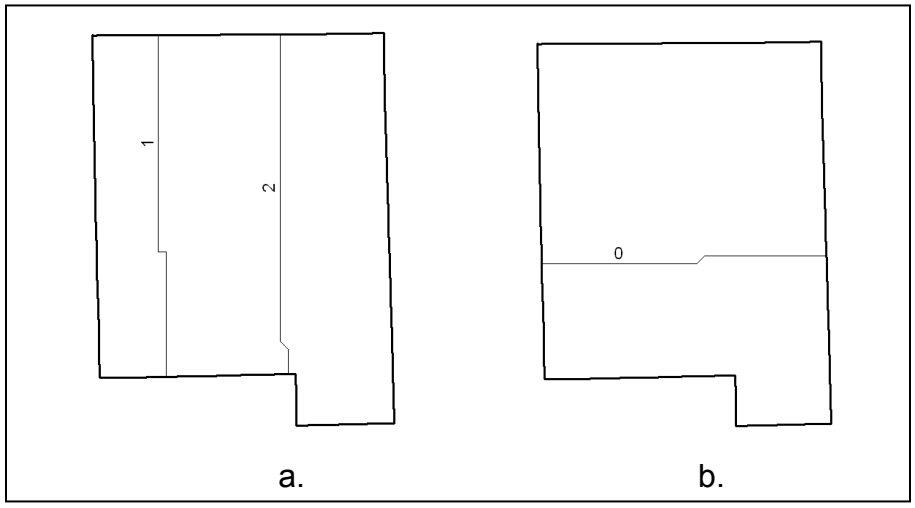
Note: Calumet, Fond du Lac, Outagamie, and Winnebago Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°30'00.000000"
2. Origin Latitude (Φ_o): 42°43'10.000000"
3. False Easting (E_o): 244754.8893 meters (802999.999 U.S. survey feet)
4. False Northing (N_o): 0.0049 meters (0.016 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000286569

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Calumet County

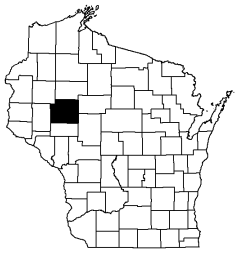
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Chippewa County



WISCRS (Wisconsin Coordinate Reference Systems)

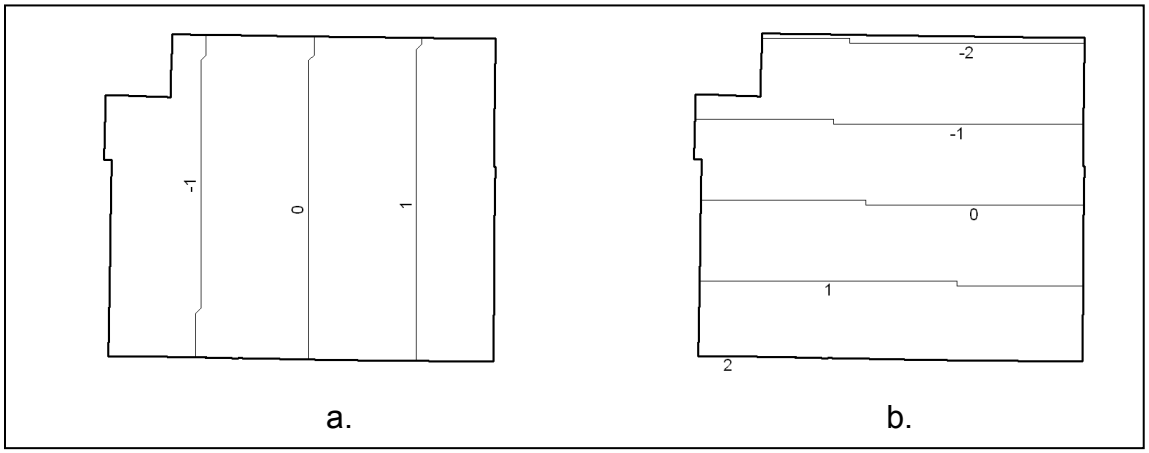
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 91°17'40.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°58'40.284835"
3. False Easting (E_o): 60045.7200 meters (197000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   44091.4346 meters (144656.648 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000391127

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Chippewa County

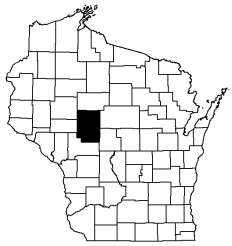
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Clark County



WISCRS (Wisconsin Coordinate Reference Systems)

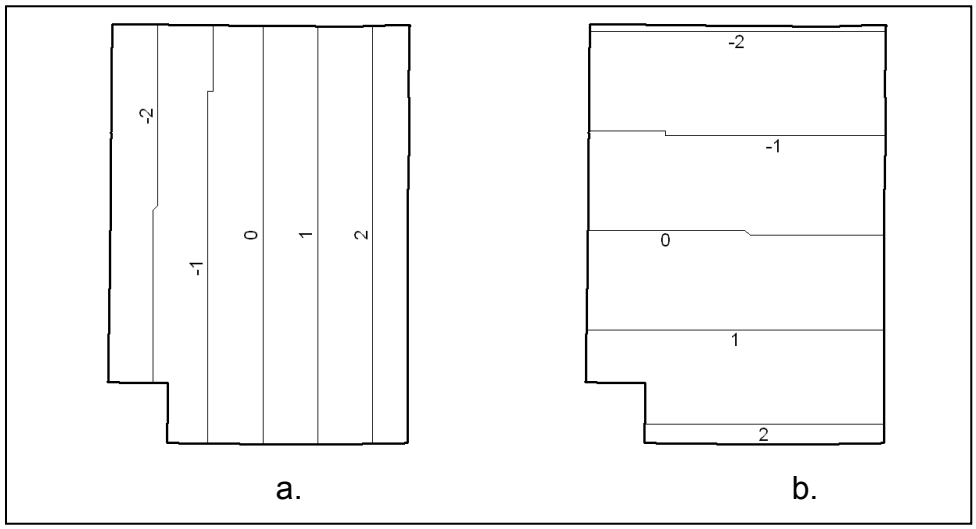
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°42'30.000000"
2. Origin Latitude (Φ_o): 43°36'00.000000"
3. False Easting (E_o): 199949.1989 meters (655999.997 U.S. survey feet)
4. False Northing (N_o): 0.0086 meters (0.028 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000463003

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Clark County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Columbia County

WISCRS (Wisconsin Coordinate Reference Systems)

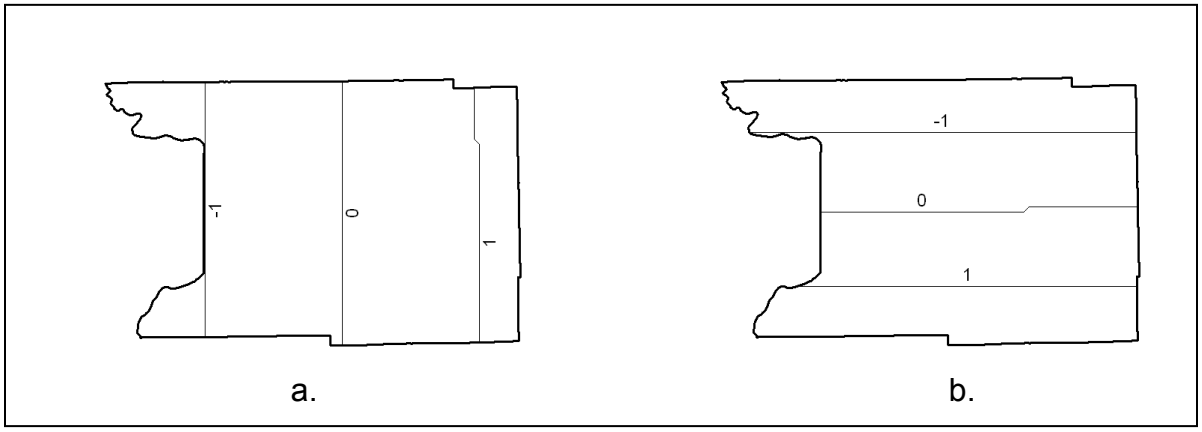
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°23'40.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°27'45.167925"
3. False Easting (E_o): 169164.3381 meters (554999.999 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   111569.6134 meters (366041.307 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000349800

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Columbia County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Crawford County

WISCRS (Wisconsin Coordinate Reference Systems)

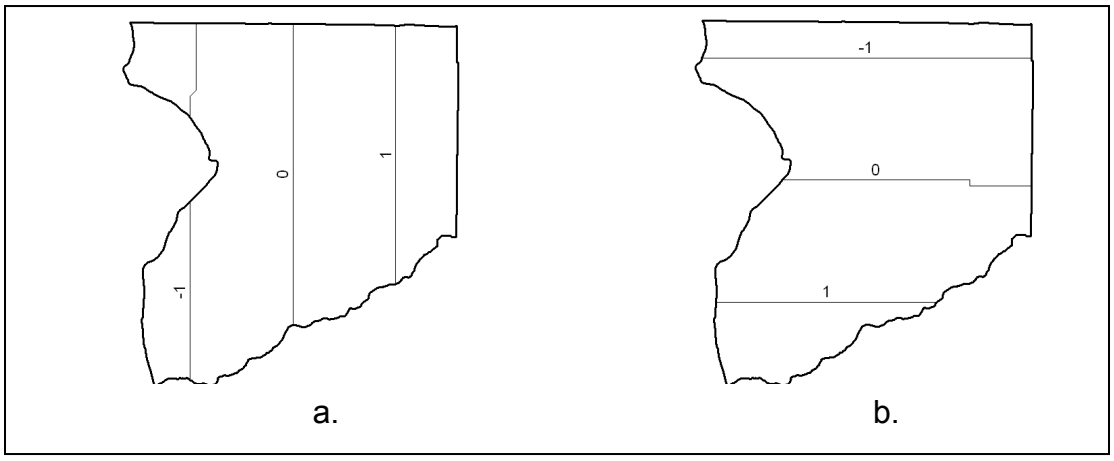
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°56'20.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°12'00.200178"
3. False Easting (E_o): 113690.6274 meters (373000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   53703.1201 meters (176190.987 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000349151

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Crawford County

The maximum absolute value in any easting shift is less than 2 millimeters.

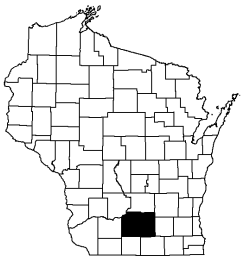
The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Dane County

WISCRS (Wisconsin Coordinate Reference Systems)



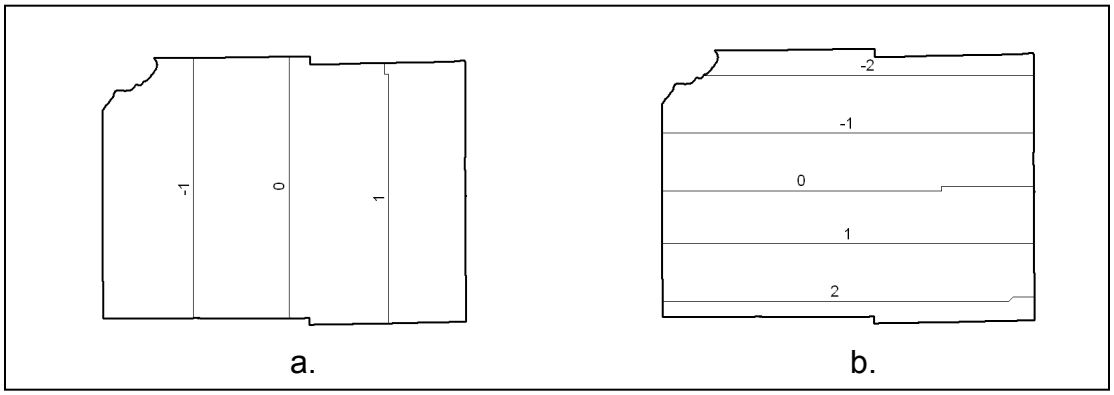
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°25’20.000000”
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°04’10.257735”
3. False Easting (E_o): 247193.2944 meters (811000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   146591.9896 meters (480943.886 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000384786

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Dane County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Dodge County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

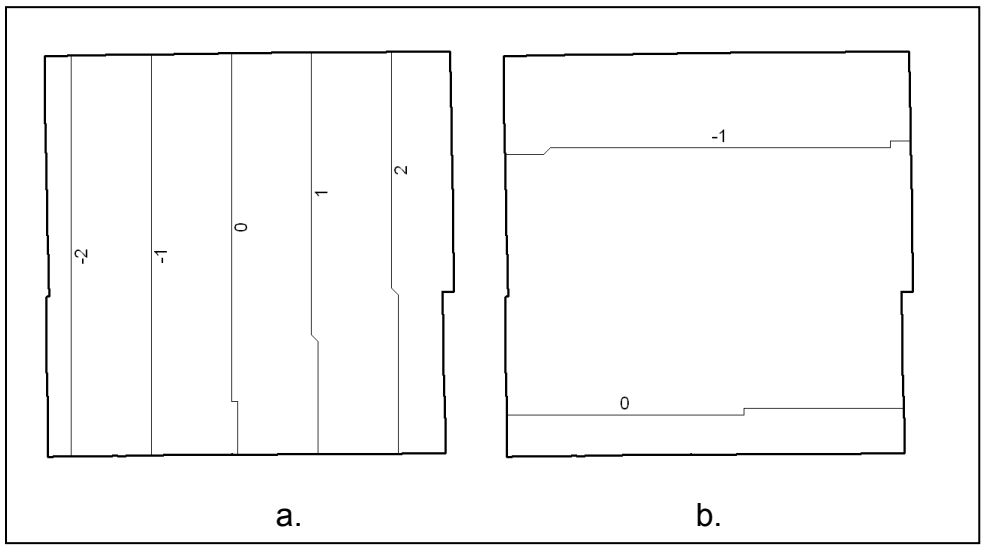
Note: Dodge and Jefferson Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°46'30.000000"
2. Origin Latitude (Φ_o): 41°28'20.000000"
3. False Easting (E_o): 263347.7263 meters (863999.999 U.S. survey feet)
4. False Northing (N_o): 0.0076 meters (0.025 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000346418

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Dodge County

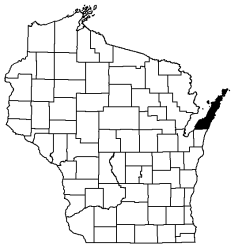
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Door County



WISCRS (Wisconsin Coordinate Reference Systems)

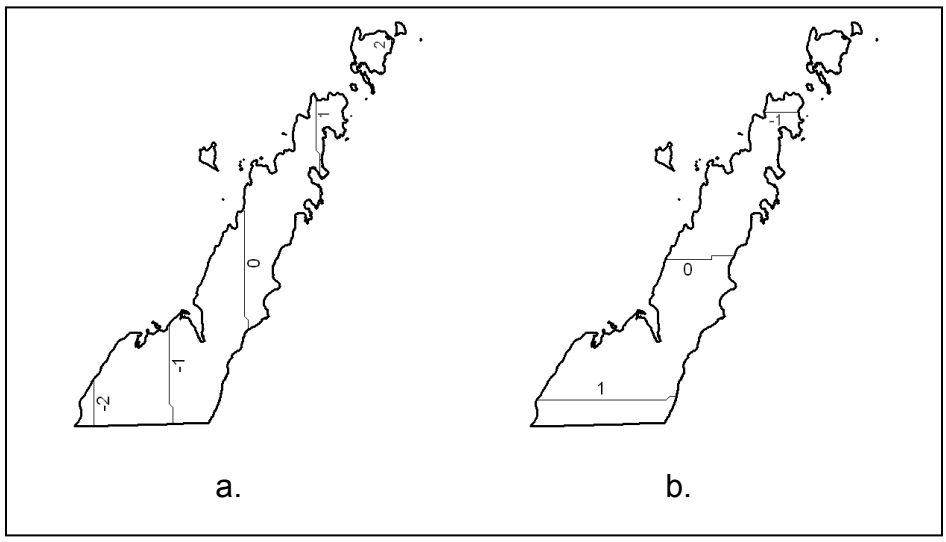
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 87°16'20.000000"
2. Origin Latitude (Φ_o): 44°24'00.000000"
3. False Easting (E_o): 158801.1176 meters (521000.000 U.S. survey feet)
4. False Northing (N_o): 0.0023 meters (0.008 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000187521

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Door County

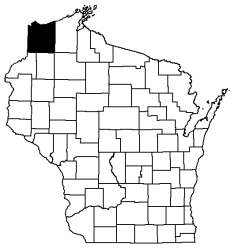
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Douglas County



WISCRS (Wisconsin Coordinate Reference Systems)

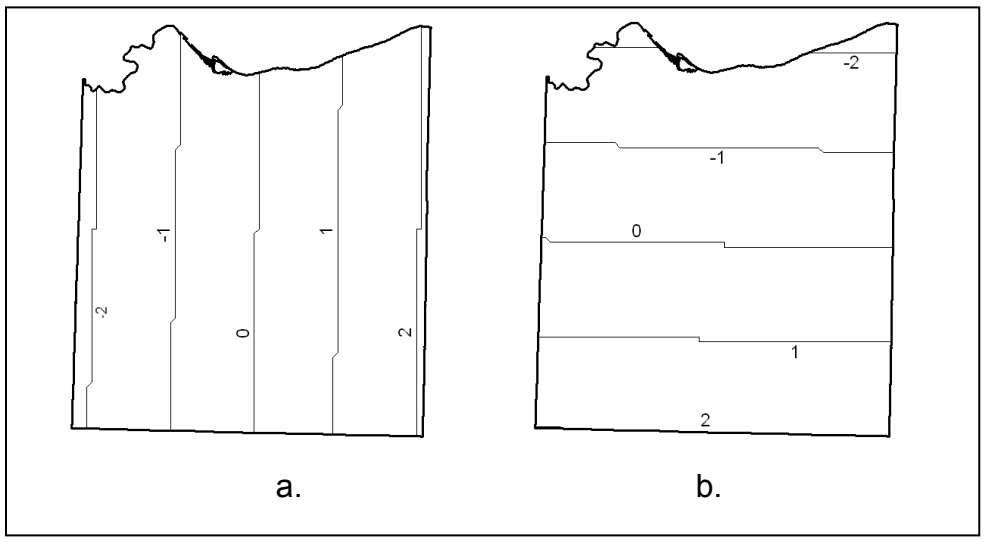
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°55'00.000000"
2. Origin Latitude (Φ_o): 45°53'00.000000"
3. False Easting (E_o): 59131.3183 meters (194000.000 U.S. survey feet)
4. False Northing (N_o): 0.0041 meters (0.013 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000385418

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Douglas County

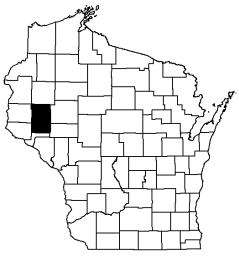
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Dunn County



WISCRS (Wisconsin Coordinate Reference Systems)

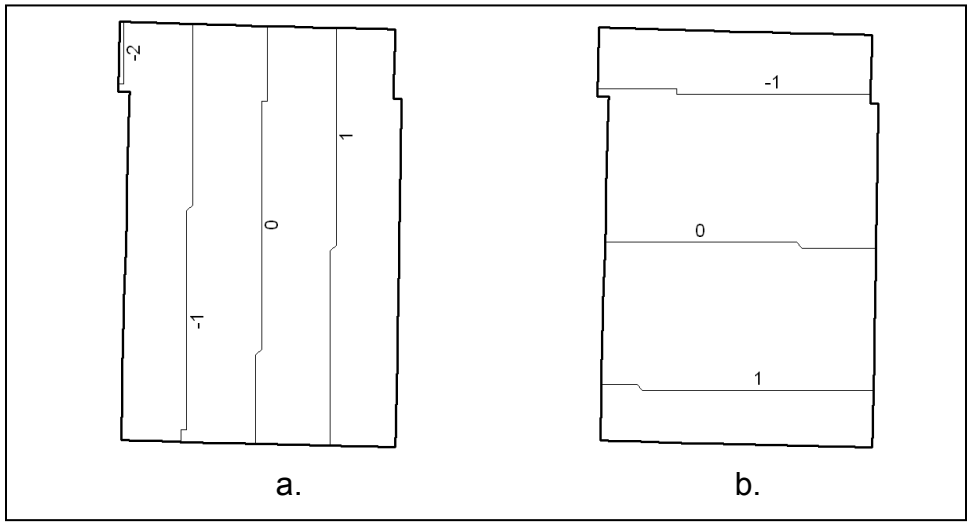
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°53'40.000000"
2. Origin Latitude (Φ_o): 44°24'30.000000"
3. False Easting (E_o): 51816.1040 meters (170000.001 U.S. survey feet)
4. False Northing (N_o): 0.0030 meters (0.010 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000410324

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Dunn County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Eau Claire County

WISCRS (Wisconsin Coordinate Reference Systems)

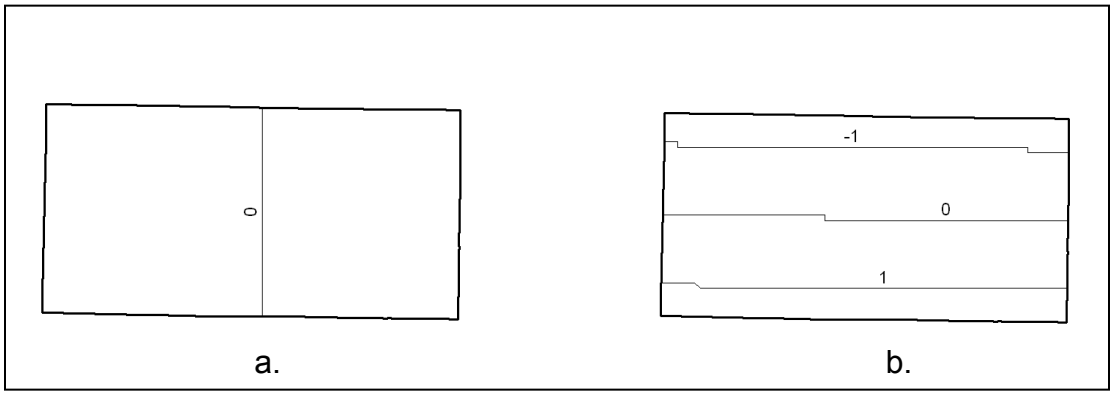
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 91°17'20.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o): 44°52'20.212055"
3. False Easting (E_o): 120091.4402 meters (394000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o): 91687.9239 meters (300812.797 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000350790

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Eau Claire County

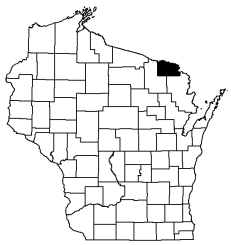
The maximum absolute value in any easting shift is less than 1 millimeter.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Florence County



WISCRS (Wisconsin Coordinate Reference Systems)

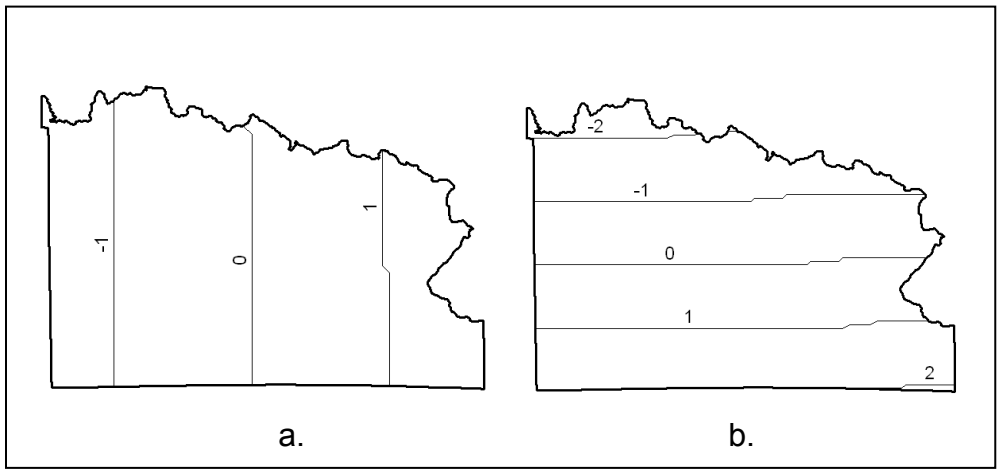
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°08'30.000000"
2. Origin Latitude (Φ_o): 45°26'20.000000"
3. False Easting (E_o): 133502.6683 meters (438000.004 U.S. survey feet)
4. False Northing (N_o): 0.0063 meters (0.021 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000552095

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Florence County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Fond du Lac County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

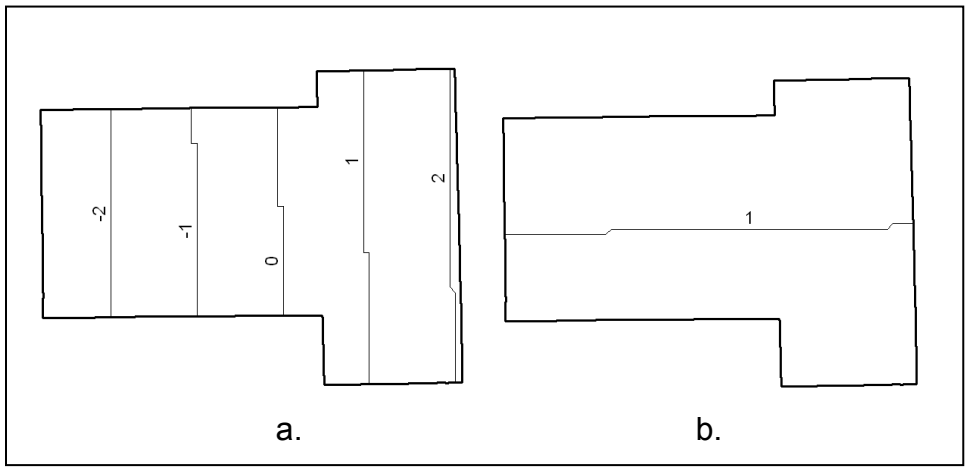
Note: Calumet, Fond du Lac, Outagamie, and Winnebago Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°30'00.000000"
2. Origin Latitude (Φ_o): 42°43'10.000000"
3. False Easting (E_o): 244754.8893 meters (802999.999 U.S. survey feet)
4. False Northing (N_o): 0.0049 meters (0.016 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000286569

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Fond du Lac County

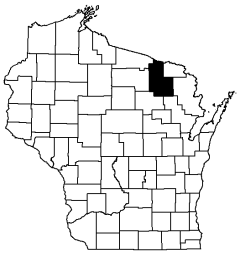
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Forest County



WISCRS (Wisconsin Coordinate Reference Systems)

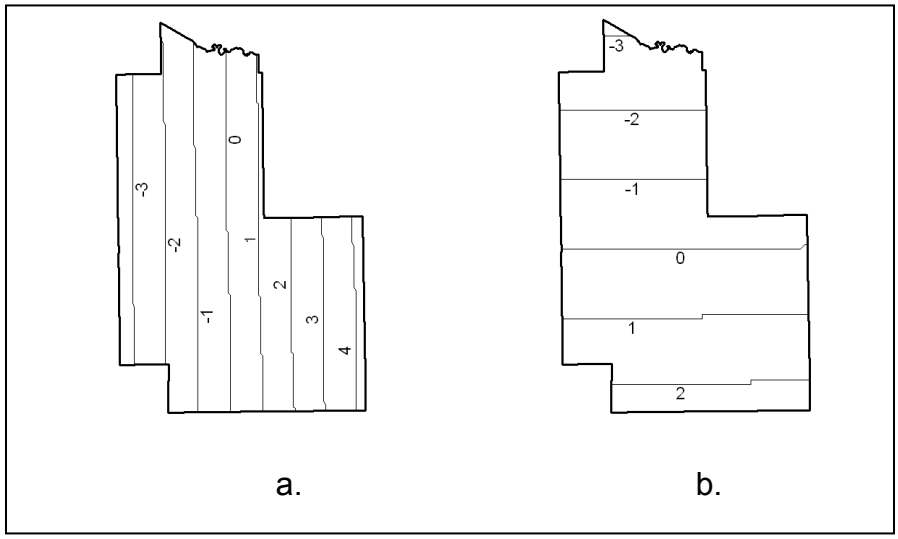
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°38'00.000000"
2. Origin Latitude (Φ_o): 44°00'20.000000"
3. False Easting (E_o): 275844.5533 meters (905000.005 U.S. survey feet)
4. False Northing (N_o): 0.0157 meters (0.052 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000673004

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Forest County

The maximum absolute value in any easting shift is less than 5 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Grant County

WISCRS (Wisconsin Coordinate Reference Systems)

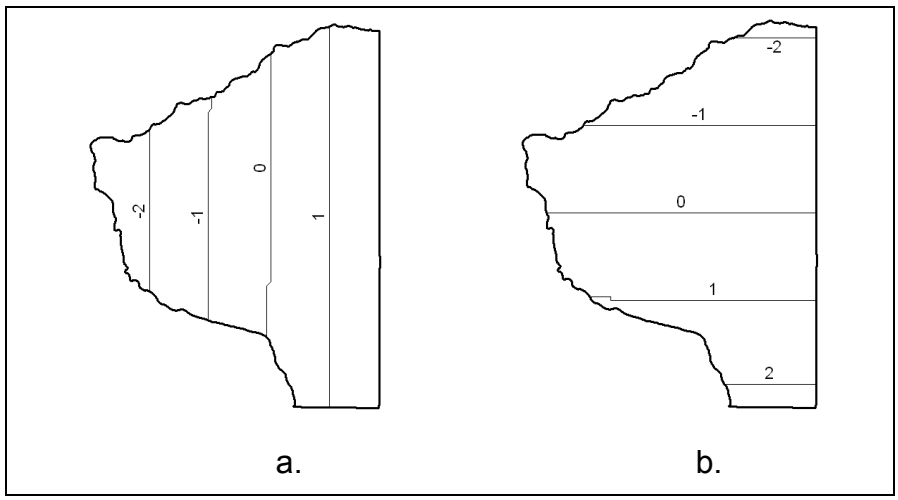
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°48'00.000000"
2. Origin Latitude (Φ_o): 41°24'40.000000"
3. False Easting (E_o): 242316.4841 meters (794999.998 U.S. survey feet)
4. False Northing (N_o): 0.0100 meters (0.033 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000349452

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Grant County

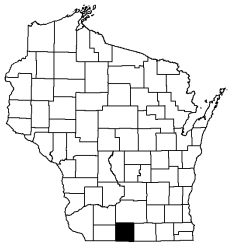
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Green County



WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

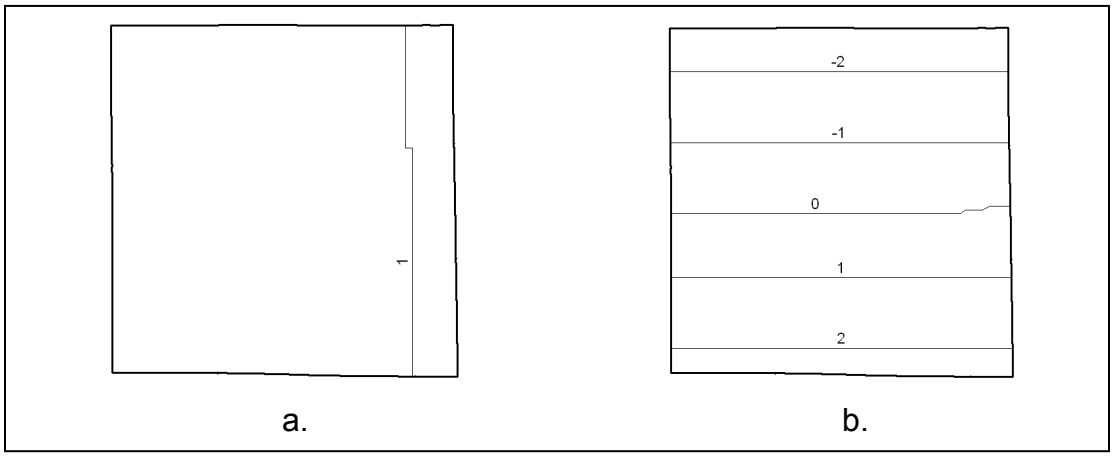
Note: Green and Lafayette Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 89°50'20.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   42°38'15.224197"
3. False Easting (E_o): 170078.7403 meters (558000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   45830.2947 meters (150361.559 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000390487

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Green County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Green Lake County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

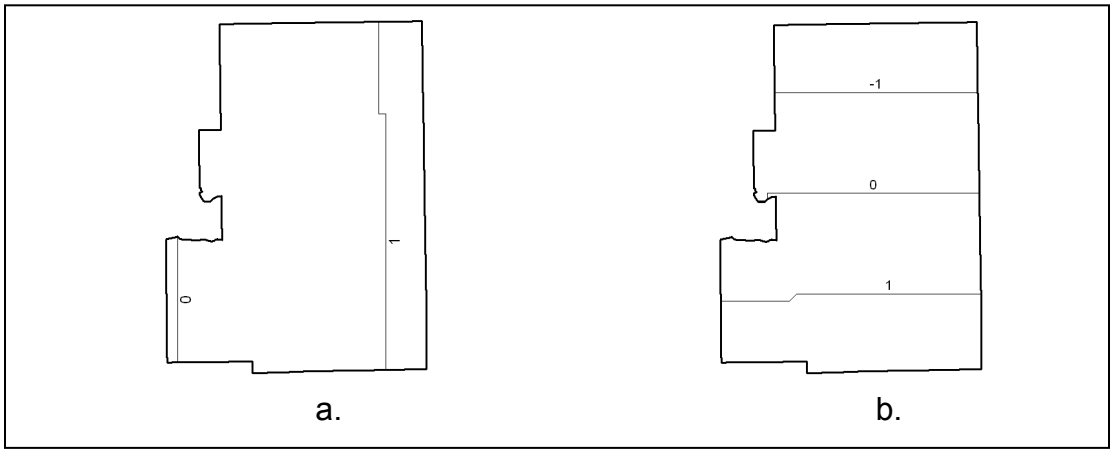
Note: Green Lake and Marquette Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 89°14'30.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°48'25.200424"
3. False Easting (E_o): 150876.3018 meters (495000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   79170.7795 meters (259746.132 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000344057

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Green Lake County

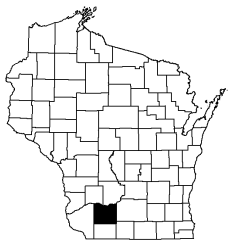
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Iowa County



WISCRS (Wisconsin Coordinate Reference Systems)

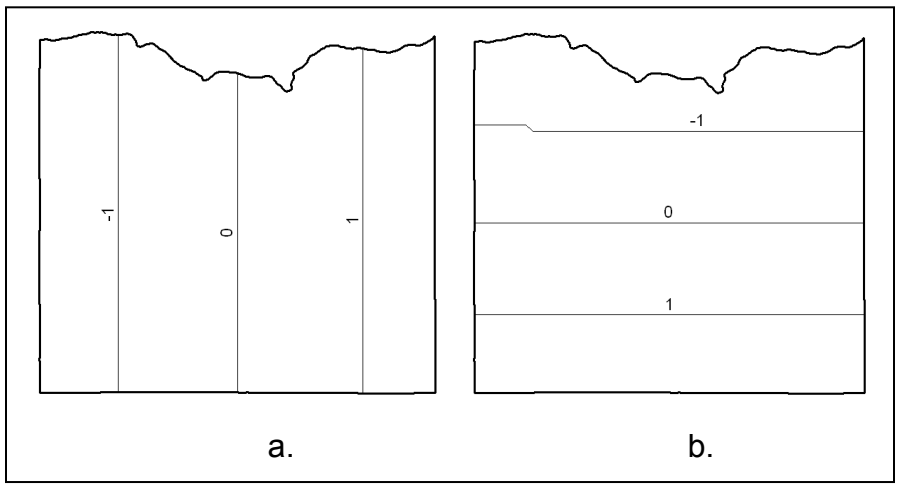
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°09'40.000000"
2. Origin Latitude (Φ_o): 42°32'20.000000"
3. False Easting (E_o): 113081.0261 meters (371000.000 U.S. survey feet)
4. False Northing (N_o): 0.0045 meters (0.015 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000394961

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Iowa County

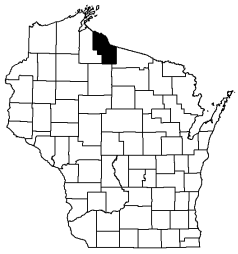
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Iron County



WISCRS (Wisconsin Coordinate Reference Systems)

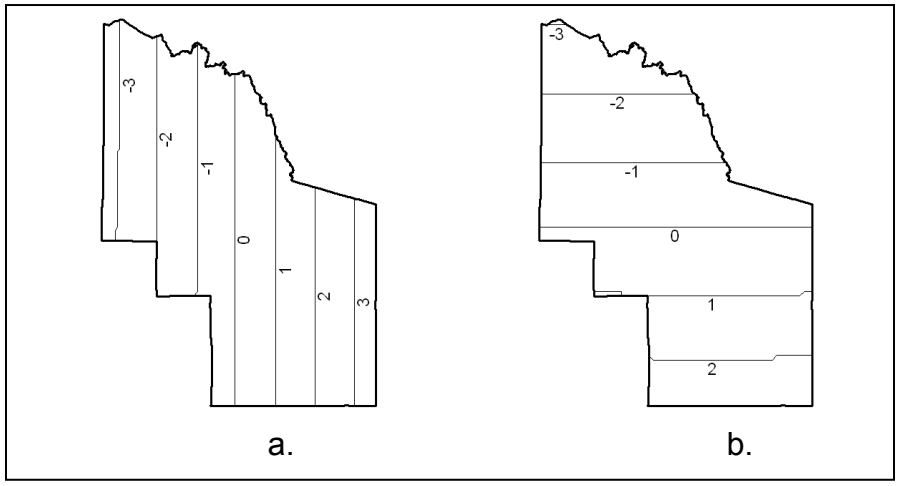
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°15'20.000000"
2. Origin Latitude (Φ_o): 45°26'00.000000"
3. False Easting (E_o): 220980.4419 meters (725000.000 U.S. survey feet)
4. False Northing (N_o): 0.0085 meters (0.028 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000677153

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Iron County

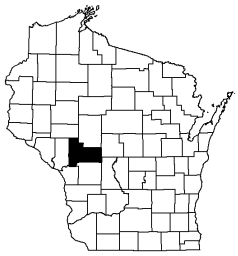
The maximum absolute value in any easting shift is less than 4 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Jackson County



WISCRS (Wisconsin Coordinate Reference Systems)

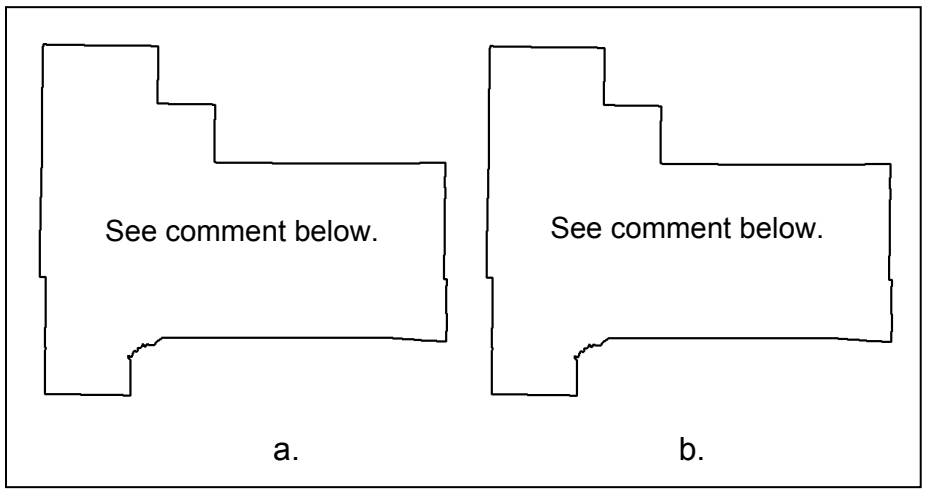
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°50'39.467470"
2. Origin Latitude (Φ_o): 44°15'12.006460"
3. False Easting (E_o): 27000.0000 meters (88582.500 U.S. survey feet)
4. False Northing (N_o): 25000.0000 meters (82020.833 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000353000

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus Jackson County Official Coordinate System)

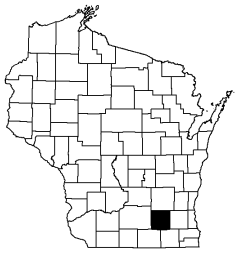


Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Jackson County

The Jackson County Official Coordinate System was adopted for WISCRS, Jackson County. However, WCCS for Jackson County was based upon an entirely different map projection. Therefore, WISCRS, Jackson County and WCCS coordinates for Jackson County will not match and should not be used together.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).



Jefferson County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

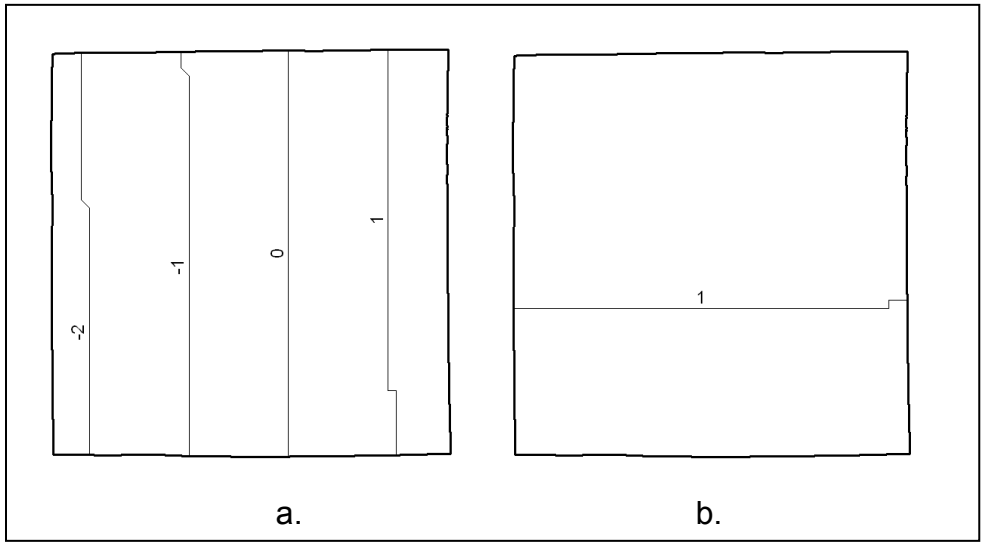
Note: Dodge and Jefferson Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°46'30.000000"
2. Origin Latitude (Φ_o): 41°28'20.000000"
3. False Easting (E_o): 263347.7263 meters (863999.999 U.S. survey feet)
4. False Northing (N_o): 0.0076 meters (0.025 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000346418

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Jefferson County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Juneau County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

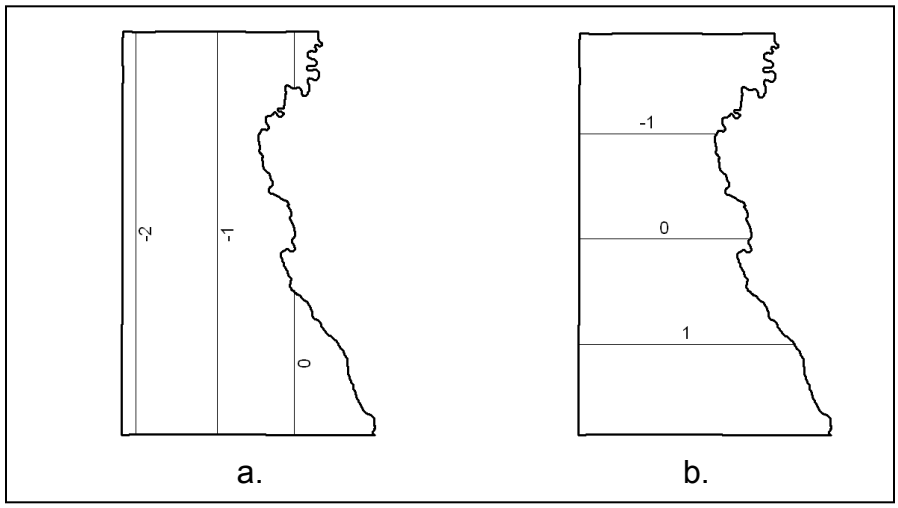
Note: Adams and Juneau Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 90°00'00.000000"
2. Origin Latitude (Φ_o): 43°22'00.000000"
3. False Easting (E_o): 147218.6942 meters (482999.999 U.S. survey feet)
4. False Northing (N_o): 0.0037 meters (0.012 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000365285

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Juneau County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Kenosha County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

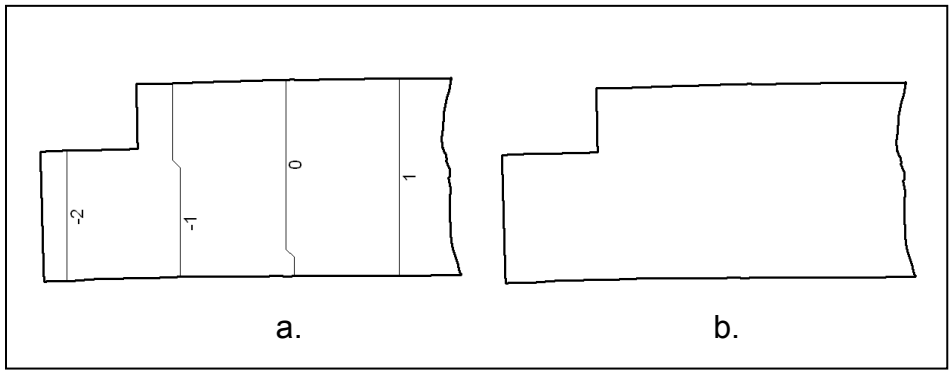
Note: Kenosha, Milwaukee, Ozaukee, and Racine Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°53'40.000000"
2. Origin Latitude (Φ_o): 42°13'00.000000"
3. False Easting (E_o): 185928.3728 meters (610000.003 U.S. survey feet)
4. False Northing (N_o): 0.0009 meters (0.003 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000260649

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Kenosha County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Kewaunee County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

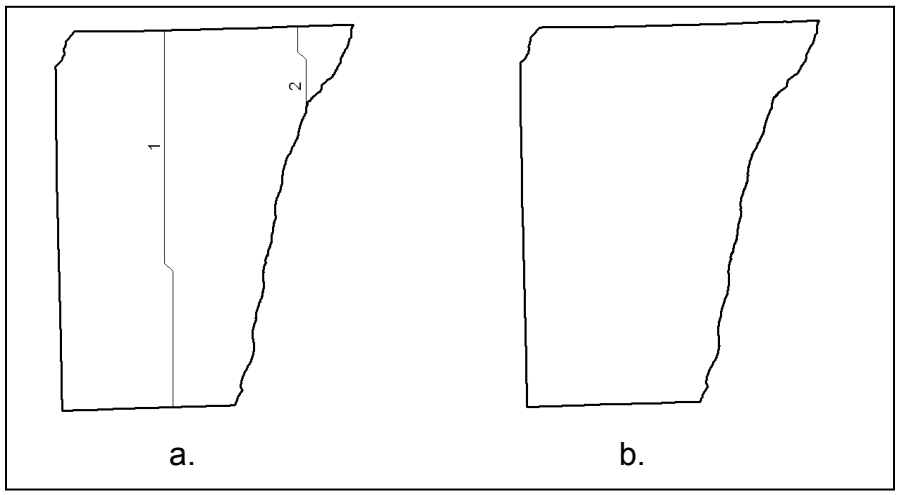
Note: Kewaunee, Manitowoc, and Sheboygan Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°33'00.000000"
2. Origin Latitude (Φ_o): 43°16'00.000000"
3. False Easting (E_o): 79857.7614 meters (262000.006 U.S. survey feet)
4. False Northing (N_o): 0.0012 meters (0.004 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000233704

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Kewaunee County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

La Crosse County

WISCRS (Wisconsin Coordinate Reference Systems)

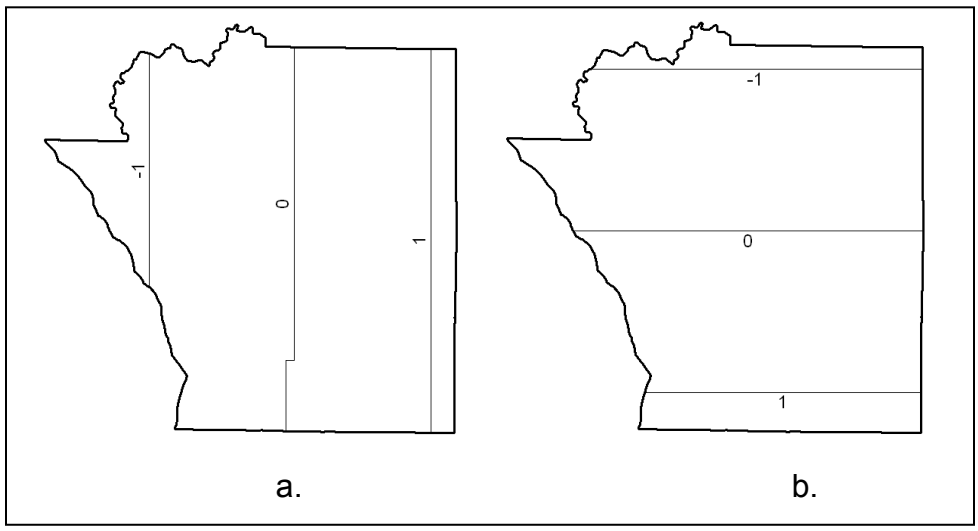
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°19'00.000000"
2. Origin Latitude (Φ_o): 43°27'04.000000"
3. False Easting (E_o): 130454.6598 meters (427999.996 U.S. survey feet)
4. False Northing (N_o): 0.0033 meters (0.011 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000319985

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for La Crosse County

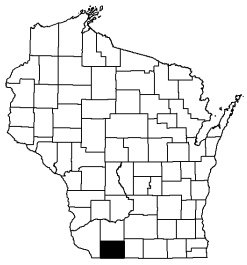
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Lafayette County



WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

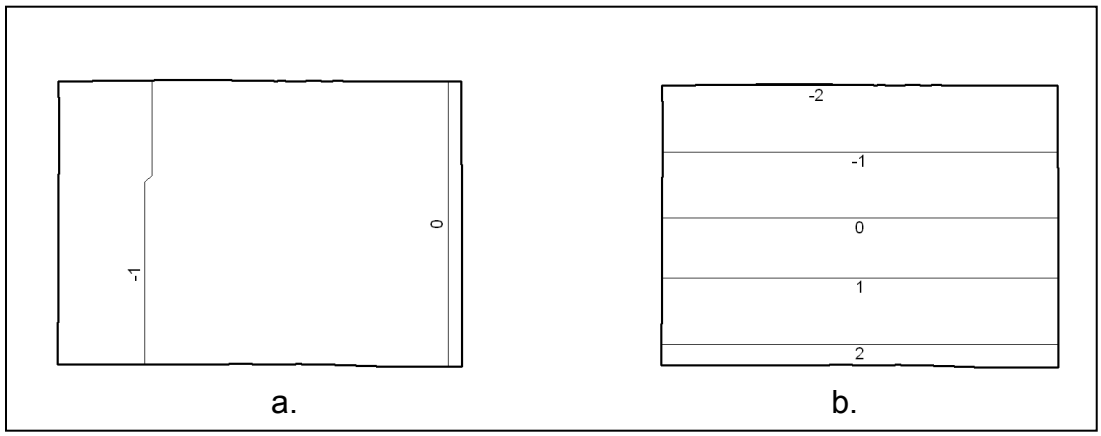
Note: Green and Lafayette Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 89°50'20.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   42°38'15.224197"
3. False Easting (E_o): 170078.7403 meters (558000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   45830.2947 meters (150361.559 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000390487

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Lafayette County

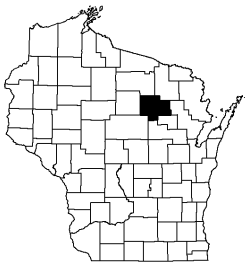
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Langlade County



WISCRS (Wisconsin Coordinate Reference Systems)

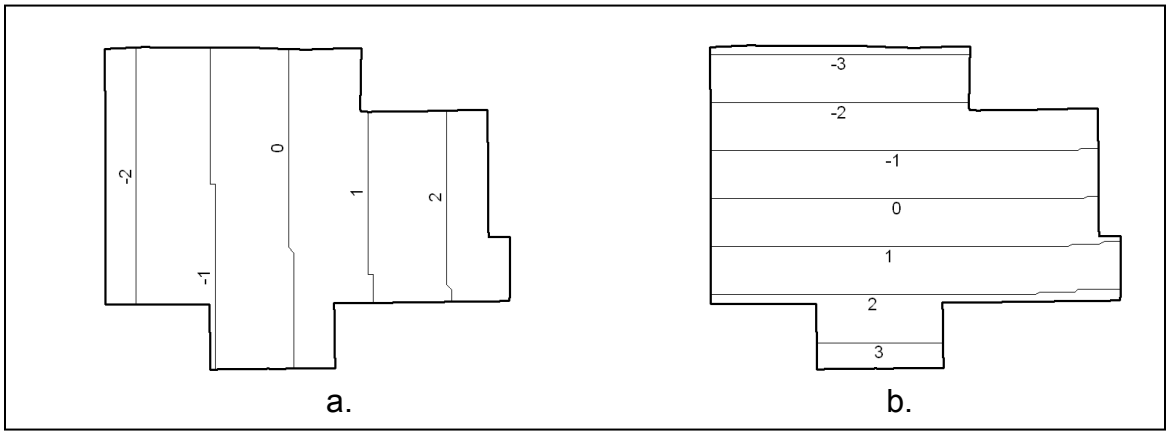
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°02'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   45°09' 15.253579"
3. False Easting (E_o): 198425.1970 meters (651000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   105279.7829 meters (345405.421 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000627024

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Langlade County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Lincoln County

WISCRS (Wisconsin Coordinate Reference Systems)

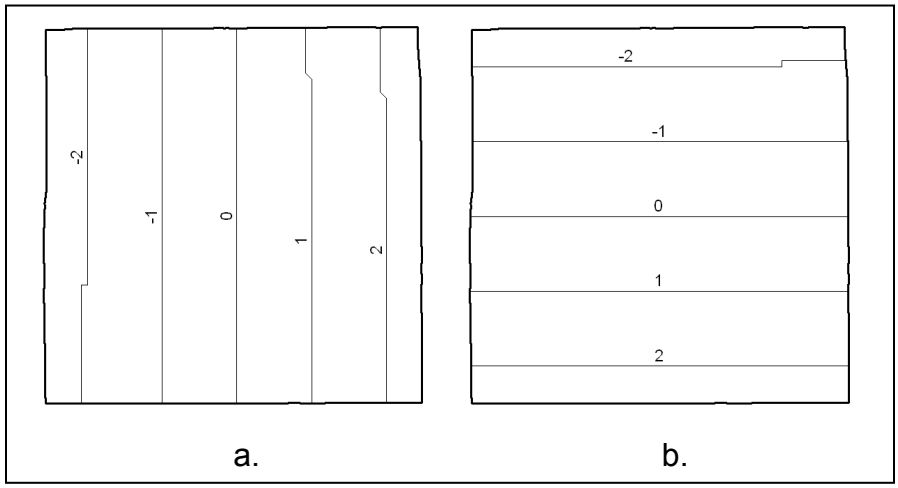
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 89°44'00.000000"
2. Origin Latitude (Φ_o): 44°50'40.000000"
3. False Easting (E_o): 116129.0323 meters (381000.000 U.S. survey feet)
4. False Northing (N_o): 0.0058 meters (0.019 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000599003

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Lincoln County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Manitowoc County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

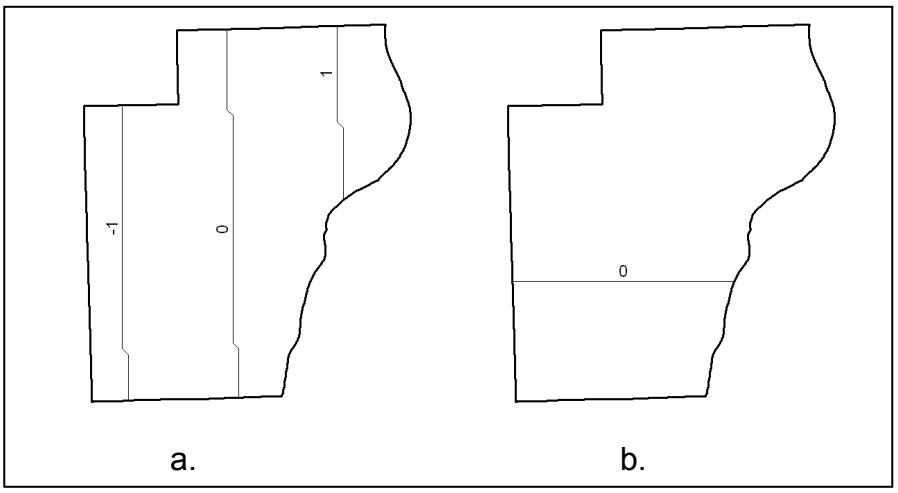
Note: Kewaunee, Manitowoc, and Sheboygan Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°33'00.000000"
2. Origin Latitude (Φ_o): 43°16'00.000000"
3. False Easting (E_o): 79857.7614 meters (262000.006 U.S. survey feet)
4. False Northing (N_o): 0.0012 meters (0.004 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000233704

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Manitowoc County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Marathon County

WISCRS (Wisconsin Coordinate Reference Systems)

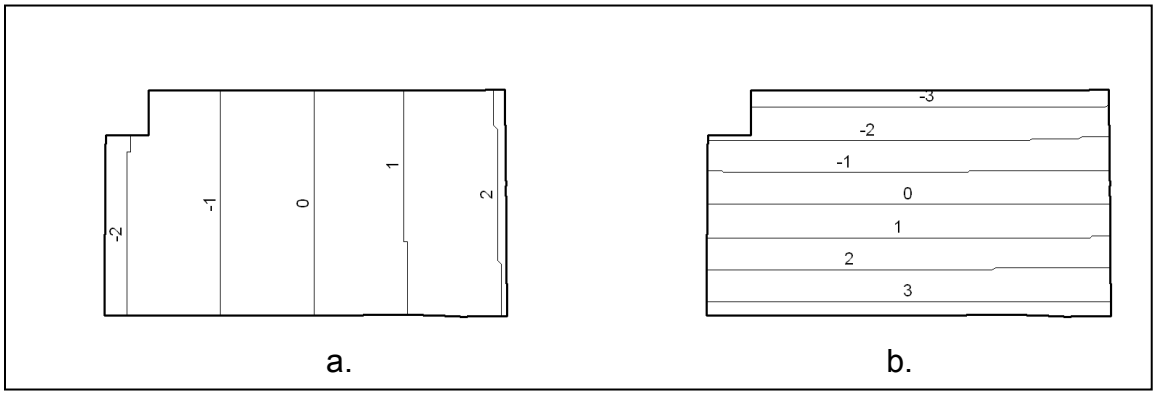
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°46'12.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°54'03.255925"
3. False Easting (E_o): 74676.1493 meters (245000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   55049.2669 meters (180607.470 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000532890

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Marathon County

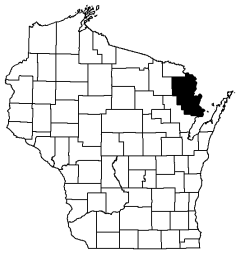
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Marinette County



WISCRS (Wisconsin Coordinate Reference Systems)

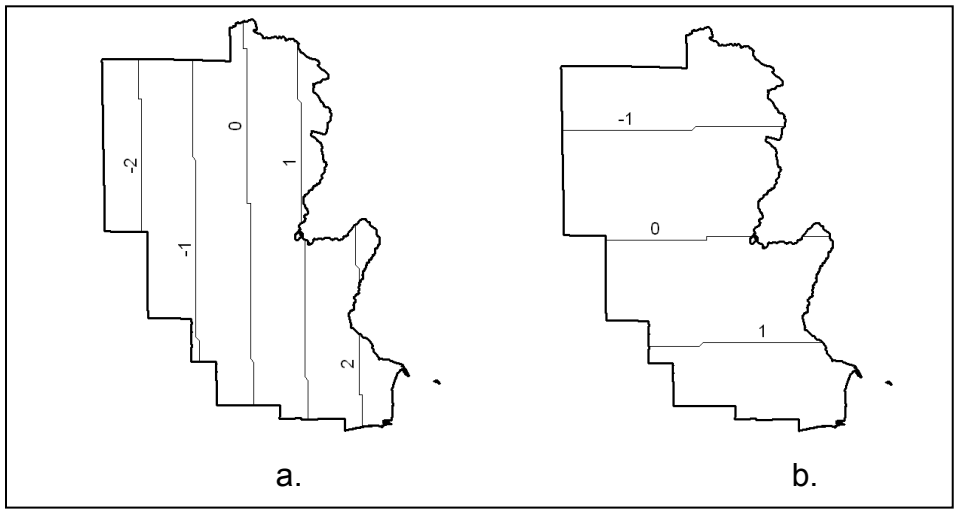
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 87°42'40.000000"
2. Origin Latitude (Φ_o): 44°41'30.000000"
3. False Easting (E_o): 238658.8794 meters (783000.007 U.S. survey feet)
4. False Northing (N_o): 0.0032 meters (0.010 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000234982

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Marinette County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Marquette County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

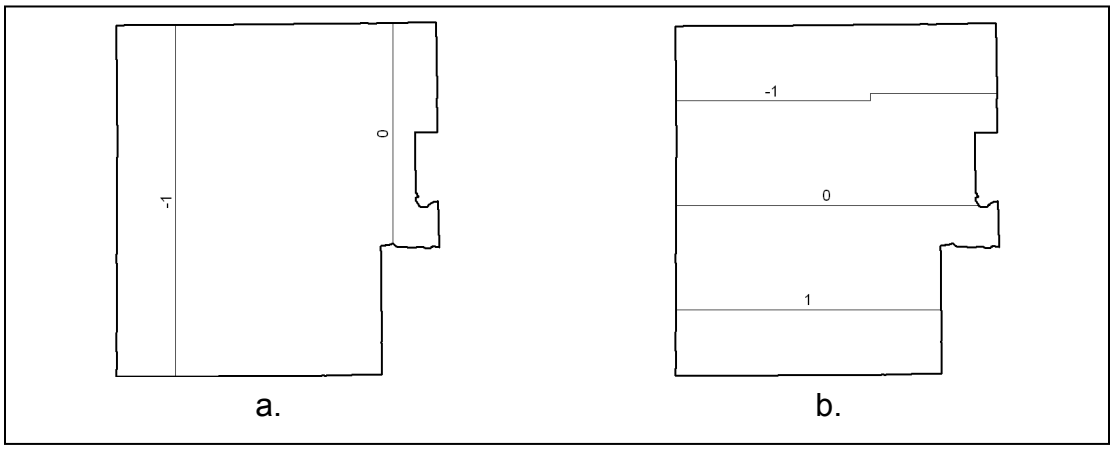
Note: Green Lake and Marquette Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 89°14'30.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°48'25.200424"
3. False Easting (E_o): 150876.3018 meters (495000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   79170.7795 meters (259746.132 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000344057

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Marquette County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Menominee County

WISCRS (Wisconsin Coordinate Reference Systems)

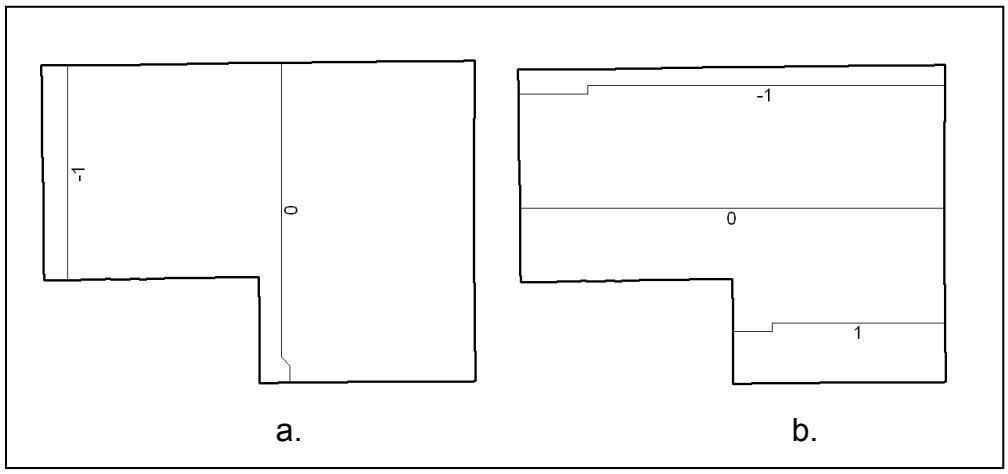
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°25'00.000000"
2. Origin Latitude (Φ_o): 44°43'00.000000"
3. False Easting (E_o): 105461.0121 meters (346000.004 U.S. survey feet)
4. False Northing (N_o): 0.0029 meters (0.010 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000362499

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Menominee County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Milwaukee County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

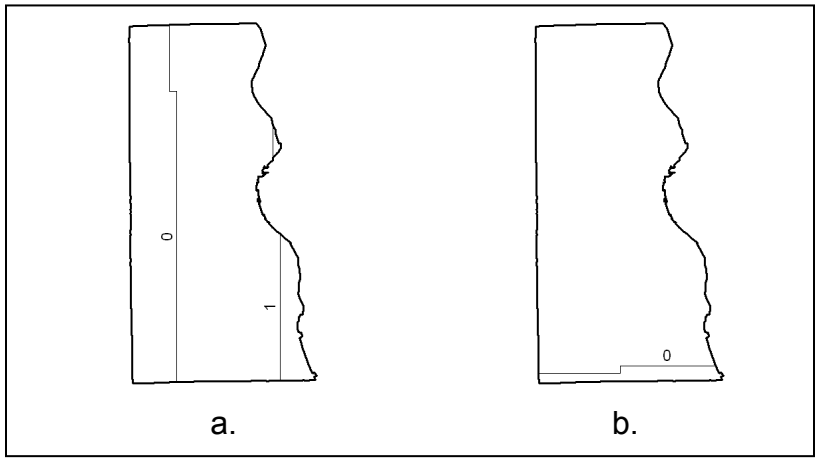
Note: Kenosha, Milwaukee, Ozaukee, and Racine Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°53'40.000000"
2. Origin Latitude (Φ_o): 42°13'00.000000"
3. False Easting (E_o): 185928.3728 meters (610000.003 U.S. survey feet)
4. False Northing (N_o): 0.0009 meters (0.003 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000260649

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Milwaukee County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Monroe County

WISCRS (Wisconsin Coordinate Reference Systems)

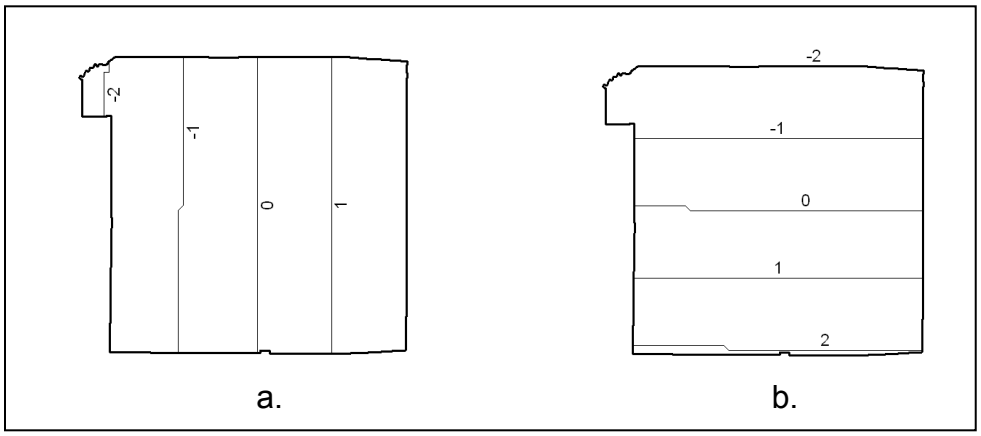
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°38'30.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°00'00.266143"
3. False Easting (E_o): 204521.2090 meters (671000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   121923.9861 meters (400012.278 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000434122

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Monroe County

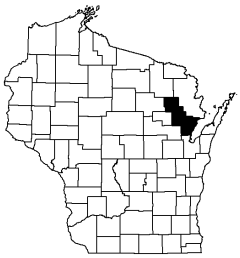
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Oconto County



WISCRS (Wisconsin Coordinate Reference Systems)

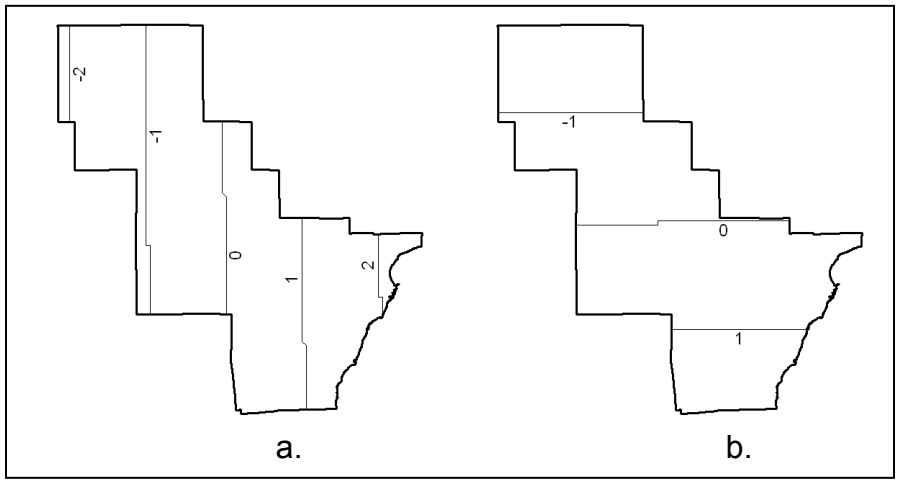
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 87°54'30.000000"
2. Origin Latitude (Φ_o): 44°23'50.000000"
3. False Easting (E_o): 182880.3676 meters (600000.006 U.S. survey feet)
4. False Northing (N_o): 0.0033 meters (0.011 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000236869

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Oconto County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Oneida County

WISCRS (Wisconsin Coordinate Reference Systems)

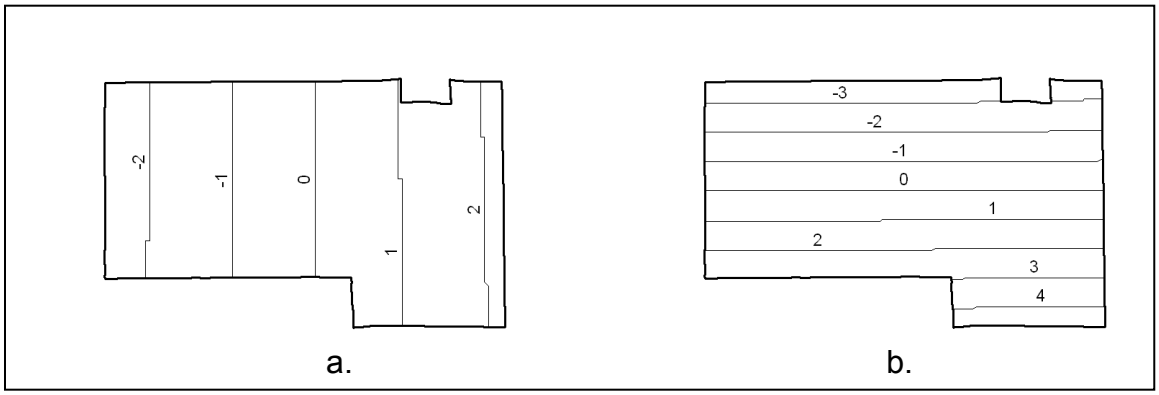
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°32'40.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   45°42'15.205573"
3. False Easting (E_o): 70104.1401 meters (230000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   57588.0346 meters (188936.744 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000686968

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Oneida County

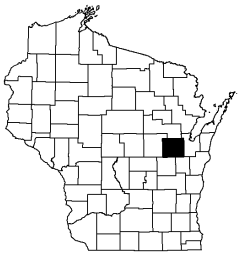
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 5 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Outagamie County



WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

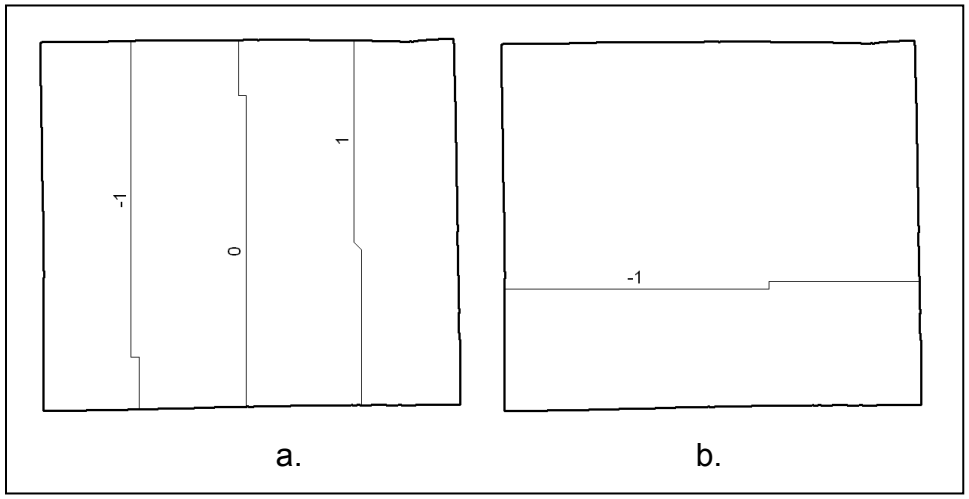
Note: Calumet, Fond du Lac, Outagamie, and Winnebago Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°30'00.000000"
2. Origin Latitude (Φ_o): 42°43'10.000000"
3. False Easting (E_o): 244754.8893 meters (802999.999 U.S. survey feet)
4. False Northing (N_o): 0.0049 meters (0.016 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000286569

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Outagamie County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Ozaukee County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

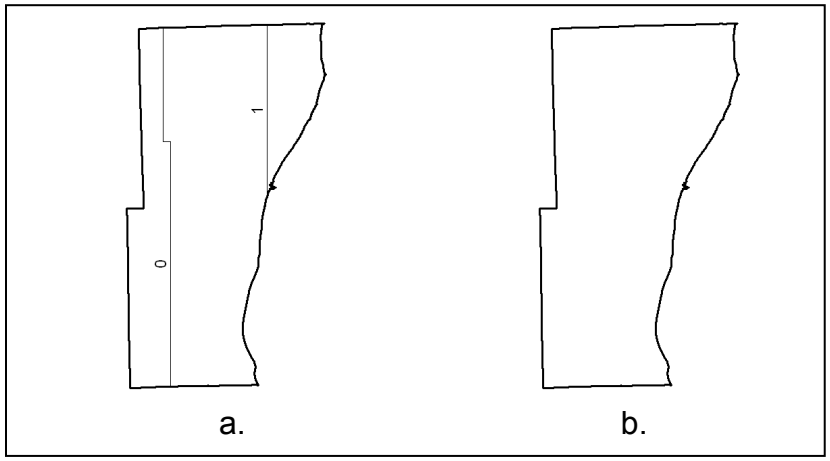
Note: Kenosha, Milwaukee, Ozaukee, and Racine Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°53'40.000000"
2. Origin Latitude (Φ_o): 42°13'00.000000"
3. False Easting (E_o): 185928.3728 meters (610000.003 U.S. survey feet)
4. False Northing (N_o): 0.0009 meters (0.003 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000260649

   NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Ozaukee County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Pepin County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

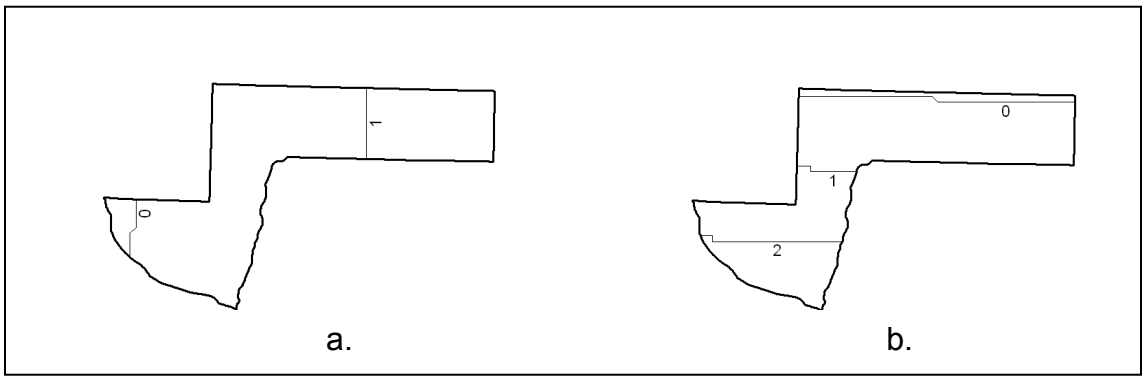
Note: Pepin and Pierce Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 92°13'40.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°38'10.135939"
3. False Easting (E_o): 167640.3354 meters (550000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   86033.0876 meters (282260.222 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000362977

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Pepin County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Pierce County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Lambert Conformal Conic

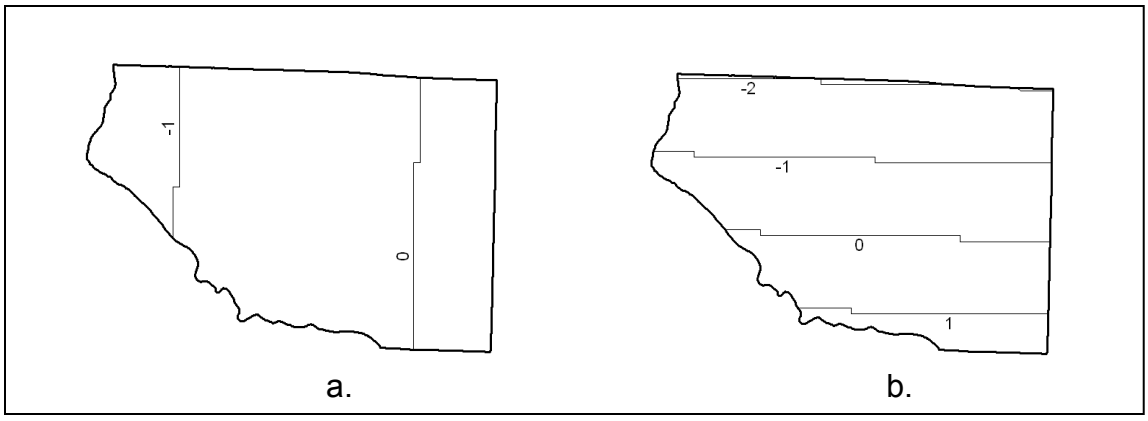
Note: Pepin and Pierce Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 92°13'40.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°38'10.135939"
3. False Easting (E_o): 167640.3354 meters (550000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   86033.0876 meters (282260.222 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000362977

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Pierce County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Polk County

WISCRS (Wisconsin Coordinate Reference Systems)

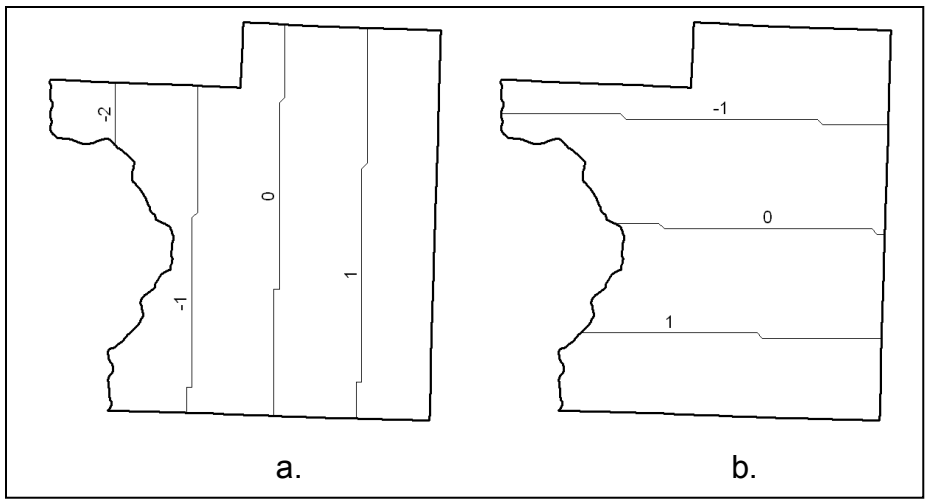
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 92°38'00.000000"
2. Origin Latitude (Φ_o): 44°39'40.000000"
3. False Easting (E_o): 141732.2823 meters (464999.996 U.S. survey feet)
4. False Northing (N_o): 0.0059 meters (0.019 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000433849

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Polk County

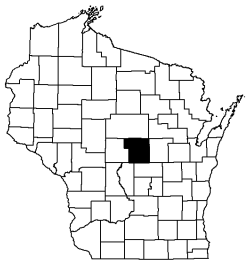
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Portage County



WISCRS (Wisconsin Coordinate Reference Systems)

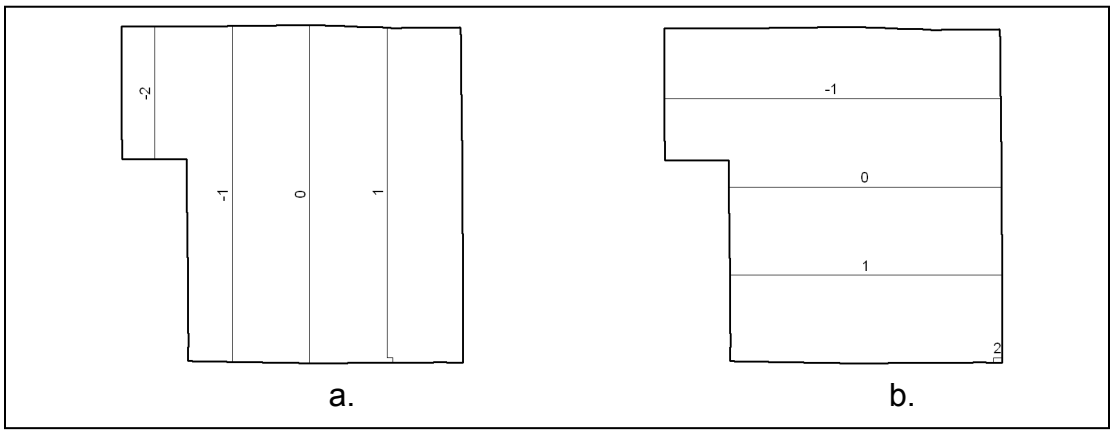
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°30'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°25'00.566311"
3. False Easting (E_o): 56388.1128 meters (185000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   50022.1874 meters (164114.460 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000399360

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Portage County

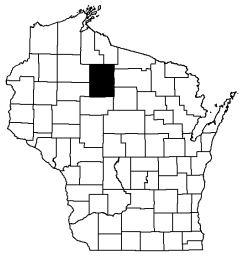
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Price County



WISCRS (Wisconsin Coordinate Reference Systems)

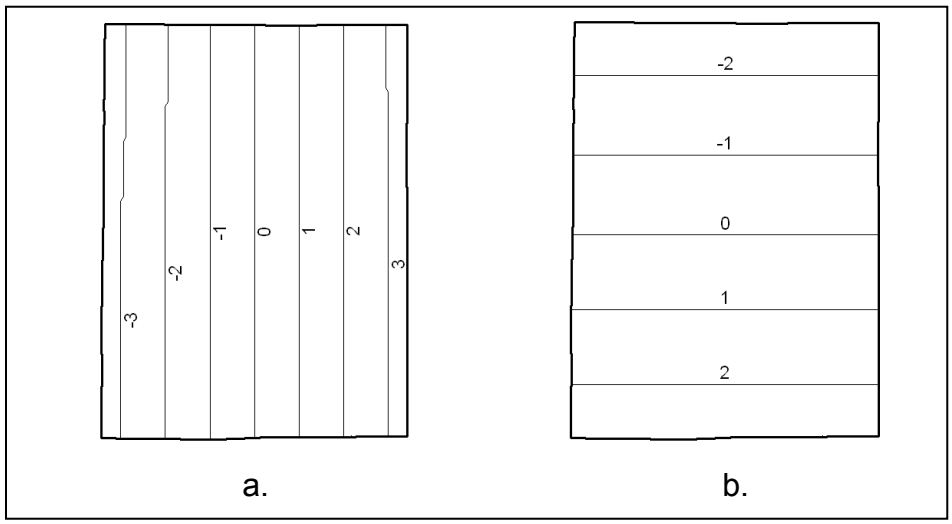
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 90°29'20.000000"
2. Origin Latitude (Φ_o): 44°33'20.000000"
3. False Easting (E_o): 227990.8546 meters (747999.995 U.S. survey feet)
4. False Northing (N_o): 0.0109 meters (0.036 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000649554

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Price County

The maximum absolute value in any easting shift is less than 4 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Racine County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

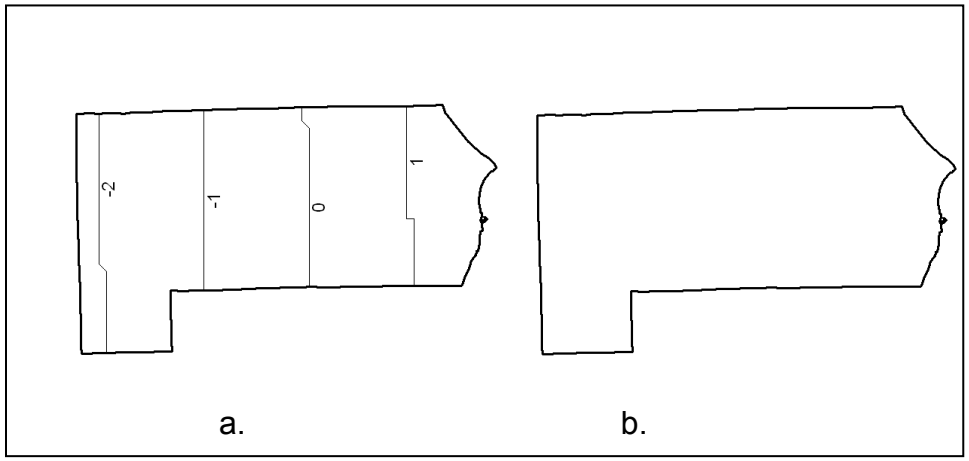
Note: Kenosha, Milwaukee, Ozaukee, and Racine Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°53'40.000000"
2. Origin Latitude (Φ_o): 42°13'00.000000"
3. False Easting (E_o): 185928.3728 meters (610000.003 U.S. survey feet)
4. False Northing (N_o): 0.0009 meters (0.003 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000260649

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Racine County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Richland County

WISCRS (Wisconsin Coordinate Reference Systems)

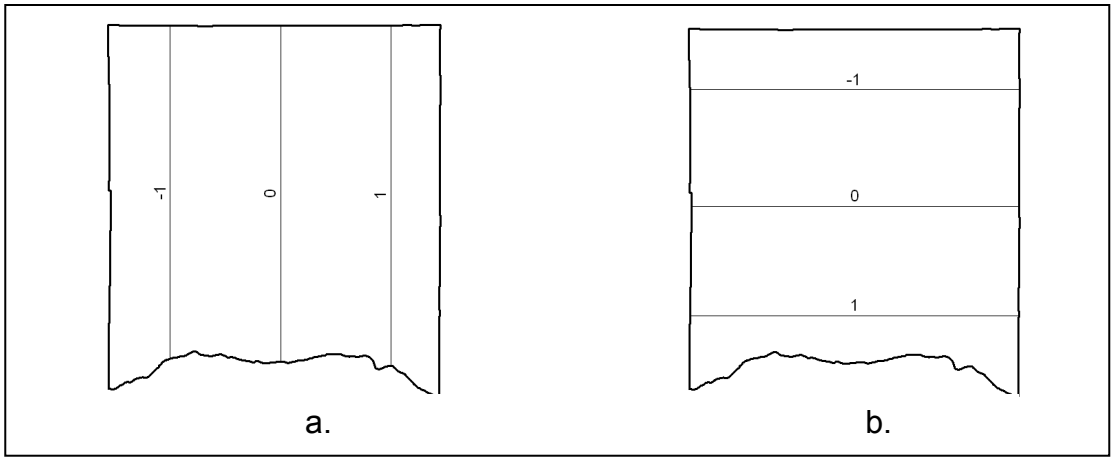
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°25’50.000000”
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°19’20.326539”
3. False Easting (E_o): 202387.6048 meters (664000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   134255.4253 meters (440469.675 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000375653

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Richland County

The maximum absolute value in any easting shift is less than 2 millimeters.

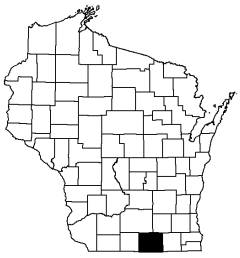
The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Rock County

WISCRS (Wisconsin Coordinate Reference Systems)



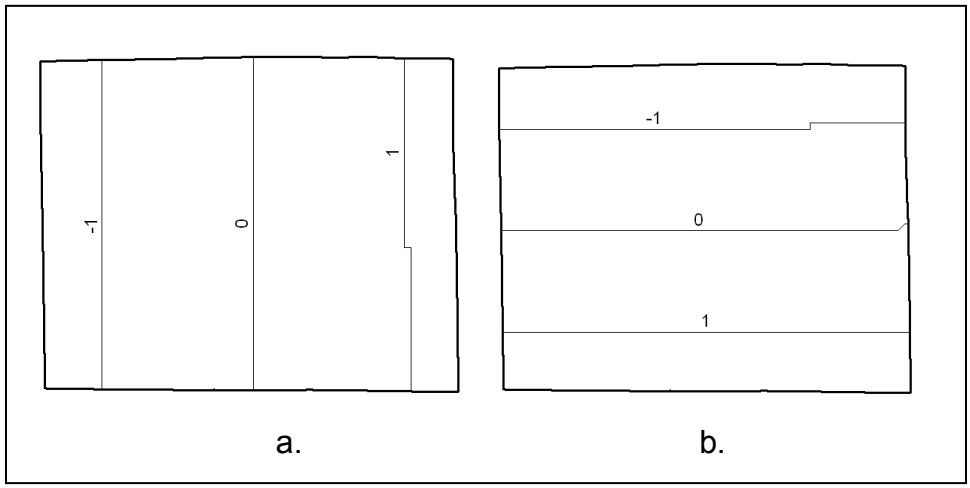
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 89°04’20.000000”
2. Origin Latitude (Φ_o): 41°56’40.000000”
3. False Easting (E_o): 146304.2926 meters (480000.000 U.S. survey feet)
4. False Northing (N_o): 0.0068 meters (0.022 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000337311

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Rock County

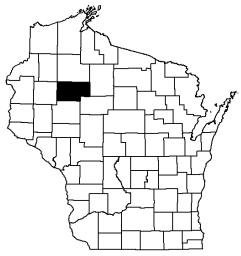
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Rusk County



WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

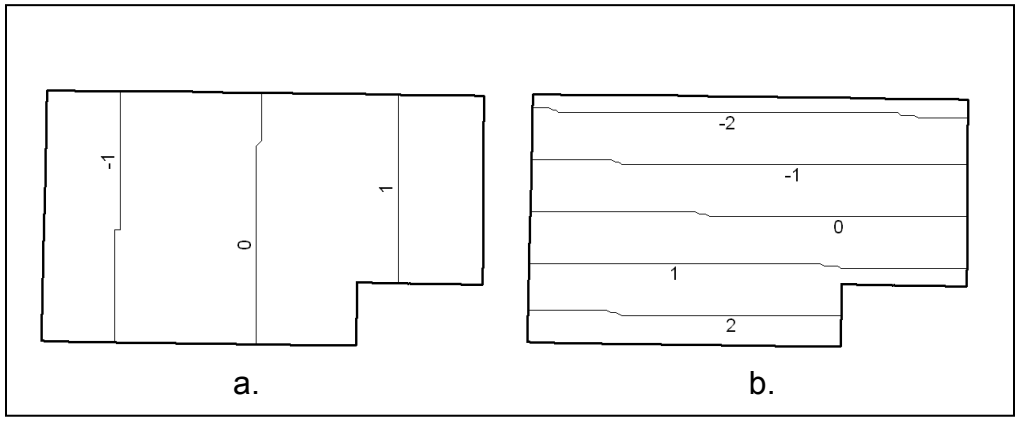
.

The parameters for this projection are

1. Origin Longitude (λ_o): 91°04'00.000000"
2. Origin Latitude (Φ_o): 43°55'10.000000"
3. False Easting (E_o): 250546.1013 meters (822000.001 U.S. survey feet)
4. False Northing (N_o): 0.0234 meters (0.077 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000495976

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Rusk County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

St. Croix County

WISCRS (Wisconsin Coordinate Reference Systems)

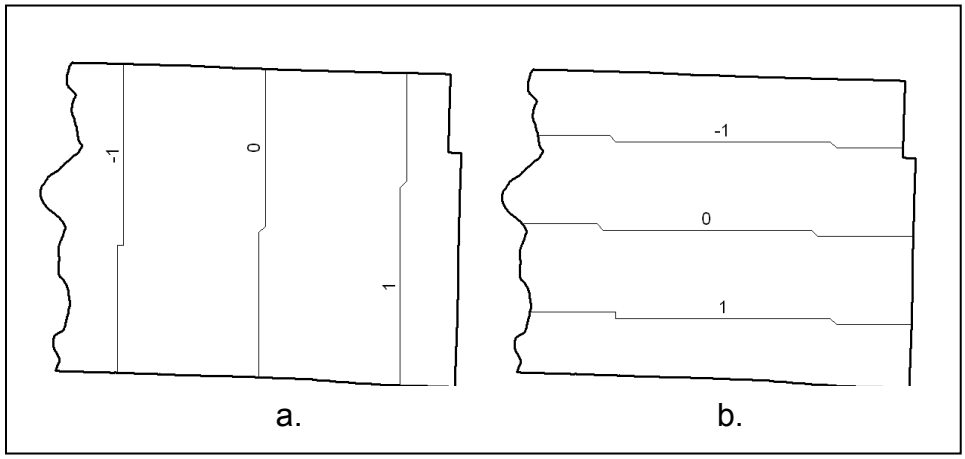
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 92°38'00.000000"
2. Origin Latitude (Φ_o): 44°02'10.000000"
3. False Easting (E_o): 165506.7302 meters (542999.997 U.S. survey feet)
4. False Northing (N_o): 0.0103 meters (0.034 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000381803

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for St. Croix County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Sauk County

WISCRS (Wisconsin Coordinate Reference Systems)

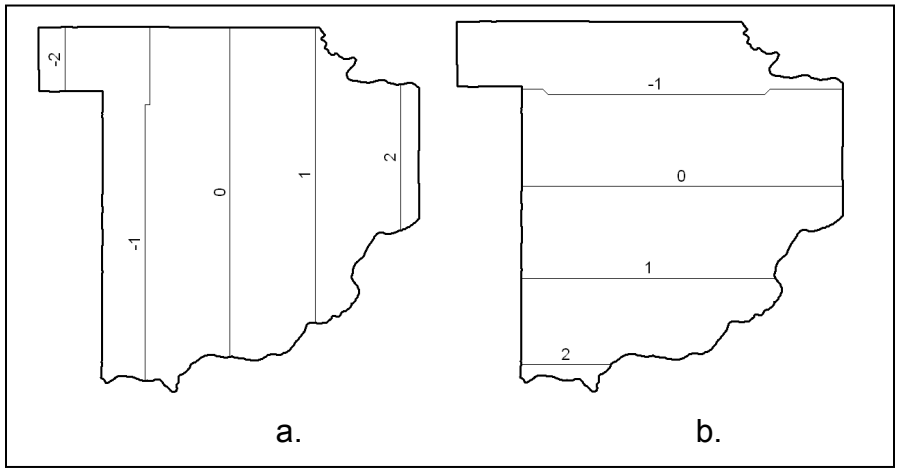
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 89°54'00.000000"
2. Origin Latitude (Φ_o): 42°49'10.000000"
3. False Easting (E_o): 185623.5716 meters (609000.001 U.S. survey feet)
4. False Northing (N_o): 0.0051 meters (0.017 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000373868

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Sauk County

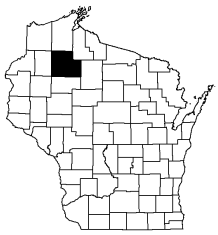
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Sawyer County



WISCRS (Wisconsin Coordinate Reference Systems)

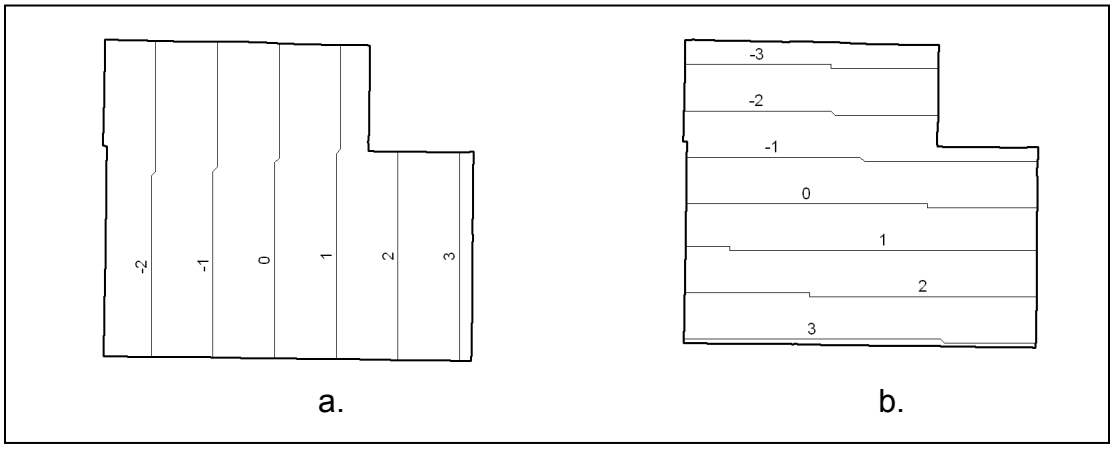
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 91°07'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o): 45°54'00.356873"
3. False Easting (E_o): 216713.2336 meters (711000.001 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o): 120734.1631 meters (396108.667 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000573461

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Sawyer County

The maximum absolute value in any easting shift is less than 4 millimeters.

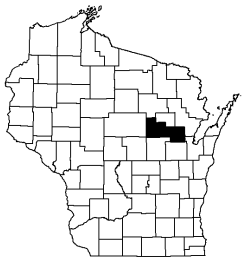
The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Shawano County

WISCRS (Wisconsin Coordinate Reference Systems)



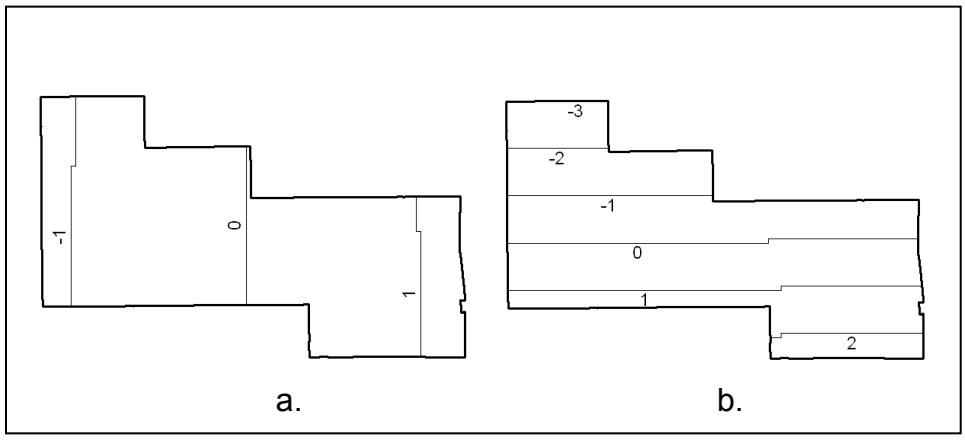
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°36'20.000000"
2. Origin Latitude (Φ_o): 44°02'10.000000"
3. False Easting (E_o): 262433.3253 meters (861000.001 U.S. survey feet)
4. False Northing (N_o): 0.0096 meters (0.031 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000321440

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Shawano County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Sheboygan County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

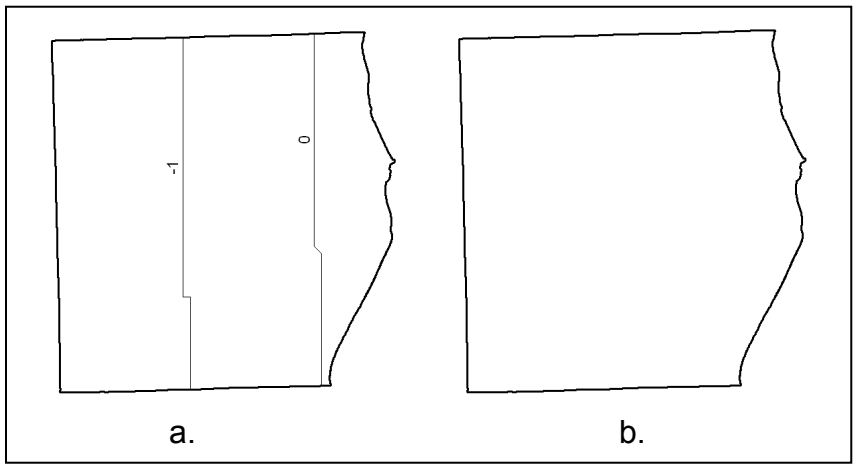
Note: Kewaunee, Manitowoc, and Sheboygan Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 87°33'00.000000"
2. Origin Latitude (Φ_o): 43°16'00.000000"
3. False Easting (E_o): 79857.7614 meters (262000.006 U.S. survey feet)
4. False Northing (N_o): 0.0012 meters (0.004 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000233704

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Sheboygan County

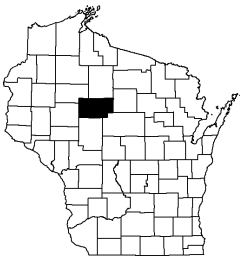
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Taylor County



WISCRS (Wisconsin Coordinate Reference Systems)

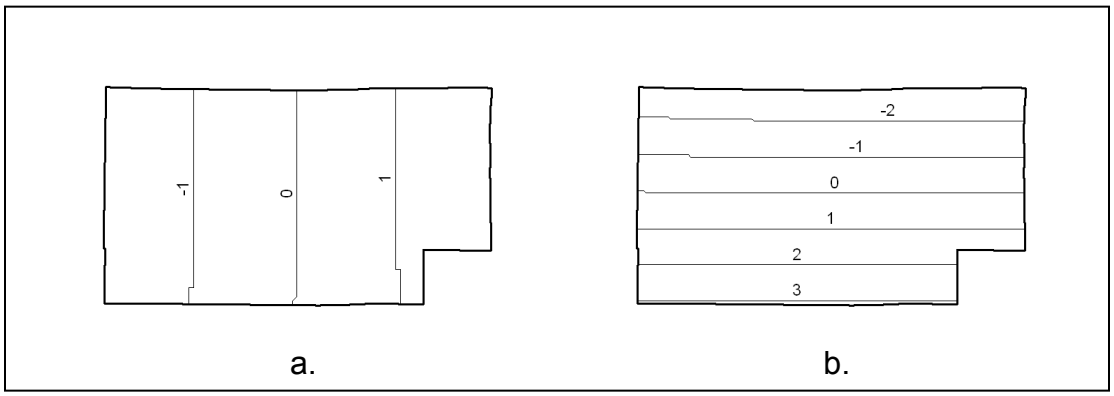
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°29'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   45°10'40.159509"
3. False Easting (E_o): 187147.5744 meters (614000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   107746.7522 meters (353499.136 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000597566

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Taylor County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 4 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Trempealeau County

WISCRS (Wisconsin Coordinate Reference Systems)

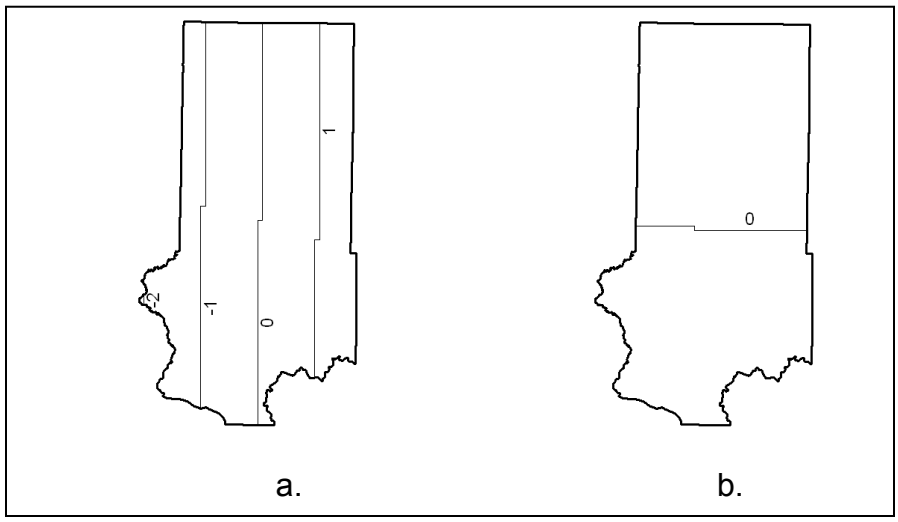
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 91°22'00.000000"
2. Origin Latitude (Φ_o): 43°09'40.000000"
3. False Easting (E_o): 256946.9138 meters (843000.000 U.S. survey feet)
4. False Northing (N_o): 0.0041 meters (0.013 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000361538

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Trempealeau County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Vernon County

WISCRS (Wisconsin Coordinate Reference Systems)

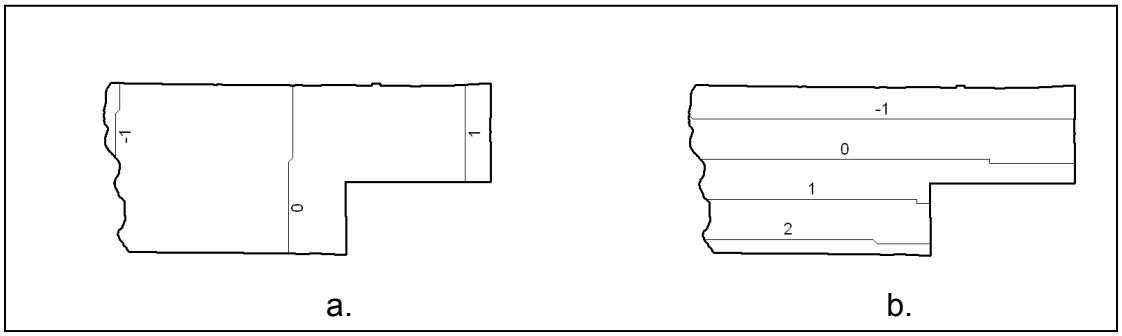
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°47'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   43°34'30.118583"
3. False Easting (E_o): 222504.4451 meters (730000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   47532.0602 meters (155944.768 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000408158

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Vernon County

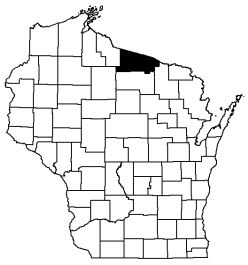
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 3 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Vilas County



WISCRS (Wisconsin Coordinate Reference Systems)

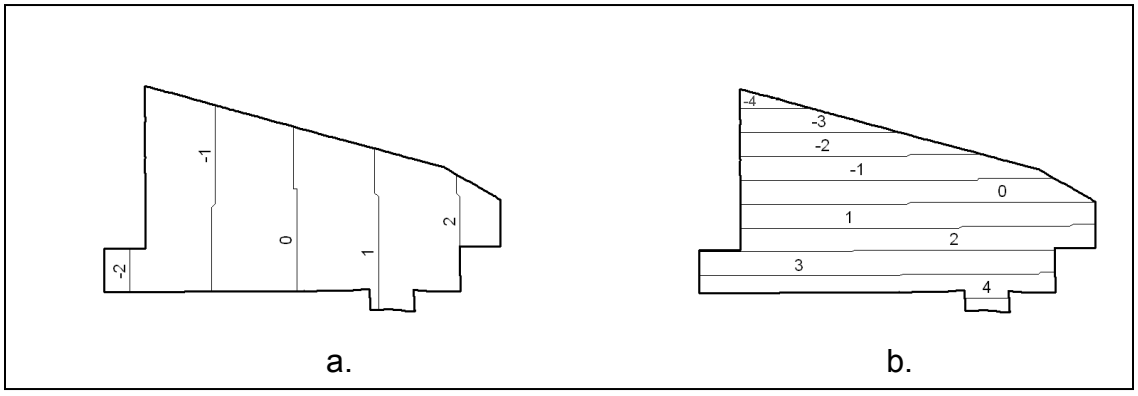
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°29'20.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o): 46°04'40.238726"
3. False Easting (E_o): 134417.0689 meters (441000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o): 50337.1092 meters (165147.666 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000730142

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Vilas County

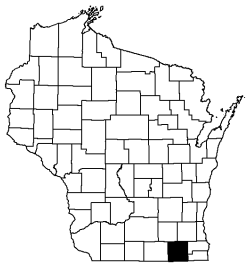
The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 5 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Walworth County



WISCRS (Wisconsin Coordinate Reference Systems)

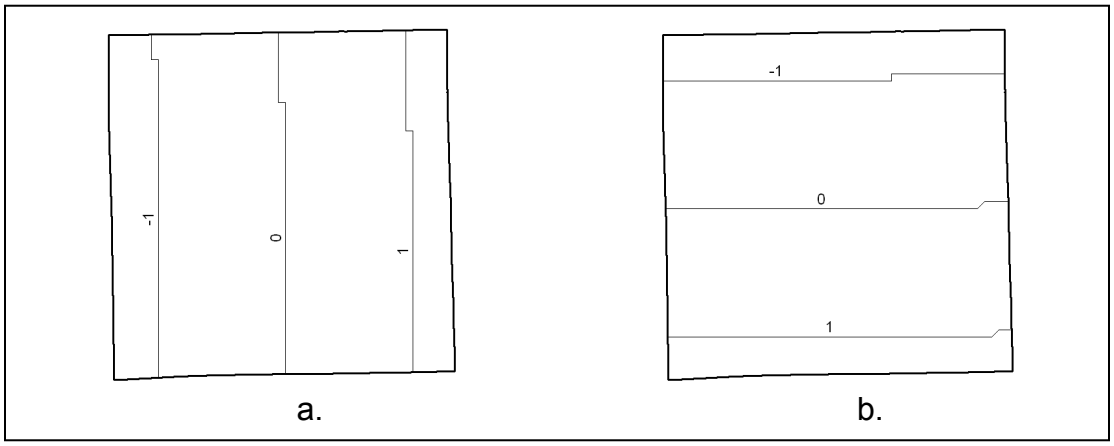
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 88°32'30.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   42°40'10.063549"
3. False Easting (E_o): 232562.8651 meters (763000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   111088.2224 meters (364461.943 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000367192

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Walworth County

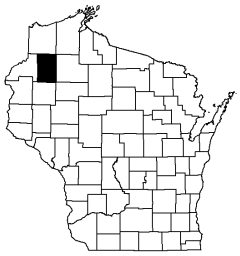
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Washburn County



WISCRS (Wisconsin Coordinate Reference Systems)

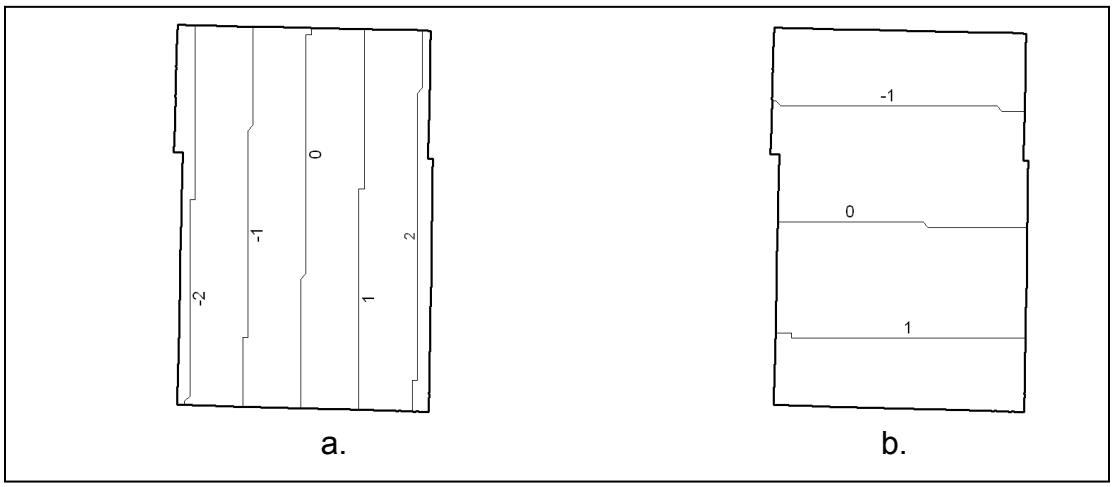
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 91°47'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   45°57'40.391400"
3. False Easting (E_o): 234086.8682 meters (768000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   188358.6058 meters (617973.193 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000475376

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Washburn County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Washington County

WISCRS (Wisconsin Coordinate Reference Systems)

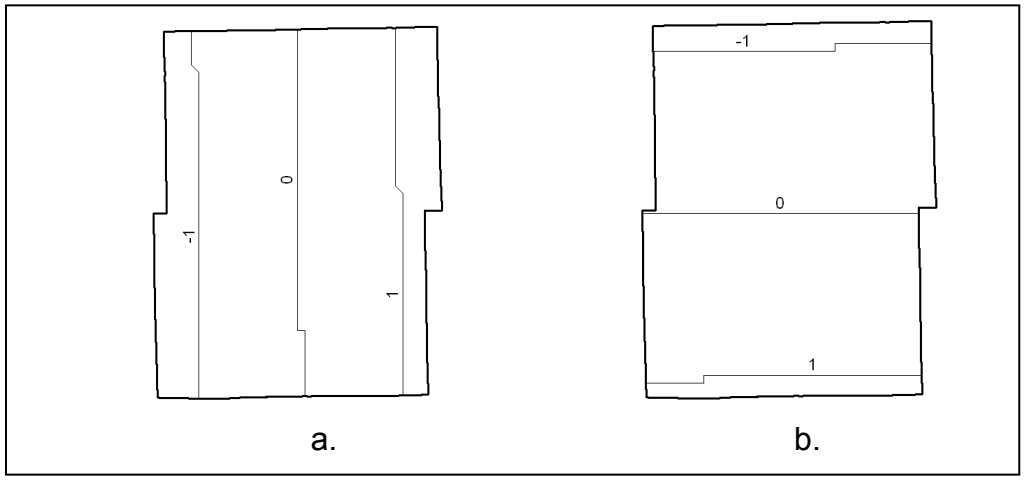
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°03'50.000000"
2. Origin Latitude (Φ_o): 42°55'05.000000"
3. False Easting (E_o): 120091.4415 meters (394000.004 U.S. survey feet)
4. False Northing (N_o): 0.0030 meters (0.010 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000373800

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Washington County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Waukesha County

WISCRS (Wisconsin Coordinate Reference Systems)

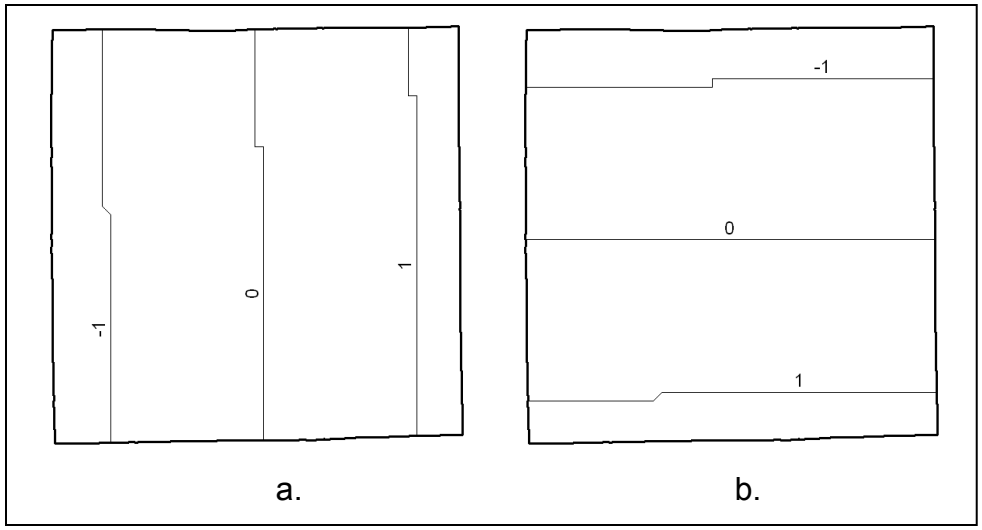
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°13'30.000000"
2. Origin Latitude (Φ_o): 42°34'10.000000"
3. False Easting (E_o): 208788.4180 meters (685000.001 U.S. survey feet)
4. False Northing (N_o): 0.0034 meters (0.011 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000346179

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Waukesha County

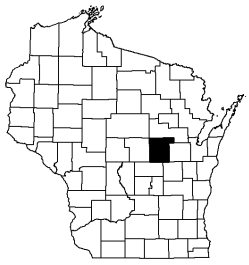
The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Waupaca County



WISCRS (Wisconsin Coordinate Reference Systems)

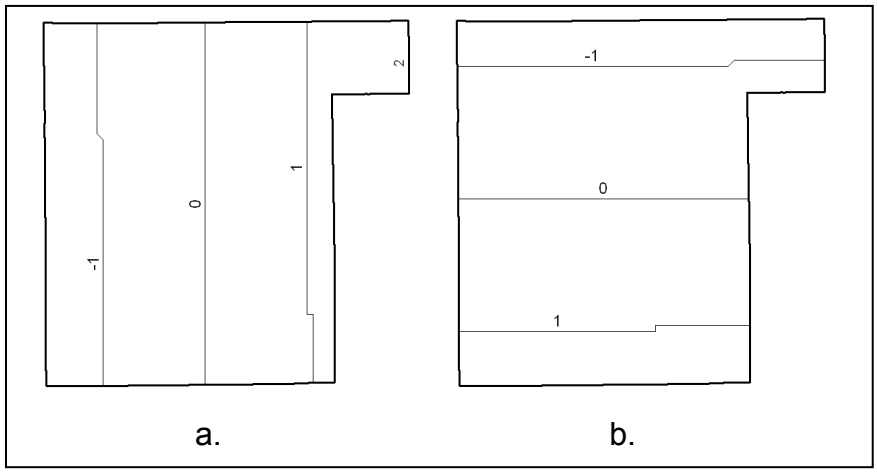
Projection: Transverse Mercator

The parameters for this projection are

1. Origin Longitude (λ_o): 88°49'00.000000"
2. Origin Latitude (Φ_o): 43°25'13.000000"
3. False Easting (E_o): 185013.9709 meters (607000.003 U.S. survey feet)
4. False Northing (N_o): 0.0070 meters (0.023 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000333645

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Waupaca County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Waushara County

WISCRS (Wisconsin Coordinate Reference Systems)

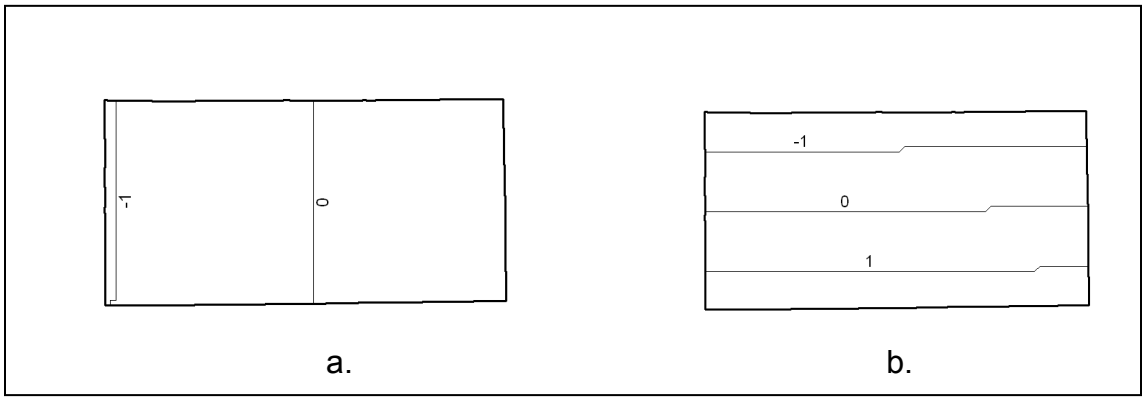
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 89°14'30.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°06'50.198565"
3. False Easting (E_o): 120091.4402 meters (394000.000 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   45069.7587 meters (147866.367 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000392096

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Waushara County

The maximum absolute value in any easting shift is less than 2 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Winnebago County

WISCRS (Wisconsin Coordinate Reference Systems)

Projection: Transverse Mercator

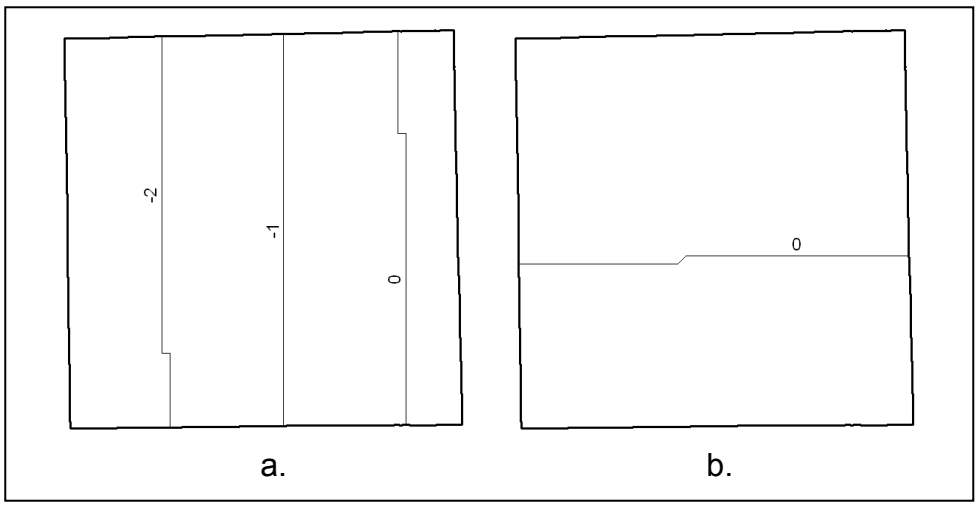
Note: Calumet, Fond du Lac, Outagamie, and Winnebago Counties share the same projection.

The parameters for this projection are

1. Origin Longitude (λ_o): 88°30'00.000000"
2. Origin Latitude (Φ_o): 42°43'10.000000"
3. False Easting (E_o): 244754.8893 meters (802999.999 U.S. survey feet)
4. False Northing (N_o): 0.0049 meters (0.016 U.S. survey feet)
5. Scale Factor on Central Meridian (k_o): 1.0000286569

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Winnebago County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 1 millimeter.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Wood County

WISCRS (Wisconsin Coordinate Reference Systems)

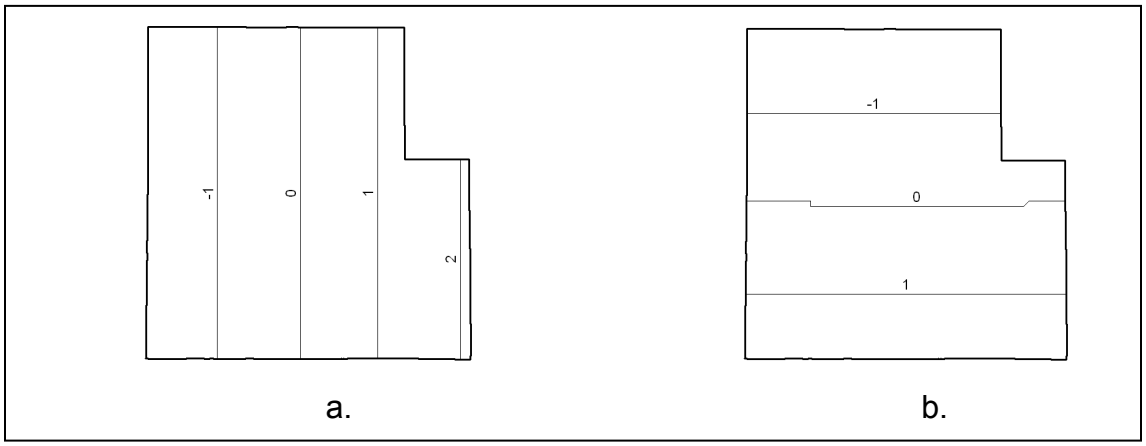
Projection: Lambert Conformal Conic

The parameters for this projection are

1. Origin Longitude (λ_o): 90°00'00.000000"
2. Latitude of the Central Parallel and Coordinate Origin (Φ_o):
   44°21'45.343690"
3. False Easting (E_o): 208483.6173 meters (684000.001 U.S. survey feet)
4. False Northing and Northing of the Central Parallel at the Central Meridian (N_o):
   134589.7540 meters (441566.551 U.S. survey feet)
5. Scale Factor on Central Parallel (k_o): 1.0000421209

NOTE: Distance units in meters; angular units in degrees, minutes, seconds; and the scale factor are exact.

Coordinate Shifts (WISCRS minus WCCS)



Isoline Maps of a) Easting (X) Shift and b) Northing (Y) Shift (in Millimeters) for Wood County

The maximum absolute value in any easting shift is less than 3 millimeters.

The maximum absolute value in any northing shift is less than 2 millimeters.

NOTES:

1. WISCRS parameters, above, are for use with the GRS 80 ellipsoid. WCCS parameters, published in 1995, were for use with enlarged or raised ellipsoids.
2. The *de facto* horizontal geodetic datum and adjustment for WISCRS is NAD 83 (1991). However, ground-to-grid ratios, for most applications, are also negligible for other adjustments of NAD 83 (e.g., NAD 83 (1986), NAD 83 (1997)).

Appendix B

Direct and Inverse Transformations for Transverse Mercator Projections

(From Stem (1989))

A.1 Notation and Definitions

Φ	Geodetic latitude, positive north.
λ	Geodetic longitude, positive west.
ω	Rectifying latitude.
N	Northing coordinate on the projection.
E	Easting coordinate on the projection.
λ_o	Longitude of the central meridian.
E_o	False easting of the coordinate origin.
S	Meridional distance from the equator.
Φ_o	Latitude of the coordinate origin.
N_o	False northing of the coordinate origin.
S_o	Meridional distance from the equator to Φ_o, multiplied by k_o.
k_o	Scale factor along the central meridian.
a	Semimajor axis of the reference ellipsoid.
b	Semiminor axis of the reference ellipsoid.
e	First eccentricity of the reference ellipsoid.
e'	Second eccentricity of the ellipsoid.
R	Radius of curvature in the prime vertical.
r	Radius of the rectifying sphere.

A.2 Computing Projection Constants

$$e^2 = \frac{a^2 - b^2}{a^2}$$

$$e'^2 = \frac{e^2}{1 - e^2}$$

$$n = \frac{a - b}{a + b}$$

$$r = a(1-n)(1-n^2)\left(1+\frac{9n^2}{4}+\frac{225n^4}{64}\right)$$

$$u_2 = -\frac{3n}{2}+\frac{9n^3}{16}$$

$$u_4 = \frac{15n^2}{16}-\frac{15n^4}{32}$$

$$u_6 = -\frac{35n^3}{48}$$

$$u_8 = \frac{315n^4}{512}$$

$$U_0 = 2(u_2 - 2u_4 + 3u_6 - 4u_8)$$
$$U_2 = 8(u_4 - 4u_6 + 10u_8)$$
$$U_4 = 32(u_6 - 6u_8)$$
$$U_6 = 128u_8$$

$$v_2 = \frac{3n}{2}-\frac{27n^3}{32}$$

$$v_4 = \frac{21n^2}{16}-\frac{55n^4}{32}$$

$$v_6 = \frac{151n^3}{96}$$

$$v_8 = \frac{1097n^4}{512}$$

$$V_0 = 2(v_2 - 2v_4 + 3v_6 - 4v_8)$$
$$V_2 = 8(v_4 - 4v_6 + 10v_8)$$
$$V_4 = 32(v_6 - 6v_8)$$
$$V_6 = 128v_8$$

$$\omega_o = \phi_o + \sin\phi_o\cos\phi_o(U_0 + U_2\cos^2\phi_o + U_4\cos^4\phi_o + U_6\cos^6\phi_o)$$
$$S_o = k_o\omega_o r$$

A.3 Direct Transformation (Φ,λ to N,E)

$$L = (\lambda - \lambda_o)\cos\phi$$
$$\omega = \phi + \sin\phi\cos\phi(U_0 + U_2\cos^2\phi + U_4\cos^4\phi + U_6\cos^6\phi)$$
$$S = k_o\omega r$$

$$t = \tan\phi$$

$$\eta^2 = e'^2 \cos^2\phi$$

$$R = \frac{k_o a}{\sqrt{1 - e^2 \sin^2\phi}}$$

$$A_1 = -R$$

$$A_2 = \frac{Rt}{2}$$

$$A_3 = \frac{1 - t^2 + \eta^2}{6}$$

$$A_4 = \frac{5 - t^2 + \eta^2(9 + 4\eta^2)}{12}$$

$$A_5 = \frac{5 - 18t^2 + t^4 + \eta^2(14 - 58t^2)}{120}$$

$$A_6 = \frac{61 - 58t^2 + t^4 + \eta^2(270 - 330t^2)}{360}$$

$$A_7 = \frac{61 - 479t^2 + 179t^4 - t^6}{5040}$$

$$N = S - S_o + N_o + A_2 L^2 \left[1 + L^2 (A_4 + A_6 L^2)\right]$$

$$E = E_o + A_1 L \left\{1 + L^2 \left[A_3 + L^2 (A_5 + A_7 L^2)\right]\right\}$$

A.4 Inverse Transformation (N,E to Φ,λ)

$$\omega = \frac{N - N_o + S_o}{k_o r}$$

$$\phi_f = \omega + \sin\omega\cos\omega(V_0 + V_2 \cos^2\omega + V_4 \cos^4\omega + V_6 \cos^6\omega)$$

$$t_f = \tan\phi_f$$

$$\eta_f^2 = e'^2 \cos^2\phi_f$$

$$R_f = \frac{k_o a}{\sqrt{1 - e^2 \sin^2\phi_f}}$$

$$Q = \frac{E - E_o}{R_f}$$

$$B_2 = \frac{-t_f(1 + \eta_f^2)}{2}$$

$$B_3 = \frac{-(1+2t_f^2+\eta_f^2)}{6}$$

$$B_4 = \frac{-(5+3t_f^2+\eta_f^2(1-9t_f^2)-4\eta_f^4)}{12}$$

$$B_5 = \frac{5+28t_f^2+24t_f^4+\eta_f^2(6+8t_f^2)}{120}$$

$$B_6 = \frac{61+90t_f^2+45t_f^4+\eta_f^2(46-252t_f^2-90t_f^4)}{360}$$

$$B_7 = \frac{-(61+662t_f^2+1320t_f^4+720t_f^6)}{5040}$$

$$L = Q\left\{1+Q^2\left[B_3+Q^2(B_5+B_7Q^2)\right]\right\}$$

$$\phi = \phi_f + B_2Q^2\left[1+Q^2(B_4+B_6Q^2)\right]$$

$$\lambda = \lambda_o - \frac{L}{\cos\phi_f}$$

Appendix C

Direct and Inverse Transformations for Non-Intersecting Lambert Conformal Conic Projections

(From Bomford (1985))

C.1 Notation and Definitions

Φ	Geodetic latitude, positive north.
λ	Geodetic longitude, negative west.
N	Northing coordinate on the projection.
E	Easting coordinate on the projection.
λ_o	Longitude of the central meridian.
E_o	False easting of the coordinate origin.
Φ_o	Latitude of the central parallel and coordinate origin.
N_o	False northing of the coordinate origin and northing of the central parallel at the central meridian.
k_o	Scale factor along the central parallel (Φ_o).
a	Semimajor axis of the reference ellipsoid.
b	Semiminor axis of the reference ellipsoid.
e	First eccentricity of the reference ellipsoid.
e'	Second eccentricity of the reference ellipsoid.
γ	Convergence angle.
r_o	Mapping radius at the coordinate origin.
v_o	Radius of curvature in the meridian at Φ_o.
ρ_o	Radius of curvature in the prime vertical at Φ_o.
M_o	Meridional arc from the equator to Φ_o.
M_Φ	Meridional arc from the equator to Φ.
M	Meridional arc from Φ to Φ_o (M is negative if $M_\Phi < M_o$).
s	Meridional arc from Φ to Φ_o scaled to the projection (s is negative if $M_\Phi < M_o$).

C.2 Computing Projection Constants

$$e^2 = \frac{a^2 - b^2}{a^2}$$

$$e'^2 = \frac{e^2}{1-e^2}$$

$$v_o = \frac{a}{\sqrt{1-e^2 \sin^2 \phi_o}}$$

$$\rho_o = \frac{a(1-e^2)}{(1-e^2 \sin^2 \phi_o)^{\frac{3}{2}}}$$

$$r_o = \frac{k_o v_o}{\tan \phi_o}$$

$$A_o = 1 - \frac{e^2}{4} - \frac{3e^4}{64} - \frac{5e^6}{256}$$

$$A_2 = \frac{3}{8}\left(e^2 + \frac{e^4}{4} + \frac{15e^6}{128}\right)$$

$$A_4 = \frac{15}{256}\left(e^4 + \frac{3e^6}{4}\right)$$

$$A_6 = \left(\frac{35}{3072}\right)e^6$$

$$M_o = a(A_0\phi_o - A_2 \sin 2\phi_o + A_4 \sin 4\phi_o - A_6 \sin 6\phi_o)$$

C.3 Direct Transformation (Φ,λ to N,E)

$$M_\phi = a(A_0\phi - A_2 \sin 2\phi + A_4 \sin 4\phi - A_6 \sin 6\phi)$$

$$M = M_\phi - M_o$$

$$M_3 = \frac{M^3}{6\rho_o v_o}$$

$$M_4 = \frac{M^4 \tan \phi_o (1 - 4e'^2 \cos^2 \phi_o)}{24\rho_o v_o^2}$$

$$M_5 = \frac{M^5 (5 + 3\tan^2 \phi_o - 3e'^2 - e'^2 \cos^2 \phi_o)}{120\rho_o^2 v_o^2}$$

$$M_6 = \frac{M^6 \tan \phi_o (7 + 4\tan^2 \phi_o)}{240\rho_o^2 v_o^3}$$

$$M_7 = \frac{M^7 (60\tan^4 \phi_o + 180\tan^2 \phi_o + 61)}{5040\rho_o^3 v_o^3}$$

$$s = k_o(M + M_3 + M_4 + M_5 + M_6 + M_7)$$

$$\gamma = (\lambda - \lambda_o)\sin\phi_o$$

$$\Delta E = (r_o - s)\sin\gamma$$

$$E = E_o + \Delta E$$

$$N = N_o + s + \Delta E \tan\left(\frac{\gamma}{2}\right)$$

C.4 Inverse Transformation (N,E to Φ,λ)

$$\gamma = \tan^{-1}\left(\frac{E - E_o}{r_o - N + N_o}\right)$$

$$\lambda = \left(\frac{\gamma}{\sin\phi_o}\right) + \lambda_o$$

$$s = N - N_o - (E - E_o)\tan\left(\frac{\gamma}{2}\right)$$

Computation of M is iterative:

1. Begin with an approximation of $M_a = \frac{s}{k_o}$.

2. Compute the following:

$$M_{3_a} = \frac{M_a^3}{6\rho_o\nu_o}$$

$$M_{4_a} = \frac{M_a^4 \tan\phi_o(1 - 4e'^2\cos^2\phi_o)}{24\rho_o\nu_o^2}$$

$$M_{5_a} = \frac{M_a^5(5 + 3\tan^2\phi_o - 3e'^2 - e'^2\cos^2\phi_o)}{120\rho_o^2\nu_o^2}$$

$$M_{6_a} = \frac{M_a^6 \tan\phi_o(7 + 4\tan^2\phi_o)}{240\rho_o^2\nu_o^3}$$

$$M_{7_a} = \frac{M_a^7(60\tan^4\phi_o + 180\tan^2\phi_o + 61)}{5040\rho_o^3\nu_o^3}$$

$$-F_a = \left(\frac{s}{k_o}\right) - M_a - M_{3_a} - M_{4_a} - M_{5_a} - M_{6_a} - M_{7_a}$$

$$\left(\frac{\partial F}{\partial M}\right)_a = 1 + \frac{3M_{3_a}}{M_a} + \frac{4M_{4_a}}{M_a} + \frac{5M_{5_a}}{M_a} + \frac{6M_{6_a}}{M_a} + \frac{7M_{7_a}}{M_a}$$

$$\delta M = \frac{-F_a}{\left(\frac{\partial F}{\partial M}\right)_a}$$

3. Add δM to M_a.
4. Repeat steps 2 and 3 until the absolute value of δM is less than 0.00005 (meters).

$$M = M_a$$
$$M_\phi = M_o + M$$

Computation of latitude is iterative:

1. Begin with an approximation of $\phi_a = \frac{M_\phi}{aA_o}$ (radians).
2. Compute the following:

$$-G_a = M_\phi - a(A_0\phi_a - A_2 \sin 2\phi_a + A_4 \sin 4\phi_a - A_6 \sin 6\phi_a)$$

$$\left(\frac{\partial G}{\partial \phi}\right)_a = a(A_0 - 2A_2 \cos 2\phi_a + 4A_4 \cos 4\phi_a - 6A_6 \cos 6\phi_a)$$

$$\delta\phi = \frac{-G_a}{\left(\frac{\partial G}{\partial \phi}\right)_a}$$

3. Add $\delta\phi$ to ϕ_a.
4. Repeat steps 2 and 3 until the absolute value of $\delta\phi$ is less than 0.0000005 seconds of arc.

$$\phi = \phi_a$$