THESIS

MICHIGAN

AGRICULTURAL COLLEGE

CAMPUS TOPOGRAPHY

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By

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THESIS

TABLE OF CONTENTS.

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INTRODUCTION

A topographical survey, if based on a system of triangulation, is mapped by first plotting the triangulation points. If the area is small, the convergence of the meridians may be neglected and the triangulation points plotted by means of their rectangular coordinates. The drawing for this purpose is ruled off into large squares.

The topography includes the shape of the ground and the location of all objects such as houses, walls, fences, water courses, catchbasins, trees, manholes, edges of travelled ways, poles, hydrants, monuments, and in fact, any object that occurs within the limits of the survey.

This thesis deals with the extension of the topographical survey of the M. A. C. Campus which includes completing a secondary traverse control and adjusting between known points, and the taking of topography by means of the plane table.

APPARATUS USED

I. Instruments:

 1. Transit, reading to 30"

 2. Plane Table, tripod, telescopic and sight alidade.

 3. Wye level.

II. Flags or range poles.

III. Tapes: 100' standard steel tape.

 100' standard metallic tape.

THE PRELIMINARY WORK

From triangulation data previously completed, witnesses and descriptions of the following triangulation points were obtained: 9, 11, k, j, i, h, FO1, FO2, q, r, s, t, u, x, CXN5, CXN6, CXN7, GP1 and GP2. In each case, the point was located, the witnesses verified or corrected (See page 10). with the exception of the point "q". From the witnesses and descriptions given for this point, nothing was discovered, no doubt due to the fact that the field in which said point was supposedly located had been recently plowed and several trees in the vicinity removed. Another point "q" was established for this particular survey.

THE TRAVERSE

A traverse is run with a transit by setting up the instrument over the intersection of the sides of the traverse and measuring the angles at the intersection or by orienting on a given point and measuring the azimuth of the forward line. The side lengths or distances from point to point are measured with the tape. If a traverse is laid out so that the point of ending is coincident with the point of beginning, it is called a closed traverse.

In any case, if the point of ending is not coincident with the point of beginning, there is an error of closure. Since, in our case the traverse work was laid out with transit and tape, the error is due more to the measurements with the tape than to angular measurements. The error is therefore distributed throughout the various sides forming the traverse so that only the lengths will be corrected. The traverse is referenced to two coordinate axes at right angles to each other. One of the axes may be a meridian or a line in the traverse. This traverse was referenced to the base line of the Campus triangulation system. The projection of any line in a traverse on the meridian axis is called its latitude; its projection on the other axis is called its departure. The rule for distributing the error of closure is as follows: The correction in latitude or departure of any course is to the total error in latitude or departure as the latitude or departure of the course is to the arithmetical sum of the latitudes or departures..

As has been said, one of the axes may be a meridian line. Distances measured along the meridian axis are known as ordinates or "y" distances and the distances along the other axis as abscissas or "x" distances. It is well to choose the base axes so that there will be no negative values for the coordinates of any point. The coordinates of an unknown point can be calculated from those of a known point if the angle and distance to the unknown point from the known point are measured.

Check traverses were run from CXN6 to CXN7 by orienting on GP1, the azimuth of which was determined from coordinates given us; also from CXN6 to FO1, from FO1 to CXN5, h, 9, and FO2, from FO2 to x, j, 11, and i.

A closed traverse was run beginning at CXN6 and orienting as before, through points r, q, s, t, u, CP2, GP1, and CXN6. The error of closure in degrees was 0 1' 12" which was distributed in proportion to the distance between the respective points. From the field data obtained, the x and y coordinates were computed (see computations page 19). The error due to unavoidable causes in the x coordinates amounted to .25' while that of the y coordinates was 0.06'. The true azimuths of all points was then computed from the corrected coordinates for each point.

The elevation of each triangulation point was determined by precise leveling. Precise leveling differs from the ordinary leveling in the instruments employed and the care and refinement used in doing the work. The level may be either of the wye or dumpy type, the former type being used on this survey. The allowable error in this class of work according to the U. S. Coast and Geodetic Survey is 0.016 feet per mile. Since the distance around our traverse was 2782 feet, our allowable error is 0.008 feet. However, our actual error was 0.001 feet. The elevations of the triangulation points of this traverse as determined by the above method of leveling are found in the notes on page 17.

TOPOGRAPHY

There are three general methods of taking topography, namely, transit and tape topographical survey, sight alidade plane table survey, and telescopic alidade plane table survey.

In taking flat topography, which included the location of all objects such as houses, walls, fences, watercourses, catch basins, trees, monuments, edges of the travelled ways, poles, hydrants, manholes, and in fact any object that occurred within the limits of the survey, both the telescopic and the sight alidade were used. However, the sight alidade proved to be much better adapted for this class of work because of the greater ease and rapidity of locating objects through the sights.

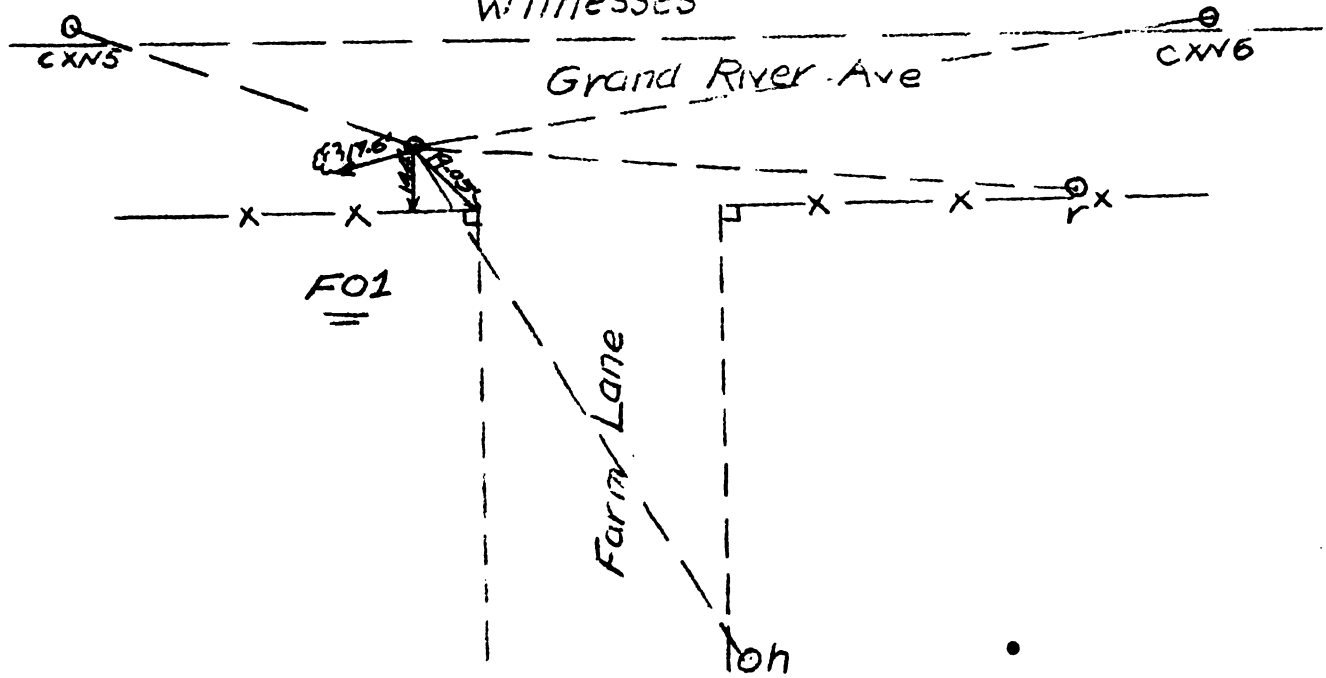
The method pursued in the taking of the flat topography was as follows: A sheet of drawing paper known as a unit sheet, upon which were plotted two or more of the known control points, was attached to the board, which was mounted on a tripod. Each unit sheet was ruled into one inch squares containing 2500 square feet of area, that is, 1" = 50'. The sheets were made continuous by numbering every one hundred foot division consecutively from the base axes. The control points were then plotted on these sheets from the coordinates previously determined by the traverse. The tripod and board was set over one of the plotted control points and the board levelled and oriented. In order to explain this method clearly an example will be worked out in detail. Refer to page 20 and consider the plane table as set up over tri-

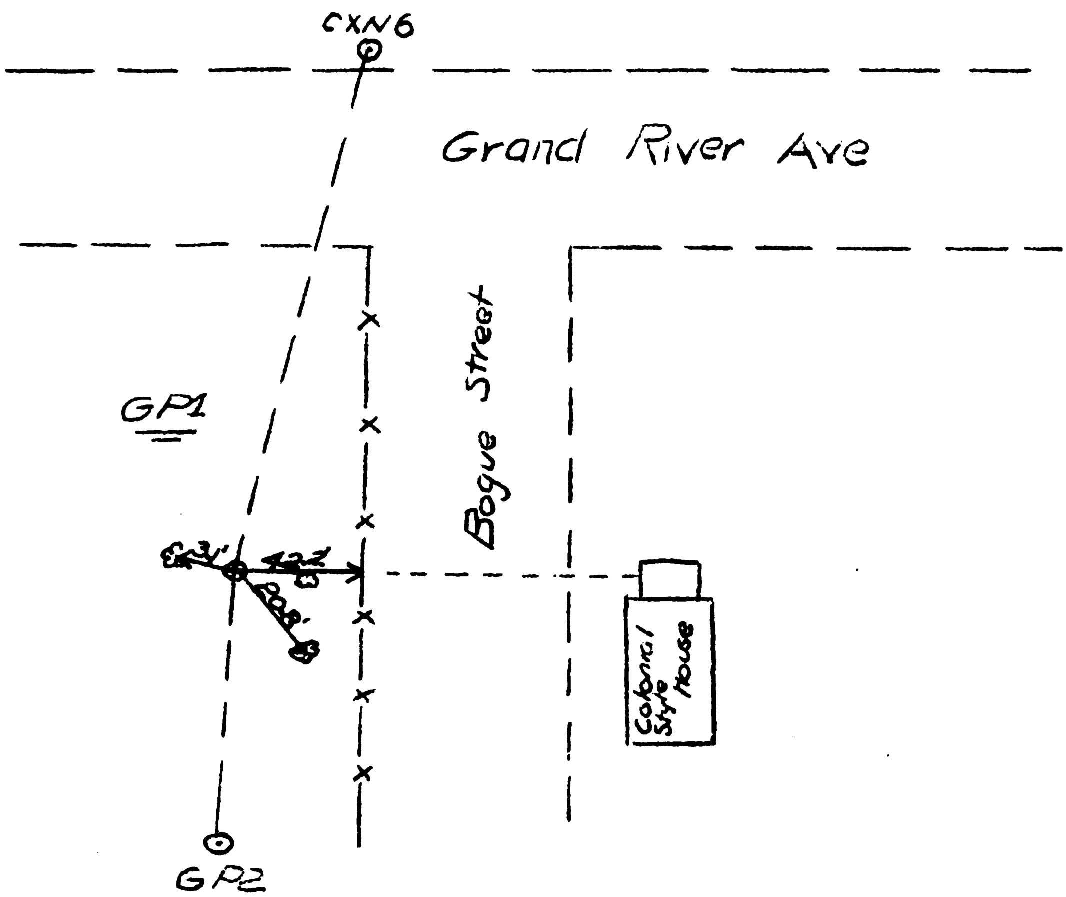
angulation point A. To orient bring the edge of the ruler of the alidade in coincidence with the line AC, which joins triangulation point A with triangulation point C, and move the plane table board horizontally about its vertical axis until triangulation point C on the ground is sighted. Clamp the board in this position. The board may be oriented in this manner by sighting on any accessible control point such as B. The objects can now be located by the intersection method. To locate the house in this example the corners m, n, and o are sighted and the lines Am, An, and Ao, respectively, are drawn approximately greater in length than the actual distance to the object. In like manner, the lines from A to objects within the scope of the instrument, such as Ay, Ax, and Az are drawn. The next step is the selection of a sub-station such as 1 from which most of the above points can be seen. To locate station 1 on the map the alidade is sighted on 1 and the line of sight A1 is drawn. The distance from A to 1 is measured on the ground and the corresponding distance is laid off to scale from A along the line A1. This definitely locates Sta 1. The board is then set up over Sta 1, levelled and oriented as explained above, using point A as a backsight. The points y, n, x, o, and z are then sighted and the lines 1y, 1n, 1x, 1o, and 1z respectively drawn on the sheet. Each point is located definitely by the intersection of the corresponding lines from Sta A and Sta 1 to the point. In a like manner as many substations as are necessary are established in order to completely locate all the objects on the sheet.

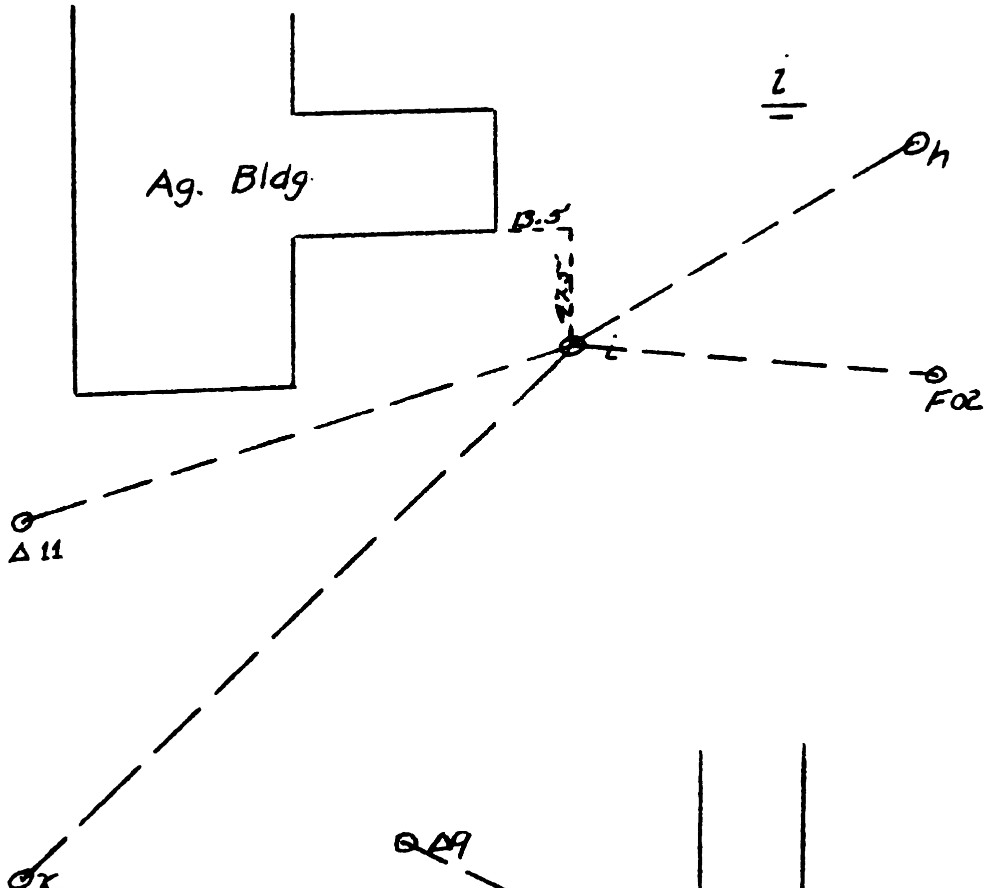
CONCLUSION.

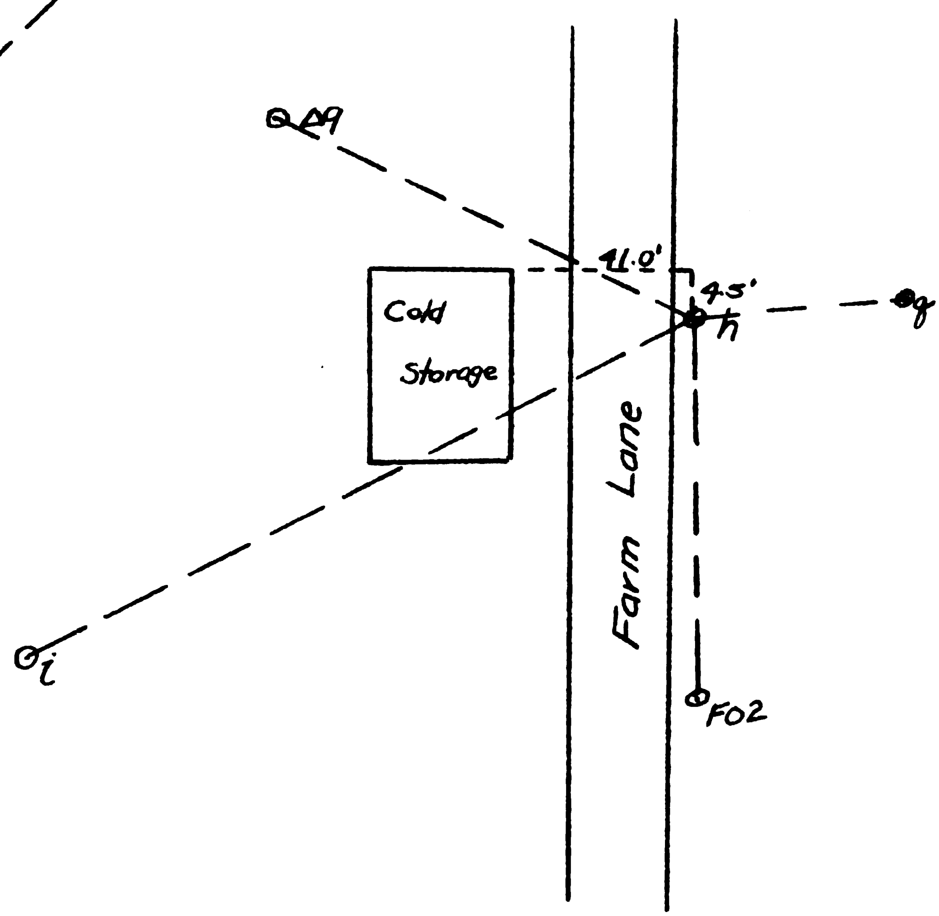
The information obtained from this plane table survey shows that the sight alidade is best adapted for this particular class of work. When the objects to be located are so situated that well defined intersections of the lines of sight from two or more setups are obtainable, one topographer is all that is required. However, in locating objects or buildings which are very close to each other, and angling roads, paths and streams, two topographers are required, one to chain distances and the other to plot the points. Of course, one topographer could do this alone but greater speed is obtained with a party of two.

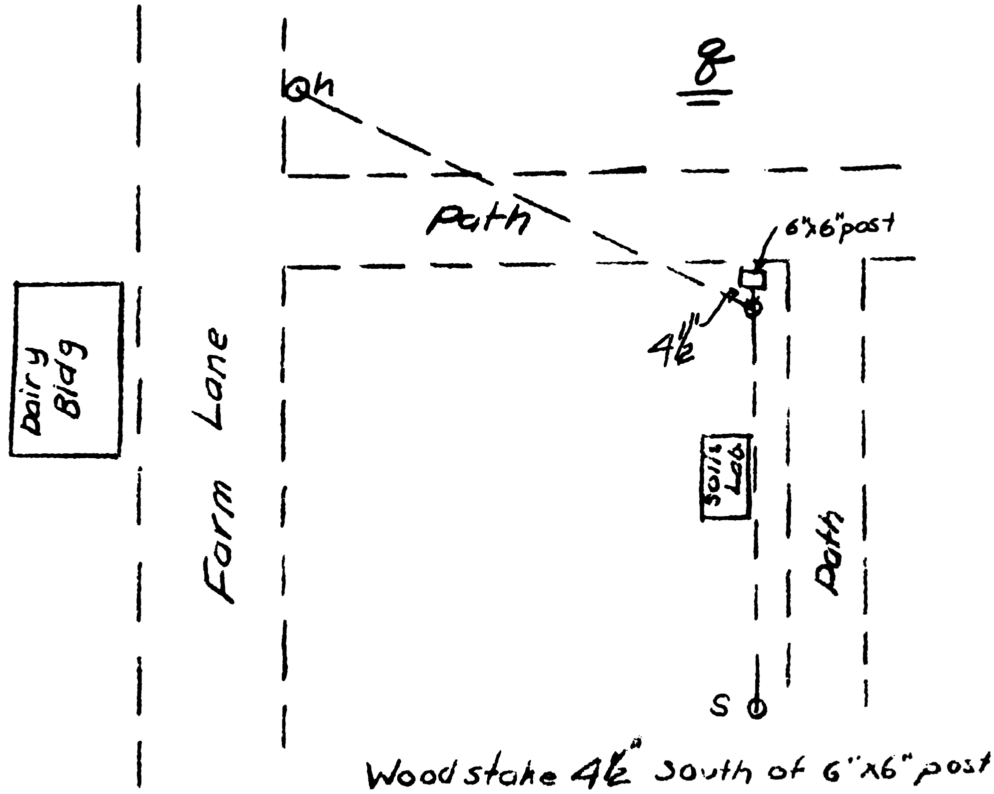
Witnesses

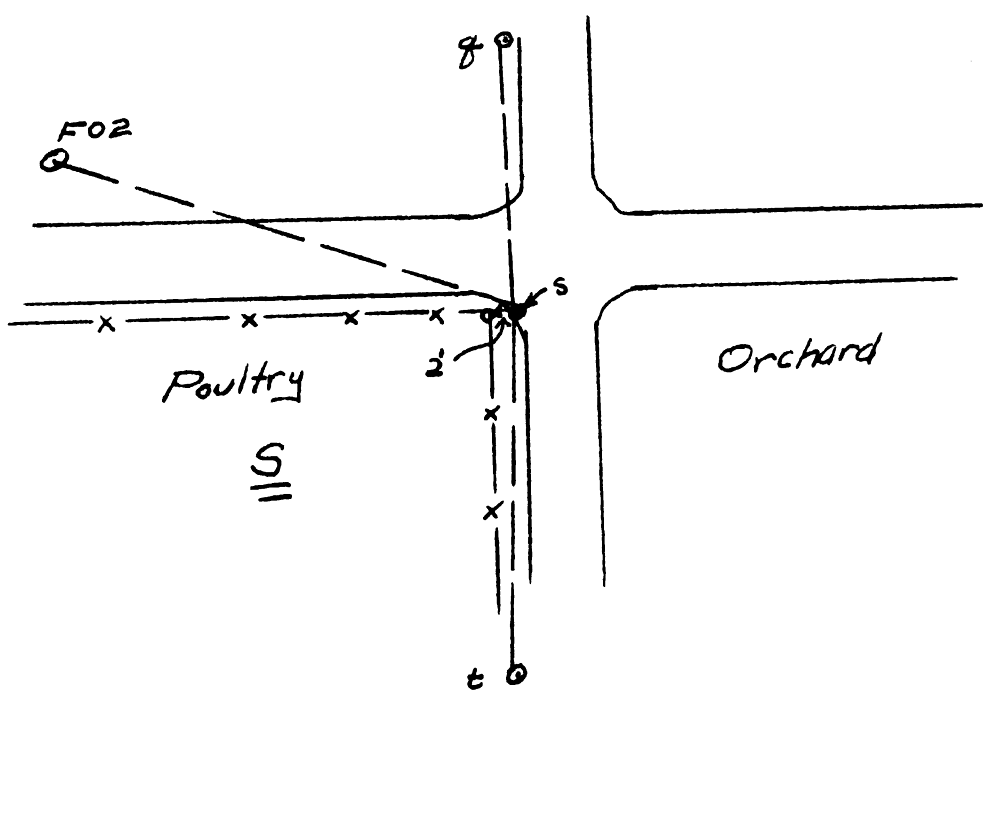

CXN5
CXN6
Grand River Ave
FO1
Farm Lane
r
oh

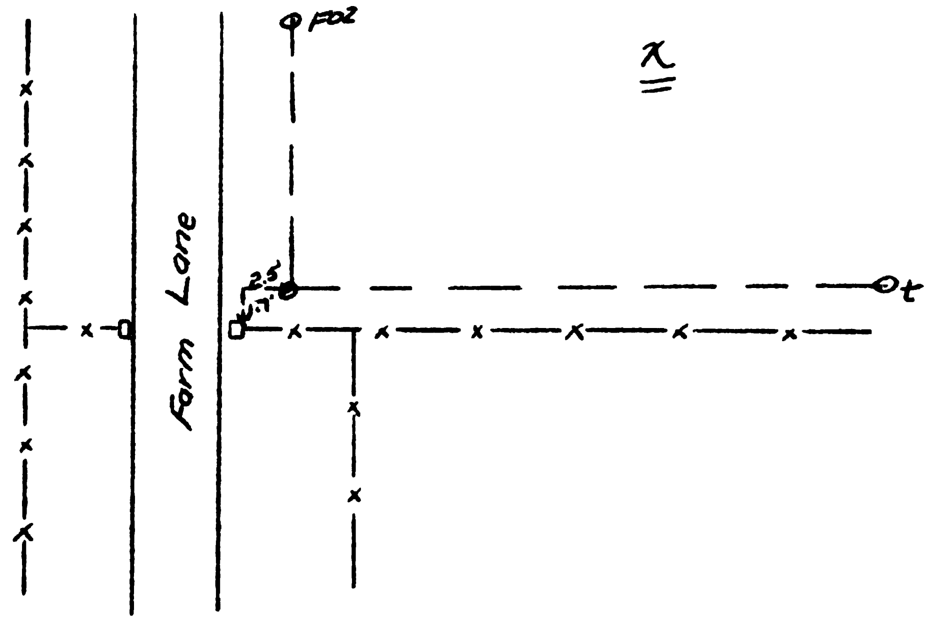

CXN6
Grand River Ave
GP1
Bogue Street
Colonial Style House
GP2

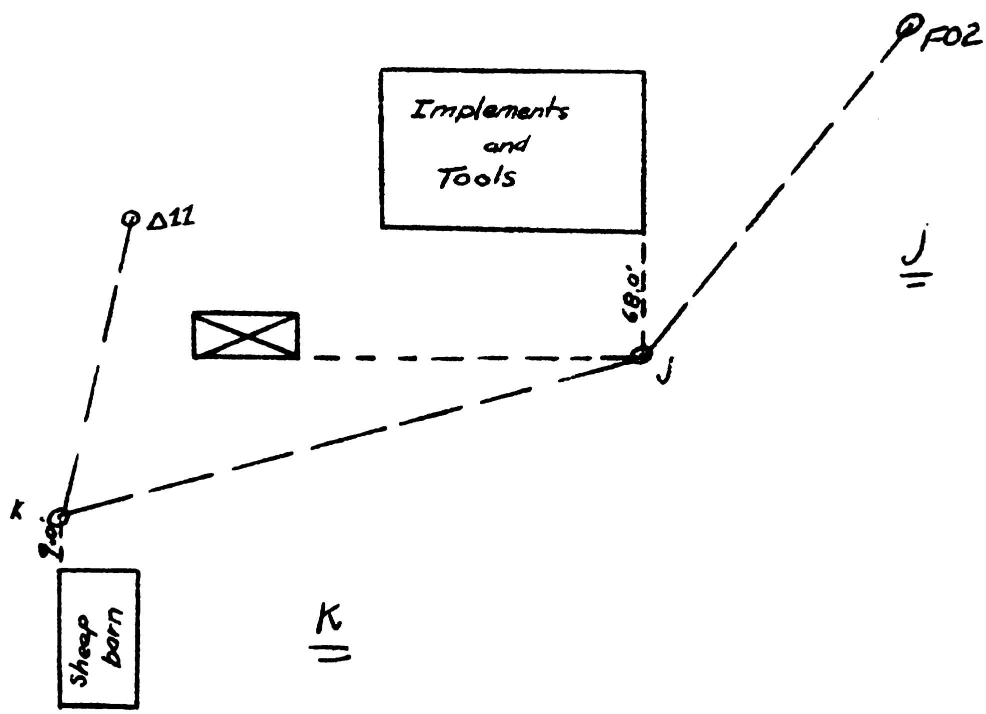

i
Ag. Bldg.
13.5'
23.5'
h
i
F02
Δ 11
x.

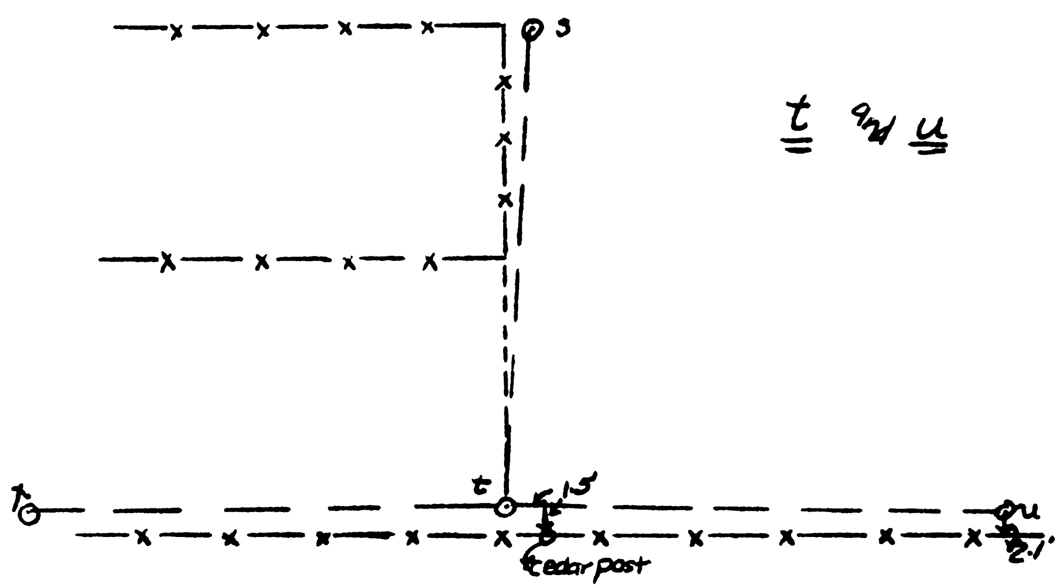

Δ9
11.0'
4.5'
h
q
Cold
Storage
Farm Lane
i
F02

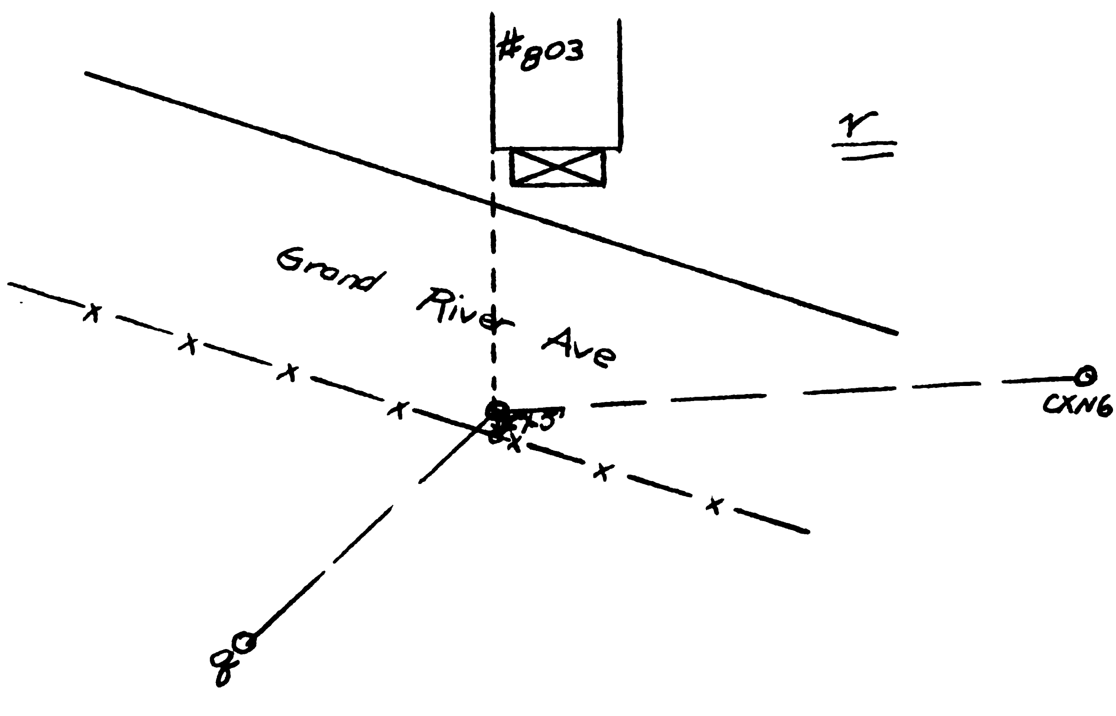

q
h
Path
6"x6" post
4½"
Dairy Bldg
Farm Lane
Soils Lab
Path
s
Wood stake 4½" South of 6"x6" post


q
F02
s
2'
Poultry
Orchard
S
t


F02
Farm Lane
t


F02
Implements
and
Tools
Δ11
68.0'
J
j
k
K
Sheep
barn


s
t and u
t
r
.15'
u
2.1'
cedar post


#803
r
Grand River Ave
.5'
CXN6
q

CHECK TRAVERSE

⋀ at	to	Measured Azimuth	Computed Azimuth
CXN6	GP1	3° 10' 41"	3° 10' 41"
	CXN7	290° 25' 15"	
	FO1	108° 54' 00"	108° 54' 28"
	FO2	71° 48' 15"	
	r	103° 38' 45"	
	q	71° 42' 35"	
FO1	CXN6	288° 54' 00"	
	FO2	359° 27' 00"	359° 29' 25"
	CXN5	112° 47' 20"	
	△9	47° 07' 30"	
	h	358° 33' 45"	
FO2	FO1	179° 29' 25"	
	x	0° 31' 45"	
	j	9° 31' 30"	
	FO3		3° 39' 06"
FO3	FO4		357° 09' 13"
GP1	GP2		1° 42' 17"

⊼ at	to	CLOSED TRAVERSE Azimuth	Distance (ft)
CXN6	GP1	3°10' 41"	
	r	103°38' 45"	431.65
r	q	48°51' 15"	588.20
q	s	359°48' 00"	281.00
s	t	0°55' 30"	664.70
t	u	270°09' 15"	380.15
u	GP2	270°01' 45"	437.50
GP2	GP1	181°43' 45"	
GP1	CXN6	183°12' 15"	
		******************	
FO2	FO1	179°29' 25"	
	x	0°31' 30"	702.30
	j	9°31' 45"	263.30

	LEVEL NOTES			
B.S.	H.I.	F.S.	Elev.	Sta.
			857.860	CXN6
3.403	861.263			
		2.333	858.930	r
		10.838	850.425	q
3.660	854.085			
		1.431	852.654	s
		9.171	844.914	t
		6.713	847.372	u
1.897	849.269			
		11.288	837.981	GP2
			848.650	FO2
1.742	850.392			
		4.428	845.964	j
		9.020	841.372	x

Point	Line	Azimuth	Dist. ft.	Computed ΔX	Computed ΔY	Corrected ΔX	Corrected ΔY	X	Y	Point
CXN6								+3471.90	- 596.80	CXN6
r	CXN6-r	103°38'45"	431.65	-419.50	+101.80	-419.46	+101.81	+3052.44	- 494.99	r
q	r-q	48°51'15"	588.20	-443.05	-387.02	-443.00	-387.01	+2609.44	- 882.00	q
s	q-s	359°48'00"	281.00	+ 0.98	-280.99	+ 1.01	-280.98	+2610.45	-1162.98	s
t	s-t	0°55'30"	664.70	- 10.73	-664.61	-10.67	-664.60	+2599.78	-1827.58	t
u	t-u	270°9'15"	380.15	+380.15	- 1.02	+380.18	- 1.01	+2979.96	-1828.59	u
GP2	u-GP2	270°1'45"	437.50	+437.50	- 0.22	+437.54	- 0.21	+3417.50	-1828.80	GP2
				- 54.65	-1232.06	- 54.40	-1232.00	- 54.40	-1232.00	
FO2								+1919.00	-1106.40	FO2
x	FO2-x	0°31'30"	702.30	- 6.43	-702.27			+1912.57	-1808.67	x
j	FO2-j	9°31'45"	263.30	- 43.58	-259.67			+1875.40	-1366.10	j

SAMPLE COMPUTATIONS

Y of CXN6 = -596.80 dy of r = +101.80

This dy is found as follows:

Distance from r to CXN6 = 431.65'

Sine (103 38' 45" - 90) = .23592

then, dy (r) = 431.65 x .23592 = +101.80

X of CXN6 = +3471.90 dx of r = -419.50

This dx is found as follows:

Distance from r to CXN6 = 431.65'

cos (103 38' 45" - 90) = .97177

then, dx (r) = 431.65 x .97177 = -419.50

Correction:

Total distance around traverse is 2783.2

Distance from r to CXN6 is 431.65'

Total error of closure is 0.25'

Amount of correction = (Dist/Total dist) x error

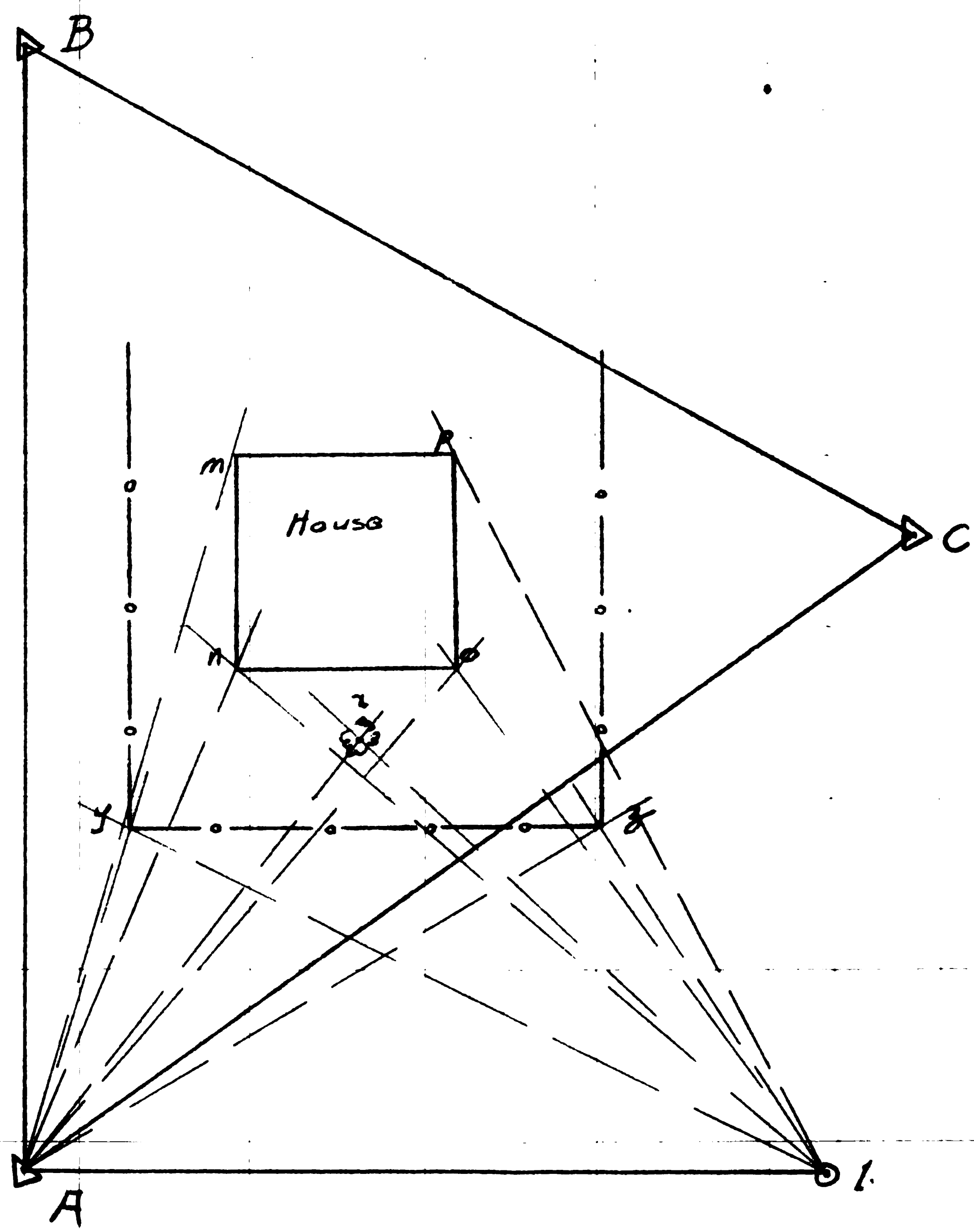
(431.65/2783.2) x 0.25 = .04

Computed dx (r) = 419.50

Corrected dx (r) = 419.50 - .04 = 419.46'

Coordinates:

(Y)	(X)
- 596.80	+ 3471.90
+ 101.81	- 419.46
- 494.99	+ 3052.44
- 387.01	- 443.00
- 882.00	+ 2609.44
- 280.98	+ ~~10~~1.01
- 1162.98	+ 2610.45
- 664.60	- 10.67
- 1827.58	+ 2599.78
- 1.01	+ 380.18
- 1828.59	+ 2979.96
- 0.21	+ 437.54
- 1828.80	+ 3417.50


B
C
m
House
n
o
y
z
A
1.

Coordinate Data
Triangulation Map
Unit Sheets