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MANUAL OF TRAVERSE COMPUTATION ON THE LAMBERT GRID

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MANUAL OF TRAVERSE COMPUTATION ON THE LAMBERT GRID

GENERAL STATEMENT

Since the Lambert projection has been made the basis for plane coordinate systems in many of the States, it seemed advisable to prepare a publication with elementary examples of its use in actual computations. To make the work more concrete, we decided to make use of some actual surveys that were made under the C. W. A. program. We have confined our selections to one State because in that way the actual tables on which the work was based could more easily be included in the publication. We have, therefore, selected several traverse surveys in Nebraska to serve as the examples to be included in this publication.

The Lambert conformal conic projection with two standard parallels is the one that was chosen for the computation of the tables. This can be looked upon as a cone the axis of which coincides with the axis of the earth and which intersects the earth instead of being tangent to the same. This does not in fact tell the whole story, but it is sufficiently accurate for a pictorial illustration. This cone intersecting the sphere is shown in figure 1. The meridians on the earth are represented by the elements of the cone and hence they all intersect in a point at the apex of the cone. When the conical surface is split along an element it can then be unrolled in a plane and the parallels become arcs of concentric circles. If the map were continued up to the pole, the point of intersection of the meridians would represent the pole of the earth. In these State coordinate systems, however, we show only a limited extent of latitude and hence we have only a portion of the conical surface which is included between two arcs of concentric circles which represent the upper and lower parallels that are included in the region for which the tables are computed.

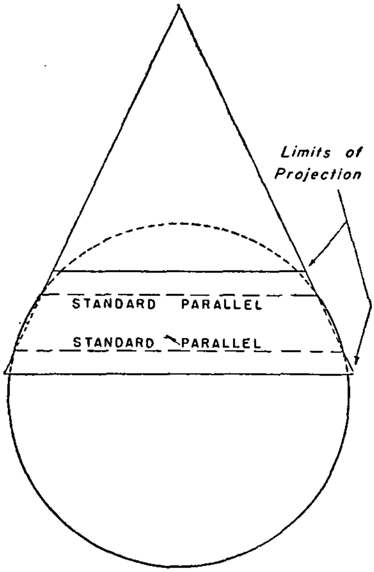

FIGURE 1.—Sphere and intersecting cone illustrating the Lambert conformal conic projection.

When the conical surface is developed in the plane, we have a sector of a circle as is shown in figure 2. A more detailed description of this figure will be given later in connection with a description of the use of the tables.

THE TABLES

The tables as computed are designed for the reduction of geographic positions to plane coordinates in the given system. All that is needed then is a table of radii values for the various latitudes at an interval sufficiently small to allow straight line interpolation. It was found that tabulation of the values for every minute of latitude would be sufficient for the accuracy required. A second table was needed to give conveniently what is called the mapping angle denoted by θ. This is merely the longitude out from the central meridian multiplied by the constant l of the projection. Of course, this multiplication could actually be made for every computation but it would require the reduction of the degrees, minutes, and seconds to seconds in each case before performing the multiplication. It seemed desirable to tabulate the values for every minute of longitude and then it would only be necessary to multiply the seconds of longitude by the constant l to get the complete value of θ for any longitude. Since the θ values are counted positive to the eastward hence when east of the central meridian this seconds value has to be subtracted numerically from the minute tabular value to determine the full value of θ. When west of the central meridian the two values are added together numerically to get the full negative value of θ.

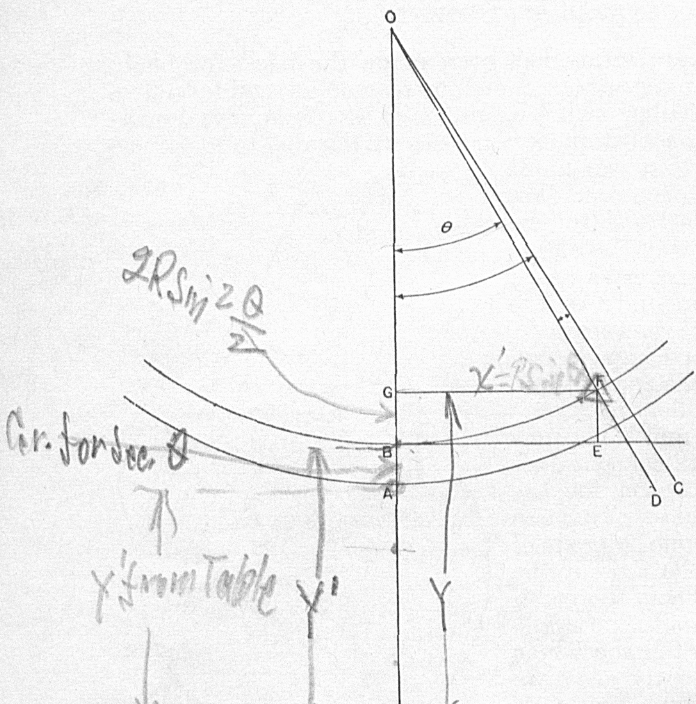

FIGURE 2.—Development of a cone in a plane.

DESCRIPTION OF THE COMPUTATION FORM

The first thing that has to be done in the use of the system is to reduce the geographic coordinates to plane coordinates. Figure 3 shows a computation form with the various entries numbered consecutively. Item no. 1 is the name of the State with the section of the State in case more than one system is included in the given State. Item no. 2 is the name of the triangulation station as given in the list of geographic positions. Item no. 3 is the latitude and item no. 4 is the longitude of the station as given in the list of geographic positions. Items nos. 5, 6, and 7 are taken from the State table of Lambert coordinates (see fig. 45), care being taken to make use of the right section in case there is more than one system in the State. These values are found in table no. I (see fig. 45) opposite the degrees and minutes of the latitude given in item no. 3, listed in the first, second, and third columns, respectively, of that table. Item no. 8 is found by multiplying item no. 7 by the seconds of latitude given in no. 3. This value is subtracted from no. 5 and added to no. 6. Item no. 9 is merely the result of subtracting no. 8 from no. 5 and item no. 10 is the sum of nos. 8 and 6.

Item no. 11 is found in table no. II (see fig. 45) for the given State and given section opposite the degrees and minutes of the longitude

Plane coordinates on Lambert projection

State 1 Station 2

ϕ = ° ′ ″ 3 λ = ° ′ ″ 4

Tabular difference of R for 1″ of ϕ = 7

R (for min. of ϕ)		5	y′ (for min. of ϕ)		6
Cor. for sec. of ϕ		− 8	Cor. for sec. of ϕ		+ 8
R		9	y′		10
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 26
θ (for min. of λ)		° ′ ″ 11	y		28
Cor. for sec. of λ		− 12			
θ		13	$\frac{\theta}{2}$		° ′ ″ 14
θ''	For machine computation	15″		For machine computation	
			log θ''		16
log θ''		16	colog 2		9.69897000
S for θ		17	S for $\frac{\theta}{2}$		18
log sin θ	sin θ	19	log sin $\frac{\theta}{2}$	sin $\frac{\theta}{2}$	20
log R		22		R sin $\frac{\theta}{2}$	
log x′		23	log $\sin^2 \frac{\theta}{2}$	R $\sin^2 \frac{\theta}{2}$	21
x′	R sin θ	25	log R		22
		2,000,000.00	log 2		0.30103000
x		27	log y″		24

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 3.—Form with index numbers for explanation of computation.

given in item no. 4. Item no. 12 is the product of the seconds of longitude given in no. 4 by the constant *l* given at the top of the pages of table no. II. Item no. 13 is the result of subtracting no. 12 from no. 11, remembering that if θ is negative the two add together numerically. Item no. 14 is this value of no. 13 divided by 2. If the computation is being made by logarithms, using the *S* table for the computations of the sines, an approximate value to the nearest tenth of a second is sufficient. However, if machine computation is being used, exactly one-half of no. 13 should be used since the sine is to be determined from it directly. Item no. 15 is the value of no. 13

reduced to seconds and item no. 16 is merely the logarithm of no. 15. This is copied both at the right and at the left of the page. Item no. 17 is the S value for the angle given in no. 13 and item no. 18 is the same value for the angle given in no. 14. These S values are tabulated for every second of arc in the 8-place logarithm table of trigonometric functions. They change very slowly so that in most cases the nearest second is sufficient and at most the nearest tenth of a second is amply sufficient to be used in interpolation. If 10-place tables have to be used a supplementary table given for every 10 seconds of arc will have to be used.

Item no. 19 is the sum of nos. 16 and 17 and item no. 20 is the sum of nos. 16 and 18 together with the colog of 2 already printed in the form. Item no. 21 is no. 20 multiplied by 2. Item no. 22 is the logarithm of no. 9 and it is copied both to the right of the form and also to the left of the same. Item no. 23 is the sum of nos. 19 and 22 and item no. 24 is the sum of nos. 21 and 22 together with the log of 2 already printed on the form. Item no. 25 is the number corresponding to the log given in no. 23, and item no. 26 is the same for the logarithm given in no. 24. Item no. 27 is the sum of no. 25 and the given constant for the State in most cases the 2,000,000 already printed on the form. Finally, item no. 28 is the sum of nos. 10 and 26. This completes the computation, no. 27 being the required x value and no. 28 the required y value.

If the computation is made by machine, a number of the steps can be omitted. No. 15 does not need to be given, for the sine of no. 13 can be taken out and entered where no. 19 is given. This number set on the multiplying machine and multiplied by no. 9 gives $R \sin \theta$ at once as no. 25. On the right-hand side the sine of no. 14 as the full value of the half of no. 13 can be found from the table and entered in the place of no. 20. This sine multiplied by no. 9 can be placed just beneath no. 20; it will be approximately equal to the half of no. 25 which will guide the placing of the decimal point. This number set on the machine and multiplied by sine $\frac{\theta}{2}$ given in place of no. 20 can be placed in the line of no. 21. This number must then be multiplied by 2 and becomes no. 26 given above. This machine computation is somewhat shorter but unfortunately not every one has a 10-bank multiplying machine such as would be required to carry out the work.

DIAGRAM OF THE COMPUTATION

We are now in a position to give a more intelligible explanation of figure no. 2 which illustrates the quantities to be computed. The radius OA is no. 5; YA is no. 6, and AB is no. 8 which can be seen to subtract from OA and add to YA. The angle AOC is no. 11 and the small angle COD is no. 12. It can be seen that it decreases the angle AOC to AOD when the station is east of the central meridian but it would increase the angle numerically when the station is west of the central meridian. Since the θ angle west of the central meridian is itself negative the effect of no. 12 is to reduce the θ angle algebraically on whichever side it may lie. The station is at F and EF is no. 26 and FG is no. 25. This diagram should make clear the steps in the computation as described on the computation form.

DESCRIPTION OF AN ACTUAL COMPUTATION

In order to be able to start a traverse computation, we must have the coordinates of the starting point together with a grid azimuth at the station from which to compute the grid azimuths of the lines of the traverse. As our first example we have chosen a loop traverse starting from the station Lars with an azimuth on Minden Catholic Church spire. We shall now describe the computation of the coordinates of Lars given on page 15. This station is in Nebraska-South and the value of ϕ is 40°27′06″.122 and of λ is 98°55′22″.953 as given in the list of geographic positions for Nebraska. From the State table on page 184 opposite 40°27′ we find nos. 5, 6, and 7 to be 24,305,408.29, 285,373.57, and 101.19350, respectively. We now multiply 101.19350 by the seconds of ϕ, or 6.122 which gives 619.51. This is no. 8 and it is subtracted from no. 5 and added to no. 6 giving 24,304,788.78 and 285,993.08, respectively, as nos. 9 and 10. Then from the table on page 190 opposite longitude 98°55′ we get +0°22′57″.7604 as no. 11. Now multiply the seconds of λ or 22.953 by 0.65607640 given at the top of the page of table no. II (see fig. 45), which gives 15.0589 as no. 12; this subtracted from no. 11, given above, results in +0°22′42″.7015 or +1362″.7015 for nos. 13 and 15, respectively. Now log 1362.7015=3.13440074 which is entered as no. 16 both to the right and to the left of the form. From the trigonometric table we find the S for no. 13 or θ to be 4.68557171−10 and for no. 14 or $\frac{\theta}{2}$ to be 4.68557408−10, respectively, as nos. 17 and 18. The sum no. 19 becomes 7.81997245−10 and that of no. 20, 7.51894482−10. Now by multiplying the latter quantity by 2, we get no. 21 as 5.03788964−10. Next the log of 24,304,788.78 is equal to 7.38569186; by entering this as no. 22, both to the right and to the left, we get by addition no. 23, at the left, as 5.20566431 and no. 24, at the right, as 2.72461150. The number corresponding to the log 5.20566431 is 160,569.96 and becomes no. 25, and the number corresponding to log 2.72461150 is 530.41 and is no. 26 on the form. No. 25 is positive because θ or no. 13 was positive, so the value of x becomes 2,160,569.96 and the value 530.41, as no. 26, added to no. 10 gives the y value 286,523.49.

The computation of the coordinates for Minden Catholic Church spire is carried out in exactly a similar manner, and with the above description in mind it should be easy to follow. Both of the computations are also carried out by machine computation as a check but it is hardly necessary to give a detailed description of the process since it should be evident from the values given on the computation form. The first part of the computation is the same whether logs are to be used or the machine in the latter part.

COMPUTATION OF THE GRID AZIMUTH

We now have the coordinates of both Lars and Minden Catholic Church spire. With these coordinates the grid or plane azimuth can be determined. Subtract the coordinates of the station from which the azimuth radiates from those of the other station. In this case subtract the coordinates of Lars from those of Minden Catholic Church spire as shown in the computation on page 12. Be sure to indicate the sign of Δx and Δy, whether minus or plus. In this example $\Delta x = -5{,}293.35$ and $\Delta y = +17{,}751.96$. Now for the time being we can pay no attention to the signs and we have

$$\log \tan \alpha = \log \Delta x - \log \Delta y.$$

This gives $\log \tan \alpha = 9.47448430 - 10$. From the trigonometric table we find that this is the log tan of 16°36′13″.5, or α=16°36′13″.5. This is the angle out from the y direction through Lars. But we wish to give this in terms of azimuth starting from the downward direction through Lars as zero.

RULES FOR DETERMINATION OF THE AZIMUTH

Now the signs of the Δx and Δy become important. The following rules will serve in all cases to determine the azimuth from the angle α.

If both Δx and Δy are *negative*, then the grid azimuth $= \alpha$.

If Δx is *negative* and Δy *positive*, then the grid azimuth $= 180° - \alpha$.

If both Δx and Δy are *positive*, then the grid azimuth $= 180° + \alpha$.

If Δx is *positive* and Δy *negative*, then the grid azimuth $= 360° - \alpha$.

We need only to bear these rules in mind to determine the grid azimuth from the angle α in any given case. In the case before us Δx is negative and Δy positive, hence grid azimuth = 180° − 16°36′13″.5 = 163°23′46″.5, which is the plane or grid azimuth from Lars to Minden Catholic Church spire.

Let us emphasize at this point the necessity of using the coordinates of the two stations for the computation of the grid azimuth *whenever* possible. This is always possible if we have the geographic positions of both stations. This is necessary because the geodetic line on the earth joining two stations is not represented exactly by the straight line joining them on the projection. In most cases there is a small correction angle that has to be taken into account. In the work of the Coast and Geodetic Survey at present, azimuth marks are established at a distance of one-fourth to 1 mile from the station to serve in turning off an azimuth for a traverse if such should be needed. With these we do not in general have the geographic position of the azimuth mark, so we cannot get the grid azimuth from the coordinates. In that case, and only in that case, the grid azimuth should be found by subtracting the θ angle at the station of origin from the geodetic azimuth of the mark as given in the list of geographic positions. This is permissible in such cases because the distance of the mark from the station is small and the correction term contains Δx as a factor and hence would be small in all cases. It should be remembered that when θ is negative, it will be added numerically to the geodetic azimuth. In other words when the computation lies in a region east of the central meridian, the grid azimuth is less than the geodetic azimuth but when the work is west of the central meridian the grid azimuth is the larger.

COMPUTATION OF THE GRID AZIMUTHS OF THE TRAVERSE

The first traverse chosen for an example is a loop traverse that starts from Lars by use of the grid azimuth Lars to Minden Catholic Church spire. It is probably best to carry the azimuth through the traverse to check on the final control azimuth before starting the regular computation of coordinates. This is done by turning at the station through the given observed angle. The reverse azimuth on each line is obtained by adding 180° to the forward azimuth on the same line, dropping out 360° if the resulting sum is greater than 360°. The troublesome matter of the convergence of the meridians is thus entirely avoided.

After the discrepancy is determined by the check on the final control azimuth, this discrepancy can then be prorated on the various angles to give values of the grid azimuths to be used in the computation of the coordinates. In the case of a loop traverse, such as this one, the starting and ending azimuth are the same. We prefer to make this computation on separate sheets rather than try to include it on the coordinate computation sheets. The details of this calculation are found on page 13.

REDUCTION OF LENGTHS

Sea-level reduction, rigid method

All geodetic computations are based on lengths at sea level. In consequence any lengths measured on the actual surface of the earth must first be reduced to sea level before they are used in the computation. If the surface on which a traverse is measured is fairly regular so that the variations in elevation are not large it is sufficient to get a mean elevation for the traverse as a whole for the computation of this reduction. However, if the course of the traverse is very rugged with great variations in elevation, it would be necessary to compute a reduction factor for each line individually. This region of Nebraska is fairly free from hills so it was possible to compute a common factor for each of the lines of the given traverse. If R_a denotes a mean radius for the given region, it can be computed from the formula

$$R_a = \sqrt{R\,N},$$

in which N is the radius of curvature perpendicular to the meridian and R is the radius of curvature in the meridian.

The value of N can be computed from the A factor given in Special Publication No. 8 taken out for the mean latitude in the following way:

$$N = \frac{1}{A \sin 1''} \times \frac{3{,}937}{1{,}200}$$

$$\text{also } R = \frac{1}{B \sin 1''} \times \frac{3{,}937}{1{,}200}.$$

The factor $\frac{3{,}937}{1{,}200}$ is introduced to reduce the values to feet since A and B are based on the meter. The factor $\frac{1}{\sin 1''} \times \frac{3{,}937}{1{,}200}$ is a constant the logarithm of which is 5.8304093. Thus we can compute R_a by the formula,

$$\log R_a = 5.8304093 - \tfrac{1}{2} \log A - \tfrac{1}{2} \log B.$$

After R_a is determined by this formula we compute the reduction factor by the formula,

$$\text{reduction factor} = \frac{R_a}{R_a + h}$$

in which h is the average elevation of the traverse.

Sea-level reduction, approximate method

Since all geodetic positions are computed on a sea-level surface of the ellipsoid*, the coordinates resulting from them are also based on a sea-level surface. If a distance is computed from the difference of the coordinates, the result is what we call a grid distance. If to this distance we apply the grid correction for the scale of the map, we obtain the sea-level distance that would be obtained from an inverse computation from the geodetic positions, that is the computation of the distance between two stations, the positions of which are given. If the actual ground-level length is desired, we must increase the sea-level length by the proper amount to raise the length to the given mean elevation of the ground in that region.

Now, considering the problem in the inverse direction, actual ground-level lengths must first be reduced to sea level and then these sea-level lengths reduced to the grid length by use of the grid factor if we wish to get the best out of our work.

In this publication the sea-level reduction factors have been computed in the most rigid manner. In actual practice, however, it is not necessary to use such great refinement. It is possible to adopt a mean R_a which can be used throughout the whole of the United States. For this purpose we have adopted R_a equal to 20,906,000 feet, which is approximately the value for the latitude of 37°. With this mean value we have computed a table of sea-level factors which can be used as a basis for interpolation for any given mean elevation. The elevation factors are listed for every 500 feet of elevation from sea level up to 5,500 feet which is a range that will cover almost any region in which traverses will be measured within the limits of the United States.

The table is given in two forms; the first with the elevation factors for use in connection with a calculating machine, and the second in the form of a correction to be applied to the measured length. When multiplications have to be made by hand, the second table is the more convenient for use.

Table I

Elevation	Sea-level factor	Elevation	Sea-level factor
Feet		*Feet*	
Sea level	1.0000000	3,000	0.9998565
500	.9999761	3,500	.9998326
1,000	.9999522	4,000	.9998087
1,500	.9999283	4,500	.9997848
2,000	.9999043	5,000	.9997609
2,500	.9998804	5,500	.9997370

From this table it can be seen that an elevation of 2,090 feet requires a reduction of 1 part in 10,000 and an elevation of 4,180 feet requires a reduction of 1 part in 5,000. Even an elevation of 500 feet has an appreciable effect on the length that should be used for the best results.

In using the second table, first divide the given length by 100,000 by moving the decimal point five places to the left. In doing this, use the result merely to the nearest digit in the fifth decimal place,

*Strictly speaking the surface of the ellipsoid is not an exact sea-level surface. The departures of the true sea-level surface from the ellipsoid are so small that they are negligible in practical surveying.

neglecting entirely the remainder of the number. Then multiply this number by the following factors and subtract the result from the measured length.

Table II

Elevation	Correction factor	Elevation	Correction factor
Feet		*Feet*	
Sea level	0.00	3,000	14.35
500	2.39	3,500	16.74
1,000	4.78	4,000	19.13
1,500	7.17	4,500	21.52
2,000	9.57	5,000	23.91
2,500	11.96	5,500	26.30

As an illustration of the use of the tables, let us assume a length of 4,327.596 feet, measured at an elevation of 1,800 feet. In table I, the tabular difference between the 1,500-foot and 2,000-foot elevation is −240 in the last decimal places. The elevation of 1,800 feet is 3/5 or 0.6 of the tabular interval.

$$0.6 \times 240 = 144$$

Hence the elevation factor is 0.9999139 which is 144 units in the last decimal places less than the factor for the 1,500-foot elevation.

$$4{,}327.596 \times 0.9999139 = 4{,}327.223$$

Thus we find the sea-level length to be 4,327.223 feet.

In table II, for the same elevations, we find the tabular difference to be 2.40. Multiply this by the above 0.6 and there results 1.44. This must be added to the 7.17 for the 1,500-foot elevation.

$$7.17 + 1.44 = 8.61$$

Now move the decimal point in 4,327.596 five places to the left and drop down to five places, and there results 0.04328.

$$0.04328 \times 8.61 = 0.373$$

$$\text{and } 4{,}327.596 - 0.373 = 4{,}327.223$$

This is the same result as was obtained by the use of table I.

Reduction for scale error

After the sea-level reduction is applied it is then necessary to reduce these geodetic lengths to grid lengths if it is desired to get the best out of the work. If the latitude extent of the survey is not great, a mean scale factor can be found by interpolating in table I (see fig. 45) for the mean latitude of the traverse. This was done on the traverse Wanda to Mason in which the reduction in question is given on page 63. This traverse runs approximately east and west so a mean latitude for the two end stations was used. On the Minden traverse loop and on the other traverses given in this publication, the following plan was used: By means of the azimuths and lengths of the lines the traverse was plotted approximately on Geological Survey quadrangle maps and the approximate latitude of the middle of each line was thus determined. By an interpolation in table I with these mean latitudes as arguments the grid factor for each line was determined. This is a very satisfactory method of handling the problem. On the traverse Prosser to Shelton east base, however, we adopted the values determined by the C. W. A. computers in their work after we had scanned them to see if they were reasonable values.

It is a fact that a mean value for the scale factor for the extent of the traverse could very well be used on all of the sections included in this publication and that method would probably suffice in most cases without doing any great violence to the measured quantities. If quadrangle maps are not available, the following procedure can be followed. Compute preliminary y values using the sea-level lengths. The traverse will start and end on geodetic stations in most cases. For these the term $2\,R\,\sin^2\frac{\theta}{2}$ will either be known or can be computed. From the value of this term at the two control stations, we can get a mean value for the traverse. Now subtract this mean value from each of the preliminary y values which gives us approximate y' values. Then a mean of these y' values for the two ends of a line will give a mean y' for the line to be used for interpolation in the y' column of table I. This in general would not be a complicated process and it would give very reasonable values for the grid reduction. We are of the opinion that at least a mean scale reduction should be applied in all cases unless the survey is made in a region of negligible scale error. From the control data it is almost always possible to know the latitude limitations of a given survey and from these a mean value of the scale or grid correction can be found.

COMPUTATION OF THE COORDINATES

We are now in a position to begin the actual computation of the coordinates. On the computation form shown on page 21 *et seq.*, we enter the names of the stations, together with the grid azimuth and the grid distance that have already been computed. Just under the grid distance of the individual line is given the continuous sum of the grid distances limited to the nearest even foot. These are to be used in prorating the discrepancies in the x and y coordinates. All of the traverse computations of the Hastings area have been made in duplicate, first with 8-place logarithms and second with 8-place natural functions. The second computation is the shorter if a multiplying machine is available, together with an 8-place natural table for every second of arc. Since it is easier to get the logarithmic trigonometric tables than it is to get the natural tables and the machine, no doubt most computations will be made by the first method.

The grid length multiplied by the cosine of the grid azimuth gives the latitude, and the same length multiplied by the sine of the grid azimuth gives the departure. The signs are determined by the following rules:

For an azimuth between 0° and 90°, the latitude is *minus* and the departure *minus*.

For an azimuth between 90° and 180°, the latitude is *plus* and the departure *minus*.

For an azimuth between 180° and 270°, the latitude is *plus* and the departure *plus*.

For an azimuth between 270° and 360°, the latitude is *minus* and the departure *plus*.

These rules, therefore, give the signs to be assigned to the latitudes and departures as they are computed and listed in their respective columns. These are successively added to the y and x values, starting with the fixed value of the control station of origin. The fixed value of the coordinates of the last or check station when subtracted from the computed value of the same gives the discrepancy in closure in the y and x coordinates. Each of these discrepancies should be divided by the total of the summation of the lengths to give the y and x factor, respectively. These should be given signs opposite to that of the discrepancy in each case. If the discrepancy is plus, the individual coordinates need to be reduced and vice versa. These factors multiplied successively by the summation lengths give the corrections to be applied to the various coordinates. If a multiplication machine is not available these multiplications can probably be made most easily by logarithms, since five places of logs will be sufficient in almost any case that may arise. With a 7- or 8-place table these values can be taken out without any need of interpolation.

After these corrections have been applied, the work is fully adjusted, and the resulting coordinates are the final values to be used in all cases. A list of these coordinates should then be made, since they represent the final adjusted results of the survey. At this point we wish to emphasize a warning to all who may at a later time wish to use the azimuth of any given line. Since corrections were made to the computed coordinates, the azimuths given in the list and on the computation sheets are no longer correct. A final value of the azimuth of any line should be computed from the final coordinates. It will in practically all cases differ somewhat from the azimuth used in the computation. A computation of the various azimuths is not made for the final list because it is such an easy matter to determine the grid azimuth from the coordinates. As a matter of fact, they will very seldom be needed, since it is only in case someone wishes to start a new traverse from one of the stations that it is necessary to have a final grid azimuth on one of the neighboring stations.

REMARKS ON THE COMPUTATIONS

In the computations that are included in this publication, 8-place tables were used both in the logarithmic calculations and in those made with natural functions. In the computation of the latitudes and departures of the lines of the traverses 7-place tables would be amply sufficient. In the reduction of geographic positions to coordinates, however, the greater number of places is essential. The office of the Coast and Geodetic Survey is engaged upon the computation of the coordinates for all of the triangulation stations, so that these will be available for general use in due course of time. Most of the necessary computation for local surveys will then consist of the calculation of the latitudes and departures through the traverse and the adjustment of the same to fit the survey into the fixed coordinates of the control stations.

COMPUTATION FOR A STATION OBSERVED FROM TWO OR MORE TRAVERSE STATIONS

In this traverse Minden Courthouse was observed from stations 394, 400, and 401. The angle at 394 was turned off from 393, that at 400 from 401, and that at 401 from 400. To make the computation we must first compute the grid azimuths and distances for the three fixed stations 394, 400, and 401. From these we can take out the angles and distances on the grid for the triangle 394, 400, and 401.

106911°—35——2

This is a fixed triangle, and the sides should be proportional to the sines of the opposite angles. They are shown to be so by computing the triangle as is usually done. The lengths are found to agree with the values already found.

By means of the observed angles the three triangles for the courthouse can be made out with the observed and concluded angles. Since 3 directions were observed, an adjustment should be made to bring the 3 into accord. This adjustment was made by the angle method, as shown on page 31. The resulting corrections show that the observations were very good, and the resulting coordinates for Minden Courthouse should be very reliable.

This closes the work of the adjustment of the loop traverse, together with the adjustment of the observations on the courthouse. The full details of the work are shown on pages 12 to 34. The list of the coordinates embodies the final results of the survey, and it is all that needs to be furnished for information. With the list of coordinates, any further applications or uses can be made without the details of the computation and adjustment being known.

TRAVERSE, THE MINDEN LOOP

COMPUTATION OF FIXED GRID AZIMUTH, LARS TO MINDEN CATHOLIC CHURCH SPIRE

	x	y
	Feet	*Feet*
Minden Catholic Church spire.	2, 155, 276. 61	304, 275. 45
Lars	2, 160, 569. 96	286, 523. 49
Δx and Δy	−5, 293. 35	+17, 751. 96

$$\log \Delta x = 3.72373061$$
$$\log \Delta y = 4.24924631$$

$$\log \tan \alpha = 9.47448430-10$$
$$\alpha = 16°36'13''.5$$
$$\text{Grid azimuth} = 163°23'46''.5$$

LIST OF ANGLES

Station	From station—	To station—	Angle °	′	″
Lars	Minden Catholic Church.	390	288	17	53.2
390	Lars	391	177	17	36.3
391	390	392	237	00	13.1
392	391	393	151	51	49.4
393	392	394	216	37	55.8
394	393	395	162	29	40.9
395	394	396	164	43	49.7
396	395	397	237	16	10.2
397	396	398	236	51	07.7
398	397	399	213	06	27.7
399	398	400	184	21	42.5
400	399	401	173	51	26.1
401	400	402	156	16	06.9
402	401	403	174	45	09.2
403	402	404	234	52	02.9
404	403	405	246	28	21.3
405	404	406	122	00	21.7
406	405	407	242	58	42.7
407	406	408	186	23	13.6
408	407	409	242	24	49.2
409	408	410	158	16	53.3
410	409	Lars	154	44	39.6
Lars	410	Minden Catholic Church.	317	03	10.7

COMPUTATION OF GRID AZIMUTHS

Stations	Preliminary azimuth			Correction for closure	Seconds of corrected azimuth	
	°	′	″	″	′	″
Lars to Minden Catholic Church	163	23	46.5			46.5
∠Minden Catholic Church to 390	288	17	53.2	+1.6		54.8
Lars to 390	91	41	39.7			41.3
390 to Lars	271	41	39.7			41.3
∠Lars to 391	177	17	36.3	+1.6		37.9
390 to 391	88	59	16.0			19.2
391 to 390	268	59	16.0			19.2
∠390 to 392	237	00	13.1	+1.6		14.7
391 to 392	145	59	29.1			33.9
392 to 391	325	59	29.1			33.9
∠391 to 393	151	51	49.4	+1.6		51.0
392 to 393	117	51	18.5			24.9
393 to 392	297	51	18.5			24.9
∠392 to 394	216	37	55.8	+1.5		57.3
393 to 394	154	29	14.3			22.2
394 to 393	334	29	14.3			22.2
∠393 to 395	162	29	40.9	+1.6		42.5
394 to 395	136	58	55.2		59	04.7
395 to 394	316	58	55.2		59	04.7
∠394 to 396	164	43	49.7	+1.6		51.3
395 to 396	121	42	44.9			56.0
396 to 395	301	42	44.9			56.0
∠395 to 397	237	16	10.2	+1.6		11.8
396 to 397	178	58	55.1		59	07.8
397 to 396	358	58	55.1		59	07.8
∠396 to 398	236	51	07.7	+1.5		09.2
397 to 398	235	50	02.8			17.0
398 to 397	55	50	02.8			17.0
∠397 to 399	213	06	27.7	+1.6		29.3
398 to 399	268	56	30.5			46.3
399 to 398	88	56	30.5			46.3
∠398 to 400	184	21	42.5	+1.6		44.1
399 to 400	273	18	13.0			30.4
400 to 399	93	18	13.0			30.4
∠399 to 401	173	51	26.1	+1.6		27.7
400 to 401	267	09	39.1			58.1
401 to 400	87	09	39.1			58.1
∠400 to 402	156	16	06.9	+1.5		08.4
401 to 402	243	25	46.0		26	06.5
402 to 401	63	25	46.0		26	06.5
∠401 to 403	174	45	09.2	+1.6		10.8
402 to 403	238	10	55.2		11	17.3
403 to 402	58	10	55.2		11	17.3
∠402 to 404	234	52	02.9	+1.6		04.5
403 to 404	293	02	58.1		03	21.8
404 to 403	113	02	58.1		03	21.8
∠403 to 405	246	28	21.3	+1.6		22.9
404 to 405	359	31	19.4			44.7
405 to 404	179	31	19.4			44.7
∠404 to 406	122	00	21.7	+1.6		23.3
405 to 406	301	31	41.1		32	08.0
406 to 405	121	31	41.1		32	08.0
∠405 to 407	242	58	42.7	+1.5		44.2
406 to 407	4	30	23.8			52.2
407 to 406	184	30	23.8			52.2
∠406 to 408	186	23	13.6	+1.6		15.2
407 to 408	10	53	37.4		54	07.4
408 to 407	190	53	37.4		54	07.4
∠407 to 409	242	24	49.2	+1.6		50.8
408 to 409	73	18	26.6			58.2

COMPUTATION OF GRID AZIMUTHS—Continued

Stations	Preliminary azimuth	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	″
409 to 408	253 18 26. 6		58. 2
∠408 to 410	158 16 53. 3	+1. 6	54. 9
409 to 410	51 35 19. 9		53. 1
410 to 409	231 35 19. 9		53. 1
∠409 to Lars	154 44 39. 6	+1. 6	41. 2
410 to Lars	26 19 59. 5		20 34. 3
Lars to 410	206 19 59. 5		20 34. 3
∠410 to Minden Catholic Church	317 03 10. 7	+1. 5	12. 2
Lars to Minden Catholic Church	163 23 10. 2		46. 5
Fixed azimuth	163 23 46. 5		
Discrepancy	−36. 3		

REDUCTION OF LENGTHS

[Average elevation=2,173 feet. Elevation factor=0.99989611]

Section	Corrected taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Lars-390	5, 156. 485	5, 155. 949	0. 9999678	5, 155. 783
390–391	5, 689. 493	5, 688. 902	. 9999672	5, 688. 715
391–392	4, 167. 373	4, 166. 940	. 9999663	4, 166. 800
392–393	6, 013. 314	6, 012. 689	. 9999647	6, 012. 477
393–394	4, 795. 494	4, 794. 996	. 9999633	4, 794. 820
394–395	7, 196. 065	7, 195. 317	. 9999614	7, 195. 039
395–396	4, 367. 639	4, 367. 185	. 9999593	4, 367. 007
396–397	6, 470. 592	6, 469. 920	. 9999576	6, 469. 646
397–398	3, 263. 514	3, 263. 175	. 9999560	3, 263. 031
398–399	7, 972. 734	7, 971. 906	. 9999558	7, 971. 554
399–400	5, 291. 859	5, 291. 309	. 9999560	5, 291. 076
400–401	5, 303. 839	5, 303. 288	. 9999562	5, 303. 056
401–402	5, 869. 877	5, 869. 267	. 9999556	5, 869. 006
402–403	5, 074. 364	5, 073. 837	. 9999548	5, 073. 608
403–404	6, 782. 071	6, 781. 366	. 9999546	6, 781. 058
404–405	5, 344. 162	5, 343. 607	. 9999564	5, 343. 374
405–406	6, 249. 825	6, 249. 176	. 9999580	6, 248. 914
406–407	4, 608. 801	4, 608. 322	. 9999601	4, 608. 138
407–408	5, 373. 241	5, 372. 683	. 9999623	5, 372. 480
408–409	3, 870. 105	3, 869. 703	. 9999636	3, 869. 562
409–410	6, 850. 254	6, 849. 542	. 9999644	6, 849. 298
410–Lars	6, 021. 623	6, 020. 997	. 9999667	6, 020. 797

Mean latitude $= 40°30'$

$\log R_a = 5.8304093 - \tfrac{1}{2}\log A - \tfrac{1}{2}\log B$

$\log A = 8.5091057-10$

$\log B = 8.5108137-10$

$\log A + \log B = 17.0199194-20$

$\tfrac{1}{2}(\log A + \log B) = 8.5099597-10$

log constant $= 5.8304093$

$\tfrac{1}{2}(\log A + \log B) = 8.5099597-10$

$\log R_a = 7.3204496$

$R_a = 20,914,600$

Elevation factor $= \dfrac{20,914,600}{20,916,773} = 0.99989611$

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Lars

ϕ = 40° 27′ 06.″122 λ = 98° 55′ 22.″953

Tabular difference of R for 1″ of ϕ = 101.19350

R (for min. of ϕ)		24,305,408.29	y′ (for min. of ϕ)		285,373.57
Cor. for sec. of ϕ		− 619.51	Cor. for sec. of ϕ		+ 619.51
R		24,304,788.78	y′		285,993.08
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 530.41
θ (for min. of λ)		+ 0° 22′ 57.″7604	y		286,523.49
Cor. for sec. of λ		− 15.0589″			
θ		+ 0 22 42.7015	$\frac{\theta}{2}$		0° 11′ 21.″35
θ''	For machine computation	+1362.″7015		For machine computation	
			log θ''		3.13440074
log θ''		3.13440074	colog 2		9.69897000 -10
S for θ		4.68557171-10	S for $\frac{\theta}{2}$		4.68557408 -10
log sin θ	~~sin θ~~	7.81997245-10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.51894482 -10
log R		7.38569186		~~R sin $\frac{\theta}{2}$~~	
log x′		5.20566431	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.03788964 -10
x′	~~R sin θ~~	+ 160,569.96	log R		7.38569186
		2,000,000.00	log 2		0.30103000
x		2,160,569.96	log y″		2.72461150

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′= the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 4.—Computation of coordinates from geographic position.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Lars

ϕ = 40° 27′ 06.″122 λ = 98° 55′ 22.″953

Tabular difference of R for 1″ of ϕ = 101.19350

R (for min. of ϕ)		24,305,408.29	y′ (for min. of ϕ)		285,373.57
Cor. for sec. of ϕ		− 619.51	Cor. for sec. of ϕ		+ 619.51
R		24,304,788.78	y′		285,993.08
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 530.41
θ (for min. of λ)		+ 0° 22′ 57.″7604	y		286,523.49
Cor. for sec. of λ		− 15.0589			
θ		+ 0 22 42.7015	$\frac{\theta}{2}$		0° 11′ 21.″35075
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0066065152	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.003303276
~~log R~~				R sin $\frac{\theta}{2}$	80285.425
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	265.205
x′	R sin θ	+ 160,569.96	~~log R~~	2Rsin²θ/2	530.41
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,160,569.96	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′= the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 4.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Minden Cath.Ch.Spire

ϕ = 40° 30′ 01″.884 λ = 98° 56′ 29″.955

Tabular difference of R for 1″ of ϕ = 101.19350

R (for min. of ϕ)		24,287,193.44	y′ (for min. of ϕ)		303,588.42
Cor. for sec. of ϕ		− 190.65	Cor. for sec. of ϕ		+ 190.65
R		24,287,002.79	y′		303,779.07
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 496.38
θ (for min. of λ)		+ 0° 22′ 18″.3959	y		304,275.45
Cor. for sec. of λ		− 19.6528			
θ		+ 0 21 58.7431	$\frac{\theta}{2}$		0° 10′ 59″.37
θ''	For machine computation	+ 1318″.7431		For machine computation	
			log θ''		3.12016020
log θ''		3.12016020	colog 2		9.69897000 -10
S for θ		4.68557191-10	S for $\frac{\theta}{2}$		4.68557413 -10
log sin θ	~~sin θ~~	7.80573211-10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.50470433 -10
log R		7.38537392		~~R sin $\frac{\theta}{2}$~~	
log x′		5.19110603	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.00940866 -10
x′	~~R sin θ~~	+ 155,276.61	log R		7.38537392
		2,000,000.00	log 2		0.30103000
x		2,155,276.61	log y″		2.69581258

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 4.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA–SOUTH Station Minden Cath.Ch.Spire

$\phi =$ 40° 30′ 01″.884 $\lambda =$ 98° 56′ 29″.955

Tabular difference of R for 1″ of $\phi =$ 101.19350

R (for min. of ϕ)		24,287,193.44	y′ (for min. of ϕ)		303,588.42
Cor. for sec. of ϕ		− 190.65	Cor. for sec. of ϕ		+ 190.65
R		24,287,002.79	y′		303,779.07
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 496.38
θ (for min. of λ)		+ 0° 22′ 18″.3959	y		304,275.45
Cor. for sec. of λ		− 19.6528			
θ		+ 0 21 58.7431	$\frac{\theta}{2}$		0° 10′ 59″.37155
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0063934034	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0031967180
~~log R~~				R sin $\frac{\theta}{2}$	77638.70
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	248.189
x′	R sin θ	+ 155,276.61	~~log R~~	2R $\sin^2 \theta/2$	496.38
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,155,276.61	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′= the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 4.—Computation of coordinates from geographic position—Continued.

ADJUSTMENT OF MINDEN COURTHOUSE

Computation of fixed grid azimuths and lengths

394 TO 400

	x	y
	Feet	*Feet*
400	2, 147, 229. 98	312, 862. 56
394	2, 140, 016. 50	297, 165. 35
Δx and Δy	+7, 213. 48	+15, 697. 21

log Δx =3. 85814484
log Δy =4. 19582247

log tan α =9. 66232237−10

α = 24°40′50″.3
Grid azimuth =204°40′50″.3

log Δx =3. 85814484
log cosec α =0. 37928106

log grid length =4. 23742590

log Δy =4. 19582247
log sec α =0. 04160369

log grid length =4. 23742616

394 TO 401

	x	y
	Feet	*Feet*
401	2, 152, 526. 37	313, 124. 50
394	2, 140, 016. 50	297, 165. 35
Δx and Δy	+12, 509. 87	+15, 959. 15

log Δx =4. 09725280
log Δy =4. 20300976

log tan α =9. 89424304−10

α = 38°05′30″.4
Grid azimuth =218°05′30″.4

log Δx =4. 09725280
log cosec α =0. 20976908

log grid length =4. 30702188

log Δy =4. 20300976
log sec α =0. 10401227

log grid length =4. 30702203

394 TO 393

	x	y
	Feet	*Feet*
393	2, 142, 081. 68	292, 838. 20
394	2, 140, 016. 50	297, 165. 35
Δx and Δy	+2, 065. 18	−4, 327. 15

log Δx =3. 31495791
log Δy =3. 63620195

log tan α =9. 67875596−10

α = 25°30′48″.0
Grid azimuth =334°29′12″.0

(Text continued on p. 31)

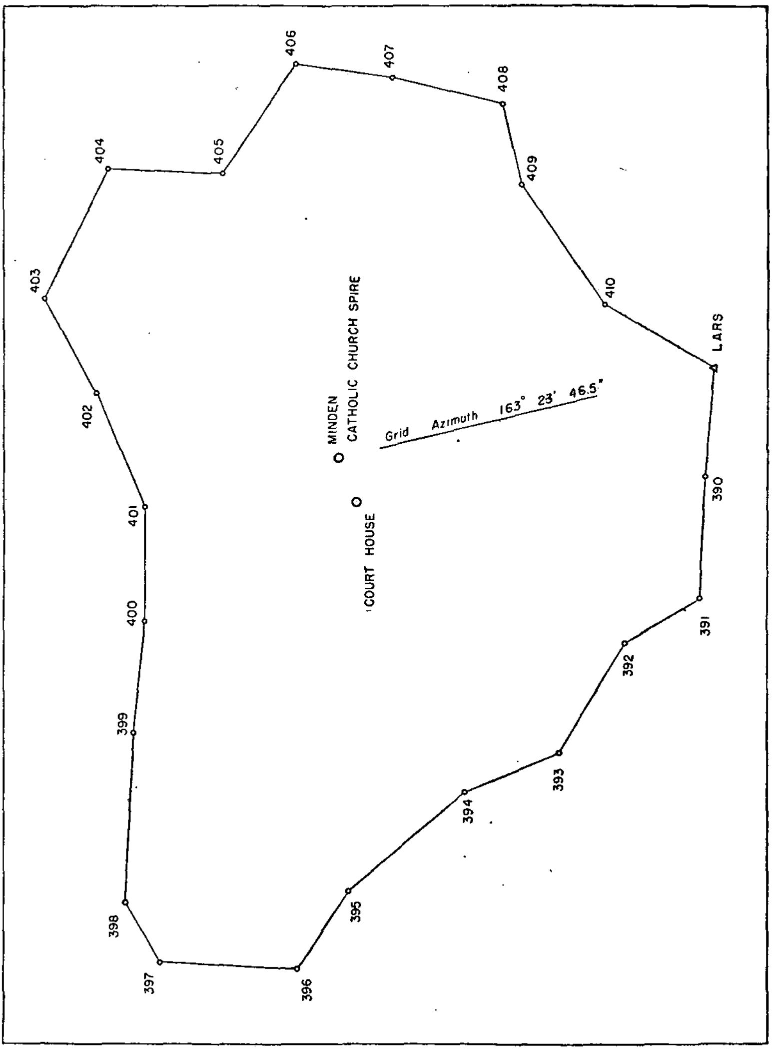

FIGURE 5.—Diagram of the Minden loop.

COMPUTATION OF COORDINATES

Traverse line No. Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Lars			2.18322854	+ 152.49		286,523.49	2,160,569.96
			8.47093391				
		5155.783	3.71229463			286,675.98	2,155,416.43
			9.99980997			-0.23	-0.17
390	91 41 41.3	5,156	3.71210460		-5153.53	286,675.75	2,155,416.26
			2.00176332	- 100.41			
			8.24674914				
		5688.775	3.75501418			286,575.57	2,149,728.60
			9.99993234			-0.48	-0.37
391	88 59 19.2	10,844	3.75494652		-5687.83	286,575.09	2,149,728.23
			3.53833980	+3454.14			
			9.91853714				
		4166.800	3.61980266			290,029.71	2,147,398.12
			9.74764312			-0.66	-0.51
392	145 59 33.9	15,011	3.36744578		-2330.48	290,029.05	2,147,397.61
			3.44861681	+2809.42			
			9.66956338				
		6012.477	3.77905343			292,839.13	2,142,082.39
			9.94650986			-0.93	-0.71
393	117 51 24.9	21,024	3.72556329		-5315.73	292,838.20	2,142,081.68
			3.63622259	+4327.36			
			9.95545028				
		4794.820	3.68077231			297,166.49	2,140,017.37
			9.63415117			-1.14	-0.87
394	154 29 22.2	25,819	3.31492348		-2065.02	297,165.35	2,140,016.50

FIGURE 6.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No~~. Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
394			3.72105201	+5260.80		297,166.49	2,140,017.37
			9.86401886			297,165.35	2,140,016.50
		7195.039	3.85703315			302,427.29	2,135,108.95
			9.83390816			-1.46	-1.11
395	136 59 04.7	33.014	3.69094131		-4908.42	302,425.83	2,135,107.84
			3.36092403	+2295.75			
			9.72074014				
		4367.007	3.64018389			304,723.04	2,131,394.08
			9.92976031			-1.66	-1.26
396	121 42 56.0	37.381	3.56994420		-3714.87	304,721.38	2,131,392.82
			3.81081243	+6468.63			
			9.99993191				
		6469.646	3.81088052			311,191.67	2,131,279.53
			8.24810672			-1.94	-1.48
397	178 59 07.8	43.850	2.05898724		-114.55	311,189.73	2,131,278.05
			3.26299719	+1832.30			
			9.74937599				
		3263.031	3.51362120			313,023.97	2,133,979.54
			9.91774372			-2.09	-1.59
398	235 50 17.0	47.113	3.43136492		+2700.01	313,021.88	2,133,977.95
			2.16615635	+ 146.61			
			8.26461336				
		7971.554	3.90154299			313,170.58	2,141,949.75
			9.99992654			-2.44	-1.86
399	268 56 46.3	55.085	3.90146953		+7970.21	313,168.14	2,141,947.89

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No~~. Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
399			2.48480384	- 305.35		313,170.58	2,141,949.75
			8.76125984			313,168.14	2,141,947.89
		5291.076	3.72354400			312,865.23	2,147,232.01
			9.99927557			-2.67	-2.03
400	273 18 30.4	60.376	3.72281957		+5282.26	312,862.56	2,147,229.98
			2.41860507	+ 262.18			
			8.69407885				
		5303.056	3.72452622			313,127.41	2,152,528.58
			9.99946857			-2.91	-2.21
401	267 09 58.1	65.679	3.72399479		+5296.57	313,124.50	2,152,526.37
			3.41907667	+2624.68			
			9.65051212				
		5869.006	3.76856455			315,752.09	2,157,777.99
			9.95154572			-3.17	-2.41
402	243 26 06.5	71.548	3.72011027		+5249.41	315,748.92	2,157,775.58
			3.42723605	+2674.46			
			9.72191915				
		5073.608	3.70531690			318,426.55	2,162,089.46
			9.92930834			-3.39	-2.58
403	238 11 17.3	76.622	3.63462524		+4311.47	318,423.16	2,162,086.88
			3.42417510	-2655.68			
			9.59287764				
		6781.058	3.83129746			315,770.87	2,168,328.86
			9.96384548			-3.69	-2.81
404	293 03 21.8	83.403	3.79514294		+6239.40	315,767.18	2,168,326.05

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line XXX Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
404			3.72780091	-5343.19		315,770.87	2,168,328.86
			9.99998533			315,767.18	2,168,326.05
		5343.374	3.72781558			310,427.68	2,168,372.78
			7.91481652			-3.93	-2.99
405	359 31 44.7	88,746	1.64263210		+ 43.92	310,423.75	2,168,369.79
			3.51432913	-3268.35			
			9.71852459				
		6248.914	3.79580454			307,159.33	2,173,698.83
			9.93060052			-4.21	-3.20
406	301 32 08.0	94,995	3.72640506		+5326.05	307,155.12	2,173,695.63
			3.66217597	-4593.84			
			9.99865049				
		4608.138	3.66352548			302,565.49	2,173,336.12
			8.89603756			-4.41	-3.36
407	4 30 52.2	99,603	2.55956304		- 362.71	302,561.08	2,173,332.76
			3.72226503	-5275.52			
			9.99209023				
		5372.480	3.73017480			297,289.97	2,172,320.02
			9.27676196			-4.65	-3.54
408	10 54 07.4	104,976	3.00693676		-1016.10	297,285.32	2,172,316.48
			3.04568025	-1110.91			
			9.45801844				
		3869.562	3.58766181			296,179.06	2,168,613.35
			9.98132178			-4.82	-3.67
409	73 18 58.2	108,845	3.56898359		-3706.67	296,174.24	2,168,609.68

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
409			3.62885933	-4254.61		296,179.06	2,168,613.35
			9.79321327			296,174.24	2,168,609.68
		6849.298	3.83564606			291,924.45	2,163,245.74
			9.89413471			-5.12	-3.90
410	51 35 53.1	115.694	3.72978077		-5367.61	291,919.33	2,163,241.84
			3.73203698	-5395.57			
			9.95238300				
		6020.797	3.77965398			286,528.88	2,160,574.06
			9.64713025			-5.39	-4.10
Lars	26 20 34.3	121.715	3.42678423		-2671.68	286,523.49	2,160,569.96
						286,523.49	2,160,569.96
				Discrepancy		+5.39	+4.10
				x Factor =	-3.3685×10^{-5}		
				y Factor =	-4.4284×10^{-5}		

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~XXX~~ Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	~~Log~~ Lat. ~~Log~~ cos Az ~~Log~~ dist. ~~Log~~ sin Az ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Lars				+ 152.49		286,523.49	2,160,569.96
			0.02957562				
		5155.783				286,675.98	2,155,416.43
			0.99956255			-0.23	-0.17
390	91 41 41.3	5.156			-5153.53	286,675.75	2,155,416.26
				- 100.41			
			0.01765018				
		5688.715				286,575.57	2,149,728.60
			0.99984423			-0.48	-0.37
391	88 59 19.2	10.844			-5687.83	286,575.09	2,149,728.23
				+3454.14			
			0.82896681				
		4166.800				290,029.71	2,147,398.12
			0.55929780			-0.66	-0.51
392	145 59 33.9	15.011			-2330.48	290,029.05	2,147,397.61
				+2809.42			
			0.46726514				
		6012.477				292,839.13	2,142,082.39
			0.88411724			-0.93	-0.71
393	117 51 24.9	21.024			-5315.73	292,838.20	2,142,081.68
				+4327.36			
			0.90250638				
		4794.820				297,166.49	2,140,017.37
			0.43067650			-1.14	-0.87
394	154 29 22.2	25.819			-2065.02	297,165.35	2,140,016.50

FIGURE 6.—Computation of coordinates—Continued.

106911°—35——3

COMPUTATION OF COORDINATES

Traverse line ~~NMX~~ Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log Lat. / Log cos Az / Log dist. / Log sin Az / Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
394				+5260.80		297,166.49	2,140,017.37
			0.73117083			297,165.35	2,140,016.50
		7195.039				302,427.29	2,135,108.95
			0.68219441			-1.46	-1.11
395	136 59 04.7	.33,014			-4908.42	302,425.83	2,135,107.84
				+2295.75			
			0.52570262				
		4367.007				304,723.04	2,131,394.08
			0.85066841			-1.66	-1.26
396	121 42 56.0	37,381			-3714.87	304,721.38	2,131,392.82
				+6468.63			
			0.99984324				
		6469.646				311,191.67	2,131,279.53
			0.01770544			-1.94	-1.48
397	178 59 07.8	43,850			- 114.55	311,189.73	2,131,278.05
				+1832.30			
			0.56153391				
		3263.031				313,023.97	2,133,979.54
			0.82745372			-2.09	-1.59
398	235 50 17.0	47,113			+2700.01	313,021.88	2,133,977.95
				+ 146.61			
			0.01839134				
		7971.554				313,170.58	2,141,949.75
			0.99983087			-2.44	-1.86
399	268 56 46.3	55,085			+7970.21	313,168.14	2,141,947.89

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line No. Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log Lat. Log cos Az Log dist. Log sin Az Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
399				- 305.35		313,170.58	2,141,949.75
			0.05771117			313,168.14	2,141,947.89
		5291.076				312,865.23	2,147,232.01
			0.99833332			-2.67	-2.03
400	273 18 30.4	60.376			+5282.26	312,862.56	2,147,229.98
				+ 262.18			
			0.04944005				
		5303.056				313,127.41	2,152,528.58
			0.99877709			-2.91	-2.21
401	267 09 58.1	65.679			+5296.57	313,124.50	2,152,526.37
				+2624.68			
			0.44721063				
		5869.006				315,752.09	2,157,777.99
			0.89442867			-3.17	-2.41
402	243 26 06.5	71.548			+5249.41	315,748.92	2,157,775.58
				+2674.46			
			0.52713172				
		5073.608				318,426.55	2,162,089.46
			0.84978359			-3.39	-2.58
403	238 11 17.3	76.622			+4311.47	318,423.16	2,162,086.88
				-2655.68			
			0.39163152				
		6781.058				315,770.87	2,168,328.86
			0.92012214			-3.69	-2.81
404	293 03 21.8	83.403			+6239.40	315,767.18	2,168,326.05

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
404				-5343.19		315,770.87	2,168,328.86
			0.99996623			315,767.18	2,168,326.05
		5343.374				310,427.68	2,168,372.78
			0.00821895			-3.93	-2.99
405	359 31 44.7	88.746			+ 43.92	310,423.75	2,168,369.79
				-3268.35			
			0.52302758				
		6248.914				307,159.33	2,173,698.83
			0.85231576			-4.21	-3.20
406	301 32 08.0	94.995			+5326.05	307,155.12	2,173,695.63
				-4593.84			
			0.99689744				
		4608.138				302,565.49	2,173,336.12
			0.07871139			-4.41	-3.36
407	4 30 52.2	99.603			- 362.71	302,561.08	2,173,332.76
				-5275.52			
			0.98195192				
		5372.480				297,289.97	2,172,320.02
			0.18913067			-4.65	-3.54
408	10 54 07.4	104.976			-1016.10	297,285.32	2,172,316.48
				-1110.91			
			0.28709025				
		3869.562				296,179.06	2,168,613.35
			0.95790354			-4.82	-3.67
409	73 18 58.2	108.845			-3706.67	296,174.24	2,168,609.68

FIGURE 6.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line XXX Minden Loop
State Nebraska (south) County Kearney Initial Station Lars
Year 1934 Month February - March - May Closing Station Lars

Station	Azimuth Plane	Grid Distance Feet	Log Lat. Log cos Az Log dist. Log sin Az Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
409				-4254.61		296,179.06	2,168,613.35
			0.62117400			296,174.24	2,168,609.68
		6849.298				291,924.45	2,163,245.74
			0.78367268			-5.12	-3.90
410	51 35 53.1	115.694			-5367.61	291,919.33	2,163,241.84
				-5395.57			
			0.89615473				
		6020.797				286,528.88	2,160,574.06
			0.44374170			-5.39	-4.10
Lars	26 20 34.3	121.715			-2671.68	286,523.49	2,160,569.96
						286,523.49	2,160,569.96
				Discrepancy		+5.39	+4.10
				x Factor =	-3.3685 x 10^{-5}		
				y Factor =	-4.4284 x 10^{-5}		

FIGURE 6.—Computation of coordinates—Continued.

Computation of fixed grid azimuths and lengths—Continued

400 TO 401

	x	y
	Feet	*Feet*
401	2, 152, 526. 37	313, 124. 50
400	2, 147, 229. 98	312, 862. 56
Δx and Δy	+5, 296. 39	+261. 94

log Δx = 3. 72397996
log Δy = 2. 41820182

log tan α = 1. 30577814

α = 87°10′07″.2
Grid azimuth = 267°10′07″.2

log Δx = 3. 72397996
log cosec α = 0. 00053048

log grid length = 3. 72451044

log Δy = 2. 41820182
log sec α = 1. 30630840

log grid length = 3. 72451022

Computation of angles of triangle

Stations	Azimuth and angle	Stations	Azimuth and angle
	° ′ ″		° ′ ″
394 to 393	334 29 12. 0	401 to 400	87 10 07. 2
∠393 to Courthouse	269 41 00. 0	∠400 to Courthouse	266 59 18. 1
394 to Courthouse	244 10 12. 0	401 to Courthouse	354 09 25. 3
394 to 400	204 40 50. 3		
∠400 to Courthouse	39 29 21. 7	401 to 394	38 05 30. 4
		401 to Courthouse	354 09 25. 3
400 to 401	267 10 07. 2	∠Courthouse to 394	43 56 05. 1
∠401 to Courthouse	58 30 48. 7		
400 to Courthouse	325 40 55. 9	401 to 400	87 10 07. 2
		401 to 394	38 05 30. 4
400 to 394	24 40 50. 3	∠394 to 400	49 04 36. 8
400 to Courthouse	325 40 55. 9		
∠Courthouse to 394	58 59 54. 4		
394 to Courthouse	244 10 12. 0		
394 to 401	218 05 30. 4		
∠401 to Courthouse	26 04 41. 6		

Length equation for adjustment of the angles

Designation of angle	Angle	Log and log sin	Tabular difference of log for one second	Designation of angle	Angle	Log and log sin	Tabular difference of log for one second
	° ′ ″				° ′ ″		
394 to 401		4. 3070220		401 to 400		3. 7245104	
+1	26 04 41. 6	9. 6430555	+4. 3	−1−3	109 59 13. 3	9. 9730216	−0. 8
−2−3	28 28 29. 4	9. 6783114	+3. 9	+2	58 30 48. 7	9. 9308286	+1. 3
		3. 6283889				3. 6283606	

$$0 = +28.3 + 3.5(1) - 5.2(2) - 4.7(3)$$
$$+61.38\ C_1 = -28.3$$
$$C_1 = -0.4611$$
$$v_1 = -1.6$$
$$v_2 = +2.4$$
$$v_3 = +2.2$$

Computation of the coordinates

Stations	Azimuth and angle
	° ′ ″
394 to 400	204 40 50.3
∠400 to Courthouse	39 29 20.1
394 to Courthouse	244 10 10.4 = α

$\log s \quad = 4.1752633$
$\log \sin \alpha = 9.9542847 - 10$

$\log \Delta x \quad = 4.1295480$
$\Delta x \quad = +13,475.60$

$\log s \quad = 4.1752633$
$\log \cos \alpha = 9.6391970 - 10$

$\log \Delta y \quad = 3.8144603$
$\Delta y \quad = +6,523.19$

	x	y
	Feet	*Feet*
394	2,140,016.50	297,165.35
Δx and Δy	+13,475.60	+6,523.19
Courthouse	2,153,492.10	303,688.54

COMPUTATIONS IN THE HASTINGS AREA

Four other traverses in what is called the "Hastings area" have been computed for further samples in this publication. All of these start on one fixed point and end on another. This furnishes a more rigid test of the accuracy of a traverse than can be found in a a loop traverse. There are two elements that are not entirely checked by a loop traverse. These are the length and the orientation. If an erroneous length standard has been used consistently in the measurements the closure of the loop will not bring it into evidence for the traverse will close provided the lengths are all off in the same proportion. This could be the case even if the lengths are all considerably in error if in the same direction and by the same proportional amount. In the second place if the controlling azimuth is in error the closure will not be affected since the traverse will close whatever azimuth is used for control. With loop traverses

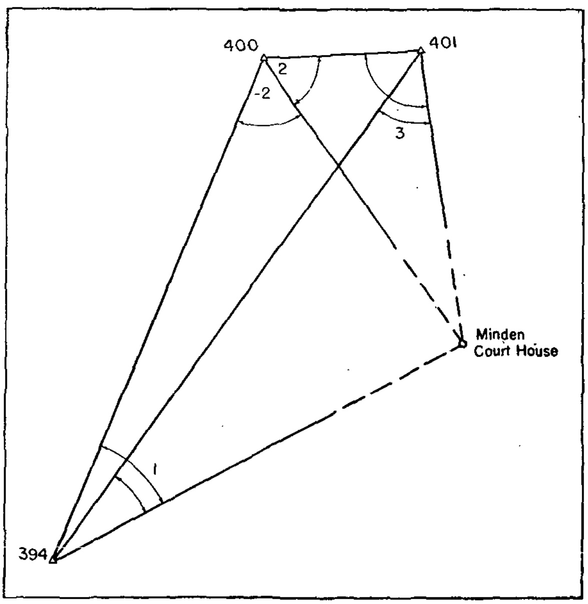

FIGURE 7.—Diagram of Minden Courthouse.

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

11—9121

COMPUTATION OF TRIANGLES

State: Nebraska

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
		Fixed Triangle					
	2-3						3.7245104
	1 394	13 24 40.1					0.6346299
	2 400	117 30 43.1					9.9478817
	3 401	49 04 36.8					9.8782858
	1-3						4.3070220
	1-2						4.2374261
	2-3						4.2374261
	1 Minden Court House	43.9	(+4.0)			81 30 47.9	0.0047817
+1	2 394	39 29 21.7	-1.6			20.1	9.8034086
-2	3 400	58 59 54.4	-2.4			52.0	9.9330555
	1-3						4.0456164
	1-2						4.1752633
	2-3						4.3070220
	1 Minden Court House	13.3	(-0.6)			109 59 12.7	0.0269780
+1	2 394	26 04 41.6	-1.6			40.0	9.6430486
+3	3 401	43 56 05.1	+2.2			07.3	9.8412634
	1-3						3.9770486
	1-2						4.1752634^{-1}
	2-3						3.7245104
	1 Minden Court House	29.4	(-4.6)			28 28 24.8	0.3217065
+2	2 400	58 30 48.7	+2.4			51.1	9.9308317
+3	3 401	93 00 41.9	+2.2			44.1	9.9993995
	1-3						3.9770486
	1-2						4.0456164

FIGURE 8.—Computation of triangles for Minden Courthouse.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 709

PLANE COORDINATES

Datum North American 1927 Projection Lambert south State Nebraska

Station	x Coordinate / y Coordinate (Feet)	Azimuth	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth	Mark
Minden Catholic Church, spire	2,155,276.61 304,275.45			398	2,133,977.95 313,021.88		
Lars	2,160,569.96 286,523.49	163° 23′ 46.5″	Minden Catholic Church, spire	399	2,141,947.89 313,168.14		
390	2,155,416.26 286,675.75			400	2,147,229.98 312,862.56		
391	2,149,728.23 286,575.09			401	2,152,526.37 313,124.50		
392	2,147,397.61 290,029.05			402	2,157,775.58 315,748.92		
393	2,142,081.68 292,838.20			403	2,162,086.88 318,423.16		
394	2,140,016.50 297,165.35			404	2,168,326.05 315,767.18		
395	2,135,107.84 302,425.83			405	2,168,369.79 310,423.75		
396	2,131,392.82 304,721.38			406	2,173,695.63 307,155.12		
397	2,131,278.05 311,189.73			407	2,173,332.76 302,561.08		

Station	x Coordinate / y Coordinate (Feet)	Azimuth	Mark
408	2,172,316.48 297,285.32		
409	2,168,609.68 296,174.24		
410	2,163,241.84 291,919.33		
Minden Court House	2,153,492.10 303,688.54		

U.S. GOVERNMENT PRINTING OFFICE

FIGURE 9.—List of adjusted coordinates.

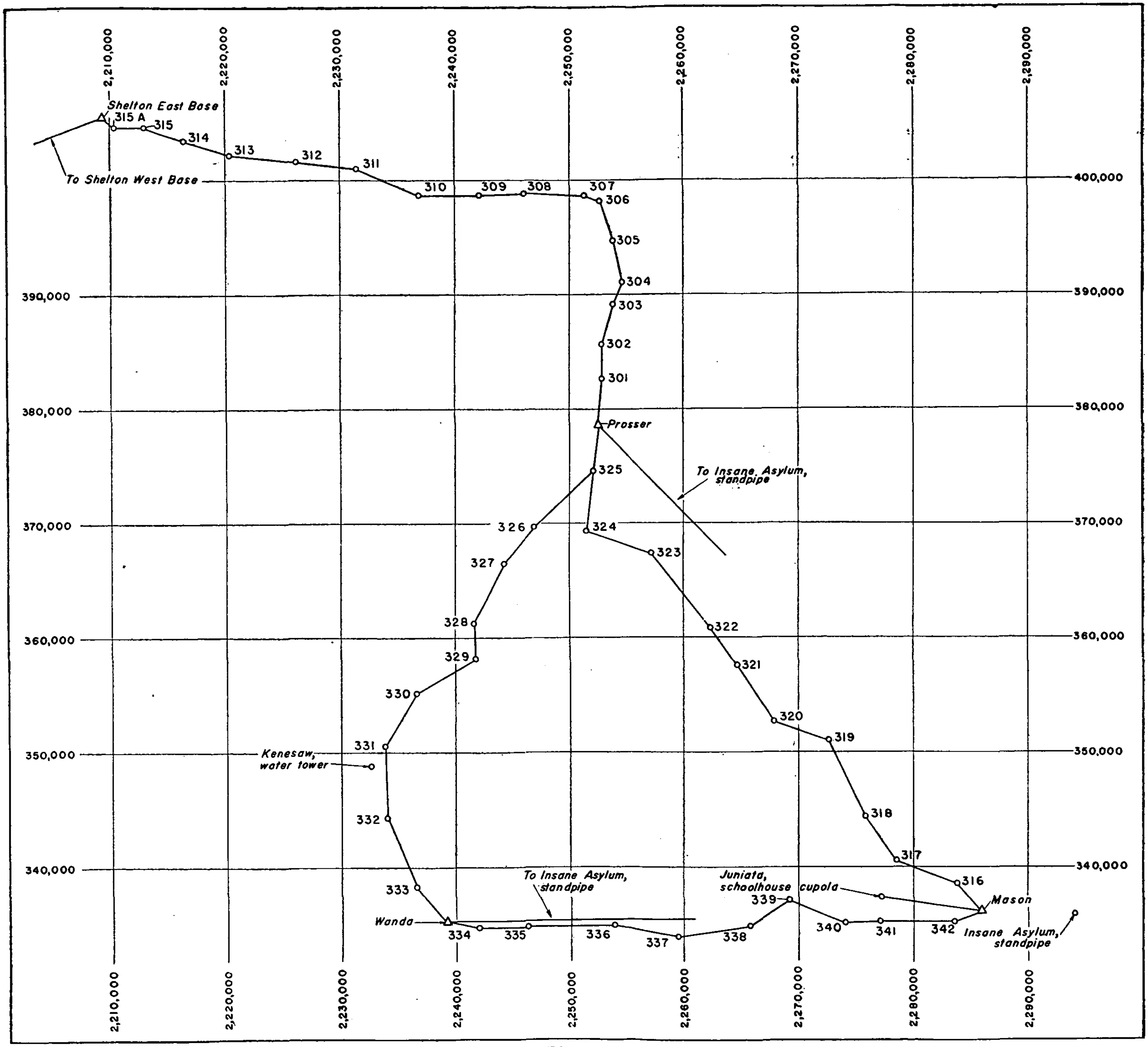

FIGURE 10.—Diagram of Hastings area.

106911°—35. (Face p. 34.)

it is therefore desirable to know definitely the standard value of the tape and to be very sure that the controlling azimuth is correct before starting the computation.

These four traverses that are now given are controlled by first-order triangulation points and these are about as accurately determined with respect to each other as it is possible for any such points on the earth's surface to be. The closures are all considerably above the required accuracy of 1 part in 10,000 which is the minimum standard for such local surveys. All of the traverses can therefore be considered as very good second-order control and the resulting coordinates can be used with full assurance and confidence in their accuracy.

Two of the traverses present an additional complication. That from Prosser to Mason has the first length in common with Prosser to Wanda. We decided to compute and adjust the Prosser to Wanda line first and then to hold station 325 fixed in the line from Prosser to Mason. This required the computation of the adjusted azimuth of the line 325 to Prosser to be used in computing the grid azimuths from 325 to Mason. All of these computations are given in their proper place just at the beginning of the computation of the line.

The computation of these four traverses is given in duplicate, first by use of logarithms and second by use of natural functions with calculating machines. It was thought that calculating machines might not be common enough among engineers to warrant confining our sample computations to that method alone. We wished to make our examples as explicit as possible so as to make them readily available to every worker in this field.

Only one extra point, Kenesaw water tower, was observed upon in these traverses. Even with this station a "no-check" observation was made upon it. When a point is observed from only two stations we have only sufficient data to form a single unchecked triangle. This is sufficient data for the computation of the point but if there is an error in either of the directions it will never be detected unless an attempt is made to use the no-check point in combination with other fixed points. It is always advisable to make observations on an object from at least three stations. This gives a check on the work and it can afterwards be used with full assurance of its accuracy. This discussion is somewhat foreign to the subject of this publication, but we believe salutary advice such as this should be germane to any discussion on engineering subjects. Many engineers who have had little experience along this line may thoughtlessly commit tactical errors such as this because they have not been adequately warned against them. If one could be absolutely sure that all observations were correct there would be no great need of checks but unfortunately the best of us make errors at times and consequently the check observations are always desirable.

This is doubtless sufficient discussion of the remaining four traverses in the Hastings area. The details of the computations will be evident to any one who wishes to look over the results that are given in the following pages.

Plane coordinates on Lambert projection

State **NEBRASKA-SOUTH** Station **Prosser**

$\phi =$ 40° 42′ 07.″778 $\lambda =$ 98° 35′ 20.″178

Tabular difference of R for 1″ of $\phi =$ 101.19467

	For machine computation			For machine computation	
R (for min. of ϕ)		24,214,333.71	y' (for min. of ϕ)		376,448.15
Cor for sec. of ϕ		− 787.09	Cor. for sec. of ϕ		+ 787.09
R		24,213,546.62	y'		377,235.24
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,317.60
θ (for min. of λ)		+ 0° 36′ 05.″0521	y		378,552.84
Cor for sec. of λ		− 13.2383			
θ		+ 0 35 51.8138	$\frac{\theta}{2}$		0° 17′ 55.″9
θ''		+2151.″8138			
			log θ''		3.33280469
log θ''		3.33280469	colog 2		9.69897000 −10
S for θ		4.68556699−10	S for $\frac{\theta}{2}$		4.68557290 −10
log sin θ	~~sin θ~~	8.01837168−10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.71734759 −10
log R		7.38405841		~~R sin $\frac{\theta}{2}$~~	
log x'		5.40243009	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.43469518 −10
x'	~~R sin θ~~	+ 252,598.10	log R		7.38405841
		2,000,000.00	log 2		0.30103000
x		2,252,598.10	log y''		3.11978359

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position.

Plane coördinates on Lambert projection

State NEBRASKA–SOUTH Station Prosser

ϕ = 40° 42' 07".778 λ = 98° 35' 20".178

Tabular difference of R for 1" of ϕ = 101.19467

R (for min. of ϕ)		24,214,333.71	y' (for min. of ϕ)		376,448.15
Cor. for sec. of ϕ		− 787.09	Cor. for sec. of ϕ		+ 787.09
R		24,213,546.62	y'		377,235.24
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,317.60
θ (for min. of λ)		+ 0° 36' 05".0521	y		378,552.84
Cor. for sec. of λ		− 13.2383			
θ		+ 0 35 51.8138	$\frac{\theta}{2}$		+ 0° 17' 55".9069
~~θ''~~	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0104320985	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0052161202
~~log R~~				R sin $\frac{\theta}{2}$	126,300.770
~~log x'~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	658.800
x'	R sin θ	+ 252,598.10	~~log R~~	2R $\sin^2 \theta/2$	1317.60
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,252,598.10	~~log y''~~		

x = 2,000,000.00 + R sin θ

y = y' + 2R $\sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y', and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Insane Asylum Standpipe

ϕ = 40°35′02″.627 λ = 98°26′26″.284

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 265.84	Cor. for sec. of ϕ		+ 265.84
R		24,256,569.48	y′		334,212.38
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,784.63
θ (for min. of λ)		+ 0°41′59″.3334	y		335,997.01
Cor. for sec. of λ		− 17.2443			
θ		+ 0 41 42.0891	$\frac{\theta}{2}$		0°20′51″.04
θ''	For machine computation	+ 2502″.0891		For machine computation	
			log θ''		3.39830277
log θ''		3.39830277	colog 2		9.69897000-10
S for θ		4.68556422-10	S for $\frac{\theta}{2}$		4.68557220-10
log sin θ	~~sin θ~~	8.08386699-10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.78284497-10
log R		7.38482938		~~R sin $\frac{\theta}{2}$~~	
log x′		5.46869637	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.56568994-10
x′	~~R sin θ~~	+ 294,236.38	log R		7.38482938
		2,000,000.00	log 2		0.30103000
x		2,294,236.38	log y″		3.25154932

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Insane Asylum Standpipe

ϕ = 40° 35′ 02.″627 λ = 98° 26′ 26.″284

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 265.84	Cor. for sec. of ϕ		+ 265.84
R		24,256,569.48	y′		334,212.38
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 1,784.63
θ (for min. of λ)		+ 0° 41′ 59.″3334	y		335,997.01
Cor for sec. of λ		− 17.2443			
θ		+ 0 41 42.0891	$\frac{\theta}{2}$		0° 20′ 51.″0446
~~θ″~~	For machine computation	″		For machine computation	
			~~log θ″~~		
~~log θ″~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0121301728	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0060651982
~~log R~~				R sin $\frac{\theta}{2}$	147,120.902
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	892.317
x′	R sin θ	+ 294,236.38	~~log R~~	2Rsin²θ/2	1,784.63
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,294,236.38	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Shelton E. Base

$\phi =$ 40°46′38.″341 $\lambda =$ 98°44′39.″309

Tabular difference of R for 1″ of $\phi =$ 101.19550

R (for min. of ϕ)		24,190,046.91	y′ (for min. of ϕ)		400,734.95
Cor. for sec. of ϕ		− 3,879.94	Cor. for sec. of ϕ		+ 3,879.94
R		24,186,166.97	y′		404,614.89
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 905.63
θ (for min. of λ)		+ 0°30′10.″7709	y		405,520.52
Cor. for sec. of λ		− 25.7897			
θ		+ 0 29 44.9812	$\frac{\theta}{2}$		0°14′52.″5
θ''	For machine computation	+ 1784.″9812		For machine computation	
			log θ''		3.25163364
log θ''		3.25163364	colog 2		9.69897000 -10
S for θ		4.68556945-10	S for $\frac{\theta}{2}$		4.68557351 -10
log sin θ	~~sin θ~~	7.93720309-10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.63617715 -10
log R		7.38356705		~~R sin $\frac{\theta}{2}$~~	
log x′		5.32077014	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.27235430 -10
x′	~~R sin θ~~	+ 209,300.44	log R		7.38356705
		2,000,000.00	log 2		0.30103000
x		2,209,300.44	log y″		2.95695135

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA—SOUTH Station Shelton East Base

$\phi =$ 40°46′38″.341 $\lambda =$ 98°44′39″.309

Tabular difference of R for 1″ of $\phi =$ 101.19550

R (for min. of ϕ)		24,190,046.91	y′ (for min. of ϕ)		400,734.95
Cor. for sec. of ϕ		− 3,879.94	Cor. for sec. of ϕ		+ 3,879.94
R		24,186,166.97	y′		404,614.89
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 905.63
θ (for min. of λ)		+ 0° 30′ 10″.7709	y		405,520.52
Cor. for sec. of λ		− 25.7897			
θ		+ 0° 29′ 44″.9812	$\frac{\theta}{2}$		0° 14′ 52″.4906
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0086537250	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0043269030
~~log R~~				R sin $\frac{\theta}{2}$	104,651.198
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	452.816
x′	R sin θ	+ 209,300.44	~~log R~~	2R$\sin^2$θ/2	905.63
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,209,300.44	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine

(see log tables)

R, y′, and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Shelton W.Base

ϕ = 40° 45′ 11.″712 λ = 98° 49′ 55.″589

Tabular difference of R for 1″ of ϕ = 101.19517

R (for min. of ϕ)		24,196,118.62	y′ (for min. of ϕ)		394,663.24
Cor. for sec. of ϕ		− 1,185.20	Cor. for sec. of ϕ		+ 1,185.20
R		24,194,933.42	y′		395,848.44
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 707.57
θ (for min. of λ)		+ 0° 26′ 53.″9479	y		396,556.01
Cor. for sec. of λ		− 36.4706			
θ		+ 0 26 17.4773	$\frac{\theta}{2}$		0° 13′ 08.″74
θ''	For machine computation	+ 1577.″4773		For machine computation	
			log θ''		3.19796312
log θ''		3.19796312	colog 2		9.69897000-10
S for θ		4.68557064-10	S for $\frac{\theta}{2}$		4.68557381-10
log sin θ	~~sin θ~~	7.88353376-10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.58250693-10
log R		7.38372443		~~R sin $\frac{\theta}{2}$~~	
log x′		5.26725819	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.16501386-10
x′	~~R sin θ~~	+ 185,036.83	log R		7.38372443
		2,000,000.00	log 2		0.30103000
x		2,185,036.83	log y″		2.84976829

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Shelton West Base

$\phi = 40°\ 45'\ 11.''712$ $\lambda = 98°\ 49'\ 55.''589$

Tabular difference of R for 1" of ϕ = 101.19517

R (for min. of ϕ)		24,196,118.62	y' (for min. of ϕ)		394,663.24
Cor. for sec. of ϕ		− 1,185.20	Cor. for sec. of ϕ		+ 1,185.20
R		24,194,933.42	y'		395,848.44
			y'' (=2R sin² $\frac{\theta}{2}$)		+ 707.57
θ (for min. of λ)		+ 0° 26′ 53.″9479	y		396,556.01
Cor. for sec. of λ		− 36.4706			
θ		+ 0 26 17.4773	$\frac{\theta}{2}$		0° 13′ 08.″7386
~~θ''~~	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0076477512	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0038239033
~~log R~~				R sin $\frac{\theta}{2}$	92519.086
~~log x'~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	353.784
x'	R sin θ	+ 185,036.83	~~log R~~	2Rsin²θ/2	707.57
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,185,036.83	~~log y''~~		

$x = 2{,}000{,}000.00 + R \sin\theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 11.—Computation of coordinates from geographic position—Continued.

TRAVERSE, PROSSER TO SHELTON EAST BASE

Computation of fixed grid azimuths

PROSSER TO INSANE ASYLUM STANDPIPE

	x	y
	Feet	*Feet*
Insane Asylum standpipe	2, 294, 236. 38	335, 997. 01
Prosser	2, 252, 598. 10	378, 552. 84
Δx and Δy	+41, 638. 28	−42, 555. 83

$$\tan (360° - \alpha) = \frac{\Delta x}{\Delta y}$$

$$\log \Delta x = 4.\ 61949278$$
$$\log \Delta y = 4.\ 62895906$$
$$\log \tan \alpha = 9.\ 99053372 - 10$$
$$\alpha = 44°22'32''.2$$
$$\text{Grid azimuth} = 315°37'27''.8$$

SHELTON EAST BASE TO SHELTON WEST BASE

	x	y
	Feet	*Feet*
Shelton west base	2, 185, 036. 83	396, 556. 01
Shelton east base	2, 209, 300. 44	405, 520. 52
Δx and Δy	−24, 263. 61	−8, 964. 51

$$\tan \alpha = \frac{\Delta x}{\Delta y}$$

$$\log \Delta x = 4.\ 38495542$$
$$\log \Delta y = 3.\ 95252655$$
$$\log \tan \alpha = 0.\ 43242887$$
$$\alpha = 69°43'21''.3$$
$$\text{Grid azimuth} = 69°43'21''.3$$

List of angles

Station	From station—	To station—	Angle °	′	″
Prosser	Insane Asylum standpipe	301	228	37	40. 0
301	Prosser	302	175	01	08. 1
302	301	303	191	13	32. 5
303	302	304	201	49	25. 9
304	303	305	133	45	02. 2
305	304	306	175	12	48. 2
306	305	307	127	45	48. 0
307	306	308	162	34	18. 8
308	307	309	176	20	24. 1
309	308	310	181	47	53. 1
310	309	311	204	11	37. 2
311	310	312	163	11	43. 3
312	311	313	178	13	51. 9
313	312	314	191	56	03. 8
314	313	315	181	08	54. 3
315	314	315A	161	08	43. 1
315A	315	Shelton east base	219	34	28. 8
Shelton east base	315A	Shelton west base	120	32	30. 4

Computation of grid azimuths

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	″
Prosser to Insane Asylum	315 37 27.8		
∠ Insane Asylum to 301	228 37 40.0		
Prosser to 301	184 15 07.8		
301 to Prosser	4 15 07.8		
∠ Prosser to 302	175 01 08.1		
301 to 302	179 16 15.9		
302 to 301	359 16 15.9		
∠ 301 to 303	191 13 32.5		
302 to 303	190 29 48.4		
303 to 302	10 29 48.4		
∠ 302 to 304	201 49 25.9		
303 to 304	212 19 14.3		
304 to 303	32 19 14.3		
∠ 303 to 305	133 45 02.2		
304 to 305	166 04 16.5		
305 to 304	346 04 16.5		
∠ 304 to 306	175 12 48.2		
305 to 306	161 17 04.7		
306 to 305	341 17 04.7		
∠ 305 to 307	127 45 48.0		
306 to 307	109 02 52.7		
307 to 306	289 02 52.7		
∠306 to 308	162 34 18.8		
307 to 308	91 37 11.5		
308 to 307	271 37 11.5		
∠307 to 309	176 20 24.1		
308 to 309	87 57 35.6		
309 to 308	267 57 35.6		
∠308 to 310	181 47 53.1		
309 to 310	89 45 28.7		
310 to 309	269 45 28.7		
∠309 to 311	204 11 37.2		
310 to 311	113 57 05.9		
311 to 310	293 57 05.9		
∠310 to 312	163 11 43.3		
311 to 312	97 08 49.2		
312 to 311	277 08 49.2		
∠311 to 313	178 13 51.9		
312 to 313	95 22 41.1		
313 to 312	275 22 41.1		
∠312 to 314	191 56 03.8		
313 to 314	107 18 44.9		
314 to 313	287 18 44.9		
∠313 to 315	181 08 54.3		
314 to 315	108 27 39.2		
315 to 314	288 27 39.2		
∠314 to 315A	161 08 43.1		
315 to 315A	89 36 22.3		
315A to 315	269 36 22.3		22.3
∠315 to Shelton east base	219 34 28.8	−0.1	28.7
315A to Shelton east base	129 10 51.1		51.0
Shelton east base to 315A	309 10 51.1		51.0
∠315A to Shelton west base	120 32 30.4	−0.1	30.3
Shelton east base to Shelton west base	69 43 21.5		21.3
Fixed azimuth	69 43 21.3		
Discrepancy	+0.2		

Computation of grid distances

Section	Geodetic length [1]	Grid factor	Grid length
	Feet		*Feet*
Prosser-301	4, 151. 567	0. 9999351	4, 151. 298
301-302	3, 027. 967	. 9999342	3, 027. 768
302-303	3, 539. 830	. 9999332	3, 539. 594
303-304	2, 253. 128	. 9999326	2, 252. 976
304-305	3, 739. 617	. 9999320	3, 739. 363
305-306	3, 679. 452	. 9999312	3, 679. 199
306-307	1, 334. 624	. 9999308	1, 334. 532
307-308	5, 362. 532	. 9999307	5, 362. 160
308-309	3, 912. 140	. 9999308	3, 911. 869
309-310	5, 247. 629	. 9999307	5, 247. 265
310-311	5, 890. 395	. 9999305	5, 889. 986
311-312	5, 321. 803	. 9999302	5, 321. 432
312-313	5, 750. 730	. 9999301	5, 750. 328
313-314	4, 227. 152	. 9999299	4, 226. 856
314-315	3, 644. 224	. 9999297	3, 643. 968
315-315A	2, 588. 451	. 9999296	2, 588. 269
315A-Shelton east base	1, 405. 786	. 9999296	1, 405. 687

[1] These values adopted from the C. W. A. computation.

TRAVERSE, WANDA TO MASON

Computation of fixed grid azimuths

WANDA TO INSANE ASYLUM STANDPIPE

	x	y
	Feet	*Feet*
Standpipe	2, 294, 236. 38	335, 997. 01
Wanda	2, 239, 317. 60	335, 261. 11
Δx and Δy	+54, 918. 78	+735. 90

$$\log \Delta x = 4.73972088$$
$$\log \Delta y = 2.86681880$$
$$\log \tan \alpha = 1.87290208$$
$$\alpha = 89°13'56''.3$$
$$\text{Grid azimuth} = 269°13'56''.3$$

MASON TO JUNIATA SCHOOLHOUSE CUPOLA

	x	y
	Feet	*Feet*
School	2, 277, 376. 38	337, 430. 20
Mason	2, 286, 204. 44	336, 326. 15
Δx and Δy	−8, 828. 06	+1, 104. 05

$$\log \Delta x = 3.94586527$$
$$\log \Delta y = 3.04298874$$
$$\log \tan \alpha = 0.90287653$$
$$\alpha = 82°52'17''.5$$
$$\text{Grid azimuth} = 97°07'42''.5$$

(Text continued on p. 62)

COMPUTATION OF COORDINATES

Traverse line ~~**No.**~~**.** Prosser to East Base
State Nebraska - South County Hall and Buffalo **Initial Station** Prosser
Year 1934 Month January - March **Closing Station** Shelton-East Base

Station	**Azimuth Plane** ° ' "	**Grid Distance Feet**	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Prosser			3.61698681	+4139.87		378,552.84	2,252,598.10
			9.99880290				
		4151.298	3.61818391			382,692.71	2,252,905.90
			8.87008891			+0.13	-0.00
301	184 15 07.8	4,151	2.48827282		+307.80	382,692.84	2,252,905.90
			3.48108745	+3027.52			
			9.99996486				
		3027.768	3.48112259			385,720.23	2,252,867.38
			8.10454353			+0.23	-0.01
302	179 16 15.9	7,179	1.58566612		-38.52	385,720.46	2,252,867.37
			3.54162409	+3480.36			
			9.99267064				
		3539.594	3.54895345			389,200.59	2,253,512.22
			9.26050124			+0.34	-0.01
303	190 29 48.4	10,719	2.80945469		+644.84	389,200.93	2,253,512.21
			3.27964889	+1903.92			
			9.92689232				
		2252.976	3.35275657			391,104.51	2,254,716.79
			9.72807509			+0.41	-0.01
304	212 19 14.3	12,972	3.08083166		+1204.57	391,104.92	2,254,716.78
			3.55983603	+3629.41			
			9.98703841				
		3739.363	3.57279762			394,733.92	2,253,816.67
			9.38150333			+0.53	-0.02
305	166 04 16.5	16,711	2.95430095		-900.12	394,734.45	2,253,816.65

FIGURE 12.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base
State Nebraska - South County Hall and Buffalo Initial Station Prosser
Year 1934 Month January - March Closing Station Shelton East Base

Station	Azimuth Plane (° ′ ″)	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
305			3.54316025	+3484.66		394,733.92	2,253,816.67
			9.97640697			394,734.45	2,253,816.65
		3679.199	3.56575328			398,218.58	2,252,636.14
			9.50632496			+0.65	-0.02
306	161 17 04.7	20,390	3.07207824		-1180.53	398,219.23	2,252,636.12
			2.63902551	+435.54			
			9.51369652				
		1334.532	3.12532899			398,654.12	2,251,374.68
			9.97554469			+0.69	-0.02
307	109 02 52.7	21,725	3.10087368		-1261.46	398,654.81	2,251,374.66
			2.18063706	+151.58			
			8.45129729				
		5362.160	3.72933977			398,805.70	2,246,014.66
			9.99982641			+0.87	-0.03
308	91 37 11.5	27,087	3.72916618		-5360.02	398,806.57	2,246,014.63
			2.14382371	-139.26			
			8.55143941				
		3911.869	3.59238430			398,666.44	2,242,105.27
			9.99972464			+0.99	-0.03
309	87 57 35.6	30,999	3.59210894		-3909.39	398,667.43	2,242,105.24
			1.34567423	-22.17			
			7.62574123				
		5247.265	3.71993300			398,644.27	2,236,858.05
			9.99999613			+1.16	-0.04
310	89 45 28.7	36,246	3.71992913		-5247.22	398,645.43	2,236,858.01

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base
State Nebraska - South County Hall and Buffalo Initial Station Prosser
Year 1934 Month January - March Closing Station Shelton East Base

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
310			3.37860330	+2391.13		398,644.27	2,236,858.05
			9.60848904			398,645.43	2,236,858.01
		5889.986	3.77011426			401,035.40	2,231,475.26
			9.96089318			+1.35	-0.05
311	113 57 05.9	42.136	3.73100744		-5382.79	401,036.75	2,231,475.21
			2.82090284	+662.07			
			9.09487432				
		5321.432	3.72602852			401,697.47	2,226,195.17
			9.99661245			+1.52	-0.05
312	97 08 49.2	47.457	3.72264097		-5280.09	401,698.99	2,226,195.12
			2.73155958	+538.96			
			8.97186696				
		5750.328	3.75969262			402,236.43	2,220,470.16
			9.99808397			+1.70	-0.06
313	95 22 41.1	53.208	3.75777659		-5725.01	402,238.13	2,220,470.10
			3.09962513	+1257.84			
			9.47360768				
		4226.856	3.62601745			403,494.27	2,216,434.80
			9.97986513			+1.84	-0.06
314	107 18 44.9	57.436	3.60588258		-4035.36	403,496.11	2,216,434.74
			3.06216398	+1153.89			
			9.50058942				
		3643.968	3.56157456			404,648.16	2,212,978.35
			9.97705567			+1.95	-0.07
315	108 27 39.2	61.079	3.53863023		-3456.45	404,650.11	2,212,978.28

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base
State Nebraska - South **County** Hall and Buffalo **Initial Station** Prosser
Year 1934 **Month** January - March **Closing Station** Shelton East Base

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
315			1.25016518	-17.79		404,648.16	2,212,978.35
			7.83715577			404,650.11	2,212,978.28
		2588.269	3.41300941			404,630.37	2,210,390.14
			9.99998974			+2.04	-0.07
315A	89 36 22.3	63.667	3.41299915		-2588.21	404,632.41	2,210,390.07
			2.94844765	+888.07			
			9.80055902				
Shelton		1405.687	3.14788863			405,518.44	2,209,300.51
East			9.88938904			+2.08	-0.07
Base	129 10 51.0	65.073	3.03727767		-1089.63	405,520.52	2,209,300.44
				Fixed coordinates		405,520.52	2,209,300.44
				Discrepancy		-2.08	+0.07

x Factor = -1.0757×10^{-6}

y Factor = $+3.1964 \times 10^{-5}$

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base

State Nebraska - South County Hall and Buffalo Initial Station Prosser

Year 1934 Month January - March Closing Station Shelton East Base

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Prosser				+4139.87		378,552.84	2,252,598.10
			0.99724738				
		4151.298				382,692.71	2,252,905.90
			0.07414620			+0.13	-0.00
301	184 15 07.8	4.151			+307.80	382,692.84	2,252,905.90
				+3027.52			
			0.99991907				
		3027.768				385,720.23	2,252,867.38
			0.01272165			+0.23	-0.01
302	179 16 15.9	7.179			-38.52	385,720.46	2,252,867.37
				+3480.36			
			0.98326516				
		3539.594				389,200.59	2,253,512.22
			0.18218023			+0.34	-0.01
303	190 29 48.4	10.719			+644.84	389,200.93	2,253,512.21
				+1903.92			
			0.84506929				
		2252.976				391,104.51	2,254,716.79
			0.53465679			+0.41	-0.01
304	212 19 14.3	12.972			+1204.57	391,104.92	2,254,716.78
				+3629.41			
			0.97059582				
		3739.363				394,733.92	2,253,816.67
			0.24071510			+0.53	-0.02
305	166 04 16.5	16.711			-900.12	394,734.45	2,253,816.65

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base

State Nebraska - South County Hall and Buffalo Initial Station Prosser

Year 1934 Month January - March Closing Station Shelton East Base

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
305				+3484.66		394,733.92	2,253,816.67
			0.94712429			394,734.45	2,253,816.65
		3679.199				398,218.58	2,252,636.14
			0.32086693			+0.65	-0.02
306	161 17 04.7	20,390			-1180.53	398,219.23	2,252,636.12
				+435.54			
			0.32635970				
		1334.532				398,654.12	2,251,374.68
			0.94524565			+0.69	-0.02
307	109 02 52.7	21,725			-1261.46	398,654.81	2,251,374.66
				+151.58			
			0.02826814				
		5362.160				398,805.70	2,246,014.66
			0.99960037			+0.87	-0.03
308	91 37 11.5	27,087			-5360.02	398,806.57	2,246,014.63
				-139.26			
			0.03559913				
		3911.869				398,666.44	2,242,105.27
			0.99936615			+0.99	-0.03
309	87 57 35.6	30,999			-3909.39	398,667.43	2,242,105.24
				-22.17			
			0.00422417				
		5247.265				398,644.27	2,236,858.05
			0.99999107			+1.16	-0.04
310	89 45 28.7	36,246			-5247.22	398,645.43	2,236,858.01

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base
State Nebraska - South **County** Hall and Buffalo **Initial Station** Prosser
Year 1934 **Month** January - March **Closing Station** Shelton East Base

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
310				+2391.13		398,644.27	2,236,858.05
			0.40596541			398,645.43	2,236,858.01
		5889.986				401,035.40	2,231,475.26
			0.91388845			+1.35	-0.05
311	113 57 05.9	42,136			-5382.79	401,036.75	2,231,475.21
				+662.07			
			0.12441545				
		5321.432				401,697.47	2,226,195.17
			0.99223021			+1.52	-0.05
312	97 08 49.2	47,457			-5280.09	401,698.99	2,226,195.12
				+538.96			
			0.09372748				
		5750.328				402,236.43	2,220,470.16
			0.99559789			+1.70	-0.06
313	95 22 41.1	53,208			-5725.01	402,238.13	2,220,470.10
				+1257.84			
			0.29758270				
		4226.856				403,494.27	2,216,434.80
			0.95469604			+1.84	-0.06
314	107 18 44.9	57,435			-4035.36	403,496.11	2,216,434.74
				+1153.89			
			0.31665724				
		3643.968				404,648.16	2,212,978.35
			0.94854003			+1.95	-0.07
315	108 27 39.2	61,079			-3456.45	404,650.11	2,212,978.28

FIGURE 12.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to East Base

State Nebraska - South County Hall and Buffalo Initial Station Prosser.

Year 1934 Month January - March Closing Station Shelton East Base

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
315				-17.79		404,648.16	2,212,978.35
			0.00687315			404,650.11	2,212,978.28
		2588.269				404,630.37	2,210,390.14
			0.99997638			+2.04	-0.07
315A	89 36 22.3	63,667			-2588.21	404,632.41	2,210,390.07
				+888.07			
			0.63177003				
Shelton		1405.687				405,518.44	2,209,300.51
East			0.77515587			+2.08	-0.07
Base	129 10 51.0	65.073			-1089.63	405,520.52	2,209,300.44
				Fixed coordinates		405,520.52	2,209,300.44
				Discrepancy		-2.08	+0.07
				x Factor =	-1.0757×10^{-6}		
				y Factor =	$+3.1964 \times 10^{-5}$		

FIGURE 12.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
FORM No. 760

PLANE COORDINATES

Datum North American 1927 Projection Lambert-South State Nebraska

Station	x Coordinate y Coordinate	Azimuth	Mark	Station	x Coordinate y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Insane Asylum, standpipe	2,294,236.38 335,997.01			309	2,242,105.24 398,667.43		
Prosser	2,252,598.10 378,552.84	315 37 27.8	Insane Asylum standpipe	310	2,236,858.01 398,645.43		
301	2,252,905.90 382,692.84			311	2,231,475.21 401,036.75		
302	2,252,867.37 385,720.46			312	2,226,195.12 401,698.99		
303	2,253,512.21 389,200.93			313	2,220,470.10 402,238.13		
304	2,254,716.78 391,104.92			314	2,216,434.74 403,496.11		
305	2,253,816.65 394,734.45			315	2,212,978.28 404,650.11		
306	2,252,636.12 398,219.23			315 A	2,210,390.07 404,632.41		
307	2,251,374.66 398,654.81			Shelton west base	2,185,036.83 396,556.01		
308	2,246,014.63 398,806.57			Shelton east base	2,209,300.44 405,520.52	69 43 21.3	Shelton west base

U.S. GOVERNMENT PRINTING OFFICE: 1936

FIGURE 13.—List of adjusted coordinates.

Plane coordinates on Lambert projection

State **Nebraska-South** Station **Wanda**

ϕ = 40° 35′ 01″.324 λ = 98° 38′ 18″.151

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 133.98	Cor. for sec. of ϕ		+ 133.98
R		24,256,701.34	y′		334,080.52
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,180.59
θ (for min. of λ)		+ 0° 34′ 06″.9584	y		335,261.11
Cor. for sec. of λ		− 11.9084			
θ		+ 0 33 55.0500	$\frac{\theta}{2}$		0° 16′ 57″.52
θ''	For machine computation	+ 2035.0500		For machine computation	
			log θ''		3.30857508
log θ''		3.30857508	colog 2		9.69897000 −10
S for θ		4.68556782 −10	S for $\frac{\theta}{2}$		4.68557310 −10
log sin θ	~~sin θ~~	7.99414290 −10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.69311818 −10
log R		7.38483174		~~R sin $\frac{\theta}{2}$~~	
log x′		5.37897464	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.38623636 −10
x′	~~R sin θ~~	+ 239,317.60	log R		7.38483174
		2,000,000.00	log 2		0.30103000
x		2,239,317.60	log y″		3.07209810

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine

(see log tables)

R, y′, and θ are given in special tables

FIGURE 14.—Computation of coordinates from geographic position.

Plane coordinates on Lambert projection

State **Nebraska-South** Station **Wanda**

ϕ = 40° 35′ 01″.324 λ = 98° 38′ 18″.151

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 133.98	Cor. for sec. of ϕ		+ 133.98
R		24,256,701.34	y′		334,080.52
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 1,180.59
θ (for min. of λ)		+ 0° 34′ 06″.9584	y		335,261.11
Cor. for sec. of λ		− 11.9084			
θ		+ 0 33 55.0500	$\frac{\theta}{2}$		0° 16′ 57″.5250
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0098660407	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0049330804
~~log R~~				R sin $\frac{\theta}{2}$	119,660.258
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	590.294
x′	R sin θ	+ 239,317.60	~~log R~~	2R sin² $\frac{\theta}{2}$	1,180.59
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,239,317.60	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 14.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State **Nebraska-South** Station **Mason**

ϕ = 40° 35′ 06″.829 λ = 98° 28′ 10″.329

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 691.05	Cor. for sec. of ϕ		+ 691.05
R		24,256,144.27	y′		334,637.59
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,688.56
θ (for min. of λ)		+ 0° 40′ 40″.6042	y		336,326.15
Cor. for sec. of λ		− 6.7766			
θ		+ 0 40 33.8276	$\frac{\theta}{2}$		0° 20′ 16″.9
θ''	For machine computation	+ 2433″.8276		For machine computation	
			log θ''		3.38628981
log θ''		3.38628981	colog 2		9.69897000 −10
S for θ		4.68556479 −10	S for $\frac{\theta}{2}$		4.68557235 −10
log sin θ	~~sin θ~~	8.07185460 −10	log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.77083216 −10
log R		7.38482176		~~R sin $\frac{\theta}{2}$~~	
log x′		5.45667636	log $\sin^2 \frac{\theta}{2}$	~~R $\sin^2 \frac{\theta}{2}$~~	5.54166432 −10
x′	~~R sin θ~~	+ 286,204.44	log R		7.38482176
		2,000,000.00	log 2		0.30103000
x		2,286,204.44	log y″		3.22751608

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log. of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 14.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Mason

ϕ = 40° 35′ 06″.829 λ = 98° 28′ 10″.329

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 691.05	Cor. for sec. of ϕ		+ 691.05
R		24,256,144.27	y′		334,637.59
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 1,688.56
θ (for min. of λ)		+ 0° 40′ 40″.6048	y		336,326.15
Cor. for sec. of λ		− 6.7766			
θ		+ 0 40 33.8276	$\frac{\theta}{2}$		0° 20′ 16″.9138
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0117992553	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0058997303
~~log R~~				R sin $\frac{\theta}{2}$	143,104.709
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	844.279
x′	R sin θ	+ 286,204.44	~~log R~~	2Rsin²θ/2	1688.56
		2,000,000.00	~~log 2~~		~~9.30103000~~
x		2,286,204.44	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine

(see log tables)

R, y′, and θ are given in special tables

FIGURE 14.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State **NEBRASKA-SOUTH** Station **Juniata Schoolhouse Cupola.**

$\phi = 40°\ 35'\ 18''.752$ $\lambda = 98°\ 30'\ 04''.581$

Tabular difference of R for 1" of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y' (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 1,897.59	Cor. for sec. of ϕ		+ 1,897.59
R		24,254,937.73	y'		335,844.13
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 1,586.07
θ (for min. of λ)		+ 0° 39' 21".8750	y		337,430.20
Cor. for sec. of λ		− 3.0055			
θ		+ 0 39 18.8695	$\frac{\theta}{2}$		0° 19' 39".43
θ''	For machine computation	+ 2358 ".8695		For machine computation	
			log θ''		3.37270391
log θ''		3.37270391	colog 2		9.69897000 - 10
S for θ		4.68556540	10 S for $\frac{\theta}{2}$		4.68557250 - 10
log sin θ	~~sin θ~~	8.05826931	10 log sin $\frac{\theta}{2}$	~~sin $\frac{\theta}{2}$~~	7.75724641 - 10
log R		7.38480016		~~R sin $\frac{\theta}{2}$~~	
log x'		5.44306947	log $\sin^2 \frac{\theta}{2}$	~~R sin² $\frac{\theta}{2}$~~	5.51449282 - 10
x'	~~R sin θ~~	+ 277,376.38	log R		7.38480016
		2,000,000.00	log 2		0.30103000
x		2,277,376.38	log y''		3.20032298

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 14.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State NEBRASKA-SOUTH Station Juniata Schoolhouse Cupola.

ϕ = 40° 35′ 18.″752 λ = 98° 30′ 04.″581

Tabular difference of R for 1″ of ϕ = 101.19400

R (for min. of ϕ)		24,256,835.32	y′ (for min. of ϕ)		333,946.54
Cor. for sec. of ϕ		− 1,897.59	Cor. for sec. of ϕ		+ 1,897.59
R		24,254,937.73	y′		335,844.13
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 1,586.07
θ (for min. of λ)		+ 0° 39′ 21.″8750	y		337,430.20
Cor. for sec. of λ		− 3.0055			
θ		+ 0 39 18.8695	$\frac{\theta}{2}$		0° 19′ 39.″43475
~~θ''~~	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0114358727	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0057180299
~~log R~~				R sin $\frac{\theta}{2}$	138,690.46
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	793.036
x′	R sin θ	+ 277,376.38	~~log R~~	2Rsin² θ/2	1,586.07
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,277,376.38	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station.

s = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables.

FIGURE 14.—Computation of coordinates from geographic position—Continued.

TRAVERSE, WANDA TO MASON—Continued

List of angles

Station	From station—	To station—	Angle		
			°	′	″
Wanda	Insane Asylum standpipe	334	12	14	51.0
334	Wanda	335	166	45	00.0
335	334	336	180	49	14.2
336	335	337	191	03	29.8
337	336	338	161	11	32.1
338	337	339	156	56	29.2
339	338	340	234	31	09.8
340	339	341	154	07	51.3
341	340	342	183	16	33.1
342	341	Mason	157	16	48.3
Mason	342	Juniata schoolhouse cupola	29	40	40.5

Computation of grid azimuths

Stations	Azimuth and angle			Correction for closure	Seconds of corrected azimuth	
	°	′	″	″	′	″
Wanda to Insane Asylum standpipe	269	13	56.3			56.3
∠Insane Asylum standpipe to 334	12	14	51.0	+0.6		51.6
Wanda to 334	281	28	47.3			47.9
334 to Wanda	101	28	47.3			47.9
∠Wanda to 335	166	45	00.0	+0.6		00.6
334 to 335	268	13	47.3			48.5
335 to 334	88	13	47.3			48.5
∠334 to 336	180	49	14.2	+0.7		14.9
335 to 336	269	03	01.5			03.4
336 to 335	89	03	01.5			03.4
∠335 to 337	191	03	29.8	+0.6		30.4
336 to 337	280	06	31.3			33.8
337 to 336	100	06	31.3			33.8
∠336 to 338	161	11	32.1	+0.6		32.7
337 to 338	261	18	03.4			06.5
338 to 337	81	18	03.4			06.5
∠337 to 339	156	56	29.2	+0.7		29.9
338 to 339	238	14	32.6			36.4
339 to 338	58	14	32.6			36.4
∠338 to 340	234	31	09.8	+0.6		10.4
339 to 340	292	45	42.4			46.8
340 to 339	112	45	42.4			46.8
∠339 to 341	154	07	51.3	+0.6		51.9
340 to 341	266	53	33.7			38.7
341 to 340	86	53	33.7			38.7
∠340 to 342	183	16	33.1	+0.7		33.8
341 to 342	270	10	06.8			12.5
342 to 341	90	10	06.8			12.5
∠341 to Mason	157	16	48.3	+0.6		48.9
342 to Mason	247	26	55.1		27	01.4
Mason to 342	67	26	55.1		27	01.4
∠342 to Juniata Schoolhouse cupola	29	40	40.5	+0.6		41.1
Mason to Juniata Schoolhouse cupola	97	07	35.6			42.5
Fixed azimuth	97	07	42.5			
Discrepancy			−6.9			

Reduction of lengths

[Average elevation=2,015 feet. Elevation factor=0.99990367]

Section	Corrected taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Wanda-334	2,766.561	2,766.294	0.9999485	2,766.152
334-335	4,247.926	4,247.517		4,247.298
335-336	7,636.828	7,636.092		7,635.699
336-337	5,730.721	5,730.169		5,729.874
337-338	6,328.590	6,327.980		6,327.654
338-339	4,179.943	4,179.540		4,179.325
339-340	5,163.698	5,163.201		5,162.935
340-341	3,113.616	3,113.316		3,113.156
341-342	6,442.592	6,441.971		6,441.639
342-Mason	2,745.821	2,745.556		2,745.415

Mean latitude $= 40°35'$
$\log R_a = 5.8304093 - \frac{1}{2}\log A - \frac{1}{2}\log B$

$\log A = 8.5091036-10$
$\log B = 8.5108073-10$

$\log A + \log B = 17.0199109-20$

$\frac{1}{2}(\log A + \log B) = 8.5099554-10$

log constant $= 5.8304093$
$\frac{1}{2}(\log A + \log B) = 8.5099554-10$

$\log R_a = 7.3204539$
$R_a = 20,914,800$

$$\text{Elevation factor} = \frac{20,914,800}{20,916,815} = 0.99990367$$

TRAVERSE, PROSSER TO WANDA

List of angles

Station	From station	To station	Angle
			° ′ ″
Prosser	Insane Asylum standpipe	325	50 32 09.3
325	Prosser	326	220 25 02.3
326	325	327	173 07 38.3
327	326	328	166 48 27.8
328	327	329	151 23 23.1
329	328	330	242 47 27.7
330	329	331	149 03 56.5
331	330	332	149 03 56.7
332	331	333	157 17 47.7
333	332	Wanda	162 52 38.8
Wanda	333	Insane Asylum standpipe	130 13 41.0

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Wanda to Mason
State Nebraska - South   County Adams   Initial Station Wanda
Year 1934   Month January - March   Closing Station Mason

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Wanda			2.74078452	-550.53		335,261.11	2,239,317.60
			9.29890848				
		2766.152	3.44187604			334,710.58	2,242,028.41
			9.99122356			+0.14	+0.01
334	281-28-47.9	2,766	3.43309960		+2710.81	334,710.72	2,242,028.42
			2.11786022	+131.18			
			8.48974748				
		4247.298	3.62811274			334,841.76	2,246,273.68
			9.99979277			+0.35	+0.02
335	268-13-48.5	7,013	3.62790551		+4245.27	334,842.11	2,246,273.70
			2.10199794	+126.47			
			8.21914914				
		7635.699	3.88284880			334,968.23	2,253,908.33
			9.99994042			+0.72	+0.05
336	269-03-03.4	14,649	3.88278922		+7634.65	334,968.95	2,253,908.38
			3.00249160	-1005.75			
			9.24434653				
		5729.874	3.75814507			333,962.48	2,259,549.24
			9.99320445			+1.00	+0.06
337	280-06-33.8	20,379	3.75134952		+5640.91	333,963.48	2,259,549.30
			2.98087973	+956.93			
			9.17963701				
		6327.654	3.80124272			334,919.41	2,265,804.12
			9.99497608			+1.31	+0.08
338	261-18-06.5	26,707	3.79621880		+6254.88	334,920.72	2,265,804.20

FIGURE 15.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Wanda to Mason
State Nebraska - South County Adams Initial Station Wanda
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	x Feet
338			3.34234877	+2199.63		334,919.41	2,265,804.12
			9.72124262			334,920.72	2,265,804.20
		4179.325	3.62110615			337,119.04	2,269,357.77
			9.92956810			+1.52	+0.10
339	238-14-36.4	30.886	3.55067425		+3553.65	337,120.56	2,269,357.87
			3.30051806	-1997.64			
			9.58762140				
		5162.935	3.71289666			335,121.40	2,274,118.58
			9.96478425			+1.77	+0.11
340	292-45-46.8	36.049	3.67768091		+4760.81	335,123.17	2,274,118.69
			2.22705532	+168.68			
			8.73385444				
		3113.156	3.49320088			335,290.08	2,277,227.16
			9.99936159			+1.93	+0.12
341	266-53-38.7	39.162	3.49256247		+3108.58	335,292.01	2,277,227.28
			1.28167670	-19.13			
			7.47268032				
		6441.639	3.80899638			335,270.95	2,283,668.77
			9.99999808			+2.24	+0.14
342	270-10-12.5	45.604	3.80899446		+6441.61	335,273.19	2,283,668.91
			3.02235440	+1052.82			
			9.58374640				
		2745.415	3.43860800			336,323.77	2,286,204.29
			9.96545939			+2.38	+0.15
Mason	247-27-01.4	48.349	3.40406739		+2535.52	336,326.15	2,286,204.44
						336,326.15	2,286,204.44
					Discrepancy	-2.38	-0.15
					x Factor = +3.1024 X 10^{-6}		
					y Factor = +4.9225 X 10^{-5}		

FIGURE 15.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Wanda to Mason
State Nebraska - South   County Adams   Initial Station Wanda
Year 1934   Month January - March   Closing Station Mason

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Wanda				-550.53		335,261.11	2,239,317.60
			0.19902538				
		2766.152				334,710.58	2,242,028.41
			0.97999434			+0.14	+0.01
334	281-28-47.9	2,766			+2710.81	334,710.72	2,242,028.42
				+131.18			
			0.03088499				
		4247.298				334,841.76	2,246,273.68
			0.99952294			+0.35	+0.02
335	268-13-48.5	7,013			+4245.27	334,842.11	2,246,273.70
				+126.47			
			0.01656339				
		7635.699				334,968.23	2,253,908.33
			0.99986282			+0.72	+0.05
336	269-03-03.4	14,649			+7634.65	334,968.95	2,253,908.38
				-1005.75			
			0.17552805				
		5729.874				333,962.48	2,259,549.24
			0.98447443			+1.00	+0.06
337	280-06-33.8	20,379			+5640.91	333,963.48	2,259,549.30
				+956.93			
			0.15122967				
		6327.654				334,919.41	2,265,804.12
			0.98849865			+1.31	+0.08
338	261-18-06.5	26,707			+6254.88	334,920.72	2,265,804.20

FIGURE 15.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Wanda to Mason
State Nebraska - South County Adams Initial Station Wanda
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
338				+2199.63		334,919.41	2,265,804.12
			0.52631121			334,920.72	2,265,804.20
		4179.325				337,119.04	2,269,357.77
			0.85029201			+1.52	+0.10
339	238-14-36.4	30,886			+3553.65	337,120.56	2,269,357.87
				-1997.64			
			0.38692020				
		5162.935				335,121.40	2,274,118.58
			0.92211321			+1.77	+0.11
340	.292-45-46.8	36,049			+4760.81	335,123.17	2,274,118.69
				+168.68			
			0.05418192				
		3113.156				335,290.08	2,277,227.16
			0.99853108			+1.93	+0.12
341	266-53-38.7	39,162			+3108.58	335,292.01	2,277,227.28
				-19.13			
			0.00296948				
		6441.639				335,270.95	2,283,668.77
			0.99999559			+2.24	+0.14
342	270-10-12.5	45,604			+6441.61	335,273.19	2,283,668.91
				+1052.82			
			0.38348326				
		2745.415				336,323.77	2,286,204.29
			0.92354783			+2.38	+0.15
Mason	247-27-01.4	48,349			+2535.52	336,326.15	2,286,204.44
						336,326.15	2,286,204.44
					Discrepancy	-2.38	-0.15

x Factor = $+3.1024 \times 10^{-6}$
y Factor = $+4.9225 \times 10^{-5}$

FIGURE 15.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 760

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate y Coordinate	Azimuth	Mark	Station	x Coordinate y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Insane Asylum, standpipe	2,294,236.38 335,997.01			342	2,283,66891 335,273.19		
Wanda	2,239,317.60 335,261.11	269 13 56.3	Insane Asylum, standpipe	Juniata schoolhouse, cupola	2,277,376.38 337,430.20		
334	2,242,028.42 334,710.72			Mason	2,286,204.44 336,326.15	97 07 42.5	Juniata schoolhouse, cupola
335	2,246,273.70 334,842.11						
336	2,253,908.38 334,96895						
337	2,259,549.30 333,963.48						
338	2,265,804.20 334,920.72						
339	2,269,357.87 337,120.56						
340	2,274,118.69 335,123.17						
341	2,277,227.28 335,292.01						

FIGURE 16.—List of adjusted coordinates.

TRAVERSE, PROSSER TO WANDA—Continued

Computation of grid azimuths

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	° ′ ″
Prosser to Insane Asylum standpipe	315 37 27.8		27.8
∠Insane Asylum standpipe to 325	50 32 09.3	+1.8	11.1
Prosser to 325	6 09 37.1		38.9
325 to Prosser	186 09 37.1		38.9
∠Prosser to 326	220 25 02.3	+1.7	04.0
325 to 326	46 34 39.4		42.9
326 to 325	226 34 39.4		42.9
∠325 to 327	173 07 38.3	+1.8	40.1
326 to 327	39 42 17.7		23.0
327 to 326	219 42 17.7		23.0
∠326 to 328	166 48 27.8	+1.7	29.5
327 to 328	26 30 45.5		52.5
328 to 327	206 30 45.5		52.5
∠327 to 329	151 23 23.1	+1.8	24.9
328 to 329	357 54 08.6		17.4
329 to 328	177 54 08.6		17.4
∠328 to 330	242 47 27.7	+1.7	29.4
329 to 330	60 41 36.3		46.8
330 to 329	240 41 36.3		46.8
∠329 to 331	149 03 56.5	+1.8	58.3
330 to 331	29 45 32.8		45.1
331 to 330	209 45 32.8		45.1
∠330 to 332	149 03 56.7	+1.7	58.4
331 to 332	358 49 29.5		43.5
332 to 331	178 49 29.5		43.5
∠331 to 333	157 17 47.7	+1.8	49.5
332 to 333	336 07 17.2		33.0
333 to 332	156 07 17.2		33.0
∠332 to Wanda	162 52 38.8	+1.7	40.5
333 to Wanda	318 59 56.0		319 00 13.5
Wanda to 333	138 59 56.0		139 00 13.5
∠333 to Insane Asylum standpipe	130 13 41.0	+1.8	42.8
Wanda to Insane Asylum standpipe	269 13 37.0		56.3
Fixed azimuth	269 13 56.3		
Discrepancy	−19.3		

Reduction of lengths

[Average elevation=2,055 feet. Elevation factor=0.99990175]

Section	Corrected taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Prosser-325	3,958.752	3,958.363	0.9999363	3,958.111
325-326	7,192.436	7,191.729	.9999372	7,191.277
326-327	4,156.096	4,155.688	.9999385	4,155.432
327-328	5,866.934	5,866.358	.9999400	5,866.006
328-329	3,056.766	3,056.466	.9999411	3,056.286
329-330	6,037.526	6,036.933	.9999420	6,036.583
330-331	5,333.603	5,333.079	.9999432	5,332.776
331-332	6,304.188	6,303.569	.9999452	6,303.224
332-333	6,495.734	6,495.096	.9999472	6,494.753
333-Wanda	4,092.182	4,091.780	.9999478	4,091.566

Mean latitude $= 40°38'.5$
log R_a $= 5.8304093 - \frac{1}{2} \log A - \frac{1}{2} \log B$

log A $= 8.5091022 - 10$
log B $= 8.5108029 - 10$

log A + log B $= 17.0199051 - 20$

$\frac{1}{2}$ (log A + log B) $= 8.5099526 - 10$

log constant $= 5.8304093$
$\frac{1}{2}$ (log A + log B) $= 8.5099526 - 10$

log R_a $= 7.3204567$
R_a $= 20,914,940$

Elevation factor $= \frac{20,914,940}{20,916,995} = 0.99990175$

Triangle, Kenesaw water tower–330–Wanda

COMPUTATION OF GRID AZIMUTHS AND LENGTHS

Wanda to 333

	x	y
	Feet	*Feet*
333	2, 236, 633. 57	338, 349. 26
Wanda	2, 239, 317. 60	335, 261. 11
Δx and Δy	−2, 684. 03	+3, 088. 15

log Δx $= 3.42878736$
log Δy $= 3.48969839$

log tan α $= 9.93908897 - 10$

α $= 40°59'42''.6$
Grid azimuth $= 139°00'17''.4$

330 to 331

	x	y
	Feet	*Feet*
331	2, 233, 876. 38	350, 590. 31
330	2, 236, 523. 71	355, 219. 68
Δx and Δy	−2, 647. 33	−4, 629. 37

log Δx $= 3.42280808$
log Δy $= 3.66552190$

log tan α $= 9.75728618 - 10$

α $= 29°45'47''.9$
Grid azimuth $= 29°45'47''.9$

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to Wanda
State Nebraska - South County Hall and Adams Initial Station Prosser
Year 1934 Month January - March Closing Station Wanda

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Prosser			3.59497248	-3935.25		378,552.84	2,252,598.10
			9.99748451				
		3958.111	3.59748797			374,617.59	2,252,173.32
			9.03067767			-0.03	-0.08
325	6 09 38.9	3,958	2.62816564		-424.78	374,617.56	2,252,173.24
			3.69398967	-4942.99			
			9.83718365				
		7191.277	3.85680602			369,674.60	2,246,950.17
			9.86112668			-0.09	-0.23
326	46 34 42.9	11,149	3.71793270		-5223.15	369,674.51	2,246,949.94
			3.50472790	-3196.89			
			9.88611172				
		4155.432	3.61861618			366,477.71	2,244,295.46
			9.80540135			-0.12	-0.31
327	39 42 23.0	15,305	3.42401753		-2654.71	366,477.59	2,244,295.15
			3.72007856	-5249.02			
			9.95173606				
		5866.006	3.76834250			361,228.69	2,241,676.72
			9.64974908			-0.17	-0.44
328	26 30 52.5	21,171	3.41809158		-2618.74	361,228.52	2,241,676.28
			3.48490356	-3054.24			
			9.99970957				
		3056.286	3.48519399			358,174.45	2,241,788.46
			8.56299915			-0.19	-0.50
329	357 54 17.4	24,227	2.04819314		+111.74	358,174.26	2,241,787.96

FIGURE 17.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to Wanda
State Nebraska - South County Hall and Adams Initial Station Prosser
Year 1934 Month January - March Closing Station Wanda

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
329			3.47048909	-2954.53		358,174.45	2,241,788.46
			9.68969791			358,174.26	2,241,787.96
		6036.583	3.78079118			355,219.92	2,236,524.33
			9.94053538			-0.24	-0.62
330	60 41 46.8	30,264	3.72132656		-5264.13	355,219.68	2,236,523.71
			3.66551824	-4629.33			
			9.93856490				
		5332.776	3.72695334			350,590.59	2,233,877.11
			9.69583731			-0.28	-0.73
331	29 45 45.1	35,596	3.42279065		-2647.22	350,590.31	2,233,876.38
			3.79947199	-6301.91			
			9.99990925				
		6303.224	3.79956274			344,288.68	2,234,005.95
			8.31049672			-0.33	-0.86
332	358 49 43.5	41,900	2.11005946		+128.84	344,288.35	2,234,005.09
			3.77371621	-5939.04			
			9.96115357				
		6494.753	3.81256264			338,349.64	2,236,634.57
			9.60716468			-0.38	-1.00
333	336 07 33.0	48,394	3.41972732		+2628.62	338,349.26	2,236,633.57
			3.48969414	-3088.12			
			9.87780458				
		4091.566	3.61188956			335,261.52	2,239,318.68
			9.81691021			-0.41	-1.08
Wanda	319 00 13.5	52,486	3.42879977		+2684.11	335,261.11	2,239,317.60
						335,261.11	2,239,317.60
				Discrepancy =		+0.41	+1.08

x Factor = -2.05769×10^{-5}
y Factor = -0.78116×10^{-5}

FIGURE 17.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to Wanda
State Nebraska - South County Hall and Adams Initial Station Prosser
Year 1934 Month January - March Closing Station Wanda

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Prosser				-3935.25		378,552.84	2,252,598.10
			0.99422461				
		3958.111				374,617.59	2,252,173.32
			0.10731926			-0.03	-0.08
325	6 09 38.9	3,958			-424.78	374,617.56	2,252,173.24
				-4942.99			
			0.68735905				
		7191.277				369,674.60	2,246,950.17
			0.72631780			-0.09	-0.23
326	46 34 42.9	11,149			-5223.15	369,674.51	2,246,949.94
				-3196.89			
			0.76932832				
		4155.432				366,477.71	2,244,295.46
			0.63885361			-0.12	-0.31
327	39 42 23.0	15,305			-2654.71	366,477.59	2,244,295.15
				-5249.02			
			0.89482077				
		5866.006				361,228.69	2,241,676.72
			0.44642558			-0.17	-0.44
328	26 30 52.5	21,171			-2618.74	361,228.52	2,241,676.28
				-3054.24			
			0.99933148				
		3056.286				358,174.45	2,241,788.46
			0.03655941			-0.19	-0.50
329	357 54 17.4	24,227			+111.74	358,174.26	2,241,787.96

FIGURE 17.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Prosser to Wanda
State Nebraska - South County Hall and Adams Initial Station Prosser
Year 1934 Month January - March Closing Station Wanda

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
329				-2954.53		358,174.45	2,241,788.46
			0.48943825			358,174.26	2,241,787.96
		6036.583				355,219.92	2,236,524.33
			0.87203795			-0.24	-0.62
330	60 41 46.8	30.264			-5264.13	355,219.68	2,236,523.71
				-4629.33			
			0.86809030				
		5332.776				350,590.59	2,233,877.11
			0.49640632			-0.28	-0.73
331	29 45 45.1	35.596			-2647.22	350,590.31	2,233,876.38
				-6301.91			
			0.99979106				
		6303.224				344,288.68	2,234,005.95
			0.02044075			-0.33	-0.86
332	358 49 43.5	41.900			+128.84	344,288.35	2,234,005.09
				-5939.04			
			0.91443653				
		6494.753				338,349.64	2,236,634.57
			0.40472933			-0.38	-1.00
333	336 07 33.0	48.394			+2628.62	338,349.26	2,236,633.57
				-3088.12			
			0.75475252				
		4091.566				335,261.52	2,239,318.68
			0.65600963			-0.41	-1.08
Wanda	319 00 13.5	52.486			+2684.11	335,261.11	2,239,317.60
						335,261.11	2,239,317.60
					Discrepancy =	+0.41	+1.08

x Factor = -2.05769×10^{-5}
y Factor = -0.78116×10^{-5}

FIGURE 17.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
FORM No. 709

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark
Insane Asylum standpipe	2,294,236.38 335,997.01			333	2,236,633.57 338,349.26		
Prosser	2,252,598.10 378,552.84	315 37 27.8	Insane Asylum standpipe				
325	2,252,173.24 374,617.56			Wanda	2,239,317.60 335,261.11	269 13 56.3	Insane Asylum standpipe
326	2,246,949.94 369,674.51			Kenesaw water tower*	2,232,574.99 348,882.63		
327	2,244,295.15 366,477.59						
328	2,241,676.28 361,228.52						
329	2,241,787.96 358,174.26						
330	2,236,523.71 355,219.68						
331	2,233,876.38 350,590.31						
332	2,234,005.09 344,288.35						

*No check on this station

FIGURE 18.—List of adjusted coordinates.

106911°—35——6

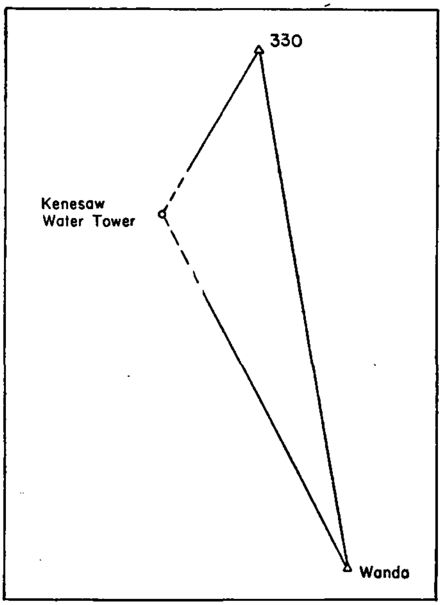

FIGURE 19.—Diagram of Kenesaw water tower.

Triangle, Kenesaw water tower–330–Wanda—Continued

COMPUTATION OF GRID AZIMUTHS AND LENGTHS—Continued

Wanda to 330

	x	*y*
	Feet	*Feet*
330	2, 236, 523. 71	355, 219. 68
Wanda	2, 239, 317. 60	335, 261. 11
Δx and Δy	−2, 793. 89	+19, 958. 57

log Δx = 3. 44620931
log Δy = 4. 30012942

log tan α = 9. 14607989−10

α = 7°58′07″.5
Grid azimuth = 172°01′52″.5

log Δx = 3. 44620931
log cosec α = 0. 85813346

log grid length = 4. 30434277

log Δy = 4. 30012942
log sec α = 0. 00421400

log grid length = 4. 30434342

COMPUTATION OF ANGLES OF TRIANGLE

Stations	Azimuth and angle		
	°	′	″
Wanda to 333	139	00	17. 4
∠333 to Kenesaw water tower	14	39	35. 6
Wanda to Kenesaw water tower	153	39	53. 0
Wanda to 330	172	01	52. 5
Wanda to Kenesaw water tower	153	39	53. 0
∠Kenesaw water tower to 330	18	21	59. 5
330 to 331	29	45	47. 9
∠331 to Kenesaw water tower	2	09	51. 8
330 to Kenesaw water tower	31	55	39. 7
330 to Wanda	352	01	52. 5
∠Wanda to Kenesaw water tower	39	53	47. 2

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES

11—9121
U. S. GOVERNMENT PRINTING OFFICE

State: ....

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
2-3							4.3043434
1	Kenesaw Water Tower	13.3				121 44	0.0703403
2	330	39 53 47.2					9.8071303
3	Wanda	18 21 59.5					9.4984411
1-3							4.1818140
1-2							3.8731248

FIGURE 20.—Computation of triangle for Kenesaw water tower.

COMPUTATION OF COORDINATES

α, Wanda to Kenesaw water tower = 153°39′53″.0

log s = 4. 1818140
log sin α = 9. 6470141 − 10

log Δx = 3. 8288281
Δx = −6, 742. 61

log s = 4. 1818140
log cos α = 9. 9524115 − 10

log Δy = 4. 1342255
Δy = +13, 621. 52

	x	y
	Feet	*Feet*
Wanda	2, 239, 317. 60	335, 261. 11
Δx and Δy	−6, 742. 61	+13, 621. 52
Kenesaw water tower	2, 232, 574. 99	348, 882. 63

α, 330 to Kenesaw water tower = 31°55′39″.7

log s = 3. 8731248
log sin α = 9. 7233314 − 10

log Δx = 3. 5964562
Δx = −3, 948. 72

log s = 3. 8731248
log cos α = 9. 9287625 − 10

log Δy = 3. 8018873
Δy = −6, 337. 05

	x	y
	Feet	*Feet*
330	2, 236, 523. 71	355, 219. 68
Δx and Δy	−3, 948. 72	−6, 337. 05
Kenesaw water tower	2, 232, 574. 99	348, 882. 63

TRAVERSE, 325 TO MASON

Computation of fixed grid azimuth

	x	y
	Feet	*Feet*
Prosser	2, 252, 598. 10	378, 552. 84
325	2, 252, 173. 24	374, 617. 56
Δx and Δy	+424. 86	+3, 935. 28

$$\log \Delta x = 2.62824584$$
$$\log \Delta y = 3.59497564$$
$$\log \tan \alpha = 9.03327020 - 10$$
$$\alpha = 6°09'42''.8$$
$$\text{Grid azimuth} = 186°09'42''.8$$

List of angles

PROSSER TO MASON

Station	From station—	To station—	Angle °	′	″
Prosser	Insane Asylum standpipe.	325	50	32	09. 3
325	Prosser	324	176	27	45. 3
324	325	323	106	59	29. 4
323	324	322	209	07	14. 4
322	323	321	190	41	10. 6
321	322	320	177	19	57. 9
320	321	319	143	05	44. 5
319	320	318	223	40	14. 0
318	319	317	172	27	53. 3
317	318	316	145	02	50. 5
316	317	Mason	203	18	53. 3
Mason	316	Juniata school	322	47	30. 4

Computation of grid azimuths

Stations	Azimuth and angle °	′	″	Correction for closure ″	Seconds of corrected azimuth ′	″
325 to Prosser	186	09	42. 8			42. 8
∠Prosser to 324	176	27	45. 3	−4. 0		41. 3
325 to 324	2	37	28. 1			24. 1
324 to 325	182	37	28. 1			24. 1
∠325 to 323	106	59	29. 4	−4. 0		25. 4
324 to 323	289	36	57. 5			49. 5
323 to 324	109	36	57. 5			49. 5
∠ 324 to 322	209	07	14. 4	−4. 0		10. 4
323 to 322	318	44	11. 9		43	59. 9
322 to 323	138	44	11. 9		43	59. 9
∠ 323 to 321	190	41	10. 6	−4. 0		06. 6
322 to 321	329	25	22. 5			06. 5
321 to 322	149	25	22. 5			06. 5
∠ 322 to 320	177	19	57. 9	−4. 0		53. 9
321 to 320	326	45	20. 4			00. 4
320 to 321	146	45	20. 4			00. 4
∠ 321 to 319	143	05	44. 5	−3. 9		40. 6
320 to 319	289	51	04. 9		50	41. 0

Computation of grid azimuths—Continued

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
319 to 320	109 51 04.9		50 41.0
∠ 320 to 318	223 40 14.0	−4.0	10.0
319 to 318	333 31 18.9		30 51.0
318 to 319	153 31 18.9		30 51.0
∠ 319 to 317	172 27 53.3	−4.0	49.3
318 to 317	325 59 12.2		58 40.3
317 to 318	145 59 12.2		58 40.3
∠ 318 to 316	145 02 50.5	−4.0	46.5
317 to 316	291 02 02.7		01 26.8
316 to 317	111 02 02.7		01 26.8
∠ 317 to Mason	203 18 53.3	−4.0	49.3
316 to Mason	314 20 56.0		16.1
Mason to 316	134 20 56.0		16.1
∠ 316 to Juniata school	322 47 30.4	−4.0	26.4
Mason to Juniata school	97 08 26.4		07 42.5
Fixed azimuth	97 07 42.5		
Discrepancy	+43.9		

Reduction of lengths

[Average elevation=2,013 feet. Elevation factor=0.99990376]

Section	Corrected taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Prosser-325	3, 958. 752	3, 958. 363	0. 9999363	*3, 958. 111
325-324	5, 325. 048	5, 324. 536	. 9999374	5, 324. 203
324-323	5, 648. 324	5, 647. 780	. 9999381	5, 647. 430
323-322	7, 945. 866	7, 945. 101	. 9999388	7, 944. 615
322-321	4, 444. 544	4, 444. 116	. 9999400	4, 443. 849
321-320	5, 835. 658	5, 835. 096	. 9999418	5, 834. 756
320-319	5, 035. 208	5, 034. 723	. 9999431	5, 034. 437
319-318	7, 298. 890	7, 298. 188	. 9999445	7, 297. 783
318-317	4, 694. 310	4, 693. 858	. 9999465	4, 693. 607
317-316	5, 775. 536	5, 774. 980	. 9999474	5, 774. 676
316-Mason	3, 141. 734	3, 141. 432	. 9999478	3, 141. 268

* Kept the same as on Prosser to Wanda.

Mean latitude $=40°38'.5$

R_a $=20,914,940$ (same as Prosser to Wanda).

$$\text{Elevation factor}=\frac{20,914,940}{20,916,953}=0.99990376$$

TRAVERSES IN THE COLUMBUS AREA

In the vicinity of Columbus the C. W. A. parties measured a number of traverses that we have chosen to include in this publication because they present some features to which we wished to call attention. A sketch of the lines included is shown in figure 23. They include the traverses Columbus to Curtis, Columbus to Monroe, Monroe to Genoa, Monroe to Osceola, Genoa to Osceola, and finally two traverses that intersect which might be called Columbus to Osceola and Monroe to Curtis. As actually computed these last two in no case

(Text continued on p. 85)

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 325 to Mason
State Nebraska - South County Adams Initial Station 325
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates	
	° ′ ″					y Feet	x Feet
325			3.72579922	-5318.62		374,617.56	2,252,173.24
			9.99954462				
		5324.203	3.72625460			369,298.94	2,251,929.55
			8,66058370			-0.20	+0.18
324	2 - 37 - 24.1	5,324	2.38683830		-243.69	369,298.74	2,251,929.73
			3.27777327	-1895.72			
			9.52592241				
		5647.430	3.75185086			367,403.22	2,257,249.30
			9.97404026			-0.41	+0.38
323	289-36 - 49.5	10,972	3.72589112		+5319.75	367,402.81	2,257,249.68
			3.77608717	-5971.55			
			9.87601431				
		7944.615	3.90007286			361,431.67	2,262,489.29
			9.81925750			-0.71	+0.65
322	318-43-59.9	18,916	3.71933036		+5239.99	361,430.96	2,262,489.94
			3.58271507	-3825.74			
			9.93495578				
		4443.849	3.64775929			357,605.93	2,264,750.16
			9.70651628			-0.88	+0.80
321	329-25-06.5	23,360	3.35427557		+2260.87	357,605.05	2,264,750.96
			3.68837816	-4879.53			
			9.92235546				
		5834.756	3.76602270			352,726.40	2,267,949.31
			9.73901160			-1.10	+1.01
320	326-45-00.4	29,195	3.50503430		+3199.15	352,725.30	2,267,950.32

FIGURE 21.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 325 to Mason
State Nebraska - South County Adams Initial Station 325
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
320			3.23275515	-1709.05		352,726.40	2,267,949.31
			9.53080424			352,725.30	2,267,950.32
		5034.437	3.70195091			351,017.35	2,272,684.78
			9.97341240			-1.29	+1.18
319	289-50-41.0	34.229	3.67536331		+4735.47	351,016.06	2,272,685.96
			3.81503566	-6531.84			
			9.95184471				
		7297.783	3.86319095			344,485.51	2,275939.42
			9.64931200			-1.57	+1.43
318	333-30-51.0	41.527	3.51250295		+3254.64	344,483.94	2,275,940.85
			3.58996771	-3890.16			
			9.91846098				
		4693.607	3.67150673			340,595.35	2,278,565.56
			9.74781034			-1.74	+1.59
317	325-58-40.3	46.221	3.41931707		+2626.14	340,593.61	2,278,567.15
			3.31633259	-2071.73			
			9.55480496				
		5774.676	3.76152763			338,523.62	2,283,955.81
			9.97008154			-1.96	+1.79
316	291-01-26.8	51.995	3.73160917		+5390.25	338,521.66	2,283,957.60
			3.34151219	-2195.39			
			9.84440720				
		3141.268	3.49710498			336,328.23	2,286,202.54
			9.85444678			-2.08	+1.90
Mason	314-20-16.1	55.137	3.35155177		+2246.73	336,326.15	2,286,204.44
						336,326.15	2,286,204.44
					Discrepancy	+2.08	-1.90
					x Factor =	$+3.44596 \times 10^{-5}$	
					y Factor =	-3.77242×10^{-5}	

FIGURE 21.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 325 to Mason
State Nebraska - South County Adams Initial Station 325
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
325				-5318.62		374,617.56	2,252,173.24
			0.99895199				
		5324.203				369,298.94	2,251,929.55
			0.04577029			-0.20	+0.18
324	2 - 37 - 24.1	5,324			-243.69	369,298.74	2,251,929.73
				-1895.72			
			0.33567763				
		5647.430				367,403.22	2,257,249.30
			0.94197692			-0.41	+0.38
323	289 - 36 - 49.5	10,972			+5319.75	367,402.81	2,257,249.68
				-5971.55			
			0.75164766				
		7944.615				361,431.67	2,262,489.29
			0.65956485			-0.71	+0.65
322	318 - 43 - 59.9	18,916			+5239.99	361,430.96	2,262,489.94
				-3825.74			
			0.86090609				
		4443.849				357,605.93	2,264,750.16
			0.50876389			-0.88	+0.80
321	329 - 25 - 06.5	23,360			+2260.87	357,605.05	2,264,750.96
				-4879.53			
			0.83628722				
		5834.756				352,726.40	2,267,949.31
			0.54829161			-1.10	+1.01
320	326 - 45 - 00.4	29,195			+3199.15	352,725.30	2,267,950.32

FIGURE 21.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 325 to Mason
State Nebraska - South County Adams Initial Station 325
Year 1934 Month January - March Closing Station Mason

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Lat. / cos Az / dist. / sin Az / Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
320				-1709.05		352,726.40	2,267,949.31
			0.33947222			352,725.30	2,267,950.32
		5034.437				351,017.35	2,272,684.78
			0.94061608			-1.29	+1.18
319	289-50-41.0	34.229			+4735.47	351,016.06	2,272,685.96
				-6531.84			
			0.89504466				
		7297.783				344,485.51	2,275,939.42
			0.44597652			-1.57	+1.43
318	333-30-51.0	41.527			+3254.64	344,483.94	2,275,940.85
				-3890.16			
			0.82882144				
		4693.607				340,595.35	2,278,565.56
			0.55951320			-1.74	+1.59
317	325-58-40.3	46.221			+2626.14	340,593.61	2,278,567.15
				-2071.73			
			0.35876079				
		5774.676				338,523.62	2,283,955.81
			0.93342954			-1.96	+1.79
316	291-01-26.8	51.995			+5390.25	338,521.66	2,283,957.60
				-2195.39			
			0.69888737				
		3141.268				336,328.23	2,286,202.54
			0.71523174			-2.08	+1.90
Mason	314-20-16.1	55.137			+2246.73	336,326.15	2,286,204.44
						336,326.15	2,286,204.44
					Discrepancy	+2.08	-1.90

x Factor = $+3.44596 \times 10^{-5}$
y Factor = -3.77242×10^{-5}

FIGURE 21.—Computation of coordinates—Continued.

Department of Commerce
U.S. Coast and Geodetic Survey
Form No. 709

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Presser	2,252,598.10			316	2,283,957.60		
	378,552.84				338,521.66		
325	2,252,173.24	186 09 42.8	Presser	Juniata schoolhouse,	2,277,376.38		
	374,617.56			cupola	337,430.20		
324	2,251,929.73			Mason	2,286,204.44	97 07 42.5	Juniata schoolhouse
	369,298.74				336,326.15		cupola
323	2,257,249.68						
	367,402.81						
322	2,262,48994						
	361,43096						
321	2,264,75096						
	357,60505						
320	2,267,950.32						
	352,725.30						
319	2,272,685.96						
	351,016.06						
918	2,275,94085						
	344,48394						
317	2,278,567.15						
	340,59361						

FIGURE 22.—List of adjusted coordinates.

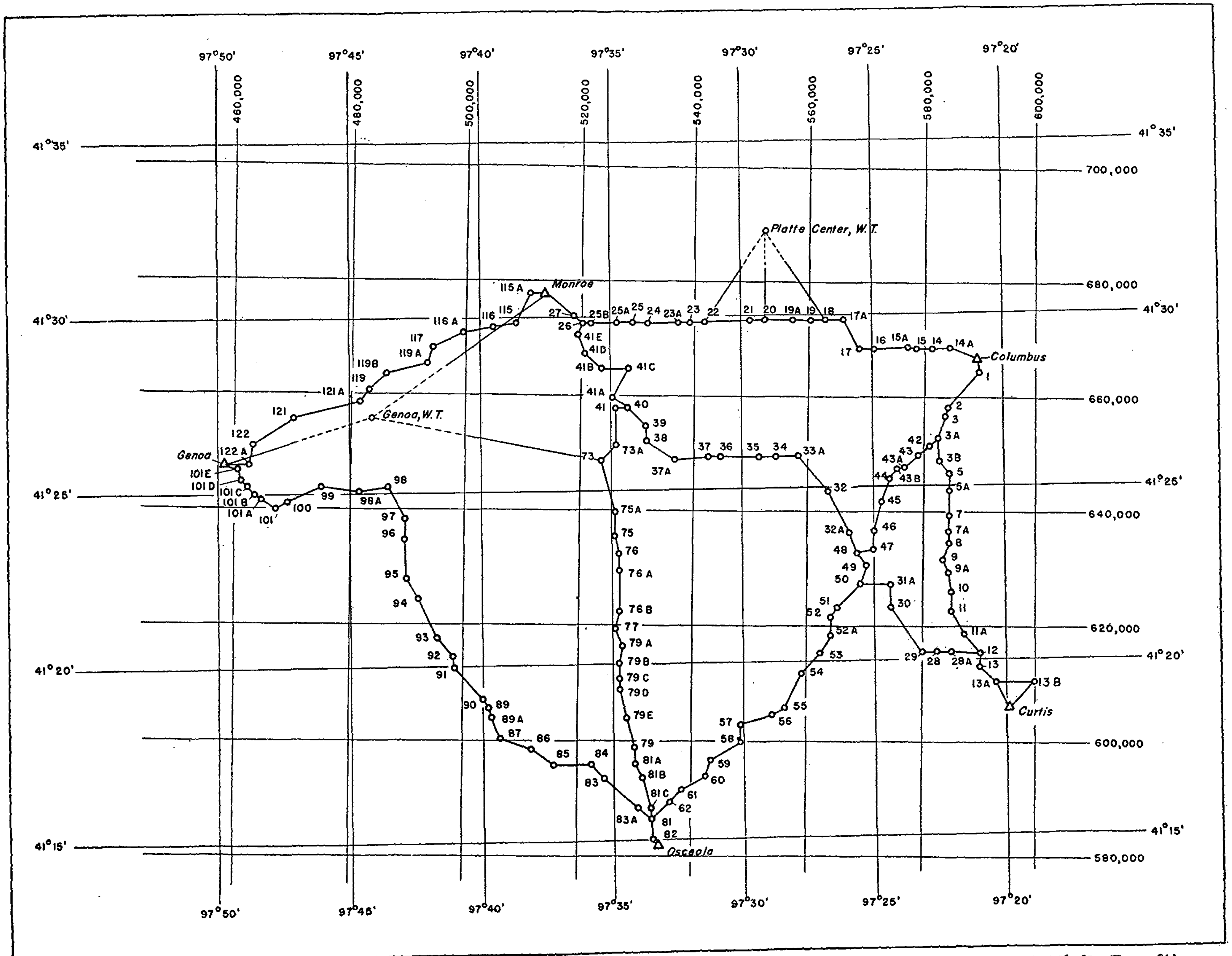

FIGURE 23.—Diagram of the Columbus area.

extend to the end stations as named but are computed from stations on the traverses that are held fixed from previous adjustments.

The traverse Osceola to Monroe ended on station 26 of the line from Columbus to Monroe. This traverse crosses the Loup River and the length 41A to 41C had to be computed from the observed triangle 41A, 41B, and 41C. Thus the crossing of the river was effected and it was possible to carry the computation of the traverse to its junction with station 26.

The traverse from Genoa to Osceola had stations 81, 82, and Osceola in common with the one from Osceola to Monroe. Accordingly, station 81 was held fixed in computing from Genoa with the fixed grid azimuth 81 to 81C.

From the traverses Columbus to Curtis and Osceola to Monroe two others branch off, one at station 40 and the other at station 81. These two intersect and meet two others from stations 3A and 12 in the vicinity of the Platte River. The one from 81 and that from 3A intersect at station 50. Those from 40 and 12 intersect at station 48. The problem presented was to compute to these points and then to adopt a weighted mean at one of the points. This was done for the station 48; then stations 49 and 50 were fixed in the one coming from station 12 and this value of station 50 was held in the one coming from station 81. In these traverses the length of 48 to 49 was computed from the triangle 49, 48, and 47. This was no doubt due to the difficulty of crossing the Platte River.

In the traverse Columbus to Curtis the length of the line 13A to Curtis was also computed from the triangle Curtis, 13A, and 13B. The coordinates of 13B were computed after the direct traverse was completed from 13A to Curtis.

In the traverse from Columbus to Monroe observations were made on Platte Center water tower. Three of the observations were used in an adjustment to determine the coordinates of this tower. These were from stations 18, 20, and 22. The fixed triangle was so flat that it could not be computed by the law of sines, the three stations being so nearly in a straight line. The details of the adjustment show that the fixed data were perfectly consistent.

Observations were also made on Genoa water tower, but not all of them were from stations on the same traverse. The observations from Monroe, Genoa, and 73 were chosen for an adjustment to determine the coordinates of this station. These were the only extra observations that were computed in the Columbus area.

These traverses furnish examples of almost all kinds of computation that are apt to arise in applying the coordinates to traverse computations. All of the work is shown in great detail so a careful checking over the computations should serve as a guide to those who wish to make similar computations.

Plane coördinates on Lambert projection

State Nebraska (south) Station Columbus

ϕ = 41° 28′ 37.″551 λ = 97° 20′ 56.″234

Tabular difference of R for 1″ of ϕ = 101.21067

R (for min. of ϕ)		23,935,018.92	y′ (for min. of ϕ)		655,762.94
Cor. for sec. of ϕ		− 3,800.56	Cor. for sec. of ϕ		+ 3,800.56
R		23,931,218.36	y′		659,563.50
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 7,258.98
θ (for min. of λ)		+ 1° 25′ 17.″3959	y		666,822.48
Cor. for sec. of λ		− 36.8938			
θ		+ 1 24 40.5021	$\frac{\theta}{2}$		0° 42′ 20.″25105
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0246284788	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0123151733
~~log R~~				R sin $\frac{\theta}{2}$	294,717.10
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3629.492
x′	R sin θ	+589,389.50	~~log R~~	2Rsin²θ/2	7258.98
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,589,389.50	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 24.—Computation of coordinates from geographic position.

Plane coordinates on Lambert projection

State Nebraska (south) Station Monroe

ϕ = 41° 30' 42".429 λ = 97° 37' 23".550

Tabular difference of R for 1" of ϕ = 101.21167

R (for min. of ϕ)		23,922,873.61	y' (for min. of ϕ)		667,908.25
Cor. for sec. of ϕ		− 4,294.31	Cor. for sec. of ϕ		+ 4,294.31
R		23,918,579.30	y'		672,202.56
			y'' (=2R sin² $\frac{\theta}{2}$)		+ 5,523.12
θ (for min. of λ)		+ 1° 14' 08".1980	y		677,725.68
Cor. for sec. of λ		− 15.4506			
θ		+ 1 13 52.7474	$\frac{\theta}{2}$		0° 36' 56".3737
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0214889117	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0107450761
~~log R~~				R sin $\frac{\theta}{2}$	257,006.95
~~log x'~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	2761.559
x'	R sin θ	+513,984.24	~~log R~~	2Rsin²θ/2	5523.12
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,513,984.24	~~log y''~~		

x = 2,000,000.00 + R sin θ

y = y' + 2R sin² $\frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 24.—*Computation of coordinates from geographic position—Continued.*

Plane coordinates on Lambert projection

State Nebraska (south) Station Columbus Municipal Tank

ϕ = 41°25′37″.192 λ = 97°21′40″.377

Tabular difference of R for 1″ of ϕ = 101.20900

R (for min. of ϕ)		23,953,236.63	y′ (for min. of ϕ)		637,545.23
Cor. for sec. of ϕ		− 3,764.17	Cor. for sec. of ϕ		+ 3,764.17
R		23,949,472.46	y′		641,309.40
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 7,181.94
θ (for min. of λ)		+ 1°24′38″.0313	y		648,491.34
Cor. for sec. of λ		− 26.4904			
θ		+ 1 24 11.5409	$\frac{\theta}{2}$		0°42′05″.77045
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0244881133	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0122449747
~~log R~~				R sin $\frac{\theta}{2}$	293,260.68
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3590.970
x′	R sin θ	+586,477.40	~~log R~~	2R sin²θ/2	7181.94
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,586,477.40	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin\theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 24.—Computation of coordinates from geographic position—Continued.

TRAVERSE, COLUMBUS TO MONROE

Computation of fixed grid azimuths

	°	′	″
Geodetic azimuth Columbus to azimuth mark (R. M. no. 1) =	182	24	16. 5
θ at Columbus =	1	24	40. 5
Grid azimuth =	180	59	36. 0

	x	y
	Feet	*Feet*
Columbus municipal tank	2, 586, 477. 40	648, 491. 34
Monroe	2, 513, 984. 24	677, 725. 68
Δx and Δy	+72, 493. 16	−29, 234. 34

$$\log \Delta x = 4.86029703$$
$$\log \Delta y = 4.46589329$$
$$\log \tan \alpha = 0.39440374$$

$$\alpha = 68°02'14''.1$$
Grid azimuth = 291°57′45″.9

List of angles

Station	From station—	To station—	Angle °	′	″
Columbus	Azimuth mark	14A	289	16	45. 6
14A	Columbus	14	157	58	39. 7
14	14A	15	180	23	01. 2
15	14	15A	181	44	10. 5
15A	15	16	177	54	47. 3
16	15A	17	181	56	53. 9
17	16	17A	240	22	46. 6
17A	17	18	117	45	49. 5
18	17A	19	180	21	45. 0
19	18	19A	179	02	55. 6
19A	19	20	181	37	49. 4
20	19A	21	179	18	30. 3
21	20	22	179	37	02. 2
22	21	23	179	22	48. 4
23	22	23A	182	11	33. 7
23A	23	24	178	48	27. 1
24	23A	25	179	57	32. 8
25	24	25A	180	03	39. 5
25A	25	25B	180	16	16. 5
25B	25A	26	181	05	34. 1
26	25B	27	220	47	42. 4
27	26	Monroe	179	16	56. 5
Monroe	27	Columbus municipal tank	341	45	42. 6

Computation of grid azimuths

Stations	Azimuth and angle			Correction for closure	Seconds of corrected azimuth	
	°	′	″	″	′	″
Columbus to azimuth mark	180	59	36.0			36.0
∠Azimuth mark to 14A	289	16	45.6	+2.6		48.2
Columbus to 14A	110	16	21.6			24.2
14A to Columbus	290	16	21.6			24.2
∠Columbus to 14	157	58	39.7	+2.6		42.3
14A to 14	88	15	01.3			06.5
14 to 14A	268	15	01.3			06.5
∠14A to 15	180	23	01.2	+2.6		03.8
14 to 15	88	38	02.5			10.3
15 to 14	268	38	02.5			10.3
∠14 to 15A	181	44	10.5	+2.6		13.1
15 to 15A	90	22	13.0			23.4
15A to 15	270	22	13.0			23.4
∠15 to 16	177	54	47.3	+2.6		49.9
15A to 16	88	17	00.3			13.3
16 to 15A	268	17	00.3			13.3
∠15A to 17	181	56	53.9	+2.6		56.5
16 to 17	90	13	54.2		14	09.8
17 to 16	270	13	54.2		14	09.8
∠16 to 17A	240	22	46.6	+2.6		49.2
17 to 17A	150	36	40.8			59.0
17A to 17	330	36	40.8			59.0
∠17 to 18	117	45	49.5	+2.5		52.0
17A to 18	88	22	30.3			51.0
18 to 17A	268	22	30.3			51.0
∠17A to 19	180	21	45.0	+2.6		47.6
18 to 19	88	44	15.3			38.6
19 to 18	268	44	15.3			38.6
∠18 to 19A	179	02	55.6	+2.6		58.2
19 to 19A	87	47	10.9			36.8
19A to 19	267	47	10.9			36.8
∠19 to 20	181	37	49.4	+2.6		52.0
19A to 20	89	25	00.3			28.8
20 to 19A	269	25	00.3			28.8
∠19A to 21	179	18	30.3	+2.6		32.9
20 to 21	88	43	30.6		44	01.7
21 to 20	268	43	30.6		44	01.7
∠20 to 22	179	37	02.2	+2.6		04.8
21 to 22	88	20	32.8		21	06.5
22 to 21	268	20	32.8		21	06.5
∠21 to 23	179	22	48.4	+2.6		51.0
22 to 23	87	43	21.2			57.5
23 to 22	267	43	21.2			57.5
∠22 to 23A	182	11	33.7	+2.6		36.3
23 to 23A	89	54	54.9		55	33.8
23A to 23	269	54	54.9		55	33.8
∠23 to 24	178	48	27.1	+2.5		29.6
23A to 24	88	43	22.0		44	03.4
24 to 23A	268	43	22.0		44	03.4
∠23A to 25	179	57	32.8	+2.6		35.4
24 to 25	88	40	54.8		41	38.8
25 to 24	268	40	54.8		41	38.8
∠24 to 25A	180	03	39.5	+2.6		42.1
25 to 25A	88	44	34.3		45	20.9
25A to 25	268	44	34.3		45	20.9
∠25 to 25B	180	16	16.5	+2.6		19.1
25A to 25B	89	00	50.8		01	40.0
25B to 25A	269	00	50.8		01	40.0
∠25A to 26	181	05	34.1	+2.6		36.7
25B to 26	90	06	24.9		07	16.7

Computation of grid azimuths—Continued

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
26 to 25B	270 06 24.9		07 16.7
∠25B to 27	220 47 42.4	+2.6	45.0
26 to 27	130 54 07.3		55 01.7
27 to 26	310 54 07.3		55 01.7
∠26 to Monroe	179 16 56.5	+2.6	59.1
27 to Monroe	130 11 03.8		12 00.8
Monroe to 27	310 11 03.8		12 00.8
∠27 to Columbus municipal tank	341 45 42.6	+2.5	45.1
Monroe to Columbus municipal tank	291 56 46.4		57 45.9
Fixed azimuth	291 57 45.9		
Discrepancy	−59.5		

Reduction of lengths

[Average elevation=1,470 feet. Elevation factor=0.99992973]

Section	Taped length	Geodetic length	Mean grid factor	Grid length
	Feet	*Feet*		*Feet*
Columbus-14A	5,057.476	5,057.121	0.9999600	5,056.919
14A-14	3,159.596	3,159.374		3,159.248
14-15	2,607.864	2,607.681		2,607.577
15-15A	1,601.840	1,601.727		1,601.663
15A-16	6,002.310	6,001.888		6,001.648
16-17	2,391.799	2,391.631		2,391.535
17-17A	6,021.250	6,020.826		6,020.586
17A-18	3,140.659	3,140.438		3,140.312
18-19	2,573.282	2,573.101		2,572.998
19-19A	3,181.402	3,181.178		3,181.051
19A-20	4,810.594	4,810.256		4,810.064
20-21	2,599.549	2,599.366		2,599.262
21-22	7,687.551	7,687.011		7,686.704
22-23	2,831.276	2,831.077		2,830.964
23-23A	2,043.691	2,043.547		2,043.465
23A-24	5,225.298	5,224.931		5,224.722
24-25	2,713.921	2,713.730		2,713.621
25-25A	2,798.906	2,798.709		2,798.597
25A-25B	4,605.746	4,605.422		4,605.238
25B-26	1,591.488	1,591.376		1,591.312
26-27	1,826.576	1,826.448		1,826.375
27-Monroe	6,262.922	6,262.482		6,262.232

$$\text{Mean latitude} = 41°29'.7$$
$$\log R_a = 5.8304093 - \tfrac{1}{2}\log A - \tfrac{1}{2}\log B$$

$$\log A = 8.5090804-10$$
$$\log B = 8.5107377-10$$

$$\log A + \log B = 17.0198181-20$$

$$\tfrac{1}{2}(\log A + \log B) = 8.5099090-10$$

$$\log \text{constant} = 5.8304093$$
$$\tfrac{1}{2}(\log A + \log B) = 8.5099090-10$$

$$\log R_a = 7.3205003$$
$$R_a = 20{,}917{,}040$$

$$\text{Elevation factor} = \frac{20{,}917{,}040}{20{,}918{,}510} = 0.99992973$$

COMPUTATION OF COORDINATES

Traverse line Columbus to Monroe
State Nebraska (south) County Platte Initial Station Columbus
Year 1934 Month January - March Closing Station Monroe

Station	Azimuth Plane ° ' "	Grid Distance Feet	Lat. / cos Az / dist. / sin Az / Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Colum-				+1752.22		666,822.48	2,589,389.50
bus			0.34650001				
		5056.919				668,574.70	2,584,645.86
			0.93804996			+0.38	-0.20
14A	110 16 24.2	5,057			-4743.64	668,575.08	2,584,645.66
				- 96.38			
			0.03050702				
		3159.248				668,478.32	2,581,488.08
			0.99953456			+0.62	-0.32
14	88 15 06.5	8,216			-3157.78	668,478.94	2,581,487.76
				- 62.06			
			0.02380065				
		2607.577				668,416.26	2,578,881.24
			0.99971673			+0.82	-0.43
15	88 38 10.3	10,824			-2606.84	668,417.08	2,578,880.81
				+ 10.43			
			0.00651294				
		1601.663				668,426.69	2,577,279.61
			0.99997879			+0.94	-0.49
15A	90 22 23.4	12,425			-1601.63	668,427.63	2,577,279.12
				- 179.40			
			0.02989256				
		6001.648				668,247.29	2,571,280.64
			0.99955311			+1.39	-0.73
16	88 17 13.3	18,427			-5998.97	668,248.68	2,571,279.91

FIGURE 25.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Columbus to Monroe
State Nebraska (south) County Platte Initial Station Columbus
Year 1934 Month January - March Closing Station Monroe

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~log~~ Lat. / ~~log~~ cos Az / ~~log~~ dist. / ~~log~~ sin Az / ~~log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
16				+ 9.85		668,247.29	2,571,280.64
			0.00411993			668,248.68	2,571,279.91
		2391.535				668,257.14	2,568,889.13
			0.99999151			+1.57	-0.82
17	90 14 09.8	20,819			-2391.51	668,258.71	2,568,888.31
				+5246.06			
			0.87135419				
		6020.586				673,503.20	2,565,935.10
			0.49065453			+2.03	-1.06
17A	150 36 59.0	26.839			-2954.03	673,505.23	2,565,934.04
				- 88.73			
			0.02825603				
		3140.312				673,414.47	2,562,796.04
			0.99960072			+2.27	-1.18
18	88 22 51.0	29.979			-3139.06	673,416.74	2,562,794.86
				- 56.40			
			0.02191861				
		2572.998				673,358.07	2,560,223.66
			0.99975976			+2.46	-1.29
19	88 44 38.6	32.552			-2572.38	673,360.53	2,560,222.37
				- 122.47			
			0.03850020				
		3181.051				673,235.60	2,557,044.97
			0.99925859			+2.70	-1.41
19A	87 47 36.8	35.734			-3178.69	673,238.30	2,557,043.56

FIGURE 25.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Columbus to Monroe
State Nebraska (south) County Platte Initial Station Columbus
Year 1934 Month January - March Closing Station Monroe

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
19A				- 48.30		673,235.60	2,557,044.97
			0.01004129			673,238.30	2,557,043.56
		4810.064				673,187.30	2,552,235.15
			0.99994958			+3.06	-1.60
20	89 25 28.8	40.544			-4809.82	673,190.36	2,552,233.55
				- 57.44			
			0.02209746				
		2599.262				673,129.86	2,549,636.52
			0.99975582			+3.26	-1.70
21	88 44 01.7	43.143			-2598.63	673,133.12	2,549,634.82
				-221.09			
			0.02876246				
		7686.704				672,908.77	2,541,953.00
			0.99958627			+3.84	-2.01
22	88 21 06.5	50.830			-7683.52	672,912.61	2,541,950.99
				-112.00			
			0.03956259				
		2830.964				672,796.77	2,539,124.25
			0.99921710			+4.05	-2.12
23	87 43 57.5	53.661			-2828.75	672,800.82	2,539,122.13
				- 2.64			
			0.00129057				
		2043.465				672,794.13	2,537,080.79
			0.99999917			+4.21	-2.20
23A	89 55 33.8	55.704			-2043.46	672,798.34	2,537,078.59

FIGURE 25.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Columbus to Monroe
State Nebraska (south) County Platte Initial Station Columbus
Year 1934 Month January - March Closing Station Monroe

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
23A				-115.41		672,794.13	2,537,080.79
			0.02208922			672,798.34	2,537,078.59
		5224.722				672,678.72	2,531,857.34
			0.99975600			+4.60	-2.41
24	88 44 03.4	60.929			-5223.45	672,683.32	2,531,854.93
				- 61.84			
			0.02279009				
		2713.621				672,616.88	2,529,144.42
			0.99974027			+4.81	-2.51
25	88 41 38.8	63.642			-2712.92	672,621.69	2,529,141.91
				- 60.77			
			0.02171358				
		2798.597				672,556.11	2,526,346.48
			0.99976423			+5.02	-2.63
25A	88 45 20.9	66.441			-2797.94	672,561.13	2,526,343.85
				- 78.14			
			0.01696766				
		4605.238				672,477.97	2,521,741.90
			0.99985604			+5.37	-2.81
25B	89 01 40.0	71.046			-4604.58	672,483.34	2,521,739.09
				+ 3.37			
			0.00211718				
		1591.312				672,481.34	2,520,150.59
			0.99999776			+5.49	-2.87
26	90 07 16.7	72.637			-1591.31	672,486.83	2,520,147.72

FIGURE 25.—Computation of coordinates—Continued

COMPUTATION OF COORDINATES

Traverse line ~~Nox~~ Columbus to Monroe
State Nebraska (south) County Platte Initial Station Columbus
Year 1934 Month January - March Closing Station Monroe

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. ~~Log.~~ cos Az ~~Log.~~ dist. ~~Log.~~ sin Az ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
26				+1196.22		672,481.34	2,520,150.59
			0.65496688			672,486.83	2,520,147.72
		1826.375				673,677.56	2,518,770.48
			0.75565758			+5.63	-2.94
27	130 55 01.7	74.464			-1380.11	673,683.19	2,518,767.54
				+4042.02			
			0.64546065				
		6262.232				677,719.58	2,513,987.43
			0.76379353			+6.10	-3.19
Monroe	130 12 00.8	80.726			-4783.05	677,725.68	2,513,984.24
						677,725.68	2,513,984.24
					Discrepancy	-6.10	+3.19
					x Factor =	-3.95164×10^{-5}	
					y Factor =	$+7.55643 \times 10^{-5}$	

FIGURE 25.—Computation of coordinates—Continued.

Adjustment of Platte Center water tower

COMPUTATION OF GRID AZIMUTHS FROM COORDINATES

18 to 20

	x	y
	Feet	*Feet*
20	2, 552, 233. 55	673, 190. 36
18	2, 562, 794. 86	673, 416. 74
Δx and Δy	−10, 561. 31	−226. 38

$\log \Delta x = 4.0237178$ $\qquad$ $\log \Delta x = 4.0237178$

$\log \Delta y = 2.3548381$ $\qquad$ $\log \sin \alpha_1 = 9.9999002-10$

$\log \tan \alpha_1 = 1.6688797$ $\qquad$ $\log s_1 = 4.0238176$

$\alpha_1 = 88°46'19''.4 =$ grid azimuth

18 to 22

	x	y
	Feet	*Feet*
22	2, 541, 950. 99	672, 912. 61
18	2, 562, 794. 86	673, 416. 74
Δx and Δy	−20, 843. 87	−504. 13

$\log \Delta x = 4.3189784$ $\qquad$ $\log \Delta x = 4.3189784$

$\log \Delta y = 2.7025425$ $\qquad$ $\log \sin \alpha_2 = 9.9998730-10$

$\log \tan \alpha_2 = 1.6164359$ $\qquad$ $\log s_2 = 4.3191054$

$\alpha_2 = 88°36'52''.3 =$ grid azimuth

20 to 22

	x	y
	Feet	*Feet*
22	2, 541, 950. 99	672, 912. 61
20	2, 552, 233. 55	673, 190. 36
Δx and Δy	−10, 282. 56	−277. 75

$\log \Delta x = 4.0121012$ $\qquad$ $\log \Delta x = 4.0121012$

$\log \Delta y = 2.4436541$ $\qquad$ $\log \sin \alpha_3 = 9.9998416-10$

$\log \tan \alpha_3 = 1.5684471$ $\qquad$ $\log s_3 = 4.0122596$

$\alpha_3 = 88°27'09''.8 =$ grid azimuth

COMPUTATION OF GRID AZIMUTHS FROM COORDINATES—Continued

18 to 17A

	x	y
	Feet	*Feet*
17A	2, 565, 934. 04	673, 505. 23
18	2, 562, 794. 86	673, 416. 74
Δx and Δy	+3, 139. 18	+88. 49

$$\log \Delta x = 3.\ 4968162$$
$$\log \Delta y = 1.\ 9468942$$
$$\log \tan \alpha = 1.\ 5499220$$
$$\alpha = 88°23'07''.2$$
$$\text{Grid azimuth} = 268°23'07''.2$$

20 to 19A

	x	y
	Feet	*Feet*
19A	2, 557, 043. 56	673, 238. 30
20	2, 552, 233. 55	673, 190. 36
Δx and Δy	+4, 810. 01	+47. 94

$$\log \Delta x = 3.\ 6821460$$
$$\log \Delta y = 1.\ 6806980$$
$$\log \tan \alpha = 2.\ 0014480$$
$$\alpha = 89°25'44''.3$$
$$\text{Grid azimuth} = 269°25'44''.3$$

22 to 21

	x	y
	Feet	*Feet*
21	2, 549, 634. 82	673, 133. 12
22	2, 541, 950. 99	672, 912. 61
Δx and Δy	+7, 683. 83	+220. 51

$$\log \Delta x = 3.\ 8855778$$
$$\log \Delta y = 2.\ 3434283$$
$$\log \tan \alpha = 1.\ 5421495$$
$$\alpha = 88°21'22''.3$$
$$\text{Grid azimuth} = 268°21'22''.3$$

COMPUTATION OF THE ANGLES FOR TRIANGLES

Stations	Azimuth and angle	Stations	Azimuth and angle
	° ′ ″		° ′ ″
18 to 17A	268 23 07.2	20 to Platte Center water tower	180 00 59.3
∠17A to Platte Center water tower	237 41 23.4	20 to 22	88 27 09.8
18 to Platte Center water tower	146 04 30.6	∠22 to Platte Center water tower	91 33 49.5
18 to 20	88 46 19.4		
∠20 to Platte Center water tower	57 18 11.2	22 to 21	268 21 22.3
		∠21 to Platte Center water tower	304 03 46.2
18 to Platte Center water tower	146 04 30.6	22 to Platte Center water tower	212 25 08.5
18 to 22	88 36 52.3		
∠22 to Platte Center water tower	57 27 38.3	22 to 18	268 36 52.3
		22 to Platte Center water tower	212 25 08.5
20 to 19A	269 25 44.3	∠ Platte Center water tower to 18	56 11 43.8
∠19A to Platte Center water tower	270 35 15.0		
20 to Platte Center water tower	180 00 59.3	22 to 20	268 27 09.8
20 to 18	268 46 19.4	22 to Platte Center water tower	212 25 08.5
∠ Platte Center water tower to 18	88 45 20.1	∠ Platte Center water tower to 20	56 02 01.3

LENGTH EQUATION

Designation of angle	Angle	Log and log sin	Tabular difference of log for one second	Designation of angle	Angle	Log and log sin	Tabular difference of log for one second
	° ′ ″				° ′ ″		
20 to 18		4.0238176		20 to 22		4.0122596	
+1	57 18 11.2	9.9250749	+1.35	−1−2	33 56 28.7	9.7469014	+3.13
+2−3	32 24 09.2	9.7290550	+3.32	+3	56 02 01.3	9.9187463	+1.42
		3.6779475				3.6779073	

$$0=+40.2+4.48(1)+6.45(2)-4.74(3)$$
$$+84.1405C_1=-40.2$$
$$C_1=-0.4778$$

No.	Computed v	Adopted v
1	−2.14	−2.1
2	−3.08	−3.1
3	+2.26	+2.3

COMPUTATION OF COORDINATES

Stations	Azimuth and angle
	° ′ ″
18 to 20	88 46 19.4
∠20 to Platte Center water tower	57 18 09.1
18 to Platte Center water tower	146 04 28.5 = α_1

$\log \sin \alpha_1 = 9.7467223-10$
$\log s_1 = 4.2767976$

$\log \Delta x = 4.0235199$

$\log \cos \alpha_1 = 9.9189550-10$
$\log s_1 = 4.2767976$

$\log \Delta y = 4.1957526$

	x	y
	Feet	*Feet*
18	2,562,794.86	673,416.74
Δx and Δy	−10,556.50	+15,694.69
Platte Center water tower	2,552,238.36	689,111.43 −1

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

11—9121
U. S. GOVERNMENT PRINTING OFFICE

COMPUTATION OF TRIANGLES

State: ....

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	2-3						4.0238176
(-1-2)	1 Platte Center Water Tower	28.7				33 56 33.9	0.2530824
+1	2 18	57 18 11.2	-2.1			09.1	9.9250719
+2	3 20	88 45 20.1	-3.1			17.0	9.9998974 +1
	1-3						4.2019719 +2
	1-2						4.2767974
	2-3						4.3191054
(-1-3)	1 Platte Center Water Tower	37.9				66 20 37.7	0.0381189
+1	2 18	57 27 38.3	-2.1			36.2	9.9258362
+3	3 22	56 11 43.8	+2.3			46.1	9.9195733
	1-3						4.2830605
	1-2						4.2767976
	2-3						4.0122596
(+2-3)	1 Platte Center Water Tower	09.2				32 24 03.8	0.2709630
-2	2 20	91 33 49.5	+3.1			52.6	9.9998380
+3	3 22	56 02 01.3	+2.3			03.6	9.9187496 -1
	1-3						4.2830606 -2
	1-2						4.2019722

FIGURE 26.—Computation of triangles for Platte Center water tower.

Adjustment of Platte Center water tower—Continued

COMPUTATION OF COORDINATES—Continued

Stations	Azimuth and angle
	° ′ ″
22 to 18	268 36 52.3
∠Platte Center water tower to 18	56 11 46.1
22 to Platte Center water tower	212 25 06.2 = α_2

$\log \sin \alpha_2 = 9.7292440 - 10$
$\log s_2 \quad = 4.2830605$

$\log \Delta x \quad = 4.0123045$

$\log \sin \alpha_2 = 9.9264226 - 10$
$\log s_2 \quad = 4.2830605$

$\log \Delta y \quad = 4.2094831$

	x	y
	Feet	*Feet*
22	2,541,950.99	672,912.61
Δx and Δy	+10,287.37	+16,198.81
Platte Center water tower	2,552,238.36	689,111.42

Stations	Azimuth and angle
	° ′ ″
20 to 22	88 27 09.8
∠22 to Platte Center water tower	91 33 52.6
20 to Platte Center water tower	180 01 02.4 = α_3

$\log \sin \alpha_3 = 6.4807595 - 10$
$\log s_3 \quad = 4.2019720$

$\log \Delta x \quad = 0.6827315$

$\log \cos \alpha_3 = 0.0000000$
$\log s_3 \quad = 4.2019720$

$\log \Delta y \quad = 4.2019720$

	x	y
	Feet	*Feet*
20	2,552,233.55	673,190.36
Δx and Δy	+4.82	+15,921.06
Platte Center water tower	2,552,238.37 −1	689,111.42

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
FORM No. 700

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Columbus	2,589,389.50	180 59 36.0	Reference Mark	19A	2,557,043.56		
	666,822.48		No. 1		673,238.30		
14A	2,584,645.66			20	2,552,233.55		
	668,575.08				673,190.36		
14	2,581,487.76			21	2,549,634.82		
	668,478.94				673,133.12		
15	2,578,880.81			22	2,541,950.99		
	668,417.08				672,912.61		
15A	2,577,279.12			23	2,539,122.13		
	668,427.63				672,800.82		
16	2,571,279.91			23A	2,537,078.59		
	668,248.68				672,798.34		
17	2,568,888.31			24	2,531,854.93		
	668,258.71				672,683.32		
17A	2,565,934.04			25	2,529,141.91		
	673,505.23				672,621.69		
18	2,562,794.86			25A	2,526,343.85		
	673,416.74				672,561.13		
19	2,560,222.37			25B	2,521,739.09		
	673,360.53				672,483.34		

U. S. GOVERNMENT PRINTING OFFICE: 1936

FIGURE 27.—List of adjusted coordinates.

Department of Commerce
U.S. Coast and Geodetic Survey
Form No. 709

PLANE COORDINATES

Datum *North American 1927* Projection *Lambert South* State *Nebraska*

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
26	2,520,147.72						
	672,486.83						
27	2,518,767.54						
	673,683.19						
Columbus, municipal	2,586,477.40						
water tank	648,491.34						
Monroe	2,513,984.24	291 57 45.9	Columbus,				
	677,725.68		municipal water				
			tank.				
Platte Center,	2,552,238.36						
water tower	689,111.42						

FIGURE 27.—List of adjusted coordinates—Continued.

TRAVERSE, MONROE TO GENOA

List of angles

Station	From station—	To station—	Angle °	′	″
Monroe	Columbus municipal tank	115A	156	06	00.5
115A	Monroe	115	115	17	06.6
115	115A	116	237	20	46.9
116	115	116A	178	55	22.0
116A	116	117	163	36	37.1
117	116A	119A	135	23	38.8
119A	117	119B	238	12	37.0
119B	119A	119	150	12	22.3
119	119B	121A	163	56	48.5
121A	119	121	223	35	17.6
121	121A	122	162	37	16.4
122	121	122A	131	45	26.7
122A	122	Genoa	259	51	25.1
Genoa	122A	Azimuth mark	3	10	09.3

Geodetic azimuth

	°	′	″
Genoa to azimuth mark (R. M. no. 1)	273	04	38.2
θ at Genoa	1	05	51.8
Grid azimuth	271	58	46.4

Plane coordinates on Lambert projection

State Nebraska(south) Station Genoa

φ = 41° 25′ 50″.708 λ = 97° 49′ 36″.639

Tabular difference of R for 1″ of φ = 101.20900

R (for min. of φ)		23,953,236.63	y′ (for min. of φ)		637,545.23
Cor. for sec. of φ		− 5,132.11	Cor. for sec. of φ		+ 5,132.11
R		23,948,104.52	y′		642,677.34
			y″ (=2R sin² θ/2)		+ 4,395.05
θ (for min. of λ)		+ 1° 06′ 15″.8230	y		647,072.39
Cor. for sec. of λ		− 24.0380			
θ		+ 1 05 51.7850	θ/2		0° 32′ 55″.8925
θ″	For machine computation	″		For machine computation	
			~~log θ″~~		
~~log θ″~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for θ/2~~		
~~log sin θ~~	sin θ	0.0191576222	~~log sin θ/2~~	sin θ/2	0.0095792507
~~log R~~				R sin θ/2	229,404.90
~~log x′~~			~~log sin² θ/2~~	R sin² θ/2	2197.527
x′	R sin θ	+458,788.74	~~log R~~	2Rsin²θ/2	4395.05
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,458,788.74	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin\theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 28.—Computation of coordinates from geographic position.

Computation of grid azimuths

Stations	Azimuth and angle			Correction for closure	Seconds of corrected azimuth
	°	′	″	″	″
Monroe to Columbus municipal tank	291	57	45.9		45.9
∠Columbus municipal tank to 115A	156	06	00.5	+0.4	00.9
Monroe to 115A	88	03	46.4		46.8
115A to Monroe	268	03	46.4		46.8
∠Monroe to 115	115	17	06.6	+0.4	07.0
115A to 115	23	20	53.0		53.8
115 to 115A	203	20	53.0		53.8
∠115A to 116	237	20	46.9	+0.4	47.3
115 to 116	80	41	39.9		41.1
116 to 115	260	41	39.9		41.1
∠115 to 116A	178	55	22.0	+0.4	22.4
116 to 116A	79	37	01.9		03.5
116A to 116	259	37	01.9		03.5
∠116 to 117	163	36	37.1	+0.4	37.5
116A to 117	63	13	39.0		41.0
117 to 116A	243	13	39.0		41.0
∠116A to 119A	135	23	38.8	+0.4	39.2
117 to 119A	18	37	17.8		20.2
119A to 117	198	37	17.8		20.2
∠117 to 119B	238	12	37.0	+0.4	37.4
119A to 119B	76	49	54.8		57.6
119B to 119A	256	49	54.8		57.6
∠119A to 119	150	12	22.3	+0.4	22.7
119B to 119	47	02	17.1		20.3
119 to 119B	227	02	17.1		20.3
∠119B to 121A	163	56	48.5	+0.4	48.9
119 to 121A	30	59	05.6		09.2
121A to 119	210	59	05.6		09.2
∠119 to 121	223	35	17.6	+0.4	18.0
121A to 121	74	34	23.2		27.2
121 to 121A	254	34	23.2		27.2
∠121A to 122	162	37	16.4	+0.4	16.8
121 to 122	57	11	39.6		44.0
122 to 121	237	11	39.6		44.0
∠121 to 122A	131	45	26.7	+0.4	27.1
122 to 122A	8	57	06.3		11.1
122A to 122	188	57	06.3		11.1
∠122 to Genoa	259	51	25.1	+0.4	25.5
122A to Genoa	88	48	31.4		36.6
Genoa to 122A	268	48	31.4		36.6
∠122A to azimuth mark	3	10	09.3	+0.5	09.8
Genoa to azimuth mark	271	58	40.7		46.4
Fixed azimuth	271	58	46.4		
Discrepancy			−5.7		

Reduction of lengths

[Average elevation=1,700 feet. Elevation factor =0.99991873]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Monroe-115A	2, 893. 174	2, 892. 939	0. 9999616	2, 892. 828
115A-115	5, 798. 705	5, 798. 234	. 9999612	5, 798. 009
115-116	3, 998. 672	3, 998. 347	. 9999605	3, 998. 189
116-116A	5, 356. 463	5, 356. 028	. 9999599	5, 355. 813
116A-117	5, 893. 108	5, 892. 629	. 9999591	5, 892. 388
117-119A	3, 012. 892	3, 012. 647	. 9999582	3, 012. 521
119A-119B	7, 439. 943	7, 439. 338	. 9999570	7, 439. 018
119B-119	3, 979. 364	3, 979. 041	. 9999562	3, 978. 867
119-121A	2, 665. 796	2, 665. 579	. 9999550	2, 665. 459
121A-121	12, 067. 070	12, 066. 089	. 9999535	12, 065. 528
121-122	8, 369. 318	8, 368. 638	. 9999519	8, 368. 235
122-122A	3, 644. 138	3, 643. 842	. 9999512	3, 643. 664
122A-Genoa	3, 810. 170	3, 809. 860	. 9999504	3, 809. 671

Mean latitude $= 41°28'.3$
$\log R_a = 5.8304093 - \frac{1}{2}\log A - \frac{1}{2}\log B$

$\log A = 8.5090810-10$
$\log B = 8.5107394-10$

$\log A + \log B = 17.0198204-20$

$\frac{1}{2}(\log A + \log B) = 8.5099102-10$

log constant $= 5.8304093$
$\frac{1}{2}(\log A + \log B) = 8.5099102-10$

$\log R_a = 7.3204991$
$R_a = 20{,}917{,}000$

Elevation factor $= \frac{20{,}917{,}000}{20{,}918{,}700} = 0.99991873$

TRAVERSE, COLUMBUS TO CURTIS

Computation of fixed grid azimuth

CURTIS TO CÔLUMBUS MUNICIPAL TANK

	x	*y*
	Feet	*Feet*
Tank	2, 586, 477. 40	648, 491. 34
Curtis	2, 595, 895. 14	605, 879. 69
Δx and Δy	−9, 417. 74	+42, 611. 65

$\log \Delta x = 3.97394669$
$\log \Delta y = 4.62952835$

$\log \tan \alpha = 9.34441834-10$

$\alpha = 12°27'46''.0$
Grid azimuth $= 167°32'14''.0$

106911°—35——8

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Monroe to Genoa
State Nebraska (south) County Platte and Nance Initial Station Monroe
Year 1934 Month January - March Closing Station Genoa

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Monroe				- 97.78		677,725.68	2,513,984.24
			0.03380059				
		2892.828				677,627.90	2,511,093.06
			0.99942860			+0.04	-0.09
115A	88 03 46.8	2,893			-2891.18	677,627.94	2,511,092.97
				-5323.23			
			0.91811276				
		5798.009				672,304.67	2,508,795.20
			0.39631925			+0.13	-0.26
115	23 20 53.8	8,691			-2297.86	672,304.80	2,508,794.94
				- 646.48			
			0.16169424				
		3998.189				671,658.19	2,504,849.62
			0.98684091			+0.19	-0.38
116	80 41 41.1	12,689			-3945.58	671,658.38	2,504,849.24
				- 965.21			
			0.18021634				
		5355.813				670,692.98	2,499,581.50
			0.98362700			+0.27	-0.53
116A	79 37 03.5	18,045			-5268.12	670,693.25	2,499,580.97
				-2654.17			
			0.45044042				
		5892.388				668,038.81	2,494,320.74
			0.89280649			+0.35	-0.71
117	63 13 41.0	23,937			-5260.76	668,039.16	2,494,320.03

FIGURE 29.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line Monore to Genoa
State Nebraska (south) County Platte and Nance Initial Station Monroe
Year 1934 Month January - March Closing Station Genoa

Station	Azimuth Plane ° ' "	Grid Distance Feet	Lat. / cos Az / dist. / sin Az / Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
117				-2854.80		668,038.81	2,494,320.74
			0.94764432			668,039.16	2,494,320.03
		3012.521				665,184.01	2,493,358.76
			0.31932780			+0.40	-0.80
119A	18 37 20.2	26.950			-961.98	665,184.41	2,493,357.96
				-1694.58			
			0.22779576				
		7439.018				663,489.43	2,486,115.32
			0.97370894			+0.51	-1.02
119B	76 49 57.6	34,389			-7243.44	663,489.94	2,486,114.30
				-2711.60			
			0.68150074				
		3978.867				660,777.83	2,483,203.52
			0.73181742			+0.57	-1.14
119	47 02 20.3	38,368			-2911.80	660,778.40	2,483,202.38
				-2285.08			
			0.85729412				
		2665.459				658,492.75	2,481,831.27
			0.51482695			+0.61	-1.21
121A	30 59 09.2	41,033			-1372.25	658,493.36	2,481,830.06
				-3209.31			
			0.26598985				
		12065.528				655,283.44	2,470,200.39
			0.96397583			+0.79	-1.57
121	74 34 27.2	53,099			-11630.88	655,284.23	2,470,198.82

FIGURE 29.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Monroe to Genoa
State Nebraska (south) County Platte and Nance Initial Station Monroe
Year 1934 Month January - March Closing Station Genoa

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
121				-4533.69		655,283.44	2,470,200.39
			0.54177341			655,284.23	2,470,198.82
		8368.235				650,749.75	2,463,166.68
			0.84052458			+0.91	-1.82
122	57 11 44.0	61,467			-7033.71	650,750.66	2,463,164.86
				-3599.27			
			0.98781610				
		3643.664				647,150.48	2,462,599.63
			0.15562564			+0.96	-1.93
122A	8 57 11.1	65,111			- 567.05	647,151.44	2,462,597.70
				- 79.11			
			0.02076502				
		3809.671				647,071.37	2,458,790.78
			0.99978438			+1.02	-2.04
Genoa	88 48 36.6	68,920			-3808.85	647,072.39	2,458,788.74
						647,072.39	2,458,788.74
					Discrepancy	-1.02	+2.04
					x Factor =	-2.95995×10^{-5}	
					y Factor =	$+1.47998 \times 10^{-5}$	

FIGURE 29.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
FORM NO. 759

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Columbus, Municipal water tank	2,586,477.40			121A	2,481,830.06		
	648,491.34				658,493.36		
Monroe	2,513,984.24	291 57 45.9	Columbus, Municipal water tank	121	2,470,198.82		
	677,725.68				655,284.23		
115A	2,511,092.97			122	2,463,164.86		
	677,627.94				650,750.66		
115	2,508,794.94			122A	2,462,597.70		
	672,304.80				647,151.44		
116	2,504,849.24			Genoa	2,458,788.74	271 58 46.4	Reference mark no. 1
	671,658.38				647,072.39		
116A	2,499,580.97			Genoa, water tower	2,484,195.55		
	670,693.25				655,855.78		
117	2,494,320.03						
	668,039.16						
119A	2,493,357.96						
	665,184.41						
119B	2,486,114.30						
	663,489.94						
119	2,483,202.38						
	660,778.40						

FIGURE 30.—List of adjusted coordinates.

Plane coordinates on Lambert projection

State Nebraska(south) Station Curtis

ϕ = 41°18′33.″992 λ = 97°19′50.″679

Tabular difference of R for 1″ of ϕ = 101.20567

R (for min. of ϕ)		23,995,743.59	y′ (for min. of ϕ)		595,038.27
Cor. for sec. of ϕ		− 3,440.18	Cor. for sec. of ϕ		+ 3,440.18
R		23,992,303.41	y′		598,478.45
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 7,401.24
θ (for min. of λ)		+ 1°25′56.″7605	y		605,879.69
Cor. for sec. of λ		− 33.2493			
θ		+ 1 25 23.5112	$\frac{\theta}{2}$		0°42′41.″7556
θ''	For machine computation	″		For machine computation	
			~~log θ″~~		
~~log θ″~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for θ/2~~		
~~log sin θ~~	sin θ	0.0248369290	~~log sin θ/2~~	sin $\frac{\theta}{2}$	0.0124194223
~~log R~~				R sin $\frac{\theta}{2}$	297,970.55
~~log x′~~			~~log sin² θ/2~~	R sin² $\frac{\theta}{2}$	3700.622
x′	R sin θ	+595,895.14	~~log R~~	2Rsin²θ/2	7401.24
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,595,895.14	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine

(see log tables)

R, y′, and θ are given in special tables

FIGURE 31.—Computation of coordinates from geographic position.

TRAVERSE, COLUMBUS TO CURTIS—Continued.

List of angles

Station	From station—	To station—	Angle
			° ′ ″
Columbus	Azimuth mark	1	170 55 36.5
1	Columbus	2	228 41 34.9
2	1	3	153 43 42.2
3	2	3A	182 13 07.7
3A	3	3B	161 30 20.8
3B	3A	5	145 59 27.3
5	3B	5A	214 38 43.1
5A	5	7	180 01 18.3
7	5A	7A	179 58 48.5
7A	7	8	180 12 30.1
8	7A	9	204 07 50.2
9	8	9A	132 47 56.6
9A	9	10	195 04 40.2
10	9A	11	188 36 54.4
11	10	11A	148 16 47.6
11A	11	12	171 52 22.9
12	11A	13	219 54 13.7
13	12	13A	132 20 20.5
13A	13	Curtis	198 17 48.9
Curtis	13A	Columbus municipal tank	17 18 19.8

Computation of grid azimuths

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
Columbus to azimuth mark	180 59 36.0		36.0
∠Azimuth mark to 1	170 55 36.5	+0.7	37.2
Columbus to 1	351 55 12.5		13.2
1 to Columbus	171 55 12.5		13.2
∠Columbus to 2	228 41 34.9	+0.7	35.6
1 to 2	40 36 47.4		48.8
2 to 1	220 36 47.4		48.8
∠1 to 3	153 43 42.2	+0.7	42.9
2 to 3	14 20 29.6		31.7
3 to 2	194 20 29.6		31.7
∠2 to 3A	182 13 07.7	+0.7	08.4
3 to 3A	16 33 37.3		40.1
3A to 3	196 33 37.3		40.1
∠3 to 3B	161 30 20.8	+0.7	21.5
3A to 3B	358 03 58.1		04 01.6
3B to 3A	178 03 58.1		04 01.6
∠3A to 5	145 59 27.3	+0.7	28.0
3B to 5	324 03 25.4		29.6
5 to 3B	144 03 25.4		29.6
∠3B to 5A	214 38 43.1	+0.7	43.8
5 to 5A	358 42 08.5		13.4
5A to 5	178 42 08.5		13.4
∠5 to 7	180 01 18.3	+0.7	19.0
5A to 7	358 43 26.8		32.4
7 to 5A	178 43 26.8		32.4
∠5A to 7A	179 58 48.5	+0.7	49.2
7 to 7A	358 42 15.3		21.6
7A to 7	178 42 15.3		21.6
∠7 to 8	180 12 30.1	+0.6	30.7
7A to 8	358 54 45.4		52.3
8 to 7A	178 54 45.4		52.3
∠7A to 9	204 07 50.2	+0.7	50.9
8 to 9	23 02 35.6		43.2

Computation of grid azimuths—Continued

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
9 to 8	203 02 35.6		43.2
∠8 to 9A	132 47 56.6	+0.7	57.3
9 to 9A	335 50 32.2		40.5
9A to 9	155 50 32.2		40.5
∠9 to 10	195 04 40.2	+0.7	40.9
9A to 10	350 55 12.4		21.4
10 to 9A	170 55 12.4		21.4
∠9A to 11	188 36 54.4	+0.7	55.1
10 to 11	359 32 06.8		16.5
11 to 10	179 32 06.8		16.5
∠10 to 11A	148 16 47.6	+0.7	48.3
11 to 11A	327 48 54.4		49 04.8
11A to 11	147 48 54.4		49 04.8
∠11 to 12	171 52 22.9	+0.7	23.6
11A to 12	319 41 17.3		28.4
12 to 11A	139 41 17.3		28.4
∠11A to 13	219 54 13.7	+0.7	14.4
12 to 13	359 35 31.0		42.8
13 to 12	179 35 31.0		42.8
∠12 to 13A	132 20 20.5	+0.7	21.2
13 to 13A	311 55 51.5		56 04.0
13A to 13	131 55 51.5		56 04.0
∠13 to Curtis	198 17 48.9	+0.7	49.6
13A to Curtis	330 13 40.4		53.6
Curtis to 13A	150 13 40.4		53.6
∠13A to Columbus municipal tank	17 18 19.8	+0.6	20.4
Curtis to Columbus municipal tank	167 32 00.2		14.0
Fixed azimuth	167 32 14.0		
Discrepancy	−13.8		

Reduction of lengths

[Average elevation = 1,500 feet. Elevation factor = 0.99992829]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Columbus to 1	2,513.835	2,513.655	0.9999561	2,513.545
1-2	8,296.503	8,295.908	.9999544	8,295.530
2-3	1,415.413	1,415.312	.9999529	1,415.245
3-3A	4,015.372	4,015.084	.9999519	4,014.891
3A-3B	3,855.744	3,855.468	.9999505	3,855.277
3B-5	2,861.519	2,861.314	.9999494	2,861.169
5-5A	3,084.769	3,084.548	.9999485	3,084.389
5A-7	4,192.774	4,192.473	.9999472	4,192.252
7-7A	2,537.759	2,537.577	.9999461	2,537.440
7A-8	2,400.440	2,400.268	.9999452	2,400.136
8-9	3,144.308	3,144.082	.9999444	3,143.907
9-9A	2,416.772	2,416.599	.9999436	2,416.463
9A-10	3,366.002	3,365.761	.9999428	3,365.568
10-11	3,371.326	3,371.084	.9999417	3,370.887
11-11A	4,619.767	4,619.436	.9999406	4,619.162
11A-12	4,208.640	4,208.338	.9999396	4,208.084
12-13	2,518.811	2,518.630	.9999388	2,518.476
13-13A	3,828.705	3,828.430	.9999381	3,828.193
13A-Curtis	5,261.973	5,261.596	.9999372	5,261.266
13A-13B [1]	5,191.439	5,191.067	.9999372	5,190.741
13B-Curtis [1]	5,388.382	5,387.996	.9999372	5,387.658

[1] Grid factor used same as on 13A to Curtis.

COMPUTATION OF COORDINATES

Traverse line ~~**No.**~~ Columbus to Curtis
State Nebraska - South **County** Platte and Butler **Initial Station** Columbus
Year 1934 **Month** March **Closing Station** Curtis

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. ~~Log.~~ cos Az ~~Log.~~ dist. ~~Log.~~ sin Az ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
Columbus				-2488.59		666,822.48	2,589,389.50
			0.99007360				
		2513.545				664,333.89	2,589,742.78
			0.14054988			-0.09	-0.16
1	351 55 13.2	2,514			+353.28	664,333.80	2,589,742.62
				-6297.28			
			0.75911732				
		8295.530				658,036.61	2,584,342.77
			0.65095383			-0.38	-0.71
2	40 36 48.8	10,809			-5400.01	658,036.23	2,584,342.06
				-1371.14			
			0.96883381				
		1415.245				656,665.47	2,583,992.20
			0.24771162			-0.43	-0.80
3	14 20 31.7	12,224			-350.57	656,665.04	2,583,991.40
				-3848.34			
			0.95851612				
		4014.891				652,817.13	2,582,847.80
			0.28503831			-0.57	-1.06
3A	16 33 40.1	16,239			-1144.40	652,816.56	2,582,846.74
				-3853.08			
			0.99943101				
		3855.277				648,964.05	2,582,977.83
			0.03372888			-0.71	-1.32
3B	358 04 01.6	20,094			+130.03	648,963.34	2,582,976.51

FIGURE 32.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Columbus to Curtis
State Nebraska - South County Platte and Butler Initial Station Columbus
Year 1934 Month March Closing Station Curtis

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
3B				-2316.44		648,964.05	2,582,977.83
			0.80961386			648,963.34	2,582,976.51
		2861.169				646,647.61	2,584,657.23
			0.58696285			-0.81	-1.50
5	324 03 29.6	22,956			+1679.40	646,646.80	2,584,655.73
				-3083.60			
			0.99974408				
		3084.389				643,564.01	2,584,727.01
			0.02262238			-0.92	-1.71
5A	358 42 13.4	26,040			+69.78	643,563.09	2,584,725.30
				-4191.22			
			0.99975267				
		4192.252				639,372.79	2,584,820.24
			0.02223948			-1.06	-1.98
7	358 43 32.4	30,232			+93.23	639,371.73	2,584,818.26
				-2536.79			
			0.99974498				
		2537.440				636,836.00	2,584,877.54
			0.02258264			-1.15	-2.15
7A	358 42 21.6	32,770			+57.30	636,834.85	2,584,875.39
				-2399.71			
			0.99982055				
		2400.136				634,436.29	2,584,923.01
			0.01894394			-1.24	-2.30
8	358 54 52.3	35,170			+45.47	634,435.05	2,584,920.71

FIGURE 32.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~**No.**~~ Columbus to Curtis
State Nebraska - South **County** Platte and Butler **Initial Station** Columbus
Year 1934 **Month** March **Closing Station** Curtis

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
8				-2893.01		634,436.29	2,584,923.01
			0.92019541			634,435.05	2,584,920.71
		3143.907				631,543.28	2,583,692.30
			0.39145932			-1.35	-2.51
9	23 02 43.2	38.314			-1230.71	631,541.93	2,583,689.79
				-2204.87			
			0.91243881				
		2416.463				629,338.41	2,584,681.15
			0.40921317			-1.43	-2.67
9A	335 50 40.5	40.730			+988.85	629,336.98	2,584,678.48
				-3323.42			
			0.98747615				
		3365.568				626,014.99	2,585,212.13
			0.15776838			-1.55	-2.89
10	350 55 21.4	44,096			+530.98	626,013.44	2,585,209.24
				-3370.78			
			0.99996748				
		3370.887				622,644.21	2,585,239.32
			0.00806479			-1.67	-3.11
11	359 32 16.5	47.467			+27.19	622,642.54	2,585,236.21
				-3909.48			
			0.84636053				
		4619.162				618,734.73	2,587,699.53
			0.53261041			-1.83	-3.41
11A	327 49 04.8	52.086			+2460.21	618,732.90	2,587,696.12

FIGURE 32.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Columbus to Curtis
State Nebraska - South **County** Platte and Butler **Initial Station** Columbus
Year 1934 **Month** March **Closing Station** Curtis

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
11A				-3208.96		618,734.73	2,587,699.53
			0.76256923			618,732.90	2,587,696.12
		4208.084				615,525.77	2,590,421.77
			0.64690661			-1.98	-3.69
12	319 41 28.4	56.294			+2722.24	615,523.79	2,590,418.08
				-2518.41			
			0.99997504				
		2518.476				613,007.36	2,590,439.56
			0.00706465			-2.07	-3.85
13	359 35 42.8	58.812			+17.79	613,005.29	2,590,435.71
				-2558.30			
			0.66827989				
		3828.193				610,449.06	2,593,287.39
			0.74390993			-2.20	-4.11
13A	311 56 04.0	62.641			+2847.83	610,446.86	2,593,283.28
				-4566.98			
			0.86803903				
		5261.266				605,882.08	2,595,899.59
			0.49649596			-2.39	-4.45
Curtis	330 13 53.6	67.902			+2612.20	605,879.69	2,595,895.14
						605,879.69	2,595,895.14
					Discrepancy	+2.39	+4.45

x Factor = -6.55356×10^{-5}
y Factor = -3.51978×10^{-5}

FIGURE 32.—*Computation of coordinates—Continued.*

TRAVERSE, COLUMBUS TO CURTIS—Continued

Computation of fixed grid azimuth

CURTIS TO 13A

	x	y
	Feet	*Feet*
13A	2, 593, 283. 28	610, 446. 86
Curtis	2, 595, 895. 14	605, 879. 69
Δx and Δy	−2, 611. 86	+4, 567. 17

$$\log \Delta x = 3.4169499$$
$$\log \Delta y = 3.6596471$$
$$\log \tan \alpha = 9.7573028 - 10$$

$$\alpha = 29°45'51''.3$$
$$\text{Grid azimuth} = 150°14'08''.7$$

Computation of coordinates of 13B

Stations	Azimuth and angle
	° ′ ″
Curtis to 13A	150 14 08. 7
∠13A to 13B	58 19 51. 0
Curtis to 13B	208 33 59. 7 $= \alpha_1$

$$s_1 = 5387.658$$

$\sin \alpha_1 = 0.47817971$ $\cos \alpha_1 = 0.87826202$

	x	y
	Feet	*Feet*
Curtis	2, 595, 895. 14	605, 879. 69
Δx and Δy	+2, 576. 27	+4, 731. 78
13B	2, 598, 471. 41	610, 611. 47 −1

Stations	Azimuth and angle
	° ′ ″
13A to Curtis	330 14 08. 7
∠13B to Curtis	62 03 10. 5
13A to 13B	268 10 58. 2 $= \alpha_2$

$$s_2 = 5190.741$$

$\sin \alpha_2 = 0.99949710$ $\cos \alpha_2 = 0.03171022$

	x	y
	Feet	*Feet*
13A	2, 593, 283. 28	610, 446. 86
Δx and Δy	+5, 188. 13	+164. 60
13B	2, 598, 471. 41	610, 611. 46

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
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11—9121

COMPUTATION OF TRIANGLES

State: ____________

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
2-3						5191.439	3.7152878
1	Curtis	58 19 52.0	-1.0			51.0	0.0700226
2	13A	62 03 11.5	-1.0			10.5	9.9461480
3	13B	59 36 59.5	-1.0			58.5	9.9358382
1-3			-3.0			5388.382	3.7314584
1-2						5261.973	3.7211486
		03.0					

FIGURE 33.—Computation of triangle for Curtis.

TRAVERSE, OSCEOLA TO 26

Computation of fixed grid azimuths

OSCEOLA TO COLUMBUS NORTHWEST POWER & LIGHT CO. STACK

	x	y
	Feet	*Feet*
Columbus Northwest Power & Light Co. stack	2, 586, 534. 06	648, 492. 32
Osceola	2, 534, 639. 91	581, 919. 12
Δx and Δy	+51, 894. 15	+66, 573. 20

$$\log \Delta x = 4.71511841$$
$$\log \Delta y = 4.82329943$$
$$\log \tan \alpha = 9.89181898 - 10$$
$$\alpha = 37°56'11''.8$$
$$\text{Grid azimuth} = 217°56'11''.8$$

26 TO 27

	x	y
	Feet	*Feet*
27	2, 518, 767. 54	673, 683. 19
26	2, 520, 147. 72	672, 486. 83
Δx and Δy	−1, 380. 18	+1, 196. 36

$$\log \Delta x = 3.13993573$$
$$\log \Delta y = 3.07786188$$
$$\log \tan \alpha = 0.06207385$$
$$\alpha = 49°04'50''.8$$
$$\text{Grid azimuth} = 130°55'09''.2$$

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
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PLANE COORDINATES

Datum North-American 1927 Projection Lambert South State Nebraska

Station	x Coordinate (Feet)	y Coordinate (Feet)	Azimuth (° ′ ″)	Mark
Columbus	2,589,389.50	666,822.48	180 59 36.0	Reference Mark No. 1
1	2,589,742.62	664,333.80		
2	2,584,342.06	658,036.23		
3	2,583,991.40	656,665.04		
3A	2,582,846.74	652,816.56		
3B	2,582,976.51	648,963.34		
5	2,584,655.73	646,646.80		
5 A	2,584,725.30	643,563.09		
7	2,584,818.26	639,371.73		
7A	2,584,875.39	636,834.85		
8	2,584,920.71	634,435.05		
9	2,583,689.79	631,541.93		
9 A	2,584,678.48	629,336.98		
10	2,585,209.24	626,013.44		
11	2,585,236.21	622,642.54		
11 A	2,587,696.12	618,732.90		
12	2,590,418.08	615,523.79		
13	2,590,435.71	613,005.29		
13 A	2,593,283.28	610,446.86		
Columbus Municipal water tank	2,586,477.40	648,491.34		
Curtis	2,595,895.14	605,879.69	167 32 14.0	Columbus Municipal water tank
13 B	2,598,471.41	610,611.46		

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FIGURE 34.—List of adjusted coordinates.

Plane coordinates on Lambert projection

State Nebraska (south) Station Osceola

ϕ = 41° 14′ 51″.558 λ = 97° 33′ 20″.150

Tabular difference of R for 1″ of ϕ = 101.20383

R (for min. of ϕ)		24,020,032.67	y′ (for min. of ϕ)		570,749.19
Cor. for sec. of ϕ		− 5,217.87	Cor. for sec. of ϕ		+ 5,217.87
R		24,014,814.80	y′		575,967.06
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,952.06
θ (for min. of λ)		+ 1° 16′ 45″.6563	y		581,919.12
Cor. for sec. of λ		− 13.2199			
θ		+ 1 16 32.4364	$\frac{\theta}{2}$		0° 38′ 16″.2182
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0222629205	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0111321500
~~log R~~				R sin $\frac{\theta}{2}$	267,336.52
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2976.030
x′	R sin θ	+534,639.91	~~log R~~	2R$\sin^2\theta/2$	5952.06
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,534,639.91	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 35.—Computation of coordinates from geographic position.

Plane coordinates on Lambert projection

State Nebraska (south) Station Columbus-Northwest Power and Light Co., Smokestack

ϕ = 41° 25′ 37″.188 λ = 97° 21′ 39″.633

Tabular difference of R for 1″ of ϕ = 101.20900

R (for min. of ϕ)		23,953,236.63	y′ (for min. of ϕ)		637,545.23
Cor. for sec. of ϕ		− 3,763.76	Cor. for sec. of ϕ		+ 3,763.76
R		23,949,472.87	y′		641,308.99
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 7,183.33
θ (for min. of λ)		+ 1°24′38″.0313	y		648,492.32
Cor. for sec. of λ		− 26.0023			
θ		+ 1 24 12.0290	$\frac{\theta}{2}$		0°42′06″.0145
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0244904789	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0122461578
~~log R~~				R sin $\frac{\theta}{2}$	293,289.02
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3591.664
x′	R sin θ	+586,534.06	~~log R~~		7183.33
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,586,534.06	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 35.—Computation of coordinates from geographic position—Continued.

TRAVERSE, OSCEOLA TO 26—Continued

List of angles

Station	From station—	To station—	Angle	Station	From station—	To station—	Angle
			° ′ ″				° ′ ″
Osceola	Columbus Northwest Power & Light Co. stack	82	276 20 35.8	76	76A	75	168 43 47.5
				75	76	75A	195 13 09.4
				75A	75	73	161 37 58.1
				73	75A	73A	239 53 30.1
				73A	73	41	134 42 42.8
82	Osceola	81	221 41 22.1	41	73A	40	268 58 52.5
81	82	81C	179 31 39.1	40	41	41A	35 10 03.1
81C	81	81B	170 26 42.2	41A	40	41C	265 47 19.3
81B	81C	81A	164 57 45.7	41C	41A	41B	60 29 41.9
				41B	41C	41D	225 14 12.0
81A	81B	79	205 10 00.3				
79	81A	79E	169 47 30.3	41D	41B	41E	202 25 59.0
79E	79	79D	178 16 33.7	41E	41D	26	217 26 28.6
79D	79E	79C	194 48 55.0	26	41E	27	117 09 44.7
79C	79D	79B	179 25 45.0				
79B	79C	79A	191 51 17.9				
79A	79B	77	147 47 27.5				
77	79A	76B	213 15 23.0				
76B	77	76A	167 20 48.1				
76A	76B	76	179 24 16.1				

Computation of grid azimuths

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
Osceola to Columbus Northwest Power & Light Co. stack	217 56 11.8		11.8
∠Columbus Northwest Power & Light Co. stack to 82	276 20 35.8	−1.2	34.6
Osceola to 82	134 16 47.6		46.4
82 to Osceola	314 16 47.6		46.4
∠Osceola to 81	221 41 22.1	−1.2	20.9
82 to 81	175 58 09.7		07.3
81 to 82	355 58 09.7		07.3
∠82 to 81C	179 31 39.1	−1.2	37.9
81 to 81C	175 29 48.8		45.2
81C to 81	355 29 48.8		45.2
∠81 to 81B	170 26 42.2	−1.2	41.0
81C to 81B	165 56 31.0		26.2
81B to 81C	345 56 31.0		26.2
∠81C to 81A	164 57 45.7	−1.2	44.5
81B to 81A	150 54 16.7		10.7
81A to 81B	330 54 16.7		10.7
∠81B to 79	205 10 00.3	−1.2	09 59.1
81A to 79	176 04 17.0		09.8
79 to 81A	356 04 17.0		09.8
∠81A to 79E	169 47 30.3	−1.2	29.1
79 to 79E	165 51 47.3		38.9
79E to 79	345 51 47.3		38.9
∠79 to 79D	178 16 33.7	−1.2	32.5
79E to 79D	164 08 21.0		11.4
79D to 79E	344 08 21.0		11.4
∠79E to 79C	194 48 55.0	−1.2	53.8
79D to 79C	178 57 16.0		05.2
79C to 79D	358 57 16.0		05.2
∠79D to 79B	179 25 45.0	−1.2	43.8
79C to 79B	178 23 01.0		22 49.0
79B to 79C	358 23 01.0		22 49.0
∠79C to 79A	191 51 17.9	−1.2	16.7
79B to 79A	190 14 18.9		05.7

Computation of grid azimuths—Continued

Stations	Azimuth and angle			Correction for closure	Seconds of corrected azimuth	
	°	′	″	″	′	″
79A to 79B	10	14	18.9			05.7
∠79B to 77	147	47	27.5	−1.2		26.3
79A to 77	158	01	46.4			32.0
77 to 79A	338	01	46.4			32.0
∠79A to 76B	213	15	23.0	−1.2		21.8
77 to 76B	191	17	09.4		16	53.8
76B to 77	11	17	09.4		16	53.8
∠77 to 76A	167	20	48.1	−1.1		47.0
76B to 76A	178	37	57.5			40.8
76A to 76B	358	37	57.5			40.8
∠76B to 76	179	24	16.1	−1.2		14.9
76A to 76	178	02	13.6		01	55.7
76 to 76A	358	02	13.6		01	55.7
∠76A to 75	168	43	47.5	−1.2		46.3
76 to 75	166	46	01.1		45	42.0
75 to 76	346	46	01.1		45	42.0
∠76 to 75A	195	13	09.4	−1.2		08.2
75 to 75A	181	59	10.5		58	50.2
75A to 75	1	59	10.5		58	50.2
∠75 to 73	161	37	58.1	−1.2		56.9
75A to 73	163	37	08.6		36	47.1
73 to 75A	343	37	08.6		36	47.1
∠75A to 73A	239	53	30.1	−1.2		28.9
73 to 73A	223	30	38.7			16.0
73A to 73	43	30	38.7			16.0
∠73 to 41	134	42	42.8	−1.2		41.6
73A to 41	178	13	21.5		12	57.6
41 to 73A	358	13	21.5		12	57.6
∠73A to 40	268	58	52.5	−1.2		51.3
41 to 40	267	12	14.0		11	48.9
40 to 41	87	12	14.0		11	48.9
∠41 to 41A	35	10	03.1	−1.2		01.9
40 to 41A	122	22	17.1		21	50.8
41A to 40	302	22	17.1		21	50.8
∠40 to 41C	265	47	19.3	−1.2		18.1
41A to 41C	208	09	36.4			08.9
41C to 41A	28	09	36.4			08.9
∠41A to 41B	60	29	41.9	−1.2		40.7
41C to 41B	88	39	18.3		38	49.6
41B to 41C	268	39	18.3		38	49.6
∠41C to 41D	225	14	12.0	−1.2		10.8
41B to 41D	133	53	30.3			00.4
41D to 41B	313	53	30.3			00.4
∠41B to 41E	202	25	59.0	−1.2		57.8
41D to 41E	156	19	29.3		18	58.2
41E to 41D	336	19	29.3		18	58.2
∠41D to 26	217	26	28.6	−1.2		27.4
41E to 26	193	45	57.9			25.6
26 to 41E	13	45	57.9			25.6
∠41E to 27	117	09	44.7	−1.1		43.6
26 to 27	130	55	42.6			09.2
Fixed azimuth	130	55	09.2			
Discrepancy			+33.4			

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES

State: ....

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
2-3						4886.481	3.6889962
1	41A	52 06 40.5	-3.0	37.5			0.1028153
2	41B	67 23 46.5	-2.9	43.6			9.9652862
3	41C	60 29 41.9	-3.0	38.9			9.9396717
1-3						5716.072	3.7570977
1-2							
		08.9					

FIGURE 36.—Computation of triangle for Osceola.

Reduction of lengths

[Average elevation = 1,550 feet. Elevation factor = 0.99992590]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Osceola–82	1, 494. 531	1, 494. 420	0. 9999318	1, 494. 318
82–81	3, 211. 256	3, 211. 018	. 9999322	3, 210. 800
81–81C	1, 871. 373	1, 871. 234	. 9999325	1, 871. 108
81C–81B	5, 474. 295	5, 473. 889	. 9999331	5, 473. 523
81B–81A	2, 965. 783	2, 965. 563	. 9999341	2, 965. 368
81A–79	2, 708. 957	2, 708. 756	. 9999348	2, 708. 579
79–79E	5, 417. 210	5, 416. 809	. 9999356	5, 416. 460
79E–79D	4, 973. 840	4, 973. 471	. 9999364	4, 973. 155
79D–79C	2, 050. 197	2, 050. 045	. 9999376	2, 049. 917
79C–79B	2, 517. 969	2, 517. 782	. 9999380	2, 517. 626
79B–79A	3, 094. 123	3, 093. 894	. 9999388	3, 093. 705
79A–77	3, 349. 088	3, 348. 840	. 9999396	3, 348. 638
77–76B	2, 912. 562	2, 912. 346	. 9999405	2, 912. 173
76B–76A	7, 253. 514	7, 252. 977	. 9999419	7, 252. 556
76A–76	2, 801. 189	2, 800. 981	. 9999438	2, 800. 824
76–75	3, 256. 333	3, 256. 092	. 9999449	3, 255. 913
75–75A	4, 403. 344	4, 403. 018	. 9999462	4, 402. 781
75A–73	9, 151. 587	9, 150. 909	. 9999483	9, 150. 436
73–73A	3, 696. 579	3, 696. 305	. 9999499	3, 696. 120
73A–41	6, 548. 172	6, 547. 687	. 9999521	6, 547. 373
41–40	2, 165. 274	2, 165. 114	. 9999527	2, 165. 012
40–41A	3, 080. 395	3, 080. 167	. 9999535	3, 080. 024
41A–41C	5, 716. 072	5, 715. 648	. 9999538	5, 715. 384
41C–41B	4, 886. 481	4, 886. 119	. 9999550	4, 885. 899
41B–41D	3, 779. 445	3, 779. 165	. 9999558	3, 778. 998
41D–41E	3, 215. 618	3, 215. 380	. 9999574	3, 215. 243
41E–26	2, 446. 536	2, 446. 355	. 9999582	2, 446. 253

$$\text{Mean latitude} = 41°22'.5$$
$$\log A = 8.5090835-10$$
$$\log B = 8.5107469-10$$
$$\log A+\log B = 17.0198304-20$$
$$\tfrac{1}{2}(\log A+\log B) = 8.5099152-10$$
$$\log \text{constant} = 5.8304093$$
$$\tfrac{1}{2}(\log A+\log B) = 8.5099152-10$$
$$\log R_a = 7.3204941$$
$$R_a = 20,916,300$$
$$\text{Elevation factor} = \frac{20,916,300}{20,917,850} = 0.99992590$$

COMPUTATION OF COORDINATES

Traverse line No. Osceola to 26
State Nebraska (south) County Polk and Platte Initial Station Osceola
Year 1934 Month January - March Closing Station 26

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log Lat. / Log cos Az / Log dist. / Log sin Az / Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	x Feet
Osceola				+1043.27		581,919.12	2,534,639.91
			0.69815987				
		1494.318				582,962.39	2,533,570.07
			0.71594189			+0.05	-0.04
82	134 -16 -46.4	1,494			-1069.84	582,962.44	2,533,570.03
				+3202.86			
			0.99752578				
		3210.800				586,165.25	2,533,344.35
			0.07030152			+0.17	-0.12
81	175- 58- 07.3	4,705			- 225.72	586,165.42	2,533,344.23
				+1865.33			
			0.99691171				
		1871.108				588,030.58	2,533,197.41
			0.07853062			+0.23	-0.17
81C	175 - 29 - 45.2	6,576			- 146.94	588,030.81	2,533,197.24
				+5309.56			
			0.97004445				
		5473.523				593,340.14	2,531,867.74
			0.24292751			+0.43	-0.32
81B	165 - 56 - 26.2	12,050			-1329.67	593,340.57	2,531,867.42
				+2591.13			
			0.87379745				
		2965.368				595,931.27	2,530,425.71
			0.48629005			+0.53	-0.39
81A	150 - 54 - 10.7	15,015			-1442.03	595,931.80	2,530,425.32

FIGURE 37.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line Osceola to 26
State Nebraska (south) County Polk and Platte Initial Station Osceola
Year 1934 Month January - March Closing Station 26

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
81A				+2702.21		595,931.27	2,530,425.71
			0.99764779			595,931.80	2,530,425.32
		2708.579				598,633.48	2,530,240.04
			0.06854831			+0.63	-0.46
79	176 - 04 - 09.8	17.724			- 185.67	598,634.11	2,530,239.58
				+5252.37			
			0.96970514				
		5416.460				603,885.85	2,528,916.92
			0.24427842			+0.82	-0.60
79E	165 - 51 - 38.9	23.140			-1323.12	603,886.67	2,528,916.32
				+4783.76			
			0.96191564				
		4973.155				608,669.61	2,527,557.53
			0.27334649			+1.00	-0.73
79D	164 - 08 - 11.4	28.113			-1359.39	608,670.61	2,527,556.80
				+2049.57			
			0.99983255				
		2049.917				610,719.18	2,527,520.02
			0.01829973			+1.07	-0.79
79C	178 - 57 - 05.2	30.163			- 37.51	610,720.25	2,527,519.23
				+2516.62			
			0.99960044				
		2517.626				613,235.80	2,527,448.86
			0.02826572			+1.16	-0.85
79B	178 - 22 - 49.0	32.681			- 71.16	613,236.96	2,527,448.01

FIGURE 37.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Osceola to 26
State Nebraska - South | County Polk & Platte | Initial Station Osceola
Year 1934 | Month Jan. - March | Closing Station 26

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
79B				+3044.48		613,235.80	2,527,448.86
			0.98408751			613,236.96	2,527,448.01
		3093.705				616,280.28	2,527,998.56
			0.17768449			+1.27	-0.94
79A	190-14-05.7	35.775			+549.70	616,281.55	2,527,997.62
				+3105.36			
			0.92735085				
		3348.638				619,385.64	2,526,745.52
			0.37419301			+1.39	-1.02
77	158-01-32.0	39.123			-1253.04	619,387.03	2,526,744.50
				+2855.90			
			0.98067750				
		2912.173				622,241.54	2,527,315.23
			0.19563141			+1.50	-1.10
76B	191-16-53.8	42.035			+569.71	622,243.04	2,527,314.13
				+7250.48			
			0.99971331				
		7252.556				629,492.02	2,527,141.58
			0.02394363			+1.76	-1.29
76A	178-37-40.8	49.288			-173.65	629,493.78	2,527,140.29
				+2799.17			
			0.99941025				
		2800.824				632,291.19	2,527,045.40
			0.03433890			+1.86	-1.36
76	178-01-55.7	52.089			-96.18	632,293.05	2,527,044.04

FIGURE 37.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Osceola to 26
State Nebraska - South County Polk & Platte Initial Station Osceola
Year 1934 Month January - March Closing Station 26

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist., / ~~Log~~ sin Az / ~~Log~~. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
76				+3169.39		632,291.19	2,527,045.40
			0.97342591			632,293.05	2,527,044.04
		3255.913				635,460.58	2,526,299.79
			0.22900218			+1.97	-1.45
75	166-45-42.0	55,345			-745.61	635,462.55	2,526,298.34
				+4400.15			
			0.99940258				
		4402.781				639,860.73	2,526,451.96
			0.03456130			+2.13	-1.56
75A	181-58-50.2	59,747			+152.17	639,862.86	2,526,450.40
				+8778.73			
			0.95937842				
		9150.436				648,639.46	2,523,870.42
			0.28212240			+2.45	-1.80
73	163-36-47.1	68,898			-2581.54	648,641.91	2,523,868.62
				+2680.87			
			0.72532097				
		3696.120				651,320.33	2,526,414.87
			0.68841084			+2.59	-1.90
73A	223-30-16.0	72,594			+2544.45	651,322.92	2,526,412.97
				+6544.20			
			0.99951529				
		6547.373				657,864.53	2,526,211.04
			0.03113164			+2.82	-2.07
41	178-12-57.6	79,141			-203.83	657,867.35	2,526,208.97

FIGURE 37.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Osceola to 26
State Nebraska - South County Polk & Platte Initial Station Osceola
Year 1934 Month January - March Closing Station 26

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
41				+105.88		657,864.53	2,526,211.04
			0.04890352			657,867.35	2,526,208.97
		2165.012				657,970.41	2,528,373.46
			0.99880351			+2.90	-2.13
40	267-11-48.9	81,306			+2162.42	657,973.31	2,528,371.33
				+1648.73			
			0.53529782				
		3080.024				659,619.14	2,525,771.88
			0.84466339			+3.01	-2.21
41A	122-21-50.8	84,386			-2601.58	659,622.15	2,525,769.67
				+5039.23			
			0.88169514				
		5715.384				664,658.37	2,528,468.51
			0.47181954			+3.21	-2.36
41C	208-09-08.9	90,102			+2696.63	664,661.58	2,528,466.15
				-115.36			
			0.02361017				
		4885.899				664,543.01	2,523,583.97
			0.99972124			+3.38	-2.48
41B	88-38-49.6	94,988			-4884.54	664,546.39	2,523,581.49
				+2619.58			
			0.69319360				
		3778.998				667,162.59	2,520,860.25
			0.72075144			+3.52	-2.58
41D	133-53-00.4	98,767			-2723.72	667,166.11	2,520,857.67

FIGURE 37.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Osceola to 26
State Nebraska - South County Polk & Platte Initial Station Osceola
Year 1934 Month January - March Closing Station 26

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
41D				+2944.44		667,162.59	2,520,860.25
			0.91577597			667,166.11	2,520,857.67
		3215.243				670,107.03	2,519,568.72
			0.40168939			+3.63	-2.67
41E	156-18-58.2	101,982			-1291.53	670,110.66	2,519,566.05
				+2376.08			
			0.97131256				
		2446.253				672,483.11	2,520,150.45
			0.23780645			+3.72	-2.73
26.	193-45-25.6	104,428			+581.73	672,486.83	2,520,147.72
						672,486.83	2,520,147.72
						-3.72	+2.73
					x Factor =	-2.61424×10^{-5}	
					y Factor =	$+3.56226 \times 10^{-5}$	

FIGURE 37.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 700

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Columbus, Northwest	2,586,534.06			79 C	2,527,519.23		
Power & Light Co., stack	648,492.32				610,720.25		
Osceola	2,534,639.91	217 56 11.8	Columbus, Northwest Power & Light Co., stack.	79 B	2,527,448.01		
	581,919.12				613,236.96		
82	2,533,570.03			79 A	2,527,997.62		
	582,962.44				616,281.55		
81	2,533,344.23			77	2,526,744.50		
	586,165.42				619,387.03		
81 C	2,533,197.24			76 B	2,527,314.13		
	588,030.81				622,243.04		
81 B	2,531,867.42			76 A	2,527,140.29		
	593,340.57				629,493.78		
81 A	2,530,425.32			76	2,527,044.04		
	595,931.80				632,293.05		
79	2,530,239.58			75	2,526,298.34		
	598,634.11				635,462.55		
79 E	2,528,916.32			75 A	2,526,450.40		
	603,886.67				639,862.86		
79 D	2,527,556.80			73	2,523,868.62		
	608,670.61				648,641.91		

FIGURE 38.—List of adjusted coordinates.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. [illegible]

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
73A	2,526,412.97						
	651,322.92						
41	2,526,208.97						
	657,867.35						
40	2,528,371.33						
	657,973.31						
41A	2,525,769.67						
	659,622.15						
41C	2,528,466.15						
	664,661.58						
41B	2,523,581.49						
	664,546.39						
41D	2,520,857.67						
	667,166.11						
41E	2,519,566.05						
	670,110.66						
27	2,518,767.54						
	673,683.19						
26	2,520,147.72	130 55 09.2	27				
	672,486.83						

FIGURE 38.—List of adjusted coordinates—Continued.

Adjustment of Genoa water tower

COMPUTATION OF GRID AZIMUTHS AND LENGTHS

Monroe to Genoa

	x	y
	Feet	*Feet*
Genoa	2, 458, 788. 74	647, 072. 39
Monroe	2, 513, 984. 24	677, 725. 68
Δx and Δy	−55, 195. 50	−30, 653. 29

$\log \Delta x = 4.7419037$
$\log \Delta y = 4.4864771$

$\log \tan \alpha_1 = 0.2554266$

$\alpha_1 = 60°57'14''.5$
Grid azimuth $= 60°57'14''.5$

$\log \Delta x = 4.7419037$
$\log \sin \alpha_1 = 9.9416259 - 10$

$\log s_1 = 4.8002778$

Monroe to 73

	x	y
	Feet	*Feet*
73	2, 523, 868. 62	648, 641. 91
Monroe	2, 513, 984. 24	677, 725. 68
Δx and Δy	+9, 884. 38	−29, 083. 77

$\log \Delta x = 3.9949494$
$\log \Delta y = 4.4636507$

$\log \tan \alpha_2 = 9.5312987 - 10$

$\alpha_2 = 18°46'14''.8$
Grid azimuth $= 341°13'45''.2$

$\log \Delta y = 4.4636507$
$\log \cos \alpha_2 = 9.9762644 - 10$

$\log s_2 = 4.4873863$

Genoa to 73

	x	y
	Feet	*Feet*
73	2, 523, 868. 62	648, 641. 91
Genoa	2, 458, 788. 74	647, 072. 39
Δx and Δy	+65, 079. 88	+1, 569. 52

$\log \Delta x = 4.8134467$
$\log \Delta y = 3.1957668$

$\log \tan \alpha_3 = 1.6176799$

$\alpha_3 = 88°37'06''.5$
Grid azimuth $= 268°37'06''.5$

$\log \Delta x = 4.8134467$
$\log \sin \alpha_3 = 9.9998737 - 10$

$\log s_3 = 4.8135730$

COMPUTATION OF GRID AZIMUTHS AND LENGTHS—Continued

73 to 73A

	x	y
	Feet	*Feet*
73A	2, 526, 412. 97	651, 322. 92
73	2, 523, 868. 62	648, 641. 91
Δx and Δy	+2, 544. 35	+2, 681. 01

$$\log \Delta x = 3.4055768$$
$$\log \Delta y = 3.4282984$$
$$\log \tan \alpha_4 = 9.9772784-10$$
$$\alpha_4 = 43°30'06''.7$$
$$\text{Grid azimuth} = 223°30'06''.7$$

Monroe to 27

	x	y
	Feet	*Feet*
27	2, 518, 767. 54	673, 683. 19
Monroe	2, 513, 984. 24	677, 725. 68
Δx and Δy	+4, 783. 30	−4, 042. 49

$$\log \Delta x = 3.6797276$$
$$\log \Delta y = 3.6066489$$
$$\log \tan \alpha_5 = 0.0730787$$
$$\alpha_5 = 49°47'52''.7$$
$$\text{Grid azimuth} = 310°12'07''.3$$

Genoa to 122A

	x	y
	Feet	*Feet*
122A	2, 462, 597. 70	647, 151. 44
Genoa	2, 458, 788. 74	647, 072. 39
Δx and Δy	+3, 808. 96	+79. 05

$$\log \Delta x = 3.5808064$$
$$\log \Delta y = 1.8979019$$
$$\log \tan \alpha_6 = 1.6829045$$
$$\alpha_6 = 88°48'39''.9$$
$$\text{Grid azimuth} = 268°48'39''.9$$

COMPUTATION OF ANGLES OF TRIANGLES

Stations	Azimuth and angle (° ′ ″)	Stations	Azimuth and angle (° ′ ″)
Monroe to Genoa	60 57 14.5	Monroe to Genoa water tower	53 43 01.9
Monroe to 73	341 13 45.2	Monroe to 73	341 13 45.2
∠73 to Genoa	79 43 29.3	∠73 to Genoa water tower	72 29 16.7
Genoa to 73	268 37 06.5	Monroe to Genoa	60 57 14.5
Genoa to Monroe	240 57 14.5	Monroe to Genoa water tower	53 43 01.9
∠Monroe to 73	27 39 52.0	∠Genoa water tower to Genoa	7 14 12.6
73 to Monroe	161 13 45.2	Genoa to 73	268 37 06.5
73 to Genoa	88 37 06.5	Genoa to Genoa water tower	250 55 53.4
∠Genoa to Monroe	72 36 38.7	∠Genoa water tower to 73	17 41 13.1
Monroe to 27	310 12 07.3	Genoa to Genoa water tower	250 55 53.4
∠ 27 to Genoa water tower	103 30 54.6	Genoa to Monroe	240 57 14.5
Monroe to Genoa water tower	53 43 01.9	∠Monroe to Genoa water tower	9 58 38.9
Genoa to 122A	268 48 39.9	73 to Monroe	161 13 45.2
∠122A to Genoa water tower	342 07 13.5	73 to Genoa water tower	100 18 25.4
Genoa to Genoa water tower	250 55 53.4	∠Genoa water tower to Monroe	60 55 19.8
73 to 73A	223 30 06.7	73 to Genoa water tower	100 18 25.4
∠73A to Genoa water tower	236 48 18.7	73 to Genoa	88 37 06.5
73 to Genoa water tower	100 18 25.4	∠Genoa to Genoa water tower	11 41 18.9

LENGTH EQUATION

Designation of angle	Angle (° ′ ″)	Log and log sin	Tabular difference of log for one second	Designation of angle	Angle (° ′ ″)	Log and log sin	Tabular difference of log for one second
Genoa to Monroe		4.8002778		Genoa to 73		4.8135730	
−1	7 14 12.6	9.1002706	+16.6	+1+3	162 47 08.5	9.4712133	−6.8
+2−3	150 37 28.0	9.6906674	−3.7	−2	11 41 18.9	9.3066227	+10.2
		3.5912158				3.5914090	

$$0 = -193.2 - 9.8\,(1) + 6.5\,(2) + 10.5\,(3)$$
$$+248.54C_1 = +193.2$$
$$C_1 = +0.77734$$

Number	Computed v	Adopted v
1	−7.62	−7.6
2	+5.05	+5.0
3	+8.16	+8.2

Department of Commerce
U. S. Coast and Geodetic Survey
Form 25
Ed. Jan., 1929

11—4121

Computation of Triangles

State: ____________________

No.		Station	Observed angle	Corr'n	Spher'l angle	Spher'l excess	Plane angle and distance	Logarithm
	2-3							4.8135730
	1	Monroe	79 43 29.3					0.0070215
	2	73	72 36 38.7					9.9796833
	3	Genoa	27 39 52.0					9.6667917
	1-3							4.8002778
	1-2							4.4873863
	2-3							4.4873863
	1	Genoa Water Tower	23.5				46 35 26.1	0.1387873
+1	2	Monroe	72 29 16.7	-7.6			09.1	9.9793857
+2	3	73	60 55 19.8	+5.0			24.8	9.9414976
	1-3							4.6055593
	1-2							4.5676712
	2-3							4.8135730
	1	Genoa Water Tower	28.0				150 37 24.8	0.3093207
-2	2	73	11 41 18.9	-5.0			13.9	9.3065718
+3	3	Genoa	17 41 13.1	+8.2			21.3	9.4826654
	1-3							4.4294655 -1
	1-2							4.6055591 +2
	2-3							4.8002778
	1	Genoa Water Tower	08.5				162 47 09.1	0.5287908
-3	2	Genoa	9 58 38.9	-8.2			30.7	9.2386025
-1	3	Monroe	7 14 12.6	+7.6			20.2	9.1003966
	1-3							4.5676712 +1
	1-2							4.4294652 +2

Figure 39.—Computation of triangles for Genoa water tower.

Adjustment of Genoa water tower—Continued

COMPUTATION OF COORDINATES

Stations	Azimuth and angle
	° ′ ″
Monroe to 73	341 13 45.2
∠73 to Genoa water tower	72 29 09.1
Monroe to Genoa water tower	53 42 54.3 = α_1

$\log s_1 = 4.5676712$ $\log s_1 = 4.5676712$
$\log \sin \alpha_1 = 9.9063803 - 10$ $\log \cos \alpha_1 = 9.7721754 - 10$

$\log \Delta x = 4.4740515$ $\log \Delta y = 4.3398466$

	x	y
	Feet	*Feet*
Monroe	2, 513, 984. 24	677, 725. 68
Δx and Δy	−29, 788. 70	−21, 869. 89
Genoa water tower	2, 484, 195. 54 +1	655, 855. 79 −1

Stations	Azimuth and angle
	° ′ ″
73 to Monroe	161 13 45.2
∠Genoa water tower to Monroe	60 55 24.8
73 to Genoa water tower	100 18 20.4 = α_2

$\log s_2 = 4.6055593$ $\log s_2 = 4.6055593$
$\log \sin \alpha_2 = 9.9929365 - 10$ $\log \cos \alpha_2 = 9.2526091 - 10$

$\log \Delta x = 4.5984958$ $\log \Delta y = 3.8581684$

	x	y
	Feet	*Feet*
73	2, 523, 868. 62	648, 641. 91
Δx and Δy	−39, 673. 07	+7, 213. 87
Genoa water tower	2, 484, 195. 55	655, 855. 78

Stations	Azimuth and angle
	° ′ ″
Genoa to 73	268 37 06.5
∠Genoa water tower to 73	17 41 21.3
Genoa to Genoa water tower	250 55 45.2 = α_3

$\log s_3 = 4.4294654$ $\log s_3 = 4.4294654$
$\log \sin \alpha_3 = 9.9754849 - 10$ $\log \cos \alpha_3 = 9.5141969 - 10$

$\log \Delta x = 4.4049503$ $\log \Delta y = 3.9436623$

	x	y
	Feet	*Feet*
Genoa	2, 458, 788. 74	647, 072. 39
Δx and Δy	+25, 406. 82	+8, 783. 39
Genoa water tower	2, 484, 195. 56 −1	655, 855. 78

THE TWO TRAVERSES, OSCEOLA TO COLUMBUS AND MONROE TO CURTIS

In the computation of the traverses with intersections at 48 and 50, it would have been satisfactory to adjust one of them and then hold the intersection points fixed in computing the other. That is, the two sections from 3A to 12 might have been computed and adjusted first since these are the two shortest sections. Then 40 to 48 could have been computed holding 48 as fixed; also 81 to 50 could have been adjusted in a similar manner. This would have been a simpler method of handling the matter but we wished to show a sample of the more rigid method of making the computation. As a matter of fact, the whole scheme between Columbus, Monroe, Genoa, Osceola, and Curtis could have been computed with junction points at 26, 40, 81, 48, 50, 3A, and 12. This would have given the most rigid adjustment, but we did not wish to introduce too much complication in the work. Our aim has been to keep the computations as simple as possible, so that no one would meet with any difficulty in applying the principles in ordinary computations.

Computation of fixed grid azimuths

12 TO 13

	x	y
	Feet	*Feet*
13	2, 590, 435. 71	613, 005. 29
12	2, 590, 418. 08	615, 523. 79
Δx and Δy	+17. 63	−2, 518. 50

log Δx = 1. 2462523
log Δy = 3. 4011420

log tan α = 7. 8451103 − 10

α = 0°24′03″. 9
Grid azimuth = 359°35′56″. 1

3A TO 3

	x	y
	Feet	*Feet*
3	2, 583, 991. 40	656, 665. 04
3A	2, 582, 846. 74	652, 816. 56
Δx and Δy	+1, 144. 66	+3, 848. 48

log Δx = 3. 0586765
log Δy = 3. 5852892

log tan α = 9. 4733873 − 10

α = 16°33′50″. 9
Grid azimuth = 196°33′50″. 9

81 TO 81C

	x	y
	Feet	*Feet*
81C	2, 533, 197. 24	588, 030. 81
81	2, 533, 344. 23	586, 165. 42
Δx and Δy	−146. 99	+1, 865. 39

log Δx = 2. 1672878
log Δy = 3. 2707697

log tan α = 8. 8965181 − 10

α = 4°30′19″. 8
Grid azimuth = 175°29′40″. 2

40 TO 41A

	x	y
	Feet	*Feet*
41A	2, 525, 769. 67	659, 622. 15
40	2, 528, 371. 33	657, 973. 31
Δx and Δy	−2, 601. 66	+1, 648. 84

$$\log \Delta x = 3.4152505$$
$$\log \Delta y = 3.2171785$$
$$\log \tan \alpha = 0.1980720$$
$$\alpha = 57°38'05''.7$$
Grid azimuth = 122°21′54″. 3

Traverse, 12 to 48

LIST OF ANGLES

Station	From station—	To station—	Angle	Station	From station—	To station—	Angle
			° ′ ″				° ′ ″
12	13	28A	92 45 24. 4	30	29	31A	214 00 08. 9
28A	12	28	176 50 24. 6	31A	30	50	91 34 38. 0
28	28A	29	178 02 34. 3	50	31A	49	289 54 51. 0
29	28	30	237 47 17. 4	49	50	48	124 33 27. 7

COMPUTATION OF GRID AZIMUTHS

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	″
12 to 13	359 35 56. 1		56. 1
∠13 to 28A	92 45 24. 4	+2. 0	26. 4
12 to 28A	92 21 20. 5		22. 5
28A to 12	272 21 20. 5		22. 5
∠12 to 28	176 50 24. 6	+2. 1	26. 7
28A to 28	89 11 45. 1		49. 2
28 to 28A	269 11 45. 1		49. 2
∠28A to 29	178 02 34. 3	+2. 0	36. 3
28 to 29	87 14 19. 4		25. 5
29 to 28	267 14 19. 4		25. 5
∠28 to 30	237 47 17. 4	+2. 1	19. 5
29 to 30	145 01 36. 8		45. 0
30 to 29	325 01 36. 8		45. 0
∠29 to 31A	214 00 08. 9	+2. 0	10. 9
30 to 31A	179 01 45. 7		55. 9
31A to 30	359 01 45. 7		55. 9
∠30 to 50	91 34 38. 0	+2. 1	40. 1
31A to 50	90 36 23. 7		36. 0
50 to 31A	270 36 23. 7		36. 0
∠31A to 49	289 54 51. 0	+2. 0	53. 0
50 to 49	200 31 14. 7		29. 0
49 to 50	20 31 14. 7		29. 0
∠50 to 48	124 33 27. 7	+0. 8	28. 5
49 to 48	145 04 42. 4		57. 5
Adopted mean azimuth	145 04 57. 5		
Discrepancy	−15. 1		

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

11—9131

COMPUTATION OF TRIANGLES

State: ....

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
2-3							3.4238094
1	49	54 06 18.6	-0.4			18.2	0.0914649
2	48	63 36 40.6	-0.5			40.1	9.9522102
3	47	62 17 02.1	-0.4			01.7	9.9470719
1-3			-1.3				3.4674845
1-2						2899.654	3.4623462
		01.3					

FIGURE 40.—Computation of triangle for junction of traverses.

REDUCTION OF LENGTHS

[Average elevation=1,480 feet. Elevation factor=0.99992925]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
12–28A	5, 025. 502	5, 025. 146	0. 9999394	5, 024. 841
28A–28	2, 585. 783	2, 585. 600	. 9999394	2, 585. 443
28–29	2, 662. 762	2, 662. 574	. 9999394	2, 662. 413
29–30	9, 637. 978	9, 637. 296	. 9999405	9, 636. 723
30–31A	3, 902. 829	3, 902. 553	. 9999419	3, 902. 326
31A–50	5, 306. 155	5, 305. 780	. 9999429	5, 305. 477
50–49	3, 398. 266	3, 398. 026	. 9999437	3, 397. 835
49–48	2, 899. 654	2, 899. 449	. 9999443	2, 899. 288

A mean latitude of 41°22′ can be used to compute R_a

$$\begin{aligned}
\log A &= 8.5090837-10\\
\log B &= 8.5107475-10\\
\log A+\log B &= 17.0198312-20\\
\tfrac{1}{2}(\log A+\log B) &= 8.5099156-10\\
\log \text{constant} &= 5.8304093\\
\tfrac{1}{2}(\log A+\log B) &= 8.5099156-10\\
\log R_a &= 7.3204937\\
R_a &= 20,916,200
\end{aligned}$$

$$\text{Elevation factor}=\frac{20,916,200}{20,917,680}=0.99992925$$

Traverse, 3A to 48

LIST OF ANGLES

Station	From station—	To station—	Angle	Station	From station—	To station—	Angle
			° ′ ″				° ′ ″
3A	3	42	210 13 55. 6	44	43B	45	154 21 17. 4
42	3A	43	187 46 33. 2	45	44	46	177 52 50. 3
43	42	43A	170 33 27. 9	46	45	47	171 19 55. 8
43A	43	43B	217 58 39. 6	47	46	48	256 26 09. 6
43B	43A	44	138 21 22. 4	48	47	49	63 36 40. 6

COMPUTATION OF GRID AZIMUTHS

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
3A to 3	196 33 50.9		50.9
∠3 to 42	210 13 55.6	+1.4	57.0
3A to 42	46 47 46.5		47.9
42 to 3A	226 47 46.5		47.9
∠3A to 43	187 46 33.2	+1.4	34.6
42 to 43	54 34 19.7		22.5
43 to 42	234 34 19.7		22.5
∠42 to 43A	170 33 27.9	+1.4	29.3
43 to 43A	45 07 47.6		51.8
43A to 43	225 07 47.6		51.8
∠43 to 43B	217 58 39.6	+1.4	41.0
43A to 43B	83 06 27.2		32.8
43B to 43A	263 06 27.2		32.8
∠43A to 44	138 21 22.4	+1.5	23.9
43B to 44	41 27 49.6		56.7
44 to 43B	221 27 49.6		56.7
∠43B to 45	154 21 17.4	+1.4	18.8
44 to 45	15 49 07.0		15.5
45 to 44	195 49 07.0		15.5
∠44 to 46	177 52 50.3	+1.4	51.7
45 to 46	13 41 57.3		42 07.2
46 to 45	193 41 57.3		42 07.2
∠45 to 47	171 19 55.8	+1.4	57.2
46 to 47	5 01 53.1		02 04.4
47 to 46	185 01 53.1		02 04.4
∠46 to 48	256 26 09.6	+1.4	11.0
47 to 48	81 28 02.7		15.4
48 to 47	261 28 02.7		15.4
∠47 to 49	63 36 40.6	+1.5	42.1
48 to 49	325 04 43.3		57.5
Adopted mean azimuth	325 04 57.5		
Discrepancy	−14.2		

REDUCTION OF LENGTHS

[Average elevation=1,480 feet. [1] Elevation factor=0.99992925]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
3A–42	2,145.276	2,145.124	0.9999512	2,145.019
42–43	2,424.995	2,424.823	.9999504	2,424.703
43–43A	3,319.481	3,319.246	.9999499	3,319.080
43A–43B	1,461.702	1,461.599	.9999495	1,461.525
43B–44	2,090.771	2,090.623	.9999494	2,090.517
44–45	4,199.188	4,198.891	.9999483	4,198.674
45–46	5,394.446	5,394.064	.9999467	5,393.776
46–47	3,217.561	3,217.333	.9999452	3,217.157
47–48	2,653.441	2,653.253	.9999449	2,653.107

[1] Use same elevation factor as on section 12 to 48, 0.99992925.

Traverse, 40 to 48

LIST OF ANGLES

Station	From station—	To station—	Angle			Station	From station—	To station—	Angle		
			°	′	″				°	′	″
40	41A	39	193	27	48.2	35	36	34	180	18	47.0
39	40	38	221	27	15.6	34	35	33A	177	37	26.0
38	39	37A	124	09	26.4	33A	34	32	231	26	48.5
37A	38	37	146	56	35.0	32	33A	32A	193	14	22.2
37	37A	36	179	26	12.9	32A	32	48	185	33	51.6
36	37	35	181	17	55.4	48	32A	49	167	46	56.3

COMPUTATION OF GRID AZIMUTHS

Stations	Azimuth and angle			Correction for closure	Seconds of corrected azimuth	
	°	′	″	″	′	″
40 to 41A	122	21	54.3			54.3
∠41A to 39	193	27	48.2	−1.8		46.4
40 to 39	315	49	42.5			40.7
39 to 40	135	49	42.5			40.7
∠40 to 38	221	27	15.6	−1.8		13.8
39 to 38	357	16	58.1			54.5
38 to 39	177	16	58.1			54.5
∠39 to 37A	124	09	26.4	−1.8		24.6
38 to 37A	301	26	24.5			19.1
37A to 38	121	26	24.5			19.1
∠38 to 37	146	56	35.0	−1.9		33.1
37A to 37	268	22	59.5			52.2
37 to 37A	88	22	59.5			52.2
∠37A to 36	179	26	12.9	−1.8		11.1
37 to 36	267	49	12.4			03.3
36 to 37	87	49	12.4			03.3
∠37 to 35	181	17	55.4	−1.8		53.6
36 to 35	269	07	07.8		06	56.9
35 to 36	89	07	07.8		06	56.9
∠36 to 34	180	18	47.0	−1.8		45.2
35 to 34	269	25	54.8			42.1
34 to 35	89	25	54.8			42.1
∠35 to 33A	177	37	26.0	−1.9		24.1
34 to 33A	267	03	20.8			06.2
∠A to 34	87	03	20.8			06.2
3334 to 32	231	26	48.5	−1.8		46.7
33A to 32	318	30	09.3		29	52.9
32 to 33A	138	30	09.3		29	52.9
∠33A to 32A	193	14	22.2	−1.8		20.4
32 to 32A	331	44	31.5			13.3
32A to 32	151	44	31.5			13.3
∠32 to 48	185	33	51.6	−1.8		49.8
32A to 48	337	18	23.1			03.1
48 to 32A	157	18	23.1			03.1
∠32A to 49	167	46	56.3	−1.9		54.4
48 to 49	325	05	19.4		04	57.5
Adopted mean azimuth	325	04	57.5			
Discrepancy			+21.9			

REDUCTION OF LENGTHS

[Average elevation=1,480 feet. [1] Elevation factor=0.99992925]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
40-39	4, 591. 502	4, 591. 177	0. 9999527	4, 590. 960
39-38	2, 609. 836	2, 609. 651	. 9999516	2, 609. 525
38-37A	5, 932. 735	5, 932. 315	. 9999510	5, 932. 024
37A-37	5, 593. 000	5, 592. 604	. 9999504	5, 592. 327
37-36	2, 341. 012	2, 340. 846	. 9999504	2, 340. 730
36-35	6, 747. 851	6, 747. 374	. 9999504	6, 747. 039
35-34	2, 920. 648	2, 920. 441	. 9999504	2, 920. 296
34-33A	3, 839. 035	3, 838. 763	. 9999504	3, 838. 573
33A-32	8, 100. 740	8, 100. 167	. 9999494	8, 099. 757
32-32A	8, 019. 025	8, 018. 458	. 9999472	8, 018. 035
32A-48	3, 736. 626	3, 736. 362	. 9999456	3, 736. 159

[1] Use same elevation factor as on section 12 to 48, 0.99992925.

Traverse, 81 to 49

LIST OF ANGLES

Station	From station—	To station—	Angle °	′	″	Station	From station—	To station—	Angle °	′	″
81	81C	62	51	09	29. 4	55	56	54	145	32	43. 1
62	81	61	177	16	46. 3	54	55	53	201	00	59. 1
61	62	60	196	40	09. 4	53	54	52A	165	25	22. 7
60	61	59	136	47	30. 1	52A	53	52	147	43	28. 8
59	60	58	222	15	50. 0	52	52A	51	218	26	33. 1
58	59	57	119	49	48. 9	51	52	50	187	16	27. 6
57	58	56	253	38	14. 8	50	51	49	156	56	10. 3
56	57	55	165	02	39. 7	49	50	48	124	33	27. 7

COMPUTATION OF GRID AZIMUTHS

Stations	Azimuth and angle °	′	″	Correction for closure ″	Seconds of corrected azimuth ′	″
81 to 81C	175	29	40. 2			40. 2
∠81C to 62	51	09	29. 4	−1. 6		27. 8
81 to 62	226	39	09. 6			08. 0
62 to 81	46	39	09. 6			08. 0
∠81 to 61	177	16	46. 3	−1. 6		44. 7
62 to 61	223	55	55. 9			52. 7
61 to 62	43	55	55. 9			52. 7
∠62 to 60	196	40	09. 4	−1. 7		07. 7
61 to 60	240	36	05. 3			00. 4
60 to 61	60	36	05. 3			00. 4
∠61 to 59	136	47	30. 1	−1. 6		28. 5
60 to 59	197	23	35. 4			28. 9
59 to 60	17	23	35. 4			28. 9
∠60 to 58	222	15	50. 0	−1. 6		48. 4
59 to 58	239	39	25. 4			17. 3
58 to 59	59	39	25. 4			17. 3
∠59 to 57	119	49	48. 9	−1. 7		47. 2
58 to 57	179	29	14. 3			04. 5
57 to 58	359	29	14. 3			04. 5
∠58 to 56	253	38	14. 8	−1. 6		13. 2
57 to 56	253	07	29. 1			17. 7
56 to 57	73	07	29. 1			17. 7
∠57 to 55	165	02	39. 7	−1. 6		38. 1
56 to 55	238	10	08. 8		09	55. 8

COMPUTATION OF GRID AZIMUTHS—Continued

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	′ ″
55 to 56	58 10 08.8		09 55.8
∠56 to 54	145 32 43.1	−1.7	41.4
55 to 54	203 42 51.9		37.2
54 to 55	23 42 51.9		37.2
∠55 to 53	201 00 59.1	−1.6	57.5
54 to 53	224 43 51.0		34.7
53 to 54	44 43 51.0		34.7
∠54 to 52A	165 25 22.7	−1.6	21.1
53 to 52A	210 09 13.7		08 55.8
52A to 53	30 09 13.7		08 55.8
∠53 to 52	147 43 28.8	−1.7	27.1
52A to 52	177 52 42.5		22.9
52 to 52A	357 52 42.5		22.9
∠52A to 51	218 26 33.1	−1.6	31.5
52 to 51	216 19 15.6		18 54.4
51 to 52	36 19 15.6		18 54.4
∠52 to 50	187 16 27.6	−1.6	26.0
51 to 50	223 35 43.2		20.4
50 to 51	43 35 43.2		20.4
∠51 to 49	156 56 10.3	−1.7	08.6
50 to 49	200 31 53.5		29.0
49 to 50	20 31 53.5		29.0
∠50 to 48	124 33 27.7	+0.8	28.5
49 to 48	145 05 21.2		04 57.5
Adopted mean azimuth	145 04 57.5		
Discrepancy	+23.7		

REDUCTION OF LENGTHS

[Average elevation=1,520 feet. Elevation factor=0.99992733]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
81–62	4, 289. 705	4, 289. 393	0. 9999328	4, 289. 105
62–61	2, 972. 955	2, 972. 739	. 9999332	2, 972. 540
61–60	4, 843. 422	4, 843. 070	. 9999337	4, 842. 749
60–59	3, 026. 659	3, 026. 439	. 9999341	3, 026. 240
59–58	6, 031. 288	6, 030. 850	. 9999348	6, 030. 457
58–57	3, 316. 399	3, 316. 158	. 9999356	3, 315. 944
57–56	5, 522. 444	5, 522. 043	. 9999361	5, 521. 690
56–55	2, 724. 320	2, 724. 122	. 9999364	2, 723. 949
55–54	6, 585. 221	6, 584. 742	. 9999372	6, 584. 328
54–53	4, 621. 507	4, 621. 171	. 9999388	4, 620. 888
53–52A	3, 759. 059	3, 758. 786	. 9999399	3, 758. 560
52A–52	3, 111. 777	3, 111. 551	. 9999410	3, 111. 367
52–51	2, 208. 500	2, 208. 340	. 9999414	2, 208. 211
51–50	5, 592. 146	5, 591. 740	. 9999424	5, 591. 418
50–49[1]	3, 398. 266	3, 398. 026	. 9999437	3, 397. 835

Use same R_a as for section 12 to 48.

$$\text{Elevation factor} = \frac{20{,}916{,}200}{20{,}917{,}720} = 0.99992733.$$

Determination of weighted mean for grid azimuth of line 49 to 48

	°	′	″
From 12 to 49 with 8 angles, azimuth 49 to 48=	145	04	42.4
From 3A to 48 with 10 angles, azimuth 49 to 48=	145	04	43.3
From 40 to 48 with 12 angles, azimuth 49 to 48=	145	05	19.4
From 81 to 49 with 16 angles, azimuth 49 to 48=	145	05	21.2

[1] This length held as in section 12 to 48.

Assign weights to these results inversely proportional to the number of angles in each case. We could adopt the weights of $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, and $\frac{1}{8}$, respectively, but it is somewhat troublesome to use fractions. To avoid this we multiply each of the above weights by the continued product of the denominators, so that it results that each weight is the product of the other three denominators since the respective denominator cancels out. The weights therefore become 240, 192, 160, and 120, respectively. The seconds of the respective results with 145°04′ become the following:

$$42.4\times240=10176.0$$
$$43.3\times192=8313.6$$
$$79.4\times160=12704.0$$
$$81.2\times120=9744.0$$

Totals=712 40937.6

$$40937.6\div712=57.5$$

The adopted mean, therefore, is 145°04′57″.5. The azimuth of 49 to 50 should also be held the same in 12 to 49 and 81 to 49. This can be done by adding 1″.1 more to the required angles of 12 to 49 and by subtracting 2″.3 more from required angles of 81 to 49. This result is shown in the computations of the grid azimuths on pages 140 and 145.

After the azimuths were corrected to hold the adopted mean of 49 to 48, two values were derived for 49 to 50:

From 12 to 48, we got 20°31′27″.9.

From 81 to 49, we obtained 20°31′31″.3.

Since it was desirable to have the same value for the azimuth of this line on both of the traverses, we further adopted the weighted mean for this line. The number of angles up to this point on the 2 traverses were 7 from 12 to 48 and 15 from 81 to 49. By weighting inversely as the number of angles, we have the following computation:

$$27.9\times15=418.5$$
$$31.3\times7=219.1$$

Totals=22 637.6

$$637.6\div22=29.0$$

Hence, we held for the azimuth of line 49 to 50 20°31′29″.0. This resulted in a correction of +0″.8 to the angle at 49 between 50 and 48. The discrepancy between this value of 49 to 50 and the computed value of the same on each of the lines 12 to 48 and 81 to 49 was then prorated on the angles up to that point. The final results are shown in the computation of grid azimuths on the two traverses.

Computation of the value of 48 to be held in the four traverses

The four values of the coordinates of 48 as determined by the four traverses are tabulated below:

	y	*x*
	Feet	*Feet*
As computed from 12	632, 980. 45	2, 568, 790. 28
As computed from 40	632, 982. 51	2, 568, 790. 05
As computed from 81	632, 977. 56	2, 568, 788. 09
As computed from 3A	632, 981. 01	2, 568, 791. 41

The total approximate lengths of these traverses are as follows:

	Length
	Feet
From 12	35,414
From 40	54,425
From 81	64,895
From 3A	26,904

To determine the coordinates of 48 to be held fixed, we should weight the values inversely as the length. We can get weights accurate enough by dividing 100,000 by each of the lengths in succession approximating to the nearest one one-hundredth. We thus get the following weights:

	Weight
From 12	2.82
From 40	1.84
From 81	1.54
From 3A	3.72

In computing the weighted mean, we need only use the last four figures in each coordinate for the remainder is the same in each case. This considerably shortens the necessary computation. We multiply each value by its weight and then divide the sum of these products by the sum of the weights. This gives the last four figures to be held on each coordinate of 48.

$$80.45\times 2.82=226.8690$$
$$82.51\times 1.84=151.8184$$
$$77.56\times 1.54=119.4424$$
$$81.01\times 3.72=301.3572$$
$$\text{Totals}=9.92 \quad 799.4870$$

$$799.4870\div 9.92=80.59$$

The y coordinate is, therefore, 632,980.59.

$$90.28\times 2.82=254.5896$$
$$90.05\times 1.84=165.6920$$
$$88.09\times 1.54=135.6586$$
$$91.41\times 3.72=340.0452$$
$$\text{Totals}=9.92 \quad 895.9854$$

$$895.9854\div 9.92=90.32$$

The x coordinate, therefore, becomes 2,568,790.32.

We meet an additional complication in this case from the fact that 49 and 50 both occur in two of the traverses. Since that from 12 is the shorter of the two we decided to fix the values of these two stations in that and then hold them fixed in the one from 81 which is the longest of the four. The final discrepancy in this traverse will, therefore, have to be derived from station 50.

COMPUTATION OF COORDINATES

Traverse line ~~Nos~~ 12 to 48
State Nebraska (south) County Butler and Polk Initial Station 12
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~log~~ Lat. / ~~log~~ cos Az / ~~log~~ dist. / ~~log~~ sin Az / ~~log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
12				+ 206.58		615,523.79	2,590,418.08
			0.04111273				
		5024.841				615,730.37	2,585,397.49
			0.99915451			+0.02	+0.01
28A	92 21 22.5	5,025			-5020.59	615,730.39	2,585,397.50
				- 36.23			
			0.01401453				
		2585.443				615,694.14	2,582,812.30
			0.99990179			+0.03	+0.01
28	89 11 49.2	7.610			-2585.19	615,694.17	2,582,812.31
				- 128.18			
			0.04814520				
		2662.413				615,565.96	2,580,152.97
			0.99884035			+0.04	+0.01
29	87 14 25.5	10.273			-2659.33	615,566.00	2,580,152.98
				+7896.75			
			0.81944392				
		9636.723				623,462.71	2,574,629.59
			0.57315937			+0.08	+0.02
30	145 01 45.0	19.909			-5523.38	623,462.79	2,574,629.61
				+3901.77			
			0.99985734				
		3902.326				627,364.48	2,574,563.68
			0.01689059			+0.09	+0.03
31A	179 01 55.9	23.812			- 65.91	627,364.57	2,574,563.71

FIGURE 41.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 12 to 48
State Nebraska (south) County Butler and Polk Initial Station 12
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane °	'	"	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	x Feet
31A						+ 56.48		627,364.48	2,574,563.68
					0.01064631			627,364.57	2,574,563.71
				5305.477				627,420.96	2,569,258.50
					0.99994333			+0.12	+0.03
50	90	36	36.0	29.117			-5305.18	627,421.08	2,569,258.53
						+3182.14			
					0.93652099				
				3397.835				630,603.10	2,570,449.82
					0.35061151			+0.13	+0.04
49	200	31	29.0	32.515			+1191.32	630,603.23	2,570,449.86
						+2377.35			
					0.81997848				
				2899.288				632,980.45	2,568,790.28
					0.57239436			+0.14	+0.04
48	145	04	57.5	35.414			-1659.54	632,980.59	2,568,790.32
						Adopted mean value		632,980.59	2,568,790.32
						Discrepancy		-0.14	-0.04
						x Factor = +1.12950x 10^{-6}			
						y Factor = +3.95324x 10^{-6}			

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line 3A to 48
State Nebraska (south) County Platte and Polk Initial Station 3A
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane °	'	"	Grid Distance Feet	Lat. / cos Az / dist. / sin Az / Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
3A						-1468.46		652,816.56	2,582,846.74
					0.68458986				
				2145.019				651,348.10	2,581,283.17
					0.72892847			-0.03	-0.09
42	46	47	47.9	2.145			-1563.57	651,348.07	2,581,283.08
						-1405.52			
					0.57966641				
				2424.703				649,942.58	2,579,307.39
					0.81485389			-0.07	-0.19
43	54	34	22.5	4.570			-1975.78	649,942.51	2,579,307.20
						-2341.57			
					0.70548753				
				3319.080				647,601.01	2,576,955.08
					0.70872234			-0.12	-0.32
43A	45	07	51.8	7.889			-2352.31	647,600.89	2,576,954.76
						- 175.35			
					0.11997897				
				1461.525				647,425.66	2,575,504.11
					0.99277643			-0.15	-0.38
43B	83	06	32.8	9.350			-1450.97	647,425.51	2,575,503.73
						-1566.53			
					0.74935168				
				2090.517				645,859.13	2,574,119.83
					0.66217222			-0.18	-0.46
44	41	27	56.7	11.441			-1384.28	645,858.95	2,574,119.37

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 3A to 48
State Nebraska (south) County Platte and Polk Initial Station 3A
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. ~~Log.~~ cos Az ~~Log.~~ dist. ~~Log.~~ sin Az ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
44				-4039.62		645,859.13	2,574,119.83
			0.96211827			645,858.95	2,574,119.37
		4198.674				641,819.51	2,572,975.14
			0.27263243			-0.24	-0.63
45	15 49 15.5	15,640			-1144.69	641,819.27	2,572,974.51
				-5240.27			
			0.97154085				
		5393.776				636,579.24	2,571,697.51
			0.23687206			-0.33	-0.85
46	13 42 07.2	21,033			-1277.63	636,578.91	2,571,696.66
				-3204.75			
			0.99614195				
		3217.157				633,374.49	2,571,415.18
			0.08775654			-0.38	-0.98
47	5 02 04.4	24,250			- 282.33	633,374.11	2,571,414.20
				- 393.48			
			0.14831093				
		2653.107				632,981.01	2,568,791.41
			0.98894078			-0.42	-1.09
48	81 28 15.4	26,904			-2623.77	632,980.59	2,568,790.32
				Adopted mean value		632,980.59	2,568,790.32
					Discrepancy	+0.42	+1.09
					x Factor =	-4.05144 x	10^{-5}
					y Factor =	-1.56111 x	10^{-5}

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 40 to 48
State Nebraska - South County Platte Initial Station 40
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
40				-3292.87		657,973.31	2,528,371.33
			0.71725089				
		4590.960				654,680.44	2,531,570.38
			0.69681502			-0.16	+0.02
39	315-49-40.7	4,591			+3199.05	654,680.28	2,531,570.40
				-2606.59			
			0.99887487				
		2609.525				652,073.85	2,531,694.13
			0.04742365			-0.25	+0.04
38	357-16-54.5	7,200			+123.75	652,073.60	2,531,694.17
				-3094.06			
			0.52158512				
		5932.024				648,979.79	2,536,755.33
			0.85319925			-0.46	+0.07
37A	301-26-19.1	13,133			+5061.20	648,979.33	2,536,755.40
				+157.98			
			0.02825021				
		5592.327				649,137.77	2,542,345.43
			0.99960089			-0.66	+0.09
37	268-22-52.2	18,725			+5590.10	649,137.11	2,542,345.52
				+89.14			
			0.03808115				
		2340.730				649,226.91	2,544,684.46
			0.99927465			-0.74	+0.10
36	267-49-03.3	21,066			+2339.03	649,226.17	2,544,684.56

FIGURE 41.—Computation of coordinates—Continued

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 40 to 48
State Nebraska - South County Platte Initial Station 40
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
36				+104.12		649,226.91	2,544,684.46
			0.01543149			649,226.17	2,544,684.56
		6747.039				649,331.03	2,551,430.70
			0.99988092			-0.98	+0.14
35	269-06-56.9	27.813			+6746.24	649,330.05	2,551,430.84
				+29.14			
			0.00997682				
		2920.296				649,360.17	2,554,350.85
			0.99995024			-1.08	+0.15
34	269-25-42.1	30.733			+2920.15	649,359.09	2,554,351.00
				+197.43			
			0.05143445				
		3838.573				649,557.60	2,558,184.34
			0.99867637			-1.22	+0.17
33A	267-03-06.2	34.571			+3833.49	649,556.38	2,558,184.51
				-6066.17			
			0.74893291				
		8099.757				643,491.43	2,563,551.61
			0.66264583			-1.51	+0.21
32	318-29-52.9	42.671			+5367.27	643,489.92	2,563,551.82
				-7062.15			
			0.88078355				
		8018.035				636,429.28	2,567,348.30
			0.47351910			-1.79	+0.25
32A	331-44-13.3	50.689			+3796.69	636,427.49	2,567,348.55

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 40 to 48
State Nebraska - South County Platte Initial Station 40
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log. Lat. / Log. cos Az / Log. dist. / Log. sin Az / Log. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
32A				-3446.77		636,429.28	2,567,348.30
			0.92254389			636,427.49	2,567,348.55
		3736.159				632,982.51	2,568,790.05
			0.38589217			-1.92	+0.27
48	337-18-03.1	54.425			+1441.75	632,980.59	2,568,790.32
						632,980.59	2,568,790.32
					Discrepancy	+1.92	-0.27

x Factor = +0.49610 X 10^{-5}

y Factor = -3.52779 X 10^{-5}

FIGURE 41.—Computation of coordinates—Continued

106911°—35——11

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 81 to 48
State Nebraska - South County Polk Initial Station 81
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
81				+2944.15		586,165.42	2,533,344.23
			0.68642499				
		4289.105				589,109.57	2,536,463.27
			0.72720061			+0.22	+0.16
62	226-39-08.0	4,289			+3119.04	589,109.79	2,536,463.43
				+2140.74			
			0.72017214				
		2972.540				591,250.31	2,538,525.60
			0.69379542			+0.37	+0.28
61	223 -55-52.7	7,262			+2062.33	591,250.68	2,538,525.88
				+2377.32			
			0.49090206				
		4842.749				593,627.63	2,542,744.67
			0.87121476			+0.62	+0.46
60	240-36-00.4	12,104			+4219.07	593,628.25	2,542,745.13
				+2887.90			
			0.95428540				
		3026.240				596,515.53	2,543,649.20
			0.29889691			+0.78	+0.57
59	197-23-28.9	15,131			+904.53	596,516.31	2,543,649.77
				+3046.64			
			0.50520851				
		6030.457				599,562.17	2,548,853.47
			0.86299732			+1.09	+0.80
58	239-39-17.3	21,161			+5204.27	599,563.26	2,548,854.27

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 81 to 48
State Nebraska - South County Polk Initial Station 81
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ′ ″.	Grid Distance Feet	~~Log~~. Lat. ~~Log~~. cos Az ~~Log~~. dist. ~~Log~~. sin Az ~~Log~~. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
58				+3315.81		599,562.17	2,548,853.47
			0.99995954			599,563.26	2,548,854.27
		3315.944				602,877.98	2,548,823.64
			0.00899560			+1.26	+0.93
57	179-29-04.5	24.477			-29.83	602,879.24	2,548,824.57
				+1603.18			
			0.29034174				
		5521.690				604,481.16	2,554,107.47
			0.95692303			+1.54	+1.14
56	253-07-17.7	29.999			+5283.83	604,482.70	2,554,108.61
				+1436.79			
			0.52746745				
		2723.949				605,917.95	2,556,421.67
			0.84957524			+1.68	+1.24
55	238-09-55.8	32.723			+2314.20	605,919.63	2,556,422.91
				+6028.55			
			0.91559009				
		6584.328				611,946.50	2,559,069.31
			0.40211291			+2.02	+1.49
54	203-42-37.2	39.307			+2647.64	611,948.52	2,559,070.80
				+3283.03			
			0.71047645				
		4620.888				615,229.53	2,562,321.13
			0.70372097			+2.26	+1.66
53	224-43-34.7	43.928			+3251.82	615,231.79	2,562,322.79

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 81 to 48
State Nebraska - South County Polk Initial Station 81
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
53				+3250.12		615,229.53	2,562,321.13
			0.86472367			615,231.79	2,562,322.79
		3758.560				618,479.65	2,564,208.86
			0.50224792			+2.45	+1.81
52A	210-08-55.8	47,686			+1887.73	618,482.10	2,564,210.67
				+3109.22			
			0.99931103				
		3111.367				621,588.87	2,564,093.38
			0.03711414			+2.61	+1.92
52	177-52-22.9	50,798			-115.48	621,591.48	2,564,095.30
				+1779.31			
			0.80577212				
		2208.211				623,368.18	2,565,401.14
			0.59222571			+2.72	+2.01
51	216-18-54.4	53,006			+1307.76	623,370.90	2,565,403.15
				+4049.89			
			0.72430424				
		5591.418				627,418.07	2,569,256.31
			0.68948050			+3.01	+2.22
50	223-35-20.4	58,597			+3855.17	627,421.08	2,569,258.53
				+3182.14			
			0.93652099				
		3397.835				630,600.21	2,570,447.63
			0.35061151			+3.02	+2.23
49	200-31-29.0	61,995			+1191.32	630,603.23	2,570,449.86

x Factor = $+3.78859 \times 10^{-5}$
y Factor = $+5.13678 \times 10^{-5}$

Determined from 50.

Discrepancy at 50 -3.01 -2.22

FIGURE 41.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ 81 to 48
State Nebraska - South County Polk Initial Station 81
Year 1934 Month January - March Closing Station 48

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
49				+2377.35		630,600.21	2,570,447.63
			0.81997848			630,603.23	2,570,449.86
		2899.288				632,977.56	2,568,788.09
			0.57239436			+3.03	+2.23
48	145-04-57.5	64.895			-1659.54	632,980.59	2,568,790.32

FIGURE 41.—Computation of coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 709

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
13	2,590,435.71						
	613,005.29						
12	2,590,418.08	359 35 56.1	13				
	615,523.79						
28 A	2,585,397.50						
	615,730.39						
28	2,582,812.31						
	615,694.17						
29	2,580,152.98						
	615,566.00						
30	2,574,629.61						
	623,462.79						
31 A	2,574,563.71						
	627,364.57						
50	2,569,258.53						
	627,421.08						
49	2,570,449.86						
	630,603.23						
48	2,568,790.32						
	632,980.59						

U.S. GOVERNMENT PRINTING OFFICE: 1936

FIGURE 42.—List of adjusted coordinates.

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form No. 709

PLANE COORDINATES

Datum *North American 1927* Projection *Lambert South* State *Nebraska*

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
3	2,583,991.40			48	2,568,790.32		
	656,665.04				632,980.59		
3A	2,582,846.74	196 33 50.9	3				
	652,816.56						
42	2,581,283.08						
	651,348.07						
43	2,579,307.20						
	649,942.51						
43A	2,576,954.76						
	647,600.89						
43B	2,575,503.73						
	647,425.51						
44	2,574,119.37						
	645,858.95						
45	2,572,974.51						
	641,819.27						
46	2,571,696.66						
	636,578.91						
47	2,571,414.20						
	633,374.11						

FIGURE 42.—List of adjusted coordinates—Continued.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 708

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark
41A	2,525,769.67			32	2,563,551.82		
	659,622.15				643,489.92		
40	2,528,371.33	122 21 54.3	41A	32A	2,567,348.55		
	657,973.31				636,427.49		
39	2,531,570.40			48	2,568,790.32		
	654,680.28				632,980.59		
38	2,531,694.17						
	652,073.60						
37A	2,536,755.40						
	648,979.33						
37	2,542,345.52						
	649,137.11						
36	2,544,684.56						
	649,226.17						
35	2,551,430.84						
	649,330.05						
34	2,554,351.00						
	649,359.09						
33A	2,558,184.51						
	649,556.38						

FIGURE 42.—List of adjusted coordinates—Continued.

Department of Commerce
U.S. Coast and Geodetic Survey
Form No. 700

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate y Coordinate	Azimuth	Mark	Station	x Coordinate y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
81C	2,533,197.24 588,030.81			54	2,559,070.80 611,948.52		
81	2,533,344.23 586,165.42	175 29 40.2	81C	53	2,562,322.79 615,231.79		
62	2,536,463.43 589,109.79			52A	2,564,210.67 618,482.10		
61	2,538,525.88 591,250.68			52	2,564,095.30 621,591.48		
60	2,542,745.13 593,628.25			51	2,565,403.15 623,370.90		
59	2,543,649.77 596,516.31			50	2,569,258.53 627,421.08		
58	2,548,854.27 599,563.26						
57	2,548,824.57 602,879.24						
56	2,554,108.61 604,482.70						
55	2,556,422.91 605,919.63						

U.S. GOVERNMENT PRINTING OFFICE: 1934

FIGURE 42.—List of adjusted coordinates—Continued.

Traverse, Genoa to 81

LIST OF ANGLES

Station	From station—	To station—	Angle	Station	From station—	To station—	Angle
			° ′ ″				° ′ ″
Genoa	Azimuth mark	101E	17 45 51.4	93	94	92	164 59 45.8
101E	Genoa	101D	232 53 51.0	92	93	91	216 13 47.9
101D	101E	101C	156 44 17.5	91	92	90	140 21 12.9
101C	101D	101B	174 19 29.5	90	91	89	193 45 22.9
101B	101C	101A	176 06 17.9	89	90	89A	196 48 38.9
101A	101B	101	168 26 45.4	89A	89	87	169 32 43.9
101	101A	100	127 34 59.3	87	89A	86	134 41 05.7
100	101	99	177 54 22.5	86	87	85	191 42 16.9
99	100	98A	215 01 42.2	85	86	84	146 38 15.7
98A	99	98	158 33 54.6	84	85	83	244 46 08.5
98	98A	97	255 03 56.7	83	84	83A	152 43 29.0
97	98	96	207 10 33.1	83A	83	81	182 41 00.1
96	97	95	178 07 42.1	81	83A	81C	46 40 48.7
95	96	94	149 21 24.2				
94	95	93	186 51 14.6				

COMPUTATION OF GRID AZIMUTHS

Stations	Azimuth and angle	Correction for closure	Seconds of corrected azimuth
	° ′ ″	″	° ′ ″
Genoa to azimuth mark	271 58 46.4		46.4
∠Azimuth mark to 101E	17 45 51.4	−0.2	51.2
Genoa to 101E	289 44 37.8		37.6
101E to Genoa	109 44 37.8		37.6
∠Genoa to 101D	232 53 51.0	−0.2	50.8
101E to 101D	342 38 28.8		28.4
101D to 101E	162 38 28.8		28.4
∠101E to 101C	156 44 17.5	−0.2	17.3
101D to 101C	319 22 46.3		45.7
101C to 101D	139 22 46.3		45.7
∠101D to 101B	174 19 29.5	−0.2	29.3
101C to 101B	313 42 15.8		15.0
101B to 101C	133 42 15.8		15.0
∠101C to 101A	176 06 17.9	−0.2	17.7
101B to 101A	309 48 33.7		32.7
101A to 101B	129 48 33.7		32.7
∠101B to 101	168 26 45.4	−0.2	45.2
101A to 101	298 15 19.1		17.9
101 to 101A	118 15 19.1		17.9
∠101A to 100	127 34 59.3	−0.1	59.2
101 to 100	245 50 18.4		17.1
100 to 101	65 50 18.4		17.1
∠101 to 99	177 54 22.5	−0.2	22.3
100 to 99	243 44 40.9		39.4
99 to 100	63 44 40.9		39.4
∠100 to 98A	215 01 42.2	−0.2	42.0
99 to 98A	278 46 23.1		21.4
98A to 99	98 46 23.1		21.4
∠99 to 98	158 33 54.6	−0.2	54.4
98A to 98	257 20 17.7		15.8
98 to 98A	77 20 17.7		15.8
∠98A to 97	255 03 56.7	−0.2	56.5
98 to 97	332 24 14.4		12.3
97 to 98	152 24 14.4		12.3
∠98 to 96	207 10 33.1	−0.2	32.9
97 to 96	359 34 47.5		45.2

COMPUTATION OF GRID AZIMUTHS—Continued

Stations	Azimuth and angle °	′	″	Correction for closure ″	Seconds of corrected azimuth °	′	″
96 to 97	179	34	47.5				45.2
∠97 to 95	178	07	42.1	−0.2			41.9
96 to 95	357	42	29.6				27.1
95 to 96	177	42	29.6				27.1
∠96 to 94	149	21	24.2	−0.1			24.1
95 to 94	327	03	53.8				51.2
94 to 95	147	03	53.8				51.2
∠95 to 93	186	51	14.6	−0.2			14.4
94 to 93	333	55	08.4				05.6
93 to 94	153	55	08.4				05.6
∠94 to 92	164	59	45.8	−0.2			45.6
93 to 92	318	54	54.2				51.2
92 to 93	138	54	54.2				51.2
∠93 to 91	216	13	47.9	−0.2			47.7
92 to 91	355	08	42.1				38.9
91 to 92	175	08	42.1				38.9
∠92 to 90	140	21	12.9	−0.2			12.7
91 to 90	315	29	55.0				51.6
90 to 91	135	29	55.0				51.6
∠91 to 89	193	45	22.9	−0.2			22.7
90 to 89	329	15	17.9				14.3
89 to 90	149	15	17.9				14.3
∠90 to 89A	196	48	38.9	−0.2			38.7
89 to 89A	346	03	56.8				53.0
89A to 89	166	03	56.8				53.0
∠89 to 87	169	32	43.9	−0.1			43.8
89A to 87	335	36	40.7				36.8
87 to 89A	155	36	40.7				36.8
∠89A to 86	134	41	05.7	−0.2			05.5
87 to 86	290	17	46.4				42.3
86 to 87	110	17	46.4				42.3
∠87 to 85	191	42	16.9	−0.2			16.7
86 to 85	302	00	03.3		301	59	59.0
85 to 86	122	00	03.3		301	59	59.0
∠86 to 84	146	38	15.7	−0.2			15.5
85 to 84	268	38	19.0				14.5
84 to 85	88	38	19.0				14.5
∠85 to 83	244	46	08.5	−0.1			08.4
84 to 83	333	24	27.5				22.9
83 to 84	153	24	27.5				22.9
∠84 to 83A	152	43	29.0	−0.2			28.8
83 to 83A	306	07	56.5				51.7
83A to 83	126	07	56.5				51.7
∠83 to 81	182	41	00.1	−0.2		40	59.9
83A to 81	308	48	56.6				51.6
81 to 83A	128	48	56.6				51.6
∠83A to 81C	46	40	48.7	−0.1			48.6
81 to 81C	175	29	45.3				40.2
Fixed azimuth	175	29	40.2				
Discrepancy			+5.1				

REDUCTION OF LENGTHS

[Average elevation=1,580 feet. Elevation factor=0.99992447]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Genoa-101E	1, 913. 538	1, 913. 393	0. 9999497	1, 913. 297
101E-101D	1, 783. 321	1, 783. 186	. 9999494	1, 783. 096
101D-101C	1, 715. 674	1, 715. 544	. 9999490	1, 715. 457
101C-101B	2, 010. 755	2, 010. 603	. 9999483	2, 010. 499
101B-101A	1, 347. 115	1, 347. 013	. 9999478	1, 346. 943
101A-101	2, 821. 780	2, 821. 567	. 9999478	2, 821. 420
101-100	2, 348. 521	2, 348. 344	. 9999478	2, 348. 221
100-99	6, 373. 781	6, 373. 300	. 9999478	6, 372. 967
99-98A	6, 752. 606	6, 752. 096	. 9999483	6, 751. 747
98A-98	5, 253. 319	5, 252. 922	. 9999483	5, 252. 650
98-97	6, 372. 154	6, 371. 673	. 9999476	6, 371. 339
97-96	3, 447. 657	3, 447. 397	. 9999462	3, 447. 212
96-95	6, 972. 987	6, 972. 460	. 9999448	6, 972. 075
95-94	4, 079. 973	4, 079. 665	. 9999430	4, 079. 432
94-93	7, 517. 860	7, 517. 292	. 9999414	7, 516. 851
93-92	4, 234. 112	4, 233. 792	. 9999396	4, 233. 536
92-91	2, 012. 202	2, 012. 050	. 9999392	2, 011. 928
91-90	7, 567. 549	7, 566. 977	. 9999383	7, 566. 510
90-89	1, 756. 399	1, 756. 266	. 9999372	1, 756. 156
89-89A	1, 692. 378	1, 692. 250	. 9999368	1, 692. 143
89A-87	4, 066. 230	4, 065. 923	. 9999364	4, 065. 664
87-86	5, 568. 172	5, 567. 751	. 9999352	5, 567. 390
86-85	4, 765. 448	4, 765. 088	. 9999351	4, 764. 779
85-84	6, 569. 315	6, 568. 819	. 9999346	6, 568. 389
84-83	2, 927. 893	2, 927. 672	. 9999345	2, 927. 480
83-83A	8, 644. 666	8, 644. 013	. 9999334	8, 643. 437
83A-81	2, 988. 488	2, 988. 262	. 9999328	2, 988. 061

Mean latitude $=41°20'.4$

$$\log A = 8.5090843-10$$
$$\log B = 8.5107495-10$$
$$\log A+\log B = 17.0198338-20$$
$$\tfrac{1}{2}(\log A+\log B) = 8.5099169-10$$

$$\log \text{constant} = 5.8304093$$
$$\tfrac{1}{2}(\log A+\log B) = 8.5099169-10$$
$$\log R_a = 7.3204924$$
$$R_a = 20,916,700$$

$$\text{Elevation factor} = \frac{20,916,700}{20,918,280} = 0.99992447$$

GRID LINES ON GEOLOGICAL SURVEY QUADRANGLE MAPS

In some cases it may be desirable to put the grid lines on the quadrangle maps of the United States Geological Survey. The David City quadrangle in Nebraska lies between the parallels 41°00′ and 41°30′ and between the meridians 97°00′ and 97°30′. The grid coordinates were computed for the four corners on pages 195 to 198 and from these it is possible to determine the distance from the corner in both directions

(Text continued on p. 194)

COMPUTATION OF COORDINATES

Traverse line No. Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane			Grid Distance Feet	Log Lat. Log cos Az Log dist. Log sin Az Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates	
	°	'	"					y Feet	x Feet
Genoa						- 646.34		647,072.39	2,458,788.74
					0.33781451				
				1913.297				646,426.05	2,460,589.56
					0.94121271			-0.05	+0.15
101E	289	44	37.6	1,913			+1800.82	646,426.00	2,460,589.71
						-1701.89			
					0.95445523				
				1783.096				644,724.16	2,461,121.55
					0.29835418			-0.09	+0.30
101D	342	38	28.4	3,696			+ 531.99	644,724.07	2,461,121.85
						-1302.10			
					0.75903684				
				1715.457				643,422.06	2,462,238.39
					0.65104767			-0.13	+0.43
101C	319	22	45.7	5,412			+1116.84	643,421.93	2,462,238.82
						-1389.12			
					0.69093498				
				2010.499				642,032.94	2,463,691.81
					0.72291690			-0.18	+0.60
101B	313	42	15.0	7,422			+1453.42	642,032.76	2,463,692.41
						- 862.36			
					0.64023149				
				1346.943				641,170.58	2,464,726.51
					0.76818203			-0.21	+0.70
101A	309	48	32.7	8,769			+1034.70	641,170.37	2,464,727.21

FIGURE 43.—Computation of coordinates.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
101A				-1335.65		641,170.58	2,464,726.51
			0.47339611			641,170.37	2,464,727.21
		2821.420				639,834.93	2,467,211.76
			0.88084966			-0.27	+0.93
101	298 15 17.9	11.591			+2485.25	639,834.66	2,467,212.69
				+ 961.17			
			0.40931668				
		2348.221				640,796.10	2,469,354.26
			0.91239238			-0.33	+1.12
100	245 50 17.1	13.939			+2142.50	640,795.77	2,469,355.38
				+2819.26			
			0.44237826				
		6372.967				643,615.36	2,475,069.72
			0.89682857			-0.48	+1.63
99	243 44 39.4	20.312			+5715.46	643,614.88	2,475,071.35
				-1029.73			
			0.15251342				
		6751.747				642,585.63	2,481,742.48
			0.98830140			-0.64	+2.17
98A	278 46 21.4	27.064			+6672.76	642,584.99	2,481,744.65
				+1151.40			
			0.21920389				
		5252.650				643,737.03	2,486,867.38
			0.97567908			-0.76	+2.59
98	257 20 15.8	32.316			+5124.90	643,736.27	2,486,869.97

FIGURE 43.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~Mox~~ Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Log~~ Lat. / ~~Log~~ cos Az / ~~Log~~ dist. / ~~Log~~ sin Az / ~~Log~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
98				-5646.48		643,737.03	2,486,867.38
			0.88623121			643,736.27	2,486,869.97
		6371.339				638,090.55	2,489,818.86
			0.46324319			-0.91	+3.10
97	332 24 12.3	38,688			+2951.48	638,089.64	2,489,821.96
				-3447.12			
			0.99997304				
		3447.212				634,643.43	2,489,844.18
			0.00734389			-1.00	+3.38
96	359 34 45.2	42,135			+ 25.32	634,642.43	2,489,847.56
				-6966.49			
			0.99919966				
		6972.075				627,676.94	2,490,123.07
			0.04000052			-1.16	+3.94
95	357 42 27.1	49,107			+ 278.89	627,675.78	2,490,127.01
				-3423.79			
			0.83928052				
		4079.432				624,253.15	2,492,341.05
			0.54369864			-1.26	+4.26
94	327 03 51.2	53,186			+2217.98	624,251.89	2,492,345.31
				-6751.39			
			0.89816745				
		7516.851				617,501.76	2,495,645.86
			0.43965354			-1.43	+4.87
93	333 55 05.6	60,703			+3304.81	617,500.33	2,495,650.73

FIGURE 43.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line No. Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log Lat. / Log cos Az / Log dist. / Log sin Az / Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
93				-3190.93		617,501.76	2,495,645.86
			0.75372655			617,500.33	2,495,650.73
		4233.536				614,310.83	2,498,428.09
			0.65718817			-1.53	+5.21
92	318 54 51.2	64.937			+2782.23	614,309.30	2,498,433.30
				-2004.71			
			0.99641080				
		2011.928				612,306.12	2,498,598.40
			0.08464934			-1.58	+5.37
91	355 08 38.9	66.949			+ 170.31	612,304.54	2,498,603.77
				-5396.60			
			0.71322190				
		7566.510				606,909.52	2,503,902.06
			0.70093831			-1.76	+5.97
90	315 29 51.6	74.515			+5303.66	606,907.76	2,503,908.03
				-1509.31			
			0.85944185				
		1756.156				605,400.21	2,504,799.87
			0.51123350			-1.80	+6.12
89	329 15 14.3	76.271			+ 897.81	605,398.41	2,504,805.99
				-1642.34			
			0.97056839				
		1692.143				603,757.87	2,505,207.38
			0.24082568			-1.84	+6.25
89A	346 03 53.0	77.963			+ 407.51	603,756.03	2,505,213.63

FIGURE 43.—Computation of coordinates—Continued.

COMPUTATION OF COORDINATES

Traverse line ~~No.~~ Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane ° ' "	Grid Distance Feet	~~Log.~~ Lat. / ~~Log.~~ cos Az / ~~Log.~~ dist. / ~~Log.~~ sin Az / ~~Log.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
89A				-3702.83		603,757.87	2,505,207.38
			0.91075735			603,756.03	2,505,213.63
		4065.664				600,055.04	2,506,886.26
			0.41294194			-1.94	+6.58
87	335 36 36.8	82,029			+1678.88	600,053.10	2,506,892.84
				-1931.08			
			0.34685516				
		5567.390				598,123.96	2,512,108.02
			0.93791871			-2.07	+7.02
86	290 17 42.3	87,597			+5221.76	598,121.89	2,512,115.04
				-2524.93			
			0.52991515				
		4764.779				595,599.03	2,516,148.79
			0.84805067			-2.18	+7.41
85	301 59 59.0	92,361			+4040.77	595,596.85	2,516,156.20
				+ 156.20			
			0.02378030				
		6568.389				595,755.23	2,522,715.32
			0.99971721			-2.34	+7.93
84	268 38 14.5	98,930			+6566.53	595,752.89	2,522,723.25
				-2617.76			
			0.89420394				
		2927.480				593,137.47	2,524,025.84
			0.44765981			-2.41	+8.17
83	333 24 22.9	101,857			+1310.52	593,135.06	2,524,034.01

FIGURE 43.—Computation of coordinates—Continued.

10691°—35——12

COMPUTATION OF COORDINATES

Traverse line Genoa to 81
State Nebraska (south) County Nance and Polk Initial Station Genoa
Year 1934 Month January - March Closing Station 81

Station	Azimuth Plane ° ' "	Grid Distance Feet	Log Lat. / Log cos Az / Log dist. / Log sin Az / Log Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
83				-5096.46		593,137.47	2,524,025.84
			0.58963383			593,135.06	2,524,034.01
		8643.437				588,041.01	2,531,006.89
			0.80767070			-2.61	+8.86
83A	306 07 51.7	110,501			+6981.05	588,038.40	2,531,015.75
				-1872.91			
			0.62679875				
		2988.061				586,168.10	2,533,335.13
			0.77918119			-2.68	+9.10
81	308 48 51.6	113,489			+2328.24	586,165.42	2,533,344.23
						586,165.42	2,533,344.23
					Discrepancy	+2.68	-9.10
					x Factor =	$+8.01840 \times 10^{-5}$	
					y Factor =	-2.36146×10^{-5}	

FIGURE 43.—Computation of coordinates—Continued.

Department of Commerce
U.S. Coast and Geodetic Survey
Form No. 760

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Genoa	2,458,788.74	271 58 46.4	Azimuth mark,	98	2,486,869.97		
	647,072.39		reference mark No.1		643,736.27		
101 E	2,460,589.71			97	2,489,821.96		
	646,426.00				638,089.64		
101 D	2,461,121.85			96	2,489,847.56		
	644,724.07				634,642.43		
101 C	2,462,238.82			95	2,490,127.01		
	643,421.93				627,675.78		
101 B	2,463,692.41			94	2,492,345.31		
	642,032.76				624,251.89		
101 A	2,464,727.21			93	2,495,650.73		
	641,170.37				617,500.33		
101	2,467,212.69			92	2,498,433.30		
	639,834.66				614,309.30		
100	2,469,355.38			91	2,498,603.77		
	640,795.77				612,304.54		
99	2,475,071.35			90	2,503,908.03		
	643,614.88				606,907.76		
98 A	2,481,744.65			89	2,504,805.99		
	642,584.99				605,398.41		

U. S. GOVERNMENT PRINTING OFFICE: 1934

FIGURE 44.—List of adjusted coordinates.

DEPARTMENT OF COMMERCE
U.S. COAST AND GEODETIC SURVEY
Form No. 709

PLANE COORDINATES

Datum North American 1927 Projection Lambert South State Nebraska

Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark
89 A	2,505,213.63						
	603,756.03						
87	2,506,892.84						
	600,053.10						
86	2,512,115.04						
	598,121.89						
85	2,516,156.20						
	595,596.85						
84	2,522,723.25						
	595,752.89						
83	2,524,034.01						
	593,135.06						
83 A	2,531,015.75						
	588,038.40						
81 C	2,533,197.24						
	588,030.81						
81	2,533,344.23	175 29 40.2	81 C				
	586,165.42						

FIGURE 44.—List of adjusted coordinates—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table I.

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
41° 20'	23,368,977.46	0	101.22417	+502.3	1.0001157
21	23,362,904.01	6,073.45	101.22383	+480.6	1.0001107
22	23,356,830.58	12,146.88	101.22383	+459.4	1.0001058
23	23,350,757.15	18,220.31	101.22350	+438.5	1.0001010
24	23,344,683.74	24,293.72	101.22333	+417.9	1.0000962
25	23,338,610.34	30,367.12	101.22317	+397.8	1.0000916
41° 26'	23,332,536.95	36,440.51	101.22300	+377.9	1.0000870
27	23,326,463.57	42,513.89	101.22283	+358.5	1.0000825
28	23,320,390.20	48,587.26	101.22267	+339.4	1.0000781
29	23,314,316.84	54,660.62	101.22267	+320.7	1.0000738
30	23,308,243.48	60,733.98	101.22250	+302.3	1.0000696
41° 31'	23,302,170.13	66,807.33	101.22233	+284.3	1.0000655
32	23,296,096.79	72,880.67	101.22217	+266.6	1.0000614
33	23,290,023.46	78,954.00	101.22217	+249.3	1.0000574
34	23,283,950.13	85,027.33	101.22200	+232.4	1.0000535
35	23,277,876.81	91,100.65	101.22183	+215.8	1.0000497
41° 36'	23,271,803.50	97,173.96	101.22200	+199.6	1.0000460
37	23,265,730.18	103,247.28	101.22167	+183.8	1.0000423
38	23,259,656.88	109,320.58	101.22183	+168.3	1.0000388
39	23,253,583.57	115,393.89	101.22167	+153.2	1.0000353
40	23,247,510.27	121,467.19	101.22167	+138.4	1.0000319
41° 41'	23,241,436.97	127,540.49	101.22167	+124.0	1.0000286
42	23,235,363.67	133,613.79	101.22150	+110.0	1.0000253
43	23,229,290.38	139,687.08	101.22167	+ 96.3	1.0000222
44	23,223,217.08	145,760.38	101.22150	+ 83.0	1.0000191
45	23,217,143.79	151,833.67	101.22167	+ 70.0	1.0000161
41° 46'	23,211,070.49	157,906.97	101.22150	+ 57.4	1.0000132
47	23,204,997.20	163,980.26	101.22167	+ 45.2	1.0000104
48	23,198,923.90	170,053.56	101.22167	+ 33.4	1.0000077
49	23,192,850.60	176,126.86	101.22167	+ 21.9	1.0000050
50	23,186,777.30	182,200.16	101.22167	+ 10.8	1.0000025
41° 51'	23,180,704.00	188,273.46	101.22167	0.0	1.0000000
52	23,174,630.70	194,346.76	101.22183	- 10.4	0.9999976
53	23,168,557.39	200,420.07	101.22183	- 20.4	0.9999953
54	23,162,484.08	206,493.38	101.22200	- 30.1	0.9999931
55	23,156,410.76	212,566.70	101.22200	- 39.4	0.9999909

FIGURE 45.—Lambert projection table for Nebraska.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
41° 56'	23,150,337.44	218,640.02	101.22217	- 48.3	0.9999889
57	23,144,264.11	224,713.35	101.22233	- 56.9	0.9999869
58	23,138,190.77	230,786.69	101.22233	- 65.1	0.9999850
59	23,132,117.43	236,860.03	101.22250	- 73.0	0.9999832
42° 00	23,126,044.08	242,933.38	101.22250	- 80.5	0.9999815
42° 01'	23,119,970.73	249,006.73	101.22283	- 87.6	0.9999798
02	23,113,897.36	255,080.10	101.22283	- 94.4	0.9999783
03	23,107,823.99	261,153.47	101.22300	-100.8	0.9999768
04	23,101,750.61	267,226.85	101.22317	-106.9	0.9999754
05	23,095,677.22	273,300.24	101.22350	-112.6	0.9999741
42° 06'	23,089,603.81	279,373.65	101.22350	-117.9	0.9999729
07	23,083,530.40	285,447.06	101.22367	-122.8	0.9999717
08	23,077,456.98	291,520.48	101.22400	-127.4	0.9999707
09	23,071,383.54	297,593.92	101.22417	-131.7	0.9999697
10	23,065,310.09	303,667.37	101.22433	-135.5	0.9999688
42° 11'	23,059,236.63	309,740.83	101.22450	-139.0	0.9999680
12	23,053,163.16	315,814.30	101.22483	-142.1	0.9999673
13	23,047,089.67	321,887.79	101.22500	-144.9	0.9999666
14	23,041,016.17	327,961.29	101.22533	-147.3	0.9999660
15	23,034,942.65	334,034.81	101.22550	-149.3	0.9999656
42° 16'	23,028,869.12	340,108.34	101.22583	-151.0	0.9999652
17	23,022,795.57	346,181.89	101.22600	-152.3	0.9999649
18	23,016,722.01	352,255.45	101.22633	-153.2	0.9999647
19	23,010,648.43	358,329.03	101.22667	-153.8	0.9999646
20	23,004,574.83	364,402.63	101.22700	-154.0	0.9999645
42° 21'	22,998,501.21	370,476.25	101.22717	-153.8	0.9999646
22	22,992,427.58	376,549.88	101.22767	-153.3	0.9999647
23	22,986,353.92	382,623.54	101.22783	-152.4	0.9999649
24	22,980,280.25	388,697.21	101.22817	-151.1	0.9999652
25	22,974,206.56	394,770.90	101.22867	-149.5	0.9999656
42° 26'	22,968,132.84	400,844.62	101.22883	-147.5	0.9999660
27	22,962,059.11	406,918.35	101.22933	-145.1	0.9999666
28	22,955,985.35	412,992.11	101.22950	-142.4	0.9999672
29	22,949,911.58	419,065.88	101.23000	-139.3	0.9999679
30	22,943,837.78	425,139.68	101.23050	-135.8	0.9999687

FIGURE 45.—Lambert projection table for Nebraska.—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
42° 31'	22,937,763.95	431,213.51	101.23083	-132.0	0.9999696
32	22,931,690.10	437,287.36	101.23117	-127.8	0.9999706
33	22,925,616.23	443,361.23	101.23150	-123.2	0.9999716
34	22,919,542.34	449,435.12	101.23200	-118.3	0.9999728
35	22,913,468.42	455,509.04	101.23250	-113.0	0.9999740
42° 36'	22,907,394.47	461,582.99	101.23283	-107.3	0.9999753
37	22,901,320.50	467,656.96	101.23333	-101.3	0.9999767
38	22,895,246.50	473,730.96	101.23383	- 94.9	0.9999782
39	22,889,172.47	479,804.99	101.23417	- 88.1	0.9999797
40	22,883,098.42	485,879.04	101.23467	- 81.0	0.9999814
42° 41'	22,877,024.34	491,953.12	101.23533	- 73.5	0.9999831
42	22,870,950.22	498,027.24	101.23567	- 65.6	0.9999849
43	22,864,876.08	504,101.38	101.23617	- 57.3	0.9999868
44	22,858,801.91	510,175.55	101.23667	- 48.7	0.9999888
45	22,852,727.71	516,249.75	101.23717	- 39.7	0.9999908
42° 46'	22,846,653.48	522,323.98	101.23767	- 30.3	0.9999930
47	22,840,579.22	528,398.24	101.23817	- 20.6	0.9999953
48	22,834,504.93	534,472.53	101.23883	- 10.5	0.9999976
49	22,828,430.60	540,546.86	101.23933	0.0	1.0000000
50	22,822,356.24	546,621.22	101.23983	+ 10.8	1.0000025
42° 51'	22,816,281.85	552,695.61	101.24050	+ 22.0	1.0000051
52	22,810,207.42	558,770.04	101.24100	+ 33.6	1.0000077
53	22,804,132.96	564,844.50	101.24167	+ 45.5	1.0000105
54	22,798,058.46	570,919.00	101.24217	+ 57.8	1.0000133
55	22,791,983.93	576,993.53	101.24267	+ 70.5	1.0000162
42° 56'	22,785,909.37	583,068.09	101.24350	+ 83.6	1.0000192
57	22,779,834.76	589,142.70	101.24400	+ 97.0	1.0000223
58	22,773,760.12	595,217.34	101.24450	+110.8	1.0000255
59	22,767,685.45	601,292.01	101.24533	+124.9	1.0000288
43° 00	22,761,610.73	607,366.73	101.24583	+139.4	1.0000321
43° 01'	22,755,535.98	613,441.48	101.24667	+154.3	1.0000355
02	22,749,461.18	619,516.28	101.24717	+169.6	1.0000391
03	22,743,386.35	625,591.11	101.24800	+185.2	1.0000426
04	22,737,311.47	631,665.99	101.24850	+201.2	1.0000463
05	22,731,236.56	637,740.90	101.24917	+217.6	1.0000501

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
43° 06'	22,725,161.61	643,815.85	101.25000	+234.4	1.0000540
07	22,719,086.61	649,890.85	101.25067	+251.5	1.0000579
08	22,713,011.57	655,965.89	101.25133	+269.0	1.0000619
09	22,706,936.49	662,040.97	101.25200	+286.9	1.0000661
10	22,700,861.37	668,116.09	101.25283	+305.1	1.0000703
43° 11'	22,694,786.20	674,191.26	101.25350	+323.7	1.0000745
12	22,688,710.99	680,266.47	101.25433	+342.7	1.0000789
13	22,682,635.73	686,341.73	101.25500	+362.0	1.0000834
14	22,676,560.43	692,417.03	101.25583	+381.7	1.0000880
15	22,670,485.08	698,492.38	101.25650	+401.8	1.0000925
43° 16'	22,664,409.69	704,567.77	101.25733	+422.3	1.0000972
17	22,658,334.25	710,643.21	101.25817	+443.1	1.0001020
18	22,652,258.76	716,718.70	101.25900	+464.3	1.0001069
19	22,646,183.22	722,794.24	101.25967	+485.9	1.0001119
20	22,640,107.64	728,869.82		+507.8	1.0001169

$\ell = 0.6734507906$

$\log \ell = 9.8283058671 - 10$

$\log k = 7.5994373150$

$y_0 = 364,631.17$ *feet*

$\log \dfrac{1}{2\rho_0^2 \sin 1''} = 0.3723088 - 10$

$$\text{Geod. Az.} - \text{Grid. Az.} = +\theta - \frac{x_2 - x_1}{2\rho_0^2 \sin 1''}\left(y_1 - y_0 + \frac{y_2 - y_1}{3}\right)$$

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table II.

1" of long. = 0".67345079 of θ

Long.	θ.	Long.	θ	Long.	θ
95° 40'	+2° 55' 05".8323				
41	+2 54 25.4253	96° 16'	+2° 30' 51".1786	96° 51'	+2° 07' 16".9320
42	+2 53 45.0182	17	+2 30 10.7716	52	+2 06 36.5249
43	+2 53 04.6112	18	+2 29 30.3645	53	+2 05 56.1179
44	+2 52 24.2041	19	+2 28 49.9575	54	+2 05 15.7108
45	+2 51 43.7971	20	+2 28 09.5504	55	+2 04 35.3038
95° 46'	+2 51 03.3900	96° 21'	+2 27 29.1434	96° 56'	+2 03 54.8967
47	+2 50 22.9830	22	+2 26 48.7363	57	+2 03 14.4897
48	+2 49 42.5759	23	+2 26 08.3293	58	+2 02 34.0826
49	+2 49 02.1689	24	+2 25 27.9222	59	+2 01 53.6756
50	+2 48 21.7618	25	+2 24 47.5152	97° 00	+2 01 13.2685
95° 51'	+2 47 41.3548	96° 26'	+2 24 07.1081	97° 01'	+2 00 32.8615
52	+2 47 00.9477	27	+2 23 26.7011	02	+1 59 52.4545
53	+2 46 20.5407	28	+2 22 46.2941	03	+1 59 12.0474
54	+2 45 40.1337	29	+2 22 05.8870	04	+1 58 31.6404
55	+2 44 59.7266	30	+2 21 25.4800	05	+1 57 51.2333
95° 56'	+2 44 19.3196	96° 31'	+2 20 45.0729	97° 06'	+1 57 10.8263
57	+2 43 38.9125	32	+2 20 04.6659	07	+1 56 30.4192
58	+2 42 58.5055	33	+2 19 24.2588	08	+1 55 50.0122
59	+2 42 18.0984	34	+2 18 43.8518	09	+1 55 09.6051
96° 00	+2 41 37.6914	35	+2 18 03.4447	10	+1 54 29.1981
96° 01'	+2 40 57.2843	96° 36'	+2 17 23.0377	97° 11'	+1 53 48.7910
02	+2 40 16.8773	37	+2 16 42.6306	12	+1 53 08.3840
03	+2 39 36.4702	38	+2 16 02.2236	13	+1 52 27.9769
04	+2 38 56.0632	39	+2 15 21.8165	14	+1 51 47.5699
05	+2 38 15.6561	40	+2 14 41.4095	15	+1 51 07.1628
96° 06'	+2 37 35.2491	96° 41'	+2 14 01.0024	97° 16'	+1 50 26.7558
07	+2 36 54.8420	42	+2 13 20.5954	17	+1 49 46.3487
08	+2 36 14.4350	43	+2 12 40.1883	18	+1 49 05.9417
09	+2 35 34.0279	44	+2 11 59.7813	19	+1 48 25.5346
10	+2 34 53.6209	45	+2 11 19.3743	20	+1 47 45.1276
96° 11'	+2 34 13.2139	96° 46'	+2 10 38.9672	97° 21'	+1 47 04.7206
12	+2 33 32.8068	47	+2 09 58.5602	22	+1 46 24.3135
13	+2 32 52.3998	48	+2 09 18.1531	23	+1 45 43.9065
14	+2 32 11.9927	49	+2 08 37.7461	24	+1 45 03.4994
15	+2 31 31.5857	50	+2 07 57.3390	25	+1 44 23.0924

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table II (Cont'd).

1" of long. = 0".67345079 of θ

Long.	θ	Long.	θ	Long.	θ
97° 26'	+1° 43' 42".6853	98° 01'	+1° 20' 08".4386	98° 36'	+0° 56' 34".1920
27	+1 43 02.2783	02	+1 19 28.0316	37	+0 55 53.7849
28	+1 42 21.8712	03	+1 18 47.6245	38	+0 55 13.3779
29	+1 41 41.4642	04	+1 18 07.2175	39	+0 54 32.9708
30	+1 41 01.0571	05	+1 17 26.8105	40	+0 53 52.5638
97° 31'	+1 40 20.6501	98° 06'	+1 16 46.4034	98° 41'	+0 53 12.1567
32	+1 39 40.2430	07	+1 16 05.9964	42	+0 52 31.7497
33	+1 38 59.8360	08	+1 15 25.5893	43	+0 51 51.3426
34	+1 38 19.4289	09	+1 14 45.1823	44	+0 51 10.9356
35	+1 37 39.0219	10	+1 14 04.7752	45	+0 50 30.5286
97° 36'	+1 36 58.6148	98° 11'	+1 13 24.3682	98° 46'	+0 49 50.1215
37	+1 36 18.2078	12	+1 12 43.9611	47	+0 49 09.7145
38	+1 35 37.8007	13	+1 12 03.5541	48	+0 48 29.3074
39	+1 34 57.3937	14	+1 11 23.1470	49	+0 47 48.9004
40	+1 34 16.9867	15	+1 10 42.7400	50	+0 47 08.4933
97° 41'	+1 33 36.5796	98° 16'	+1 10 02.3329	98° 51'	+0 46 28.0863
42	+1 32 56.1726	17	+1 09 21.9259	52	+0 45 47.6792
43	+1 32 15.7655	18	+1 08 41.5188	53	+0 45 07.2722
44	+1 31 35.3585	19	+1 08 01.1118	54	+0 44 26.8651
45	+1 30 54.9514	20	+1 07 20.7047	55	+0 43 46.4581
97° 46'	+1 30 14.5444	98° 21'	+1 06 40.2977	98° 56'	+0 43 06.0510
47	+1 29 34.1373	22	+1 05 59.8906	57	+0 42 25.6440
48	+1 28 53.7303	23	+1 05 19.4836	58	+0 41 45.2369
49	+1 28 13.3232	24	+1 04 39.0766	59	+0 41 04.8299
50	+1 27 32.9162	25	+1 03 58.6695	99° 00	+0 40 24.4228
97° 51'	+1 26 52.5091	98° 26'	+1 03 18.2625	99° 01'	+0 39 44.0158
52	+1 26 12.1021	27	+1 02 37.8554	02	+0 39 03.6087
53	+1 25 31.6950	28	+1 01 57.4484	03	+0 38 23.2017
54	+1 24 51.2880	29	+1 01 17.0413	04	+0 37 42.7947
55	+1 24 10.8809	30	+1 00 36.6343	05	+0 37 02.3876
97° 56'	+1 23 30.4739	98° 31'	+0 59 56.2272	99° 06'	+0 36 21.9806
57	+1 22 50.0668	32	+0 59 15.8202	07	+0 35 41.5735
58	+1 22 09.6598	33	+0 58 35.4131	08	+0 35 01.1665
59	+1 21 29.2527	34	+0 57 55.0061	09	+0 34 20.7594
98° 00	+1 20 48.8457	35	+0 57 14.5990	10	+0 33 40.3524

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table II (Cont'd).

1" of long. = 0".67345079 of θ

Long.	θ	Long.	θ	Long.	θ
99° 11'	+0° 32' 59".9453	99° 46'	+0° 09' 25".6987	100° 21'	-0° 14' 08".5480
12	+0 32 19.5383	47	+0 08 45.2916	22	-0 14 48.9550
13	+0 31 39.1312	48	+0 08 04.8846	23	-0 15 29.3621
14	+0 30 58.7242	49	+0 07 24.4775	24	-0 16 09.7691
15	+0 30 18.3171	50	+0 06 44.0705	25	-0 16 50.1762
99° 16'	+0 29 37.9101	99° 51'	+0 06 03.6634	100° 26'	-0 17 30.5832
17	+0 28 57.5030	52	+0 05 23.2564	27	-0 18 10.9903
18	+0 28 17.0960	53	+0 04 42.8493	28	-0 18 51.3973
19	+0 27 36.6889	54	+0 04 02.4423	29	-0 19 31.8044
20	+0 26 56.2819	55	+0 03 22.0352	30	-0 20 12.2114
99° 21'	+0 26 15.8748	99° 56'	+0 02 41.6282	100° 31'	-0 20 52.6185
22	+0 25 35.4678	57	+0 02 01.2211	32	-0 21 33.0255
23	+0 24 55.0608	58	+0 01 20.8141	33	-0 22 13.4326
24	+0 24 14.6537	59	+0 00 40.4070	34	-0 22 53.8396
25	+0 23 34.2467	100° 00	0 00 00.0000	35	-0 23 34.2467
99° 26'	+0 22 53.8396	100° 01'	-0 00 40.4070	100° 36'	-0 24 14.6537
27	+0 22 13.4326	02	-0 01 20.8141	37	-0 24 55.0608
28	+0 21 33.0255	03	-0 02 01.2211	38	-0 25 35.4678
29	+0 20 52.6185	04	-0 02 41.6282	39	-0 26 15.8748
30	+0 20 12.2114	05	-0 03 22.0352	40	-0 26 56.2819
99° 31'	+0 19 31.8044	100° 06'	-0 04 02.4423	100° 41'	-0 27 36.6889
32	+0 18 51.3973	07	-0 04 42.8493	42	-0 28 17.0960
33	+0 18 10.9903	08	-0 05 23.2564	43	-0 28 57.5030
34	+0 17 30.5832	09	-0 06 03.6634	44	-0 29 37.9101
35	+0 16 50.1762	10	-0 06 44.0705	45	-0 30 18.3171
99° 36'	+0 16 09.7691	100° 11'	-0 07 24.4775	100° 46'	-0 30 58.7242
37	+0 15 29.3621	12	-0 08 04.8846	47	-0 31 39.1312
38	+0 14 48.9550	13	-0 08 45.2916	48	-0 32 19.5383
39	+0 14 08.5480	14	-0 09 25.6987	49	-0 32 59.9453
40	+0 13 28.1409	15	-0 10 06.1057	50	-0 33 40.3524
99° 41'	+0 12 47.7339	100° 16'	-0 10 46.5128	100° 51'	-0 34 20.7594
42	+0 12 07.3269	17	-0 11 26.9198	52	-0 35 01.1665
43	+0 11 26.9198	18	-0 12 07.3269	53	-0 35 41.5735
44	+0 10 46.5128	19	-0 12 47.7339	54	-0 36 21.9806
45	+0 10 06.1057	20	-0 13 28.1409	55	-0 37 02.3876

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table II (Cont'd).

1" of long. = 0".67345079 of θ

Long.	θ	Long.	θ	Long.	θ
100° 56'	-0° 37' 42".7947	101° 31'	-1° 01' 17".0413	102° 06'	-1° 24' 51".2880
57	-0 38 23.2017	32	-1 01 57.4484	07	-1 25 31.6950
58	-0 39 03.6087	33	-1 02 37.8554	08	-1 26 12.1021
59	-0 39 44.0158	34	-1 03 18.2625	09	-1 26 52.5091
101° 00	-0 40 24.4228	35	-1 03 58.6695	10	-1 27 32.9162
101° 01'	-0 41 04.8299	101° 36'	-1 04 39.0766	102° 11'	-1 28 13.3232
02	-0 41 45.2369	37	-1 05 19.4836	12	-1 28 53.7303
03	-0 42 25.6440	38	-1 05 59.8906	13	-1 29 34.1373
04	-0 43 06.0510	39	-1 06 40.2977	14	-1 30 14.5444
05	-0 43 46.4581	40	-1 07 20.7047	15	-1 30 54.9514
101° 06'	-0 44 26.8651	101° 41'	-1 08 01.1118	102° 16'	-1 31 35.3585
07	-0 45 07.2722	42	-1 08 41.5188	17	-1 32 15.7655
08	-0 45 47.6792	43	-1 09 21.9259	18	-1 32 56.1726
09	-0 46 28.0863	44	-1 10 02.3329	19	-1 33 36.5796
10	-0 47 08.4933	45	-1 10 42.7400	20	-1 34 16.9867
101° 11'	-0 47 48.9004	101° 46'	-1 11 23.1470	102° 21'	-1 34 57.3937
12	-0 48 29.3074	47	-1 12 03.5541	22	-1 35 37.8007
13	-0 49 09.7145	48	-1 12 43.9611	23	-1 36 18.2078
14	-0 49 50.1215	49	-1 13 24.3682	24	-1 36 58.6148
15	-0 50 30.5286	50	-1 14 04.7752	25	-1 37 39.0219
101° 16'	-0 51 10.9356	101° 51'	-1 14 45.1823	102° 26'	-1 38 19.4289
17	-0 51 51.3426	52	-1 15 25.5893	27	-1 38 59.8360
18	-0 52 31.7497	53	-1 16 05.9964	28	-1 39 40.2430
19	-0 53 12.1567	54	-1 16 46.4034	29	-1 40 20.6501
20	-0 53 52.5638	55	-1 17 26.8105	30	-1 41 01.0571
101° 21'	-0 54 32.9708	101° 56'	-1 18 07.2175	102° 31'	-1 41 41.4642
22	-0 55 13.3779	57	-1 18 47.6245	32	-1 42 21.8712
23	-0 55 53.7849	58	-1 19 28.0316	33	-1 43 02.2783
24	-0 56 34.1920	59	-1 20 08.4386	34	-1 43 42.6853
25	-0 57 14.5990	102° 00	-1 20 48.8457	35	-1 44 23.0924
101° 26'	-0 57 55.0061	102° 01'	-1 21 29.2527	102° 36'	-1 45 03.4994
27	-0 58 35.4131	02	-1 22 09.6598	37	-1 45 43.9065
28	-0 59 15.8202	03	-1 22 50.0668	38	-1 46 24.3135
29	-0 59 56.2272	04	-1 23 30.4739	39	-1 47 04.7206
30	-1 00 36.6343	05	-1 24 10.8809	40	-1 47 45.1276

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (NORTH)

Table II (Cont'd).

1" of long. = 0".67345079 of θ

Long.	θ	Long.	θ	Long.	θ
102° 41'	-1° 48' 25".5346	103° 16'	-2° 11' 59".7813	103° 51'	-2° 35' 34".0279
42	-1 49 05.9417	17	-2 12 40.1883	52	-2 36 14.4350
43	-1 49 46.3487	18	-2 13 20.5954	53	-2 36 54.8420
44	-1 50 26.7558	19	-2 14 01.0024	54	-2 37 35.2491
45	-1 51 07.1628	20	-2 14 41.4095	55	-2 38 15.6561
102° 46'	-1 51 47.5699	103° 21'	-2 15 21.8165	103° 56'	-2 38 56.0632
47	-1 52 27.9769	22	-2 16 02.2236	57	-2 39 36.4702
48	-1 53 08.3840	23	-2 16 42.6306	58	-2 40 16.8773
49	-1 53 48.7910	24	-2 17 23.0377	59	-2 40 57.2843
50	-1 54 29.1981	25	-2 18 03.4447	104° 60	-2 41 37.6914
102° 51'	-1 55 09.6051	103° 26'	-2 18 43.8518	104° 01'	-2 42 18.0984
52	-1 55 50.0122	27	-2 19 24.2588	02	-2 42 58.5055
53	-1 56 30.4192	28	-2 20 04.6659	03	-2 43 38.9125
54	-1 57 10.8263	29	-2 20 45.0729	04	-2 44 19.3196
55	-1 57 51.2333	30	-2 21 25.4800	05	-2 44 59.7266
102° 56'	-1 58 31.6404	103° 31'	-2 22 05.8870	104° 06'	-2 45 40.1337
57	-1 59 12.0474	32	-2 22 46.2941	07	-2 46 20.5407
58	-1 59 52.4545	33	-2 23 26.7011	08	-2 47 00.9477
59	-2 00 32.8615	34	-2 24 07.1081	09	-2 47 41.3548
103° 00	-2 01 13.2685	35	-2 24 47.5152	10	-2 48 21.7618
103° 01'	-2 01 53.6756	103° 36'	-2 25 27.9222	104° 11'	-2 49 02.1689
02	-2 02 34.0826	37	-2 26 08.3293	12	-2 49 42.5759
03	-2 03 14.4897	38	-2 26 48.7363	13	-2 50 22.9830
04	-2 03 54.8967	39	-2 27 29.1434	14	-2 51 03.3900
05	-2 04 35.3038	40	-2 28 09.5504	15	-2 51 43.7971
103° 06'	-2 05 15.7108	103° 41'	-2 28 49.9575	104° 16'	-2 52 24.2041
07	-2 05 56.1179	42	-2 29 30.3645	17	-2 53 04.6112
08	-2 06 36.5249	43	-2 30 10.7716	18	-2 53 45.0182
09	-2 07 16.9320	44	-2 30 51.1786	19	-2 54 25.4253
10	-2 07 57.3390	45	-2 31 31.5857	20	-2 55 05.8323
103° 11'	-2 08 37.7461	103° 46'	-2 32 11.9927		
12	-2 09 18.1531	47	-2 32 52.3998		
13	-2 09 58.5602	48	-2 33 32.8068		
14	-2 10 38.9672	49	-2 34 13.2139		
15	-2 11 19.3743	50	-2 34 53.6209		

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table I.

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
39° 40'	24,590,781.86	0	101.20200	+827.1	1.0001904
41	24,584,709.74	6,072.12	101.20150	+798.3	1.0001838
42	24,578,637.65	12,144.21	101.20133	+769.8	1.0001773
43	24,572,565.57	18,216.29	101.20083	+741.7	1.0001708
44	24,566,493.52	24,288.34	101.20050	+713.9	1.0001644
45	24,560,421.49	30,360.37	101.20017	+686.5	1.0001581
39° 46'	24,554,349.48	36,432.38	101.20000	+659.5	1.0001519
47	24,548,277.48	42,504.38	101.19950	+632.8	1.0001457
48	24,542,205.51	48,576.35	101.19917	+606.5	1.0001397
49	24,536,133.56	54,648.30	101.19900	+580.6	1.0001337
50	24,530,061.62	60,720.24	101.19867	+555.0	1.0001278
39° 51'	24,523,989.70	66,792.16	101.19833	+529.7	1.0001220
52	24,517,917.80	72,864.06	101.19800	+504.8	1.0001162
53	24,511,845.92	78,935.94	101.19783	+480.3	1.0001106
54	24,505,774.05	85,007.81	101.19750	+456.2	1.0001050
55	24,499,702.20	91,079.66	101.19717	+432.4	1.0000996
39° 56'	24,493,630.37	97,151.49	101.19717	+408.9	1.0000942
57	24,487,558.54	103,223.32	101.19667	+385.8	1.0000888
58	24,481,486.74	109,295.12	101.19667	+363.1	1.0000836
59	24,475,414.94	115,366.92	101.19633	+340.8	1.0000785
40° 00	24,469,343.16	121,438.70	101.19600	+318.8	1.0000734
40° 01'	24,463,271.40	127,510.46	101.19600	+297.1	1.0000684
02	24,457,199.64	133,582.22	101.19567	+275.8	1.0000635
03	24,451,127.90	139,653.96	101.19550	+254.9	1.0000587
04	24,445,056.17	145,725.69	101.19533	+234.4	1.0000540
05	24,438,984.45	151,797.41	101.19517	+214.2	1.0000493
40° 06'	24,432,912.74	157,869.12	101.19500	+194.3	1.0000447
07	24,426,841.04	163,940.82	101.19483	+174.8	1.0000402
08	24,420,769.35	170,012.51	101.19483	+155.7	1.0000359
09	24,414,697.66	176,084.20	101.19450	+137.0	1.0000315
10	24,408,625.99	182,155.87	101.19450	+118.6	1.0000273
40° 11'	24,402,554.32	188,227.54	101.19433	+100.6	1.0000232
12	24,396,482.66	194,299.20	101.19417	+ 82.9	1.0000191
13	24,390,411.01	200,370.85	101.19417	+ 65.6	1.0000151
14	24,384,339.36	206,442.50	101.19400	+ 48.6	1.0000112
15	24,378,267.72	212,514.14	101.19400	+ 32.0	1.0000074

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
40° 16'	24,372,196.08	218,585.78	101.19383	+ 15.8	1.0000036
17	24,366,124.45	224,657.41	101.19367	0.0	1.0000000
18	24,360,052.83	230,729.03	101.19383	- 15.5	0.9999964
19	24,353,981.20	236,800.66	101.19367	- 30.7	0.9999929
20	24,347,909.58	242,872.28	101.19350	- 45.5	0.9999895
40° 21'	24,341,837.97	248,943.89	101.19367	- 59.9	0.9999862
22	24,335,766.35	255,015.51	101.19350	- 73.9	0.9999830
23	24,329,694.74	261,087.12	101.19367	- 87.6	0.9999798
24	24,323,623.12	267,158.74	101.19350	-100.9	0.9999768
25	24,317,551.51	273,230.35	101.19350	-113.9	0.9999738
40° 26'	24,311,479.90	279,301.96	101.19350	-126.5	0.9999709
27	24,305,408.29	285,373.57	101.19350	-138.7	0.9999681
28	24,299,336.68	291,445.18	101.19367	-150.6	0.9999653
29	24,293,265.06	297,516.80	101.19367	-162.1	0.9999627
30	24,287,193.44	303,588.42	101.19350	-173.3	0.9999601
40° 31'	24,281,121.83	309,660.03	101.19383	-184.1	0.9999576
32	24,275,050.20	315,731.66	101.19367	-194.5	0.9999552
33	24,268,978.58	321,803.28	101.19383	-204.5	0.9999529
34	24,262,906.95	327,874.91	101.19383	-214.2	0.9999507
35	24,256,835.32	333,946.54	101.19400	-223.6	0.9999485
40° 36'	24,250,763.68	340,018.18	101.19417	-232.5	0.9999465
37	24,244,692.03	346,089.83	101.19417	-241.1	0.9999445
38	24,238,620.38	352,161.48	101.19417	-249.4	0.9999426
39	24,232,548.73	358,233.13	101.19450	-257.3	0.9999409
40	24,226,477.06	364,304.80	101.19450	-264.8	0.9999390
40° 41'	24,220,405.39	370,376.47	101.19467	-271.9	0.9999374
42	24,214,333.71	376,448.15	101.19467	-278.7	0.9999358
43	24,208,262.03	382,519.83	101.19500	-285.1	0.9999344
44	24,202,190.33	388,591.53	101.19517	-291.2	0.9999329
45	24,196,118.62	394,663.24	101.19517	-296.9	0.9999316
40° 46'	24,190,046.91	400,734.95	101.19550	-302.2	0.9999304
47	24,183,975.18	406,806.68	101.19567	-307.2	0.9999293
48	24,177,903.44	412,878.42	101.19583	-311.8	0.9999282
49	24,171,831.69	418,950.17	101.19600	-316.0	0.9999272
50	24,165,759.93	425,021.93	101.19633	-319.9	0.9999263

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
40° 51'	24,159,688.15	431,093.71	101.19633	-323.4	0.9999255
52	24,153,616.37	437,165.49	101.19667	-326.5	0.9999248
53	24,147,544.57	443,237.29	101.19700	-329.3	0.9999242
54	24,141,472.75	449,309.11	101.19717	-331.7	0.9999236
55	24,135,400.92	455,380.94	101.19750	-333.7	0.9999232
40° 56'	24,129,329.07	461,452.79	101.19767	-335.4	0.9999228
57	24,123,257.21	467,524.65	101.19783	-336.7	0.9999225
58	24,117,185.34	473,596.52	101.19833	-337.6	0.9999222
59	24,111,113.44	479,668.42	101.19850	-338.2	0.9999221
41° 00	24,105,041.53	485,740.33	101.19883	-338.4	0.9999221
41° 01'	24,098,969.60	491,812.26	101.19917	-338.3	0.9999221
02	24,092,897.65	497,884.21	101.19933	-337.8	0.9999222
03	24,086,825.69	503,956.17	101.19983	-336.9	0.9999224
04	24,080,753.70	510,028.16	101.20000	-335.6	0.9999227
05	24,074,681.70	516,100.16	101.20050	-334.0	0.9999231
41° 06'	24,068,609.67	522,172.19	101.20083	-332.0	0.9999236
07	24,062,537.62	528,244.24	101.20100	-329.7	0.9999241
08	24,056,465.56	534,316.30	101.20150	-326.9	0.9999247
09	24,050,393.47	540,388.39	101.20200	-323.9	0.9999254
10	24,044,321.35	546,460.51	101.20217	-320.4	0.9999262
41° 11'	24,038,249.22	552,532.64	101.20267	-316.6	0.9999271
12	24,032,177.06	558,604.80	101.20300	-312.4	0.9999281
13	24,026,104.88	564,676.98	101.20350	-307.9	0.9999291
14	24,020,032.67	570,749.19	101.20383	-302.9	0.9999303
15	24,013,960.44	576,821.42	101.20433	-297.6	0.9999315
41° 16'	24,007,888.18	582,893.68	101.20467	-292.0	0.9999328
17	24,001,815.90	588,965.96	101.20517	-286.0	0.9999341
18	23,995,743.59	595,038.27	101.20567	-279.6	0.9999356
19	23,989,671.25	601,110.61	101.20600	-272.8	0.9999372
20	23,983,598.89	607,182.97	101.20667	-265.7	0.9999388
41° 21'	23,977,526.49	613,255.37	101.20700	-258.2	0.9999405
22	23,971,454.07	619,327.79	101.20750	-250.3	0.9999424
23	23,965,381.62	625,400.24	101.20800	-242.1	0.9999443
24	23,959,309.14	631,472.72	101.20850	-233.5	0.9999462
25	23,953,236.63	637,545.23	101.20900	-224.5	0.9999483

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
41° 26'	23,947,164.09	643,617.77	101.20950	-215.2	0.9999504
27	23,941,091.52	649,690.34	101.21000	-205.5	0.9999527
28	23,935,018.92	655,762.94	101.21067	-195.4	0.9999550
29	23,928,946.28	661,835.58	101.21117	-185.0	0.9999574
30	23,922,873.61	667,908.25	101.21167	-174.1	0.9999599
41° 31'	23,916,800.91	673,980.95	101.21217	-163.0	0.9999625
32	23,910,728.18	680,053.68	101.21283	-151.4	0.9999651
33	23,904,655.41	686,126.45	101.21350	-139.5	0.9999679
34	23,898,582.60	692,199.26	101.21400	-127.2	0.9999707
35	23,892,509.76	698,272.10	101.21450	-114.6	0.9999736
41° 36'	23,886,436.89	704,344.97	101.21517	-101.5	0.9999766
37	23,880,363.98	710,417.88	101.21583	- 88.1	0.9999797
38	23,874,291.03	716,490.83	101.21650	- 74.4	0.9999829
39	23,868,218.04	722,563.82	101.21700	- 60.2	0.9999861
40	23,862,145.02	728,636.84	101.21767	- 45.7	0.9999895
41° 41'	23,856,071.96	734,709.90	101.21850	- 30.9	0.9999929
42	23,849,998.85	740,783.01	101.21900	- 15.6	0.9999964
43	23,843,925.71	746,856.15	101.21967	0.0	1.0000000
44	23,837,852.53	752,929.33	101.22033	+ 16.0	1.0000037
45	23,831,779.31	759,002.55	101.22100	+ 32.3	1.0000074
41° 46'	23,825,706.05	765,075.81	101.22167	+ 49.1	1.0000113
47	23,819,632.75	771,149.11	101.22250	+ 66.2	1.0000152
48	23,813,559.40	777,222.46	101.22317	+ 83.6	1.0000192
49	23,807,486.01	783,295.85	101.22383	+101.5	1.0000234
50	23,801,412.58	789,369.28	101.22450	+119.7	1.0000276
41° 51'	23,795,339.11	795,442.75	101.22533	+138.3	1.0000318
52	23,789,265.59	801,516.27	101.22617	+157.2	1.0000362
53	23,783,192.02	807,589.84	101.22683	+176.5	1.0000406
54	23,777,118.41	813,663.45	101.22750	+196.2	1.0000452
55	23,771,044.76	819,737.10	101.22833	+216.3	1.0000498
41° 56'	23,764,971.06	825,810.80	101.22917	+236.7	1.0000545
57	23,758,897.31	831,884.55	101.22983	+257.5	1.0000593
58	23,752,823.52	837,958.34	101.23083	+278.7	1.0000642
59	23,746,749.67	844,032.19	101.23150	+300.2	1.0000691
42° 00	23,740,675.78	850,106.08	101.23233	+322.2	1.0000742

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table I (Cont'd).

Lat.	R (feet)	y' y value on central meridian (feet)	Tabular difference for 1 sec. of lat. (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
42° 01'	23,734,601.84	856,180.02	101.23300	+344.5	1.0000793
02	23,728,527.86	862,254.00	101.23400	+367.1	1.0000845
03	23,722,453.82	868,328.04	101.23483	+390.2	1.0000898
04	23,716,379.73	874,402.13	101.23567	+413.6	1.0000952
05	23,710,305.59	880,476.27	101.23650	+437.3	1.0001007
42° 06'	23,704,231.40	886,550.46	101.23750	+461.5	1.0001063
07	23,698,157.15	892,624.71	101.23817	+486.0	1.0001119
08	23,692,082.86	898,699.00	101.23917	+510.9	1.0001176
09	23,686,008.51	904,773.35	101.24017	+536.2	1.0001235
10	23,679,934.10	910,847.76		+561.8	1.0001294

$\ell = 0.6560764003$

$\log \ell = 9.8169544160 - 10$

$\log k = 7.6047575985$

$y_0 = 486{,}220.80$ *feet*

$$\log \frac{1}{2\rho_0^2 \sin 1''} = 0.3724450 - 10$$

$$\text{Geod. Az.} - \text{Grid Az.} = +\theta - \frac{x_2 - x_1}{2\rho_0^2 \sin 1''}\left(y_1 - y_0 + \frac{y_2 - y_1}{3}\right)$$

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II.

1" of long. = 0".65607640 of θ

Long.	θ	Long.	θ	Long.	θ
95° 00'	+2° 57' 08".4377	95° 36'	+2° 33' 31".3127	96° 11'	+2° 10' 33".5522
01	+2 56 29.0731	37	+2 32 51.9481	12	+2 09 54.1876
02	+2 55 49.7085	38	+2 32 12.5835	13	+2 09 14.8231
03	+2 55 10.3439	39	+2 31 33.2189	14	+2 08 35.4585
04	+2 54 30.9793	40	+2 30 53.8543	15	+2 07 56.0939
05	+2 53 51.6148				
95° 06'	+2 53 12.2502	95° 41'	+2 30 14.4897	96° 16'	+2 07 16.7293
07	+2 52 32.8856	42	+2 29 35.1252	17	+2 06 37.3647
08	+2 51 53.5210	43	+2 28 55.7606	18	+2 05 58.0001
09	+2 51 14.1564	44	+2 28 16.3960	19	+2 05 18.6355
10	+2 50 34.7918	45	+2 27 37.0314	20	+2 04 39.2710
95° 11'	+2 49 55.4273	95° 46'	+2 26 57.6668	96° 21'	+2 03 59.9064
12	+2 49 16.0627	47	+2 26 18.3022	22	+2 03 20.5418
13	+2 48 36.6981	48	+2 25 38.9377	23	+2 02 41.1772
14	+2 47 57.3335	49	+2 24 59.5731	24	+2 02 01.8126
15	+2 47 17.9689	50	+2 24 20.2085	25	+2 01 22.4480
95° 16'	+2 46 38.6043	95° 51'	+2 23 40.8439	96° 26'	+2 00 43.0835
17	+2 45 59.2398	52	+2 23 01.4793	27	+2 00 03.7189
18	+2 45 19.8752	53	+2 22 22.1147	28	+1 59 24.3543
19	+2 44 40.5106	54	+2 21 42.7501	29	+1 58 44.9897
20	+2 44 01.1460	55	+2 21 03.3856	30	+1 58 05.6251
95° 21'	+2 43 21.7814	95° 56'	+2 20 24.0210	96° 31'	+1 57 26.2605
22	+2 42 42.4168	57	+2 19 44.6564	32	+1 56 46.8960
23	+2 42 03.0523	58	+2 19 05.2918	33	+1 56 07.5314
24	+2 41 23.6877	59	+2 18 25.9272	34	+1 55 28.1668
25	+2 40 44.3231	96° 00	+2 17 46.5626	35	+1 54 48.8022
95° 26'	+2 40 04.9585	96° 01'	+2 17 07.1981	96° 36'	+1 54 09.4376
27	+2 39 25.5939	02	+2 16 27.8335	37	+1 53 30.0730
28	+2 38 46.2293	03	+2 15 48.4689	38	+1 52 50.7085
29	+2 38 06.8647	04	+2 15 09.1043	39	+1 52 11.3439
30	+2 37 27.5002	05	+2 14 29.7397	40	+1 51 31.9793
95° 31'	+2 36 48.1356	96° 06'	+2 13 50.3751	96° 41'	+1 50 52.6147
32	+2 36 08.7710	07	+2 13 11.0106	42	+1 50 13.2501
33	+2 35 29.4064	08	+2 12 31.6460	43	+1 49 33.8855
34	+2 34 50.0418	09	+2 11 52.2814	44	+1 48 54.5209
35	+2 34 10.6772	10	+2 11 12.9168	45	+1 48 15.1564

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II (Cont'd).

1" of long. = 0".65607640 of θ

Long.	θ	Long.	θ	Long.	θ
96° 46'	+1° 47' 35".7918	97° 21'	+1° 24' 38".0313	97° 56'	+1° 01' 40".2709
47	+1 46 56.4272	22	+1 23 58.6668	57	+1 01 00.9063
48	+1 46 17.0626	23	+1 23 19.3022	58	+1 00 21.5417
49	+1 45 37.6980	24	+1 22 39.9376	59	+0 59 42.1771
50	+1 44 58.3334	25	+1 22 00.5730	98° 00	+0 59 02.8126
96° 51'	+1 44 18.9689	97° 26'	+1 21 21.2084	98° 01'	+0 58 23.4480
52	+1 43 39.6043	27	+1 20 41.8438	02	+0 57 44.0834
53	+1 43 00.2397	28	+1 20 02.4793	03	+0 57 04.7188
54	+1 42 20.8751	29	+1 19 23.1147	04	+0 56 25.3542
55	+1 41 41.5105	30	+1 18 43.7501	05	+0 55 45.9896
96° 56'	+1 41 02.1459	97° 31'	+1 18 04.3855	98° 06'	+0 55 06.6251
57	+1 40 22.7814	32	+1 17 25.0209	07	+0 54 27.2605
58	+1 39 43.4168	33	+1 16 45.6563	08	+0 53 47.8959
59	+1 39 04.0522	34	+1 16 06.2917	09	+0 53 08.5313
97° 00	+1 38 24.6876	35	+1 15 26.9272	10	+0 52 29.1667
97° 01'	+1 37 45.3230	97° 36'	+1 14 47.5626	98° 11'	+0 51 49.8021
02	+1 37 05.9584	37	+1 14 08.1980	12	+0 51 10.4376
03	+1 36 26.5939	38	+1 13 28.8334	13	+0 50 31.0730
04	+1 35 47.2293	39	+1 12 49.4688	14	+0 49 51.7084
05	+1 35 07.8647	40	+1 12 10.1042	15	+0 49 12.3438
97° 06'	+1 34 28.5001	97° 41'	+1 11 30.7397	98° 16'	+0 48 32.9792
07	+1 33 49.1355	42	+1 10 51.3751	17	+0 47 53.6146
08	+1 33 09.7709	43	+1 10 12.0105	18	+0 47 14.2500
09	+1 32 30.4063	44	+1 09 32.6459	19	+0 46 34.8855
10	+1 31 51.0418	45	+1 08 53.2813	20	+0 45 55.5209
97° 11'	+1 31 11.6772	97° 46'	+1 08 13.9167	98° 21'	+0 45 16.1563
12	+1 30 32.3126	47	+1 07 34.5522	22	+0 44 36.7917
13	+1 29 52.9480	48	+1 06 55.1876	23	+0 43 57.4271
14	+1 29 13.5834	49	+1 06 15.8230	24	+0 43 18.0625
15	+1 28 34.2188	50	+1 05 36.4584	25	+0 42 38.6980
97° 16'	+1 27 54.8543	97° 51'	+1 04 57.0938	98° 26'	+0 41 59.3334
17	+1 27 15.4897	52	+1 04 17.7292	27	+0 41 19.9688
18	+1 26 36.1251	53	+1 03 38.3646	28	+0 40 40.6042
19	+1 25 56.7605	54	+1 02 59.0001	29	+0 40 01.2396
20	+1 25 17.3959	55	+1 02 19.6355	30	+0 39 21.8750

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II (Cont'd).

1" of long. = 0".65607640 of θ

Long.	θ	Long.	θ	Long.	θ
98° 31'	+0° 38' 42".5105	99° 06'	+0° 15' 44".7500	99° 41'	−0° 07' 13".0104
32	+0 38 03.1459	07	+0 15 05.3854	42	−0 07 52.3750
33	+0 37 23.7813	08	+0 14 26.0208	43	−0 08 31.7396
34	+0 36 44.4167	09	+0 13 46.6563	44	−0 09 11.1042
35	+0 36 05.0521	10	+0 13 07.2917	45	−0 09 50.4688
98° 36'	+0 35 25.6875	99° 11'	+0 12 27.9271	99° 46'	−0 10 29.8333
37	+0 34 46.3230	12	+0 11 48.5625	47	−0 11 09.1979
38	+0 34 06.9584	13	+0 11 09.1979	48	−0 11 48.5625
39	+0 33 27.5938	14	+0 10 29.8333	49	−0 12 27.9271
40	+0 32 48.2292	15	+0 09 50.4688	50	−0 13 07.2917
98° 41'	+0 32 08.8646	99° 16'	+0 09 11.1042	99° 51'	−0 13 46.6563
42	+0 31 29.5000	17	+0 08 31.7396	52	−0 14 26.0208
43	+0 30 50.1354	18	+0 07 52.3750	53	−0 15 05.3854
44	+0 30 10.7709	19	+0 07 13.0104	54	−0 15 44.7500
45	+0 29 31.4063	20	+0 06 33.6458	55	−0 16 24.1146
98° 46'	+0 28 52.0417	99° 21'	+0 05 54.2813	99° 56'	−0 17 03.4792
47	+0 28 12.6771	22	+0 05 14.9167	57	−0 17 42.8438
48	+0 27 33.3125	23	+0 04 35.5521	58	−0 18 22.2084
49	+0 26 53.9479	24	+0 03 56.1875	59	−0 19 01.5729
50	+0 26 14.5834	25	+0 03 16.8229	100° 00	−0 19 40.9375
98° 51'	+0 25 35.2188	99° 26'	+0 02 37.4583	100° 01'	−0 20 20.3021
52	+0 24 55.8542	27	+0 01 58.0938	02	−0 20 59.6667
53	+0 24 16.4896	28	+0 01 18.7292	03	−0 21 39.0313
54	+0 23 37.1250	29	+0 00 39.3646	04	−0 22 18.3959
55	+0 22 57.7604	30	0 00 00.0000	05	−0 22 57.7604
98° 56'	+0 22 18.3959	99° 31'	−0 00 39.3646	100° 06'	−0 23 37.1250
57	+0 21 39.0313	32	−0 01 18.7292	07	−0 24 16.4896
58	+0 20 59.6667	33	−0 01 58.0938	08	−0 24 55.8542
59	+0 20 20.3021	34	−0 02 37.4583	09	−0 25 35.2188
99° 00	+0 19 40.9375	35	−0 03 16.8229	10	−0 26 14.5834
99° 01'	+0 19 01.5729	99° 36'	−0 03 56.1875	100° 11'	−0 26 53.9479
02	+0 18 22.2084	37	−0 04 35.5521	12	−0 27 33.3125
03	+0 17 42.8438	38	−0 05 14.9167	13	−0 28 12.6771
04	+0 17 03.4792	39	−0 05 54.2813	14	−0 28 52.0417
05	+0 16 24.1146	40	−0 06 33.6458	15	−0 29 31.4063

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II (Cont'd).

1" of long. = 0".65607640 of θ

Long.	θ	Long.	θ	Long.	θ
100° 16'	-0° 30' 10".7709	100° 51'	-0° 53' 08".5313	101° 26'	-1° 16' 06".2917
17	-0 30 50.1354	52	-0 53 47.8959	27	-1 16 45.6563
18	-0 31 29.5000	53	-0 54 27.2605	28	-1 17 25.0209
19	-0 32 08.8646	54	-0 55 06.6251	29	-1 18 04.3855
20	-0 32 48.2292	55	-0 55 45.9896	30	-1 18 43.7501
100° 21'	-0 33 27.5938	100° 56'	-0 56 25.3542	101° 31'	-1 19 23.1147
22	-0 34 06.9584	57	-0 57 04.7188	32	-1 20 02.4793
23	-0 34 46.3230	58	-0 57 44.0834	33	-1 20 41.8438
24	-0 35 25.6875	59	-0 58 23.4480	34	-1 21 21.2084
25	-0 36 05.0521	101° 00	-0 59 02.8126	35	-1 22 00.5730
100° 26'	-0 36 44.4167	101° 01'	-0 59 42.1771	101° 36'	-1 22 39.9376
27	-0 37 23.7813	02	-1 00 21.5417	37	-1 23 19.3022
28	-0 38 03.1459	03	-1 01 00.9063	38	-1 23 58.6668
29	-0 38 42.5105	04	-1 01 40.2709	39	-1 24 38.0313
30	-0 39 21.8750	05	-1 02 19.6355	40	-1 25 17.3959
100° 31'	-0 40 01.2396	101° 06'	-1 02 59.0001	101° 41'	-1 25 56.7605
32	-0 40 40.6042	07	-1 03 38.3646	42	-1 26 36.1251
33	-0 41 19.9688	08	-1 04 17.7292	43	-1 27 15.4897
34	-0 41 59.3334	09	-1 04 57.0938	44	-1 27 54.8543
35	-0 42 38.6980	10	-1 05 36.4584	45	-1 28 34.2188
100° 36'	-0 43 18.0625	101° 11'	-1 06 15.8230	101° 46'	-1 29 13.5834
37	-0 43 57.4271	12	-1 06 55.1876	47	-1 29 52.9480
38	-0 44 36.7917	13	-1 07 34.5522	48	-1 30 32.3126
39	-0 45 16.1563	14	-1 08 13.9167	49	-1 31 11.6772
40	-0 45 55.5209	15	-1 08 53.2813	50	-1 31 51.0418
100° 41'	-0 46 34.8855	101° 16'	-1 09 32.6459	101° 51'	-1 32 30.4063
42	-0 47 14.2500	17	-1 10 12.0105	52	-1 33 09.7709
43	-0 47 53.6146	18	-1 10 51.3751	53	-1 33 49.1355
44	-0 48 32.9792	19	-1 11 30.7397	54	-1 34 28.5001
45	-0 49 12.3438	20	-1 12 10.1042	55	-1 35 07.8647
100° 46'	-0 49 51.7084	101° 21'	-1 12 49.4688	101° 56'	-1 35 47.2293
47	-0 50 31.0730	22	-1 13 28.8334	57	-1 36 26.5939
48	-0 51 10.4376	23	-1 14 08.1980	58	-1 37 05.9584
49	-0 51 49.8021	24	-1 14 47.5626	59	-1 37 45.3230
50	-0 52 29.1667	25	-1 15 26.9272	102° 00	-1 38 24.6876

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II (Cont'd).

1" of long. = 0".65607640 of θ

Long.	θ	Long.	θ	Long.	θ
102° 01'	-1° 39' 04".0522	102° 36'	-2° 02' 01".8126	103° 11'	-2° 24' 59".5731
02	-1 39 43.4168	37	-2 02 41.1772	12	-2 25 38.9377
03	-1 40 22.7814	38	-2 03 20.5418	13	-2 26 18.3022
04	-1 41 02.1459	39	-2 03 59.9064	14	-2 26 57.6668
05	-1 41 41.5105	40	-2 04 39.2710	15	-2 27 37.0314
102° 06'	-1 42 20.8751	102° 41'	-2 05 18.6355	103° 16'	-2 28 16.3960
07	-1 43 00.2397	42	-2 05 58.0001	17	-2 28 55.7606
08	-1 43 39.6043	43	-2 06 37.3647	18	-2 29 35.1252
09	-1 44 18.9689	44	-2 07 16.7293	19	-2 30 14.4897
10	-1 44 58.3334	45	-2 07 56.0939	20	-2 30 53.8543
102° 11'	-1 45 37.6980	102° 46'	-2 08 35.4585	103° 21'	-2 31 33.2189
12	-1 46 17.0626	47	-2 09 14.8231	22	-2 32 12.5835
13	-1 46 56.4272	48	-2 09 54.1876	23	-2 32 51.9481
14	-1 47 35.7918	49	-2 10 33.5522	24	-2 33 31.3127
15	-1 48 15.1564	50	-2 11 12.9168	25	-2 34 10.6772
102° 16'	-1 48 54.5209	102° 51'	-2 11 52.2814	103° 26'	-2 34 50.0418
17	-1 49 33.8855	52	-2 12 31.6460	27	-2 35 29.4064
18	-1 50 13.2501	53	-2 13 11.0106	28	-2 36 08.7710
19	-1 50 52.6147	54	-2 13 50.3751	29	-2 36 48.1356
20	-1 51 31.9793	55	-2 14 29.7397	30	-2 37 27.5002
102° 21'	-1 52 11.3439	102° 56'	-2 15 09.1043	103° 31'	-2 38 06.8647
22	-1 52 50.7085	57	-2 15 48.4689	32	-2 38 46.2293
23	-1 53 30.0730	58	-2 16 27.8335	33	-2 39 25.5939
24	-1 54 09.4376	59	-2 17 07.1981	34	-2 40 04.9585
25	-1 54 48.8022	103° 00	-2 17 46.5626	35	-2 40 44.3231
102° 26'	-1 55 28.1668	103° 01'	-2 18 25.9272	103° 36'	-2 41 23.6877
27	-1 56 07.5314	02	-2 19 05.2918	37	-2 42 03.0523
28	-1 56 46.8960	03	-2 19 44.6564	38	-2 42 42.4168
29	-1 57 26.2605	04	-2 20 24.0210	39	-2 43 21.7814
30	-1 58 05.6251	05	-2 21 03.3856	40	-2 44 01.1460
102° 31'	-1 58 44.9897	103° 06'	-2 21 42.7501	103° 41'	-2 44 40.5106
32	-1 59 24.3543	07	-2 22 22.1147	42	-2 45 19.8752
33	-2 00 03.7189	08	-2 23 01.4793	43	-2 45 59.2398
34	-2 00 43.0835	09	-2 23 40.8439	44	-2 46 38.6043
35	-2 01 22.4480	10	-2 24 20.2085	45	-2 47 17.9689

FIGURE 45.—Lambert projection table for Nebraska—Continued.

LAMBERT PROJECTION FOR NEBRASKA (SOUTH)

Table II (Cont'd).

1" of long. = 0".65607640 of θ

Long.		θ		
103°	46'	-2°	47'	57".3335
	47	-2	48	36.6981
	48	-2	49	16.0627
	49	-2	49	55.4273
	50	-2	50	34.7918
103°	51'	-2	51	14.1564
	52	-2	51	53.5210
	53	-2	52	32.8856
	54	-2	53	12.2502
	55	-2	53	51.6148
103°	56'	-2	54	30.9793
	57	-2	55	10.3439
	58	-2	55	49.7085
	59	-2	56	29.0731
104°	00	-2	57	08.4377
104°	01'	-2	57	47.8023
	02	-2	58	27.1669
	03	-2	59	06.5315
	04	-2	59	45.8960
	05	-3	00	25.2606
104°	06'	-3	01	04.6252
	07	-3	01	43.9898
	08	-3	02	23.3544
	09	-3	03	02.7190
	10	-3	03	42.0835
104°	11'	-3	04	21.4481
	12	-3	05	00.8127
	13	-3	05	40.1773
	14	-3	06	19.5419
	15	-3	06	58.9065
104°	16'	-3	07	38.2710
	17	-3	08	17.6356
	18	-3	08	57.0002
	19	-3	09	36.3648
	20	-3	10	15.7294

FIGURE 45.—Lambert projection table for Nebraska—Continued.

of the first grid line that is to be shown on the map. The coordinates of the corners are as follows:

	x	y
	Feet	*Feet*
Southeast corner	2, 689, 954. 35	495, 616. 57
Northeast corner	2, 684, 740. 19	677, 709. 86
Northwest corner	2, 547, 819. 09	674, 181. 43
Southwest corner	2, 551, 990. 62	492, 061. 28

Let us suppose we wish to draw grid lines for every 40,000 feet beginning with 2,560,000.00 in the x-values at the west and ending with 2,680,000.00 at the east; with the y values, we may have 500,000.00 at the bottom and 660,000.00 at the top.

With this arrangement, at the southeast corner the 500-thousand line will lie 4,383.43 feet north of the corner and the 2,680-thousand line will be 9,954.35 feet west of the corner. The scale of the map is one part in 125,000; hence, these distances will be 0.421 inch north of the corner and 0.956 inch west of the corner.

At the northeast corner, the 660-thousand line is 17,709.86 feet south of the corner and the 2,680-thousand line is 4,740.19 feet west of the corner. On a map of one part in 125,000 these distances become 1.700 inches and 0.455 inch respectively. At the northwest corner the 2,560-thousand line is 12,180.91 feet east of the corner and the 660-thousand line is 14,181.43 feet south of the corner; these distances on the map become 1.169 inches and 1.361 inches, respectively.

Finally, at the southwest corner, the 2,560-thousand line is 8,009.38 feet east of the corner and the 500-thousand line is 7,938.72 feet north of the corner. These represent map distances of 0.769 inch and 0.762 inch, respectively.

Now straight lines joining the respective points at the top and bottom of the map as also at the two sides will give the grid lines for 2,560- and 2,680-thousand in a north-south direction and the 500- and the 660-thousand lines in an east-west direction. If we divide the distance between the two north-south lines into three equal parts both at the top and at the bottom of the map, we shall determine the 2,600- and the 2,640-thousand lines. In a similar way by dividing the distance between the 500- and the 660-thousand lines into four equal parts at the east side and at the west side of the map, we shall locate the 540-, 580- and 620-thousand lines for the east-west grid lines.

There is some slight approximation in this procedure because the quadrangle maps are made on the polyconic projection and the grid is supposed to be placed on a Lambert projection map made from the same system tables. The slight error introduced is probably not as great as the uncertainty of plotting, so for all mapping purposes it is permissible to employ the scheme as outlined above.

METHOD OF CONSTRUCTING THE MERIDIANS AND PARALLELS ON THE GRID PROJECTION

If a map is to be made for the whole or a part of a given system, it may be desirable to place the meridians and parallels on it as well as the grid lines. In order to show how this can be done, we have made the computations necessary for the Columbus area. (See fig. 47.) We selected the upper and lower parallel of the region to be shown. These were 41°35′ and 41°15′, respectively. We then computed the coordinates of the intersection of these parallels with the meridians to

Plane coördinates on Lambert projection

State Nebraska (south) Station Quadrangle Corner

ϕ = 41° 00' " λ = 97° 00' "

Tabular difference of R for 1" of ϕ =

R (for min. of ϕ)		24,105,041.53	y' (for min. of ϕ)		485,740.33
Cor. for sec. of ϕ		– .	Cor. for sec. of ϕ		+
R			y'		
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 9,876.24
θ (for min. of λ)		+1° 38' 24".6876	y		495,616.57
Cor. for sec. of λ		–			
θ			$\frac{\theta}{2}$		0° 49' 12".3438
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0286228236	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0143128779
~~log R~~				R sin $\frac{\theta}{2}$	345,012.516
~~log x'~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	4938.122
x'	R sin θ	+689,954.35	~~log R~~	2R$\sin^2\theta/2$	9876.24
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,689,954.35	~~log y''~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 46.—Computation of coordinates of quadrangle corners.

Plane coordinates on Lambert projection

State Nebraska (south) Station Quadrangle Corner

$\phi =$ 41° 30′ ″ $\lambda =$ 97° 00′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		23,922,873.61	y′ (for min. of ϕ)		667,908.25
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 9,801.61
θ (for min. of λ)		+ 1° 38′ 24″.6876	y		677,709.86
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 49′ 12″.3438
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0286228236	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0143128779
~~log R~~				R sin $\frac{\theta}{2}$	342,405.169
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	4900.803
x′	R sin θ	+684,740.19	~~log R~~	2R $\sin^2\theta/2$	9801.61
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,684,740.19	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 46.—Computation of coordinates of quadrangle corners—Continued.

Plane coordinates on Lambert projection

State Nebraska(south) Station Quadrangle Corner

ϕ = 41° 00′ ″ λ = 97° 30′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,105,041.53	y′ (for min. of ϕ)		485,740.33
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
		°	y″ (=2R sin² $\frac{\theta}{2}$)		+ 6,320.95
θ (for min. of λ)		+ 1° 18′ 43″.7501	y		492,061.28
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 39′ 21″.87505
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		9-69897000-
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0228993849	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0114504431
~~log R~~				R sin $\frac{\theta}{2}$	276,013.406
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3160.476
x′	R sin θ	+551,990.62	~~log R~~	2Rsin²θ/2	6320.95
		2,000,000.00	~~log 2~~		0.30103000-
x		2,551,990.62	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin\theta$

$y = y' + 2R\sin^2\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 46.—Computation of coordinates of quadrangle corners—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Quadrangle Corner

$\phi =$ 41° 30′ ″ $\lambda =$ 97° 30′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		23,922873.61	y′ (for min. of ϕ)		667,908.25
Cor. for sec. of ϕ		–	Cor. for sec. of ϕ		+
R			y′		
			y″ ($\doteq 2R \sin^2 \frac{\theta}{2}$)		+ 6,273.18
θ (for min. of λ)		+1° 18′ 43″.7501	y		674,181.43
Cor. for sec. of λ		–			
θ			$\frac{\theta}{2}$		0° 39′ 21″.87505
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		9.69897000
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0228993849	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0114504431
~~log R~~				R sin $\frac{\theta}{2}$	273,927.503
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3136.591
x′	R sin θ	+547,819.09	~~log R~~	2Rsin²θ/2	6273.18
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,547,819.09	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$.

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine

(see *log tables*)

R, y′, and θ are given in special tables

FIGURE 46.—Computation of coordinates of quadrangle corners—Continued.

be shown. These were for every 5 minutes of longitude from 97°20′ to 97°50′, inclusive. This gave us seven points on each of these parallels which could be plotted on the map. The parallels are circles but the curvature is so slight that it would not be practical to use a radius in their construction. A smooth curve drawn through the plotted points gives the parallel in question. The meridians are straight lines, so such lines drawn through corresponding longitude points on the two parallels give all of the meridians. The spacing of the remaining parallels on the various meridians can be found from the table. The y' value for 41°20′ is found from the table to be 607,182.97 and that for 41°15′ is 576,821.42. The difference of these gives the spacing of 41°20′ on each of the included meridians, or 607,182.97 − 576,821.42 = 30,361.55.

In the same way the spacing from 41°20′ to 41°25′ can be found.

	Spacing
′ ′	*Feet*
15 to 20	30, 361. 55
20 to 25	30, 362. 26
25 to 30	30, 363. 02
30 to 35	30, 363. 85

If these spacings are laid off on each of the straight-line meridians to the scale of the map, seven points on each of the parallels will be determined. They can then be drawn in as smooth curves just as were the upper and lower parallels from their coordinates. In this way a map projection for the whole area of a system can be computed and constructed. Also county maps can be constructed with parallels, meridians and grid lines for use in plotting data fixed by surveying, either geodetic or plane. Larger areas for power projects or for engineering construction projects on a large scale can be mapped by this method with coordinate relation of meridians, parallels, and grid lines. For States having a single system based on the Lambert projection such a map for the whole State would be very useful. The method of handling the problem is so simple that it should give no trouble in its execution.

TRANSFORMATION OF A LOCAL SYSTEM OF PLANE COORDINATES TO GRID COORDINATES

In case a local system of plane coordinates has been computed, it is possible under certain conditions to transform the coordinates directly without passing through the geographic positions. The first requisite is that the geographic position of the local origin should be given. If this is not known, we should not be able to locate the system accurately on the grid.

With the geographic position of the origin given, we can compute the grid coordinates of the origin. This gives us the θ angle through which the local axes must be turned in order to make them parallel to the grid axes. This is not the whole problem as we shall show, but it is the main part of it. In order to test the results accurately, we have chosen a system of plane coordinates in Cincinnati, Ohio, for which we have geographic positions of the stations as well as the local plane coordinates. In this way we can compute the grid coordinates from the positions and thus compare them with the result of the direct transformation.

The origin for the local system is Hughes High School for which the grid coordinates become x=1,426,605.64 and y=417,458.88, and the

(Text continued on p. 214)

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

$\phi = 41° 15' \; ''$ $\lambda = 97° 20' \; ''$

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 7,390.25
θ (for min. of λ)		+ 1° 25′ 17″.3959	y		584,211.67
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 42′ 38″.69795
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0248072903	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0124045996
~~log R~~				R sin $\frac{\theta}{2}$	297,883.56
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3695.126
x′	R sin θ	+ 595,721.29	~~log R~~	2R$\sin^2 \theta/2$	7390.25
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,595,721.29	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 15′ ″ λ = 97° 25′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 6,832.73
θ (for min. of λ)		+ 1° 22′ 00.″5730	y		583,654.15
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 41′ 00.″2865
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0238533485	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0119275227
~~log R~~				R sin $\frac{\theta}{2}$	286,427.06
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3416.365
x′	R sin θ	+ 572,813.37	~~log R~~	2R$\sin^2\theta/2$	6832.73
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,572,813.37	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine

(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska(south) Station Five Minute Intersection

ϕ = 41° 15′ ″ λ = 97° 30′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		–	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 6,297.07
θ (for min. of λ)		+ 1° 18′ 43″.7501	y		583,118.49
Cor. for sec. of λ		–			
θ			$\frac{\theta}{2}$		0° 39′ 21″.87505
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0228993849	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0114504431
~~log R~~				R sin $\frac{\theta}{2}$	274,970.49
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3148.534
x′	R sin θ	+ 549,904.92	~~log R~~	2Rsin²θ/2	6297.07
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,549,904.92	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

$\phi =$ 41° 15' " $\lambda =$ 97° 35' "

Tabular difference of R for 1" of ϕ =

R (for min. of ϕ)		24,013,960.44	y' (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y'		
			y'' $(=2R \sin^2 \frac{\theta}{2})$		+ 5,783.27
θ (for min. of λ)		+ 1° 15' 26."9272	y		582,604.69
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 37' 43."4636
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.6989700 0~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0219454005	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0109733610
~~log R~~				R sin $\frac{\theta}{2}$	263,513.86
~~log x'~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	2891.633
x'	R sin θ	+ 526,995.98	~~log R~~	2Rsin²θ/2	5783.27
		2,000,000.00	~~log 2~~		~~0.3010300 0~~
x		2,526,995.98	~~log y''~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 15′ ″ λ = 97° 40′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 5,291.32
θ (for min. of λ)		+ 1° 12′ 10″.1042	y		582,112.74
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 36′ 05″.0521
θ″	For machine computation	″		For machine computation	
			~~log θ″~~		
~~log θ″~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0209913956	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0104962760
~~log R~~				R sin $\frac{\theta}{2}$	252,057.16
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	2645.662
x′	R sin θ	+ 504,086.54	~~log R~~	2Rsin²θ/2	5291.32
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,504,086.54	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = *log of ratio for reducing arc expressed in seconds to sine*

(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 15′ ″ λ = 97° 45′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 4,821.24
θ (for min. of λ)		+ 1° 08′ 53″.2813	y		581,642.66
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 34′ 26″.64065
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0200373722	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0100191890
~~log R~~				R sin $\frac{\theta}{2}$	240,600.41
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2410.621
x′	R sin θ	+ 481,176.66	~~log R~~	2Rsin²θ/2	4821.24
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,481,176.66	~~log y″~~		

$x = 2,000,000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 15′ ″ λ = 97° 50′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		24,013,960.44	y′ (for min. of ϕ)		576,821.42
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 4,373.02
θ (for min. of λ)		+ 1° 05′ 36.4584″	y		581,194.44
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 32′ 48.2292″
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0190833304	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0095420996
~~log R~~				R sin $\frac{\theta}{2}$	229,143.60
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	2186.511
x′	R sin θ	+ 458,266.34	~~log R~~	2Rsin²θ/2	4373.02
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,458,266.34	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska(south) Station Five Minute Intersection

ϕ = 41° 35' " λ = 97° 20' "

Tabular difference of R for 1" of ϕ =

R (for min. of ϕ)		23,892,509.76	y' (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y'		
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 7,352.88
θ (for min. of λ)		+ 1° 25' 17."3959	y		705,624.98
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0 °42 '38."69795
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0248072903	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0124045996
~~log R~~				R sin $\frac{\theta}{2}$	296,377.02
~~log x'~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3676.438
x'	R sin θ	+ 592,708.43	~~log R~~	2R$\sin^2\theta/2$	7352.88
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,592,708.43	~~log y''~~		

x = 2,000,000.00 + R sin θ

y = y' + 2R $\sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska(south) Station Five Minute Intersection

ϕ = 41° 35' " λ = 97° 25' "

Tabular difference of R for 1" of ϕ =

R (for min. of ϕ)		23,892,509.76	y' (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y'		
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 6,798.17
θ (for min. of λ)		+ 1° 22' 00".5730	y		705,070.27
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 41' 00".2865
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0238533485	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0119275227
~~log R~~				R sin $\frac{\theta}{2}$	284,978.45
~~log x'~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3399.087
x'	R sin θ	+ 569,916.36	~~log R~~	2Rsin²θ/2	6798.17
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,569,916.36	~~log y''~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 35 " λ = 97° 30 "

Tabular difference of R for 1" of ϕ =

R (for min. of ϕ)		23,892,509.76	y' (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y'		
			y'' (=2R $\sin^2 \frac{\theta}{2}$)		+ 6,265.22
θ (for min. of λ)		+ 1° 18' 43".7501	y		704,537.32
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 39' 21".87505
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0228993849	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0114504431
~~log R~~				R sin $\frac{\theta}{2}$	273,579.82
~~log x'~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	3132.610
x'	R sin θ	+ 547,123.78	~~log R~~	2R $\sin^2 \theta/2$	6265.22
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,547,123.78	~~log y''~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y', and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 35′ ″ λ = 97° 35′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		23,892,509.76	y′ (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,754.02
θ (for min. of λ)		+ 1° 15′ 26.″9272	y		704,026.12
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 37′ 43.″4636
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0219454005	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0109733610
~~log R~~				R sin $\frac{\theta}{2}$	262,181.13
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2877.008
x′	R sin θ	+ 524,330.70	~~log R~~	2Rsin²θ/2	5754.02
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,524,330.70	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 35′ ″ λ = 97° 40′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		23,892,509.76	y′ (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,264.56
θ (for min. of λ)		+ 1° 12′ 10″.1042	y		703,536.66
Cor. for sec. of λ		− ′			
θ			$\frac{\theta}{2}$		0° 36′ 05″.0521
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0209913956	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0104962760
~~log R~~				R sin $\frac{\theta}{2}$	250,782.38
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2632.281
x′	R sin θ	+ 501,537.12	~~log R~~	2R $\sin^2\theta/2$	5264.56
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,501,537.12	~~log y″~~		

x = 2,000,000.00 + R sin θ

y ≐ y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

$\phi =$ 41° 35′ ″ $\lambda =$ 97° 45′ ″

Tabular difference of R for 1″ of $\phi =$

R (for min. of ϕ)		23,892,509.76	y′ (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 4,796.86
θ (for min. of λ)		+ 1° 08′ 53″.2813	y		703,068.96
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 34′ 26″.64065
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0200373722	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0100191890
~~log R~~				R sin $\frac{\theta}{2}$	239,383.57
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2398.429
x′	R sin θ	+ 478,743.11	~~log R~~	2R$\sin^2\theta/2$	4796.86
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,478,743.11	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

Plane coordinates on Lambert projection

State Nebraska (south) Station Five Minute Intersection

ϕ = 41° 35′ ″ λ = 97° 50′ ″

Tabular difference of R for 1″ of ϕ =

R (for min. of ϕ)		23,892,509.76	y′ (for min. of ϕ)		698,272.10
Cor. for sec. of ϕ		−	Cor. for sec. of ϕ		+
R			y′		
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 4,350.91
θ (for min. of λ)		+ 1° 05′ 36.″4584	y		702,623.01
Cor. for sec. of λ		−			
θ			$\frac{\theta}{2}$		0° 32′ 48.″2292
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0190833304	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0095420996
~~log R~~				R sin $\frac{\theta}{2}$	227,984.71
~~log x′~~			~~log $\sin^2 \frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2175.453
x′	R sin θ	+ 455,948.66	~~log R~~	2R$\sin^2\theta/2$	4350.91
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		2,455,948.66	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 47.—Computation of coordinates of 5-minute intersections—Continued.

θ angle is $-1°16'57''.46$ as far as it is necessary to use it in the transformation. The coordinates of five other stations have been computed from their geographic positions and we shall compute the same by transformation to see how closely they will check. We must bear in mind that the geographic positions have been computed to three places of decimals and that one unit in the last place represents approximately one-tenth of a foot. Also in computing the geographic positions it is sometimes necessary to add or subtract a unit in the last place so it is always possible that the resulting positions may be one whole unit in the last place in error with respect to the origin of coordinates or Hughes High School.

In this system of coordinates, the geographic positions were recomputed on the North American Datum of 1927 after the local coordinates were computed. This recomputation on the new datum involved a change in azimuth of $+2''.58$ which was added to the θ angle to take care of this relative change. We must therefore turn the axes through the sum of the two angles.

$$\begin{array}{r} 1°16'57''.46 \\ 2\ .58 \\ \hline 1\ 17\ 00\ .04 \end{array}$$

There is another difficulty that we have to contend with and that is due to the fact that the geodetic line does not coincide with the straight line joining its end points on the grid system. We shall now, by the five examples, attempt to show the method to be employed.

The station Clifton School has the local coordinates,

$$x=+634.66 \text{ and } y=+7{,}853.95.$$

log x	$=2.8025411$	log y	$=3.8950882$
log y	$=3.8950882$	log cos a	$=9.9985867-10$
log tan a	$=8.9074529-10$	log s	$=3.8965015$
			-238
a	$=\ 4°37'11''.65$		
Local plane azimuth	$=184°37'11''.65$	log grid length	$=3.8964777$

This is the plane azimuth in the local system and the log s computed may be considered the logarithm of the geodetic distance of Clifton School from Hughes High School. From the State table for Ohio-South we find the grid correction for the log should be -238 in the seventh place of logs. The log of the grid length is therefore 3.8964777. To obtain the grid azimuth we must add 1°17'00."04 to the local plane azimuth, as explained above.

Local plane azimuth	$=184°37'11''.65$
Correction	$=\ 1\ 17\ 00\ .04$
Grid azimuth	$=185\ 54\ 11\ .69$

log sin grid azimuth	$=9.0121997-10$	log cos grid azimuth	$=9.9976908-10$
log grid length	$=3.8964777$	log grid length	$=3.8964777$
log Δx	$=2.9086774$	log Δy	$=3.8941685$

	x	y
	Feet	*Feet*
Hughes High School	1, 426, 605. 64	417, 458. 88
Δx and Δy	+810. 36	+7, 837. 34
Clifton School	1, 427, 416. 00	425, 296. 22

It is thus seen that the resulting x coordinate is 0.01 too large and the y coordinate 0.06 too small; but the check is as good as one could expect, due to the use of only three decimal places in the geographic positions. There is one thing further to consider and that is the correction term to the azimuth. This is given by the formula

$$\frac{(x_2-x_1)\left(y_1-y_0+\frac{y_2-y_1}{3}\right)}{2\rho_o^2 \sin 1''}$$

The y_o and $\frac{1}{2\rho_o^2 \sin 1''}$ are constants that are given in the tables. The y_o for Ohio-South is given as +504,195 feet.

$$\log\left(\frac{1}{2\rho_o^2 \sin 1''}\right)=0.3726089-10.$$

It is more convenient to use the numerical value if a machine is available for multiplication.

$$\frac{1}{2\rho_o^2 \sin 1''}=2.35835\times 10^{-10}.$$

In this case x_1 and y_1 are the grid coordinates of Hughes High School and x_2 and y_2 the coordinates of Clifton School.

$x_2-x_1=$	+810. 36	y_1	= 417, 459
$y_2-y_1=$	+7, 837. 34	y_0	= 504, 195
		y_1-y_0	= −86, 736
		$\frac{1}{3}(y_2-y_1)=$	+2, 612
			−84, 124

$$\text{Correction}=+810\ (-84{,}124)2.35835\times 10^{-10}.$$

The factor 10^{-10} can be accounted for by pointing off 5 places in each of the first 2 factors. We have then

$$\text{Correction}=-0.00810\times 0.84124\times 2.35835=-0''.02.$$

The correction is too small in this case to trouble about, but we wished to show the method to be used.

The station Observatory has the local coordinates,

$$x=+27{,}698.35 \text{ and } y=+3{,}813.66.$$

log x	=4. 4424539	log x	=4. 4424539
log y	=3. 5813419	log sin a	=9. 9959220−10
log tan a	=0. 8611120	log s	=4. 4465319
a	= 82°09′37″.79	Grid factor	= −237
Local plane azimuth	= 262°09′37″.79	log grid length	=4. 4465082

Local plane azimuth	=262°09′37″.79
Correction	= 1 17 00 .04
Grid azimuth	=263 26 37 .83

log sin grid azimuth	=9. 9971506−10	log cos grid azimuth	=9. 0575786−10
log grid length	=4. 4465082	log grid length	=4. 4465082
log Δx	=4. 4436588	log Δy	=3. 5040868

	x	y
	Feet	*Feet*
Hughes High School	1, 426, 605. 64	417, 458. 88
Δx and Δy	+27, 775. 30	+3, 192. 18
Observatory	1, 454, 380. 94	420, 651. 06

In calculating the correction, it should be borne in mind that $y_1 - y_0$ is constant for any one transformation system.

$$y_1 - y_0 = -86,736$$
$$\tfrac{1}{3}(y_2 - y_1) = +1,064$$
$$-85,672$$

Correction $= -0.27775 \times 0.85672 \times 2.35835 = -0''.56$.

The corrected grid azimuth therefore becomes 263°26′37″.27.

log sin grid azimuth	=9. 9971505−10	log cos grid azimuth	=9. 0575889−10
log grid length	=4. 4465082	log grid length	=4. 4465082
log Δx	=4. 4436587	log Δy	=3. 5040971

	x	y
	Feet	*Feet*
Hughes High School	1, 426, 605. 64	417, 458. 88
Δx and Δy	+27, 775. 29	+3, 192. 25
Observatory	1, 454, 380. 93	420, 651. 13

The failure to check is 0.01 in x and 0.05 in y, as close as could be expected. These values may fit the actual conditions better than the results from the positions.

The station Reading has the local coordinates,

$$x = +22{,}566.30 \text{ and } y = +30{,}894.10.$$

log x	=4. 3534604	log y	=4. 4898755
log y	=4. 4898755	log cos a	=9. 9071520−10
log tan a	=9. 8635849−10	log s	=4. 5827235
		Grid factor	−248
a	= 36°08′45″.27		
Local plane azimuth	=216°08′45″.27	log grid length	=4. 5826987

Local plane azimuth	=216°08′45″.27
Correction	= 1 17 00 .04
Grid azimuth	=217 25 45 .31

log sin grid azimuth	=9. 7837474−10	log cos grid azimuth	=9. 8998776−10
log grid length	=4. 5826987	log grid length	=4. 5826987
log Δx	=4. 3664461	log Δy	=4. 4825763

	x	y
	Feet	Feet
Hughes High School	1,426,605.64	417,458.88
Δx and Δy	+23,251.24	+30,379.20
Reading	1,449,856.88	447,838.08

$$y_1-y_0 = -86,736$$
$$\tfrac{1}{3}(y_2-y_1) = +10,126$$
$$-76,610$$

Correction $= -0.23251\times 0.76610\times 2.35835 = -0''.42$
Corrected grid azimuth $= 217°25'44''.89$

log sin grid azimuth	= 9.7837462−10	log cos grid azimuth	= 9.8998783−10
log grid length	= 4.5826987	log grid length	= 4.5826987
log Δx	= 4.3664449	log Δy	= 4.4825770

	x	y
	Feet	Feet
Hughes High School	1,426,605.64	417,458.88
Δx and Δy	+23,251.18	+30,379.24
Reading	1,449,856.82	447,838.12

This does not check quite as well as those already given. The relative positions of Reading and Hughes High School must be somewhat in error.

For station St. Joe the coordinates are given as

$$x = -35{,}282.26 \text{ and } y = -11{,}386.90.$$

log x	= 4.5475564	log x	= 4.5475564
log y	= 4.0564055	log sin a	= 9.9784841−10
log tan a	= 0.4911509	log s	= 4.5690723
		grid factor	= −230
a	= 72°06′47″.43		
Local plane azimuth	= 72°06′47″.43	log grid s	= 4.5690493

Local plane azimuth	= 72°06′47″.43
Correction	= 1 17 00 .04
Grid azimuth	= 73 23 47 .47

log sin grid azimuth	= 9.9815039−10	log cos grid azimuth	= 9.4559811−10
log grid length	= 4.5690493	log grid length	= 4.5690493
log Δx	= 4.5505532	log Δy	= 4.0250304

	x	y
	Feet	*Feet*
Hughes High School	1,426,605.64	417,458.88
Δx and Δy	−35,526.57	−10,593.28
St. Joe	1,391,079.07	406,865.60

$$y_1 - y_0 = -86,736$$
$$\tfrac{1}{3}(y_2 - y_1) = -3,531$$
$$-90,267$$

Correction = +0.35526 × 0.90267 × 2.35835 = +0″.76
Corrected grid azimuth = 73°23′48″.23

log sin grid azimuth = 9.9815043 − 10
log grid length = 4.5690493
log Δx = 4.5505536

log cos grid azimuth = 9.4559757 − 10
log grid length = 4.5690493
log Δy = 4.0250250

	x	y
	Feet	*Feet*
Hughes High School	1,426,605.64	417,458.88
Δx and Δy	−35,526.60	−10,593.15
St. Joe	1,391,079.04	406,865.73

The check is +0.05 in x and −0.12 in y, but these coordinates probably represent better the relative positions of Hughes High School and St. Joe than do the coordinates from the position of St. Joe.

As a final example, we shall take the station Mt. Washington School, the local coordinates of which are $x = +38,050.30$ and $y = -13,578.20$.

log x = 4.5803581
log y = 4.1328422
log tan a = 0.4475159
a = 70°21′40″.05
Local plane azimuth = 289°38′19″.95

log x = 4.5803581
log sin a = 9.9739723 − 10
log s = 4.6063858
grid factor = −235
log grid length = 4.6063623

Local plane azimuth = 289°38′19″.95
Correction = 1 17 00.04
Grid azimuth = 290 55 19.99

log sin grid azimuth = 9.9703776 − 10
log grid length = 4.6063623
log Δx = 4.5767399

log cos grid azimuth = 9.5527901 − 10
log grid length = 4.6063623
log Δy = 4.1591524

	x	y
	Feet	*Feet*
Hughes High School	1, 426, 605. 64	417, 458. 88
Δx and Δy	+37, 734. 61	−14, 426. 22
Mt. Washington School	1, 464, 340. 25	403, 032. 66

$$y_1-y_0 = -86{,}736$$
$$\tfrac{1}{3}(y_2-y_1) = -\ 4{,}809$$
$$-91{,}545$$

$$\text{Correction} = -0.37735 \times 0.91545 \times 2.35835 = -0''.81$$
$$\text{Corrected grid azimuth} = 290°55'19''.18$$

log sin grid azimuth	=9. 9703783−10	log cos grid azimuth	=9. 5527857−10
log grid length	=4. 6063623	log grid length	=4. 6063623
log Δx	=4. 5767406	log Δy	=4. 1591480

	x	y
	Feet	*Feet*
Hughes High School	1, 426, 605. 64	417, 458. 88
Δx and Δy	+37, 734. 67	−14, 426. 07
Mt. Washington School	1, 464, 340. 31	403, 032. 81

This is about the usual check.

We shall now show how to accomplish the same result in another way. Let us denote the angle through which the axes are turned by ϕ. Then if x' and y' denote the original plane coordinates reduced for the scale factor, we shall have:

$$\text{Grid } x = 1{,}426{,}605.64 + x' \cos\phi + y' \sin\phi$$

$$\text{Grid } y = 417{,}458.88 + y' \cos\phi - x' \sin\phi.$$

This system lies west of the central meridian for Ohio-South. If it were east of the central meridian the sign of the sin term would change for each of the coordinates, being minus for x and plus for y.

It will be most convenient to use natural functions with this method. In this case,

$$\phi = 1°17'00''.04$$
$$\sin\phi = 0.02239671$$
$$\cos\phi = 0.99974917.$$

The effect of the correction term will be computed in another way. For Clifton School,

x	= +634. 66	x'=	+634. 625
y	= +7, 853. 95	y'=	+7, 853. 520
Grid factor	=0.9999452		

	x		y
	Feet		*Feet*
Hughes High School	1, 426, 605. 64	Hughes High School	417, 458. 88
x' cos ϕ	+634. 47	y' cos ϕ	+7, 851. 55
y' sin ϕ	+175. 89	x' sin ϕ	−14. 21
Clifton School	1, 427, 416. 00	Clifton School	425, 296. 22

The results are the same as already obtained.

For station Observatory,

x = +27, 698. 35 x' = +27, 696. 84
y = +3, 813. 66 y' = +3, 813. 45
Grid factor = 0. 99994543

	x		y
	Feet		*Feet*
Hughes High School	1, 426, 605. 64	Hughes High School	417, 458. 88
x' cos ϕ	+27, 689. 89	y' cos ϕ	+3, 812. 49
y' sin ϕ	+85. 41	x' sin ϕ	−620. 32
Observatory	1, 454, 380. 94	Observatory	420, 651. 05

We shall not recompute the correction term but take it from the previous computation. For *Observatory it was* −0."56. If we denote this by $\Delta\phi$, the corrections become, $+\Delta y\ \Delta\phi\ (4.848\times10^{-6})$ and $-\Delta x\ \Delta\phi\ (4.848\times10^{-6})$ for x and y, respectively. Δx and Δy must be found by adding the two computed terms above or by taking them from the previous computation. The factor 10^{-6} can be taken care of by pointing off six places in Δx and Δy.

$$\text{Correction for } x = -0.003192\times0.56\times4.848 = -0.01$$
$$\text{Correction for } y = +0.027775\times0.56\times4.848 = +0.08$$

Hence Observatory has the coordinates,

$$x = 1{,}454{,}380.93$$
$$y = 420{,}651.13.$$

These are the same results as previously obtained. If the correction term had not previously been computed, it would have been necessary to add the two terms of both x and y to use in the computation as shown in the computation by the other method.

For station Reading,

x = +22,566.30 x' = +22,565.01
y = +30,894.10 y' = +30,892.34
Grid factor = 0.99994290

	x		y
	Feet		*Feet*
Hughes High School	1, 426, 605. 64	Hughes High School	417, 458. 88
x' cos ϕ	+22, 559. 35	y' cos ϕ	+30, 884. 59
y' sin ϕ	+691. 89	x' sin ϕ	−505. 38
Reading	1, 449, 856. 88	Reading	447, 838. 09

$$\text{Correction for } x = -0.030379\times0.42\times4.848 = -0.06$$
$$\text{Correction for } y = +0.023251\times0.42\times4.848 = +0.05$$

Hence Reading has the coordinates,

$$x = 1{,}449{,}856.82$$
$$y = 447{,}838.14.$$

For station St. Joe,

$x = -35{,}282.26$ $\quad x' = -35{,}280.39$
$y = -11{,}386.90$ $\quad y' = -11{,}386.30$
Grid factor $= 0.99994704$

	x		y
	Feet		*Feet*
Hughes High School	1, 426, 605. 64	Hughes High School	417, 458. 88
$x' \cos \phi$	−35, 271. 54	$y' \cos \phi$	−11, 383. 44
$y' \sin \phi$	−255. 02	$x' \sin \phi$	+790. 16
St. Joe	1, 391, 079. 08	St. Joe	406, 865. 60

Correction for $x = -0.010593 \times 0.76 \times 4.848 = -0.04$
Correction for $y = -0.035527 \times 0.76 \times 4.848 = +0.13$

Hence St. Joe has the coordinates,

$$x = 1{,}391{,}079.04$$
$$y = 406{,}865.73.$$

For Mt. Washington School,

$x = +38{,}050.30$ $\quad x' = +38{,}048.24$
$y = -13{,}578.20$ $\quad y' = -13{,}577.47$
Grid factor $= 0.99994589$

	x		y
	Feet		*Feet*
Hughes High School	1, 426, 605. 64	Hughes High School	417, 458. 88
$x' \cos \phi$	+38, 038. 70	$y' \cos \phi$	−13, 574. 06
$y' \sin \phi$	−304. 09	$x' \sin \phi$	−852. 16
Mt. Washington School	1, 464, 340. 25	Mt. Washington School	403, 032. 66

Correction for $x = +0.014426 \times 0.81 \times 4.848 = +0.06$
Correction for $y = +0.037735 \times 0.81 \times 4.848 = +0.15$

Hence Mt. Washington School has the coordinates,

$$x = 1{,}464{,}340.31$$
$$y = 403{,}032.81.$$

Besides these main stations determined by triangulation, there are no doubt hundreds of others that are found in the detail traverses. With these, the results of the computation by transformation of the main stations would be more consistent than the coordinates derived from the geographic positions. These detail traverses have been computed only by plane coordinates; so no geographic positions would be available for the computation of grid coordinates. It seems then that either of the above methods of transformation would be very useful for such cases. The latter method is probably the shorter in the long run especially if a calculating machine is available.

Plane coordinates on Lambert projection

State Ohio - South Station Hughes High School

$\phi =$ 39° 07′ 42.″914 $\lambda =$ 84° 31′ 17.″094

Tabular difference of R for 1″ of ϕ = 101.168.00

R (for min. of ϕ)		25,620,372.05	y′ (for min. of ϕ)		406,699.07
Cor. for sec. of ϕ		– 4,341.52	Cor. for sec. of ϕ		+ 4,341.52
R		25,616,030.53	y′		411,040.59
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 6,418.29
θ (for min. of λ)		– 1° 16′ 46.″61189	y		417,458.88
Cor. for sec. of λ		– 10.84648			
θ		– 1 16 57.45837	$\frac{\theta}{2}$		0° 38′ 28.″729185
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0223842002	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0111928012
~~log R~~				R sin $\frac{\theta}{2}$	286,715.14
~~log x′~~ θ			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3209.146
x′	R sin θ	–573,394.36	~~log R~~	2Rsin²θ/2	6418.29
		2,000,000,00	~~log 2~~		~~0.30103000~~
x		1,426,605.64	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R sin² $\frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 48.—*Computation of coordinates from geographic position.*

Plane coordinates on Lambert projection

State Ohio - South Station Clifton School

ϕ = 39° 09′ 00″.543 λ = 84° 31′ 09″.037

Tabular difference of R for 1″ of ϕ = 101.16833

R (for min. of ϕ)		25,608,231.89	y′ (for min. of ϕ)		418,839.23
Cor. for sec. of ϕ		− 54.93	Cor. for sec. of ϕ		+ 54.93
R		25,608,176.96	y′		418,894.16
			y″ (=2R sin² $\frac{\theta}{2}$)		+ 6,402.12
θ (for min. of λ)		− 1° 16′ 46″.61189	y		425,296.28
Cor. for sec. of λ		− 5.73415			
θ		− 1 16 52.34604	$\frac{\theta}{2}$		0° 38′ 26″.17302
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			S for $\frac{\theta}{2}$		
~~log sin θ~~	sin θ	0.0223594211	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0111804094
~~log R~~				R sin $\frac{\theta}{2}$	286,309.90
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3201.062
x′	R sin θ	−572,584.01	~~log R~~	2Rsin²θ/2	6402.12
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		1,427,415.99	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 48.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State Ohio - South Station Observatory

ϕ = 39°08′20″.458 λ = 84°25′25″.563

Tabular difference of R for 1″ of ϕ = 101.16800

R (for min. of ϕ)		25,614,301.97	y′ (for min. of ϕ)		412,769.15
Cor. for sec. of ϕ		− 2,069.69	Cor. for sec. of ϕ		+ 2,069.69
R		25,612,232.28	y′		414,838.84
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,812.34
θ (for min. of λ)		− 1°12′58″.18485	y		420,651.18
Cor. for sec. of λ		− 16.22022			
θ		− 1 13 14.40507	$\frac{\theta}{2}$		0°36′37″.202535
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0213030654	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0106521370
~~log R~~				R sin $\frac{\theta}{2}$	272,825.01
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	2906.169
x′	R sin θ	−545,619.06	~~log R~~	2R sin²θ/2	5812.34
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		1,454,380.94	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 48.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State Ohio - South Station Reading

ϕ = 39° 12′ 48″.170 λ = 84° 26′ 30″.389

Tabular difference of R for 1″ of ϕ = 101.16883

R (for min. of ϕ)		25,590,021.57	y′ (for min. of ϕ)		437,049.55
Cor. for sec. of ϕ		− 4,873.30	Cor. for sec. of ϕ		+ 4,873.30
R		25,585,148.27	y′		441,922.85
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,915.39
θ (for min. of λ)		− 1° 13′ 36″.25603	y		447,838.24
Cor. for sec. of λ		− 19.28241			
θ		− 1 13 55.53844	$\frac{\theta}{2}$		0° 36′ 57″.76922
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0215024399	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0107518414
~~log R~~				R sin $\frac{\theta}{2}$	275,087.46
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R $\sin^2 \frac{\theta}{2}$	2957.697
x′	R sin θ	−550,143.11	~~log R~~	2R$\sin^2\theta/2$	5915.39
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		1,449,856.89	~~log y″~~		

x = 2,000,000.00 + R sin θ

y = y′ + 2R $\sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine (see log tables)

R, y′, and θ are given in special tables

FIGURE 48.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State Ohio - South Station St. Joe

ϕ = 39° 05′ 50.″132 λ = 84° 38′ 44.″613

Tabular difference of R for 1″ of ϕ = 101.16750

R (for min. of ϕ)		25,632,512.16	y′ (for min. of ϕ)		394,558.96
Cor. for sec. of ϕ		− 5,071.73	Cor. for sec. of ϕ		+ 5,071.73
R		25,627,440.43	y′		399,630.69
			y″ (=2R $\sin^2 \frac{\theta}{2}$)		+ 7,235.16
θ (for min. of λ)		−1° 21′ 13.″11010	y		406,865.85
Cor. for sec. of λ		− 28.30782			
θ		−1 21 41.41792	$\frac{\theta}{2}$		0° 40′ 50.″70896
θ''	For machine computation	″		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0237605084	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0118810928
~~log R~~				R sin $\frac{\theta}{2}$	304,482.00
~~log x′~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	3617.579
x′	R sin θ	−608,921.01	~~log R~~	2R $\sin^2\theta/2$	7235.16
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		1,391,078.99	~~log y″~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y′ = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y′, and θ are given in special tables

FIGURE 48.—Computation of coordinates from geographic position—Continued.

Plane coordinates on Lambert projection

State Ohio- South Station Mt. Washington School

$\phi = 39° 05' 28''.425$ $\lambda = 84° 23' 14''.511$

Tabular difference of R for 1" of ϕ = 101.16750

R (for min. of ϕ)		25,632,512.16	y' (for min. of ϕ)		394,558.96
Cor. for sec. of ϕ		− 2,875.69	Cor. for sec. of ϕ		+ 2,875.69
R		25,629,636.47	y'		397,434.65
			y" (=2R $\sin^2 \frac{\theta}{2}$)		+ 5,598.26
θ (for min. of λ)		− 1° 11' 42".04251	y		403,032.91
Cor. for sec. of λ		− 9.20751			
θ		− 1 11 51.25002	$\frac{\theta}{2}$		0° 35' 55".62501
θ''	For machine computation	"		For machine computation	
			~~log θ''~~		
~~log θ''~~			~~colog 2~~		~~9.69897000~~
~~S for θ~~			~~S for $\frac{\theta}{2}$~~		
~~log sin θ~~	sin θ	0.0209000081	~~log sin $\frac{\theta}{2}$~~	sin $\frac{\theta}{2}$	0.0104505746
~~log R~~				R sin $\frac{\theta}{2}$	267,844.43
~~log x'~~			~~log sin² $\frac{\theta}{2}$~~	R sin² $\frac{\theta}{2}$	~~2799.128~~
x'	R sin θ	−535,659.61	~~log R~~	2Rsin²θ/2	5598.26
		2,000,000.00	~~log 2~~		~~0.30103000~~
x		1,464,340.39	~~log y"~~		

$x = 2{,}000{,}000.00 + R \sin \theta$

$y = y' + 2R \sin^2 \frac{\theta}{2}$

y' = the value of y on the central meridian for the latitude of the station

S = log of ratio for reducing arc expressed in seconds to sine
(see log tables)

R, y', and θ are given in special tables

FIGURE 48.—Computation of coordinates from geographic position—Continued.

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