U. S. DEPARTMENT OF COMMERCE
DANIEL C. ROPER, Secretary

COAST AND GEODETIC SURVEY
R. S. PATTON, Director

Special Publication No. 195

MANUAL OF TRAVERSE COMPUTATION ON THE TRANSVERSE MERCATOR GRID

By

OSCAR S. ADAMS
Senior Mathematician

AND

CHARLES N. CLAIRE
Associate Mathematician

(Slight change in 1944. See p. 86.)

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1935

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 50 cents

National Oceanic and Atmospheric Administration

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library and the Climate Database Modernization Program, National Climate Data Center (NCDC). To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or www.reference@nodc.noaa.gov.

CONTENTS

ILLUSTRATIONS

MANUAL OF TRAVERSE COMPUTATION ON THE TRANSVERSE MERCATOR GRID

INTRODUCTION

Special Publication No. 193, entitled "Manual of Plane Coordinate Computation", gives some account of both the Lambert projection and the transverse Mercator projection as applied to systems of plane coordinates in the various States. In addition to this it was thought advisable to prepare a separate publication on each of the systems, with copious illustrations of the more elementary computations that apply to traverse, since the greater part of the surveys that will be computed on the grids will consist of this class of work. A publication similar to this one, applied to the Lambert grid, has been issued as Special Publication No. 194.

DESCRIPTION OF THE TRANSVERSE MERCATOR PROJECTION

The transverse Mercator projection is not as easily illustrated as is the Lambert projection but, as a matter of fact, it is just as simple in conception and in use. The ordinary Mercator projection starts from the Equator which is equally divided for the various meridians. The meridians are straight lines. Then with a table which gives the distances of the various parallels from the Equator, we have all that is needed for the construction of the projection. When the distance north or south of the Equator is not great, an approximate series can be used to determine the position of the parallel on the map; so that a table is no longer required. This distance on the map from the Equator is the y value of the coordinate system and it is defined by the integral as follows:

$$y=a\int_0^{\phi}\frac{d\phi}{\cos\phi},$$

in which a is the radius of the sphere.

Now the series for $\frac{1}{\cos\phi}$ or $\sec\phi$ is given in the form:

$$\sec\phi=1+\frac{\phi^2}{2}+\frac{5\phi^4}{24}+\ldots\ldots$$

For the distance that it is necessary to go for systems of plane coordinates, two terms of the series are a sufficient approximation. Accordingly we have

$$y=a\int_0^{\phi}\left(1+\frac{\phi^2}{2}\right)d\phi=a\left(\phi+\frac{\phi^3}{6}\right).$$

If S denotes the distance in ordinary units, we have

$$S=a\phi \quad \text{or} \quad \phi=\frac{S}{a}.$$

Now by substituting this value of ϕ in the formula for y, we have

$$y=S+\frac{S^3}{6a^2}.$$

For a distance less than 100 miles north or south of the Equator this formula would be amply sufficient to give the required accuracy.

In the transverse Mercator projection as applied to the State systems that have been computed, we have the condition that the projection is turned through 90° in azimuth; so that a given meridian becomes the great circle from which we proceed out in both east and west directions just as we proceed in north and south directions from the Equator in the ordinary Mercator projection. Since the projection has been turned through a right angle, it is better to interchange the x and y coordinates to conform to the generally accepted relations. Thus the x coordinate will be expressed by the formula

$$x=S+\frac{S^3}{6a^2}$$

instead of the y value as in the ordinary Mercator projection. In a similar way the new y coordinate is placed equal to the distance along the meridian reckoned from some arbitrary point as origin. This point is always chosen far enough south to make sure that all of the y values in the region to be mapped will be positive. This is accomplished by taking $y=0$ at a latitude some distance south of the most southern point to be included in the projection.

METHOD OF COMPUTATION OF THE PROJECTION

To establish the projection, we need to be able to compute two elements. These are the correct distance along the central meridian from the point of origin and the length of a perpendicular let fall from any point on this central meridian. These elements are indicated on the sphere shown in figure 1. The lengths along the meridian are easily computed but it requires some manipulation to compute the perpendicular on the meridian. It could be done by solving a spherical triangle but this would be more work than necessary. By basing the computation on the position computation formula, we have succeeded in making the calculation by a comparatively short formula. We imagine that we know the point of the foot of the perpendicular on the central meridian and that we are computing the difference of longitude between it and the given station. The azimuth is perpendicular to the meridian and hence the sine is either +1 or −1. In any case the log sin=0. Now we know the difference of longitude from the known longitude of the station and from the adopted longitude of the central meridian. Since we are computing from the central meridian to the station, the latitude of the station is the ϕ' for which the A factor is to be taken out and also for which cos ϕ' is to be used as given in our position computation form.

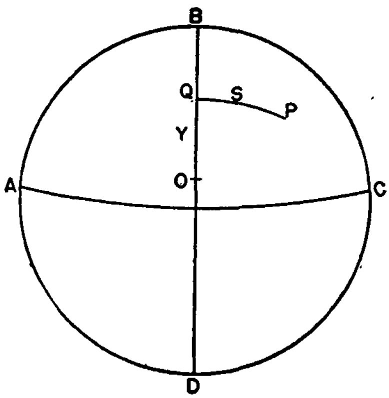

FIGURE 1.—Sphere illustrating the elements of the transverse Mercator projection.

For convenience we omit the prime and take out log A for the latitude of the station and log cos ϕ for the same. In the position computation form, everything is known but the length; we must therefore work backward, since $\Delta\lambda$ is known and we wish to determine the length or S. Remembering that the numerical value of sin α is one, we proceed as follows. We first apply the arc-to-sine correction to log $\Delta\lambda$, giving

$$\log \Delta\lambda_1 = \log \Delta\lambda - \text{correction arc to sine.}$$

Then we have

$$S_1 = \frac{\Delta\lambda_1 \cos\phi}{A}.$$

This is computed by logarithms since the A factors are given as logs. As a final step we must apply the sine-to-arc correction to log S_1 to get log S_m.

$$\log S_m = \log S_1 + \text{correction sine to arc.}$$

This gives us the length of this perpendicular on the central meridian expressed in meters. The subscript m is used to denote that the unit is the meter. You will note that the arc-to-sine corrections are applied in the reverse order to what is done in the direct position computation because we are really backing up on the computation and the processes should be reversed.

Now we have methods of determining the two elements necessary for the projection. In order to preserve the balance of scale error in the projection an arbitrary reduction is made on all elements so as to have the scale too small near the central meridian. In this way the scale at the east and west margins of the projection will not be excessively large. We aim in most cases to have the scale just as much too large along these margins as it is too small along the central meridian. We have not been able in all cases to attain this ideal because of the irregular shapes of the regions to be included, but that is the goal toward which we strove in all cases. This plan is exactly similar to what is done in the Lambert projection when the scale along two chosen parallels is held. In this case, instead of parallels, we have the scale correct along two small circles whose planes are parallel to the central meridian plane, and some miles distant from it depending upon the amount of the reduction in scale placed on the central meridian.

The projection tables have the y values along the central meridian tabulated for every minute of latitude. These are merely the length along the central meridian from the latitude at which $y=0$, with the chosen reduction in scale applied. With these are also tabulated the tabular differences for 1 second of latitude.

Now we can proceed with the computation of the coordinates. Since we have the length of the perpendicular in meters, we must reduce it to feet since the foot is the unit for all of the tables. The length reduced to feet with the reduction factor applied is denoted by S_g which means merely the length on the projection or the grid length.

$$S_g = \frac{3{,}937}{1{,}200} S_m R.$$

The factor $\frac{3{,}937}{1{,}200}$ reduces the length to feet and R is the scale reduction factor, the log of which is given in the tables. The log of the reduction to feet is printed on the computation form, but log R must be written in for the State in which the computation is being made. It is a constant for any given system, but when two or more systems are established in a given State the value of log R may be different on the different systems. Next we have

$$x' = S_g + \left(\frac{S_g^3}{6\rho_0^2}\right)_g$$

and

$$\log\left(\frac{1}{6\rho_0^2}\right)_g = \log\frac{1}{6\rho_0^2 R^2}.$$

Log $\left(\frac{1}{6\rho_0^2}\right)_g$ is a constant for a given system and is given in the tables.

At this point we introduce a slight departure from strict conformality. To make such a projection strictly conformal, we should have to first project the spheroid on a sphere conformally and then work on this sphere entirely. This would make the scale vary along the central meridian and this is just what we wish to avoid. It was thought advisable to tolerate slight deviations from conformality rather than to introduce added complications.

The value of ρ_0 is computed in the following way. A latitude about the mean of the region to be included in the system is chosen. Then with log A and log B from the position-factor tables given in Special Publication No. 8, we have

$$\log \rho_0 = 5.8304093 - \frac{1}{2}\log A - \frac{1}{2}\log B.$$

As stated before, log $\left(\frac{1}{6\rho_0^2}\right)_g$ is a constant value given in the tables for each of the various systems; so there is no occasion to compute any such value.

For the extent of longitude that is included in the various systems, the term that includes this constant is not very large so that the combined effect on the final value of the x coordinate is not very great. Since all neighboring points are similarly affected, the value of Δx for any such stations is affected much less than the values of the individual x's.

After x' is computed, it will have the same sign as $\Delta\lambda$; that is, positive to the east of the central meridian and negative to the west of it.

To obviate the use of signs on the coordinates, an arbitrary constant, is added algebraically to the computed x' values. In all of the states with the transverse Mercator projection except New Jersey this constant is taken as 500,000. For New Jersey the value is taken as 2,000,000 because early computations with this value were made in this state in conformity with the value used in most of the States with the Lambert projection.

To determine the y coordinate, we must know the latitude of the foot of the perpendicular on the central meridian. We now return to the position computation formula. In the latitude part of the formula, all of the principal terms are zero except the second. This comes about because the azimuth of the line at this point is perpendicular to the meridian. In direct computation, we should know the latitude of this foot of the perpendicular, but in this case we are computing inversely. In all cases that will arise this difference of latitude between the foot of the perpendicular and the given station is not very great. The log of the C factor should be taken out for the latitude of the foot of the perpendicular, but this is what we are trying to compute. Since the difference of latitude is not large, as already stated, we can take out log C for the latitude of the station as an approximate value and thus compute an approximate $\Delta\phi$ by the formula

$$\Delta\phi = CS_m^2$$
$$\text{or } \log \Delta\phi = 2 \log S_m + \log C.$$

When this value of $\Delta\phi$ is added to the latitude of the station, we get an approximate ϕ'. With this value of ϕ', we go back and change log C and thus compute the final value of $\Delta\phi$ and so of ϕ'. To the y value for the minutes of ϕ' taken from the table, we add the interpolated value for the seconds of ϕ' and thus obtain the y coordinate.

The rest of the computation form is merely the computation of the back azimuth between the station and the foot of the perpendicular on the central meridian.

This gives approximately the difference between the grid azimuth at the station and the true azimuth at the point. If the straight line joining two points on the projection represented the geodetic line joining them, this back azimuth would be the exact difference between the grid azimuth and the true azimuth at the station. To take care of this element, a small correction term has to be computed as shown in the tables for the various systems.

Since it was necessary to compute longer lines with greater accuracy in this work than is usual in position computations, a table of colog A and log C was computed one place farther than is given in Special Publication No. 8. These are given in each table for the latitude included in the table. The arc-to-sine corrections can be taken from Special Publication No. 8, or from a sheet that has been reproduced from it. The log of the factor F must be taken from Special Publication No. 8. The back azimuth computation does not need to be made in general unless there is an azimuth mark at the station that needs to be reduced to a grid azimuth. With these we can reduce the true azimuth of the azimuth mark by the formula

$$\text{grid azimuth} = \text{geodetic azimuth} - \Delta\alpha.$$

The correction term on these azimuth stations would be negligible because they are always comparatively near the station. It should be noted that the $\Delta\alpha$ will have the same sign as $\Delta\lambda$ and hence will be plus east of the central meridian and minus west of it. It follows that grid azimuths east of the central meridian are smaller than the geodetic azimuths and those west of the central meridian are larger than the corresponding geodetic azimuths.

For all stations for which coordinates can be computed, the grid azimuths should be computed from the differences of the coordinates. With the azimuth marks, we have to use the other method because the distance of the mark from the station is not accurately measured.

Figure 2 shows schematically how these computed elements are laid down in the plane to serve as the coordinates of the station on the projection.

THE TABLES

The tables are intended for the purpose of computing the coordinates of a station from its geodetic position. As arranged they consist of three parts. Table I gives the y values in feet for every minute of latitude for the extent covered by the State. With these is given a column with the tabular differences for 1 second of latitude. This makes it an easy matter to interpolate for the seconds of ϕ'. Table II gives the scale factors for every 5,000 feet from the central meridian. These are given in two forms; one in units of the seventh place of decimals and another as a ratio. The first is more convenient when logs are used and the second for calculating-machine work. In table III we have given the values of colog A and log C to 1 decimal place further than they could be found in Special Publication No. 8. These values are given for every minute of latitude which makes it convenient for interpolation for the fraction of a minute given by the seconds of latitude. In some of the States, tables II and III are interchanged; that is, what is table III in this State is listed as table II, and table II as table III. In all States, however, the same 3 tables are given as the necessary data for the computation of coordinates.

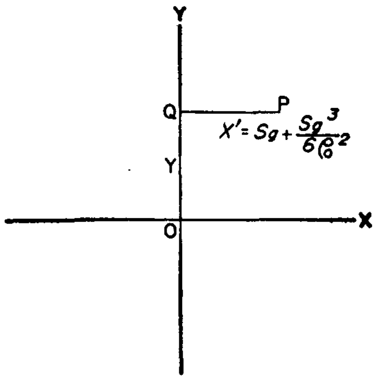

FIGURE 2.—Transverse Mercator coordinates in the plane.

DESCRIPTION OF THE COMPUTATION FORM

In figure 3 we have shown an index copy of the computation form for the transverse Mercator projection. The various items are indicated by consecutive numbers and we shall now explain in detail what each numeral stands for. Item no. 1 is the latitude of the station to be reduced to coordinates. Item no. 2 is the longitude of the central meridian of the system and item no. 3 is the longitude of the station. Item no. 4 is the difference of longitude from the station to the central meridian. This quantity should be given its proper sign, plus when the station is east of the central meridian and minus when it is west. Item no. 5 is this longitude difference reduced to seconds; the proper sign should also be retained with this quantity. Item no. 6 is the log of no. 5. Item no. 7 is the arc-to-sine correction taken from the latest edition of Special Publication No. 8 or from the sheet reproduced from the same. The old editions of the publication gave this correction in units of the seventh place of decimals and hence the later edition is needed since the computation should be made in general to 8 places of decimals. The log of $\Delta\lambda$ is the argument to be used in this table. When this correction is subtracted from log $\Delta\lambda$, we get item no. 8 which we denote by log $\Delta\lambda_1$. Item no. 9 is the log cosine of no. 1 or the latitude of the station. This should be taken from the eight-place trigonometric table.

Item no. 10 is the colog of the A factor which is taken from table no. II of the given coordinate tables. The latitude ϕ is the argument for this factor. The values are tabulated for every minute of latitude and interpolation should be made for the seconds of latitude. Item no. 11 is the sum of the last three items and we have denoted it by log S_1. Item no. 12 is the correction for sine to arc and it is merely the arc-to-sine correction applied in the opposite manner; that is, it is added instead of subtracted. This is obtained from the same table as was used for the correction to log $\Delta\lambda$. The log of S_1 is the argument. For those who are not familiar with the computation of geodetic positions, we should call attention to the fact that this table is arranged with the argument log S at the left and log $\Delta\lambda$ at the right of

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State		Station	
		λ (Central meridian)	° ′ ″ 2
φ	° 1 ′ ″	λ	3
		Δλ (Central meridian−λ)	4
		Δλ (in sec.)	″ 5

log Δλ	6	log S_m^2	23
Cor. arc to sine	− 7	log C*	24
log $\Delta\lambda_1$	8	log Δφ	25
log cos φ	9		′
colog A	10	φ	° 26 ″
log S_1	11	Δφ	+ 27
Cor. sine to arc	+ 12	φ′	28
log S_m	13		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	29
log R	− 14		
log S_g	15	y (for min. of φ′)	30
log S_g^3	16	y (for seconds of φ′)	+ 31
log $1/6\rho_0^2R^2$	17	y	32
log $(S_g^3/6\rho_0^2)_g$	18		
S_g	19	log sin $\frac{\phi+\phi'}{2}$	33
		log Δλ	34
$(S_g^3/6\rho_0^2)_g$	20	log $\Delta\alpha_1$	35
x′	21		
	500,000.00	log $(\Delta\lambda)^3$	36
x	22	log F	37
		log b	38
		$\Delta\alpha_1$	39 ″
		b	40
		Δα	41 ″
		Δα	° 42 ″

* Take out C first for φ and correct for approximate φ′

FIGURE 3.—Index of the computation form.

the column that gives the correction. For log $\Delta\lambda$ therefore we should look to the right of the column and for log S to the left. When this correction is added to log S_1, we obtain log S_m which is the length of the perpendicular on the central meridian expressed in meters. Since the coordinates are expressed in feet, we make the reduction to feet by adding the log of the reduction factor which is printed on the form.

Item no. 14 is the log of the reduction factor which is a constant for any given system and is given in the coordinate tables with the list of constants. This value is in general confined to the last four places of the eight-place logs and it is always subtracted. For those who cannot readily add two numbers and at the same time subtract a third, we would advise the addition of the first two on a separate slip of paper and then the subtraction of log R from the last four digits of the result. This gives us item no. 15 which we have denoted by log S_g; it is merely the length of the perpendicular expressed in feet and reduced for the scale reduction. Item no. 16 is this log multiplied by 3 to give the log S_g^3; this should be given to seven decimal places. Item no. 17 is another constant of the projection table and is listed with the constants as log $\left(\frac{1}{6\rho_0^2}\right)_g$. The last two items added together give item no. 18 which is the second term in the series for x'. Item no. 19 is the number corresponding to the log given as item no. 15, and item no. 20 is the same for no. 18. These last two items added together give item no. 21 which is the x' distance from the central meridian. This quantity has the same sign as item no. 5, being plus when the station is east of the central meridian and minus when it is west. This item added algebraically to the constant gives item no. 22 which is the final x coordinate for the station.

Next we must determine the y coordinate. Item no. 23 is log S_m multiplied by 2 to give the log of the square of S_m; this is used to six decimal places only. Item no. 24 is the log of the C factor taken from the coordinate table as an approximate value with the argument ϕ given as item no. 1. These values are listed for every minute of latitude, and interpolation should be made for the seconds of ϕ. This value can be most conveniently taken out at the same time that item no. 10 is looked up in the table since the two factors are listed together.

These two values added give item no. 25, which is an approximate value of log $\Delta\phi$. Item no. 26 is merely item no. 1 recopied on the form. Item no. 27 is the number corresponding to the log in item no. 25. These last two items added together give item no. 28 as an approximate value of ϕ'. Now with this approximate value of ϕ', we return to the table for log C and make a new interpolation to get a final value for log C. This will change items nos. 25 and 27 and will give the final value for no. 28. The value of $\Delta\phi$ should be taken out to four decimal places. Items nos. 29 and 30 are taken from coordinate table I, using the degrees and minutes of ϕ' as argument. Item no. 31 is item no. 29 multiplied by the seconds of ϕ'. These last two items added together give item no. 32 which is the final y coordinate for the station.

The remainder of the form is for the computation of the back azimuth from ϕ to ϕ'. Item no. 33 is the log sine of the mean of ϕ and ϕ'. Item no. 34 is item no. 6 recopied in this place. These two items added together give item no. 35, the main term of the back azimuth. Item no. 36 is item no. 34 multiplied by 3 to give the log of the cube of $\Delta\lambda$.

This is taken to only three decimal places. Item no. 37 is the log of the F factor taken from Special Publication No. 8 with ½ $(\phi+\phi')$ as argument. These last two items added together give item no. 38. Item no. 39 is the number corresponding to the log given as item no. 35, and item no. 40 is the same for item no. 38. These last two items added together give item no. 41 which is the $\Delta\alpha$ in seconds. Item no. 42 is this same value reduced to degrees, minutes, and seconds. As already explained, this value is only used to reduce the geodetic azimuth of an azimuth mark to a grid azimuth. For most stations this computation of the back azimuth would not need to be made, and the computation could close when the x and y coordinates were obtained.

DESCRIPTION OF AN ACTUAL COMPUTATION

As an example of an actual computation we shall describe the computation of the coordinates for the station Eastman located in Rochester, N. Y., in the western system in that State. The latitude of the station is 43°09′38″.886 and the longitude 77°37′11″.842. These data are taken from the list of geodetic positions. These values are copied as items nos. 1 and 3 of figure 3. The central meridian for New York-West is found on page 92 (fig. 18) of the table for the State and its value is 78°35′. This is copied as item no. 2 of figure 3. The value of $\Delta\lambda$ is +0°57′48″.158 or +3,468″.158. These values appear as items nos. 4 and 5 of figure 3. The log of $\Delta\lambda$ is found from the eight-place table to be 3.54009887, which is item no. 6 of figure 3. From the table of arc-to-sine corrections the correction is found to be 2,046 by using 3.5401 as the argument in the log $\Delta\lambda$ column at the right of the column of corrections. This value subtracted from log $\Delta\lambda$ gives 3.54007841 as the value of log $\Delta\lambda_1$. The log cosine of 43°09′38″.886 is found from the eight-place trigonometric table to be 9.86298766−10. From the State coordinate table on page 95 (fig. 18), by interpolation between the value for 43°09′ and 43°10′, we obtain the value of colog A as 1.49096228 which is inserted on the form as item no. 10 of figure 3. At the same time, in the same way, we obtain the approximate value of log C as 1.376288−10 which is inserted as item no. 24 of figure 3. By addition we find 4.89402835 to be the value of log S_1. Again from the table of arc-to-sine corrections with 4.8940 as argument in the log S column we find the correction to be 1,089. When this is added to log S_1 we get log S_m as 4.89403924. On page 92 (fig. 18) of the State table we find log R to be −2,714 in units of the eighth decimal place of the logarithms. By addition we find the value of log S_g to be 5.40999627. By multiplying this by 3 and dropping to seven places of decimals, we get 16.2299888. Again on page 92 (fig. 18) of the State table, we find log $\left(\frac{1}{6\rho_0^2}\right)_g$ to be 4.5807825−20. This added to log S_g^3 gives the log of this term to be 0.8107713. From the table of logs of numbers we find S_g to be +257,037.371 and $\left(\frac{S_g^3}{6\rho_0^2}\right)_g$ to be +6.468, and by addition we find x' equal to +257,043.84. All of these last three quantities have the same sign as $\Delta\lambda$; that is, plus when east of the central meridian and minus when west of it. By adding x' algebraically to the constant 500,000, we obtain the value of x as 757,043.84.

Now at the top of the form at the right we insert twice the log of S_m dropping down to six places of decimals. This added to the log of C, 1.376288−10, already found gives the approximate log $\Delta\phi$ as 1.164366. The number 14.6004 corresponding to this log is added to ϕ which is recopied on the form as item no. 26 of figure 3, giving the approximate ϕ' as 43°09′53″.4864. Now with this value of ϕ' we return to the State table on page 95 (fig. 18) and interpolate the final value of log C. We find it to be 1.376350−10 and this gives 1.164428 for the value of log $\Delta\phi$. On looking up the number corresponding to this log, we get 14.6025 for the final value

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Eastman

		λ (Central meridian)	78° 35′ 00″.000
φ	43° 09′ 38″.886	λ	77 37 11.842
		Δλ (Central meridian-λ)	+ 0 57 48.158
		Δλ (in sec.)	+ 3468.158″

log Δλ	3.54009887	log S_m^2	9.788078
Cor. arc to sine	− 2046	log C*	350 1.376~~288~~-10
log $\Delta\lambda_1$	3.54007841	log Δφ	428 1.164~~366~~
log cos φ	9.86298766-10		
colog A	1.49096228	φ	43° 09′ 38″.886
log S_1	4.89402835	Δφ	+ 25 14.60~~64~~
Cor. sine to arc	+ 1089	φ′	85 43 09 53.48~~64~~
log S_m	4.89403924		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23900
log R	− 2714		
log S_g	5.40999627	y (for min. of φ′)	1,147,727.29
log S_g^3	16.2299888	y (for seconds of φ′)	+ 5,415.12
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,153,142.41
log $(S_g^3/6\rho_o^2)_g$	0.8107713		
		log sin $\frac{\phi+\phi'}{2}$	9.8351031
S_g	+257,037.371	log Δλ	3.5400989
$(S_g^3/6\rho_o^2)_g$	+ 6.468	log $\Delta\alpha_1$	3.3752020
x′	+257,043.84		
	500,000.00	log $(\Delta\lambda)^3$	10.620
x	757,043.84	log F	7.854-20
		log b	8.474-10
		$\Delta\alpha_1$	+ 2372″.48
		b	+ 0.03
		Δα	+ 2372″.51
		Δα	+ 0° 39′ 32″.51

* Take out C first for φ and correct for approximate φ′

FIGURE 4.—Computation of coordinates for Eastman.

of $\Delta\phi$ and 43°09′53″.4885 as the final value of ϕ'. Now we return to the State table on page 88 (fig. 18) and opposite 43°09′ we find 1,147,727.29 for y (for minutes of ϕ') and 101.23900 as the tabular difference of y for 1 second of ϕ'. These are inserted as items nos. 30 and 29 of the index. Now the tabular difference is multiplied by the seconds of ϕ' or 53.4885 giving 5,415.12 which becomes item no. 31 of figure 3. This quantity is added to the y for minutes of ϕ', giving the value of y as 1,153,142.41. These coordinates are expressed in feet since the tabular values are so expressed.

The computation for the back azimuth is then made. The mean of ϕ and ϕ' is 43°09′46″.19 of which the log sine is 9.8351031−10. To this we add the log $\Delta\lambda$ already found as 3.5400989 giving log $\Delta\alpha_1$, as 3.3752020. Multiply log $\Delta\lambda$ by 3 and, using 3 decimal places, we get 10.620. Log F from Special Publication No. 8 is found to be 7.854−20 for the mean ϕ. These last quantities added give log b as 8.474−10. The numerical values of $\Delta\alpha_1$ and b are found from the log table to be +2372″.48 and +0″.03, respectively. By adding these we get for $\Delta\alpha$, +2372″.51, or +0°39′32″.51. This completes the entire computation.

COMPUTATION OF THE GRID AZIMUTH FROM COORDINATES

With two stations for which the coordinates are given, the grid azimuth of the line joining them can be found in the following manner: Subtract the coordinates of the station at which the azimuth is desired from the respective coordinates of the other station. Always perform the subtraction in this way and give the proper sign to both Δx and Δy. Then log tan α=log Δx−log Δy. In this operation no attention needs to be paid to the signs of Δx and Δy. From the table take out the angle α, corresponding to log tan α, in the first quadrant. Then the grid azimuth can be found in its proper quadrant in the following way, depending upon the signs of Δx and Δy:

1. If Δx is negative and Δy negative, then the grid azimuth is equal to α.
2. If Δx is negative and Δy positive, the grid azimuth is equal to $180°-\alpha$.
3. If Δx is positive and Δy positive, the grid azimuth is equal to $180°+\alpha$.
4. If Δx is positive and Δy negative, the grid azimuth is equal to $360°-\alpha$.

These rules will serve to locate the grid azimuth for any case that may arise provided the coordinates of the station of the origin are subtracted from the respective coordinates of the station observed. Care should *always* be taken to append the proper sign to Δx and Δy.

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 necessity exists because the geodetic line on the earth joining two stations is not exactly represented 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. It is the present practice in the Coast and Geodetic Survey to establish azimuth marks at the main stations at a distance of one-half to 1 mile from the station to serve as an initial mark for turning off an azimuth for a traverse, if such should be needed. With these in general, we do not have the geographic positions because their distances from the stations are given only approximately. In such cases and only in such cases, the grid azimuth can be found by subtracting the $\Delta\alpha$ from the geodetic azimuth on the mark. This is permissible in such cases because the distance of the mark from the station is small and the correction term contains Δy as a factor and hence its value would be small in all cases. It should be remembered that when $\Delta\alpha$ 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 A TRAVERSE

We find it most convenient to compute the grid azimuths of the lines of the traverse before copying anything on the computation form. From the coordinates of the ends of the initial line, the starting grid azimuth is computed as already described. Then the successive angles are added at the various stations, the back azimuth on any line being determined by adding 180° to the forward azimuth and dropping out 360° if the sum is greater than that amount. It is thus seen that the troublesome matter of the convergence of the meridians is entirely avoided.

After the discrepancy is determined by the check on the final control azimuth, this discrepancy can be prorated on the various angles of the traverse to give values of the grid azimuths of the lines to be used in the computation of coordinates. In the case of a loop traverse, the starting and the ending azimuths are the same. These calculations are shown just preceding the computations of each of the traverses in the following examples.

SEA-LEVEL REDUCTION, APPROXIMATE METHOD

Since all geodetic positions are computed on a sea-level surface of the ellipsoid,[1] 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.

[1] 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.

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 (feet)	Sea-level factor
Sea level	1.0000000
500	.9999761
1,000	.9999522
1,500	.9999283
2,000	.9999043
2,500	.9998804
3,000	.9998565
3,500	.9998326
4,000	.9998087
4,500	.9997848
5,000	.9997609
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 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 (feet)	Correction factor
Sea level	0.00
500	2.39
1,000	4.78
1,500	7.17
2,000	9.57
2,500	11.96
3,000	14.35
3,500	16.74
4,000	19.13
4,500	21.52
5,000	23.91
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.

620745 O - 44 - 2

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.

$$0.04328\times 8.61=0.373$$

and

$$4{,}327.596-0.373=4{,}327.223$$

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

LENGTH REDUCTIONS

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 compute a mean elevation for the traverse as a whole for the computation of the sea-level reduction. However, if the course of the traverse is very rugged with great variations in elevation, it is necessary to compute a reduction factor for each line individually. It may happen that a given line runs for a time with slight variations of elevation and then by a sudden change proceeds for the remainder of the way at a higher or lower elevation. In this case we can compute elevation factors for the separate sections to sufficient exactness.

For these reductions, it is the general custom to compute a mean radius for the given region. If we denote this mean radius by R_a, it can be computed from the formula,

$$R_a=\sqrt{RN},$$

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

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

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

Similarly

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

The factor $\frac{3{,}937}{1{,}200}$ is introduced to reduce the radii to feet, since A and B are based on the meter as a unit. The quantity $\frac{1}{\sin 1''}\times\frac{3{,}937}{1{,}200}$ 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 sea-level reduction factor by the formula,

$$\text{Reduction factor}=\frac{R_a}{R_a+h},$$

in which h is the average elevation of the traverse or of a given line in case it is necessary to reduce the lines individually.

After the sea-level reduction is applied, it is then necessary to reduce the geodetic lengths to grid lengths if it is desired to get the best out of the work. In the transverse Mercator projection the scale varies with the distance from the central meridian. In most cases it would be exact enough to estimate a mean distance from the central meridian and thus determine a grid factor to apply to the whole extent of the traverse. To be most exact, however, it would be necessary to compute the approximate x coordinates throughout the traverse with lengths uncorrected. From these a mean x' for each line could be found and interpolation in table II would give the scale factor for each line. For traverses that run approximately north and south, a mean value for the whole line could be found from the mean of the x' values of the two end, or control, stations. If Geological Survey quadrangle maps are available for the extent of the traverse, the line can be plotted approximately on them; and then it can be determined just how much the middle of each line is east or west of the station of origin and from this the x' for the middle of the line could be ascertained to a sufficient degree of exactness. In any case it is better to determine a mean scale factor for the whole traverse rather than not to take any account of the scale.

The five C. W. A. traverses in the vicinity of Rochester, N. Y., had been computed on the Rochester local system of coordinates. Since the Δx's in that computation did not differ very greatly from the Δx's on the State system, they were used to compute the x''s for the determination of the scale factors. If these had not been available, we should without doubt have resorted to the plotting of the traverses on the Geological Survey quadrangle map, a copy of which we had at hand.

COMPUTATION OF THE COORDINATES

We are now in a position to begin the actual computation of the coordinates of the traverse. The grid azimuths of the lines corrected for azimuth closure are copied onto the computation form together with the grid lengths of the lines that have already been computed. Just beneath the grid length of the individual lines is given the continuous sum of the grid distances limited to the nearest foot. These values are to be used in prorating the discrepancies in the x and y coordinates. All of the computations of traverses in the vicinity of Rochester, N. Y., which are included in this publication have been made in duplicate; first with 8-place logarithms and second with 8-place natural functions. Seven-place logarithms would be amply sufficient for the work since the lines are not long enough to require more places, but we used the 8-place tables to put the two computations on the same basis. The second computation is the shorter if a multiplying machine is available together with an 8-place natural-function table for every second of arc. Since it is easier to get the logarithmic tables than it is to get the natural tables and the machines, 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 rules following:

1. If the azimuth is between 0° and 90°, the latitude is *minus* and the departure is *minus*.
2. If the azimuth is between 90° and 180°, the latitude is *plus* and the departure is *minus*.
3. If the azimuth is between 180° and 270°, the latitude is *plus* and the departure is *plus*.
4. If the azimuth is between 270° and 360°, the latitude is *minus* and the departure is *plus*.

These rules give the signs to be assigned to the latitudes and departures as they are computed and listed in their respective columns. These quantities are then successively added to the y and x values starting with the fixed value of the control station of origin. The fixed values of the last or check station when subtracted from the computed value of the same give the discrepancies in closure of 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 factors, respectively. These should be given signs opposite to those of the discrepancies 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 of lengths give the corrections to be applied to the various coordinates. If a multiplying machine is not available, these multiplications can probably be made most easily by logarithms since 5-place logarithms will be sufficient in almost any case that may arise in practice. With a 7- or 8-place table, it would be sufficiently accurate to make the multiplications without interpolation; since the last figures will scarcely be needed to give the required result.

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. In practically all cases, this azimuth will differ somewhat from that 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 in case it should be needed. As a matter of fact, but few of them will ever 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 to one of the neighboring stations. There is no reason, however, that the individual azimuths should not be computed and listed once and for all if anyone so desires. It is not necessary to give the azimuth from both ends of the line, because the back azimuth differs from the forward azimuth by 180°, which can be applied if needed.

COMPUTATION OF TRAVERSES IN THE VICINITY OF ROCHESTER, N. Y.

In all, five traverses in the vicinity of Rochester, N. Y., were computed for this publication. All of the observations on these were made by engineers working under the C. W. A. program. They are all based on control points of the Rochester city survey. For these

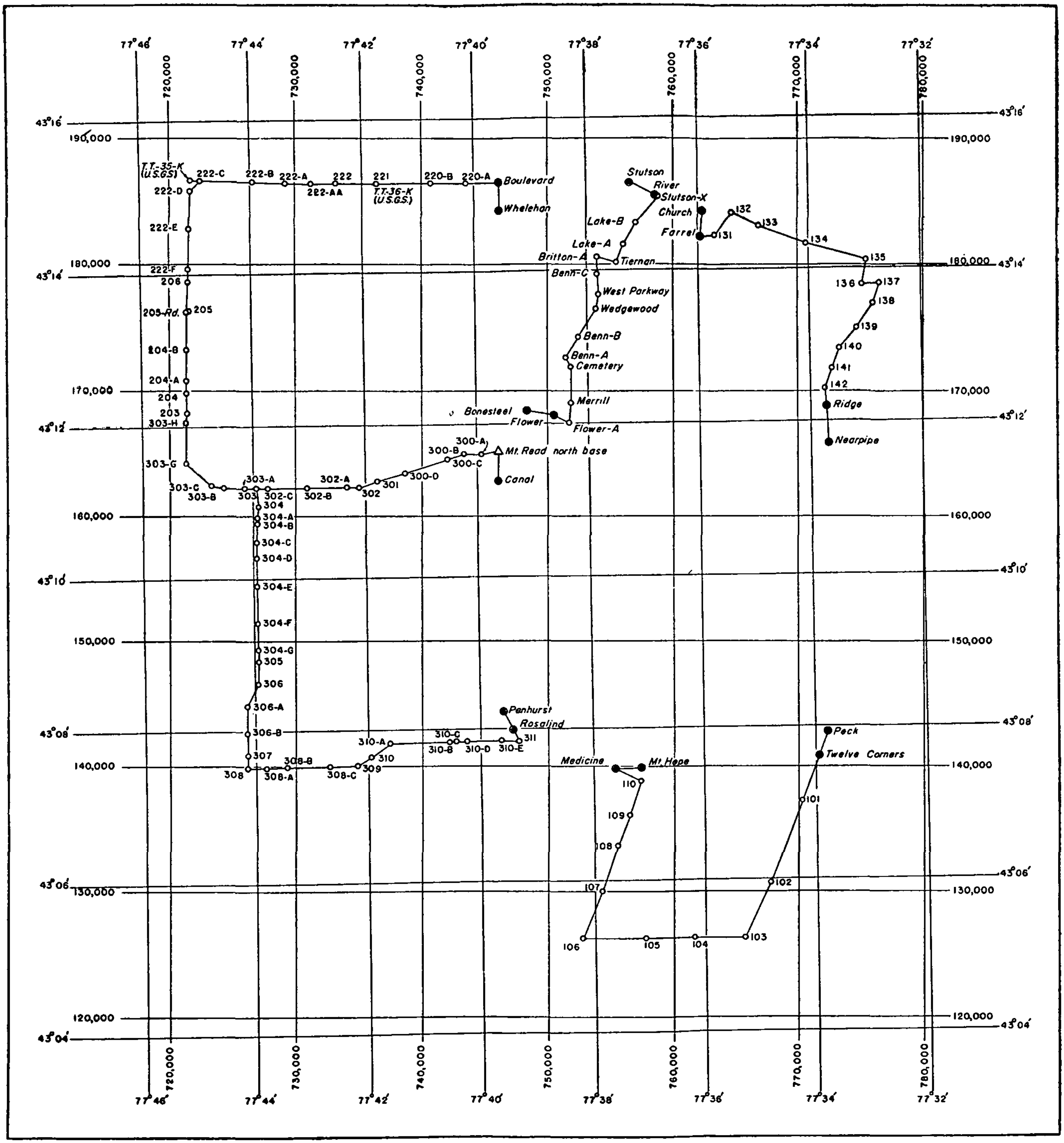

FIGURE 5.—Sketch of traverses in the vicinity of Rochester, N. Y.

control points no geodetic positions were available, but they were computed on a local system of plane coordinates. For this reason the grid coordinates of the control stations were computed by the method of transformation of a local system of plane coordinates to coordinates on the grid system. This method of transformation is given on page 174 et seq. In that section the coordinates of all of the control stations are computed, and it is there that they should be sought if needed. Only one triangulation station was used; and even for that the coordinates that resulted from the transformation were used instead of the values given from the geodetic position, because it was considered that these values would be more consistent with the others obtained by means of transformation.

On these five traverses the computations were made in duplicate; first with logarithms and then with natural functions by use of a calculating machine. It was thought that probably most computations of this kind would be made with logarithms rather than with natural functions, since it is easier to get the logarithmic tables than it is to get the natural tables and a machine. We used 8-place tables for both computations, but 7-place tables would be amply sufficient for general use.

COMPUTATION OF TRAVERSE NO. 3, MOUNT READ NORTH BASE TO ROSALIND

This traverse was the first to be computed. Roughly, it consists of three sides of an approximate square, the fourth side being held fixed by the Rochester city survey. It lies to the west of the city proper. All of the details of the computation are clearly shown on the following computation pages. For a sketch of the traverse see figure 5.

Computation of grid azimuths for control

MOUNT READ NORTH BASE TO CANAL

	x	y
Canal	746, 123. 28	1, 162, 873. 20
Mount Read north base	746, 119. 78	1, 165, 344. 75
Δx and Δy	+3. 50	−2, 471. 55

$$\log \Delta x = 0.5440680$$
$$\log \Delta y = 3.3929694$$
$$\log \tan \alpha = 7.1510986-10$$
$$\alpha = 0°04'52''.1$$
$$\text{grid azimuth} = 359°55'07''.9$$

ROSALIND TO PENHURST

	x	y
Penhurst	746, 490. 80	1, 144, 427. 02
Rosalind	747, 265. 26	1, 142, 983. 18
Δx and Δy	−774. 46	+1, 443. 84

$$\log \Delta x = 2.8889990$$
$$\log \Delta y = 3.1595190$$
$$\log \tan \alpha = 9.7294800-10$$
$$\alpha = 28°12'31''.1$$
$$\text{grid azimuth} = 151°47'28''.9$$

List of angles

Station	From station—	To station—	Angle °	′	″
Mount Read north base	Canal	300A	77	54	31.5
300A	Mount Read north base	300B	192	03	52.1
300B	300A	300C	162	27	12.1
300C	300B	300D	179	34	48.8
300D	300C	301	181	04	54.6
301	300D	302	177	52	56.2
302	301	302A	201	12	25.8
302A	302	302B	177	22	47.5
302B	302A	302C	179	47	05.4
302C	302B	303	181	43	40.8
303	302C	304	84	16	49.6
304	303	304A	186	30	45.2
304A	304	304B	183	52	20.6
304B	304A	304C	175	37	25.8
304C	304B	304D	177	50	07.1
304D	304C	304E	179	57	54.2
304E	304D	304F	180	38	29.6
304F	304E	304G	179	20	29.6
304G	304F	305	177	42	52.1
305	304G	306	185	30	57.1
306	305	306A	203	57	57.7
306A	306	306B	153	17	19.6
306B	306A	307	178	08	56.2
307	306B	308	182	27	59.0
308	307	308A	86	56	02.1
308A	308	308B	181	40	42.2
308B	308A	308C	180	21	55.4
308C	308B	309	177	53	02.5
309	308C	310	154	14	30.8
310	309	310A	172	10	28.8
310A	310	310B	215	03	10.4
310B	310A	310C	180	17	54.6
310C	310B	310D	181	48	31.8
310D	310C	310E	177	08	59.8
310E	310D	311	183	19	59.4
311	310E	Rosalind	63	48	44.2
Rosalind	311	Penhurst	176	54	27.5

Computation of grid azimuths

Stations	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
Mount Read north base to Canal	359	55	07.9			07.9
∠Canal to 300A	77	54	31.5	−1.2		30.3
Mount Read north base to 300A	77	49	39.4			38.2
300A to Mount Read north base	257	49	39.4			38.2
∠Mount Read north base to 300B	192	03	52.1	−1.3		50.8
300A to 300B	89	53	31.5			29.0
300B to 300A	269	53	31.5			29.0
∠300A to 300C	162	27	12.1	−1.2		10.9
300B to 300C	72	20	43.6			39.9
300C to 300B	252	20	43.6			39.9
∠300B to 300D	179	34	48.8	−1.3		47.5
300C to 300D	71	55	32.4			27.4
300D to 300C	251	55	32.4			27.4
∠300C to 301	181	04	54.6	−1.3		53.3
300D to 301	73	00	27.0			20.7
301 to 300D	253	00	27.0			20.7
∠300D to 302	177	52	56.2	−1.2		55.0
301 to 302	70	53	23.2			15.7
302 to 301	250	53	23.2			15.7
∠301 to 302A	201	12	25.8	−1.3		24.5
302 to 302A	92	05	49.0			40.2
302A to 302	272	05	49.0			40.2
∠302 to 302B	177	22	47.5	−1.3		46.2
302A to 302B	89	28	36.5			26.4
302B to 302A	269	28	36.5			26.4
∠302A to 302C	179	47	05.4	−1.2		04.2
302B to 302C	89	15	41.9			30.6
302C to 302B	269	15	41.9			30.6
∠302B to 303	181	43	40.8	−1.3		39.5
302C to 303	90	59	22.7			10.1
303 to 302C	270	59	22.7			10.1
∠302C to 304	84	16	49.6	−1.3		48.3
303 to 304	355	16	12.3		15	58.4
304 to 303	175	16	12.3		15	58.4
∠303 to 304A	186	30	45.2	−1.2		44.0
304 to 304A	1	46	57.5			42.4
304A to 304	181	46	57.5			42.4
∠304 to 304B	183	52	20.6	−1.3		19.3
304A to 304B	5	39	18.1			01.7
304B to 304A	185	39	18.1			01.7
∠304A to 304C	175	37	25.8	−1.3		24.5
304B to 304C	1	16	43.9			26.2
304C to 304B	181	16	43.9			26.2
∠304B to 304D	177	50	07.1	−1.2		05.9
304C to 304D	359	06	51.0			32.1
304D to 304C	179	06	51.0			32.1
∠304C to 304E	179	57	54.2	−1.3		52.9
304D to 304E	359	04	45.2			25.0
304E to 304D	179	04	45.2			25.0
∠304D to 304F	180	38	29.6	−1.3		28.3
304E to 304F	359	43	14.8		42	53.3
304F to 304E	179	43	14.8		42	53.3
∠304E to 304G	179	20	29.6	−1.2		28.4
304F to 304G	359	03	44.4			21.7
304G to 304F	179	03	44.4			21.7
∠304F to 305	177	42	52.1	−1.3		50.8
304G to 305	356	46	36.5			12.5

Stations	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
305 to 304G	176	46	36.5			12.5
∠304G to 306	185	30	57.1	−1.3		55.8
305 to 306	2	17	33.6			08.3
306 to 305	182	17	33.6			08.3
∠305 to 306A	203	57	57.7	−1.2		56.5
306 to 306A	26	15	31.3			04.8
306A to 306	206	15	31.3			04.8
∠306 to 306B	153	17	19.6	−1.3		18.3
306A to 306B	359	32	50.9			23.1
306B to 306A	179	32	50.9			23.1
∠306A to 307	178	08	56.2	−1.3		54.9
306B to 307	357	41	47.1			18.0
307 to 306B	177	41	47.1			18.0
∠306B to 308	182	27	59.0	−1.2		57.8
307 to 308	0	09	46.1			15.8
308 to 307	180	09	46.1			15.8
∠307 to 308A	86	56	02.1	−1.3		00.8
308 to 308A	267	05	48.2			16.6
308A to 308	87	05	48.2			16.6
∠308 to 308B	181	40	42.2	−1.3		40.9
308A to 308B	268	46	30.4		45	57.5
308B to 308A	88	46	30.4		45	57.5
∠308A to 308C	180	21	55.4	−1.2		54.2
308B to 308C	269	08	25.8		07	51.7
308C to 308B	89	08	25.8		07	51.7
∠308B to 309	177	53	02.5	−1.3		01.2
308C to 309	267	01	28.3		00	52.9
309 to 308C	87	01	28.3		00	52.9
∠308C to 310	154	14	30.8	−1.3		29.5
309 to 310	241	15	59.1			22.4
310 to 309	61	15	59.1			22.4
∠309 to 310A	172	10	28.8	−1.2		27.6
310 to 310A	233	26	27.9		25	50.0
310A to 310	53	26	27.9		25	50.0
∠310 to 310B	215	03	10.4	−1.3		09.1
310A to 310B	268	29	38.3		28	59.1
310B to 310A	88	29	38.3		28	59.1
∠310A to 310C	180	17	54.6	−1.3		53.3
310B to 310C	268	47	32.9		46	52.4
310C to 310B	88	47	32.9		46	52.4
∠310B to 310D	181	48	31.8	−1.2		30.6
310C to 310D	270	36	04.7		35	23.0
310D to 310C	90	36	04.7		35	23.0
∠310C to 310E	177	08	59.8	−1.3		58.5
310D to 310E	267	45	04.5		44	21.5
310E to 310D	87	45	04.5		44	21.5
∠310D to 311	183	19	59.4	−1.3		58.1
310E to 311	271	05	03.9		04	19.6
311 to 310E	91	05	03.9		04	19.6
∠310E to Rosalind	63	48	44.2	−1.2		43.0
311 to Rosalind	154	53	48.1			02.6
Rosalind to 311	334	53	48.1			02.6
∠311 to Penhurst	176	54	27.5	−1.2		26.3
Rosalind to Penhurst	151	48	15.6		47	28.9
Fixed azimuth	151	47	28.9			
Discrepancy			+46.7			

Reduction of lengths

[Average elevation=563 feet. Elevation factor=0.99997309]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Mount Read north base-300A	1, 426. 407	1, 426. 369	1. 0000063	1, 426. 378
300A-300B	1, 348. 553	1, 348. 517	1. 0000055	1, 348. 524
300B-300C	1, 434. 791	1, 434. 752	1. 0000048	1, 434. 759
300C-300D	3, 538. 508	3, 538. 413	1. 0000035	3, 538. 425
300D-301	2, 328. 439	2, 328. 376	1. 0000020	2, 328. 381
301-302	1, 431. 121	1, 431. 082	1. 0000010	1, 431. 083
302-302A	1, 002. 426	1, 002. 399	1. 0000003	1, 002. 399
302A-302B	3, 155. 640	3, 155. 555	. 9999992	3, 155. 552
302B-302C	3, 126. 201	3, 126. 117	. 9999976	3, 126. 109
302C—303	901. 597	901. 573	. 9999965	901. 570
303-304	1, 541. 381	1, 541. 340	. 9999963	1, 541. 334
304-304A	891. 284	891. 260	. 9999963	891. 257
304A-304B	477. 536	477. 523	. 9999963	477. 521
304B-304C	1, 448. 758	1, 448. 719	. 9999963	1, 448. 714
304C-304D	1, 208. 403	1, 208. 370	. 9999963	1, 208. 366
304D-304E	2, 261. 908	2, 261. 847	. 9999963	2, 261. 839
304E-304F	3, 030. 000	3, 029. 918	. 9999963	3, 029. 907
304F-304G	2, 110. 000	2, 109. 943	. 9999963	2, 109. 935
304G-305	943. 018	942. 993	. 9999963	942. 990
305-306	1, 807. 864	1, 807. 815	. 9999963	1, 807. 808
306-306A	2, 008. 294	2, 008. 240	. 9999960	2, 008. 232
306A-306B	2, 188. 421	2, 188. 362	. 9999958	2, 188. 353
306B-307	1, 657. 733	1, 657. 688	. 9999960	1, 657. 681
307-308	1, 110. 389	1, 110. 359	. 9999958	1, 110. 354
308-308A	1, 449. 442	1, 449. 403	. 9999962	1, 449. 397
308A-308B	1, 694. 407	1, 694. 361	. 9999970	1, 694. 356
308B-308C	3, 356. 759	3, 356. 669	. 9999983	3, 356. 663
308C-309	2, 144. 405	2, 144. 347	. 9999998	2, 144. 347
309-310	1, 315. 578	1, 315. 543	1. 0000006	1, 315. 544
310-310A	1, 828. 008	1, 827. 959	1. 0000015	1, 827. 962
310A-310B	4, 728. 300	4, 728. 173	1. 0000031	4, 728. 188
310B-310C	474. 382	474. 369	1. 0000045	474. 371
310C-310D	877. 055	877. 031	1. 0000049	877. 035
310D-310E	2, 790. 724	2, 790. 649	1. 0000059	2, 790. 665
310E-311	1, 375. 506	1, 375. 469	1. 0000070	1, 375. 479
311-Rosalind	993. 763	993. 736	1. 0000074	993. 743

Mean latitude = 43°09′.7

$$\log A = 8.5090377-10$$
$$\log B = 8.5106096-10$$
$$\log A + \log B = 17.0196473-20$$
$$\frac{\log A + \log B}{2} = 8.5098236-10$$

$$\log \text{constant} = 5.8304093$$
$$\frac{\log A + \log B}{2} = 8.5098236-10$$
$$\log R_a = 7.3205857$$
$$R_a = 20{,}921{,}160$$

$$\text{Elevation factor} = \frac{20{,}921{,}160}{20{,}921{,}723} = 0.99997309$$

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West — County Monroe — Initial Station Mt.Read north base
Year 1934 — Month January-March — Closing Station Rosalind

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
Mt.Read	° ' "						
north base			2.47822768	-300.77		1,165,344.75	746,119.78
			9.32399305				
		1426.378	3.15423463			1,165,043.98	744,725.47
			9.99012405			+0.00	+0.05
300A	77 49 38.2	1,426	3.14435868		-1394.31	1,165,043.98	744,725.52
			0.40761004	-2.56			
			7.27775136				
		1348.524	3.12985868			1,165,041.42	743,376.95
			9.99999922			+0.00	+0.10
300B	89 53 29.0	2,775	3.12985790		-1348.52	1,165,041.42	743,377.05
			2.63864342	-435.15			
			9.48186446				
		1434.759	3.15677896			1,164,606.27	742,009.77
			9.97904590			+0.00	+0.16
300C	72 20 39.9	4,210	3.13582486		-1367.18	1,164,606.27	742,009.93
			3.04055488	-1097.88			
			9.49174488				
		3538.425	3.54881000			1,163,508.39	738,645.98
			9.97801942			+0.00	+0.29
300D	71 55 27.4	7,748	3.52682942		-3363.79	1,163,508.39	738,646.27
			2.83284681	-680.53			
			9.46579276				
		2328.381	3.36705405			1,162,827.86	736,419.27
			9.98060964			+0.01	+0.38
301	73 00 20.7	10,076	3.34766369		-2226.71	1,162,827.87	736,419.65

FIGURE 6.—Computation of coordinates, traverse no. 3.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt. Read north base
Year 1934 Month January - March Closing Station Rosalind

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
301			2.67077114	-468.57		1,162,827.86	736,419.27
			9.51510632			1,162,827.87	736,419.65
		1431.083	3.15566482			1,162,359.29	735,067.07
			9.97537602			+0.01	+0.43
302	70 53 15.7	11.508	3.13104084		-1352.20	1,162,359.30	735,067.50
			1.56390164	+36.64			
			8.56286101				
		1002.399	3.00104063			1,162,395.93	734,065.34
			9.99970975			+0.01	+0.47
302A	92 05 40.2	12.510	3.00075038		-1001.73	1,162,395.94	734,065.81
			1.46193234	-28.97			
			7.96285700				
		3155.552	3.49907534			1,162,366.96	730,909.92
			9.99998170			+0.01	+0.58
302B	89 28 26.4	15.666	3.49905704		-3155.42	1,162,366.97	730,910.50
			1.60698051	-40.46			
			8.11197639				
		3126.109	3.49500412			1,162,326.50	727,784.07
			9.99996363			+0.01	+0.70
302C	89 15 30.6	18.792	3.49496775		-3125.85	1,162,326.51	727,784.77
			1.19079346	+15.52			
			8.23579401				
		901.570	2.95499945			1,162,342.02	726,882.63
			9.99993567			+0.01	+0.73
303	90 59 10.1	19.693	2.95493512		-901.44	1,162,342.03	726,883.36

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West
Year 1934

County Monroe
Month January - March

Initial Station Mt. Read north base
Closing Station Rosalind

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
303			3.18641281	-1536.08		1,162,342.02	726,882.63
			9.99851605			1,162,342.03	726,883.36
		1541.334	3.18789676			1,160,805.94	727,009.83
			8.91659104			+0.01	+0.79
304	355 15 58.4	21,235	2.10448780		+127.20	1,160,805.95	727,010.62
			2.94989371	-890.83			
			9.99979075				
		891.257	2.95000296			1,159,915.11	726,982.17
			8.49184793			+0.01	+0.83
304A	1 46 42.4	22,126	1.44185089		-27.66	1,159,915.12	726,983.00
			2.67687712	-475.20			
			9.99788464				
		477,521	2.67899248			1,159,439.91	726,935.15
			8.99325791			+0.01	+0.84
304B	5 39 01.7	22.603	1.67225039		-47.02	1,159,439.92	726,935.99
			3.16087530	-1448.36			
			9.99989264				
		1448.714	3.16098266			1,157,991.55	726,902.94
			8.34699207			+0.01	+0.90
304C	1 16 26.2	24.052	1.50797473		-32.21	1,157,991.56	726,903.84
			3.08214596	-1208.22			
			9.99994747				
		1208.366	3.08219849			1,156,783.33	726,921.73
			8.19177818			+0.02	+0.94
304D	359 06 32.1	25.260	1.27397667		+18.79	1,156,783.35	726,922.67

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West — County Monroe — Initial Station Mt. Read north base
Year 1934 — Month January - March — Closing Station Rosalind

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
304D			3.35440492	-2261.54		1,156,783.33	726,921.73
			9.99994323			1,156,783.35	726,922.67
		2261.839	3.35446169			1,154,521.79	726,958.30
			8.20865178			+0.02	+1.03
304E	359 04 25.0	27.522	1.56311347		+36.57	1,154,521.81	726,959.33
			3.48142392	-3029.87			
			9.99999462				
		3029.907	3.48142930			1,151,491.92	726,973.38
			7.69701660			+0.02	+1.14
304F	359 42 53.3	30.552	1.17844590		+15.08	1,151,491.94	726,974.52
			3.32421014	-2109.65			
			9.99994106				
		2109.935	3.32426908			1,149,382.27	727,008.14
			8.21681693			+0.02	+1.22
304G	359 03 21.7	32.662	1.54108601		+34.76	1,149,382.29	727,009.36
			2.97381668	-941.49			
			9.99930959				
		942.990	2.97450709			1,148,440.78	727,061.27
			8.75083117			+0.02	+1.25
305	356 46 12.5	33.605	1.72533826		+53.13	1,148,440.80	727,062.52
			3.25680665	-1806.37			
			9.99965435				
		1807.808	3.25715230			1,146,634.41	726,989.17
			8.60076979			+0.02	+1.32
306	2 17 08.3	35.413	1.85792209		-72.10	1,146,634.43	726,990.49

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West — County Monroe — Initial Station Mt.Read north base
Year 1934 — Month January - March — Closing Station Rosalind

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
306			3.25553972	-1801.11		1,146,634.41	726,939.17
			9.95272584			1,146,634.43	726,990.49
		2008.232	3.30281388			1,144,833.30	726,100.91
			9.64572633			+0.02	+1.40
306A	26 15 04.8	37,421	2.94854021		-888.26	1,144,833.32	726,102.31
			3.34010337	-2188.28			
			9.99998599				
		2188.353	3.34011738			1,142,645.02	726,118.49
			7.90486648			+0.02	+1.48
306B	359 32 23.1	39,609	1.24498386		+17.58	1,142,645.04	726,119.97
			3.21914739	-1656.33			
			9.99964643				
		1657.681	3.21950096			1,140,988.69	726,185.35
			8.60568475			+0.03	+1.54
307	357 41 18.0	41,267	1.82518571		+66.86	1,140,988.72	726,186.89
			3.04545988	-1110.35			
			9.99999842				
		1110.354	3.04546146			1,139,878.34	726,182.36
			7.43049277			+0.03	+1.58
308	0 09 15.8	42,377	0.47595423		-2.99	1,139,878.37	726,183.94
			1.86707739	+73.63			
			8.70589003				
		1449.397	3.16118736			1,139,951.97	727,629.89
			9.99943883			+0.03	+1.64
308A	267 05 16.6	43,827	3.16062619		+1447.53	1,139,952.00	727,631.53

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt.Read north base
Year 1934 Month January - March Closing Station Rosalind

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
308A			1.56217339	+36.49		1,139,951.97	727,629.89
			8.33316872			1,139,952.00	727,631.53
		1694.356	3.22900467			1,139,988.46	729,323.85
			9.99989926			+0.03	+1.70
308B	268 45 57.5	45.521	3.22890393		+1693.96	1,139,988.49	729,325.55
			1.70677434	+50.91			
			8.18086660				
		3356.663	3.52590774			1,140,039.37	732,680.13
			9.99995005			+0.03	+1.82
308C	269 07 51.7	48.878	3.52585779		+3356.28	1,140,039.40	732,681.95
			2.04796471	+111.68			
			8.71666964				
		2144.347	3.33129507			1,140,151.05	734,821.57
			9.99941023			+0.03	+1.90
309	267 00 52.9	51.022	3.33070530		+2141.44	1,140,151.08	734,823.47
			2.80115433	+632.64			
			9.68204895				
		1315.544	3.11910538			1,140,783.69	735,975.01
			9.94289013			+0.03	+1.95
310	241 15 22.4	52.338	3.06199551		+1153.44	1,140,783.72	735,976.96
			3.03706522	+1089.09			
			9.77509806				
		1827.962	3.26196716			1,141,872.78	737,443.11
			9.90478873			+0.03	+2.02
310A	233 25 50.0	54.166	3.16675589		+1468.10	1,141,872.81	737,445.13

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West — County Monroe — Initial Station Mt.Read north base
Year 1934 — Month January - March — Closing Station Rosalind

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
310A			2.09748309	+125.17		1,141,872.78	737,443.11
			8.42278835			1,141,872.81	737,445.13
		4728.188	3.67469474			1,141,997.95	742,169.64
			9.99984778			+0.04	+2.20
310B	268 28 59.1	58,894	3.67454252		+4726.53	1,141,997.99	742,171.84
			1.00388728	+10.09			
			8.32776914				
		474.371	2.67611814			1,142,008.04	742,643.90
			9.99990174			+0.04	+2.21
310C	268 46 52.4	59,368	2.67601988		+474.26	1,142,008.08	742,646.11
			0.95553412	-9.03			
			8.01251719				
		877.035	2.94301693			1,141,999.01	743,520.89
			9.99997700			+0.04	+2.25
310D	270 35 23.0	60,245	2.94299393		+876.99	1,141,999.05	743,523.14
			2.04171424	+110.08			
			8.59600654				
		2790.665	3.44570770			1,142,109.09	746,309.38
			9.99966185			+0.04	+2.35
310E	267 44 21.5	63,036	3.44536955		+2788.49	1,142,109.13	746,311.73
			1.41054578	-25.74			
			8.27209182				
		1375.479	3.13845396			1,142,083.35	747,684.62
			9.99992397			+0.04	+2.40
311	271 04 19.6	64,411	3.13837793		+1375.24	1,142,083.39	747,687.02

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt.Read north base
Year 1934 Month January - March Closing Station Rosalind

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
311			2.95413889	+899.79		1,142,083.35	747,684.62
			9.95686481			1,142,083.39	747,687.02
		993.743	2.99727408			1,142,983.14	747,262.82
			9.62782798			+0.04	+2.44
Rosalind	154 53 02.6	65.405	2.62510206		-421.80	1,142,983.18	747,265.26
						1,142,983.18	747,265.26
				Discrepancy		-0.04	-2.44

x Factor = +3.73060 X 10^{-5}

y Factor = +0.06116 X 10^{-5}

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt.Read north base
Year 1934 Month January - March Closing Station Rosalind

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
Mt.Read north base				-300.77		1,165,344.75	746,119.78
			0.21085944				
		1426.378				1,165,043.98	744,725.47
			0.97751640			+0.00	+0.05
300A	77 49 38.2	1,426			-1394.31	1,165,043.98	744,725.52
				-2.56			
			0.00189562				
		1348.524				1,165,041.42	743,376.95
			0.99999820			+0.00	+0.10
300B	89 53 29.0	2,775			-1348.52	1,165,041.42	743,377.05
				-435.15			
			0.30329445				
		1434.759				1,164,606.27	742,009.77
			0.95289688			+0.00	+0.16
300C	72 20 39.9	4,210			-1367.18	1,164,606.27	742,009.93
				-1097.88			
			0.31027365				
		3538.425				1,163,508.39	738,645.98
			0.95064729			+0.00	+0.29
300D	71 55 27.4	7,748			-3363.79	1,163,508.39	738,646.27
				-680.53			
			0.29227573				
		2328.381				1,162,827.86	736,419.27
			0.95633409			+0.01	+0.38
301	73 00 20.7	10,076			-2226.71	1,162,827.87	736,419.65

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

620745 O - 44 - 3

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt. Read north base
Year 1934 Month January - March Closing Station Rosalind

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
301				-468.57		1,162,827.86	736,419.27
			0.32742084			1,162,827.87	736,419.65
		1431.083				1,162,359.29	735,067.07
			0.94487861			+0.01	+0.43
302	70 53 15.7	11,508			-1352.20	1,162,359.30	735,067.50
				+36.64			
			0.03654778				
		1002.399				1,162,395.93	734,065.34
			0.99933190			+0.01	+0.47
302A	92 05 40.2	12,510			-1001.73	1,162,395.94	734,065.81
				-28.97			
			0.00918030				
		3155.552				1,162,366.96	730,909.92
			0.99995786			+0.01	+0.58
302B	89 28 26.4	15,666			-3155.42	1,162,366.97	730,910.50
				-40.46			
			0.01294126				
		3126.109				1,162,326.50	727,784.07
			0.99991626			+0.01	+0.70
302C	89 15 30.6	18,792			-3125.85	1,162,326.51	727,784.77
				+15.52			
			0.01721052				
		901.570				1,162,342.02	726,882.63
			0.99985189			+0.01	+0.73
303	90 59 10.1	19,693			-901.44	1,162,342.03	726,883.36

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt. Read north base
Year 1934 Month January - March Closing Station Rosalind

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
303				-1536.08		1,162,342.02	726,882.63
			0.99658891			1,162,342.03	726,883.36
		1541.334				1,160,805.94	727,009.83
			0.08252605			+0.01	+0.79
304	355 15 58.4	21.235			+127.20	1,160,805.95	727,010.62
				-890.83			
			0.99951831				
		891.257				1,159,915.11	726,982.17
			0.03103473			+0.01	+0.83
304A	1 46 42.4	22.126			-27.66	1,159,915.12	726,983.00
				-475.20			
			0.99514105				
		477.521				1,159,439.91	726,935.15
			0.09845956			+0.01	+0.84
304B	5 39 01.7	22.603			-47.02	1,159,439.92	726,935.99
				-1448.36			
			0.99975282				
		1448.714				1,157,991.55	726,902.94
			0.02223269			+0.01	+0.90
304C	1 16 26.2	24.052			-32.21	1,157,991.56	726,903.84
				-1208.22			
			0.99987907				
		1208.366				1,156,783.33	726,921.73
			0.01555172			+0.02	+0.94
304D	359 06 32.1	25.260			+18.79	1,156,783.35	726,922.67

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West   County Monroe   Initial Station Mt. Read north base
Year 1934   Month January - March   Closing Station Rosalind

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
304D				-2261.54		1,156,783.33	726,921.73
			0.99986929			1,156,783.35	726,922.67
		2261.839				1,154,521.79	726,958.30
			0.01616783			+0.02	+1.03
304E	359 04 25.0	27.522			+36.57	1,154,521.81	726,959.33
				-3029.87			
			0.99998761				
		3029.907				1,151,491.92	726,973.38
			0.00497757			+0.02	+1.14
304F	359 42 53.3	30.552			+15.08	1,151,491.94	726,974.52
				-2109.65			
			0.99986429				
		2109.935				1,149,382.27	727 008.14
			0.01647467			+0.02	+1.22
304G	359 03 21.7	32.662			+34.76	1,149,382.29	727,009.36
				-941.49			
			0.99841154				
		942.990				1,148,440.78	727,061.27
			0.05634186			+0.02	+1.25
305	356 46 12.5	33.605			+53.13	1,148,440.80	727,062.52
				-1806.37			
			0.99920442				
		1807.808				1,146,634.41	726,989.17
			0.03988134		-	+0.02	+1.32
306	2 17 08.3	35.413			-72.10	1,146,634.43	726,990.49

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt.Read north base
Year 1934 Month January - March Closing Station Rosalind

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
306				-1801.11		1,146,634.41	726,989.17
			0.89686245			1,146,634.43	726,990.49
		2008.232				1,144,833.30	726,100.91
			0.44230956			+0.02	+1.40
306A	26 15 04.8	37.421			-888.26	1,144,833.32	726,102.31
				-2188.28			
			0.99996773				
		2188.353				1,142,645.02	726,118.49
			0.00803280			+0.02	+1.48
306B	359 32 23.1	39.609			+17.58	1,142,645.04	726,119.97
				-1656.33			
			0.9918620				
		1657.681				1,140,988.69	726,185.35
			0.04033525			+0.03	+1.54
307	357 41 18.0	41.267			+66.86	1,140,988.72	726,186.89
				-1110.35			
			0.99999637				
		1110.354				1,139,878.34	726,182.36
			0.00269459			+0.03	+1.58
308	0 09 15.8	42.377			-2.99	1,139,878.37	726,183.94
				+73.63			
			0.05080308				
		1449.397				1,139,951.97	727,629.89
			0.99870869			+0.03	+1.64
308A	267 05 16.6	43.827			+1447.53	1,139,952.00	727,631.53

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt.Read north base
Year 1934 Month January - March Closing Station Rosalind

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
308A				+36.49		1,139,951.97	727,629.89
			0.02153619			1,139,952.00	727,631.53
		1694.356				1,139,988.46	729,323.85
			0.99976807			+0.03	+1.70
308B	268 45 57.5	45,521			+1693.96	1,139,988.49	729,325.55
				+50.91			
			0.01516584				
		3356.663				1,140,039.37	732,680.13
			0.99988499			+0.03	+1.82
308C	269 07 51.7	48,878			+3356.28	1,140,039.40	732,681.95
				+111.68			
			0.05207984				
		2144.347				1,140,151.05	734,821.57
			0.99864293			+0.03	+1.90
309	267 00 52.9	51,022			+2141.44	1,140,151.08	734,823.47
				+632.64			
			0.48089356				
		1315.544				1,140,783.69	735,975.01
			0.87677898			+0.03	+1.95
310	241 15 22.4	52,338			+1153.44	1,140,783.72	735,976.96
				+1089.09			
			0.59579665				
		1827.962				1,141,872.78	737,443.11
			0.80313532			+0.03	+2.02
310A	233 25 50.0	54,166			+1468.10	1,141,872.81	737,445.13

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West   County Monroe   Initial Station Mt. Read north base
Year 1934   Month January - March   Closing Station Rosalind

Station	Azimuth Plane ° ' "	Grid Distance Feet	kmg. Lat. / kmg. cos Az / kmg. dist. / kmg. sin Az / kmg. Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
310A				+125.17		1,141,872.78	737,443.11
			0.02647210			1,141,872.81	737,445.13
		4728.188				1,141,997.95	742,169.64
			0.99964955			+0.04	+2.20
310B	268 28 59.1	58.894			+4726.53	1,141,997.99	742,171.84
				+10.09			
			0.02127008				
		474.371				1,142,008.04	742,643.90
			0.99977377			+0.04	+2.21
310C	268 46 52.4	59.368			+474.26	1,142,008.08	742,646.11
				-9.03			
			0.01029241				
		877.035				1,141,999.01	743,520.89
			0.99994703			+0.04	+2.25
310D	270 35 23.0	60.245			+876.99	1,141,999.05	743,523.14
				+110.08			
			0.03944633				
		2790.665				1,142,109.09	746,309.38
			0.99922170			+0.04	+2.35
310E	267 44 21.5	63.036			+2788.49	1,142,109.13	746,311.73
				-25.74			
			0.01871078				
		1375.479				1,142,083.35	747,684.62
			0.99982494			+0.04	+2.40
311	271 04 19.6	64.411			+1375.24	1,142,083.39	747,687.02

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New York - West County Monroe Initial Station Mt. Read north base
Year 1934 Month January - March Closing Station Rosalind

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
311				+899.79		1,142,083.35	747,684.62
			0.90545072			1,142,083.39	747,687.02
		993.743				1,142,983.14	747,262.82
			0.42445141			+0.04	+2.44
Rosalind	154 53 02.6	65.405			-421.80	1,142,983.18	747,265.26
						1,142,983.18	747,265.26
				Discrepancy		-0.04	-2.44

x Factor = $+3.73060 \times 10^{-5}$

y Factor = $+0.06116 \times 10^{-5}$

FIGURE 6.—Computation of coordinates, traverse no. 3—Continued.

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

PLANE COORDINATES

Datum North American 1927 Projection Transverse Mercator State New York - West

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Canal	746,123.28			302 C	727,784.77		
	1,162,873.20				1,162,326.51		
Mount Read	746,119.78	359 55 07.9	Canal	303	726,883.36		
north base	1,165,344.75				1,162,342.03		
300 A	744,725.52			304	727,010.62		
	1,165,043.98				1,160,805.95		
300 B	743,377.05			304 A	726,983.00		
	1,165,041.42				1,159,915.12		
300 C	742,009.93			304 B	726,935.99		
	1,164,606.27				1,159,439.92		
300 D	738,646.27			304 C	726,903.84		
	1,163,508.39				1,157,991.56		
301	736,419.65			304 D	726,922.67		
	1,162,827.87				1,156,783.35		
302	735,067.50			304 E	726,959.33		
	1,162,359.30				1,154,521.81		
302 A	734,065.81			304 F	726,974.52		
	1,162,395.94				1,151,491.94		
302 B	730,910.50			304 G	727,009.36		
	1,162,366.97				1,149,382.29		

FIGURE 7.—List of plane coordinates.

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

PLANE COORDINATES

Datum North American 1927 Projection Transverse Mercator State New York - West

Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth (° ′ ″)	Mark
305	727,062.52			310	735,976.96		
	1,148,440.80				1,140,783.72		
306	726,990.49			310 A	737,445.13		
	1,146,634.43				1,141,872.81		
306 A	726,102.31			310 B	742,171.84		
	1,144,833.32				1,141,997.99		
306 B	726,119.97			310 C	742,646.11		
	1,142,645.04				1,142,008.08		
307	726,186.89			310 D	743,529.14		
	1,140,988.72				1,141,999.05		
308	726,183.94			310 E	746,311.73		
	1,139,878.37				1,142,109.13		
308 A	727,631.53			311	747,687.02		
	1,139,952.00				1,142,083.39		
308 B	729,325.55			Penhurst	746,490.80		
	1,139,988.49				1,144,427.02		
308 C	732,681.95			Rosalind	747,265.26	151 47 28.9	Penhurst
	1,140,039.40				1,142,983.18		
309	734,823.47						
	1,140,151.08						

U.S. GOVERNMENT PRINTING OFFICE

FIGURE 7.—List of plane coordinates—Continued.

COMPUTATION OF TRAVERSE NO. 1, TWELVE CORNERS TO MEDICINE

This traverse lies to the southward of the city and it forms three sides of an irregular rhombus. All the details of the computation are also shown in duplicate on the following pages. For a sketch of the traverse see figure 5.

Computation of grid azimuths for control

TWELVE CORNERS TO PECK

	x	y
Peck	772, 352. 65	1, 142, 829. 20
Twelve Corners	771, 628. 93	1, 140, 932. 21
Δx and Δy	+723. 72	+1, 896. 99

$$\log \Delta x = 2.8595706$$
$$\log \Delta y = 3.2780650$$
$$\log \tan \alpha = 9.5815056 - 10$$
$$\alpha = 20°52'56''.4$$
$$\text{grid azimuth} = 200°52'56''.4$$

MEDICINE TO MOUNT HOPE

	x	y
Mount Hope	757, 407. 94	1, 139, 983. 37
Medicine	755, 317. 65	1, 139, 856. 90
Δx and Δy	+2, 090. 29	+126. 47

$$\log \Delta x = 3.3202065$$
$$\log \Delta y = 2.1019875$$
$$\log \tan \alpha = 1.2182190$$
$$\alpha = 86°32'15''.4$$
$$\text{grid azimuth} = 266°32'15''.4$$

List of angles

Station	From station—	To station—	Angle ° ′ ″
Twelve Corners	Peck	101	179 23 42. 4
101	Twelve Corners	102	180 44 39. 6
102	101	103	183 29 47. 2
103	102	104	246 45 28. 3
104	103	105	176 22 11. 9
105	104	106	182 30 17. 4
106	105	107	291 08 40. 8
107	106	108	178 09 12. 9
108	107	109	181 09 51. 3
109	108	110	178 24 24. 4
110	109	Medicine	97 16 24. 8
Medicine	110	Mount Hope	330 14 46. 9

Computation of grid azimuths

Station	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
Twelve Corners to Peck	200	52	56.4			56.4
∠Peck to 101	179	23	42.4	−0.7		41.7
Twelve Corners to 101	20	16	38.8			38.1
101 to Twelve Corners	200	16	38.8			38.1
∠Twelve Corners to 102	180	44	39.6	−0.8		38.8
101 to 102	21	01	18.4			16.9
102 to 101	201	01	18.4			16.9
∠101 to 103	183	29	47.2	−0.7		46.5
102 to 103	24	31	05.6			03.4
103 to 102	204	31	05.6			03.4
∠102 to 104	246	45	28.3	−0.8		27.5
103 to 104	91	16	33.9			30.9
104 to 103	271	16	33.9			30.9
∠103 to 105	176	22	11.9	−0.7		11.2
104 to 105	87	38	45.8			42.1
105 to 104	267	38	45.8			42.1
∠104 to 106	182	30	17.4	−0.8		16.6
105 to 106	90	09	03.2		08	58.7

Station	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
106 to 105	270	09	03.2		03	58.7
∠105 to 107	291	08	40.8	−0.7		40.1
106 to 107	201	17	44.0			38.8
107 to 106	21	17	44.0			38.8
∠106 to 108	178	09	12.9	−0.8		12.1
107 to 108	199	26	56.9			50.9
108 to 107	19	26	56.9			50.9
∠107 to 109	181	09	51.3	−0.7		50.6
108 to 109	200	36	48.2			41.5
109 to 108	20	36	48.2			41.5
∠108 to 110	178	24	24.4	−0.8		23.6
109 to 110	199	01	12.6			05.1
110 to 109	19	01	12.6			05.1
∠109 to Medicine	97	16	24.8	−0.7		24.1
110 to Medicine	116	17	37.4			29.2
Medicine to 110	296	17	37.4			29.2
∠110 to Mt. Hope	330	14	46.9	−0.7		46.2
Medicine to Mt. Hope	266	32	24.3			15.4
Fixed azimuth	266	32	15.4			
Discrepancy			+8.9			

Reduction of lengths

[Average elevation=532 feet. Elevation factor=0.99997457]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Twelve Corners-101	3, 925. 337	3, 925. 237	1. 0000213	3, 925. 321
101–102	6, 939. 307	6, 939. 131	1. 0000201	6, 939. 270
102–103	4, 919. 745	4, 919. 620	1. 0000187	4, 919. 712
103–104	4, 111. 652	4, 111. 547	1. 0000168	4, 111. 616
104–105	3, 846. 252	3, 846. 154	1. 0000147	3, 846. 211
105–106	5, 018. 042	5, 017. 914	1. 0000118	5, 017. 973
106–107	4, 053. 438	4, 053. 335	1. 0000108	4, 053. 379
107–108	3, 847. 055	3, 846. 957	1. 0000117	3, 847. 002
108–109	2, 661. 624	2, 661. 556	1. 0000124	2, 661. 589
109–110	2, 852. 240	2, 852. 167	1. 0000130	2, 852. 204
110–Medicine	2, 306. 246	2, 306. 187	1. 0000120	2, 306. 215

Mean latitude = 43° 07′

$$\log A = 8.5090389-10$$
$$\log B = 8.5106130-10$$
$$\log A+\log B = 17.0196519-20$$
$$\frac{\log A+\log B}{2} = 8.5098260-10$$

$$\log \text{constant} = 5.8304093$$
$$\frac{\log A+\log B}{2} = 8.5098260-10$$
$$\log R_a = 7.3205833$$
$$R_a = 20,921,040$$

$$\text{Elevation factor} = \frac{20,921,040}{20,921,572} = 0.99997457$$

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West County Monroe Initial Station Twelve Corners
Year 1934 Month January - March Closing Station Medicine

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
Twelve	° ′ ″						
Corners			3.56609033	-3682.06		1,140,932.21	771,628.93
			9.97221516				
		3925.321	3.59387517			1,137,250.15	770,268.56
			9.53978247			+0.03	-0.02
101	20 16 38.1	3.925	3.13365764		-1360.37	1,137,250.18	770,268.54
			3.81140333	-6477.44			
			9.97008955				
		6939.270	3.84131378			1,130,772.71	767,779.33
			9.55475073			+0.08	-0.05
102	21 01 16.9	10.865	3.39606451		-2489.23	1,130,772.79	767,779.28
			3.65090173	-4476.12			
			9.95896205				
		4919.712	3.69193968			1,126,296.59	765,737.78
			9.61801976			+0.11	-0.07
103	24 31 03.4	15.784	3.30995944		-2041.55	1,126,296.70	765,737.71
			1.96144939	+91.51			
			8.34743684				
		4111.616	3.61401255			1,126,388.10	761,627.18
			9.99989242			+0.14	-0.09
104	91 16 30.9	19.896	3.61390497		-4110.60	1,126,388.24	761,627.09
			2.19877397	-158.04			
			8.61374087				
		3846.211	3.58503310			1,126,230.06	757,784.22
			9.99963305			+0.17	-0.11
105	87 38 42.1	23.742	3.58466615		-3842.96	1,126,230.23	757,784.11

FIGURE 8.—Computation of coordinates, traverse no. 1.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West County Monroe Initial Station Twelve Corners
Year 1934 Month January - March Closing Station Medicine

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
105			1,11744951	+13.11		1,126,230.06	757,784.22
			7.41692119			1,126,230.23	757,784.11
		5017.973	3.70052832			1,126,243.17	752,766.26
			9.99999852			+0.20	-0.14
106	90 08 58.7	28.760	3.70052684		-5017.96	1,126,243.37	752,766.12
			3.57710661	+3776.65			
			9.96928940				
		4053.379	3.60781721			1,130,019.82	754,238.27
			9.56009259			+0.23	-0.15
107	201 17 38.8	32.813	3.16790980		+1472.01	1,130,020.05	754,238.12
			3.55960976	+3627.52			
			9.97448734				
		3847.002	3.58512242			1,133,647.34	755,519.10
			9.52236926			+0.26	-0.17
108	199 26 50.9	36.660	3.10749168		+1280.83	1,133,647.60	755,518.93
			3.39641160	+2491.22			
			9.97127061				
		2661.589	3.42514099			1,136,138.56	756,456.06
			9.54657964			+0.27	-0.19
109	200 36 41.5	39.322	2.97172063		+936.96	1,136,138.83	756,455.87
			3.43080344	+2696.52			
			9.97562285				
		2852.204	3.45518059			1,138,835.08	757,385.50
			9.51303979			+0.29	-0.20
110	199 01 05.1	42.174	2.96822038		+929.44	1,138,835.37	757,385.30

FIGURE 8.—Computation of coordinates, traverse no. 1—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West County Monroe Initial Station Twelve Corners
Year 1934 Month January - March Closing Station Medicine

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
110			3.00924206	+1021.51		1,138,835.08	757,385.50
			9.64634227			1,138,835.37	757,385.30
		2306.215	3.36289979			1,139,856.59	755,317.86
			9.95257576			+0.31	-0.21
Medicine	116 17 29.2	44.480	3.31547555		-2067.64	1,139,856.90	755,317.65
						1,139,856.90	755,317.65
				Discrepancy		-0.31	+0.21

x Factor = -0.47212×10^{-5}

y Factor = $+0.69694 \times 10^{-5}$

FIGURE 8.—Computation of coordinates, traverse no. 1—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West County Monroe Initial Station Twelve Corners
Year 1934 Month January - March Closing Station Medicine

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
Twelve	° ' "						
Corners				-3682.06		1,140,932.21	771,628.93
			0.93802661				
		3925.321				1,137,250.15	770,268.56
			0.34656322			+0.03	-0.02
101	20 16 38.1	3,925			-1360.37	1,137,250.18	770,268.54
				-6477.44			
			0.93344675				
		6939.270				1,130,772.71	767,779.33
			0.35871599			+0.08	-0.05
102	21 01 16.9	10,865			-2489.23	1,130,772.79	767,779.28
				-4476.12			
			0.90983376				
		4919.712				1,126,296.59	765,737.78
			0.41497292			+0.11	-0.07
103	24 31 03.4	15,784			-2041.55	1,126,296.70	765,737.71
				+91.51			
			0.02225548				
		4111.616				1,126,388.10	761,627.18
			0.99975232			+0.14	-0.09
104	91 16 30.9	19,896			-4110.60	1,126,388.24	761,627.09
				-158.04			
			0.04109045				
		3846.211				1,126,230.06	757,784.22
			0.99915543			+0.17	-0.11
105	87 38 42.1	23,742			-3842.96	1,126,230.23	757,784.11

FIGURE 8.—Computation of coordinates, traverse no. 1—Continued.

620745 O - 44 - 4

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West County Monroe Initial Station Twelve Corners
Year 1934 Month January - March Closing Station Medicine

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
105				+ 13.11		1,126,230.06	757,784.22
			0.00261169			1,126,230.23	757,784.11
		5017.973				1,126,243.17	752,766.26
			0.99999659			+ 0.20	-0.14
106	90 08 58.7	28.760			-5017.96	1,126,243.37	752,766.12
				+ 3776.65			
			0.93172855				
		4053.379				1,130,019.82	754,238.27
			0.36315547			+ 0.23	-0.15
107	201 17 38.8	32.813			+1472.01	1,130,020.05	754,238.12
				+ 3627.52			
			0.94294712				
		3847.002				1,133,647.34	755,519.10
			0.33294252			+ 0.26	-0.17
108	199 26 50.9	36.660			+1280.83	1,133,647.60	755,518.93
				+ 2491.22			
			0.93598872				
		2661.589				1,136,138.56	756,456.06
			0.35202998			+ 0.27	-0.19
109	200 36 41.5	39.322			+ 936.96	1,136,138.83	756,455.87
				+ 2696.52			
			0.94541577				
		2852.204				1,138,835.08	757,385.50
			0.32586656			+ 0.29	-0.20
110	199 01 05.1	42.174			+ 929.44	1,138,835.37	757,385.30

FIGURE 8.—Computation of coordinates, traverse no. 1—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New York - West   County Monroe   Initial Station Twelve Corners
Year 1934   Month January - March   Closing Station Medicine

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
110				+1021.51		1,138,835.08	757,385.50
			0.44293732			1,138,835.37	757,385.30
		2306.215				1,139,856.59	755,317.86
			0.89655258			+0.31	-0.21
Medicine	116 17 29.2	44.480			-2067.64	1,139,856.90	755,317.65
						1,139,856.90	755,317.65
					Discrepancy	-0.31	+0.21

x Factor = -0.47212×10^{-5}

y Factor = $+0.69694 \times 10^{-5}$

FIGURE 8.—Computation of coordinates, traverse no. 1—Continued

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

PLANE COORDINATES

Datum *North American 1927* Projection *Transverse Mercator* State *New York - West*

Station	x Coordinate y Coordinate Feet	Azimuth ° ′ ″	Mark	Station	x Coordinate y Coordinate Feet	Azimuth ° ′ ″	Mark
Peck	772,352.65			109	756,455.87		
	1,142,829.20				1,136,138.83		
Twelve Corners	771,628.93	200 52 56.4	Peck	110	757,385.30		
	1,140,932.21				1,138,835.37		
101	770,268.54			Mount Hope	757,407.94		
	1,137,250.18				1,139,983.37		
102	767,779.28			Medicine	755,317.65	266 32 15.4	Mount Hope
	1,130,772.79				1,139,856.90		
103	765,737.71						
	1,126,296.70						
104	761,627.09						
	1,126,388.24						
105	757,784.11						
	1,126,230.23						
106	752,766.12						
	1,126,243.37						
107	754,238.12						
	1,130,020.05						
108	755,518.93						
	1,133,647.60						

FIGURE 9.—List of plane coordinates.

COMPUTATION OF TRAVERSE NO. 1B, FARREL TO RIDGE

This traverse lies to the north and east of the city and it forms an irregular line between the two control points. The computation is shown in duplicate as was done for traverse no. 3. All details are clearly shown on the following computation forms. For a sketch of the traverse see figure 5.

Computation of grid azimuths for control

FARREL TO CHURCH

	x	y
Church	762, 314. 89	1, 184, 286. 59
Farrel	762, 197. 90	1, 182, 275. 52
Δx and Δy	+116. 99	+2, 011. 07

$$\log \Delta x = 2.0681487$$
$$\log \Delta y = 3.3034272$$
$$\log \tan \alpha = 8.7647215 - 10$$
$$\alpha = 3°19'45''.5$$
$$\text{grid azimuth} = 183°19'45''.5$$

RIDGE TO NEARPIPE

	x	y
Nearpipe	772, 445. 04	1, 165, 917. 77
Ridge	772, 271. 87	1, 168, 829. 59
Δx and Δy	+173. 17	−2, 911. 82

$$\log \Delta x = 2.2384727$$
$$\log \Delta y = 3.4641645$$
$$\log \tan \alpha = 8.7743082 - 10$$
$$\alpha = 3°24'12''.4$$
$$\text{grid azimuth} = 356°35'47''.6$$

List of angles

Station	From station—	To station—	Angle ° ′ ″	Station	From station—	To station—	Angle ° ′ ″
Farrel	Church	131	80 45 18. 3	137	136	138	291 33 03. 3
131	Farrel	132	130 51 40. 0	138	137	139	196 40 44. 1
132	131	133	260 18 29. 0	139	138	140	182 18 39. 6
133	132	134	175 21 08. 4	140	139	141	163 12 56. 7
134	133	135	174 21 00. 0	141	140	142	179 32 54. 6
135	134	136	264 38 10. 4	142	141	Ridge	157 03 51. 2
136	135	137	76 56 46. 7	Ridge	142	Nearpipe	179 41 21. 7

Computation of grid azimuths

Stations	Preliminary azimuth and angle	Correction for closure	Corrected azimuth and angle	Stations	Preliminary azimuth and angle	Correction for closure	Corrected azimuth and angle
	° ′ ″	″	′ ″		° ′ ″	″	′ ″
Farrel to Church	183 19 45.5		45.5	137 to 136	86 32 18.3		17.4
∠Church to 131	80 45 18.3	−0.1	18.2	∠136 to 138	291 33 03.3	−0.1	03.2
Farrel to 131	264 05 03.8		03.7	137 to 138	18 05 21.6		20.6
131 to Farrel	84 05 03.8		03.7	138 to 137	198 05 21.6		20.6
∠Farrel to 132	130 51 40.0	−0.1	39.9	∠137 to 139	196 40 44.1	−0.2	43.9
131 to 132	214 56 43.8		43.6	138 to 139	34 46 05.7		04.5
132 to 131	34 56 43.8		43.6	139 to 138	214 46 05.7		04.5
∠131 to 133	260 18 29.0	−0.2	28.8	∠138 to 140	182 18 39.6	−0.1	39.5
132 to 133	295 15 12.8		12.4	139 to 140	37 04 45.3		44.0
133 to 132	115 15 12.8		12.4	140 to 139	217 04 45.3		44.0
∠132 to 134	175 21 08.4	−0.1	08.3	∠139 to 141	163 12 56.7	−0.1	56.6
133 to 134	290 36 21.2		20.7	140 to 141	20 17 42.0		40.6
134 to 133	110 36 21.2		20.7	141 to 140	200 17 42.0		40.6
∠133 to 135	174 21 00.0	−0.1	20 59.9	∠140 to 142	179 32 54.6	−0.2	54.4
134 to 135	284 57 21.2		20.6	141 to 142	19 50 36.6		35.0
135 to 134	104 57 21.2		20.6	142 to 141	199 50 36.6		35.0
∠134 to 136	264 38 10.4	−0.2	10.2	∠141 to Ridge	157 03 51.2	−0.1	51.1
135 to 136	9 35 31.6		30.8	142 to Ridge	356 54 27.8		26.1
136 to 135	189 35 31.6		30.8	Ridge to 142	176 54 27.8		26.1
∠135 to 137	76 56 46.7	−0.1	46.6	∠142 to Nearpipe	179 41 21.7	−0.2	21.5
136 to 137	266 32 18.3		17.4	Ridge to Nearpipe	356 35 49.5		47.6
				Fixed azimuth	356 35 47.6		
				Discrepancy	+1.9		

Reduction of lengths

[Average elevation=328 feet. Elevation factor=0.99998432]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Farrel–131	1,299.37	1,299.35	1.0000164	1,299.37
131–132	2,197.65	2,197.62	1.0000172	2,197.66
132–133	2,389.35	2,389.31	1.0000182	2,389.35
133–134	3,988.20	3,988.14	1.0000201	3,988.22
134–135	4,949.74	4,949.66	1.0000227	4,949.77
135–136	1,998.50	1,998.47	1.0000240	1,998.52
136–137	1,389.07	1,389.05	1.0000243	1,389.08
137–138	1,656.73	1,656.70	1.0000247	1,656.74
138–139	2,362.26	2,362.22	1.0000240	2,362.28
139–140	2,099.05	2,099.02	1.0000232	2,099.07
140–141	1,672.50	1,672.47	1.0000226	1,672.51
141–142	1,699.36	1,699.33	1.0000222	1,699.37
142–Ridge	1,439.34	1,439.32	1.0000221	1,439.35

Mean latitude=43°13′

$$\log A = 8.5090363-10$$
$$\log B = 8.5106053-10$$
$$\log A + \log B = 17.0196416-20$$
$$\frac{\log A + \log B}{2} = 8.5098208-10$$

$$\log \text{constant} = 5.8304093$$
$$\frac{\log A + \log B}{2} = 8.5098208-10$$
$$\log R_a = 7.3205885$$
$$R_a = 20{,}921{,}300$$

$$\text{Elevation factor} = \frac{20{,}921{,}300}{20{,}921{,}628} = 0.99998432$$

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York - West   County Monroe   Initial Station Farrel
Year 1934   Month Jauary - March   Closing Station Ridge

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
Farrel			2.12683999	+133.92		1,182,275.52	762,197.90
			9.01310715				
		1299.37	3.11373284			1,182,409.44	763,490.35
			9.99768108			+0.01	-0.03
131	264 05 03.7	1.299	3.11141392		+1292.45	1,182,409.45	763,490.32
			3.25561429	+1801.42			
			9.91365378				
		2197.66	3.34196051			1,184,210.86	764,749.16
			9.75800013			+0.03	-0.08
132	214 56 43.6	3,497	3.09996064		+1258.81	1,184,210.89	764,749.08
			3.00832415	-1019.35			
			9.63004438				
		2389.35	3.37827977			1,183,191.51	766,910.16
			9.95637472			+0.05	-0.13
133	295 15 12.4	5,886	3.33465449		+2161.00	1,183,191.56	766,910.03
			3.14724229	-1403.60			
			9.54646318				
		3988.22	3.60077911			1,181,787.91	770,643.23
			9.97128709			+0.08	-0.22
134	290 36 20.7	9.875	3.57206620		+3733.07	1,181,787.99	770,643.01
			3.10632676	-1277.40			
			9.41174174				
		4949.77	3.69458502			1,180,510.51	775,425.33
			9.98503357			+0.12	-0.33
135	284 57 20.6	14.824	3.67961859		+4782.10	1,180,510.63	775,425.00

FIGURE 10.—Computation of coordinates, traverse no. 1B.

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York - West County Monroe Initial Station Farrel
Year 1934 Month January - March Closing Station Ridge

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
135			3.29459406	-1970.58		1,180,510.51	775,425.33
			9.99388556			1,180,510.63	775,425.00
		1998.52	3.30070850			1,178,539.93	775,092.32
			9.22175101			+0.13	-0.37
136	9 35 30.8	16,823	2.52245951		-333.01	1,178,540.06	775,091.95
			1.92364651	+83.88			
			8.78091925				
		1389.08	3.14272726			1,178,623.81	776,478.87
			9.99920679			+0.14	-0.40
137	266 32 17.4	18,212	3.14193405		+1386.55	1,178,623.95	776,478.47
			3.19724078	-1574.86			
			9.97798642				
		1656.74	3.21925436			1,177,048.95	775,964.46
			9.49205441			+0.16	-0.44
138	18 05 20.6	19,869	2.71130877		-514.41	1,177,049.11	775,964.02
			3.28792236	-1940.54			
			9.91459099				
		2362.28	3.37333137			1,175,108.41	774,617.36
			9.75606809			+0.18	-0.49
139	34 46 04.5	22,231	3.12939946		-1347.10	1,175,108.59	774,616.87
			3.22392429	-1674.65			
			9.90189737				
		2099.07	3.32202692			1,173,433.76	773,351.80
			9.78025542			+0.19	-0.53
140	37 04 44.0	24,330	3.10228234		-1265.56	1,173,433.95	773,351.27

FIGURE 10.—Computation of coordinates, traverse no. 1B—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York - West County Monroe Initial Station Farrel
Year 1934 Month January - March Closing Station Ridge

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
140			3.19553524	-1568.68		1,173,433.76	773,351.80
			9.97216652			1,173,433.95	773,351.27
		1672.51	3.22336872			1,171,865.08	772,771.69
			9.54013848			+0.21	-0.57
141	20 17 40.6	26.003	2.76350720		-580.11	1,171,865.29	772,771.12
			3.20370491	-1598.47			
			9.97341696				
		1699.37	3.23028795			1,170,266.61	772,194.85
			9.53076924			+0.22	-0.61
142	19 50 35.0	27.702	2.76105719		-576.84	1,170,266.83	772,194.24
			3.15753340	-1437.25			
			9.99936699				
		1439.35	3.15816641			1,168,829.36	772,272.51
			8.73201126			+0.23	-0.64
Ridge	356 54 26.1	29.141	1.89017767		+77.66	1,168,829.59	772,271.87
						1,168,829.59	772,271.87
				Discrepancy		-0.23	+0.64
				x Factor = -2.19622×10^{-5}			
				y Factor = $+0.78927 \times 10^{-5}$			

FIGURE 10.—Computation of coordinates, traverse no. 1B—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York -West   County Monroe   Initial Station Farrel
Year 1934   Month January - March   Closing Station Ridge

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
Farrel				+133.92		1,182,275.52	762,197.90
			0.10306404				
		1299.37				1,182,409.44	763,490.35
			0.99467472			+0.01	-0.03
131	264 05 03.7	1,299			+1292.45	1,182,409.45	763,490.32
				+1801.42			
			0.81969782				
		2197.66				1,184,210.86	764,749.16
			0.57279620			+0.03	-0.08
132	214 56 43.6	3,497			+1258.81	1,184,210.89	764,749.08
				-1019.35			
			0.42662311				
		2389.35				1,183,191.51	766,910.16
			0.90442950			+0.05	-0.13
133	295 15 12.4	5,886			+2161.00	1,183,191.56	766,910.03
				-1403.60			
			0.35193559				
		3988.22				1,181,787.91	770,643.23
			0.93602422			+0.08	-0.22
134	290 36 20.7	9,875			+3733.07	1,181,787.99	770,643.01
				-1277.40			
			0.25807251				
		4949.77				1,180,510.51	775,425.33
			0.96612555			+0.12	-0.33
135	284 57 20.6	14,824			+4782.10	1,180,510.63	775,425.00

FIGURE 10.—Computation of coordinates, traverse no. 1B—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York - West County Monroe Initial Station Farrel
Year 1934 Month January - March Closing Station Ridge

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
135				-1970.58		1,180,510.51	775,425.33
			0.98601963			1,180,510.63	775,425.60
		1998.52				1,178,539.93	775,092.32
			0.16662916			+0.13	-0.37
136	9 35 30.8	16.823			-333.01	1,178,540.06	775,091.95
				+83.88			
			0.06038363				
		1389.08				1,178,623.81	776,478.87
			0.99817525			+0.14	-0.40
137	266 32 17.4	18.212			+1386.55	1,178,623.95	776,478.47
				-1574.86			
			0.95057506				
		1656.74				1,177,048.95	775,964.46
			0.31049486			+0.16	-0.44
138	18 05 20.6	19.869			-514.41	1,177,049.11	775,964.02
				-1940.54			
			0.82146866				
		2362.28				1,175,108.41	774,617.36
			0.57025367			+0.18	-0.49
139	34 46 04.5	22.231			-1347.10	1,175,108.59	774,616.87
				-1674.65			
			0.79780613				
		2099.07				1,173,433.76	773,351.80
			0.60291407			+0.19	-0.53
140	37 04 44.0	24.330			-1265.56	1,173,433.95	773,351.27

FIGURE 10.—Computation of coordinates, traverse no. 1B—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1B
State New York - West County Monroe Initial Station Farrel
Year 1934 Month January - March Closing Station Ridge

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
140				-1568.68		1,173,433.76	773,351.80
			0.93792156			1,173,433.95	773,351.27
		1672.51				1,171,865.08	772,771.69
			0.34684744			+0.21	-0.57
141	20 17 40.6	26.003			-580.11	1,171,865.29	772,771.12
				-1598.47			
			0.94062595				
		1699.37				1,170,266.61	772,194.85
			0.33944486			+0.22	-0.61
142	19 50 35.0	27.702			-576.84	1,170,266.83	772,194.24
				-1437.25			
			0.99854351				
		1439.35				1,168,829.36	772,272.51
			0.05395247			+0.23	-0.64
Ridge	356 54 26.1	29.141			+77.66	1,168,829.59	772,271.87
						1,168,829.59	772,271.87
				Discrepancy		-0.23	+0.64
				x Factor = -2.19622 X 10^{-5}			
				y Factor = +0.78927 X 10^{-5}			

FIGURE 10.—Computation of coordinates, traverse no. 1B—Continued.

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

PLANE COORDINATES

Datum *North American 1927* Projection *Transverse Mercator* State *New York - West*

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Church	762,314.89			139	774,616.87		
	1,184,286.59				1,175,108.59		
Farrel	762,197.90	183 19 45.5	Church	140	773,351.27		
	1,182,275.52				1,173,433.95		
131	763,490.32			141	772,771.12		
	1,182,409.45				1,171,865.29		
132	764,749.08			142	772,194.24		
	1,184,210.89				1,170,266.83		
133	766,910.03			Nearpipe	772,445.04		
	1,183,191.56				1,165,917.77		
134	770,643.01			Ridge	772,271.87	356 35 47.6	Nearpipe
	1,181,787.99				1,168,829.59		
135	775,425.00						
	1,180,510.63						
136	775,091.95						
	1,178,540.06						
137	776,478.47						
	1,178,623.95						
138	775,964.02						
	1,177,049.11						

FIGURE 11.—List of plane coordinates.

COMPUTATION OF TRAVERSE NO. 3A, FLOWER TO RIVER

This traverse lies north of the city extending approximately in a northward direction from station Flower to River. For a sketch of the traverse see figure 5.

Computation of grid azimuths for control

FLOWER TO BONESTEEL

	x	y
Bonesteel	748, 364. 74	1, 168, 551. 77
Flower	750, 546. 46	1, 168, 164. 51
Δx and Δy	−2, 181. 72	+387. 26

$$\begin{aligned} \log \Delta x &= 3.3387990 \\ \log \Delta y &= 2.5880026 \\ \log \tan \alpha &= 0.7507964 \\ \alpha &= 79°56'05''.0 \\ \text{grid azimuth} &= 100°03'55''.0 \end{aligned}$$

RIVER TO STUTSON

	x	y
Stutson	756, 497. 25	1, 186, 570. 46
River	758, 552. 37	1, 185, 553. 01
Δx and Δy	−2, 055. 12	+1, 017. 45

$$\begin{aligned} \log \Delta x &= 3.3128372 \\ \log \Delta y &= 3.0075130 \\ \log \tan \alpha &= 0.3053242 \\ \alpha &= 63°39'39''.2 \\ \text{grid azimuth} &= 116°20'20''.8 \end{aligned}$$

List of angles

Station	From station—	To station—	Angle °	′	″
Flower	Bonesteel	Flower A	196	10	50. 6
Flower A	Flower	Merrill	65	51	02. 9
Merrill	Flower A	Cemetery	177	42	38. 8
Cemetery	Merrill	Benn A	149	31	32. 5
Benn A	Cemetery	Benn B	241	52	39. 6
Benn B	Benn A	Wedgewood	180	05	00. 3
Wedgewood	Benn B	West Parkway	160	32	21. 7
West Parkway	Wedgewood	Benn C	164	50	33. 9
Benn C	West Parkway	Britton A	184	03	04. 4
Britton A	Benn C	Tiernan	283	15	20. 2
Tiernan	Britton A	Lake A	93	19	19. 2
Lake A	Tiernan	Lake B	192	53	30. 8
Lake B	Lake A	Stutson X	189	23	29. 2
Stutson X	Lake B	River	76	44	47. 5
River	Stutson X	Stutson	180	00	00. 0

Computation of grid azimuths

Stations	Preliminary azimuth and angle			Correction for closure	Corrected azimuth and angle	
	°	′	″	″	′	″
Flower to Bonesteel	100	03	55.0			55.0
∠Bonesteel to Flower A	196	10	50.6	+1.0		51.6
Flower to Flower A	296	14	45.6			46.6
Flower A to Flower	116	14	45.6			46.6
∠Flower to Merrill	65	51	02.9	+1.0		03.9
Flower A to Merrill	182	05	48.5			50.5
Merrill to Flower A	2	05	48.5			50.5
∠Flower A to Cemetery	177	42	38.8	+1.0		39.8
Merrill to Cemetery	179	48	27.3			30.3
Cemetery to Merrill	359	48	27.3			30.3
∠Merrill to Benn A	149	31	32.5	+1.0		33.5
Cemetery to Benn A	149	19	59.8		20	03.8
Benn A to Cemetery	329	19	59.8		20	03.8
∠Cemetery to Benn B	241	52	39.6	+1.1		40.7
Benn A to Benn B	211	12	39.4			44.5
Benn B to Benn A	31	12	39.4			44.5
∠Benn A to Wedgewood	180	05	00.3	+1.0		01.3
Benn B to Wedgewood	211	17	39.7			45.8
Wedgewood to Benn B	31	17	39.7			45.8
∠Benn B to West Parkway	160	32	21.7	+1.0		22.7
Wedgewood to West Parkway	191	50	01.4			08.5
West Parkway to Wedgewood	11	50	01.4			08.5
∠Wedgewood to Benn C	164	50	33.9	+1.0		34.9
West Parkway to Benn C	176	40	35.3			43.4
Benn C to West Parkway	356	40	35.3			43.4
∠West Parkway to Britton A	184	03	04.4	+1.0		05.4
Benn C to Britton A	180	43	39.7			48.8
Britton A to Benn C	0	43	39.7			48.8
∠Benn C to Tiernan	283	15	20.2	+1.1		21.3
Britton A to Tiernan	283	58	59.9		59	10.1
Tiernan to Britton A	103	58	59.9		59	10.1
∠Britton A to Lake A	93	19	19.2	+1.0		20.2
Tiernan to Lake A	197	18	19.1			30.3
Lake A to Tiernan	17	18	19.1			30.3
∠Tiernan to Lake B	192	53	30.8	+1.0		31.8
Lake A to Lake B	210	11	49.9		12	02.1
Lake B to Lake A	30	11	49.9		12	02.1
∠Lake A to Stutson X	189	23	29.2	+1.0		30.2
Lake B to Stutson X	219	35	19.1			32.3
Stutson X to Lake B	39	35	19.1			32.3
∠Lake B to River	76	44	47.5	+1.0		48.5
Stutson X to River	116	20	06.6			20.8
River to Stutson X	296	20	06.6			20.8
∠Stutson X to Stutson	180	00	00.0	+0.0		00.0
River to Stutson	116	20	06.6			20.8
Fixed azimuth	116	20	20.8			
Discrepancy			−14.2			

Reduction of lengths

[Average elevation=387 feet. Elevation factor=0.99998150]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
Flower-Flower A	1,362.108	1,362.083	1.0000095	1,362.096
Flower A-Merrill	1,567.461	1,567.432	1.0000099	1,567.448
Merrill-Cemetery	2,858.392	2,858.339	1.0000099	2,858.367
Cemetery-Benn A	768.218	768.204	1.0000098	768.212
Benn A-Benn B	1,940.763	1,940.727	1.0000101	1,940.747
Benn B-Wedgewood	2,665.248	2,665.199	1.0000108	2,665.228
Wedgewood-West Parkway	1,206.123	1,206.101	1.0000112	1,206.115
West Parkway-Benn C	1,566.698	1,566.669	1.0000113	1,566.687
Benn C-Britton A	1,278.231	1,278.207	1.0000113	1,278.221
Britton A-Tiernan	1,642.970	1,642.940	1.0000117	1,642.959
Tiernan-Lake A	1,533.181	1,533.153	1.0000123	1,533.172
Lake A-Lake B	1,991.613	1,991.576	1.0000128	1,991.601
Lake B-Stutson X	2,674.814	2,674.765	1.0000136	2,674.801
Stutson X-River	215.314	215.310	1.0000140	215.313

Mean latitude=43°13′

Use same R_a as for traverse no. 1B—Farrel to Ridge.

$$\text{Elevation factor}=\frac{20{,}921{,}300}{20{,}921{,}687}=0.99998150$$

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West | County Monroe | Initial Station Flower
Year 1934 | Month January - March | Closing Station River

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
Flower			2.77985633	-602.36		1,168,164.51	750,546.46
			9.64564862				
		1362.096	3.13420771			1,167,562.15	751,768.13
			9.95274474			+0.04	+0.07
Flower A	296 14 46.6	1,362	3.08695245		+1221.67	1,167,562.19	751,768.20
			3.19490211	+1566.40			
			9.99970896				
		1567.448	3.19519315			1,169,128.55	751,825.49
			8.56345358			+0.09	+0.15
Merrill	182 05 50.5	2,930	1.75864673		+57.36	1,169,128.64	751,825.64
			3.45611556	+2858.35			
			9.99999757				
		2858.367	3.45611799			1,171,986.90	751,815.93
			7.52423419			+0.19	+0.29
Cemetery	179 48 30.3	5,788	0.98035218		-9.56	1,171,987.09	751,816.22
			2.82005960	+660.78			
			9.93457851				
		768.212	2.88548109			1,172,647.68	751,424.12
			9.70759295			+0.21	+0.33
Benn A	149 20 03.8	6,556	2.59307404		-391.81	1,172,647.89	751,424.45
			3.22006326	+1659.83			
			9.93209434				
		1940.747	3.28796892			1,174,307.51	752,429.84
			9.71450708			+0.27	+0.43
Benn B	211 12 44.5	8,497	3.00247600		+1005.72	1,174,307.78	752,430.27

FIGURE 12.—Computation of coordinates, traverse no. 3A.

620745 O - 44 - 5

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West | County Monroe | Initial Station Flower
Year 1934 | Month January - March | Closing Station River

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
Benn B			3.35744368	+2277.42		1,174,307.51	752,429.84
			9.93170932			1,174,307.78	752,430.27
		2665.228	3.42573436			1,176,584.93	753,814.32
			9.71555235			+0.36	+0.57
Wd.Wood	211 17 45.8	11,162	3.14128671		+1384.48	1,176,585.29	753,814.89
			3.07205597	+1180.47			
			9.990066725				
		1206.115	3.08138872			1,177,765.40	754,061.70
			9.31197801			+0.40	+0.63
W.Park.	191 50 08.5	12,368	2.39336673		+247.38	1,177,765.80	754,062.33
			3.19425217	+1564.06			
			9.99926993				
		1566.687	3.19498224			1,179329.46	753,970.93
			8.76293932			+0.45	+0.71
Benn C	176 40 43.4	13,935	1.95792156		-90.77	1,179,329.91	753,971.64
			3.10657068	+1278.12			
			9.99996473				
		1278.221	3.10660595			1,180,607.58	753,987.22
			8.10532065			+0.49	+0.77
BrittonA	180 43 48.8	15,213	1.21192660		+16.29	1,180,608.07	753,987.99
			2.59888029	-397.08			
			9.38325356				
		1642.959	3.21562673			1,180,210.50	755,581.47
			9.98693030			+0.54	+0.85
Tiernan	283 59 10.1	16,856	3.20255703		+1594.25	1,180,211.04	755,582.32

FIGURE 12.—Computation of coordinates, traverse no. 3A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West County Monroe Initial Station Flower
Year 1934 Month January - March Closing Station River

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
Tiernan			3.16546558	+1463.75		1,180,210.50	755,581.47
			9.97987470			1,180,211.04	755,582.32
		1533.172	3.18559088			1,181,674.25	756,037.61
			9.47350905			+0.59	+0.93
Lake A	197 18 30.3	18.389	2.65909993		+456.14	1,181,674.84	756,038.54
			3.23585162	+1721.28			
			9.93664928				
		1991.601	3.29920234			1,183,395.53	757,039.44
			9.70159280			+0.66	+1.03
Lake B	210 12 02.1	20.381	3.00079514		+1001.83	1,183,396.19	757,040.47
			3.31411982	+2061.20			
			9.88682835				
		2674.801	3.42729147			1,185,456.73	758,744.15
			9.80435789			+0.74	+1.17
Stutson X	219 35 32.3	23.056	3.23164936		+1704.71	1,185,457.47	758,745.32
			1.98014308	+95.53			
			9.64707283				
		215.313	2.33307025			1,185,552.26	758,551.19
			9.95239708			+0.75	+1.18
River	116 20 20.8	23.271	2.28546733		-192.96	1,185,553.01	758,552.37
						1,185,553.01	758,552.37
				Discrepancy		-0.75	-1.18
				x Factor =	+ 5.07069 X	10^{-5}	
				y Factor =	+ 3.22290 X	10^{-5}	

FIGURE 12.—Computation of coordinates, traverse no. 3A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West
Year 1934
County Monroe
Month January - March
Initial Station Flower
Closing Station River

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
Flower				-602.36		1,168,164.51	750,546.46
			0.44223042				
		1362.096				1,167,562.15	751,768.13
			0.89690148			+0.04	+0.07
Flower A	296 14 46.6	1,362			+1221.67	1,167,562.19	751,768.20
				+1566.40			
			0.99933008				
		1567.448				1,169,128.55	751,825.49
			0.03659768			+0.09	+0.15
Merrill	182 05 50.5	2,930			+57.36	1,169,128.64	751,825.64
				+2858.35			
			0.99999441				
		2858.367				1,171,986.90	751,815.93
			0.00334376			+0.19	+0.29
Cemetery	179 48 30.3	5,788			-9.56	1,171,987.09	751,816.22
				+660.78			
			0.86015855				
		768.212				1,172,647.68	751,424.12
			0.51002674			+0.21	+0.33
Benn A	149 20 03.8	6,556			-391.81	1,172,647.89	751,424.45
				+1659.83			
			0.85525248				
		1940.747				1,174,307.51	752,429.84
			0.51821154			+0.27	+0.43
Benn B	211 12 44.5	8,497			+1005.72	1,174,307.78	752,430.27

FIGURE 12.—Computation of coordinates, traverse no. 3A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West
Year 1934

County Monroe
Month January - March

Initial Station Flower
Closing Station River

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
Benn B				+2277.42		1,174,307.51	752,429.84
			0.85449459			1,174,307.78	752,430.27
		2665.228				1,176,584.93	753,814.32
			0.51946029			+0.36	+0.57
W. Wood	211 17 45.8	11,162			+1384.48	1,176,585.29	753,814.89
				+1180.47			
			0.97873980				
		1206.115				1,177,765.40	754,061.70
			0.20510583			+0.40	+0.63
W. Park	191 50 08.5	12,368			+247.38	1,177,765.80	754,062.33
				+1564.06			
			0.99832037				
		1566.687				1,179,329.46	753,970.93
			0.05793477			+0.45	+0.71
Benn C	176 40 43.4	13,935			-90.77	1,179,329.91	753,971.64
				+1278.12			
			0.99991878				
		1278.221				1,180,607.58	753,987.22
			0.01274444			+0.49	+0.77
Britton A	180 43 48.8	15,213			+16.29	1,180,608.07	753,987.99
				-397.08			
			0.24168715				
		1642.959				1,180,210.50	755,581.47
			0.97035422			+0.54	+0.85
Tiernan	283 59 10.1	16,856			+1594.25	1,180,211.04	755,582.32

FIGURE 12.—Computation of coordinates, traverse no. 3A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3A
State New York - West County Monroe Initial Station Flower
Year 1934 Month January - March Closing Station River

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
Tiernan				+1463.75		1,180,210.50	755,581.47
			0.95471711			1,180,211.04	755,582.32
		1533.172				1,181,674.25	756,037.61
			0.29751513			+0.59	+0.93
Lake A	197 18 30.3	18,389			+456.14	1,181,674.84	756,038.54
				+1721.28			
			0.86426968				
		1991.601				1,183,395.53	757,039.44
			0.50302875			+0.66	+1.03
Lake B	210 12 02.1	20,381			+1001.83	1,183,396.19	757,040.47
				+2061.20			
			0.77059883				
		2674.801				1,185,456.73	758,744.15
			0.63732051			+0.74	+1.17
StutsonX	219 35 32.3	23,056			+1704.71	1,185,457.47	758,745.32
				+95.53			
			0.44368304				
		215.313				1,185,552.26	758,551.19
			0.89618377			+0.75	+1.18
River	116 20 20.8	23,271			-192.96	1,185,553.01	758,552.37
						1,185,553.01	758,552.37
				Discrepancy		-0.75	-1.18
				x Factor =	+ 5.07069 X	10^{-5}	
				y Factor =	+ 3.22290 X	10^{-5}	

FIGURE 12.—Computation of coordinates, traverse no. 3A—Continued.

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

PLANE COORDINATES

Datum *North American 1927* Projection *Transverse Mercator* State *New York - West*

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Bonesteel	748,364.74 1,168,551.77			Britton A	753,987.99 1,180,608.07		
Flower	750,546.46 1,168,164.51	100 03 55.0	Bonesteel	Tiernan	755,582.32 1,180,211.04		
Flower A	751,768.20 1,167,562.19			Lake A	756,038.54 1,181,674.84		
Merrill	751,825.64 1,169,128.64			Lake B	757,040.47 1,183,396.19		
Cemetery	751,816.22 1,171,987.09			Stutson X	758,745.32 1,185,457.47		
Benn A	751,424.45 1,172,647.89			Stutson	756,497.25 1,186,570.46		
Benn B	752,430.27 1,174,307.78			River	758,552.37 1,185,553.01	116 20 20.8	Stutson
Wedgewood	753,814.89 1,176,585.29						
West Parkway	754,062.33 1,177,765.80						
Benn C	753,971.64 1,179,329.91						

U S GOVERNMENT PRINTING OFFICE

FIGURE 13.—List of plane coordinates.

COMPUTATION OF TRAVERSE NO. 2A, 303 TO BOULEVARD

This traverse lies north of traverse no. 3 and it starts from station 303 of that traverse. This combined work could have been computed in a different way if so desired. We could have computed from Rosalind to 303, from Mount Read north base to 303, and from Boulevard to 303; and then held fixed a weighted mean at 303. However, the results of the computations as made are eminently satisfactory as can be seen from the closures that resulted. On this traverse two connections were made to Geological Survey points. These are shown on the sketch shown in figure 5.

Computation of grid azimuths for control

303 TO 304

	x	y
304	727, 010. 62	1, 160, 805. 95
303	726, 883. 36	1, 162, 342. 03
Δx and Δy	+127. 26	−1, 536. 08

$$\log \Delta x = 2.1046919$$
$$\log \Delta y = 3.1864138$$
$$\log \tan \alpha = 8.9182781-10$$
$$\alpha = 4°44'09''.5$$
$$\text{grid azimuth} = 355°15'50''.5$$

BOULEVARD TO WHELEHAN

	x	y
Whelehan	2, 246, 182. 87	1, 184, 385. 73
Boulevard	2, 246, 134. 40	1, 186, 591. 88
Δx and Δy	+48. 47	−2, 206. 15

$$\log \Delta x = 1.6854730$$
$$\log \Delta y = 3.3436350$$
$$\log \tan \alpha = 8.3418380-10$$
$$\alpha = 1°15'31''.0$$
$$\text{grid azimuth} = 358°44'29''.0$$

List of angles

Station	From station—	To station—	Angle °	′	″	Station	From station—	To station—	Angle °	′	″
303	304	303A	94	35	03. 6	222F	206	222E	178	55	09. 2
303A	303	303B	178	39	42. 8	222E	222F	222D	179	55	10. 1
303B	303A	303C	191	35	27. 2	222D	222E	222C	225	34	48. 8
303C	303B	303G	211	41	48. 6	222C	222D	222B	224	03	04. 8
303G	303C	303H	228	04	56. 4	222B	222C	222A	180	05	48. 3
303H	303G	203	183	08	31. 6	222A	222B	222AA	179	12	21. 0
203	303H	204	175	40	18. 7	222AA	222A	222	181	27	58. 0
204	203	204A	182	52	00. 6	222	222AA	221	178	32	52. 5
204A	204	204B	179	09	26. 7	221	222	220B	179	18	42. 5
204B	204A	205Rd	180	06	49. 5	220B	221	220A	180	14	42. 4
205Rd	204B	206	180	20	53. 3	220A	220B	Boulevard	178	40	08. 8
206	205Rd	222F	181	17	01. 9	Boulevard	220A	Whelehan	270	16	46. 3

Computation of grid azimuths

Stations	Preliminary azimuth and angle			Correction for closure	Corrected azimuth and angle	
	°	′	″	″	′	″
303 to 304	355	15	50.5			50.5
∠304 to 303A	94	35	03.6	−2.3		01.3
303 to 303A	89	50	54.1			51.8
303A to 303	269	50	54.1			51.8
∠303 to 303B	178	39	42.8	−2.3		40.5
303A to 303B	88	30	36.9			32.3
303B to 303A	268	30	36.9			32.3
∠303A to 303C	191	35	27.2	−2.3		24.9
303B to 303C	100	06	04.1		05	57.2
303C to 303B	280	06	04.1		05	57.2
∠303B to 303G	211	41	48.6	−2.3		46.3
303C to 303G	131	47	52.7			43.5
303G to 303C	311	47	52.7			43.5
∠303C to 303H	228	04	56.4	−2.3		54.1
303G to 303H	179	52	49.1			37.6
303H to 303G	359	52	49.1			37.6
∠303G to 203	183	08	31.6	−2.3		29.3
303H to 203	183	01	20.7			06.9
203 to 303H	3	01	20.7			06.9
∠303H to 204	175	40	18.7	−2.3		16.4
203 to 204	178	41	39.4			23.3
204 to 203	358	41	39.4			23.3
∠203 to 204A	182	52	00.6	−2.3	51	58.3
204 to 204A	181	33	40.0			21.6
204A to 204	1	33	40.0			21.6
∠204 to 204B	179	09	26.7	−2.3		24.4
204A to 204B	180	43	06.7		42	46.0
204B to 204A	0	43	06.7		42	46.0
∠204A to 205 Rd	180	06	49.5	−2.3		47.2
204B to 205 Rd	180	49	56.2			33.2
205 Rd to 204B	0	49	56.2			33.2
∠204B to 206	180	20	53.3	−2.3		51.0
205 Rd to 206	181	10	49.5			24.2
206 to 205 Rd	1	10	49.5			24.2
∠205 Rd to 222F	181	17	01.9	−2.3	16	59.6
206 to 222F	182	27	51.4			23.8
222F to 206	2	27	51.4			23.8
∠206 to 222E	178	55	09.2	−2.2		07.0
222F to 222E	181	23	00.6		22	30.8

Stations	Preliminary azimuth and angle			Correction for closure	Corrected azimuth and angle	
	°	′	″	″	′	″
222E to 222F	1	23	00.6		22	30.8
∠222F to 222D	179	55	10.1	−2.3		07.8
222E to 222D	181	18	10.7		17	38.6
222D to 222E	1	18	10.7		17	38.6
∠222E to 222C	225	34	48.8	−2.3		46.5
222D to 222C	226	52	59.5			25.1
222C to 222D	46	52	59.5			25.1
∠222D to 222B	224	03	04.8	−2.3		02.5
222C to 222B	270	56	04.3		55	27.6
222B to 222C	90	56	04.3		55	27.6
∠222C to 222A	180	05	48.3	−2.3		46.0
222B to 222A	271	01	52.6			13.6
222A to 222B	91	01	52.6			13.6
∠222B to 222AA	179	12	21.0	−2.3		18.7
222A to 222AA	270	14	13.6		13	32.3
222AA to 222A	90	14	13.6		13	32.3
∠222A to 222	181	27	58.0	−2.3		55.7
222AA to 222	271	42	11.6		41	28.0
222 to 222AA	91	42	11.6		41	28.0
∠222AA to 221	178	32	52.5	−2.3		50.2
222 to 221	270	15	04.1		14	18.2
221 to 222	90	15	04.1		14	18.2
∠222 to 220B	179	18	42.5	−2.3		40.2
221 to 220B	269	33	46.6		32	58.4
220B to 221	89	33	46.6		32	58.4
∠221 to 220A	180	14	42.4	−2.3		40.1
220B to 220A	269	48	29.0		47	38.5
220A to 220B	89	48	29.0		47	38.5
∠220B to Boulevard	178	40	08.8	−2.3		06.5
220A to Boulevard	268	28	37.8		27	45.0
Boulevard to 220A	88	28	37.8		27	45.0
∠220A to Whelehan	270	16	46.3	−2.3		44.0
Boulevard to Whelehan	358	45	24.1		44	29.0
Fixed azimuth	358	44	29.0			
Discrepancy			+55.1			

Reduction of lengths

[Average elevation=491 feet. Elevation factor=0.99997653]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
303-303A	973. 295	973. 272	0. 9999961	973. 268
303A-303B	1, 637. 085	1, 637. 047	. 9999954	1, 637. 039
303B-303C	1, 016. 146	1, 016. 122	. 9999947	1, 016. 117
303C-303G	2, 670. 145	2, 670. 082	. 9999939	2, 670. 066
303G-303H	3, 205. 132	3, 205. 057	. 9999934	3, 205. 036
303H-203	835. 075	835. 055	. 9999935	835. 050
203-204	1, 520. 021	1, 519. 985	. 9999935	1, 519. 975
204-204A	1, 009. 006	1, 008. 982	. 9999935	1, 008. 975

[Average elevation=402 feet. Elevation factor=0.99998078]

Section	Taped length	Geodetic length	Grid factor	Grid length
204A-204B	2, 517. 751	2, 517. 703	0. 9999935	2, 517. 687
204B-205Rd	2, 884. 644	2, 884. 589	. 9999936	2, 884. 571
205Rd-206	2, 454. 543	2, 454. 496	. 9999936	2, 454. 480
206-222F	1, 051. 106	1, 051. 086	. 9999936	1, 051. 079
222F-222E	3, 144. 363	3, 144. 303	. 9999937	3, 144. 283
222E-222D	3, 002. 589	3, 002. 531	. 9999937	3, 002. 512
222D-222C	1, 171. 307	1, 171. 284	. 9999939	1, 171. 277
222C-222B	4, 133. 628	4, 133. 549	. 9999952	4, 133. 529
222B-222A	2, 603. 782	2, 603. 732	. 9999970	2, 603. 724
222A-222AA	2, 021. 577	2, 021. 538	. 9999982	2, 021. 534
222AA-222	2, 016. 349	2, 016. 310	. 9999992	2, 016. 308
222-221	3, 202. 630	3, 202. 568	1. 0000006	3, 202. 570
221-220B	4, 308. 940	4, 308. 857	1. 0000026	4, 308. 868
220B-220A	2, 808. 288	2, 808. 234	1. 0000045	2, 808. 247
220A-Boulevard	2, 564. 699	2, 564. 650	1. 0000058	2, 564. 665

Mean latitude=43°13′

$\log A = 8.5090363-10$

$\log B = 8.5106053-10$

$\log A+\log B=17.0196416-20$

$\frac{\log A+\log B}{2}= 8.5098208-10$

$\log \text{constant} =5.8304093$

$\frac{\log A+\log B}{2}=8.5098208-10$

$\log R_a =7.3205885$

$R_a =20,921,300$

Elevation factor 303 to 204A $=\frac{20,921,300}{20,921,791}=0.99997653$

Elevation factor 204A to Boulevard $=\frac{20,921,300}{20,921,702}=0.99998078$

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
303					0.41274572	-2.59		1,162,342.03	726,883.36
					7.42451327				
				973.268	2.98823245			1,162,339.44	725,910.10
					9.99999847			-0.01	-0.01
303A	89	50	51.8	973	2.98823092		-973.26	1,162,339.43	725,910.09
					1.62937311	-42.60			
					8.41531408				
				1637.039	3.21405903			1,162,296.84	724,273.62
					9.99985293			-0.02	-0.04
303B	88	30	32.3	2.610	3.21391196		-1636.48	1,162,296.82	724,273.58
					2.25085781	+178.18			
					9.24391409				
				1016.117	3.00694372			1,162,475.02	723,273.25
					9.99321817			-0.03	-0.06
303C	100	05	57.2	3.626	3.00016189		-1000.37	1,162,474.99	723,273.19
					3.25030445	+1779.53			
					9.82378245				
				2670.066	3.42652200			1,164,254.55	721,282.64
					9.87246473			-0.05	-0.10
303G	131	47	43.5	6.296	3.29898673		-1990.61	1,164,254.50	721,282.54
					3.50583191	+3205.03			
					9.99999900				
				3205.036	3.50583291			1,167,459.58	721,275.77
					7.33138938			-0.07	-0.15
303H	179	52	37.6	9.502	0.83722229		-6.87	1,167,459.51	721,275.62

FIGURE 14.—Computation of coordinates, traverse no. 2A.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
303H					2.92110948	+833.89		1,167,459.58	721,275.77
					9.99939700			1,167,459.51	721,275.62
				835.050	2.92171248			1,168,293.47	721,319.74
					8.72147962			-0.08	-0.16
203	183	01	06.9	10.337	1.64319210		+43.97	1,168,293.39	721,319.58
					3.18172288	+1519.58			
					9.99988644				
				1519.975	3.18183644			1,169,813.05	721,284.99
					8.35917527			-0.09	-0.18
204	178	41	23.3	11,857	1.54101171		-34.75	1,169,812.96	721,284.81
					3.00372023	+1008.60			
					9.99983983				
				1008.975	3.00388040			1,170,821.65	721,312.39
					8.43383358			-0.10	-0.20
204A	181	33	21.6	12,866	1.43771398		+27.40	1,170,821.55	721,312.19
					3.40096813	+2517.49			
					9.99996639				
				2517.687	3.40100174			1,173,339.14	721,343.71
					8.09482032			-0.11	-0.24
204B	180	42	46.0	15,383	1.49582206		+31.32	1,173,339.03	721,343.47
					3.46003611	+2884.27			
					9.99995488				
				2884.571	3.46008123			1,176,223.41	721,385.29
					8.15878395			-0.14	-0.28
205Rd	180	49	33.2	18,268	1.61886518		+41.58	1,176,223.27	721,385.01

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
205Rd					3.38986842	+2453.97		1,176,223.41	721,385.29
					9.99990892			1,176,223.27	721,385.01
				2454.480	3.38995950			1,178,677.38	721,435.55
					8.31128898			-0.15	-0.32
206	181	10	24.2	20,722	1.70124848		+50.26	1,178,677.23	721,435.23
					3.02123605	+1050.11			
					9.99960069				
				1051.079	3.02163536			1,179,727.49	721,480.60
					8.63208070			-0.16	-0.33
222F	182	27	23.8	21,773	1.65371606		+45.05	1,179,727.33	721,480.27
					3.49739652	+3143.38			
					9.99987489				
				3144.283	3.49752163			1,182,870.87	721,556.06
					8.38020855			-0.18	-0.38
222E	181	22	30.8	24,918	1.87773018		+75.46	1,182,870.69	721,555.68
					3.47737398	+3001.75			
					9.99988922				
				3002.512	3.47748476			1,185,872.62	721,623.87
					8.35379337			-0.21	-0.43
222D	181	17	38.6	27,920	1.83127813		+67.81	1,185,872.41	721,623.44
					2.90346780	+800.70			
					9.83480818				
				1171.277	3.06865962			1,186,673.32	722,478.72
					9.86323233			-0.22	-0.45
222C	226	52	25.1	29,091	2.93189195		+854.85	1,186,673.10	722,478.27

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
222C			1.82400813	-66.68		1,186,673.32	722,478.72
			8.20768714			1,186,673.10	722,478.27
		4133.529	3.61632099			1,186,606.64	726,611.71
			9.99994348			-0.25	-0.51
222B	270 55 27.6	33,225	3.61626447		+4132.99	1,186,606.39	726,611.20
			1.66623871	-46.37			
			8.25064377				
		2603.724	3.41559494			1,186,560.27	729,215.02
			9.99993112			-0.26	-0.55
222A	271 01 13.6	35,829	3.41552606		+2603.31	1,186,560.01	729,214.47
			0.90097118	-7.96			
			7.59529013				
		2021.534	3.30568105			1,186,552.31	731,236.54
			9.99999663			-0.28	-0.58
222AA	270 13 32.3	37,850	3.30567768		+2021.52	1,186,552.03	731,235.96
			1.77454332	-59.50			
			8.46998645				
		2016.308	3.30455687			1,186,492.81	733,251.97
			9.99981080			-0.29	-0.61
222	271 41 28.0	39,867	3.30436767		+2015.43	1,186,492.52	733,251.36
			1.12466071	-13.32			
			7.61916208				
		3202.570	3.50549863			1,186,479.49	736,454.51
			9.99999624			-0.32	-0.66
221	270 14 18.2	43,069	3.50549487		+3202.54	1,186,479.17	736,453.85

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
221			1.52987730	+33.87		1,186,479.49	736,454.51
			7.89551411			1,186,479.17	736,453.85
		4308.868	3.63436319			1,186,513.36	740,763.24
			9.99998658			-0.35	-0.73
220B	269 32 58.4	47.378	3.63434977		+4308.73	1,186,513.01	740,762.51
			1.00412030	+10.10			
			7.55568499				
		2808.247	3.44843531			1,186,523.46	743,571.47
			9.99999719			-0.37	-0.77
220A	269 47 38.5	50.186	3.44843250		+2808.23	1,186,523.09	743,570.70
			1.83767101	+68.81			
			8.42864037				
		2564.665	3.40903064			1,186,592.27	746,135.21
			9.99984362			-0.39	-0.81
Blvd.	268 27 45.0	52.751	3.40887426		+2563.74	1,186,591.88	746,134.40
						1,186,591.88	746,134.40
				Discrepancy		+0.39	+0.81
				x Factor = -1.53552×10^{-5}			
				y Factor = -0.73932×10^{-5}			

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
303				-2.59		1,162,342.03	726,883.36
			0.00265775				725,910.10
		973.268				1,162,339.44	-0.01
			0.99999647			-0.01	725,910.09
303A	89 50 51.8	973			-973.26	1,162,339.43	
				-42.60			
			0.02602040				
		1637.039				1,162,296.84	724,273.62
			0.99966141			-0.02	-0.04
303B	88 30 32.3	2.610			-1636.48	1,162,296.82	724,273.58
				+178.18			
			0.17535336				
		1016.117				1,162,475.02	723,273.25
			0.98450556			-0.03	-0.06
303C	100 05 57.2	3.626			-1000.37	1,162,474.99	723,273.19
				+1779.53			
			0.66647284				
		2670.66				1,164,254.55	721,282.64
			0.74552931			-0.05	-0.10
303G	131 47 43.5	6.296			-1990.61	1,164,254.50	721,282.54
				+3205.03			
			0.99999770				
		3205.036				1,167,459.58	721,275.77
			0.00214481			-0.07	-0.15
303H	179 52 37.6	9.502			-6.87	1,167,459.51	721,275.62

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

NOTE.—*The grid distance shown in the third column should be 2670.066 instead of 2670.66.*

COMPUTATION OF COORDINATES

Traverse line No. 2 A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
303H				+833.89		1,167,459.58	721,275.77
			0.99861251			1,167,459.51	721,275.62
		835.050				1,168,293.47	721,319.74
			0.05265985			-0.08	-0.16
203	183 01 06.9	10,337			+43.97	1,168,293.39	721,319.58
				+1519.58			
			0.99973855				
		1519.975				1,169,813.05	721,284.99
			0.02286522			-0.09	-0.18
204	178 41 23.3	11,857			-34.75	1,169,812.96	721,284.81
				+1008.60			
			0.99963126				
		1008.975				1,170,821.65	721,312.39
			0.02715398			-0.10	-0.20
204A	181 33 21.6	12,866			+27.40	1,170,821.55	721,312.19
				+2517.49			
			0.99992262				
		2517.687				1,173,339.14	721,343.71
			0.01244000			-0.11	-0.24
204B	180 42 46.0	15,383			+31.32	1,173,339.03	721,343.47
				+2884.27			
			0.99989612				
		2884.571				1,176,223.41	721,385.29
			0.01441398			-0.14	-0.28
205Rd	180 49 33.2	18,268			+41.58	1,176,223.27	721,385.01

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
205Rd						+2453.97		1,176,223.41	721,385.29
					0.99979030			1,176,223.27	721,385.01
				2454.480				1,178,677.38	721,435.55
					0.02047807			-0.15	-0.32
206	181	10	24.2	20,722			+50.26	1,178,677.23	721,435.23
						+1050.11			
					0.99908097				
				1051.079				1,179,727.49	721,480.60
					0.04286282			-0.16	-0.33
222F	182	27	23.8	21,773			+45.05	1,179,727.33	721,480.27
						+3143.38			
					0.99971196				
				3144.283				1,182,870.87	721,556.06
					0.02399985			-0.18	-0.38
222E	181	22	30.8	24,918			+75.46	1,182,870.69	721,555.68
						+3001.75			
					0.99974495				
				3002.512				1,185,872.62	721,623.87
					0.02258361			-0.21	-0.43
222D	181	17	38.6	27,920			+67.81	1,185,872.41	721,623.44
						+800.70			
					0.68360964				
				1171.277				1,186,673.32	722,478.72
					0.72984783			-0.22	-0.45
222C	226	52	25.1	29,091			+854.85	1,186,673.10	722,478.27

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

Station	Azimuth Plane ° ′ ″	Grid Distance Feet	~~Nat.~~ Lat. / ~~Nat.~~ cos Az / ~~Nat.~~ dist. / ~~Nat.~~ sin Az / ~~Nat.~~ Dep.	Latitude Feet	Departure Feet	Grid Coordinates y Feet	Grid Coordinates x Feet
222C				-66.68		1,186,673.32	722,478.72
			0.01613196			1,186,673.10	722,478.27
		4133.529				1,186,606.64	726,611.71
			0.99986987			-0.25	-0.51
222B	270 55 27.6	33.225			+4132.99	1,186,606.39	726,611.20
				-46.37			
			0.01780918				
		2603.724				1,186,560.27	729,215.02
			0.99984141			-0.26	-0.55
222A	271 01 13.6	35.829			+2603.31	1,186,560.01	729,214.47
				-7.96			
			0.00393813				
		2021.534				1,186,552.31	731,236.54
			0.99999224			-0.28	-0.58
222AA	270 13 32.3	37.850			+2021.52	1,186,552.03	731,235.96
				-59.50			
			0.02951117				
		2016.308				1,186,492.81	733,251.97
			0.99956445			-0.29	-0.61
222	271 41 28.0	39.867			+2015.43	1,186,492.52	733,251.36
				-13.32			
			0.00416066				
		3202.570				1,186,479.49	736,454.51
			0.99999135			-0.32	-0.66
221	270 14 18.2	43.069			+3202.54	1,186,479.17	736,453.85

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York (West) County Monroe Initial Station 303
Year 1934 Month January - March Closing Station Boulevard

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
221				+33.87		1,186,479.49	736,454.51
			0.00786166			1,186,479.17	736,453.85
		4308.868				1,186,513.36	740,763.24
			0.99996910			-0.35	-0.73
220B	269 32 58.4	47.378			+4308.73	1,186,513.01	740,762.51
				+10.10			
			0.00359489				
		2808.247				1,186,523.46	743,571.47
			0.99999354			-0.37	-0.77
220A	269 47 38.5	50.186			+2808.23	1,186,523.09	743,570.70
				+68.81			
			0.02683122				
		2564.665				1,186,592.27	746,135.21
			0.99963998			-0.39	-0.81
Blvd.	268 27 45.0	52.751			+2563.74	1,186,591.88	746,134.40
						1,186,591.88	746,134.40
					Discrepancy	+0.39	+0.81
					x Factor = -1.53552 X 10^{-5}		
					y Factor = -0.73932 X 10^{-5}		

FIGURE 14.—Computation of coordinates, traverse no. 2A—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2A
State New York - West County Monroe Initial Station 303.
Year 1934 Month January - March Closing Station Boulevard

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
205Rd				+4.33		1,176,223.27	721,385.01
			0.09333313				
		46.409				1,176,227.60	721,431.22
			0.99563494				
205	264 38 40.6				+46.21		
221				+12.13		1,186,479.17	736,453.85
			0.95870302				
		12.652				1,186,491.30	736,457.45
			0.28440904				
221Rd	196 31 24.7				+3.60		
221Rd				+47.21		1,186,491.30	736,457.45
			0.99994425				
		47.212				1,186,538.51	736,456.95
			0.01055857				
TT36K (U.S.G.S.)	179 23 42.1				-0.50		
222C				+54.52		1,186,673.10	722,478.27
			0.06815556				
		799.943				1,186,727.62	721,680.19
			0.99767471				
TT35K (U.S.G.S.)	93 54 29.0				-798.08		

FIGURE 15.—Computation of coordinates connected to traverse no. 2A.

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

PLANE COORDINATES

Datum *North American 1927* Projection *Transverse Mercator* State *New York - West*

Station	x Coordinate / y Coordinate	Azimuth	Mark	Station	x Coordinate / y Coordinate	Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
304	727,010.62			204 B	721,34347		
	1,160,80595				1,173,339.03		
303	726,883.36	355 15 50.5	304	205 Rd	721,385.01		
	1,162,342.03				1,176,223.27		
303 A	725,910.09			206	721,435.23		
	1,162,339.43				1,178,677.23		
303 B	724,273.58			222 F	721,480.27		
	1,162,296.82				1,179,727.33		
303 C	723,273.19			222 E	721,555.68		
	1,162,474.99				1,182,870.69		
303 G	721,282.54			222 D	721,623.44		
	1,164,254.50				1,185,872.41		
303 H	721,275.62			222 C	722,478.27		
	1,167,459.51				1,186,673.10		
203	721,319.58			222 B	726,611.20		
	1,168,293.39				1,186,606.39		
204	721,284.81			222 A	729,214.47		
	1,169,812.96				1,186,560.01		
204 A	721,312.19			222 AA	731,235.96		
	1,170,821.55				1,186,552.03		

U. S. GOVERNMENT PRINTING OFFICE

FIGURE 16.—List of plane coordinates.

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

PLANE COORDINATES

Datum *North American 1927* Projection *Transverse Mercator* State *New York - West*

Station	x Coordinate / y Coordinate (Feet)	Azimuth	Mark	Station	x Coordinate / y Coordinate (Feet)	Azimuth	Mark
222	733,251.36						
	1,186,492.52						
221	736,453.85						
	1,186,479.17						
220 B	740,762.51						
	1,186,513.01						
220 A	743,570.70						
	1,186,523.09						
Whelehan	746,182.87						
	1,184,385.73						
Boulevard	746,134.40	358 44 29.0	Whelehan				
	1,186,591.88						
205	721,431.22						
	1,176,227.60						
TT 36 K (U.S.G.S.)[1]	736,456.95						
	1,186,538.51						
TT 35 K (U.S.G.S.)[1]	721,680.19						
	1,186,727.62						

[1] No check on this station.

FIGURE 16.—List of plane coordinates—Continued.

Computation of grid azimuth from coordinates

205Rd to 206

	x	y
206	721, 435. 23	1, 178, 677. 23
205Rd	721, 385. 01	1, 176, 223. 27
Δx and Δy	+50. 22	+2, 453. 96

$$\log \Delta x = 1.7008767$$
$$\log \Delta y = 3.3898675$$
$$\log \tan \alpha = 8.3110092 - 10$$
$$\alpha = 1°10'20''.6$$
$$\text{grid azimuth} = 181°10'20''.6$$

Station	Azimuth and angle		
	°	′	″
205Rd to 206	181	10	20. 6
∠206 to 205	83	28	20. 0
205Rd to 205	264	38	40. 6

221 to 220B

	x	y
220B	740, 762. 51	1, 186, 513. 01
221	736, 453. 85	1, 186, 479. 17
Δx and Δy	+4, 308. 66	+33. 84

$$\log \Delta x = 3.6343423$$
$$\log \Delta y = 1.5294304$$
$$\log \tan \alpha = 2.1049119$$
$$\alpha = 89°33'00''.0$$
$$\text{grid azimuth} = 269°33'00''.0$$

Station	Azimuth and angle		
	°	′	″
221 to 220B	269	33	00. 0
∠220B to 221Rd	286	58	24. 7
221 to 221Rd	196	31	24. 7
221Rd to 221	16	31	24. 7
∠221 to TT 36K (U. S. G. S.)	162	52	17. 4
221Rd to TT 36K (U. S. G. S.)	179	23	42. 1

Computation of grid azimuth from coordinates—Continued

222C to 222B

	x	y
222B	726, 611. 20	1, 186, 606. 39
222C	722, 478. 27	1, 186, 673. 10
Δx and Δy	+4, 132. 93	−66. 71

$$\log \Delta x = 3.6162580$$
$$\log \Delta y = 1.8241909$$
$$\log \tan \alpha = 1.7920671$$
$$\alpha = 89^\circ 04' 31''.0$$
$$\text{grid azimuth} = 270^\circ 55' 29''.0$$

Station	Azimuth and angle		
	°	′	″
222C to 222B	270	55	29. 0
∠222B to TT 35K (U. S. G. S.)	182	59	00. 0
222C to TT 35K (U. S. G. S.)	93	54	29. 0

[Elevation factor=0.99998078]

Section	Taped length	Geodetic length	Grid factor	Grid length
	Feet	*Feet*		*Feet*
222C-TT 35K (U. S. G. S.)	799. 963	799. 948	0. 9999939	799. 943

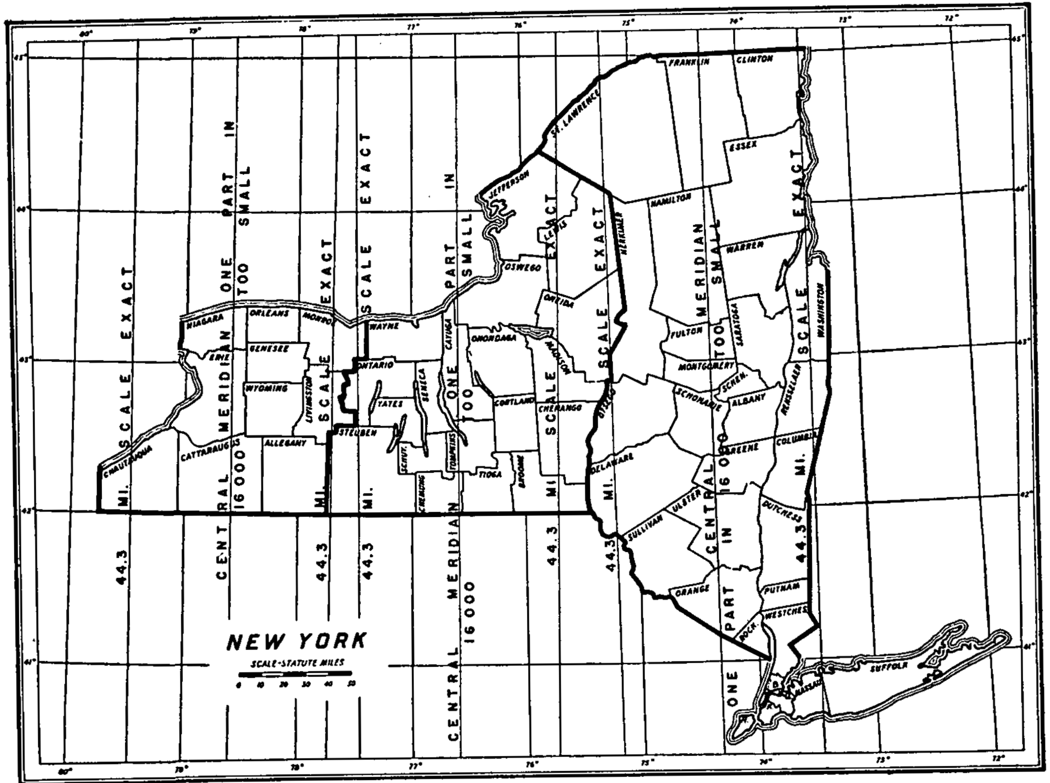

FIGURE 17.—Map of New York with grid system outline. (See note on p. 86.)

Transverse Mercator Projection for New York

Table I

Lat.	y (feet)	Tabular difference for 1 sec. of lat.	Lat.	y (feet)	Tabular difference for 1 sec. of lat.
40° 00'	0	101.18267			
01	6,070.96	101.18283	40° 36'	218,565.63	101.19317
02	12,141.93	101.18317	37	224,637.22	101.19350
03	18,212.92	101.18350	38	230,708.83	101.19383
04	24,283.93	101.18383	39	236,780.46	101.19417
05	30,354.96	101.18417	40	242,852.11	101.19450
40° 06'	36,426.01	101.18433	40° 41'	248,923.78	101.19483
07	42,497.07	101.18467	42	254,995.47	101.19500
08	48,568.15	101.18500	43	261,067.17	101.19533
09	54,639.25	101.18533	44	267,138.89	101.19567
10	60,710.37	101.18550	45	273,210.63	101.19583
40° 11'	66,781.50	101.18583	40° 46'	279,282.38	101.19617
12	72,852.65	101.18617	47	285,354.15	101.19650
13	78,923.82	101.18650	48	291,425.94	101.19683
14	84,995.01	101.18683	49	297,497.75	101.19717
15	91,066.22	101.18700	50	303,569.58	101.19750
40° 16'	97,137.44	101.18733	40° 51'	309,641.43	101.19767
17	103,208.68	101.18767	52	315,713.29	101.19800
18	109,279.94	101.18800	53	321,785.17	101.19833
19	115,351.22	101.18817	54	327,857.07	101.19867
20	121,422.51	101.18850	55	333,928.99	101.19883
40° 21'	127,493.82	101.18883	40° 56'	340,000.92	101.19917
22	133,565.15	101.18917	57	346,072.87	101.19950
23	139,636.50	101.18933	58	352,144.84	101.19983
24	145,707.86	101.18967	59	358,216.83	101.20000
25	151,779.24	101.19000	41° 00'	364,288.83	101.20033
40° 26'	157,850.64	101.19033	41° 01'	370,360.85	101.20083
27	163,922.06	101.19067	02	376,432.90	101.20100
28	169,993.50	101.19083	03	382,504.96	101.20117
29	176,064.95	101.19117	04	388,577.03	101.20150
30	182,136.42	101.19150	05	394,649.12	101.20183
40° 31'	188,207.91	101.19183	41° 06'	400,721.23	101.20217
32	194,279.42	101.19217	07	406,793.36	101.20250
33	200,350.95	101.19233	08	412,865.51	101.20283
34	206,422.49	101.19267	09	418,937.68	101.20300
35	212,494.05	101.19300	10	425,009.86	101.20333

FIGURE 18.—Projection tables for New York.

The east zone for New York State has been changed and the tables on pages 86-92 can no longer be used for it. Corresponding changes are needed in the map on page 85. Revised tables can be obtained by writing to the Director, U. S. Coast and Geodetic Survey, Washington, D. C.

Transverse Mercator Projection for New York

Table I (Cont'd)

Lat.	y (feet)	Tabular difference for 1 sec. of lat.	Lat.	y (feet)	Tabular difference for 1 sec. of lat.
41° 11'	431,082.06	101.20367	41° 46'	643,620.34	101.21400
12	437,154.28	101.20400	47	649,693.18	101.21433
13	443,226.52	101.20417	48	655,766.04	101.21467
14	449,298.77	101.20450	49	661,838.92	101.21500
15	455,371.04	101.20483	50	667,911.82	101.21533
41° 16'	461,443.33	101.20517	41° 51'	673,984.74	101.21550
17	467,515.64	101.20550	52	680,057.67	101.21583
18	473,587.97	101.20567	53	686,130.62	101.21617
19	479,660.31	101.20600	54	692,203.59	101.21633
20	485,732.67	101.20633	55	698,276.57	101.21683
41° 21'	491,805.05	101.20667	41° 56'	704,349.58	101.21700
22	497,877.45	101.20700	57	710,422.60	101.21733
23	503,949.87	101.20717	58	716,495.64	101.21767
24	510,022.30	101.20750	59	722,568.70	101.21800
25	516,094.75	101.20783	42° 00'	728,641.78	101.21817
41° 26'	522,167.22	101.20817	42° 01'	734,714.87	101.21850
27	528,239.71	101.20833	02	740,787.98	101.21883
28	534,312.21	101.20867	03	746,861.11	101.21917
29	540,384.73	101.20900	04	752,934.26	101.21950
30	546,457.27	101.20933	05	759,007.43	101.21967
41° 31'	552,529.83	101.20950	42° 06'	765,080.61	101.22000
32	558,602.40	101.20983	07	771,153.81	101.22033
33	564,674.99	101.21017	08	777,227.03	101.22067
34	570,747.60	101.21050	09	783,300.27	101.22083
35	576,820.23	101.21083	10	789,373.52	101.22117
41° 36'	582,892.88	101.21117	42° 11'	795,446.79	101.22150
37	588,965.55	101.21133	12	801,520.08	101.22183
38	595,038.23	101.21167	13	807,593.39	101.22217
39	601,110.93	101.21200	14	813,666.72	101.22250
40	607,183.65	101.21233	15	819,740.07	101.22267
41° 41'	613,256.39	101.21250	42° 16'	825,813.43	101.22300
42	619,329.14	101.21283	17	831,886.81	101.22317
43	625,401.91	101.21317	18	837,960.20	101.22367
44	631,474.70	101.21350	19	844,033.62	101.22400
45	637,547.51	101.21383	20	850,107.06	101.22417

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transverse Mercator Projection for New York

Table I (Cont'd)

Lat.	y (feet)	Tabular difference for 1 sec. of lat.	Lat.	y (feet)	Tabular difference for 1 sec. of lat.
42° 21'	856,180.51	101.22450	42° 56'	1,068,762.62	101.23500
22	862,253.98	101.22483	57	1,074,836.72	101.23533
23	868,327.47	101.22500	58	1,080,910.84	101.23550
24	874,400.97	101.22550	59	1,086,984.97	101.23583
25	880,474.50	101.22567	43° 00'	1,093,059.12	101.23617
42° 26'	886,548.04	101.22600	43° 01'	1,099,133.29	101.23650
27	892,621.60	101.22633	02	1,105,207.48	101.23683
28	898,695.18	101.22650	03	1,111,281.69	101.23700
29	904,768.77	101.22683	04	1,117,355.91	101.23733
30	910,842.38	101.22717	05	1,123,430.15	101.23767
42° 31'	916,916.01	101.22750	43° 06'	1,129,504.41	101.23800
32	922,989.66	101.22783	07	1,135,578.69	101.23817
33	929,063.33	101.22817	08	1,141,652.98	101.23850
34	935,137.02	101.22833	09	1,147,727.29	101.23900
35	941,210.72	101.22867	10	1,153,801.63	101.23917
42° 36'	947,284.44	101.22900	43° 11'	1,159,875.98	101.23950
37	953,358.18	101.22933	12	1,165,950.35	101.23967
38	959,431.94	101.22950	13	1,172,024.73	101.24000
39	965,505.71	101.22983	14	1,178,099.13	101.24033
40	971,579.50	101.23017	15	1,184,173.55	101.24067
42° 41'	977,653.31	101.23050	43° 16'	1,190,247.99	101.24100
42	983,727.14	101.23083	17	1,196,322.45	101.24117
43	989,800.99	101.23117	18	1,202,396.92	101.24167
44	995,874.86	101.23133	19	1,208,471.42	101.24183
45	1,001,948.74	101.23167	20	1,214,545.93	101.24217
42° 46'	1,008,022.64	101.23183	43° 21'	1,220,620.46	101.24233
47	1,014,096.55	101.23233	22	1,226,695.00	101.24267
48	1,020,170.49	101.23267	23	1,232,769.56	101.24317
49	1,026,244.45	101.23283	24	1,238,844.15	101.24333
50	1,032,318.42	101.23317	25	1,244,918.75	101.24367
42° 51'	1,038,392.41	101.23350	43° 26'	1,250,993.37	101.24400
52	1,044,466.42	101.23367	27	1,257,068.01	101.24417
53	1,050,540.44	101.23400	28	1,263,142.66	101.24450
54	1,056,614.48	101.23433	29	1,269,217.33	101.24483
55	1,062,688.54	101.23467	30	1,275,292.02	101.24517

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transverse Mercator Projection for New York

Table I (Cont'd)

Lat.	y (feet)	Tabular difference for 1 sec. of lat.	Lat.	y (feet)	Tabular difference for 1 sec. of lat.
43° 31'	1,281,366.73	101.24550	44° 06'	1,493,992.85	101.25600
32	1,287,441.46	101.24567	07	1,500,068.21	101.25617
33	1,293,516.20	101.24600	08	1,506,143.58	101.25650
34	1,299,590.96	101.24633	09	1,512,218.97	101.25683
35	1,305,665.74	101.24667	10	1,518,294.38	101.25717
43° 36'	1,311,740.54	101.24700	44° 11'	1,524,369.81	101.25750
37	1,317,815.36	101.24717	12	1,530,445.26	101.25767
38	1,323,890.19	101.24750	13	1,536,520.72	101.25800
39	1,329,965.04	101.24783	14	1,542,596.20	101.25833
40	1,336,039.91	101.24817	15	1,548,671.70	101.25867
43° 41'	1,342,114.80	101.24850	44° 16'	1,554,747.22	101.25900
42	1,348,189.71	101.24867	17	1,560,822.76	101.25917
43	1,354,264.63	101.24900	18	1,566,898.31	101.25950
44	1,360,339.57	101.24933	19	1,572,973.88	101.25983
45	1,366,414.53	101.24967	20	1,579,049.47	101.26017
43° 46'	1,372,489.51	101.25000	44° 21'	1,585,125.08	101.26050
47	1,378,564.51	101.25017	22	1,591,200.71	101.26067
48	1,384,639.52	101.25050	23	1,597,276.35	101.26100
49	1,390,714.55	101.25083	24	1,603,352.01	101.26133
50	1,396,789.60	101.25117	25	1,609,427.69	101.26167
43° 51'	1,402,864.67	101.25150	44° 26'	1,615,503.39	101.26183
52	1,408,939.76	101.25157	27	1,621,579.10	101.26233
53	1,415,014.86	101.25200	28	1,627,654.84	101.26250
54	1,421,089.98	101.25233	29	1,633,730.59	101.26283
55	1,427,165.12	101.25267	30	1,639,806.36	101.26317
43° 56'	1,433,240.28	101.25300	44° 31'	1,645,882.15	101.26333
57	1,439,315.46	101.25317	32	1,651,957.95	101.26367
58	1,445,390.65	101.25350	33	1,658,033.77	101.26417
59	1,451,465.86	101.25383	34	1,664,109.62	101.26433
44° 00'	1,457,541.09	101.25417	35	1,670,185.48	101.26450
44° 01'	1,463,616.34	101.25450	44° 36'	1,676,261.35	101.26500
02	1,469,691.61	101.25467	37	1,682,337.25	101.26533
03	1,475,766.89	101.25500	38	1,688,413.17	101.26550
04	1,481,842.19	101.25533	39	1,694,489.10	101.26583
05	1,487,917.51	101.25567	40	1,700,565.05	101.26600

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transverse Mercator Projection for New York

Table I (Cont'd)

Lat.	y (feet)	Tabular difference for 1 sec. of lat.	Lat.	y (feet)	Tabular difference for 1 sec. of lat.
44° 41'	1,706,641.01	101.26650	45° 16'	1,919,311.23	101.27700
42	1,712,717.00	101.26667	17	1,925,387.85	101.27717
43	1,718,793.00	101.26700	18	1,931,464.48	101.27750
44	1,724,869.02	101.26733	19	1,937,541.13	101.27783
45	1,730,945.06	101.26767	20	1,943,617.80	
44° 46'	1,737,021.12	101.26800			
47	1,743,097.20	101.26833			
48	1,749,173.30	101.26850			
49	1,755,249.41	101.26867			
50	1,761,325.53	101.26917			
44° 51'	1,767,401.68	101.26950			
52	1,773,477.85	101.26967			
53	1,779,554.03	101.27000			
54	1,785,630.23	101.27033			
55	1,791,706.45	101.27067			
44° 56'	1,797,282.69	101.27100			
57	1,803,858.95	101.27117			
58	1,809,935.22	101.27150			
59	1,816,011.51	101.27183			
45° 00'	1,822,087.82	101.27217			
45° 01'	1,828,164.15	101.27250			
02	1,834,240.50	101.27267			
03	1,840,316.86	101.27300			
04	1,846,393.24	101.27333			
05	1,852,469.64	101.27367			
45° 06'	1,858,546.06	101.27400			
07	1,864,622.50	101.27417			
08	1,870,698.95	101.27450			
09	1,876,775.42	101.27483			
10	1,882,851.91	101.27517			
45° 11'	1,888,928.42	101.27550			
12	1,895,004.95	101.27567			
13	1,901,081.49	101.27600			
14	1,907,158.05	101.27633			
15	1,913,234.63	101.27667			

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transeverse Mercator Projection for New York

Table II

X' (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio	X' (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
0	-271.4	0.9999375	175,000	-119.5	0.9999725
5,000	-271.3	0.9999375	180,000	-110.7	0.9999745
10,000	-270.9	0.9999376	185,000	-101.6	0.9999766
15,000	-270.3	0.9999378	190,000	-92.3	0.9999787
20,000	-269.4	0.9999380	195,000	-82.7	0.9999810
25,000	-268.3	0.9999382	200,000	-72.9	0.9999832
30,000	-266.9	0.9999385	205,000	-62.9	0.9999855
35,000	-265.3	0.9999389	210,000	-52.6	0.9999879
40,000	-263.5	0.9999393	215,000	-42.1	0.9999903
45,000	-261.4	0.9999398	220,000	-31.3	0.9999928
50,000	-259.0	0.9999404	225,000	-20.2	0.9999953
55,000	-256.4	0.9999410	230,000	-8.9	0.9999980
60,000	-253.5	0.9999416	235,000	+2.6	1.0000006
65,000	-250.4	0.9999423	240,000	+14.4	1.0000033
70,000	-247.1	0.9999431	245,000	+26.4	1.0000061
75,000	-243.5	0.9999439	250,000	+38.7	1.0000089
80,000	-239.6	0.9999448	255,000	+51.2	1.0000118
85,000	-235.6	0.9999458	260,000	+64.0	1.0000147
90,000	-231.2	0.9999468	265,000	+77.0	1.0000177
95,000	-226.6	0.9999478	270,000	+90.3	1.0000208
100,000	-221.8	0.9999489	275,000	+103.8	1.0000239
105,000	-216.7	0.9999501	280,000	+117.6	1.0000271
110,000	-211.4	0.9999513	285,000	+131.6	1.0000303
115,000	-205.8	0.9999526	290,000	+145.8	1.0000336
120,000	-200.0	0.9999539	295,000	+160.4	1.0000369
125,000	-193.9	0.9999554	300,000	+175.1	1.0000403
130,000	-187.6	0.9999568	305,000	+190.1	1.0000438
135,000	-181.0	0.9999583	310,000	+205.4	1.0000473
140,000	-174.2	0.9999599	315,000	+220.9	1.0000509
145,000	-167.1	0.9999615	320,000	+236.6	1.0000545
150,000	-159.8	0.9999632	325,000	+252.6	1.0000582
155,000	-152.2	0.9999650	330,000	+268.9	1.0000619
160,000	-144.4	0.9999668	335,000	+285.4	1.0000657
165,000	-136.3	0.9999686	340,000	+302.1	1.0000696
170,000	-128.0	0.9999705	345,000	+319.1	1.0000735

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transverse Mercator Projection for New York

Table II (Cont'd)

X' (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
350,000	+336.4	1.0000775
355,000	+353.9	1.0000815
360,000	+371.6	1.0000856
365,000	+389.6	1.0000897
370,000	+407.8	1.0000939
375,000	+426.3	1.0000982
380,000	+445.0	1.0001025
385,000	+464.0	1.0001068
390,000	+483.2	1.0001113
395,000	+502.7	1.0001158
400,000	+522.4	1.0001203
405,000	+542.4	1.0001249
410,000	+562.6	1.0001295
415,000	+583.1	1.0001343
420,000	+603.8	1.0001390
425,000	+624.7	1.0001438
430,000	+646.0	1.0001487
435,000	+667.4	1.0001537
440,000	+689.1	1.0001587
445,000	+711.1	1.0001637
450,000	+733.3	1.0001688
455,000	+755.7	1.0001740
460,000	+778.4	1.0001792
465,000	+801.4	1.0001845
470,000	+824.6	1.0001899
475,000	+848.0	1.0001953

East

λ (Central Meridian) = 74° 20' 00".000

$\log \left(\frac{1}{6\rho_0^2}\right)_g = 4.5807653 - 20$

$\log \left(\frac{1}{6\rho_0^2 \sin 1''}\right)_g = 9.8951904 - 20$

Central

λ (Central Meridian) = 76° 35' 00".000

$\log \left(\frac{1}{6\rho_0^2}\right)_g = 4.5807483 - 20$

$\log \left(\frac{1}{6\rho_0^2 \sin 1''}\right)_g = 9.8951734 - 20$

West

λ (Central Meridian) = 78° 35' 00".000

$\log \left(\frac{1}{6\rho_0^2}\right)_g = 4.5807825 - 20$

$\log \left(\frac{1}{6\rho_0^2 \sin 1''}\right)_g = 9.8952076 - 20$

log R = - 271.4

$$\text{Geod. Az.} - \text{Grid Az.} = + \Delta\alpha + \frac{y_2 - y_1}{(6\rho_0^2 \sin 1'')_g}(2x_1' + x_2')$$

FIGURE 18.—Projection tables for New York—Continued.

(See note on p. 86.)

Transverse Mercator Projection for New York

Table III

Lat.	Colog A	Log C	Lat.	Colog A	Log C
40° 00'	1.49088157	1.328327	40° 36'	1.49089680	1.337485
01	88199	8581	37	89722	7740
02	88242	8836	38	89765	7994
03	88284	9091	39	89807	8247
04	88326	9346	40	89849	8502
05	88368	9600			
40° 06'	88411	1.329855	40° 41'	1.49089892	1.338755
07	88453	1.330110	42	89934	9009
08	88495	0364	43	89977	9263
09	88537	0620	44	90019	9517
10	88580	0874	45	90061	1.339770
40° 11'	1.49088622	1.331128	40° 46'	90104	1.340024
12	88664	1383	47	90146	0278
13	88706	1638	48	90189	0531
14	88749	1892	49	90231	0784
15	88791	2147	50	90273	1038
40° 16'	88833	2401	40° 51'	1.49090316	1.341292
17	88876	2655	52	90358	1545
18	88918	2910	53	90401	1799
19	88960	3165	54	90443	2053
20	89002	3419	55	90486	2306
40° 21'	1.49089045	1.333674	40° 56'	90528	2560
22	89087	3928	57	90571	2814
23	89129	4182	58	90613	3067
24	89172	4437	59	90655	3321
25	89214	4691	41° 00'	90698	3574
40° 26'	89256	4945	41° 01'	1.49090740	1.343827
27	89299	5198	02	90783	4080
28	89341	5453	03	90825	4334
29	89383	5707	04	90868	4588
30	89426	5961	05	90910	4841
40° 31'	1.49089468	1.336216	41° 06'	90953	5095
32	89510	6470	07	90995	5348
33	89553	6723	08	91038	5601
34	89595	6978	09	91080	5854
35	89638	7232	10	91123	6108

FIGURE 18.—Projection tables for New York—Continued.

620745 O - 44 - 7

Transverse Mercator Projection for New York

Table III (Cont'd)

Lat.	Colog A	Log C	Lat.	Colog A	Log C
41° 11'	1.49091165	1.346360	41°46'	1.49092655	1.355214
12	91208	6614	47	92697	5466
13	91250	6867	48	92740	5719
14	91293	7120	49	92782	5972
15	91335	7374	50	92825	6224
41° 16'	91378	7627	41°51'	1.49092868	1.356475
17	91420	7880	52	92910	6727
18	91463	8132	53	92953	6980
19	91505	8386	54	92996	7233
20	91548	8639	55	93038	7485
41° 21'	1.49091590	1.348892	41°56'	93081	7737
22	91633	9145	57	93124	7990
23	91675	9398	58	93166	8242
24	91718	9651	59	93209	8494
25	91761	1.349904	42°00'	93252	8746
41° 26'	91803	1.350157	42°01'	1.49093294	1.359000
27	91846	0410	02	93337	9252
28	91888	0663	03	93379	9504
29	91931	0916	04	93422	1.359757
30	91973	1168	05	93465	1.360009
41° 31'	1.49092016	1.351423	42°06'	93507	0261
32	92058	1675	07	93550	0513
33	92101	1927	08	93593	0765
34	92144	2179	09	93635	1017
35	92186	2433	10	93678	1269
41° 36'	92229	2686	42°11'	1.49093721	1.361522
37	92271	2938	12	43763	1774
38	92314	3191	13	93806	2026
39	92357	3445	14	93849	2279
40	92399	3698	15	93892	2530
41° 41'	1.49092442	1.353952	42°16'	93934	2782
42	92484	4204	17	93977	3035
43	92527	4456	18	94020	3287
44	92569	4709	19	94062	3539
45	92612	4962	20	94105	3792

FIGURE 18.—Projection tables for New York—Continued.

Transverse Mercator Projection for New York

Table III (Cont'd)

Lat.	Colog A	Log C	Lat.	Colog A	Log C
42° 21'	1.49094148	1.364043	42° 56'	1.49095644	1.372856
22	94190	4294	57	95686	3108
23	94233	4546	58	95729	3359
24	94276	4798	59	95772	3611
25	94319	5050	43° 00'	95815	3863
42° 26'	94361	5302	43° 01'	1.49095858	1.374114
27	94404	5555	02	95900	4365
28	94447	5807	03	95943	4617
29	94489	6060	04	95986	4869
30	94532	6310	05	96029	5120
42° 31'	1.49094575	1.366562	43° 06'	96072	5371
32	94618	6815	07	96114	5624
33	94660	7065	08	96157	5875
34	94703	7318	09	96200	6125
35	94746	7569	10	96243	6377
42° 36	94789	7821	43° 11'	1.49096286	1.376629
37	94831	8074	12	96328	6880
38	94874	8325	13	96371	7132
39	94917	8577	14	96414	7384
40	94959	8829	15	96457	7635
42° 41'	1.49095002	1.369081	43° 16'	96500	7886
42	95045	9332	17	96542	8138
43	95088	9584	18	96585	8389
44	95130	1.369836	19	96628	8640
45	95173	1.370088	20	96671	8892
42° 46'	95216	0339	43° 21'	1.49096714	1.379144
47	95259	0591	22	96756	9395
48	95301	0843	23	96799	9646
49	95344	1094	24	96842	1.379898
50	95387	1346	25	96885	1.380149
42° 51'	1.49095430	1.371598	43° 26'	96928	0400
52	95473	1849	27	96971	0652
53	95515	2101	28	97013	0903
54	95558	2353	29	97056	1154
55	95601	2604	30	97099	1405

FIGURE 18.—Projection tables for New York—Continued.

Transverse Mercator Projection for New York

Table III (Cont'd)

Lat.	Colog A	Log C	Lat.	Colog A	Log C
43° 31'	1.49097142	1.381657	44° 06'	1.49098642	1.390447
32	97185	1908	07	98685	0699
33	97228	2159	08	98728	0950
34	97270	2411	09	98771	1200
35	97313	2662	10	98813	1451
43° 36'	97356	2913	44° 11'	1.49098856	1.391703
37	97399	3165	12	98899	1954
38	97442	3416	13	98942	2204
39	97485	3667	14	98985	2456
40	97527	3918	15	99028	2707
43° 41'	1.49097570	1.384170	44° 16'	99071	2958
42	97613	4421	17	99114	3209
43	97656	4671	18	99156	3460
44	97699	4923	19	99199	3711
45	97742	5174	20	99242	3962
43° 46'	97785	5425	44° 21'	1.49099285	1.394213
47	97827	5677	22	99328	4464
48	97870	5927	23	99371	4715
49	97913	6178	24	99414	4967
50	97956	6429	25	99457	5217
43° 51'	1.49097999	1.386681	44° 26'	99500	5468
52	98042	6931	27	99542	5719
53	98085	7182	28	99585	5970
54	98127	7434	29	99628	6221
55	98170	7685	30	99671	6472
43° 56'	98213	7936	44° 31'	1.49099714	1.396723
57	98256	8188	32	99757	6974
58	98299	8439	33	99800	7225
59	98342	8689	34	99843	7476
44° 00'	98385	8940	35	99886	7727
44° 01'	1.49098428	1.389192	44° 36'	99928	7978
02	98470	9443	37	1.49099971	8229
03	98513	9694	38	1.49100014	8480
04	98556	1.389944	39	00057	8731
05	98599	1.390196	40	00100	8982

FIGURE 18.—Projection tables for New York—Continued.

Transeverse Mercator Projection for New York

Table III (Cont'd)

Lat.	Colog A	Log C
44° 41'	1.49100143	1.399233
42	00186	9484
43	00229	9735
44	00272	1.399985
45	00314	1.400237
44° 46'	00357	0488
47	00400	0738
48	00443	0990
49	00486	1241
50	00529	1491
44° 51'	1.49100572	1.401743
52	00615	1995
53	00658	2244
54	00701	2495
55	00743	2747
44° 56'	00786	2997
57	00829	3248
58	00872	3500
59	00915	3750
45° 00'	00958	4001
45° 01'	1.49101001	1.404253
02	01044	4503
03	01087	4754
04	01130	5005
05	01172	5256
45° 06'	01215	5507
07	01258	5758
08	01301	6009
09	01344	6260
10	01387	6511
45° 11	1.49101430	1.406761
12	01473	7013
13	01516	7263
14	01559	7513
15	01601	7765
45° 16'	1.49101644	1.408016
17	01687	8266
18	01730	8517
19	01773	8769
20	01816	9019

FIGURE 18.—Projection tables for New York—Continued.

TRAVERSES IN NEW JERSEY

For further examples of adjustment of traverses on the transverse Mercator grid it was decided to make use of a few that were measured in New Jersey in the vicinity of Newark. These had already been computed by the State officials, but it was decided to handle them in a slightly different fashion to illustrate a method of adjustment that is often advantageous. It was a little difficult to find suitable traverses in any of the States on the transverse Mercator grid because in so many of them there was lack of adjusted control on which to base the traverse computations. There is no intention to supersede the computations made by the State officials, because they are perfectly satisfactory as they stand. We have merely made use of the material to illustrate the method of handling computations when traverses join on a single point coming from three or more directions.

The first example chosen is a traverse from Essex to Hosp. There is nothing unusual in this traverse, but we needed to fix the coordinates of Monument 612 which forms the point of departure for two of the other courses that we wished to use.

In the vicinity of Newark the elevations above sea level are so small that it was not thought necessary to reduce the lengths to sea level. Also the work lies in a region of the State in which the projection is true to scale; so it was not thought worthwhile to compute and apply grid corrections to the measured lengths. The departure from true scale throughout the whole of the State is so small that grid corrections could be neglected without serious detriment. However, we would advocate their use in parts of all States where the scale factors are large enough to be of significance. Even in this State we should use them in locations where they are large enough to mean anything.

After the position of Monument 612 was fixed by the first adjustment, a 3-section computation was chosen for a further example. Two of these start from Monument 612, one to the eastward and the other to the westward. We have assigned arbitrary numbers to these and we have also assigned arbitrary numbers and symbols to the stations, except where the marked monuments occur. These were given the designations that correspond to the markings on the station marks. The third section starts from station Newark; and all three meet at the point that we have designated as Y. This gives us an opportunity to illustrate the adoption of a weighted azimuth to be held in the azimuth closures and also the computation of a weighted mean of the coordinates to be held fixed in the position closures.

These computations have been made with 8-place natural-function tables only because it was considered that we had already given enough examples with both natural functions and logarithms. As we have already stated, 7-place logarithmic tables would give all the accuracy necessary for such computations. The complete 8-place logarithmic tables are out of print and it is difficult to get them even in the second-hand trade. On the other hand, 7-place tables are easily obtainable at a reasonable price.

It should be noted that the constant added to the x' values in this State is used as 2,000,000. Since early computations in large number were made in this State with this value conforming to the usage in most States with the Lambert projection, it was thought inadvisable to change the constant to 500,000 which is used in all of the other

(Text continued on p. 105)

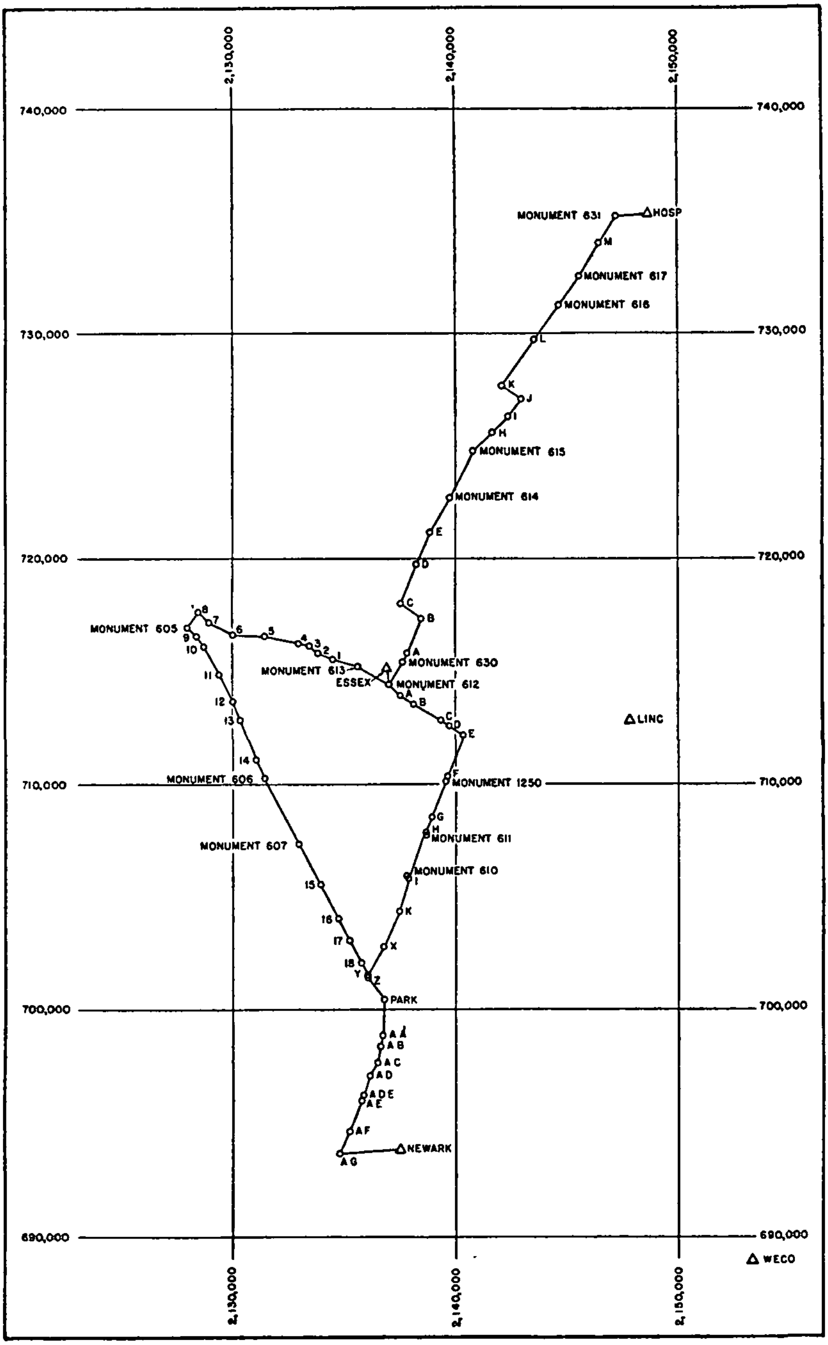

FIGURE 19.—Sketch of traverses in New Jersey.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey Station Newark

		λ (Central meridian)	74° 40′ 00″.000
φ 40° 44′ 12″.771		λ	74 10 13.651
		Δλ (Central meridian−λ)	+ 0 29 46.349
		Δλ (in sec.)	+ 1786″.349

log Δλ	3.25196631	log S_m^2	9.244740
Cor. arc to sine	− 543	log C*	1.3395~~70~~ 86 -10
log $\Delta\lambda_1$	3.25196088	log Δφ	0.5843~~10~~ 26
log cos φ	9.87950556-10		
colog A	1.49090028	φ	40° 44′ 12″.771
log S_1	4.62236672	Δφ	+ 3.8~~398~~ 400
Cor. sine to arc	+ 312	φ′	40 44 16.61~~00~~ 10
log S_m	4.62236984		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.19933
log R	− 1086		
log S_g	5.13834315	y (for min. of φ′)	692,087.97
log S_g^3	15.4150294	y (for seconds of φ′)	+ 1,681.02
log $1/6\rho_o^2R^2$	4.5810213-20	y	693,768.99
log $(S_g^3/6\rho_o^2)_g$	9.9960507-10		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+137,512.807	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 0.991	log $\Delta\alpha_1$	
x′	+137,513.80		
	2,000,000.00	log $(\Delta\lambda)^3$	
x	2,137,513.80	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 20.—Computation of coordinates for New Jersey.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey   Station Essex

		λ (Central meridian)	74° 40′ 00″.000
φ 40° 47′ 44″.145		λ	74 10 19.583
		Δλ (Central meridian−λ)	+ 0 29 40.417
		Δλ (in sec.)	+ 1780″.417

log $\Delta\lambda_s$	3.25052173	log S_m^2	9.241086
Cor. arc to sine	− 539	log C*	80 1.340464-10
log $\Delta\lambda_1$	3.25051634	log $\Delta\phi$	66 0.581550
log cos φ	9.87912186-10		
colog A	1.49090178	φ	40° 47′ 44″.145 6
log S_1	4.62053998	Δφ	+ 3.8155 6
Cor. sine to arc	+ 309	φ′	40 47 47.9605
log S_m	4.62054307		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.20033
log R	− 1086		
log S_g	5.13651638	y (for min. of φ′)	710,303.91
log S_g^3	15.4095491	y (for seconds of φ′)	+ 4,853.63
log $1/6\rho_o^2R^2$	4.5810213-20	y	715,157.54
log $(S_g^3/6\rho_o^2)_g$	9.9905704-10		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+136,935.603	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 0.979	log $\Delta\alpha_1$	
x′	+136,936.58		
	2,000,000.00	log $(\Delta\lambda)^3$	
x	2,136,936.58	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 20.—Computation of coordinates for New Jersey—Continued.

PLANE-COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey Station Hoso

λ (Central meridian)	74° 40′ 00″.000
λ	74 07 44.965
Δλ (Central meridian-λ)	+ 0 32 15.035
Δλ (in sec.)	+ 1935″.035

φ 40°. 51′ 03″.234

log Δλ	3.28668882	log S_m^2	9.312698
Cor. arc to sine	− 637	log C*	26 1.341307-10
log $\Delta\lambda_1$	3.28668245	log Δφ	24 0.654085
log cos φ	9.87875972-10		
colog A	1.49090318	φ	40° 51′ 03″.234
log S_1	4.65634535	Δφ	+ 4 4.5082
Cor. sine to arc	+ 364	φ′	4 40 51 07.7422
log S_m	4.65634899		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.20150
log R	− 1086		
log S_g	5.17232230	y (for min. of φ′)	734,592.09
log S_g^3	15.5169669	y (for seconds of φ′)	+ 783.54
log $1/6\rho_o^2R^2$	4.5810213-20	y	735,375.63
log $(S_g^3/6\rho_o^2)_g$	0.0979882		
S_g	+148,703.880	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	+ 1.253	log Δλ	
x′	+148,705.13	log $\Delta\alpha_1$	
	2,000,000.00	log $(\Delta\lambda)^3$	
x	2,148,705.13	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 20.—Computation of coordinates for New Jersey—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey   Station Lino

		λ (Central meridian)	74° 40' 00".000
φ 40° 47' 20".315		λ	74 07 58.003
		Δλ (Central meridian−λ)	+ 0 32 01.997
		Δλ (in sec.)	+ 1921".997

log Δλ	3.28375270	log S_m^2	9.307634 82
Cor. arc to sine	− 629	log C*	1.340364-10 8016
log $\Delta\lambda_1$	3.28374641	log Δφ	0.647998
log cos φ	9.87916516-10		
colog A	1.49090161	φ	40° 47' 20".315 5
log S_1	4.65381318	Δφ	+ 4.446 3 5
Cor. sine to arc	+ 360	φ'	40 47 24.761 3 5
log S_m	4.65381678		
log 3937/1200	0.51598417	Tabular difference of y for 1" of φ'	101.20033
log R	− 1086		
log S_g	5.16979009	y (for min. of φ')	710,303.91
log S_g^3	15.5093703	y (for seconds of φ')	+ 2,505.87
log $1/6\rho_o^2R^2$	4.5810213-20	y	712,809.78
log $(S_g^3/6\rho_o^2)_g$	0.0903916		
S_g	+147,839.365	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	+ 1.231	log Δλ	
x'	+147,840.60	log $\Delta\alpha_1$	
	2,000,000.00	log $(\Delta\lambda)^3$	
x	2,147,840.60	log F	
		log b	
		$\Delta\alpha_1$	"
		b	
		Δα	"
		Δα	° ' "

* Take out C first for φ and correct for approximate φ'.

FIGURE 20.—Computation of coordinates for New Jersey—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New Jersey   Station Weco

	λ (Central meridian)	74° 40′ 00″.000
φ 40° 43′ 24″.359	λ	74 06 48.721
	Δλ (Central meridian−λ)	+ 0 33 11.279
	Δλ (in sec.)	+ 1991″.279

log Δλ	3.29913211	log S_m^2	9.339245
Cor. arc to sine	− 675	log C*	1.3393~~65~~85-10
log $\Delta\lambda_1$	3.29912536	log Δφ	0.6786~~10~~30
log cos φ	9.87959333-10		
colog A	1.49089994	φ	40° 43′ 24″.359
log S_1	4.66961863	Δφ	+ 4.771~~0~~2
Cor. sine to arc	+ 387	φ′	40 43 29.130~~0~~2
log S_m	4.66962250		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.19917
log R	− 1086		
log S_g	5.18559581	y (for min. of φ′)	686,016.02
log S_g^3	15.5567874	y (for seconds of φ′)	+ 2,947.95
log $1/6\rho_o^2R^2$	4.5810213-20	y	688,963.97
log $(S_g^3/6\rho_o^2)_g$	0.1378087		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+153,318.940	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 1.373	log $\Delta\alpha_1$	
x′	+153,320.31		
	2,000,000.00	log $(\Delta\lambda)^3$	
x	2,153,320.31	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 20.—Computation of coordinates for New Jersey—Continued.

States with the transverse Mercator projection. This matter is purely arbitrary since in using the coordinates we are dealing with the differences of coordinates and these are unaffected by the added constant.

Computation of grid azimuths from coordinates, traverse no. 6, control data

ESSEX TO NEWARK

	x	y
Newark	2, 137, 513. 80	693, 768. 99
Essex	2, 136, 936. 58	715, 157. 54
Δx and Δy	+577. 22	−21, 388. 55

$$\log \Delta x = 2.7613414$$
$$\log \Delta y = 4.3301814$$
$$\log \tan \alpha = 8.4311600-10$$
$$\alpha = 1°32'45''.2$$
$$\text{grid azimuth} = 358°27'14''.8$$

HOSP TO LINC

	x	y
Linc	2, 147, 840. 60	712, 809. 78
Hosp	2, 148, 705. 13	735, 375. 63
Δx and Δy	−864. 53	−22, 565. 85

$$\log \Delta x = 2.9367801$$
$$\log \Delta y = 4.3534517$$
$$\log \tan \alpha = 8.5833284-10$$
$$\alpha = 2°11'38''.4$$
$$\text{grid azimuth} = 2°11'38''.4$$

Computation of grid azimuths, traverse no. 6

Stations	Preliminary azimuth and angle			Correction for closure	Corrected azimuth and angle	
	°	′	″	″	′	″
Essex to Newark	358	27	14.8			14.8
∠Newark to Monument 612	350	54	02.6	+2.4		05.0
Essex to Monument 612	349	21	17.4			19.8
Monument 612 to Essex	169	21	17.4			19.8
∠Essex to Monument 630	38	36	06.0	+2.3		08.3
Monument 612 to Monument 630	207	57	23.4			28.1
Monument 630 to Monument 612	27	57	23.4			28.1
∠Monument 612 to A	180	00	00.0	+2.4		02.4
Monument 630 to A	207	57	23.4			30.5
A to Monument 630	27	57	23.4			30.5
∠Monument 630 to B	174	25	22.3	+2.3		24.6
A to B	202	22	45.7			55.1
B to A	22	22	45.7			55.1
∠A to C	102	43	59.8	+2.4		62.2
B to C	125	06	45.5			57.3
C to B	305	06	45.5			57.3
∠B to D	257	58	57.7	+2.3		60.0
C to D	203	05	43.2			57.3
D to C	23	05	43.2			57.3
∠C to E	179	28	31.3	+2.4		33.7
D to E	202	34	14.5			31.0
E to D	22	34	14.5			31.0
∠D to Monument 614	187	04	14.8	+2.3		17.1
E to Monument 614	209	38	29.3			48.1
Monument 614 to E	29	38	29.3			48.1
∠E to Monument 615	177	34	18.5	+2.4		20.9
Monument 614 to Monument 615	207	12	47.8		13	09.0
Monument 615 to Monument 614	27	12	47.8		13	09.0
∠Monument 614 to H	200	03	12.0	+2.4		14.4
Monument 615 to H	227	15	59.8		16	23.4
H to Monument 615	47	15	59.8		16	23.4
∠Monument 615 to I	177	50	48.3	+2.3		50.6
H to I	225	06	48.1		07	14.0
I to H	45	06	48.1		07	14.0
∠H to J	171	45	12.8	+2.4		15.2
I to J	216	52	00.9			29.2
J to I	36	52	00.9			29.2
∠I to K	86	49	36.6	+2.3		38.9
J to K	123	41	37.5		42	08.1
K to J	303	41	37.5		42	08.1
∠J to L	271	40	17.7	+2.4		20.1
K to L	215	21	55.2		22	28.2
L to K	35	21	55.2		22	28.2
∠K to Monument 616	179	17	38.4	+2.3		40.7
L to Monument 616	214	39	33.6		40	08.9
Monument 616 to L	34	39	33.6		40	08.9
∠L to Monument 617	182	13	22.0	+2.4		24.4
Monument 616 to Monument 617	216	52	55.6		53	33.3
Monument 617 to Monument 616	36	52	55.6		53	33.3
∠Monument 616 to M	174	37	05.2	+2.3		07.5
Monument 617 to M	211	30	00.8			40.8
M to Monument 617	31	30	00.8			40.8
∠Monument 617 to Monument 631	179	54	58.8	+2.4		61.2
M to Monument 631	211	24	59.6		25	42.0
Monument 631 to M	31	24	59.6		25	42.0
∠M to Hosp	232	51	24.3	+2.4		26.7
Monument 631 to Hosp	264	16	23.9		17	08.7
Hosp to Monument 631	84	16	23.9		17	08.7
∠Monument 631 to Linc	277	54	27.4	+2.3		29.7
Hosp to Linc	2	10	51.3		11	38.4
Fixed azimuth	2	11	38.4			
Discrepancy			−47.1			

COMPUTATION OF COORDINATES

Traverse line No. 6
State New Jersey County Essex and Passaic Initial Station Essex
Year 1934 Month June - October Closing Station Hosp

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
Essex				-751.25		715,157.54	2,136,936.58
			0.98279218				
		764.403				714,406.29	2,137,077.78
			0.18471471			+0.06	0.00
Mon.612	349 21 19.8	764			+141.20	714,406.35	2,137,077.78
				+1001.80			
			0.88329308				
		1134.170				715,408.09	2,137,609.50
			0.46882121			+0.15	0.00
Mon.630	207 57 28.1	1,899			+531.72	715,408.24	2,137,609.50
				+392.86			
			0.88328764				
		444.766				715,800.95	2,137,818.02
			0.46883148			+0.18	0.00
A	207 57 30.5	2,343			+208.52	715,801.13	2,137,818.02
				+1537.64			
			0.92466589				
		1662.918				717,338.59	2,138,451.23
			0.38077946			+0.31	0.00
B	202 22 55.1	4,006			+633.21	717,338.90	2,138,451.23
				+659.60			
			0.57523251				
		1146.659				717,998.19	2,137,513.27
			0.81798995			+0.40	+0.01
C	125 06 57.3	5,153			-937.96	717,998.59	2,137,513.28

FIGURE 21.—Computation of coordinates, traverse no. 6.

COMPUTATION OF COORDINATES

Traverse line No. 6
State New Jersey County Essex and Passaic Initial Station Essex
Year 1934 Month June - October Closing Station Hosp

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
						717,998.19	2,137,513.27
C				+1725.34		717,998.59	2,137,513.28
			0.91982663				
		1875.718				719,723.53	2,138,249.16
			0.39232508			+0.55	+0.01
D	203 05 57.3	7.029			+735.89	719,724.08	2,138,249.17
				+1431.35			
			0.92337594				
		1550.125				721,154.88	2,138,844.25
			0.38389694			+0.67	+0.01
E	202 34 31.0	8.579			+595.09	721,155.55	2,138,844.26
				+1541.53			
			0.86909209				
		1773.724				722,696.41	2,139,721.62
			0.49465032			+0.80	+0.01
Mon.614	209 38 48.1	10.352			+877.37	722,697.21	2,139,721.63
				+2080.36			
			0.88926341				
		2339.417				724,776.77	2,140,791.66
			0.45739543			+0.99	+0.01
Mon.615	207 13 09.0	12.692			+1070.04	724,777.76	2,140,791.67
				+811.11			
			0.67850378				
		1195.436				725,587.88	2,141,669.82
			0.73459692			+1.08	+0.02
H	227 16 23.4	13.887			+878.16	725,588.96	2,141,669.84

FIGURE 21.—Computation of coordinates, traverse no. 6—Continued.

620745 O - 44 - 8

COMPUTATION OF COORDINATES

Traverse line No. 6
State New Jersey   County Essex and Passaic   Initial Station Essex
Year 1934   Month June - October   Closing Station Hosp

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
						725,587.88	2,141,669.82
H				+706.27		725,588.96	2,141,669.84
			0.70561740				
		1000.922				726,294.15	2,142,379.07
			0.70859303			+1.16	+0.02
I	225 07 14.0	14,888			+709.25	726,295.31	2,142,379.09
				+788.70			
			0.79994889				
		985.937				727,082.85	2,142,970.70
			0.60006814			+1.23	+0.02
J	216 52 29.2	15,874			+591.63	727,084.08	2,142,970.72
				+585.79			
			0.55487709				
		1055.703				727,668.64	2,142,092.43
			0.83193233			+1.31	+0.02
K	123 42 08.1	16,930			-878.27	727,669.95	2,142,092.45
				+2037.75			
			0.81538553				
		2499.123				729,706.39	2,143,539.22
			0.57891833			+1.51	+0.02
L	215 22 28.2	19,429			+1446.79	729,707.90	2,143,539.24
				+1579.68			
			0.82245056				
		1920.697				731,286.07	2,144,631.78
			0.56883661			+1.66	+0.02
Mon. 616	214 40 08.9	21,350			+1092.56	731,287.73	2,144,631.80

FIGURE 21.—Computation of coordinates, traverse no. 6—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 6
State New Jersey | County Essex and Passaic | Initial Station Essex
Year 1934 | Month June - October | Closing Station Hosp

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
	° ′ ″					731,286.07	2,144,631.78
Mon.616				+1256.14		731,287.73	2,144,631.80
			0.79976238				
		1570.647				732,542.21	2,145,574.67
			0.60031670			+1.78	+0.02
Mon.617	216 53 33.3	22,920			+942.89	732,543.99	2,145,574.69
				+1465.83			
			0.85253680				
		1719.375				734,008.04	2,146,473.33
			0.52266721			+1.91	+0.03
M	211 30 40.8	24,640			+898.66	734,009.95	2,146,473.36
				+1216.52			
			0.85329305				
		1425.678				735,224.56	2,147,216.72
			0.52143166			+2.02	+0.03
Mon.631	211 25 42.0	26,065			+743.39	735,226.58	2,147,216.75
				+148.93			
			0.09956722				
		1495.809				735,373.49	2,148,705.10
			0.99503083			+2.14	+0.03
Hosp	264 17 08.7	27,561			+1488.38	735,375.63	2,148,705.13
						735,375.63	2,148,705.13
					Discrepancy	-2.14	-0.03
				x Factor =	+0.10885 X 10^{-5}		
				y Factor =	+7.76459 X 10^{-5}		

FIGURE 21.—Computation of coordinates, traverse no. 6—Continued.

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

PLANE COORDINATES

Datum NORTH AMERICAN 1927 *Projection* TRANSVERSE MERCATOR *State* NEW JERSEY

Station	x Coordinate / y Coordinate	Plane Azimuth	Mark	Station	x Coordinate / y Coordinate	Plane Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Mon. 612	2,137,077.78	207 57 20.3	Mon. 630				
	714,406.35						
Mon. 630	2,137,609.50	27 57 20.3	Mon. 612				
	715,408.24						
Mon. 614	2,139,721.63	207 13 01.4	Mon. 615				
	722,687.21						
Mon. 615	2,140,791.67	27 13 01.4	Mon. 614				
	724,777.76						
Mon. 616	2,144,631.60	216 53 24.6	Mon. 617				
	731,287.73						
Mon. 617	2,145,574.69	36 53 24.6	Mon. 616				
	732,543.99						
Mon. 631	2,147,216.75	264 16 52.8	Hosp				
	735,226.56						

FIGURE 22.—List of plane coordinates.

Computation of grid azimuths from coordinates, traverse no. 5

	x	y
Essex	2, 136, 936. 58	715, 157. 54
Monument 612	2, 137, 077. 78	714, 406. 35
Δx and Δy	−141. 20	+751. 19

$$\log \Delta x = 2.1498347$$
$$\log \Delta y = 2.8757498$$
$$\log \tan \alpha = 9.2740849 - 10$$
$$\alpha = 10°38'44''.1$$

Grid azimuth—Monument 612 to Essex = 169°21′15″.9

	x	y
Monument 630	2, 137, 609. 50	715, 408. 24
Monument 612	2, 137, 077. 78	714, 406. 35
Δx and Δy	+531. 72	+1, 001. 89

$$\log \Delta x = 2.7256830$$
$$\log \Delta y = 3.0008201$$
$$\log \tan \alpha = 9.7248629 - 10$$
$$\alpha = 27°57'20''.3$$

Grid azimuth—Monument 612 to Monument 630 = 207°57′20″.3
Grid azimuth—Monument 630 to Monument 612 = 27°57′20″.3

	x	y
Monument 614	2, 139, 721. 63	722, 697. 21
Monument 615	2, 140, 791. 67	724, 777. 76
Δx and Δy	−1, 070. 04	−2, 080. 55

$$\log \Delta x = 3.0294000$$
$$\log \Delta y = 3.3181781$$
$$\log \tan \alpha = 9.7112219 - 10$$
$$\alpha = 27°13'01''.4$$

Grid azimuth—Monument 615 to Monument 614 = 27°13′01″.4
Grid azimuth—Monument 614 to Monument 615 = 207°13′01″.4

	x	y
Monument 617	2, 145, 574. 69	732, 543. 99
Monument 616	2, 144, 631. 80	731, 287. 73
Δx and Δy	+942. 89	+1, 256. 26

$$\log \Delta x = 2.9744610$$
$$\log \Delta y = 3.0990796$$
$$\log \tan \alpha = 9.8753814 - 10$$
$$\alpha = 36°53'24''.6$$

Grid azimuth—Monument 616 to Monument 617 = 216°53′24″.6
Grid azimuth—Monument 617 to Monument 616 = 36°53′24″.6

Computation of grid azimuths from coordinates, traverse no. 6—Continued

	x	y
Monument 631	2, 147, 216. 75	735, 226. 58
Hosp	2, 148, 705. 13	735, 375. 63
Δx and Δy	−1, 488. 38	−149. 05

$$\log \Delta x = 3.1727139$$
$$\log \Delta y = 2.1733320$$
$$\log \tan \alpha = 0.9993819$$
$$\alpha = 84°16'52''.8$$

Grid azimuth—Hosp to Monument 631= 84°16′52″.8
Grid azimuth—Monument 631 to Hosp=264°16′52″.8

COMPUTATION OF THE WEIGHTED-MEAN GRID AZIMUTH OF Z TO Y

We have come to the line Z to Y from three directions. We shall now determine a weighted mean of the three values to be held in closing the azimuth in the various sections. The values in the sections will be weighted inversely as the number of angles in the section.

From Newark to Y with 11 angles we get Z to Y to be 153°01′27″.1. From Monument 612 to the eastward with 14 angles we get for Z to Y 153°01′50″.9. From monument 612 to the westward through 23 angles we get for Z to Y 153°01′49″.4. We could weight each value as the product of the other two numbers of angles, but this would give the numbers too large. We can accomplish approximately the same result by the weights $\frac{n}{11}$, $\frac{n}{14}$, and $\frac{n}{23}$ in which n is some suitable number.

Taking n as 50:

$$\frac{50}{11}=4.55$$
$$\frac{50}{14}=3.57$$
$$\frac{50}{23}=2.17.$$

Since all values have the same degrees and minutes, we can find merely the weighted mean of the seconds.

$$27.1 \times 4.55 = 123.305$$
$$50.9 \times 3.57 = 181.713$$
$$49.4 \times 2.17 = 107.198$$
$$\text{Totals} = 10.29 \quad 412.216$$
$$412.216 \div 10.29 = 40.1$$

The weighted mean, therefore, is 153°01′40″.1.

Computation of grid azimuths, traverse no. 1

Stations	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
Monument 612 to Essex	169	21	15.9			15.9
∠Essex to Monument 613	309	35	20.9	−0.4		20.5
Monument 612 to Monument 613	118	56	36.8			36.4
Monument 613 to Monument 612	298	56	36.8			36.4
∠Monument 612 to 1	167	01	18.3	−0.4		17.9
Monument 613 to 1	105	57	55.1			54.3
1 to Monument 613	285	57	55.1			54.3
∠Monument 613 to 2	187	42	18.4	−0.4		18.0
1 to 2	113	40	13.5			12.3
2 to 1	293	40	13.5			12.3
∠1 to 3	193	53	22.0	−0.4		21.6
2 to 3	127	33	35.5			33.9
3 to 2	307	33	35.5			33.9
∠2 to 4	156	57	02.5	−0.4		02.1
3 to 4	104	30	38.0			36.0
4 to 3	284	30	38.0			36.0
∠3 to 5	177	42	55.0	−0.4		54.6
4 to 5	102	13	33.0			30.6
5 to 4	282	13	33.0			30.6
∠4 to 6	169	23	27.5	−0.4		27.1
5 to 6	91	37	00.5		36	57.7
6 to 5	271	37	00.5		36	57.7
∠5 to 7	205	19	17.8	−0.4		17.4
6 to 7	116	56	18.3			15.1
7 to 6	296	56	18.3			15.1
∠6 to 8	197	15	50.9	−0.4		50.5
7 to 8	134	12	09.2			05.6
8 to 7	314	12	09.2			05.6
∠7 to Monument 605	82	40	01.2	−0.4		00.8
8 to Monument 605	36	52	10.4			06.4
Monument 605 to 8	216	52	10.4			06.4
∠8 to 9	95	58	01.2	−0.4		00.8
Monument 605 to 9	312	50	11.6			07.2
9 to Monument 605	132	50	11.6			07.2
∠Monument 605 to 10	191	18	01.9	−0.4		01.5
9 to 10	324	08	13.5			08.7
10 to 9	144	08	13.5			08.7
∠9 to 11	187	25	18.7	−0.4		18.3
10 to 11	331	33	32.2			27.0
11 to 10	151	33	32.2			27.0
∠10 to 12	180	02	51.8	−0.4		51.4
11 to 12	331	36	24.0			18.4
12 to 11	151	36	24.0			18.4
∠11 to 13	186	30	31.0	−0.4		30.6
12 to 13	338	06	55.0			49.0
13 to 12	158	06	55.0			49.0
∠12 to 14	180	00	40.4	−0.4		40.0
13 to 14	338	07	35.4			29.0
14 to 13	158	07	35.4			29.0
∠13 to Monument 606	176	40	05.0	−0.4		04.6
14 to Monument 606	334	47	40.4			33.6
Monument 606 to 14	154	47	40.4			33.6
∠14 to Monument 607	177	20	18.4	−0.4		18.0
Monument 606 to Monument 607	332	07	58.8			51.6
Monument 607 to Monument 606	152	07	58.8			51.6
∠Monument 606 to 15	180	01	42.2	−0.4		41.8
Monument 607 to 15	332	09	41.0			33.4
15 to Monument 607	152	09	41.0			33.4
∠Monument 607 to 16	180	09	10.0	−0.4		09.6
15 to 16	332	18	51.0			43.0
16 to 15	152	18	51.0			43.0
∠15 to 17	179	53	24.3	−0.4		23.9
16 to 17	332	12	15.3			06.9
17 to 16	152	12	15.3			06.9
∠16 to 18	180	21	56.0	−0.4		55.6
17 to 18	332	34	11.3			02.5
18 to 17	152	34	11.3			02.5
∠17 to Y	180	27	38.1	−0.5		37.6
18 to Y	333	01	49.4			40.1
Y to 18	153	01	49.4			40.1
Z to Y [1]	153	01	49.4			40.1
Weighted mean	153	01	40.1			
Discrepancy			+9.3			

[1] The stations Z, Y, and 18 are on a line, so Z to Y is the same as Y to 18.

COMPUTATION OF WEIGHTED-MEAN COORDINATES FOR Y

For station Y we get the following coordinates:

From traverse no. 1—x=2,136,045.53 and y=701,506.57.
From traverse no. 2—x=2,136,045.29 and y=701,505.21.
From traverse no. 3—x=2,136,044.87 and y=701,504.30.

The approximate lengths in feet of the respective traverses are:

No. 1=27,719.
No. 2=15,514.
No. 3=11,280.

We must weight each value inversely proportional to the length of the traverse that produces it. This can be done with sufficient accuracy by assigning to each value a weight proportional to 100,000 divided by the length of the traverse.

$$\text{No. } 1=\frac{100{,}000}{27{,}719}=3.61.$$

$$\text{No. } 2=\frac{100{,}000}{15{,}514}=6.45.$$

$$\text{No. } 3=\frac{100{,}000}{11{,}280}=8.87.$$

Since the various values differ only in the last three figures, we can confine ourselves to the determination of the weighted mean of these and simply append the result to the other figures that are common to all of the values.

For the x coordinate we have,

$$\begin{aligned} 5.53\times 3.61&=19.9633\\ 5.29\times 6.45&=34.1205\\ 4.87\times 8.87&=43.1969\\ \text{Totals}=18.93\quad & \quad 97.2807 \end{aligned}$$

$$97.2807\div 18.93=5.14.$$

Therefore, x=2,136,045.14.

For the y coordinate we get,

$$\begin{aligned} 6.57\times 3.61&=23.7177\\ 5.21\times 6.45&=33.6045\\ 4.30\times 8.87&=38.1410\\ \text{Totals}=18.93\quad & \quad 95.4632 \end{aligned}$$

$$95.4632\div 18.93=5.04.$$

Therefore, y=701,505.04.

This gives for the weighted-mean coordinates of station Y:

x=2,136,045.14
y= 701,505.04.

These values are, therefore, to be held in closing the three traverses.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New Jersey — County Essex — Initial Station Mon. 612
Year 1934 — Month January - April — Closing Station Y

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
Mon.612				+797.76		714,406.35	2,137,077.78
			0.48394607				
		1648.456				715,204.11	2,135,635.22
			0.87509783			-0.09	-0.02
Mon.613	118 56 36.4	1,648			-1442.56	715,204.02	2,135,635.20
				+322.23			
			0.27505150				
		1171.538				715,526.34	2,134,508.87
			0.96142949			-0.16	-0.04
1	105 57 54.3	2,820			-1126.35	715,526.18	2,134,508.83
				+288.81			
			0.40146961				
		719.370				715,815.15	2,133,850.02
			0.91587234			-0.20	-0.05
2	113 40 12.3	3,539			-658.85	715,814.95	2,133,849.97
				+295.39			
			0.60958383				
		484.572				716,110.54	2,133,465.89
			0.79272162			-0.22	-0.06
3	127 33 33.9	4,024			-384.13	716,110.32	2,133,465.83
				+124.28			
			0.25054897				
		496.045				716,234.82	2,132,985.67
			0.96810393			-0.25	-0.06
4	104 30 36.0	4,520			-480.22	716,234.57	2,132,985.61

FIGURE 23.—Computation of coordinates, traverse no. 1.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New Jersey   County Essex   Initial Station Mon. 612
Year 1934   Month January - April   Closing Station Y

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
						716,234.82	2,132,985.67
4				+330.10		716,234.57	2,132,985.61
			0.21175409				
		1558.905				716,564.92	2,131,462.12
			0.97732298			-0.34	-0.09
5	102 13 30.6	6.079			-1523.55	716,564.58	2,131,462.03
				+41.03			
			0.02820127				
		1455.046				716,605.95	2,130,007.65
			0.99960226			-0.42	-0.11
6	91 36 57.7	7.534			-1454.47	716,605.53	2,130,007.54
				+554.51			
			0.45301872				
		1224.028				717,160.46	2,128,916.43
			0.89150100			-0.48	-0.12
7	116 56 15.1	8.758			-1091.22	717,159.98	2,128,916.31
				+449.65			
			0.69718457				
		644.957				717,610.11	2,128,454.07
			0.71689168			-0.52	-0.13
8	134 12 05.6	9.403			-462.36	717,609.59	2,128,453.94
				-665.85			
			0.80001522				
		832.298				716,944.26	2,127,954.71
			0.59997971			-0.56	-0.14
Mon.605	36 52 06.4	10.235			-499.36	716,943.70	2,127,954.57

FIGURE 23.—Computation of coordinates, traverse no. 1—Continued

COMPUTATION OF COORDINATES

Traverse line No. 1
State New Jersey — County Essex — Initial Station Mon. 612
Year 1934 — Month January - April — Closing Station Y

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
						716,944.26	2,127,954.71
Mon. 605				-389.70		716,943.70	2,127,954.57
			0.67989365				
		573.172				716,554.56	2,128,375.02
			0.73331072			-0.60	-0.15
9	312 50 07.2	10,808			+420.31	716,553.96	2,128,374.87
				-457.13			
			0.81040735				
		564.076				716,097.43	2,128,705.49
			0.58586681			-0.63	-0.16
10	324 08 08.7	11,372			+330.47	716,096.80	2,128,705.33
				-1255.77			
			0.87929553				
		1428.154				714,841.66	2,129,385.69
			0.47627657			-0.71	-0.18
11	331 33 27.0	12,801			+680.20	714,840.95	2,129,385.51
				-1163.77			
			0.87969100				
		1322.927				713,677.89	2,130,014.80
			0.47554573			-0.78	-0.20
12	331 36 18.4	14,124			+629.11	713,677.11	2,130,014.60
				-846.45			
			0.92792483				
		912.193				712,831.44	2,130,354.84
			0.37276736			-0.83	-0.21
13	338 06 49.0	15,036			+340.04	712,830.61	2,130,354.63

FIGURE 23.—Computation of coordinates, traverse no. 1—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New Jersey — County Essex — Initial Station Mon. 612
Year 1934 — Month January - April — Closing Station Y

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
						712,831.44	2,130,354.84
13				-1733.22		712,830.61	2,130,354.63
			0.92799711				
		1867.700				711,098.22	2,131,050.72
			0.37258740			-0.93	-0.24
14	338 07 29.0	16.903			+695.88	711,097.29	2,131,050.48
				-815.68			
			0.90477255				
		901.535				710,282.54	2,131,434.68
			0.42589510			-0.98	-0.25
Mon.606	334 47 33.6	17.805			+383.96	710,281.56	2,131,434.43
				-2914.46			
			0.88401868				
		3296.833				707,368.08	2,132,975.79
			0.46745158			-1.16	-0.30
Mon.607	332 07 51.6	21.102			+1541.11	707,366.92	2,132,975.49
				-1845.39			
			0.88424928				
		2086.954				705,522.69	2,133,950.43
			0;46701522			-1.28	-0.33
15	332 09 33.4	23.189			+974.64	705,521.41	2,133,950.10
				-1497.87			
			0.88549051				
		1691.575				704,024.82	2,134,736.43
			0.46465746			-1.37	-0.35
16	332 18 43.0	24.880			+786.00	704,023.45	2,134,736.08

FIGURE 23.—Computation of coordinates, traverse no. 1—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 1
State New Jersey County Essex Initial Station Mon. 612
Year 1934 Month January - April Closing Station Y

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
						704,024.82	2,134,736.43
16				-954.21		704,023.45	2,134,736.08
			0.88459657				
		1078.700				703,070.61	2,135,239.49
			0.46635705			-1.43	-0.37
17	332 12 06.9	25,959			+503.06	703,069.18	2,135,239.12
				-991.96			
			0.88755309				
		1117.640				702,078.65	2,135,754.39
			0.46070546			-1.49	-0.38
18	332 34 02.5	27.077			+514.90	702,077.16	2,135,754.01
				-572.08			
			0.89122674				
		641.901				701,506.57	2,136,045.53
			0.45355804			-1.53	-0.39
Y	333 01 40.1	27,719			+291.14	701,505.04	2,136,045.14
				Weighted Mean		701,505.04	2,136,045.14
				Discrepancy		+1.53	+0.39
				x Factor = -1.40698×10^{-5}			
				y Factor = -5.51968×10^{-5}			

FIGURE 23.—Computation of coordinates, traverse no. 1—Continued.

Computation of grid azimuths, traverse no. 2

Station	Preliminary azimuth and angle			Correction for closure	Corrected azimuth and angle		
	°	′	″	″	°	′	″
Monument 612 to Essex	169	21	15.9				15.9
∠Essex to A	148	42	15.0	−0.8			14.2
Monument 612 to A	318	03	30.9				30.1
A to Monument 612	138	03	30.9				30.1
∠Monument 612 to B	163	38	16.8	−0.8			16.0
A to B	301	41	47.7				46.1
B to A	121	41	47.7				46.1
∠A to C	179	16	04.2	−0.7			03.5
B to C	300	57	51.9				49.6
C to B	120	57	51.9				49.6
∠B to D	181	37	31.9	−0.8			31.1
C to D	302	35	23.8				20.7
D to C	122	35	23.8				20.7
∠C to E	180	04	58.3	−0.8			57.5
D to E	302	40	22.1				18.2
E to D	122	40	22.1				18.2
∠D to F	258	54	06.8	−0.7			06.1
E to F	21	34	28.9				24.3
F to E	201	34	28.9				24.3
∠E to Monument 1250	179	45	34.0	−0.8			33.2
F to Monument 1250	21	20	02.9			19	57.5
Monument 1250 to F	201	20	02.9			19	57.5
∠F to G	180	00	00.0	−0.8	179	59	59.2
Monument 1250 to G	21	20	02.9			19	56.7
G to Monument 1250	201	20	02.9			19	56.7
∠Monument 1250 to H	179	42	03.7	−0.7			03.0
G to H	21	02	06.6			01	59.7
H to G	201	02					
∠G to Monument 611 [1]	85	08					
H to Monument 611 [1]	286	10					
H to G	201	02	06.6			01	59.7
∠G to I	180	19	38.4	−0.8			37.6
H to I	21	21	45.0				37.3
I to H	201	22					
∠H to Monument 610 [1]	267	41					
I to Monument 610 [1]	109	03					
I to H	201	21	45.0				37.3
∠H to K	174	00	59.0	−0.8			58.2
I to K	15	22	44.0				35.5
K to I	195	22	44.0				35.5
∠I to X	188	51	48.8	−0.8			48.0
K to X	24	14	32.8				23.5
X to K	204	14	32.8				23.5
∠K to Y	184	48	07.6	−0.8			06.8
X to Y	29	02	40.4				30.3
Y to X	209	02	40.4				30.3
∠X to Z	123	59	10.5	−0.7			09.8
Y to Z	333	01	50.9				40.1
Z to Y	153	01	50.9				40.1
Weighted mean	153	01	40.1				
Discrepancy			+10.8				

[1] These stations are not on the main line of the traverse, see figure 19, and are not included in the adjustment of the azimuths.

COMPUTATION OF COORDINATES

Traverse line No. 2
State New Jersey County Essex Initial Station Mon. 612
Year 1934 Month February - October Closing Station Y

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
Mon. 612				-477.03		714,406.35	2,137,077.78
			0.74382601				
		641.322				713,929.32	2,137,506.42
			0.66837330			-0.01	-0.01
A	318 03 30.1	641			+428.64	713,929.31	2,137,506.41
				-390.29			
			0.52541431				
		742.819				713,539.03	2,138,138.44
			0.85084652			-0.02	-0.01
B	301 41 46.1	1,384			+632.02	713,539.01	2,138,138.43
				+717.44			
			0.51449608				
		1394.460				712,821.59	2,139,334.18
			0.85749274			-0.03	-0.03
C	300 57 49.6	2,779			+1195.74	712,821.56	2,139,334.15
				-252.89			
			0.53861026				
		469.516				712,568.70	2,139,729.77
			0.84255503			-0.04	-0.03
D	302 35 20.7	3,248			+395.59	712,568.66	2,139,729.74
				-400.40			
			0.53982494				
		741.716				712,168.30	2,140,354.13
			0.84177730			-0.04	-0.04
E	302 40 18.2	3,990			+624.36	712,168.26	2,140,354.09

FIGURE 24.—Computation of coordinates, traverse no. 2.

COMPUTATION OF COORDINATES

Traverse line No. 2
State New Jersey | County Essex | Initial Station Mon. 612
Year 1934 | Month February - October | Closing Station Y

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
						712,168.30	2,140,354.13
E				-1838.72		712,168.26	2,140,354.09
			0.92994718				
		1977.226				710,329.58	2,139,627.12
			0.36769313			-0.07	-0.06
F	21 34 24.3	5.967			-727.01	710,329.51	2,139,627.06
				-187.16			
			0.93148415				
		200.924				710,142.42	2,139,554.03
			0.36378192			-0.07	-0.06
Mon.1250	21 19 57.5	6.168			-73.09	710,142.35	2,139,553.97
				-1608.07			
			0.93148556				
		1726.354				708,534.35	2,138,926.02
			0.36377830			-0.09	-0.08
G	21 19 56.7	7.894			-628.01	708,534.26	2,138,925.94
				-708.56			
			0.93337230				
		759.135				707,825.79	2,138,653.56
			0.35890966			-0.09	-0.08
H	21 01 59.7	8.653			-272.46	707,825.70	2,138,653.48
				-1989.40			
			0.93130803				
		2136.136				705,836.39	2,137,875.51
			0.36423256			-0.12	-0.10
I	21 21 37.3	10.790			-778.05	705,836.27	2,137,875.41

FIGURE 24.—Computation of coordinates, traverse no. 2—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 2
State New Jersey County Essex Initial Station Mon. 612
Year 1934 Month February - October Closing Station Y

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
						705,836.39	2,137,875.51
I				-1458.59		705,836.27	2,137,875.41
			0.96420412				
		1512.744				704,377.80	2,137,474.39
			0.26516114			-0.13	-0.12
K	15 22 35.5	12.302			-401.12	704,377.67	2,137,474.27
				-1580.36			
			0.91183470				
		1733.169				702,797.44	2,136,762.82
			0.41055750			-0.15	-0.14
X	24 14 23.5	14.036			-711.57	702,797.29	2,136,762.68
				-1292.23			
			0.87426620				
		1478.072				701,505.21	2,136,045.29
			0.48544680			-0.17	-0.15
Y	29 02 30.3	15.514			-717.53	701,505.04	2,136,045.14
				Weighted Mean		701,505.04	2,136,045.14
				Discrepancy		+0.17	+0.15
				x Factor = -0.96687		$\times 10^{-5}$	
				y Factor = -1.09578		$\times 10^{-5}$	

FIGURE 24.—Computation of coordinates, traverse no. 2—Continued.

620745 O - 44 - 9

COMPUTATION OF COORDINATES

Traverse line No. 2
State New Jersey County Essex Initial Station Mon. 612
Year 1934 Month February - October Closing Station Y

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
	° '						
H				-0.91		707,825.70	2,138,653.48
			0.27843238				
		3.28				707,824.79	2,138,656.63
			0.96045583				
Mon. 611	286 10				+3.15		
I				+0.74		705,836.27	2,137,875.41
			0.32639315				
		2.28				705,837.01	2,137,873.25
			0.94523410		-2.16		
Mon. 610	109 03						

FIGURE 24.—Computation of coordinates, traverse no. 2—Continued.

Computation of grid azimuth from coordinates, traverse no. 3, control data

NEWARK TO WECO

	x	y
Weco	2, 153, 320. 31	688, 963. 97
Newark	2, 137, 513. 80	693, 768. 99
Δx and Δy	+15, 806. 51	−4, 805. 02

$$\log \Delta x = 4.1988360$$
$$\log \Delta y = 3.6816952$$
$$\log \tan \alpha = 0.5171408$$
$$\alpha = 73°05'28''.5$$
$$\text{grid azimuth} = 286°54'31''.5$$

Computation of grid azimuths, traverse no. 3

Stations	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″	Stations	Preliminary azimuth and angle °	′	″	Correction for closure ″	Corrected azimuth and angle ′	″
Newark to Weco	286	54	31. 5			31. 5	AC to AD	28	47	52. 1			59. 1
∠Weco to AG	158	32	13. 7	+1. 2		14. 9	∠AD to AB	160	01	31. 3	+1. 2		32. 5
Newark to AG	85	26	45. 2			46. 4	AC to AB	188	49	23. 4			31. 6
AG to Newark	265	26	45. 2			46. 4	AB to AC	8	49	23. 4			31. 6
∠Newark to AF	296	55	13. 4	+1. 2		14. 6	∠AC to AA	182	17	27. 2	+1. 2		28. 4
AG to AF	202	21	58. 6		22	01. 0	AB to AA	191	06	50. 6		07	00. 0
AF to AG	22	21	58. 6		22	01. 0	AA to AB	11	06	50. 6		07	00. 0
∠AG to AE	180	07	34. 5	+1. 1		35. 6	∠AB to Park	171	48	59. 8	+1. 2		61. 0
AF to AE	202	29	33. 1			36. 6	AA to Park	182	55	50. 4		56	01. 0
AE to AF	22	29	33. 1			36. 6	Park to AA	2	55	50. 4		56	01. 0
∠AF to ADE	176	55	38. 0	+1. 2		39. 2	∠AA to Z	141	24	20. 7	+1. 2		21. 9
AE to ADE	199	25	11. 1			15. 8	Park to Z	144	20	11. 1			22. 9
ADE to AE	19	25	11. 1			15. 8	Z to Park	324	20	11. 1			22. 9
∠AE to AD	180	00	00. 0	+1. 2		01. 2	∠Park to Y	188	41	16. 0	+1. 2		17. 2
ADE to AD	199	25	11. 1			17. 0	Z to Y	153	01	27. 1			40. 1
AD to ADE	19	25	11. 1			17. 0	Weighted mean	153	01	40. 1			
∠ADE to AC	189	22	41. 0	+1. 1		42. 1	Discrepancy			−13. 0			
AD to AC	208	47	52. 1			59. 1							

COMPUTATION OF COORDINATES

Traverse line No. 3
State New Jersey County Essex Initial Station Newark
Year 1934 Month February - October Closing Station Y

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
Newark				-216.11		693,768.99	2,137,513.80
			0.07939477				
		2721.990				693,552.88	2,134,800.40
			0.99684326			+0.18	+0.07
AG	85 26 46.4	2,722			-2713.40	693,553.06	2,134,800.47
				+1028.25			
			0.92476573				
		111.908				694,581.13	2,135,223.52
			0.38053692			+0.25	+0.09
AF	202 22 01.0	3,834			+423.12	694,581.38	2,135,223.61
				+1373.60			
			0.92392294				
		1486.700				695,954.73	2,135,792.30
			0.38257862			+0.35	+0.13
AE	202 29 36.6	5,321			+568.78	695,955.08	2,135,792.43
				+239.70			
			0.94310053				
		254.166				696,194.43	2,135,876.81
			0.33250774			+0.37	+0.13
ADE	199 25 15.8	5.575			+84.51	696,194.80	2,135,876.94
				+829.54			
			0.94309859				
		879.594				697,023.97	2,136,169.29
			0.33251322			+0.42	+0.15
AD	199 25 17.0	6,454			+292.48	697,024.39	2,136,169.44

FIGURE 25.—Computation of coordinates, traverse no. 3.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New Jersey County Essex Initial Station Newark
Year 1934 Month February - October Closing Station Y

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
						697,023.97	2,136,169.29
AD				+607.66		697,024.39	2,136,169.44
			0.87630879				
		693.436				697,631.63	2,136,503.35
			0.48174985			+0.47	+0.17
AC	208 47 59.1	7,148			+334.06	697,632.10	2,136,503.52
				+714.57			
			0.98816035				
		723.136				698,346.20	2,136,614.30
			0.15342468			+0.52	+0.19
AB	188 49 31.6	7,871			+110.95	698,346.72	2,136,614.49
				+512.12			
			0.98123662				
		521.908				698,858.32	2,136,714.93
			0.19280740		+100.63	+0.55	+0.20
AA	191 07 00.0	8,393				698,858.87	2,136,715.13
				+1582.25			
			0.99868951				
		1584.327				700,440.57	2,136,796.01
			0.05117880		+81.08	+0.65	+0.24
Park	182 56 01.0	9,977				700,441.22	2,136,796.25
				+1005.70			
			0.81248761				
		1237.806				701,446.27	2,136,074.40
			0.58297846			+0.74	+0.27
Z	144 20 22.9	11,215			-721.61	701,447.01	2,136,074.67

FIGURE 25.—Computation of coordinates, traverse no. 3—Continued.

COMPUTATION OF COORDINATES

Traverse line No. 3
State New Jersey County Essex Initial Station Newark
Year 1934 Month February - October Closing Station Y

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
						701,446.27	2,136,074.40
Z				+58.03		701,447.01	2,136,074.67
			0.89122674				
		65.118				701,504.30	2,136,044.87
			0.45355804			+0.74	+0.27
Y	153 01 40.1	11.280			-29.53	701,505.04	2,136,045.14
				Weighted Mean		701,505.04	2,136,045.14
				Discrepancy		-0.74	-0.27
				x Factor = +2.39362 x 10^{-5}			
				y Factor = +6.56028 x 10^{-5}			

FIGURE 25.—Computation of coordinates, traverse no. 3—Continued.

Department of Commerce
U.S. Coast and Geodetic Survey
Form No. [illegible]

PLANE COORDINATES

Datum NORTH AMERICAN 1927 *Projection* TRANSVERSE MERCATOR *State* NEW JERSEY

Station	x Coordinate / y Coordinate	Plane Azimuth	Mark	Station	x Coordinate / y Coordinate	Plane Azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Mon. 613	2,135,635.20	298 56 24.9	Mon. 612				
	715,204.02						
Mon. 605	2,127,954.57						
	716,943.70						
Mon. 606	2,131,434.43	332 07 59.6	Mon. 607				
	710,281.56						
Mon. 607	2,132,975.49	152 07 59.6	Mon. 606				
	707,366.92						
Mon. 1250	2,139,553.97						
	710,142.35						
Mon. 610	2,137,873.25	201 30 33.5	Mon. 611				
	705,837.01						
Mon. 611	2,138,656.63	21 30 33.5	Mon. 610				
	707,824.79						
Park	2,136,796.25						
	700,441.22						

FIGURE 26.—List of plane coordinates.

Computation of grid azimuths from coordinates, traverses nos. 1, 2, and 3

	x	y
Monument 612	2, 137, 077. 78	714, 406. 35
Monument 613	2, 135, 635. 20	715, 204. 02
Δx and Δy	+1, 442. 58	−797. 67

$$\log \Delta x = 3.1591399$$
$$\log \Delta y = 2.9018233$$
$$\log \tan \alpha = 0.2573166$$
$$\alpha = 61°03'35''.1$$

Grid azimuth—Monument 613 to Monument 612 = 298°56′24″.9.

	x	y
Monument 607	2, 132, 975. 49	707, 366. 92
Monument 606	2, 131, 434. 43	710, 281. 56
Δx and Δy	+1, 541. 06	−2, 914. 64

$$\log \Delta x = 3.1878195$$
$$\log \Delta y = 3.4645850$$
$$\log \tan \alpha = 9.7232345 - 10$$
$$\alpha = 27°52'00''.4$$

Grid azimuth—Monument 606 to Monument 607 = 332°07′59″.6.
Grid azimuth—Monument 607 to Monument 606 = 152°07′59″.6.

	x	y
Monument 611	2, 138, 656. 63	707, 824. 79
Monument 610	2, 137, 873. 25	705, 837. 01
Δx and Δy	+783. 38	+1, 987. 78

$$\log \Delta x = 2.8939725$$
$$\log \Delta y = 3.2983683$$
$$\log \tan \alpha = 9.5956042 - 10$$
$$\alpha = 21°30'33''.5$$

Grid azimuth—Monument 610 to Monument 611 = 201°30′33″.5.
Grid azimuth—Monument 611 to Monument 610 = 21°30′33″.5.

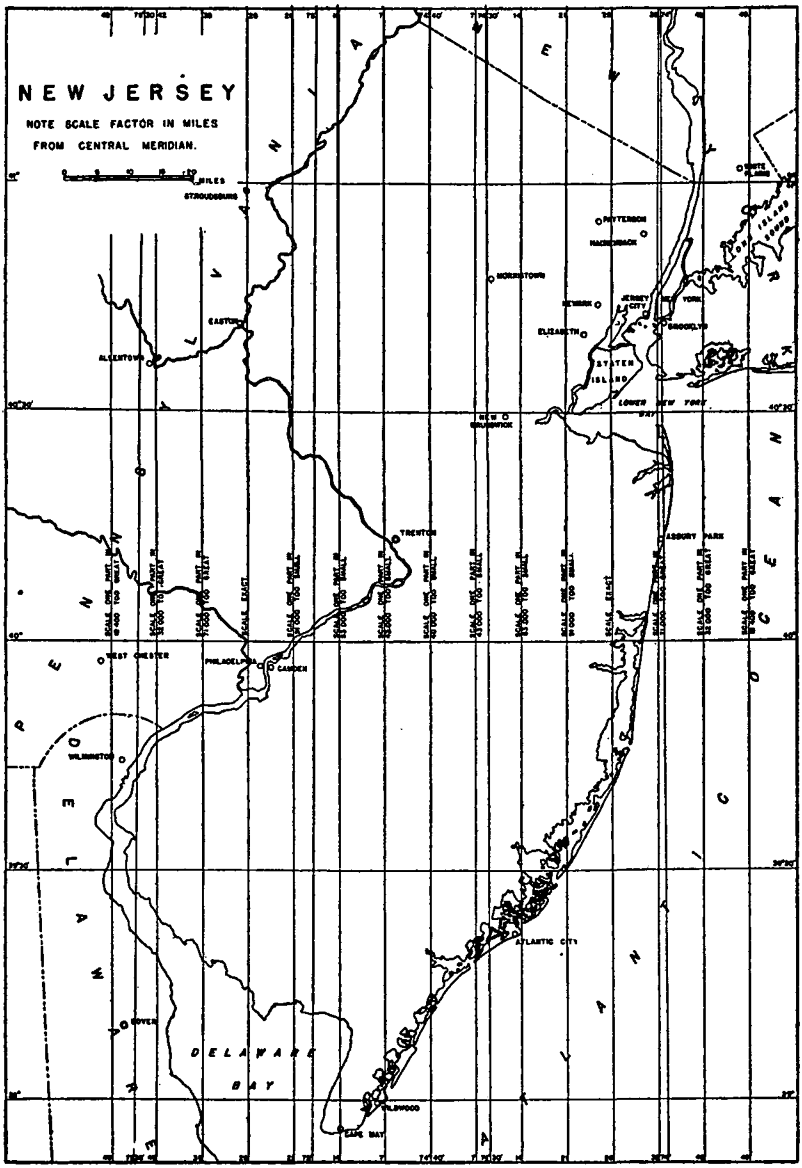

FIGURE 27.—Map of New Jersey with grid system outline.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE I.

Lat.	y (feet)	Tabular difference for one sec. of lat.	Lat.	y (feet)	Tabular difference for one sec. of lat.
38° 50'	0.00	101.16583	39° 26'	218,529.28	101.17633
51	6,069.95	101.16617	27	224,599.86	101.17667
52	12,139.92	101.16633	28	230,670.46	101.17700
53	18,209.90	101.16667	29	236,741.08	101.17733
54	24,279.90	101.16700	30	242,811.72	101.17767
55	30,349.92	101.16733			
38° 56'	36,419.96	101.16750	39° 31'	248,882.38	101.17783
57	42,490.01	101.16783	32	254,953.05	101.17817
58	48,560.08	101.16817	33	261,023.74	101.17850
59	54,630.17	101.16850	34	267,094.45	101.17883
39° 00	60,700.28	101.16883	35	273,165.18	101.17900
39° 01'	66,770.41	101.16900	39° 36'	279,235.92	101.17933
02	72,840.55	101.16933	37	285,306.68	101.17967
03	78,910.71	101.16967	38	291,377.46	101.18000
04	84,980.89	101.17000	39	297,448.26	101.18017
05	91,051.09	101.17017	40	303,519.07	101.18050
39° 06'	97,121.30	101.17050	39° 41'	309,589.90	101.18083
07	103,191.53	101.17083	42	315,660.75	101.18117
08	109,261.78	101.17117	43	321,731.62	101.18133
09	115,332.05	101.17133	44	327,802.50	101.18167
10	121,402.33	101.17167	45	333,873.40	101.18200
39° 11'	127,472.63	101.17200	39° 46'	339,944.32	101.18233
12	133,542.95	101.17233	47	346,015.26	101.18267
13	139,613.29	101.17250	48	352,086.22	101.18283
14	145,683.64	101.17283	49	358,157.19	101.18317
15	151,754.01	101.17317	50	364,228.18	101.18350
39° 16'	157,824.40	101.17350	39° 51'	370,299.19	101.18383
17	163,894.81	101.17383	52	376,370.22	101.18400
18	169,965.24	101.17400	53	382,441.26	101.18433
19	176,035.68	101.17433	54	388,512.32	101.18467
20	182,106.14	101.17467	55	394,583.40	101.18483
39° 21'	188,176.62	101.17483	39° 56'	400,654.49	101.18517
22	194,247.11	101.17533	57	406,725.60	101.18550
23	200,317.63	101.17550	58	412,796.73	101.18583
24	206,388.16	101.17583	59	418,867.88	101.18617
25	212,458.71	101.17617	40° 00	424,939.05	101.18650

FIGURE 28.—Projection tables for New Jersey.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE I (CONT'D).

Lat.	y (feet)	Tabular difference for one sec. of lat.	Lat.	y (feet)	Tabular difference for one sec. of lat.
40° 01'	431,010.24	101.18667	40° 36'	643,512.88	101.19700
02	437,081.44	101.18700	37	649,584.70	101.19733
03	443,152.66	101.18717	38	655,656.54	101.19767
04	449,223.89	101.18767	39	661,728.40	101.19800
05	455,295.15	101.18783	40	667,800.28	101.19817
40° 06'	461,366.42	101.18817	40° 41'	673,872.17	101.19867
07	467,437.71	101.18850	42	679,944.09	101.19883
08	473,509.02	101.18883	43	686,016.02	101.19917
09	479,580.35	101.18900	44	692,087.97	101.19933
10	485,651.69	101.18933	45	698,159.93	101.19967
40° 11'	491,723.05	101.18967	40° 46'	704,231.91	101.20000
12	497,794.43	101.19000	47	710,303.91	101.20033
13	503,865.83	101.19017	48	716,375.93	101.20067
14	509,937.24	101.19067	49	722,447.97	101.20083
15	516,008.68	101.19083	50	728,520.02	101.20117
40° 16'	522,080.13	101.19117	40° 51'	734,592.09	101.20150
17	528,151.60	101.19133	52	740,664.18	101.20183
18	534,223.08	101.19183	53	746,736.29	101.20217
19	540,294.59	101.19200	54	752,808.42	101.20250
20	546,366.11	101.19233	55	758,880.57	101.20283
40° 21'	552,437.65	101.19267	40° 56'	764,952.74	101.20283
22	558,509.21	101.19283	57	771,024.91	101.20317
23	564,580.78	101.19333	58	777,097.10	101.20367
24	570,652.38	101.19350	59	783,169.32	101.20383
25	576,723.99	101.19383	41° 00	789,241.55	101.20417
40° 26'	582,795.62	101.19400	41° 01'	795,313.80	101.20450
27	588,867.26	101.19450	02	801,386.07	101.20483
28	594,938.93	101.19467	03	807,458.36	101.20500
29	601,010.61	101.19500	04	813,530.66	101.20533
30	607,082.31	101.19533	05	819,602.98	101.20567
40° 31'	613,154.03	101.19550	41° 06'	825,675.32	101.20600
32	619,225.76	101.19583	07	831,747.68	101.20633
33	625,297.51	101.19633	08	837,820.06	101.20650
34	631,369.29	101.19650	09	843,892.45	101.20683
35	637,441.08	101.19667	10	849,964.86	101.20717

FIGURE 28.—Projection tables for New Jersey—Continued.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE I (CONT'D)

Lat.	Y (feet)	Tabular difference for one sec. of lat.
41° 11'	856,037.29	101.20750
12	862,109.74	101.20767
13	868,182.20	101.20800
14	874,254.68	101.20833
15	880,327.18	101.20867
41° 16'	886,399.70	101.20900
17	892,472.24	101.20917
18	898,544.79	101.20950
19	904,617.36	101.20983
20	910,689.95	101.21017
41° 21'	916,762.56	101.21050
22	922,835.19	101.21067
23	928,907.83	101.21100
24	934,980.49	101.21133
25	941,053.17	101.21167
41° 26'	947,125.87	101.21183
27	953,198.58	101.21217
28	959,271.31	101.21250
29	965,344.06	101.21283
30	971,416.83	

λ(Central meridian) = 74° 40' 00".000

log R = -108.6

$\log (1/6\rho_o^3)g = 4.5810213 - 20$

$\log (1/6\rho_o^2 \sin 1'')g = 9.8954464 - 20$

$$\text{Cor. to azimuth} = + \frac{y2 - y1}{(6\rho_o^2 \sin 1'')g}(2x_1' + x_2')$$

FIGURE 28.—Projection tables for New Jersey—Continued.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE II.

Lat.	Colog A	Log C	Lat.	Colog A	Log C
38° 50'	1.49085213	1.310415			
51	255	0672	39° 26'	1.49086724	1.319645
52	297	0929	27	766	1.319901
53	339	1185	28	808	1.320157
54	381	1442	29	850	1.320413
55	423	1699	30	892	0669
38° 56'	464	1956	39° 31'	1.49086935	1.320925
57	506	2213	32	1.49086977	1180
58	548	2469	33	1.49087019	1436
59	590	2726	34	061	1691
39° 00	632	2983	35	103	1947
39° 01'	1.49085674	1.313240	39° 36'	145	2203
02	716	3496	37	187	2458
03	758	3752	38	229	2714
04	800	4009	39	271	2969
05	842	4266	40	314	3225
39° 06'	884	4522	39° 41'	1.49087356	1.323480
07	926	4778	42	398	3736
08	1.49085968	5035	43	440	3991
09	1.49086010	5292	44	482	4246
10	052	5548	45	524	4502
39° 11'	1.49086094	1.315804	39° 46'	566	4757
12	136	6060	47	609	5012
13	178	6317	48	651	5267
14	220	6573	49	693	5523
15	262	6829	50	735	5778
39° 16'	304	7085	39° 51'	1.49087777	1.326033
17	346	7341	52	819	6288
18	388	7598	53	862	6543
19	430	7854	54	904	6798
20	472	8110	55	946	7053
39° 21'	1.49086514	1.318366	39° 56'	1.49087988	7308
22	556	8622	57	1.49088030	7563
23	598	8878	58	073	7818
24	640	9134	59	115	8073
25	682	9390	40° 00	157	8328

FIGURE 28.—Projection tables for New Jersey—Continued.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE II (CONT'D)

Lat.	Colog A	Log C	Lat.	Colog A	Log C
40° 01'	1.49088199	1.328583	40° 36'	1.49089680	1.337485
02	242	8837	37	722	7739
03	284	9092	38	765	7993
04	326	9347	39	807	8247
05	368	9602	40	849	8501
40° 06'	411	1.329856	40° 41'	1.49089892	1.338755
07	453	1.330111	42	934	9009
08	495	0366	43	1.49089977	9262
09	537	0620	44	1.49090019	9516
10	580	0875	45	061	1.339770
40° 11'	1.49088622	1.331129	40° 46'	104	1.340024
12	664	1384	47	146	0278
13	706	1638	48	189	0531
14	749	1893	49	231	0785
15	791	2147	50	273	1039
40° 16'	833	2401	40° 51'	1.49090316	1.341293
17	876	2656	52	358	1546
18	918	2910	53	401	1800
19	1.49088960	3165	54	443	2053
20	1.49089002	3419	55	486	2307
40° 21'	1.49089045	1.333673	40° 56'	528	2561
22	087	3927	57	571	2814
23	129	4182	58	613	3068
24	172	4436	59	655	3321
25	214	4690	41° 00	698	3575
40° 26'	256	4944	41° 01'	1.49090740	1.343828
27	299	5198	02	783	4082
28	341	5453	03	825	4335
29	383	5707	04	868	4588
30	426	5961	05	910	4842
40° 31'	1.49089468	1.336215	41° 06'	953	5095
32	510	6469	07	1.49090995	5348
33	553	6723	08	1.49091038	5601
34	595	6977	09	080	5855
35	638	7231	10	1123	6108

FIGURE 28.—Projection tables for New Jersey—Continued.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE II (CONT'D)

Lat.	Colog A	Log C
41° 11'	1.49091165	1.346361
12	208	6614
13	250	6867
14	293	7120
15	335	7374
41° 16'	378	7627
17	420	7880
18	463	8133
19	505	8386
20	548	8639
41° 21'	1.49091590	1.348892
22	633	9145
23	675	9398
24	718	9651
25	761	1.349904
41° 26'	803	1.350156
27	846	0409
28	888	0662
29	931	0915
30	1.49091973	1.351168

FIGURE 28.—Projection tables for New Jersey—Continued.

TRANSVERSE MERCATOR PROJECTION FOR NEW JERSEY

TABLE III.

x (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio	x′ (feet)	Scale in units of 7th place of logs	Scale expressed as a ratio
0	-108.6	0.9999750	175,000	+ 43.4	1.0000100
5,000	-108.5	0.9999750	180,000	+ 52.3	1.0000120
10,000	-108.1	0.9999751	185,000	+ 61.3	1.0000141
15,000	-107.5	0.9999752	190,000	+ 70.6	1.0000163
20,000	-106.6	0.9999755	195,000	+ 80.2	1.0000185
25,000	-105.5	0.9999757	200,000	+ 90.0	1.0000207
30,000	-104.1	0.9999760	205,000	+100.0	1.0000230
35,000	-102.5	0.9999764	210,000	+110.4	1.0000254
40,000	-100.7	0.9999768	215,000	+120.9	1.0000278
45,000	- 98.5	0.9999773	220,000	+131.7	1.0000303
50,000	- 96.2	0.9999778	225,000	+142.7	1.0000329
55,000	- 93.6	0.9999784	230,000	+154.0	1.0000355
60,000	- 90.7	0.9999791	235,000	+165.6	1.0000381
65,000	- 87.6	0.9999798	240,000	+177.4	1.0000408
70,000	- 84.3	0.9999806	245,000	+189.4	1.0000436
75,000	- 80.7	0.9999814	250,000	+201.7	1.0000464
80,000	- 76.8	0.9999823	255,000	+214.2	1.0000493
85,000	- 72.7	0.9999833	260,000	+227.0	1.0000523
90,000	- 68.4	0.9999843	265,000	+239.9	1.0000553
95,000	- 63.8	0.9999853	270,000	+253.3	1.0000583
100,000	- 59.0	0.9999864	275,000	+266.9	1.0000615
105,000	- 53.9	0.9999876	280,000	+280.6	1.0000646
110,000	- 48.5	0.9999888	285,000	+294.7	1.0000679
115,000	- 42.9	0.9999901	290,000	+308.9	1.0000711
120,000	- 37.1	0.9999915	295,000	+323.5	1.0000745
125,000	- 31.0	0.9999929	300,000	+338.2	1.0000779
130,000	- 24.7	0.9999943	305,000	+353.3	1.0000813
135,000	- 18.1	0.9999958	310,000	+368.5	1.0000848
140,000	- 11.3	0.9999974	315,000	+384.0	1.0000884
145,000	- 4.2	0.9999990	320,000	+399.8	1.0000921
150,000	+ 3.1	1.0000007	325,000	+415.8	1.0000957
155,000	+ 10.7	1.0000025	330,000	+432.1	1.0000995
160,000	+ 18.5	1.0000043	335,000	+448.6	1.0001033
165,000	+ 26.6	1.0000061	340,000	+465.3	1.0001071
170,000	+ 34.9	1.0000080	345,000	+482.3	1.0001111
			350,000	+499.6	1.0001150

FIGURE 28.—Projection tables for New Jersey—Continued.

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 Rochester, N. Y., quadrangle lies between the parallels 43°00′ and 43°20′ and between the meridians 77°30′ and 77°45′. The grid coordinates were computed for the four corners, and the computation is shown on pages 141 to 144. From these it is possible to determine the distance from the corner in both directions of the first even grid line that is to be shown on the map. The coordinates of the corners are as follows:

	x	y
Southeast corner	789, 807. 16	1, 094, 927. 87
Northeast corner	788, 235. 50	1, 216, 416. 12
Northwest corner	721, 719. 29	1, 215, 652. 50
Southwest corner	722, 928. 19	1, 094, 164. 83

Let us suppose we wish to show grid lines for every 10,000 feet beginning with 720,000 in the x values at the west and ending with 780,000 at the east; with the y values, we should begin with 1,100,000 at the bottom and end with 1,210,000 at the top.

With this arrangement at the southeast corner the 1,100,000 line is 5,072.13 feet north of the corner and the 780,000 line is 9,807.16 feet west of the corner. The quadrangle has the scale of 1 part in 62,500 so that 5,072.13 feet would be represented by 0.974 inch and 9,807.16 feet would in like manner be 1.883 inches on the map. In a similar way the distance of the first grid line at each of the corners could be located in both directions.

Now straight lines joining the respective points at the top and bottom of the map will give the grid lines for 720,000 and 780,000 in the north-south direction and straight lines similarly drawn in an east-west direction give the grid lines for 1,100,000 and 1,210,000, respectively. We can now divide the space in a north-south direction into 11 equal parts both at the east of the map and at the west of the same. The straight lines joining these corresponding points will give the other grid lines for the adopted interval in this direction. A similar division in an east-west direction at the top and bottom of the map will give the points for drawing the other grid lines in a north-south direction.

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 transverse Mercator projection of the region in question made from the given State tables. The slight error introduced is probably not as great as the uncertainty of plotting positions, so for all mapping purposes it is permissible to use the scheme as outlined above.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Quadrangle Corner

		λ (Central meridian)	78° 35′ ″
φ 43° 00′ ″		λ	77 30
		Δλ (Central meridian−λ)	+ 1 05
		Δλ (in sec.)	+3900″

log Δλ	3.59106461	log S_m^2	9.892276
Cor. arc to sine	− 2588	log C*	940 1.373~~860~~-10
log $\Delta\lambda_1$	3.59103873	log Δφ	216 1.266~~139~~
log cos φ	9.86412746-10		
colog A	1.49095815	φ	43° 00′ 00″.0000
log S_1	4.94612434	Δφ	93 + 18.45~~61~~
Cor. sine to arc	+ 1384	φ′	93 43 00 18.45~~61~~
log S_m	4.94613818		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23617
log R	− 2714		
log S_g	5.46209521	y (for min. of φ′)	1,093,059.12
log S_g^3	16.3862856	y (for seconds of φ′)	+ 1,868.75
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,094,927.87
log $(S_g^3/6\rho_o^2)_g$	0.9670681		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+289,797.885	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 9.270	log $\Delta\alpha_1$	
x′	+289,807.16		
	500,000.00	log $(\Delta\lambda)^3$	
x	789,807.16	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

*Take out C first for φ and correct for approximate φ′.

FIGURE 29.—Computation of coordinates for quadrangle corners.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Quadrangle Corner

	λ (Central meridian)	78° 35′ ″
43° 20′ ″	λ	77 30
	Δλ (Central meridian-λ)	+ 1 05
	Δλ (in sec.)	+3900″

log Δλ	3.59106461	log S_m^2	9.887553 970
Cor. arc to sine	− 2588	log C*	1.378~~892~~-10 523
log $\Delta\lambda_1$	3.59103873	log Δφ	1.266~~445~~
log cos φ	9.86175756-10		
colog A	1.49096671	φ	43° 20′ 00.0000″ 724
log S_1	4.94376300	Δφ	+ 18.4~~691~~ 724
Cor. sine to arc	+ 1369	φ′	43 20 18.4~~691~~
log S_m	4.94377669		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24217
log R	− 2714		
log S_g	5.45973372	y (for min. of φ′)	1,214,545.93
log S_g^3	16.3792012	y (for seconds of φ′)	+ 1,870.19
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,216,416.12
log $(S_g^3/6\rho_o^2)_g$	0.9599837		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+288,226.377	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 9.120	log $\Delta\alpha_1$	
x′	+288,235.50		
	500,000.00	log $(\Delta\lambda)^3$	
x	788,235.50	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

*Take out C first for φ and correct for approximate φ′.

FIGURE 29.—Computation of coordinates for quadrangle corners—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Quadrangle Corner

ϕ 43° 20′ ″

	° ′ ″
λ (Central meridian)	78 35
λ	77 45
Δλ (Central meridian−λ)	+ 50
Δλ (in sec.)	+ 3000″

log Δλ	3.47712125	log S_m^2	9.659677
Cor. arc to sine	− 1531	log C*	1.378~~892~~-10 (938)
log $\Delta\lambda_1$	3.47710594	log Δφ	1.038~~569~~ (615)
log cos φ	9.86175756-10		
colog A	1.49096671	φ	43° 20′ 00″.0000
log S_1	4.82983021	Δφ	+ 10.92~~87~~ (99)
Cor. sine to arc	+ 810	φ′	43 20 10.92~~87~~ (99)
log S_m	4.82983831		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24217
log R	− 2714		
log S_g	5.34579534	y (for min. of φ′)	1,214,545.93
log S_g^3	16.0373860	y (for seconds of φ′)	+ 1,106.57
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,215,652.50
log $(S_g^3/6\rho_o^2)_g$	0.6181685		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+221,715.135	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 4.151	log $\Delta\alpha_1$	
x′	+221,719.29		
	500,000.00	log $(\Delta\lambda)^3$	
x	721,719.29	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 29.—Computation of coordinates for quadrangle corners—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Quadrangle Corner

		λ (Central meridian)	78° 35′
φ	43° 00′ ″	λ	77 45
		Δλ (Central meridian−λ)	+ 50
		Δλ (in sec.)	+3000″

log Δλ	3.47712125	log S_m^2	9.664399
Cor. arc to sine	− 1531	log C*	909 1.373~~863~~-10
log $\Delta\lambda_1$	3.47710594	log Δφ	308 1.038~~868~~
log cos φ	9.86412746-10		
colog A	1.49095815	φ	43° 00′ 00″.0000
log S_1	4.83219155	Δφ	+ 21 10.92~~10~~
Cor. sine to arc	+ 819	φ′	21 43 00 10.92~~10~~
log S_m	4.83219974		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23617
log R	− 2714		
log S_g	5.34815677	y (for min. of φ′)	1,093,059.12
log S_g^3	16.0444703	y (for seconds of φ′)	+ 1,105.71
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,094,164.83
log $(S_g^3/6\rho_o^2)_g$	0.6252528		
S_g	+ 222,923.971	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	+ 4.219	log Δλ	
x′	+ 222,928.19	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	722,928.19	log F	
		log b	″
		$\Delta\alpha_1$	
		b	″
		Δα	
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′ (R 349)

FIGURE 29.—Computation of coordinates for quadrangle corners—Continued.

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 region in the vicinity of Rochester, N. Y. First, we selected the upper and lower parallels of the region to be shown; these were 43°16′ and 43°04′, respectively. We then computed the coordinates of the intersections of these parallels with the meridians to be shown, that is for every 2 minutes of longitude from 77°32′ to 77°46′, inclusive. This gives us eight points on each of these parallels which can be plotted by their coordinates on the grid outline of the region. The parallels are in fact curved lines but for the scale of the map they could not be distinguished from a straight line for the extent of the map. In a larger map it would be necessary to construct a smooth curve through the plotted points.

On the outer meridians the intersections of the parallels for every 2 minutes were likewise computed. These also should be slightly curved but again for the scale of the projection and for the extent of the map they could not be distinguished from straight lines. The remaining meridians and parallels were then constructed through their respective points. As a matter of fact, for a grid section as large as a Geological Survey quadrangle map, it would probably be sufficiently accurate to locate the outer parallels and meridians and then divide the space between them proportionally for the other meridians and parallels. Strictly speaking, for a map of large extent the various intersections of meridians and parallels throughout the region to be shown should be computed and plotted with their coordinate values. As was done in this case the outer meridians and parallels can be computed first, and from these it can be seen whether it would be necessary to compute all of the intersections throughout the region.

By this method complete maps of counties can be made which show the meridians and parallels as well as the grid lines. In another section we have shown how to place the grid lines on the Geological Survey quadrangle maps. The method outlined here, however, gives the meridians and parallels in perfect accord with the grid lines because they are both dependent upon the same projection. Maps for larger regions such as power projects can be made by this method so that they are correctly related in all of their parts.

The computations for the Rochester region shown in figure 5 are given in figure 30 immediately following this discussion. They are of interest as samples of the computations that are required for this purpose.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 04′ ″		λ	77 30
		Δλ (Central meridian-λ)	+ 1 05
		Δλ (in sec.)	+ 3900″

log Δλ	3.59106461	log S_m^2	9.891336
Cor. arc to sine	− 2588	log C*	1.374~~869~~ 946 -10
log $Δλ_1$	3.59103873	log Δφ	1.266~~285~~ 82
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00″.0000
log S_1	4.94565428	Δφ	+ 18.4~~589~~ 621
Cor. sine to arc	+ 1381	φ′	43 04 18.4~~589~~ 621
log S_m	4.94566809		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.46162512	y (for min. of φ′)	1,117,355.91
log S_g^3	16.3848754	y (for seconds of φ′)	+ 1,869.05
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,119,224.96
log $(S_g^3/6\rho_o^2)_g$	0.9656579		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+289,484.370	log Δλ	
$(S_g^3/6\rho_o^2)_g$	9.240 −	log $\Delta\alpha_1$	
x′	+289,493.61		
	500,000.00	log $(\Delta\lambda)^3$	
x	789,493.61	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

λ (Central meridian) 78° 35′ ″

φ 43° 04′ ″ λ 77 32

Δλ (Central meridian−λ) + 1 03

Δλ (in sec.) +3780″

log Δλ	3.57749180	log S_m^2	9.864192
Cor. arc to sine	− 2431	log C*	1.374~~869~~942-10
log $\Delta\lambda_1$	3.57746749	log Δφ	1.239~~061~~134
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00″.0000
log S_1	4.93208304	Δφ	+ 17.34~~65~~34
Cor. sine to arc	+ 1297	φ′	43 04 17.34~~65~~34
log S_m	4.93209601		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.44805304	y (for min. of φ′)	1,117,355.91
log S_g^3	16.3441591	y (for seconds of φ′)	+ 1,755.80
log $1/6\rho_0^2R^2$	4.5807825-20	y	1,119,111.71
log $(S_g^3/6\rho_0^2)_g$	0.9249416		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+280,577.629	log Δλ	
$(S_g^3/6\rho_0^2)_g$	8.413	log $\Delta\alpha_1$	
x′	+280,586.04		
	500,000.00	log $(\Delta\lambda)^3$	
x	780,586.04	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′
φ 43° 04′ ″		λ	77 34
		Δλ (Central meridian−λ)	+ 1 01
		Δλ (in sec.)	+ 3660″

log Δλ	3.56348109	log S_m^2	9.836172
Cor. arc to sine	− 2279	log C*	1.374~~869~~937-10
log $\Delta\lambda_1$	3.56345830	log Δφ	1.211~~041~~109
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04 00.0000
log S_1	4.91807385	Δφ	+ 16.25~~70~~96
Cor. sine to arc	+ 1216	φ′	43 04 16.25~~70~~96
log S_m	4.91808601		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.43404304	y (for min. of φ′)	1,117,355.91
log S_g^3	16.3021291	y (for seconds of φ′)	+ 1,646.08
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,119,001.99
log $(S_g^3/6\rho_o^2)_g$	0.8829116		
S_g	+271,670.851	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	7.637	log Δλ	
x′	+271,678.49	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	771,678.49	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		° ′ ″
ϕ 43° 04′ ″	λ (Central meridian)	78 35
	λ	77 36
	$\Delta\lambda$ (Central meridian−λ)	+ 0 59
	$\Delta\lambda$ (in sec.)	+ 3540″

log $\Delta\lambda$	3.54900326	log S_m^2	9.807218
Cor. arc to sine	− 2132	log C*	933 1.374869-10
log $\Delta\lambda_1$	3.54898194	log $\Delta\phi$	151 1.182884
log cos ϕ	9.86365569-10		
colog A	1.49095986	ϕ	43° 04′ 00.0000″
log S_1	4.90359749	$\Delta\phi$	108 + 15.2085
Cor. sine to arc	+ 1138	ϕ'	108 43 04 15.2085
log S_m	4.90360887		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of ϕ'	101.23733
log R	− 2714		
log S_g	5.41956590	y (for min. of ϕ')	1,117,355.91
log S_g^3	16.2586977	y (for seconds of ϕ')	+ 1,539.90
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,118,895.81
log $(S_g^3/6\rho_o^2)_g$	0.8394802		
S_g	+262,764.023	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	6.910	log $\Delta\lambda$	
x′	+262,770.93	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	762,770.93	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		$\Delta\alpha$	″
		$\Delta\alpha$	° ′ ″

* Take out C first for ϕ and correct for approximate ϕ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

			°	′	″
		λ (Central meridian)	78	35	
φ 43° 04′ ″		λ	77	38	
		Δλ (Central meridian–λ)	+ 0	57	
		Δλ (in sec.)	+ 3420″		

log Δλ	3.53402611	log S_m^2	9.777265
Cor. arc to sine	− 1990	log C*	928 1.374~~869~~-10
log $\Delta\lambda_1$	3.53400621	log Δφ	93 1.1521~~34~~
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00″.0000
log S_1	4.88862176	Δφ	+ 69 14.19~~58~~
Cor. sine to arc	+ 1062	φ′	69 43 04 14.19~~58~~
log S_m	4.88863238		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.40458941	y (for min. of φ′)	1,117,355.91
log S_g^3	16.2137682	y (for seconds of φ′)	+ 1,437.26
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,118,793.17
log $(S_g^3/6\rho_o^2)_g$	0.7945507		
S_g	+253,857.154	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	6.231	log Δλ	
x′	+253,863.38	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	753,863.38	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 04′ ″		λ	77 . 40
		Δλ (Central meridian−λ)	+ 0 55
		Δλ (in sec.)	+ 3300″

log Δλ	3.51851394	log S_m^2	9.746242
Cor. arc to sine	− 1853	log C*	1.374~~869~~924-10
log $\Delta\lambda_1$	3.51849541	log Δφ	1.1211~~11~~66
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00″.0000
log S_1	4.87311096	Δφ	+ 13.21~~63~~80
Cor. sine to arc	+ 989	φ′	43 04 13.21~~63~~80
log S_m	4.87312085		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.38907788	y (for min. of φ′)	1,117,355.91
log S_g^3	16.1672336	y (for seconds of φ′)	+ 1,338.16
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,118,694.07
log $(S_g^3/6\rho_o^2)_g$	0.7480161		
S_g	+244,950.248	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	5.598	log Δλ	
x′	+244,955.85	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	744,955.85	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection.**

	°	′	″
λ (Central meridian)	78	35	
λ	77	42	
Δλ (Central meridian−λ)	+ 0	53	
Δλ (in sec.)			+ 3180

φ 43° 04′ ″

log Δλ	3.50242712	log S_m^2	9.714069
Cor. arc to sine	− 1721	log C*	1.374~~869~~920-10
log $\Delta\lambda_1$	3.50240991	log Δφ	1.0889~~38~~89
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00″.0000
log S_1	4.85702546	Δφ	+ 12.27~~26~~41
Cor. sine to arc	± 918	φ′	43 04 12.27~~26~~41
log S_m	4.85703464		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.37299167	y (for min. of φ′)	1,117,355.91
log S_g^3	16.1189750	y (for seconds of φ′)	+ 1,242.60
log $1/6\rho_0^2R^2$	4.5807825-20	y	1,118,598.51
log $(S_g^3/6\rho_0^2)_g$	0.6997575		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+236,043.295	log Δλ	
$(S_g^3/6\rho_0^2)_g$	5.009	log $\Delta\alpha_1$	
x′	+236,048.30		
	500,000.00	log $(\Delta\lambda)^3$	
x	736,048.30	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 04′ ″		λ	77 44
		Δλ (Central meridian-λ)	+ 0 51
		Δλ (in sec.)	+ 3060″

log Δλ	3.48572143	log S_m^2	9.680659
Cor. arc to sine	− 1593	log C*	1.374~~869~~917-10
log $\Delta\lambda_1$	3.48570550	log Δφ	1.0555~~28~~76
log cos φ	9.86365569-10		
colog A	1.49095986	φ	43° 04′ 00.0000″
log S_1	4.84032105	Δφ	+ 11.36~~59~~52
Cor. sine to arc	+ 850	φ′	43 04 11.36~~59~~52
log S_m	4.84032955		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23733
log R	− 2714		
log S_g	5.35628658	y (for min. of φ′)	1,117,355.91
log S_g^3	16.0688597	y (for seconds of φ′)	+ 1,150.58
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,118,506.49
log $(S_g^3/6\rho_o^2)_g$	0.6496422		
S_g	+227,136.318	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	4.463	log Δλ	
x′	+227,140.78	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	727,140.78	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continue

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		°	′	″
ϕ 43° 04′ ″	λ (Central meridian)	78	35	
	λ	77	46	
	$\Delta\lambda$ (Central meridian−λ)	+ 0	49	
	$\Delta\lambda$ (in sec.)	+2940″		

log $\Delta\lambda$	3.46834733	log S_m^2	9.645912
Cor. arc to sine	− 1471	log C*	1.374~~869~~913-10
log $\Delta\lambda_1$	3.46833262	log $\Delta\phi$	1.020~~781~~825
log cos ϕ	9.86365569-10		
colog A	1.49095986	ϕ	43° 04′ 00″.0000
log S_1	4.82294817	$\Delta\phi$	+ 10.49~~01~~12
Cor. sine to arc	+ 785	ϕ'	43 04 10.49~~01~~12
log S_m	4.82295602		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of ϕ'	101.23733
log R	− 2714		
log S_g	5.33891305	y (for min. of ϕ')	1,117,355.91
log S_g^3	16.0167392	y (for seconds of ϕ')	+ 1,062.10
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,118,418.01
log $(S_g^3/6\rho_o^2)_g$	0.5975217		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+218,229.296	log $\Delta\lambda$	
$(S_g^3/6\rho_o^2)_g$	3.958	log $\Delta\alpha_1$	
x′	+218,233.25		
	500,000.00	log $(\Delta\lambda)^3$	
x	718,233.25	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		$\Delta\alpha$	″
		$\Delta\alpha$	° ′ ″

* Take out C first for ϕ and correct for approximate ϕ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 16′ ″		λ	77 30
		Δλ (Central meridian−λ)	+ 1 05
		Δλ (in sec.)	+ 3900″

log Δλ	3.59106461	log S_m^2	9.888502
Cor. arc to sine	− 2588	log C*	1.377~~886~~964 -10
log $\Delta\lambda_1$	3.59103873	log Δφ	1.266~~388~~466
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.94423748	Δφ	+ 18.4~~666~~700
Cor. sine to arc	+ 1372	φ′	43 16 18.4~~666~~700
log S_m	4.94425120		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.46020823	y (for min. of φ′)	1,190,247.99
log S_g^3	16.3806247	y (for seconds of φ′)	+ 1,869.92
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,192,117.91
log $(S_g^3/6\rho_o^2)_g$	0.9614072		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+288,541.462	log Δλ	
$(S_g^3/6\rho_o^2)_g$	9.150	log $\Delta\alpha_1$	
x′	+288,550.61		
	500,000.00	log $(\Delta\lambda)^3$	
x	788,550.61	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′ ″
φ 43° 16′ ″		λ	77 32
		Δλ (Central meridian−λ)	+ 1 03
		Δλ (in sec.)	+ 3780″

log Δλ	3.57749180	log S_m^2	9.861358
Cor. arc to sine	− 2431	log C*	1.377~~886~~959 -10
log $\Delta\lambda_1$	3.57746749	log Δφ	1.239~~244~~317
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.93066624	Δφ	+ 17.3~~478~~507
Cor. sine to arc	+ 1289	φ′	43 16 17.3~~478~~507
log S_m	4.93067913		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.44663616	y (for min. of φ′)	1,190,247.99
log S_g^3	16.3399085	y (for seconds of φ′)	+ 1,756.60
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,192,004.59
log $(S_g^3/6\rho_o^2)_g$	0.9206910		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+279,663.741	log Δλ	
$(S_g^3/6\rho_o^2)_g$	8.331	log $\Delta\alpha_1$	
x′	+279,672.07		
	500,000.00	log $(\Delta\lambda)^3$	
x	779,672.07	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

ϕ 43° 16' "	λ (Central meridian)	78° 35' "	
	λ	77 34	
	Δλ (Central meridian-λ)	+ 1 01	
	Δλ (in sec.)	+ 3660"	

log Δλ	3.56348109	log S_m^2	9.833338
Cor. arc to sine	− 2279	log C*	1.377~~886~~954-10
log $\Delta\lambda_1$	3.56345830	log Δφ	1.2112~~84~~92
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16' 00".0000
log S_1	4.91665705	Δφ	+ 16.26~~39~~64
Cor. sine to arc	± 1208	φ'	43 16 16.26~~39~~64
log S_m	4.91666913		
log 3937/1200	0.51598417	Tabular difference of y for 1" of φ'	101.24100
log R	− 2714		
log S_g	5.43262616	y (for min. of φ')	1,190,247.99
log S_g^3	16.2978785	y (for seconds of φ')	+ 1,646.83
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,191,894.82
log $(S_g^3/6\rho_o^2)_g$	0.8786610		
S_g	+270,785.973	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	7.562	log Δλ	
x'	+270,793.54	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	770,793.54	log F	
		log b	
		$\Delta\alpha_1$	"
		b	
		Δα	"
		Δα	° ' "

*Take out C first for φ and correct for approximate φ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

620745 O - 44 - 11

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		°	′	″
ϕ 43° 16′ ″	λ (Central meridian)	78	35	
	λ	77	36	
	$\Delta\lambda$ (Central meridian−λ)	+ 0	59	
	$\Delta\lambda$ (in sec.)			+ 3540

log $\Delta\lambda$	3.54900326	log S_m^2	9.804384
Cor arc to sine	− 2132	log C*	1.377~~886~~950-10
log $\Delta\lambda_1$	3.54898194	log $\Delta\phi$	1.182~~270~~334
log cos ϕ	9.86223375-10		
colog A	1.49096500	ϕ	43° 16′ 00″.0000
log S_1	4.90218069	$\Delta\phi$	+ 15.21~~49~~72
Cor sine to arc	+ 1130	ϕ'	43 16 15.21~~49~~72
log S_m	4.90219199		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of ϕ'	101.24100
log R	− 2714		
log S_g	5.41814902	y (for min. of ϕ')	1,190,247.99
log S_g^3	16.2544471	y (for seconds of ϕ')	+ 1,540.60
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,191,788.59
log $(S_g^3/6\rho_o^2)_g$	0.8352296		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+261,908.154	log $\Delta\lambda$	
$(S_g^3/6\rho_o^2)_g$	6.843	log $\Delta\alpha_1$	
x′	+261,915.00		
	500,000.00	log $(\Delta\lambda)^3$	
x	761,915.00	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		$\Delta\alpha$	″
		$\Delta\alpha$	° ′ ″

* Take out C first for ϕ and correct for approximate ϕ'

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′ ″
φ	43° 16′ ″	λ	77 38
		Δλ (Central meridian-λ)	+ 0 57
		Δλ (in sec.)	″ + 3420

log Δλ	3.53402611	log S_m^2	9.774431
Cor. arc to sine	− 1990	log C*	946 1.377~~886~~-10
log $\Delta\lambda_1$	3.53400621	log Δφ	77 1.1523~~17~~
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.88720496	Δφ	+ 29 14.20~~69~~
Cor. sine to arc	+ 1055	φ′	29 43 16 14.20~~69~~
log S_m	4.88721551		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.40317254	y (for min. of φ′)	1,190,247.99
log S_g^3	16.2095176	y (for seconds of φ′)	+ 1,437.92
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,191,685.91
log $(S_g^3/6\rho_o^2)_g$	0.7903001		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+253,030.303	log Δλ	
$(S_g^3/6\rho_o^2)_g$	6.170	log $\Delta\alpha_1$	
x′	+253,036.47		
	500,000.00	log $(\Delta\lambda)^3$	
x	753,036.47	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 16′ ″		λ	77 40
		Δλ (Central meridian−λ)	+ 0 55
		Δλ (in sec.)	+ 3300″

log Δλ	3.51851394	log S_m^2	9.743408
Cor. arc to sine	− 1853	log C*	1.377~~886~~ 942 -10
log $Δλ_1$	3.51849541	log Δφ	1.121~~294~~ 350
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.87169416	Δφ	+ 13.22~~19~~ 36
Cor. sine to arc	+ 982	φ′	43 16 13.22~~19~~ 36
log S_m	4.87170398		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.38766101	y (for min. of φ′)	1,190,247.99
log S_g^3	16.1629830	y (for seconds of φ′)	+ 1,338.77
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,191,586.76
log $(S_g^3/6\rho_o^2)_g$	0.7437655		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+244,152.406	log Δλ	
$(S_g^3/6\rho_o^2)_g$	5.543	log $Δα_1$	
x′	+244,157.95		
	500,000.00	log $(Δλ)^3$	
x	744,157.95	log F	
		log b	
		$Δα_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

ϕ 43° 16′ ″	λ (Central meridian)	78° 35′ ″
	λ	77 42
	$\Delta\lambda$ (Central meridian−λ)	+ 0 53
	$\Delta\lambda$ (in sec.)	+ 3180″

log $\Delta\lambda$	3.50242712	log S_m^2	9.711236.
Cor. arc to sine	− 1721	log C*	1.377~~886~~938-10
log $\Delta\lambda_1$	3.50240991	log $\Delta\phi$	1.0891~~22~~74
log cos ϕ	9.86223375-10		
colog A	1.49096500	ϕ	43° 16′ 00″.0000
log S_1	4.85560866	$\Delta\phi$	+ 12.27~~78~~93
Cor. sine to arc	+ 912	ϕ'	43 16 12.27~~78~~93
log S_m	4.85561778		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of ϕ'	101.24100
log R	− 2714		
log S_g	5.37157481	y (for min. of ϕ')	1,190,247.99
log S_g^3	16.1147244	y (for seconds of ϕ')	+ 1,243.17
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,191,491.16
log $(S_g^3/6\rho_o^2)_g$	0.6955069		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+235,274.475	log $\Delta\lambda$	
$(S_g^3/6\rho_o^2)_g$	4.960	log $\Delta\alpha_1$	
x′	+235,279.44		
	500,000.00	log $(\Delta\lambda)^3$	
x	735,279.44	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		$\Delta\alpha$	″
		$\Delta\alpha$	° ′ ″

* Take out C first for ϕ and correct for approximate ϕ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

			°	′	″
		λ (Central meridian)	78	35	
φ 43° 16′ ″		λ	77	44	
		Δλ (Central meridian−λ)	+ 0	51	
		Δλ (in sec.)			+ 3060″

log Δλ	3.48572143	log S_m^2	9.677825
Cor. arc to sine	− 1593	log C*	934 1.377~~886~~-10
log $\Delta\lambda_1$	3.48570550	log Δφ	59 1.0557~~11~~
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.83890425	Δφ	+ 700 11.3~~687~~
Cor. sine to arc	+ 845	φ′	700 43 16 11.3~~687~~
log S_m	4.83891270		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.35486973	y (for min. of φ′)	1,190,247.99
log S_g^3	16.0646092	y (for seconds of φ′)	+ 1,151.11
log $1/6\rho_0^2R^2$	4.5807825-20	y	1,191,399.10
log $(S_g^3/6\rho_0^2)_g$	0.6453917		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+ 226,396.512	log Δλ	
$(S_g^3/6\rho_0^2)_g$	4.420	log $\Delta\alpha_1$	
x′	+ 226,400.93		
	500,000.00	log $(\Delta\lambda)^3$	
x	726,400.93	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′ ″
φ 43° 16′ ″		λ	77 46
		Δλ (Central meridian−λ)	+ 0 49
		Δλ (in sec.)	+ 2940″

log Δλ	3.46834733	log S_m^2	9.643078
Cor. arc to sine	− 1471	log C*	930 1.377~~886~~-10
log $\Delta\lambda_1$	3.46833262	log Δφ	1008 1.02~~8964~~
log cos φ	9.86223375-10		
colog A	1.49096500	φ	43° 16′ 00″.0000
log S_1	4.82153137	Δφ	+ 56 10.49~~46~~
Cor. sine to arc	+ 780	φ′	56 43 16 10.49~~46~~
log S_m	4.82153917		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24100
log R	− 2714		
log S_g	5.33749620	y (for min. of φ′)	1,190,247.99
log S_g^3	16.0124886	y (for seconds of φ′)	+ 1,062.59
log $1/6\rho_0^2R^2$	4.5807825-20	y	1,191,310.58
log $(S_g^3/6\rho_0^2)_g$	0.5932711		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+217,518.502	log Δλ	
$(S_g^3/6\rho_0^2)_g$	3.920	log $\Delta\alpha_1$	
x′	+217,522.42		
	500,000.00	log $(\Delta\lambda)^3$	
x	717,522.42	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

*Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78 ° 35 ′ ″
φ 43° 06′ ″		λ	77 30
		Δλ (Central meridian−λ)	+ 1 05
		Δλ (in sec.)	+ 3900″

log Δλ	3.59106461	log S_m^2	9.890865
Cor. arc to sine	− 2588	log C*	1.375~~371~~ 449 -10
log $\Delta\lambda_1$	3.59103873	log Δφ	1.266~~236~~ 314
log cos φ	9.86341939-10		
colog A	1.49096072	φ	43° 06′ 00″.0000
log S_1	4.94541884	Δφ	+ 18.46~~02~~ 35
Cor. sine to arc	+ 1379	φ′	43 06 18.46~~02~~ 35
log S_m	4.94543263		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23800
log R	2714		
log S_g	5.46138966	y (for min. of φ′)	1,129,504.41
log S_g^3	16.3841690	y (for seconds of φ′)	+ 1,869.21
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,131,373.62
log $(S_g^3/6\rho_o^2)_g$	0.9649515		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+289,327.462	log Δλ	
$(S_g^3/6\rho_o^2)_g$	9.225	log $\Delta\alpha_1$	
x′	+289,336.69		
	500,000.00	log $(\Delta\lambda)^3$	
x	789,336.69	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		α	° ′ ″

* Take out C first for φ and correct for approximate Δφ.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

ϕ 43° 08′ ″		λ (Central meridian)	78° 35′ ″
		λ	77 30
		$\Delta\lambda$ (Central meridian−λ)	+ 1 05
		$\Delta\lambda$ (in sec.)	+ 3900″

log $\Delta\lambda$	3.59106461	log S_m^2	9.890394
Cor. arc to sine	− 2588	log C*	1.375~~875~~ 952 -10
log $\Delta\lambda_1$	3.59103873	log $\Delta\phi$	1.266~~289~~ 346
log cos ϕ	9.86318282-10		
colog A	1.49096157	ϕ	43° 08′ 00″.0000
log S_1	4.94518312	$\Delta\phi$	+ 18.46~~16~~ 49
Cor. sine to arc	+ 1378	ϕ'	43 08 18.46~~16~~ 49
log S_m	4.94519690		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of ϕ'	101.23850
log R	− 2714		
log S_g	5.46115393	y (for min. of ϕ')	1,141,652.98
log S_g^3	16.3834618	y (for seconds of ϕ')	+ 1,869.36
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,143,522.34
log $(S_g^3/6\rho_o^2)_g$	0.9642443		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+289,170.466	log $\Delta\lambda$	
$(S_g^3/6\rho_o^2)_g$	9.210	log $\Delta\alpha_1$	
x′	+289,179.68		
	500,000.00	log $(\Delta\lambda)^3$	
x	789,179.68	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		$\Delta\alpha$	″
		$\Delta\alpha$	° ″

*Take out C first for ϕ and correct for approximate ϕ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ 43° 10′ ″		λ	77 30
		Δλ (Central meridian−λ)	+ 1 05
		Δλ (in sec.)	+ 3900″

log Δλ	3.59106461	log S_m^2	9.889922
Cor. arc to sine	− 2588	log C*	1.376~~377~~ [455] -10
log $\Delta\lambda_1$	3.59103873	log Δφ	1.266~~299~~ [377]
log cos φ	9.86294597-10		
colog A	1.49096243	φ	43° 10′ 00″.0000
log S_1	4.94494713	Δφ	+ 18.46~~29~~ [62]
Cor. sine to arc	± 1376	φ′	43 10 18.46~~29~~ [62]
log S_m	4.94496089		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23917
log R	− 2714		
log S_g	5.46091792	y (for min. of φ′)	1,153,801.63
log S_g^3	16.3827538	y (for seconds of φ′)	+ 1,869.50
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,155,671.13
log $(S_g^3/6\rho_o^2)_g$	0.9635363		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+289,013.360	log Δλ	
$(S_g^3/6\rho_o^2)_g$	9.195	log $\Delta\alpha_1$	
x′	+289,022.55		
	500,000.00	log $(\Delta\lambda)^3$	
x	789,022.55	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35' "
φ 43° 12' "		λ	77 30
			+ 1 05
		Δλ (Central meridian-λ)	
		Δλ (in sec.)	+ 3900"

log Δλ	3.59106461	log S_m^2	9.889449
Cor. arc to sine	− 2588	log C*	1.376~~880~~ 958 -10
log $\Delta\lambda_1$	3.59103873	log Δφ	1.266~~329~~ 407
log cos φ	9.86270884-10		
colog A	1.49096328	φ	43° 12' 00".0000
log S_1	4.94471085	Δφ	+ 18.46~~41~~ 75
Cor. sine to arc	+ 1375	φ'	43 12 18.46~~41~~ 75
log S_m	4.94472460		
log 3937/1200	0.51598417	Tabular difference of y for 1" of φ'	101.23967
log R	− 2714		
log S_g	5.46068163	y (for min. of φ')	1,165,950.35
log S_g^3	16.3820449	y (for seconds of φ')	± 1,869.64
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,167,819.99
log $(S_g^3/6\rho_o^2)_g$	0.9628274		
S_g	+288,856.157	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	9.180	log Δλ	
x'	+288,865.34	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	788,865.34	log F	
		log b	
		$\Delta\alpha_1$	"
		b	
		Δα	"
		Δα	° ' "

*Take out C first for φ and correct for approximate φ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

λ (Central meridian) 78° 35′ ″

φ 43° 14′ ″ λ 77 30

Δλ (Central meridian-λ) + 1 05

Δλ (in sec.) + 3900″

log Δλ	3.59106461	log S_m^2	9.888976
Cor. arc to sine	− 2588	log C*	461 1.377384-10
log $\Delta\lambda_1$	3.59103873	log Δφ	437 1.266360
log cos φ	9.86247143-10		
colog A	1.49096414	φ	43° 14′ 00.0000″
log S_1	4.94447430	Δφ	+ 87 18.4655
Cor. sine to arc	+ 1373	φ′	87 43 14 18.4655
log S_m	4.94448803		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24033
log R	− 2714		
log S_g	5.46044506	y (for min. of φ′)	1,178,099.13
log S_g^3	16.3813352	y (for seconds of φ′)	+ 1,869.78
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,179,968.91
log $(S_g^3/6\rho_o^2)_g$	0.9621177		
S_g	+288,698.856	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	9.165	log Δλ	
x′	+288,708.02	log $\Delta\alpha_1$	
	500,000.00	log $(\Delta\lambda)^3$	
x	788,708.02	log F	
		log b	
		$\Delta\alpha_1$	
		b	
		Δα	
		Δα	

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

λ (Central meridian)	78° 35′ ″
φ 43° 06′ ″ λ	77 46
Δλ (Central meridian-λ)	+ 0 49
Δλ (in sec.)	+ 2940″

log Δλ	3.46834733	log S_m^2	9.645441
Cor. arc to sine	− 1471	log C*	1.375~~371~~415-10
log $\Delta\lambda_1$	3.46833262	log Δφ	1.0208~~12~~56
log cos φ	9.86341939-10		
colog A	1.49096072	φ	43° 06′ 00″.0000
log S_1	4.82271273	Δφ	+ 10.49~~09~~19
Cor. sine to arc	+ 784	φ′	43 06 10.49~~09~~19
log S_m	4.82272057		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23800
log R	− 2714		
log S_g	5.33867760	y (for min. of φ′)	1,129,504.41
log S_g^3	16.0160328	y (for seconds of φ′)	+ 1,062.18
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,130,566.59
log $(S_g^3/6\rho_o^2)_g$	0.5968153		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+218,111.015	log Δλ	
$(S_g^3/6\rho_o^2)_g$	3.952	log $\Delta\alpha_1$	
x′	+218,114.97		
	500,000.00	log $(\Delta\lambda)^3$	
x	718,114.97	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	
		Δα	

*Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35' "
φ	43° 08' "	λ	77 46
		Δλ (Central meridian−λ)	+ 0 49
		Δλ (in sec.)	+ 2940"

log Δλ	3.46834733	log S_m^2	9.644970
Cor. arc to sine	− 1471	log C*	919 1.3758~~75~~-10
log $\Delta\lambda_r$	3.46833262	log Δφ	89 1.0208~~45~~
log cos φ	9.86318282-10		
colog A	1.49096157	φ	43° 08' 00".0000
log S_1	4.82247701	Δφ	+ 27 10.49~~17~~
Cor. sine to arc	+ 783	φ'	43 08 27 10.49~~17~~
log S_m	4.82248484		
log 3937/1200	0.51598417	Tabular difference of y for 1" of φ'	101.23850
log R	− 2714		
log S_g	5.33844187	y (for min. of φ')	1,141,652.98
log S_g^3	16.0153256	y (for seconds of φ')	+ 1,062.27
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,142,715.25
log $(S_g^3/6\rho_o^2)_g$	0.5961081		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+217,992.661	log Δλ	
$(S_g^3/6\rho_o^2)_g$	3.946	log $\Delta\alpha_1$	
x'	+217,996.61		
	500,000.00	log $(\Delta\lambda)^3$	
x	717,996.61	log F	
		log b	
		$\Delta\alpha_1$	"
		b	
		Δα	"
		Δα	° ' "

* Take out C first for φ and correct for approximate φ'.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State **New York-West** Station **Two-minute intersection**

		λ (Central meridian)	78° 35′ ″
φ	43° 10′ ″	λ	77 46
		Δλ (Central meridian−λ)	• 0 49
		Δλ (in sec.)	+ 2940″

log Δλ	3.46834733	log S_m^2	9.644498
Cor. arc to sine	− 1471	log C*	1.376~~377~~421-10
log $\Delta\lambda_1$	3.46833262	log Δφ	1.020~~875~~919
log cos φ	9.86294597-10		
colog A	1.49096243	φ	43° 10′ 00″.0000
log S_1	4.82224102	Δφ	+ 10.49~~24~~35
Cor. sine to arc	+ 782	φ	43 10 10.49~~24~~35
log S_m	4.82224884		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23917
log R	− 2714		
log S_g	5.33820587	y (for min. of φ′)	1,153,801.63
log S_g^3	16.0146176	y (for seconds of φ′)	+ 1,062.35
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,154,863.98
log $(S_g^3/6\rho_o^2)_g$	0.5954001		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+217,874.233	log Δλ	
$(S_g^3/6\rho_o^2)_g$	3.939	log $\Delta\alpha_1$	
x′	+217,878.17		
	500,000.00	log $(\Delta\lambda)^3$	
x	717,878.17	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	

* Take out C first for φ and correct for approximate φ′.

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′ ″
φ 43° 12′ ″		λ	77 46
		Δλ (Central meridian−λ)	+ 0 49
		Δλ (in sec.)	+ 2940″
log Δλ	3.46834733	log S_m^2	9.644025
Cor. arc to sine	− 1471	log C*	1.376880-10 (924)
log $\Delta\lambda_1$	3.46833262	log Δφ	− 49 1.020985
log cos φ	9.86270884-10		
colog A	1.49096328	φ	43° 12′ 00″.0000
log S_1	4.82200474	Δφ	+ 10.4932 (42)
Cor. sine to arc	+ 782	φ′	43 12 10.4932 (42)
log S_m	4.82201256		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23967
log R	− 2714		
log S_g	5.33796959	y (for min. of φ′)	1,165,950.35
log S_g^3	16.0139088	y (for seconds of φ′)	+ 1,062.43
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,167,012.78
log $(S_g^3/6\rho_o^2)_g$	0.5946913		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+217,755.729	log Δλ	
$(S_g^3/6\rho_o^2)_g$ *	3.933	log $\Delta\alpha_1$	
x′	+217,759.66		
	500,000.00	log $(\Delta\lambda)^3$	
x	717,759.66	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Two-minute intersection

		λ (Central meridian)	78° 35′ ″
φ	43° 14′ ″	λ	77 46
		Δλ (Central meridian−λ)	0 49
		Δλ (in sec.)	+ 2940″

log Δλ	3.46834733	log S_m^2	9.643552
Cor. arc to sine	− 1471	log C*	1.377~~384~~428-10
log $Δλ_1$	3.46833262	log Δφ	1.0209~~36~~80
log cos φ	9.86247143-10		
colog A	1.49096414	φ	43° 14′ 00.0000″
log S_1	4.82176819	Δφ	+ 10.49~~39~~49
Cor. sine to arc	+ 781	φ′	43 14 10.49~~39~~49
log S_m	4.82177600		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.24033
log R	− 2714		
log S_g	5.33773303	y (for min. of φ′)	1,178,099.13
log S_g^3	16.0131991	y (for seconds of φ′)	+ 1,062.51
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,179,161.64
log $(S_g^3/6\rho_o^2)_g$	0.5939816		
S_g	+217,637.149	log sin $\frac{\phi+\phi'}{2}$	
$(S_g^3/6\rho_o^2)_g$	3.926	log Δλ	
x′	+217,641.08	log $Δα_1$	
	500,000.00	log $(Δλ)^3$	
x	717,641.08	log F	
		log b	
		$Δα_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 30.—Computation of coordinates for 2-minute intersections—Continued.

TRANSFORMATION OF A LOCAL SYSTEM OF PLANE COORDINATES TO GRID COORDINATES

We shall now show how it is possible to transform a local system of plane coordinates directly to grid coordinates without passing through the geodetic positions. The first requisite for this is that we should have the geodetic position of the origin. The city of Rochester, N. Y., has a system of plane coordinates that we can now use as an illustration of the method. The C. W. A. traverses that we have computed in the first part of this publication are based upon this local system; so it was necessary to transform the coordinates of a number of stations to serve as control for the computation of that work.

We have already described the computation of the grid coordinates for the station Eastman, and this is the station that is the origin for the Rochester system of plane coordinates. We shall first reduce the coordinates for a number of stations that are included in the city triangulation for which we also have the geodetic positions. We can then compare the results obtained by transformation with those resulting from the reduction of the geodetic positions. We must bear in mind, however, that the geodetic positions are given only to three decimal places and that one unit in the third decimal place represents approximately one-tenth of a foot. We cannot expect that the two results will check in the hundredths of a foot. In fact the result of the transformation is on the whole the better of the two because of this fact.

There is one fact that we must call attention to at the start. The geodetic positions of the city triangulation have been recomputed on the North American datum of 1927, but the plane coordinates have not been changed from the old values. The only change that was made in the triangulation was that the azimuth was increased by 6″.15. As angles are considered in ordinary coordinate systems this would require a transformation of the coordinates by +6″.15 to make them consistent with the geodetic positions. From the back azimuth computation shown in figure 4 we see that the local system must have the axes swung through −0°39′32″.51. It is not necessary to make these two transformations separately by swinging the axes first through +6″.15 and then swinging back −39′32″.51. We can combine the angles of swing and accomplish the result by a single transformation. The angle of rotation, therefore, becomes the algebraic sum of the two angles.

°	′	″
−0	39	32.51
		+06.15
−0	39	26.36

In the ordinary cases of transformation that may arise, there will be only the back azimuth of the station of origin to consider. In this case we wanted everything referred to the North American datum of 1927 and hence the geodetic positions had to be recomputed and from this arises the need to include the +6″.15 in the transformation.

If we denote the transformation angle by θ we shall have the transformation formulas:

$$x = 757{,}043.84 + x' \cos\theta - y' \sin\theta$$
$$y = 1{,}153{,}142.41 + x' \sin\theta + y' \cos\theta$$

In these formulas, the constants are the x and y coordinates of the local origin or the station Eastman. The computation of these is shown in figure 4; the angle θ can now be considered a positive angle since the effect of the minus sign has been taken care of in writing the formulas. This system is east of the central meridian; if a system were to be transformed that is west of the central meridian, the sign of sin θ would have to be changed in each of the formulas.

The transformation will be applied to the following stations of the triangulation: Pinnacle, Standard, Jackson, and Mount Read north base. The computations of the coordinates of these stations from their geodetic positions are shown in figure 31. We can thus in each case compare the two values, and in this way see just how consistent the results are.

We assume that the local system of coordinates is free from scale distortion. This is not strictly true, of course, but in general such systems are small in extent and hence the distortions are negligible for the purpose in hand. In Rochester, however, the coordinates were computed after increasing the sea-level length by +104 in the seventh place of logarithms. This was done to base the computation on a plane about 500 feet above sea level. This quantity must be subtracted from the logarithms of the local coordinates to reduce the system back to sea level. The x' and y' should be the coordinates reduced to grid length on the State system on which we are to apply them. To determine what reduction factor we should use, we must first make an approximate reduction using the local x and y without any reduction. After this is done we can then determine the factor that should be applied to the coordinates. As a matter of fact we need only compute the x value in this approximation for the grid scale factor depends only on the distance from the central meridian. With these stations, the coordinates of which have been computed from their geodetic positions, we shall use these values in determining the scale factor. We shall make the computations with natural functions and the use of calculating machines, but logarithms could be used just as well. We shall give the values of the functions once and for all and they will be used in all of the computations.

$$\sin\theta = 0.01147219$$
$$\cos\theta = 0.99993419$$

For station Pinnacle,

$$\text{local } x = +9{,}064.71$$
$$\text{local } y = -9{,}369.25.$$

To determine the scale factor we take the mean of the x' values of Eastman and Pinnacle expressed in thousands of feet. We must merely subtract the constant 500,000 from the x value.

Eastman	=257.0
Pinnacle	=266.2
	523.2
Mean	=261.6

From the State tables on page 91 (fig. 18), by interpolation we find +68 as the value. Now −104 has to be applied to reduce the system to sea level. Therefore, we have −104+68=−36. This is the correction in the seventh place of logarithms.

The correction +36 in the seventh place of decimals really means a log of 0.0000036. The number corresponding to this log is 1.00000829. But since the log is minus, the value really becomes $\frac{1}{1.00000829}$, or to the approximation required 1.00000000−0.00000829 =0.99999171.

In practice, to determine the factor in numbers, the easiest way is to divide the log correction by 434 and add the result algebraically to 1.0000.

$$\frac{-36}{434}=-0.0829$$

$$\begin{array}{r} 1.0000,0000 \\ -0,0829 \\ \hline 0.9999,9171 \end{array}$$

The commas are inserted to emphasize the point of separation. In the examples that follow the abridged computation is given, omitting the commas of separation.

A reduction of 434 would give one unit where the fourth zero occurs and hence the result is as shown. Another method would be to take out from the table the number corresponding to the log 9.9999964–10. This would give 0.99999163 which differs slightly from the other value, but it would not change the result.

With this reduction, we find

$$\text{local } x' = +9{,}064.635$$
$$\text{local } y' = -9{,}369.172.$$

With these values, we can compute the coordinates.

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	+9, 064. 04	+103. 99
$-y'\sin\theta$ and $+y'\cos\theta$	+107. 48	−9, 368. 56
Pinnacle	766, 215. 36	1, 143, 877. 84

There is still another item to be considered. The straight line joining two points on the grid does not exactly represent the geodetic line joining them. There is a small correction to the angle to be applied to get the true grid azimuth.

As given in the tables this correction can be computed from the formula:

$$\text{Correction} = -\frac{(y_2-y_1)(2x_1'+x_2')}{6\rho_0^2 \sin 1''}.$$

This will give the correction in seconds, the minus sign being used because it is to be applied to the geodetic azimuth.

For the purpose in hand it is better to have this correction in radians. We need only to omit the sin 1″ in the denominator.

From the table, we have

$$\log\left(\frac{1}{6\rho_0^2}\right)_g = 4.5807825-20$$

The number corresponding to this log is 3.80875×10^{-16}.

Hence the formula for the correction is given in radians in the form

$$-(y_2-y_1)(2x_1'+x_2')(3.80875\times10^{-16}).$$

If we denote this correction by Δn, the correction for the x coordinate$=\Delta y\Delta n$, and for the y coordinate$=-\Delta x\Delta n$.

In this case

$$\begin{aligned} y_2 &= 1{,}143{,}877.84 \\ y_1 &= 1{,}153{,}142.41 \\ \hline \Delta y &= -9{,}264.57 \end{aligned} \qquad \begin{aligned} x_2 &= 766{,}215.36 \\ x_1 &= 757{,}043.84 \\ \hline \Delta x &= +9{,}171.52 \end{aligned}$$

$$\begin{aligned} x_1' &= +257{,}044 \\ 2x_1' &= +514{,}088 \\ x_2' &= +266{,}215 \\ \hline 2x_1'+x_2' &= +780{,}303 \end{aligned}$$

$$\Delta n=+9{,}265\times780{,}303\times3.80875\times10^{-16}$$

The factor 10^{-16} can be easily handled by pointing off a total of 16 decimal places in the various factors. Let us denote this small correction to x by dx and that to y by dy.

$$dx=-9{,}265\times9{,}265\times780{,}303\times3.80875\times10^{-16}$$
$$dy=-9{,}172\times9{,}265\times780{,}303\times3.80875\times10^{-16}$$

To take care of the factor 10^{-16}, we can point off 5 decimal places in each of the first two factors and 6 decimal places in the third factor.

$$dx=-0.09265\times0.09265\times0.780303\times3.80875=-0.03$$
$$dy=-0.09172\times0.09265\times0.780303\times3.80875=-0.03$$

In actual computation, it would not be necessary to carry so many figures. Each factor could be cut down to the nearest third decimal place to obtain the same result.

With these values applied we have the coordinates for station Pinnacle,

$$x=\ 766{,}215.33$$
$$y=1{,}143{,}877.81.$$

By comparison with the computation from geodetic position in figure 31, we see that the x value checks exactly and the y value differs by 0.02 foot. This agreement is closer than could be expected from the nature of the case.

For the station Standard,

$$\text{local } x=\ -9{,}404.19$$
$$\text{local } y=-11{,}133.00.$$

$$\begin{aligned} x_1' &= 257.0 \text{ (with 1,000 as unit)} \\ x_2' &= 247.8 \\ \tfrac{1}{2}(x_1'+x_2') &= 252.4 \end{aligned}$$

From the table of scale factors, we find 252.4 gives a scale correction of +45 units in seventh place of decimals. This combined with −104 to reduce the system to sea level gives a correction of −59 to be applied.

$$\frac{-59}{434}=-0.136$$

$$\begin{array}{r} 1.0000 \\ -0136 \\ \hline 0.9999864 \end{array}$$

This scale factor gives the values

$$\text{local } x' = -9{,}404.06$$
$$\text{local } y' = -11{,}132.85.$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−9, 403. 44	−107. 89
$-y'\sin\theta$ and $+y'\cos\theta$	+127. 72	−11, 132. 12
Standard	747, 768. 12	1, 141, 902. 40

$$y_2 = 1{,}141{,}902 \qquad x_2 = 747{,}768$$
$$y_1 = 1{,}153{,}142 \qquad x_1 = 757{,}044$$
$$\Delta y = -11{,}240 \qquad \Delta x = -9{,}276$$

$$2x_1' = +514{,}088$$
$$x_2' = +247{,}768$$
$$2x_1' + x_2' = +761{,}856$$

$$\Delta n = +11{,}240 \times 761{,}856 \times 3.80875 \times 10^{-16}$$

$$dx = -0.11240 \times 0.11240 \times 0.761856 \times 3.80875 = -0.04$$
$$dy = +0.09276 \times 0.11240 \times 0.761856 \times 3.80875 = +0.03$$

Hence the final coordinates for Standard become,

$$x = 747{,}768.08$$
$$y = 1{,}141{,}902.43.$$

By comparison with the coordinates computed from the geodetic position, given in figure 31, we see that this x value is 0.03 foot larger and this y value 0.02 foot smaller than those given from the geodetic position. This is as close an agreement as could be expected from the nature of the case.

For station Jackson, the coordinates of which are computed from the geodetic position in figure 31, we have the following reduction:

$$\text{local } x = +10{,}743.14$$
$$\text{local } y = +8{,}877.87.$$

$$\text{Reduction to sea level} = -104$$
$$\text{Grid-factor reduction} = +70$$
$$\text{Total reduction} = -34$$

$$\frac{-34}{434} = -0.0783$$

$$\begin{array}{r} 1.0000 \\ -00783 \\ \hline 0.99999217 \end{array}$$

$$\text{local } x' = +10{,}743.056$$
$$\text{local } y' = +8{,}877.800$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	+10, 742. 35	+123. 25
$-y'\sin\theta$ and $+y'\cos\theta$	−101. 85	+8, 877. 22
Jackson	767, 684. 34	1, 162, 142. 88

$$y_2 = 1{,}162{,}142.88 \qquad x_2 = 767{,}684.34$$
$$y_1 = 1{,}153{,}142.41 \qquad x_1 = 757{,}043.84$$
$$\Delta y = +9{,}000.47 \qquad \Delta x = +10{,}640.50$$

$$2x_1' = +514{,}088$$
$$x_2' = +267{,}684$$
$$2x_1' + x_2' = +781{,}772$$

$$\Delta n = -9000 \times 781{,}772 \times 3.80875 \times 10^{-16}$$

$$dx = -0.09 \times 0.09 \times 0.782 \times 3.809 = -0.02$$
$$dy = +0.1064 \times 0.09 \times 0.782 \times 3.809 = +0.03$$

It will be noted that we have dropped the unnecessary figures in each of the factors after pointing off the places to take care of the factor 10^{-16}

When these corrections are applied we find the final coordinates for Jackson to be as follows:

$$x = 767{,}684.32$$
$$y = 1{,}162{,}142.91.$$

These values are +0.05 and −0.04 different from those resulting from the computation from the geodetic position. This difference is still what might be expected to result from the two different methods of handling the matter.

As a final example of stations for which we have geodetic positions, we shall take Mount Read north base. The result from the geodetic position is given in figure 31.

This is one of the stations that is a tie station for one of the traverses that has already been computed in the earlier part of this publication.

For station Mount Read north base,

local $x = -10{,}783.46$
local $y = +12{,}327.07$.

Reduction to sea level $= -104$
Grid reduction $= +43$

Total reduction $= -61$

$$\frac{-61}{434} = -0.1406$$

$$\begin{array}{r} 1.0000 \\ -01406 \\ \hline 0.99998594 \end{array}$$

local $x' = -10{,}783.308$
local $y' = +12{,}326.897$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'$ cos θ and $+x'$ sin θ	−10, 782. 60	−123. 71
$-y'$ sin θ and $+y'$ cos θ	−141. 42	+12, 326. 09
Mount Read north base	746, 119. 82	1, 165, 344. 79

$$y_2 = 1{,}165{,}344.79 \qquad x_2 = 746{,}119.82$$
$$y_1 = 1{,}153{,}142.41 \qquad x_1 = 757{,}043.84$$
$$\Delta y = +12{,}202.38 \qquad \Delta x = -10{,}924.02$$

$$2x_1' = +514{,}088$$
$$x_2' = +246{,}120$$
$$2x_1' + x_2' = +760{,}208$$

$$\Delta n = -12{,}202 \times 760{,}208 \times 3.80875 \times 10$$

$$dx = -0.122 \times 0.122 \times 0.760 \times 3.809 = -0.04$$
$$dy = -0.109 \times 0.122 \times 0.760 \times 3.809 = -0.04$$

When these corrections are applied, we get for the final coordinates of Mount Read north base,

$$x = 746{,}119.78$$
$$y = 1{,}165{,}344.75.$$

This result is 0.04 foot less in the x coordinate and 0.03 foot less in the y coordinate than the result obtained in figure 31. This is still no more than could be expected in the nature of the case.

Since all of the other stations to which ties were made in the C. W. A. work were ones for which only local coordinates were computed, it was deemed best to use the above values for the coordinates since they are better coordinated with the results for the other stations. As a whole the transformed coordinates of the local net are more consistent with the lengths and azimuths than are those resulting from the geodetic positions.

We shall now transform the local coordinates of the other stations that are needed for the C. W. A. ties. We shall first take the station Canal for which coordinates alone were computed in the Rochester city survey. For this first station, we shall give the complete computation but for the others that are to follow, we shall suppose that the preliminary computations of the x values to determine the scales have already been made. The correctness of the results can be verified from the final results that are given.

For station Canal,

$$\text{local } x = -10{,}808.33$$
$$\text{local } y = +9{,}855.60.$$

	x
Eastman	757, 043. 84
$+x$ cos θ	−10, 807. 62
$-y$ sin θ	−113. 07
Canal	746, 123. 15

Now in units of 1,000 feet, x_1' for Eastman is +257.0 and for Canal x_2' is +246.1. Therefore the mean x' for the line is $\frac{1}{2}(257.0+246.1)=+251.6$.

From the State table on page 91 (fig. 18), we find the correction for 250.0 to be +38.7. Now 1.6 thousands is 0.32 of 5,000 which is the tabular interval. The tabular difference is +12.5; 0.32×12.5=4.0; +38.7+4.0=+42.7 or +43 in the seventh place of decimals.

Reduction to sea level	= −104
Grid reduction	= +43
Total reduction	= −61

$$\frac{-61}{434}=-0.1406$$

$$\begin{array}{r} 1.0000 \\ -01406 \\ \hline 0.99998594 \end{array}$$

With this reduction factor, we find the values:

$$\text{local } x' = -10{,}808.178$$
$$\text{local } y' = +9{,}855.462.$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−10, 807. 47	−123. 99
$-y'\sin\theta$ and $+y'\cos\theta$	−113. 06	+9, 854. 81
Canal	746, 123. 31	1, 162, 873. 23

$$\begin{array}{ll} y_2 = 1{,}162{,}873.23 & x_2 = 746{,}123.31 \\ y_1 = 1{,}153{,}142.41 & x_1 = 757{,}043.84 \\ \hline \Delta y = +9{,}730.82 & \Delta x = -10{,}920.53 \end{array}$$

$$\begin{array}{ll} 2x_1' & = +514{,}088 \\ x_2' & = +246{,}123 \\ \hline 2x_1'+x_2' & = +760{,}211 \end{array}$$

$$\Delta n = -9{,}731 \times 760{,}211 \times 3.80875 \times 10^{-16}$$

$$dx = -0.0973 \times 0.0973 \times 0.7602 \times 3.8088 = -0.03$$
$$dy = -0.1092 \times 0.0973 \times 0.7602 \times 3.8088 = -0.03$$

With these corrections applied to the coordinates, we get the final values for Canal,

$$x = 746{,}123.28$$
$$y = 1{,}162{,}873.20.$$

These are the values that are used in the computation on page 17.

For the remaining stations that have to be transformed, we shall omit the preliminary computation of the approximate x and calculate the grid factor at once. Of course, in the first computation this work was carried out in full just as given in the computation for the station Canal above. Also, if any similar computations should be made by anyone, the station Canal should be used in all cases as a guide for the method to be followed. In the following computations, the value of x as given can be used to check up the correctness of the computations.

For station Rosalind, we have given

$$\text{local } x = -9{,}894.59$$
$$\text{local } y = -10{,}046.55.$$

$$x_1' = +257.0 \text{ (in thousands of feet)}$$
$$x_2' = +247.3$$
$$\text{mean } x' = +252.15$$

From the State table on page 91 (fig. 18),

correction for $+250.0 = +38.7$
and 2.15 thousands $= 0.43$ of 5,000

$$0.43 \times +12.5 = 5.4$$

$$+38.7 + 5.4 = +44.1$$

Reduction to sea level	$= -104$
Grid reduction	$= +44$
Total reduction	$= -60$

$$\frac{-60}{434} = -0.138$$

$$\begin{array}{r} 1.0000 \\ -0138 \\ \hline 0.9999862 \end{array}$$

With this reduction, we get

$$\text{local } x' = -9{,}894.453$$
$$\text{local } y' = -10{,}046.411.$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'$ cos θ and $+x'$ sin θ	−9, 893. 80	−113. 51
$-y'$ sin θ and $+y'$ cos θ	+115. 25	−10, 045. 75
Rosalind	747, 265. 29	1, 142, 983. 15

$$2x_1' = +514{,}088$$
$$x_2' = +247{,}265$$
$$2x_1' + x_2' = +761{,}353$$

To get Δx and Δy, take the algebraic sum of the two terms above; that is

$$x' \cos\theta = -9{,}893.80 \qquad x' \sin\theta = -113.51$$
$$-y' \sin\theta = +115.25 \qquad y' \cos\theta = -10{,}045.75$$
$$\Delta x = -9{,}778.55 \qquad \Delta y = -10{,}159.26$$

$$\Delta n = +10{,}159 \times 761{,}353 \times 3.80875 \times 10^{-16}$$

$$dx = -0.1016 \times 0.1016 \times 0.7614 \times 3.8088 = -0.03$$
$$dy = +0.0978 \times 0.1016 \times 0.7614 \times 3.8088 = +0.03$$

Hence the final values for Rosalind are

$$x = 747{,}265.26$$
$$y = 1{,}142{,}983.18.$$

For Penhurst, we have

$$\text{local } x = -10{,}652.46$$
$$\text{local } y = \quad -8{,}593.90.$$

$$x_1' = +257.0$$
$$x_2' = +246.5$$
$$\text{mean } x' = +251.75$$

From the table, the grid reduction for 251.75 is found to be +43. Sea-level reduction −104 gives the total reduction as −61. In the usual way this is found to give a grid factor of 0.99998594.

$$\text{Hence local } x' = -10{,}652.310$$
$$\text{and local } y' = \quad -8{,}593.779.$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	−10, 651. 61	−122. 21
$-y' \sin\theta$ and $+y' \cos\theta$	+98. 59	−8, 593. 21
Penhurst	746, 490. 82	1, 144, 426. 99

In the usual way we find

$$2x_1' + x_2' = +760{,}579$$
$$\Delta x = -10{,}553$$
$$\Delta y = -8{,}715$$

With these values, there results

$$\Delta n = +8{,}715 \times 760{,}579 \times 3.80875 \times 10^{-16}$$

$$dx = -0.087 \times 0.087 \times 0.761 \times 3.809 = -0.02$$
$$dy = +0.106 \times 0.087 \times 0.761 \times 3.809 = +0.03$$

With these corrections Penhurst has the coordinates:

$$x = \quad 746{,}490.80$$
$$y = 1{,}144{,}427.02.$$

We shall next reduce stations Farrel and Church which are needed for one of the C. W. A. traverses. Hereafter we shall merely give the results of some of the computations since we have already given enough detailed computations to serve as examples in all of the steps.

For station Farrel, we have

$$\text{local } x = + \quad 5{,}488.24 \qquad \text{sea level} = -104$$
$$\text{local } y = +29{,}072.29 \qquad \text{grid} = +63$$
$$\text{total} = -41$$

Resulting grid factor = 0.9999906.

$$\text{local } x' = \quad +5{,}488.19$$
$$\text{local } y' = +29{,}072.02.$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	+5, 487. 83	+62. 96
$-y' \sin\theta$ and $+y' \cos\theta$	−333. 52	+29, 070. 11
Farrel	762, 198. 15	1, 182, 275. 48

$$2x_1' + x_2' = +776{,}286, \quad \Delta x = +5{,}154, \quad \Delta y = +29{,}133$$

$$\Delta n = -29{,}133 \times 776{,}286 \times 3.80875 \times 10^{-16}$$

$$dx = -0.2913 \times 0.2913 \times 0.7763 \times 3.8088 = -0.25$$
$$dy = +0.0515 \times 0.2913 \times 0.7763 \times 3.8088 = +0.04$$

Final coordinates for Farrel,

$$x = 762{,}197.90$$
$$y = 1{,}182{,}275.52.$$

For station Church, we have given

local $x = +5{,}628.33$
local $y = +31{,}081.90$

sea level $= -104$
grid $= +63$
total $= -41$

Grid reduction factor=0.9999906 as for Farrel.

local $x' = +5{,}628.28$
local $y' = +31{,}081.61$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	+5, 627. 91	+64. 57
$-y' \sin\theta$ and $+y' \cos\theta$	−356. 57	+31, 079. 56
Church	762, 315. 18	1, 184, 286. 54

$$2x_1' + x_2' = +776{,}403, \quad \Delta x = +5{,}271, \quad \Delta y = +31{,}144$$

$$\Delta n = -31{,}144 \times 776{,}403 \times 3.80875 \times 10^{-16}$$

$$dx = -0.3114 \times 0.3114 \times 0.7764 \times 3.8088 = -0.29$$
$$dy = +0.0527 \times 0.3114 \times 0.7764 \times 3.8088 = +0.05$$

Final coordinates of Church,

$$x = 762{,}314.89$$
$$y = 1{,}184{,}286.59.$$

Next we take Ridge and Nearpipe. For Ridge, we have given

local $x = +15{,}407.16$
local $y = +15{,}511.48$

sea level $= -104$
grid $= +76$
total $= -28$

Grid factor=0.9999936.

local $x' = +15{,}407.06$
local $y' = +15{,}511.38$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	+15, 406. 05	+176. 75
$-y' \sin\theta$ and $+y' \cos\theta$	−177. 95	+15, 510. 36
Ridge	772, 271. 94	1, 168, 829. 52

$$2x_1' + x_2' = +786{,}360, \quad \Delta x = +15{,}228, \quad \Delta y = +15{,}687$$

$$\Delta n = -15{,}687 \times 786{,}360 \times 3.80875 \times 10^{-16}$$

$$dx = -0.1569 \times 0.1569 \times 0.7864 \times 3.8088 = -0.07$$
$$dy = +0.1523 \times 0.1569 \times 0.7864 \times 3.8088 = +0.07$$

With these corrections, we have for Ridge,

$$x = 772{,}271.87$$
$$y = 1{,}168{,}829.59.$$

For Nearpipe, we have given

local $x = +15{,}546.89$ sea level $= -104$
local $y = +12{,}597.85$ grid $= +76$

total $= -28$

Grid factor is same as for Ridge, 0.9999936.

local $x' = +15{,}546.79$
local $y' = +12{,}597.77$

	x	y
Eastman	757,043.84	1,153,142.41
$+x'\cos\theta$ and $+x'\sin\theta$	+15,545.77	+178.36
$-y'\sin\theta$ and $+y'\cos\theta$	−144.52	+12,596.94
Nearpipe	772,445.09	1,165,917.71

$$2x_1' + x_2' = +786{,}533,\ \Delta x = +15{,}401,\ \Delta y = +12{,}775$$

$$\Delta n = -12{,}775 \times 786{,}533 \times 3.80875 \times 10^{-16}$$

$$dx = -0.1278 \times 0.1278 \times 0.7865 \times 3.8088 = -0.05$$
$$dy = +0.1540 \times 0.1278 \times 0.7865 \times 3.8088 = +0.06$$

Hence the final coordinates of Nearpipe are:

$$x = 772{,}445.04$$
$$y = 1{,}165{,}917.77.$$

We shall next transform Twelve Corners and Peck. For Twelve Corners, we are given the coordinates:

local $x = +14{,}444.19$ sea level $= -104$
local $y = -12{,}376.75$ grid $= +75$

total $= -29$

Grid factor $= 0.9999933$.

local $x' = +14{,}444.09$
local $y' = -12{,}376.67$

	x	y
Eastman	757,043.84	1,153,142.41
$+x'\cos\theta$ and $+x'\sin\theta$	+14,443.14	+165.71
$-y'\sin\theta$ and $+y'\cos\theta$	+141.99	−12,375.86
Twelve Corners	771,628.97	1,140,932.26

$$2x_1' + x_2' = +785{,}717,\ \Delta x = +14{,}585,\ \Delta y = -12{,}210$$

$$\Delta n = +12{,}210 \times 785{,}717 \times 3.80875 \times 10^{-16}$$

$$dx = -0.122 \times 0.122 \times 0.786 \times 3.809 = -0.04$$
$$dy = -0.146 \times 0.122 \times 0.786 \times 3.809 = -0.05$$

Final coordinates for Twelve Corners:

$$x = 771{,}628.93$$
$$y = 1{,}140{,}932.21.$$

For Peck, we have

local $x = +15{,}189.62$
local $y = -10{,}488.18$

sea level $= -104$
grid $= +76$
total $= -28$

Grid factor $= 0.9999936$.

local $x' = +15{,}189.52$
local $y' = -10{,}488.11$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	+15, 188. 52	+174. 26
$-y'\sin\theta$ and $+y'\cos\theta$	+120. 32	−10, 487. 42
Peck	772, 352. 68	1, 142, 829. 25

$$2x_1'+x_2' = +786{,}441,\ \Delta x = +15{,}309,\ \Delta y = -10{,}313$$

$$\Delta n = +10{,}313\times 786{,}441\times 3.80875\times 10^{-16}$$

$$dx = -0.103\times 0.103\times 0.786\times 3.809 = -0.03$$
$$dy = -0.153\times 0.103\times 0.786\times 3.809 = -0.05$$

With these corrections, we get the final coordinates for Peck to be:

$$x = 772{,}352.65$$
$$y = 1{,}142{,}829.20.$$

We next transform Medicine and Mount Hope. For Medicine, we find from the list:

local $x = -1{,}878.46$
local $y = -13{,}264.99$

sea level $= -104$
grid $= +54$
total $= -50$

Grid factor $= 0.9999885$.

local $x' = -1{,}878.44$
local $y' = -13{,}264.84$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−1, 878. 32	−21. 55
$-y'\sin\theta$ and $+y'\cos\theta$	+152. 18	−13, 263. 97
Medicine	755, 317. 70	1, 139, 856. 89

$$2x_1'+x_2' = +769{,}406,\ \Delta x = -1{,}726,\ \Delta y = -13{,}285$$

$$\Delta n = +13{,}285\times 769{,}406\times 3.80875\times 10^{-16}$$

$$dx = -0.133\times 0.133\times 0.769\times 3.809 = -0.05$$
$$dy = +0.017\times 0.133\times 0.769\times 3.809 = +0.01$$

These corrections give for final coordinates of Medicine:

$$x = 755{,}317.65$$
$$y = 1{,}139{,}856.90.$$

For Mount Hope the list gives:

local $x=$	$+213.16$	sea level	$=-104$
local $y=$	$-13,162.50$	grid	$=+57$
		total	$=-47$

Grid factor = 0. 9999892.

local $x'= +213.16$
local $y'= -13,162.36$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	+213. 15	+2. 45
$-y'\sin\theta$ and $+y'\cos\theta$	+151. 00	−13, 161. 49
Mount Hope	757, 407. 99	1, 139, 983. 37

$$2x_1'+x_2'=+771,496,\ \Delta x=+364,\ \Delta y=-13,159$$

$$\Delta n=+13,159\times 771,496\times 3.80875\times 10^{-16}$$

$$dx=-0.132\times 0.132\times 0.771\times 3.809=-0.05$$
$$dy=-0.004\times 0.132\times 0.771\times 3.809=-0.00$$

Hence the final coordinates of Mount Hope are:

$x=757,407.94$
$y=1,139,983.37.$

Stations Flower and Bonesteel are the next to be transformed For Flower, we are given:

local $x=$	$-6,324.63$	sea level	$=-104$
local $y=$	$+15,095.87$	grid	$=+48$
		total	$=-56$

Grid factor = 0.9999871.

local $x'= -6,324.55$
local $y'= +15,095.68$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−6, 324. 13	−72. 56
$-y'\sin\theta$ and $+y'\cos\theta$	−173. 18	+15, 094. 69
Flower	750, 546. 53	1, 168, 164. 54

$$2x_1'+x_2'=+764,634,\ \Delta x=-6,497,\ \Delta y=+15,022$$

$$\Delta n=-15,022\times 764,634\times 3.80875\times 10^{-16}$$

$$dx=-0.150\times 0.150\times 0.765\times 3.809=-0.07$$
$$dy=-0.065\times 0.150\times 0.765\times 3.809=-0.03$$

Hence the final coordinates of Flower are:

$x=750,546.46$
$y=1,168,164.51.$

For the station Bonesteel, the coordinates are:

local $x = -8{,}501.80$ sea level $= -104$
local $y = +15{,}508.16$ grid $= +45$

total $= -59$

Grid factor = 0.9999864.

local $x' = -8{,}501.68$
local $y' = +15{,}507.95$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	−8, 501. 12	−97. 53
$-y' \sin\theta$ and $+y' \cos\theta$	−177. 91	+15, 506. 93
Bonesteel	748, 364. 81	1, 168, 551. 81

$$2x_1' + x_2' = +762{,}453, \ \Delta x = -8{,}679, \ \Delta y = +15{,}409$$

$$\Delta n = -15{,}409 \times 762{,}453 \times 3.80875 \times 10^{-16}$$

$$dx = -0.154 \times 0.154 \times 0.762 \times 3.809 = -0.07$$
$$dy = -0.087 \times 0.154 \times 0.762 \times 3.809 = -0.04$$

Hence the final coordinates for Bonesteel are:

$x = 748{,}364.74$
$y = 1{,}168{,}551.77.$

As further examples, we shall transform the stations River and Stutson. For River, we have given:

local $x = +1{,}880.58$ sea level $= -104$
local $y = +32{,}391.49$ grid $= +58$

total $= -46$

Grid factor = 0.9999894.

local $x' = +1{,}880.56$
local $y' = +32{,}391.15$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	+1, 880. 44	+21. 57
$-y' \sin\theta$ and $+y' \cos\theta$	−371. 60	+32, 389. 02
River	758, 552. 68	1, 185, 553. 00

$$2x_1' + x_2' = +772{,}641, \ \Delta x = +1{,}509, \ \Delta y = +32{,}411$$

$$\Delta n = -32{,}411 \times 772{,}641 \times 3.80875 \times 10^{-16}$$

$$dx = -0.324 \times 0.324 \times 0.773 \times 3.809 = -0.31$$
$$dy = +0.015 \times 0.324 \times 0.773 \times 3.809 = +0.01$$

With these corrections, the final coordinates of River become:

$x = 758{,}552.37$
$y = 1{,}185{,}553.01.$

For the station Stutson, we have

local $x = -162.73$
local $y = +33{,}432.49$

sea level $= -104$
grid $= +56$
total $= -48$

Grid factor = 0.9999889.

local $x' = -162.73$
local $y' = +33{,}432.12$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−162. 72	−1. 87
$-y'\sin\theta$ and $+y'\cos\theta$	−383. 54	+33, 429. 92
Stutson	756, 497. 58	1, 186, 570. 46

$$2x_1'+x_2'=+770{,}586,\ \Delta x=-546,\ \Delta y=+33{,}428$$

$$\Delta n=-33{,}428\times 770{,}586\times 3.80875\times 10^{-16}$$

$$dx=-0.334\times 0.334\times 0.771\times 3.809=-0.33$$
$$dy=-0.005\times 0.334\times 0.771\times 3.809=-0.00$$

Hence the final coordinates for Stutson are:

$x = 756{,}497.25$
$y = 1{,}186{,}570.46.$

As final examples, we shall transform the stations Boulevard and Whelehan. For Boulevard, we have

local $x = -10{,}524.81$
local $y = +33{,}573.00$

sea level $= -104$
grid $= +43$
total $= -61$

Grid factor = 0.9999860.

local $x' = -10{,}524.66$
local $y' = +33{,}572.53$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x'\cos\theta$ and $+x'\sin\theta$	−10, 523. 97	−120. 74
$-y'\sin\theta$ and $+y'\cos\theta$	−385. 15	+33, 570. 32
Boulevard	746, 134. 72	1, 186, 591. 99

$$2x_1'+x_2'=+760{,}223,\ \Delta x=-10{,}909,\ \Delta y=+33{,}450$$

$$\Delta n=-33{,}450\times 760{,}223\times 3.80875\times 10^{-16}$$

$$dx=-0.3345\times 0.3345\times 0.7602\times 3.8088=-0.32$$
$$dy=-0.1091\times 0.3345\times 0.7602\times 3.8088=-0.11$$

With these corrections, the final coordinates of Boulevard become:

$x = 746{,}134.40$
$y = 1{,}186{,}591.88.$

620745 O - 44 - 13

For the station Whelehan, we have

$$\text{local } x = -10{,}501.69 \qquad \text{sea level} = -104$$
$$\text{local } y = +31{,}366.40 \qquad \text{grid} = +43$$
$$\text{total} = -61$$

$$\text{Grid factor} = 0.9999860.$$

$$\text{local } x' = -10{,}501.54$$
$$\text{local } y' = +31{,}365.96$$

	x	y
Eastman	757, 043. 84	1, 153, 142. 41
$+x' \cos\theta$ and $+x' \sin\theta$	−10, 500. 85	−120. 48
$-y' \sin\theta$ and $+y' \cos\theta$	−359. 84	+31, 363. 90
Whelehan	746, 183. 15	1, 184, 385. 83

$$2x_1' + x_2' = +760{,}271, \quad \Delta x = -10{,}861, \quad \Delta y = +31{,}243$$

$$\Delta n = -31{,}243 \times 760{,}271 \times 3.80875 \times 10^{-16}$$

$$dx = -0.3124 \times 0.3124 \times 0.7603 \times 3.8088 = -0.28$$
$$dy = -0.1086 \times 0.3124 \times 0.7603 \times 3.8088 = -0.10$$

The final coordinates of Whelehan therefore become:

$$x = 746{,}182.87$$
$$y = 1{,}184{,}385.73.$$

A rather large number of stations have been transformed in this section but it was done because they were needed in the adjustment of the C. W. A. traverses that depend upon them. In course of time all of the Rochester city work should be reduced to the State grid for general control in that region.

As a general thing in transforming a local system, there are two features that appeared here that would not have to be considered. The addition of the angle 6″.15 to the angle θ due to the recomputation of the geodetic positions would in most cases not be present, and the reduction to sea level would also be absent unless the local coordinates were computed without reference to elevation. If it is a ground-surface computation, then a mean elevation should be determined and the proper reduction should be applied just as was done in this case. All geodetic work is based on sea-level lengths, and any work that is to be coordinated with geodetic control should also be reduced to sea level.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York (West) Station Pinnacle

		λ (Central meridian)	78° 35′ 00″.000
φ 43° 08′ 06″.327		λ	77 35 09.602
		Δλ (Central meridian−λ)	+ 0 59 50.398
		Δλ (in sec.)	+3590″.398

log Δλ	3.55514260	log S_m^2	9.818529
Cor. arc to sine	− 2193	log C*	1.375901 (67 written above) − 10
log $\Delta\lambda_1$	3.55512067	log Δφ	1.194430 (96 written above)
log cos φ	9.86317034 − 10		
colog A	1.49096162	φ	43° 08′ 06″.327
log S_1	4.90925263	Δφ	+ 15.6470 (93 written above)
Cor. sine to arc	+ 1168	φ′	43 08 21.9740 (63 written above)
log S_m	4.90926431		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23850
log R	− 2714		
log S_g	5.42522134	y (for min. of φ′)	1,141,652.98
log S_g^3	16.2756640	y (for seconds of φ′)	+ 2,224.85
log $1/6\rho_o^2R^2$	4.5807825−20	y	1,143,877.83
log $(S_g^3/6\rho_o^2)_g$	0.8564465		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+266,208.143	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 7.185	log $\Delta\alpha_1$	
x′	+266,215.33		
	500,000.00	log $(\Delta\lambda)^3$	
x	766,215.33	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′.

FIGURE 31.—Computation of coordinates for New York.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York - West Station Standard

	λ (Central meridian)	78°	35'	00".000
φ 43° 07' 48".911	λ	77	39	18.659
	Δλ (Central meridian-λ)	+ 0	55	41.341
	Δλ (in sec.)	+3341".341		

log Δλ	3.52392080	log S_m^2	9.756156
Cor. arc to sine	− 1899	log C*	85 1.3758~~29~~-10
log $Δλ_1$	3.52390181	log Δφ	1.131~~985~~ 2041
log cos φ	9.86320469-10		
colog A	1.49096149	φ	43° 07' 48".911
log S_1	4.87806799	Δφ	32 + 13.55~~14~~
Cor. sine to arc	+ 1012	φ'	43 08 02.46~~24~~ 42
log S_m	4.87807811		
log 3937/1200	0.51598417	Tabular difference of y for 1" of φ'	101.23850
log R	− 2714		
log S_g	5.39403514	y (for min. of φ')	1,141,652.98
log S_g^3	16.1821054	y (for seconds of φ')	+ 249.47
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,141,902.45
log $(S_g^3/6\rho_o^2)_g$	0.7628879		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+247,762.253	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 5.793	log $Δα_1$	
x'	+247,768.05		
	500,000.00	log $(Δλ)^3$	
x	747,768.05	log F	
		log b	
		$Δα_1$	"
		b	
		Δα	"
		Δα	° "

* Take out C first for φ and correct for approximate φ'.

(A-340)

FIGURE 31.—Computation of coordinates for New York—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York-West Station Jackson

	λ (Central meridian)	78° 35′ 00.000
φ 43° 11′ 06.542″	λ	77 34 46.842
	Δλ (Central meridian−λ)	+ 1 00 13.158
	Δλ (in sec.)	+ 3613.158″

log Δλ	3.55788695	log S_m^2	9.823308
Cor. arc to sine	− 2221	log C*	723 1.376~~656~~-10
log $\Delta\lambda_1$	3.55786474	log Δφ	1.~~199964~~ 200031
log cos φ	9.86281451-10		
colog A	1.49096291	φ	43° 11′ 06.542″
log S_1	4.91164216	Δφ	+ 15.8~~476~~ 501
Cor. sine to arc	+ 1181	φ′	43 11 22.3~~896~~ 921
log S_m	4.91165397		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23950
log R	− 2714		
log S_g	4.42761100	y (for min. of φ′)	1,159,875.98
log S_g^3	16.2828330	y (for seconds of φ′)	+ 2,266.97
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,162,142.95
log $(S_g^3/6\rho_o^2)_g$	0.8636155		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+267,676.967	log Δλ	
$-(S_g^3/6\rho_o^2)_g$	+ 7.305	log $\Delta\alpha_1$	
x′	+267,684.27		
	500,000.00	log $(\Delta\lambda)^3$	
x	767,684.27	log F	
		log b	
		$\Delta\alpha_1$	″
		b	
		Δα	″
		Δα	° ′ ″

* Take out C first for φ and correct for approximate φ′

FIGURE 31.—Computation of coordinates for New York—Continued.

PLANE COORDINATES ON TRANSVERSE MERCATOR PROJECTION

State New York -West Station Mt. Read North Base

	λ (Central meridian)	78° 35′ 00.000
φ 43° 11′ 40.615″	λ	77 39 37.400
	Δλ (Central meridian−λ)	+ 0 55 22.600
	Δλ (in sec.)	+3322.600″

log Δλ	3.52147806	log S_m^2	9.750359 855
Cor. arc to sine	− 1878	log C*	1.376~~799~~-10
log $\Delta\lambda_1$	3.52145928	log Δφ	1.127~~158~~ 214
log cos φ	9.86274716-10		
colog A	1.49096314	φ	43° 11 40.615″
log S_1	4.87516958	Δφ	+ 13.40~~16~~ 34
Cor. sine to arc	+ 998	φ′	43 11 54.01~~66~~ 84
log S_m	4.87517956		
log 3937/1200	0.51598417	Tabular difference of y for 1″ of φ′	101.23950
log R	− 2714		
log S_g	5.39113659	y (for min. of φ′)	1,159,875.98
log S_g^3	16.1734098	y (for seconds of φ′)	+ 5,468.80
log $1/6\rho_o^2R^2$	4.5807825-20	y	1,165,344.78
log $(S_g^3/6\rho_o^2)_g$	0.7531923		
		log sin $\frac{\phi+\phi'}{2}$	
S_g	+246,114.153	log Δλ	
$(S_g^3/6\rho_o^2)_g$	+ 5.665	log $\Delta\alpha_1$	
x′	+246,119.82		
	500,000.00	log $(\Delta\lambda)^3$	
x	746,119.82	log F	
		log b	
		$\Delta\alpha_1$	
		b	
		Δα	
		Δα	

* Take out C first for φ and correct for approximate φ′.

FIGURE 31.—Computation of coordinates for New York—Continued.

INDEX

(CUT ON THIS LINE)

PUBLICATION NOTICES

To make immediately available the results of its various activities to those interested, the Coast and Geodetic Survey maintains mailing lists of persons and firms desiring to receive notice of the issuance of charts, Coast Pilots, maps, and other publications.

Should you desire to receive such notices, you may use the form given below, checking the lists covering the subjects in which you are interested.

(Date)........................

DIRECTOR, U. S. COAST AND GEODETIC SURVEY,
Washington, D. C.

DEAR SIR: I desire that my name be placed on the mailing lists indicated by check below, to receive notification of the issuance of publications referring to the subjects indicated:

- ☐ 109. Astronomical work.
- ☐ 109–A. Base lines.
- ☐ 109–B. Coast Pilots.
- ☐ 109–C. Currents.
- ☐ 109–D. Geodesy.
- ☐ 109–E. Gravity.
- ☐ 109–F. Hydrography.
- ☐ 109–G. Leveling.
- ☐ 109–H. Nautical charts.
- ☐ 109–I. Oceanography.
- ☐ 109–J. Traverse.
- ☐ 109–K. Seismology.
- ☐ 109–L. Terrestrial magnetism.
- ☐ 109–M. Tides.
- ☐ 109–N. Topography.
- ☐ 109–O. Triangulation.
- ☐ 109–P. Cartography.
- ☐ 109–R. Airway maps.

(Name)............................

(Address)............................

A catalog of the publications issued by all bureaus of the Department of Commerce may be had upon application to the Chief, Division of Publications, Department of Commerce, Washington, D. C. It also contains a list of libraries located in various cities throughout the United States, designated by Congress as public depositories, where all publications printed by the Government for public distribution may be consulted.

O