A PROPOSED PLAN FOR THE IMPROVEMENT OF SURVEYS AND MAPS IN VIRGINIA

BY

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A Thesis Submitted to the Graduate Committee
For the Degree of

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in

Civil Engineering

Approved:

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Virginia Polytechnic Institute
Blacksburg, Virginia
June 9, 1946

Colonel R. B. H. Begg
Professor of Civil Engineering
Virginia Polytechnic Institute
Blacksburg, Virginia

Dear Colonel Begg:

I wish to submit this thesis on "A Proposed Plan for the Improvement of Surveys and Maps in Virginia" as partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering.

Yours very truly,

Fred C. Morris

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The history of the human race is replete with accounts of conflicts that originated in disputes over the ownership of land. Some of these disputes have been between nations, some have been between political subdivisions within nations, and others have been between individual landowners. It is to the latter of these that this writing is directed.

In some nations most of the land is owned by a few wealthy people, and it is rented to those in the lower economic group for an annual stipend in agricultural products, money, or some other form of compensation. America is a nation of home owners and landowners, which makes the question of adequate property descriptions one of common interest. When the country was first settled this problem was not serious as there was more than enough land for everyone, but as the population density and land values increased, so did the number of disputes over property boundaries. These arguments result in expensive litigation, ill-feeling between neighbors, and, sometimes, murder.

People derive a peculiar satisfaction and joy in knowing that "that certain parcel of land" is really their own, and they fight any encroachment, real or imaginary, with dogged determination. In most boundary disputes each person is convinced that he is right, and that the other fellow is the thief. The unfortunate part of it is that the dividing line is so poorly described that a surveyor has a very diffi-

cult time in locating it. Sometimes the evidence is so meager that arbitration is the only alternative. Those intimately acquainted with existing conditions are fully aware of the inadequacies of boundary surveys.

Even though land represents a very large per cent of the national wealth, it is probably the poorest described and the least negotiable of all forms of wealth. The difficulties involved in the transfer of real estate are out of all proportion to the difficulties involved in the transfer of other types of property. This situation can be, and should be, corrected. It seems that the logical and intelligent approach would be to determine first wherein the difficulties lie, and then take appropriate and adequate steps to eliminate them. This means, of course, that action will have to replace inertia in order to resolve a tremendous conglomeration of pyramided faults into an intelligible and logical form.

CHAPTER I

STATUS OF LAND SURVEYS

The function of a land description that forms a part of a deed is to enable a surveyor to relocate the boundry lines with precision many years later. Any description that does not enable the surveyor to do this is inadequate. The lawyer is interested primarily in identifying a parcel of land but the surveyor has to find it precisely. The plan that sometimes accompanies and forms a part of the deed is not for the purpose of merely having a picture of the land. It is a graphical representation of existing conditions on the ground designed to make possible and to facilitate the accurate relocation of the boundaries at some future time. Since most land descriptions are not as good as they should be, it might be well to consider wherein they are weak.

The three main elements of a description are directions, distances, and physical marks. In establishing a basis for these elements the work may be divided into six phases as follows: the measurement of angles; the measurement of distances; the keeping of notes; the computations; the plan drawing; and, the written description. All of these merit close examination.

The Measurement of Angles

The main trouble with the measurement of angles is that they are not measured. The surveyor usually just takes the magnetic bearing of the line with the compass. These bearings are highly unstable

and unsatisfactory because the compass cannot be read accurately enough, the magnetic needle is subject to local attraction, the declination of the need varies with time and place, and it is also subject to periodic variations.

The Measurement of Distances

Incorrect distances result from a poor procedure in general. The main faults are failure to reduce slope measurements to the horizontal, failure to correct for tension and temperature, and failure to keep correct count of tape lengths. The dropping or picking up of full tape lengths is a very common blunder. Sometimes lines are not measured at all, particularly the last one in which the surveyor ends with the phrase, "and thence to the beginning." In such cases the bearing and distance are omitted.

Field Notes

There is no systematic method of keeping field notes. They are messy, illegible, confusing, and constitute a source of many errors.

Computations

The methods of computation do not conform to good practice in land surveying. It is not stated whether magnetic or true bearings are used, the ratio of error is not computed, and the survey is not balanced. The area determination is largely a hit-or-miss system which may cause a loss of considerable money when the land is sold on an acreage basis.

The Plan Drawing

The plan drawing should give a very detailed representation of the tract of land. Some of the common fallacies are: failure to state the type of bearing used, failure to give the declination of the needle, curve data omitted, poorly described corners, meager or no information about adjoining tracts, north direction not indicated, scale not shown, poor execution, not dated, and, not signed. Plan drawings usually have one, all, or some combination of these faults.

The Written Description

The written description is usually as bad or worse than the plan drawing. This is brought about partly by the common difficulty of expressing physical facts in words. Incorrect punctuation may change the meaning completely. Some of the common errors are: bearing in wrong quadrant or omitted, distances incorrect or omitted, date of survey and name of surveyor not given, and vague descriptions of corners. Some of these descriptions are very uncertain phrases, such as, "to a point where a tree once stood," "to two red oak stumps upon which formerly stood two red oak trees," "to a dog tied to a stake," "to a point down on the creek where Bill Jones shot the Indian," and, "meander to the beginning." All descriptions do not have this particular variety of phrases, but most of them have points just as vague, though less amusing. If a point is described so that it cannot be located later it really does not make much difference what it is called.

Sometimes a description will look innocent enough on paper but it is an entirely different thing when the surveyor tries to locate the corners on the ground. The deed may call for a tree over on the hill, but upon inspection it is found that there is no tree, or several trees, over on the hill. Quite often a corner is described as a stake which, of course, is a very temporary mark. It is practically impossible to reconcile the description of one tract of land with the description of adjoining tracts. Common lines are given with different bearings and distances. Trying to adjust one survey to another is very much like trying to work a jigsaw puzzle in which none of the parts fit.

If there were any perceptible improvement in land surveys there might be some cause for optimism, but such is not the case. Each deed, instead of clarifying anything, merely increases the staggering mass of misinformation and confusion that will have to be waded through at the next transfer. When a deed is written history is being written -- the history of a certain parcel of land, and it is the duty of the lawyer and surveyor to keep the record clear.

The Situation as it is

From the unpleasant remarks made about the work of the land surveyor one might be inclined to think that he is a highly irresponsible individual. However, it would be neither just nor true to facts to place all the blame on him for the conditions that exist in real property descriptions. He behaves very much the same as any other person would under similar circumstances.

In the first place, he doesn't get paid enough to make a good survey. The people, including lending agencies, are using the well-known system of trying to get something for nothing. In general, you get just about what you pay for, and land surveys are not exceptions to the rule. These cheap surveys quite frequently prove to be very expensive in the long run. This may occur when the land is sold by the acre, or when lost corners result in litigation, and possibly loss of land. A contributing factor to poor surveys is that in selling land the buyer often demands a new survey, which is usually paid for by the seller. Consequently, the seller tries to get the cheapest survey possible as he feels that he is not jeopardizing his own interests. Incidentally, the new survey may be just as bad, or worse, than the previous one. The seller also pays for having the deed written and his lawyer tries to protect him by selling by the same description by which it was bought so that any errors in the original description will be sold too. If the buyer demands a new description the old one is usually referred to in the deed in order to protect the seller and to maintain the chain of title.

It is true that a surveyor has to pass a state examination before he is given a license to practice, however, this merely shows that he knows how to make a good survey, and it does not guarantee that he will make a good one. Under the present system the surveyor makes just as much money on a bad survey as he does on a good one, therefore, he is not going to do any more than he has to, particularly in view of the fact that he may never be paid for it. That is

just human nature. When the land description is incorporated in the deed the lawyer, not being familiar with surveys, makes no complaint. The deed is taken to the registry of deeds and the recorder, a government representative, enters it in the records without complaint. All in all, this makes a very bad situation. The seller is releasing the land and does not care about the survey, the surveyor does as little work as he can get by with, and the lawyer and recorder of deeds pay practically no attention to it. Years later the buyer and his neighbor may have to stand expensive litigation because of this negligence. It seems, then, that the burden of getting an adequate property description is placed on the buyer, and too often he places a blind faith in a state certified surveyor and a similar faith in the seller's lawyer.

The position of the courts is that the surveyor is expected to exercise reasonable care and skill in the execution of his work or be subject to damage suits for his failure to do so. This is a very indefinite requirement meaning different things to different people. In a damage suit of this nature it would be necessary to get another surveyor as a qualified witness. This would be difficult to do because the other surveyor knows that he has work in the records just as bad as that of the defendant. In condemning the defendant he would likewise condemn himself, therefore, it is very difficult to win a damage suit of this nature.

The finger of guilt seems to point strongly toward the private surveyor, yet he can hardly be censured. People want to pay for bad

surveys and they get them. In order to improve conditions there will have to be complete cooperation from several sources. The surveyor will have to be willing to improve his methods; the public will have to be willing to pay for good work; the state will have to provide mathematically related reference points, establish minimum requirements before a survey can be recorded, and provide a check on these requirements to protect the public and the honest surveyor from the unscrupulous one; and, the law schools should include in their curriculum a short course in surveying so that the lawyer will be able to speak the language of the surveyor, as well as, be able to distinguish between a good description and a bad one. All of these things can be accomplished when the people and the state become willing to spend money to save more money, which, in the end, is real wisdom and real economy.

CHAPTER II

GEODETIC CONTROL POINTS

In describing the position of a point for future reference it is customary to describe it as being some physical mark, or its position is stated relative to some other physical mark. Obviously, the location of the point is not any more permanent than these physical marks which may be destroyed by the forces of nature or the works of man. The lack of anything of a permanent nature to connect surveys to has always been a serious handicap to the land surveyor. There are methods by which survey points can be made permanent, but these methods have not as yet come into general use.

The U. S. Coast and Geodetic Survey has established a network of monumented points on the ground mathematically related to each other so that every monument bears witness to the position of every other monument in the system. Any point described by this method becomes indestructible because it can be accurately relocated by its relation to other monuments if the mark on the ground should be destroyed.

These geographic positions, as they are called, are given in the terms of latitude and longitude, also referred to as spherical coordinates. As shown in Figure 1, latitude is the angular measurement at the center of the earth to the north and to the south of the equator as the "0" point. Longitude is the angular measurement at the center of the earth to the east and to the west of the prime meridian passing through Greenwich as the "0" point. This gives

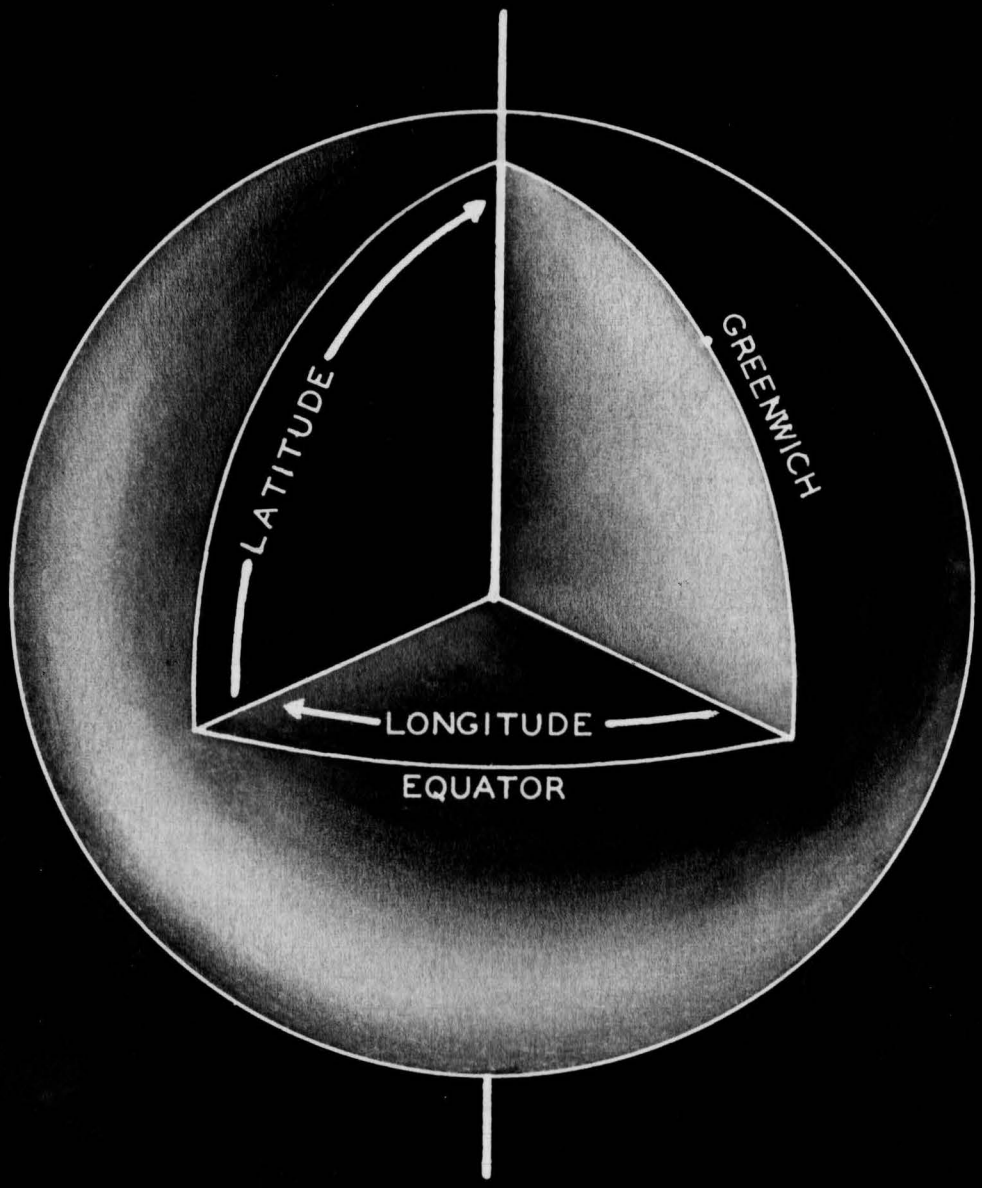


Figure 1. Measurement of latitude and longitude

90° as the maximum value for latitude and 180° as the maximum value for longitude. Lines of latitude are called parallels and lines of longitude are called meridians. The equator is established by passing a plane through the center of the earth perpendicular to the polar axis, therefore, the "0" for latitude has to be just where it is. On the other hand, the "0" for longitude is purely an arbitrary point and could have been placed anywhere.

Geographic positions of the national control system are located to an accuracy of one thousandth of a second. A point may be described as, Latitude North 37° 13' 54.456", Longitude West 80° 25' 10.961", which means that it is the intersection of a parallel of latitude and a meridian of longitude having these angular values. There is one, and only one, point on the surface of the earth that can be described by this pair of coordinates. There are an infinite number of points with the same latitude and an infinite number with the same longitude, but there is just one point with this combination of latitude and longitude.

Since the land areas of the earth are not smooth, nor is the sea, it was necessary to select some figure to which all horizontal measurements could be referred. The figure selected is an elipsoid of revolution with the polar axis approximately twenty-seven miles shorter than the equatorial axis. A conception of what this figure would look like can be gained by imagining the seas to be in a state of quiscence with the land areas sliced down to the level of the sea

and conforming thereto in shape. The dimensions for this figure were computed by Clarke in 1866 and it has given very satisfactory results.

In precise surveying all horizontal distances used in the computation of geographic positions must be reduced to distances on the elipsoid, and are known as sea level, or geodetic lengths. As is shown in Figure 2, the line AB on the surface of the earth becomes line CD at sea level. The reduction in length is accomplished by multiplying the ground distance by a factor slightly less than unity, the value of the factor being proportional to the vertical distance h of the line above sea level. If a line were measured below sea level it would have to be multiplied by a factor slightly greater than unity in order to obtain the geodetic length.

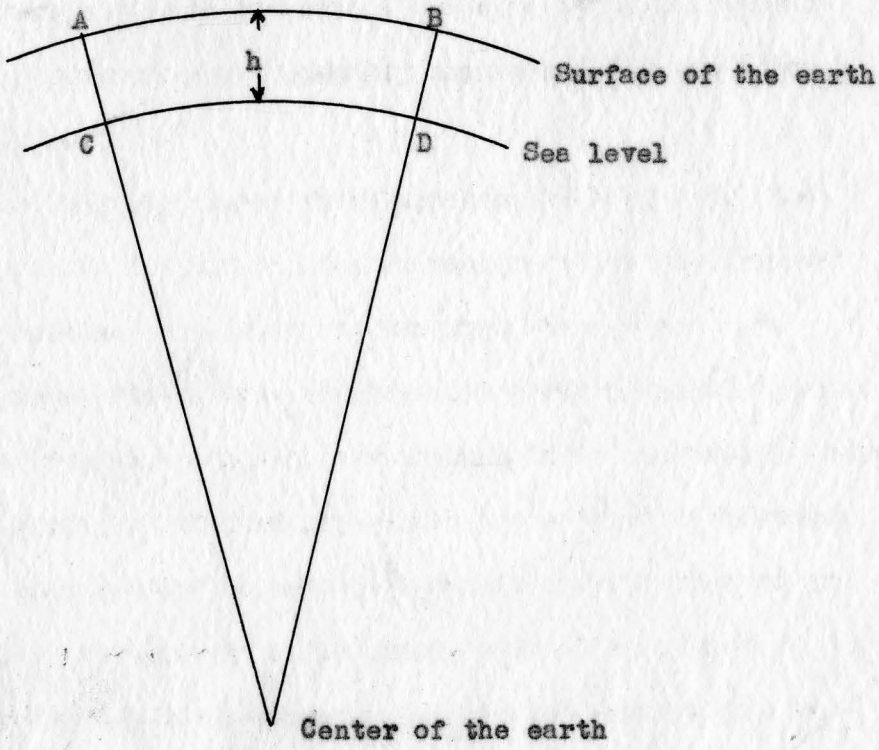


Figure 2. Reduction to Sea Level

Control points are established by triangulation and traverse. Triangulation is a series of triangles so placed as to form quadrilaterals which, in turn, form a series extending at great length with the stations spaced from ten to twenty-five miles apart. Since adjacent stations have to be intervisible in order to measure the angles, they are put at points of high elevation in rugged country, and in flat country it is necessary to erect observing towers to get the line of sight above the curvature of the earth.

Traverses are a series of straight lines, or tangents, with the changes of direction at varying intervals as may be necessitated by the nature of the terrain. The national fundamental control net was established by arcs of triangulation because of its greater accuracy and economy as compared with traverse. Traverse is used primarily for local control surveys and it usually begins and ends on a triangulation station.

A typical triangulation net is illustrated in Figure 3. The base lines AB and CD, and the angles are measured with the greatest precision practicable. The bases are measured three times with three separate invar tapes, due consideration being given to tension, temperature, and the catenary sag. From these three measurements the most probable length is computed and reduced to a geodetic distance. The angles are measured by the method of repetition in order to get a value of higher precision than the least count of the vernier. The accuracy of the angle measurements are checked against the geo-

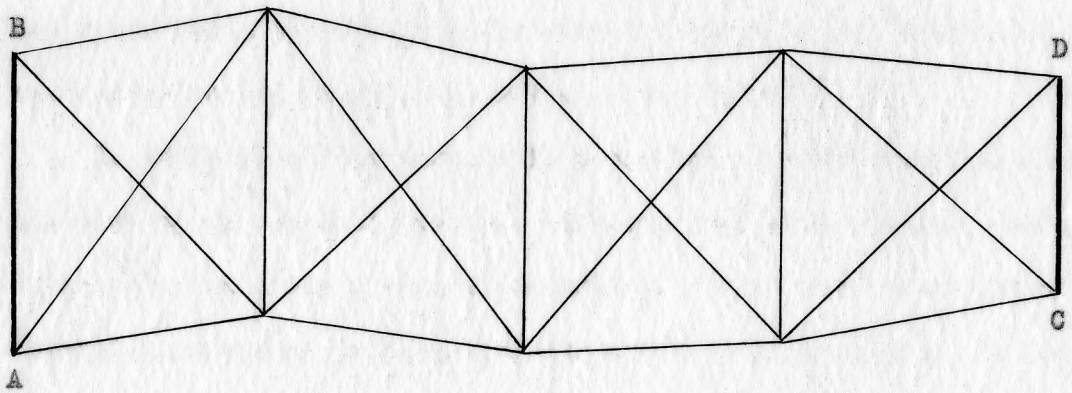


Figure 3. Typical Triangulation Net

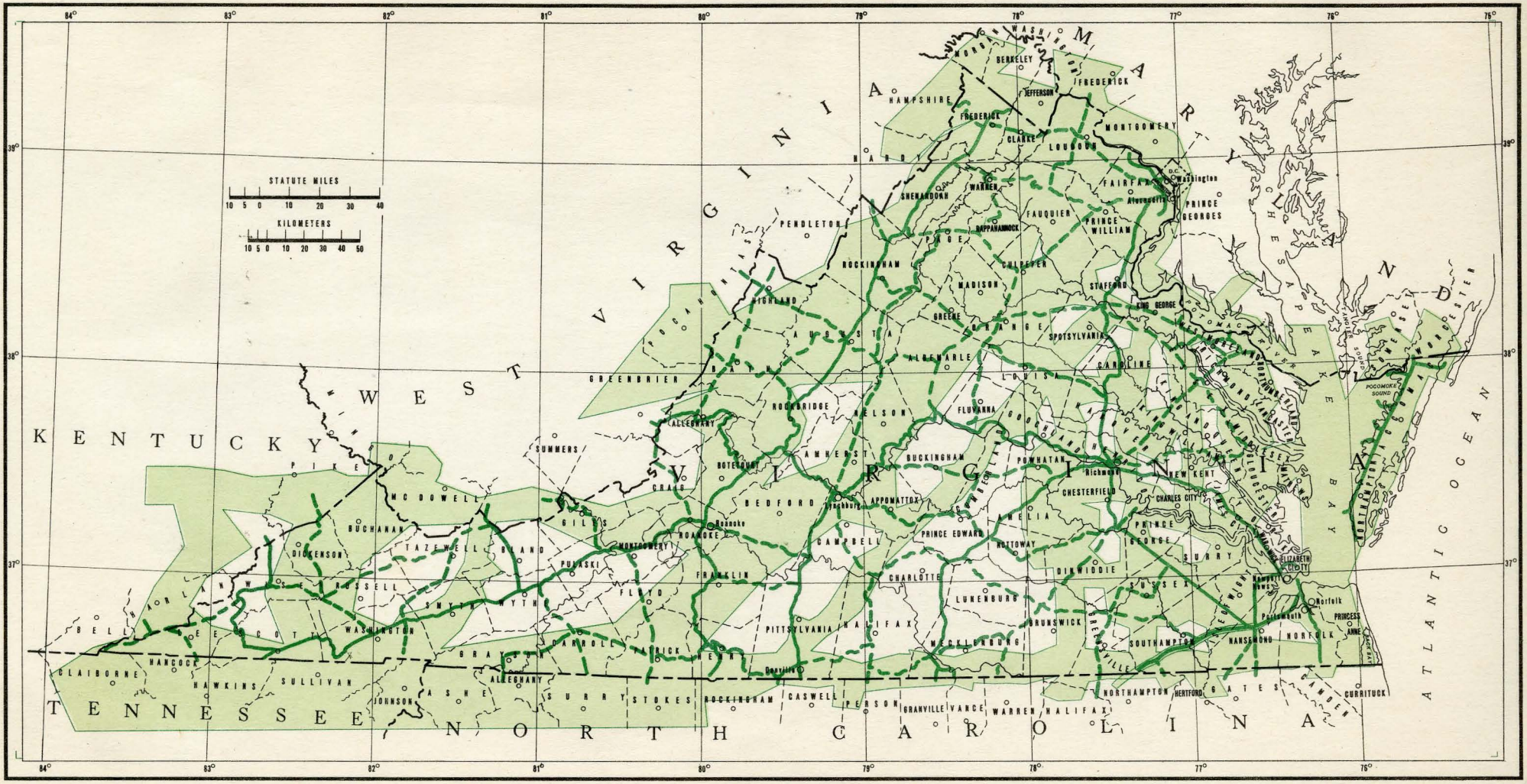
metrical requirements of the figure with spherical excess being taken into account. If the angle error is within the prescribed limits, the angles are scientifically adjusted to cause them to conform exactly with the requirements of the figure. By the application of trigonometry distance AB is carried through the scheme to establish preliminary geographic positions of all the stations and to secure a computed length of CD. If the difference between the computed length and the measured length of line CD is within accuracy limits, the error is distributed throughout the net by an adjustment of the geographic positions. These are preliminary positions and are subject to final adjustment which may alter the positions slightly due to the effect

of other nets that may be connected at AB, CD, or some other point. In carrying AB through the scheme to CD it is obvious that more than one route could be followed, therefore, a strength of figure test is made so as to be able to follow the strongest route.

In addition to the geographic positions, or horizontal control, elevations, or vertical control, has also been established. Elevations to an accuracy of one thousandth of a foot have been placed on concrete monuments, or other objects of an enduring nature, by the means of leveling, mean sea level being taken as the datum plane. Points upon which elevations have been established are known as bench marks, while those showing geographic positions are called stations, whether they be triangulation or traverse. Quite frequently a monument will give both horizontal and vertical control.

This tremendous framework of control lines extends over the entire country and is connected to the control systems of Canada and Mexico. Since it covers most of the continent, it is called the North American Datum of 1927. Figure 4 shows the part of this system that covers Virginia.

The main objection to spherical coordinates is that they are highly involved mathematically and tedious to compute. This work clearly falls in the realm of the geodetic specialist and should not be attempted by the average engineer or surveyor. In order to eliminate this difficulty there has been established a system of rectangular coordinates which makes it possible for the surveyor



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Washington, D.C.

INDEX MAP OF THE STATE OF
VIRGINIA

Figure 4. Horizontal and Vertical Control in Virginia

to use the methods of plane surveying, yet maintain the same strength of position as that of spherical coordinates.

CHAPTER III

THE PLANE COORDINATE SYSTEM

The merits of a plane coordinate system for the purpose of describing the position of a point has been recognized for a few thousand years, and it has been used just about that long. Textbooks on elementary mathematics explain the system and road maps use the very same method, usually with numbers along the horizontal sides and letters of the alphabet along the vertical sides. The index gives the coordinates of every town shown on the map, and with this information the town can be readily located. This system is illustrated in Figure 5. In land surveying the coordinates are given in feet and

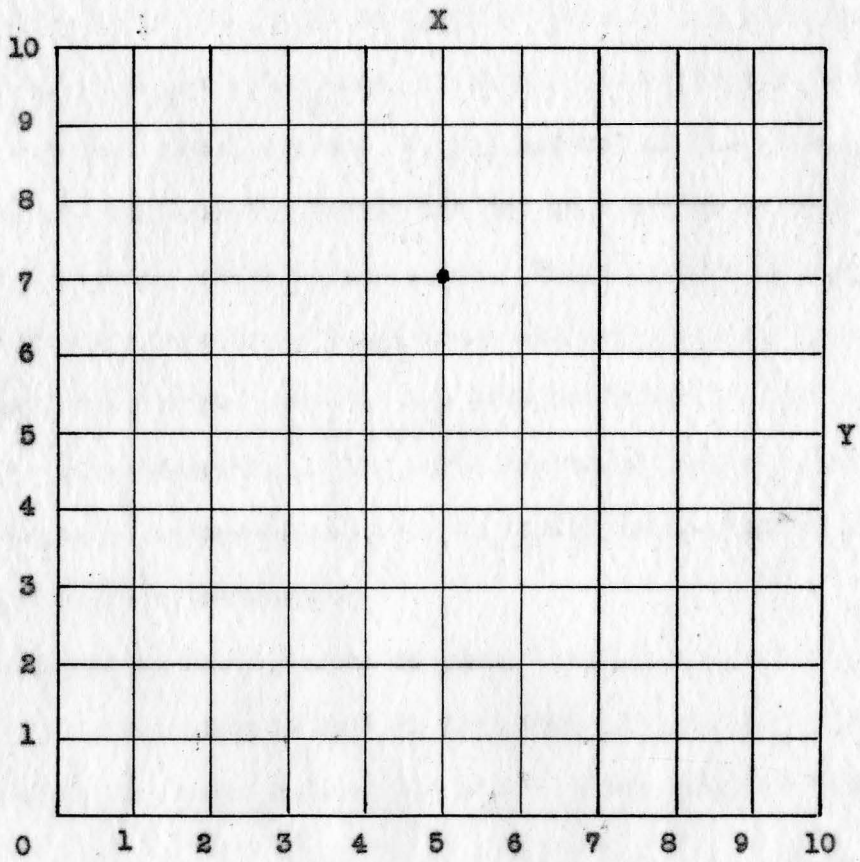

Figure 5. Plane Coordinates

decimal parts of a foot with the X values running east and west and the Y values running north and south. Thus in the figure, if coordinates are given X = 5, Y = 7, it means that the point is 5 units over from the origin at O, and 7 units above the origin. With the coordinates of any two points given the direction and distance of one relative to the other can be computed by using the differences in the X and Y values. This, of course, reduces it to the solution of a simple right triangle with the differences in coordinates representing the two legs.

Most of the coordinate systems used in the past have been set up with an arbitrary origin and designed to meet local conditions. These systems are all right except that trouble develops when they are extended for some distance, or when it is necessary to connect them to another local system. At the request of the states, the U. S. Coast and Geodetic Survey has set up a system of plane coordinates for every state in the union. These systems are capable of extension over relatively large areas and are based on the national triangulation control system. Any land described by state coordinates is also described by the world system of latitude and longitude, since plane coordinates can be readily converted to spherical coordinates and vice versa.

In order to use a system of plane coordinates points on the earth, a curved surface, must be projected onto a plane surface. In devising the state systems the cone and the cylinder were used

because they are developable figures, that is, they can be cut along one of their elements and opened into a plane without stretching or compressing any of the parts. The cone was used for states having greater extent east and west, and the cylinder was used for the states having their greater extent north and south. Since Virginia has its greater extent east and west a conic projection was used. Figure 6 illustrates a cone cutting the earth in two standard parallels, having its apex in the polar axis of the earth extended. The projection is made by radial lines from the center of the earth through the point on the surface of the earth, and piercing the cone. Figure 7 shows the cone developed into a plane upon which would be shown the projected points. The north and south limit for any one cone is 158 miles in order to keep errors within acceptable limits. Since Virginia has a north and south extent greater than 158 miles it was necessary to use two cones, one comprising the North Zone and the other the South Zone. The directions on the grid are referred to the central meridian of the projection at which point the geodetic azimuth and the grid azimuth are coincident. To the east and the west of the central meridian there is a difference, θ, in these two azimuths, the value of θ increasing with the distance from the central meridian. The azimuths are measured clockwise from the south. A situation may arise in which a part of a tract of land lies in the south zone and part in the north zone, in which case all of the coordinates should be shown in one zone. There is

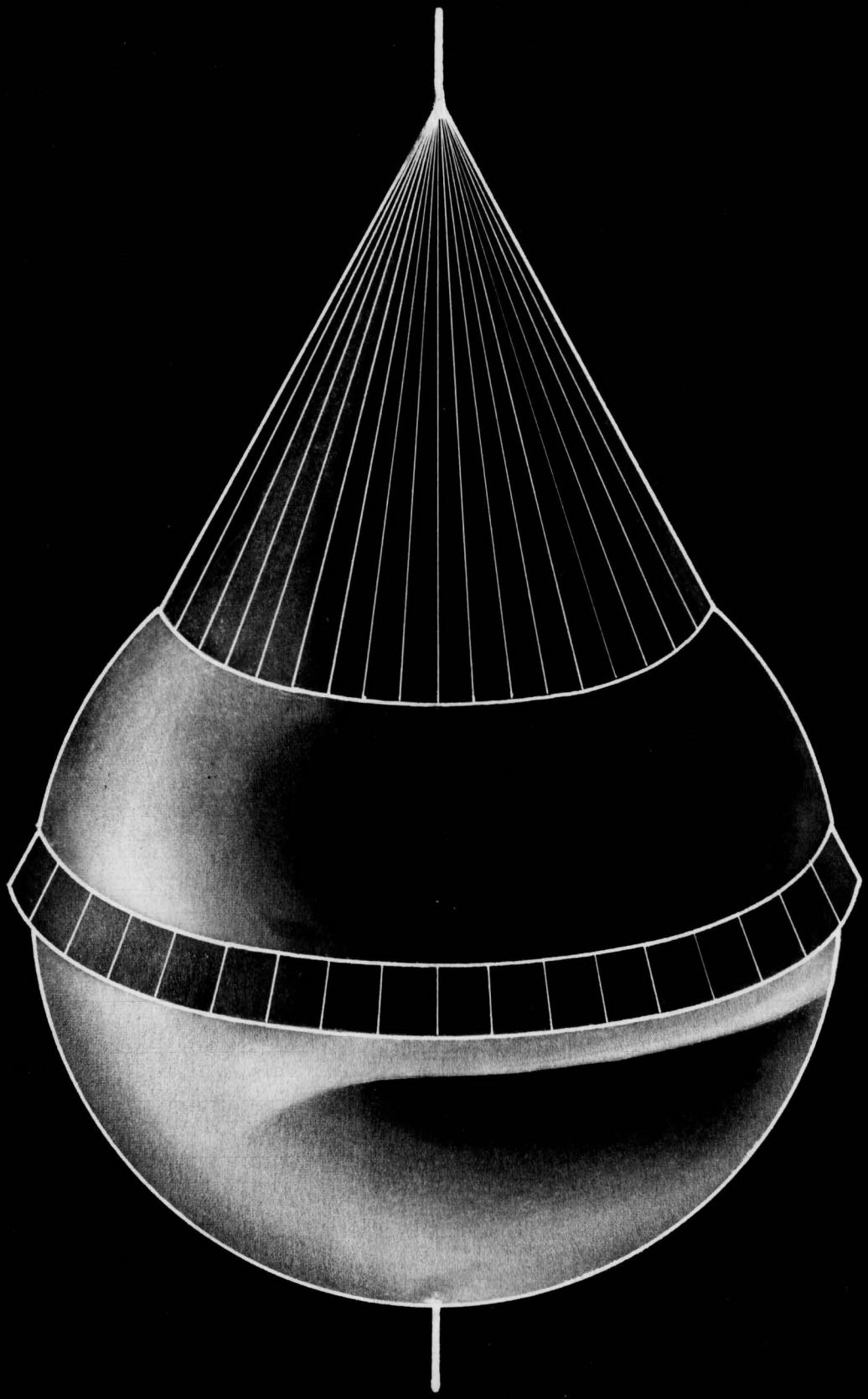

Figure 6. A cone cutting the earth at two standard parallels

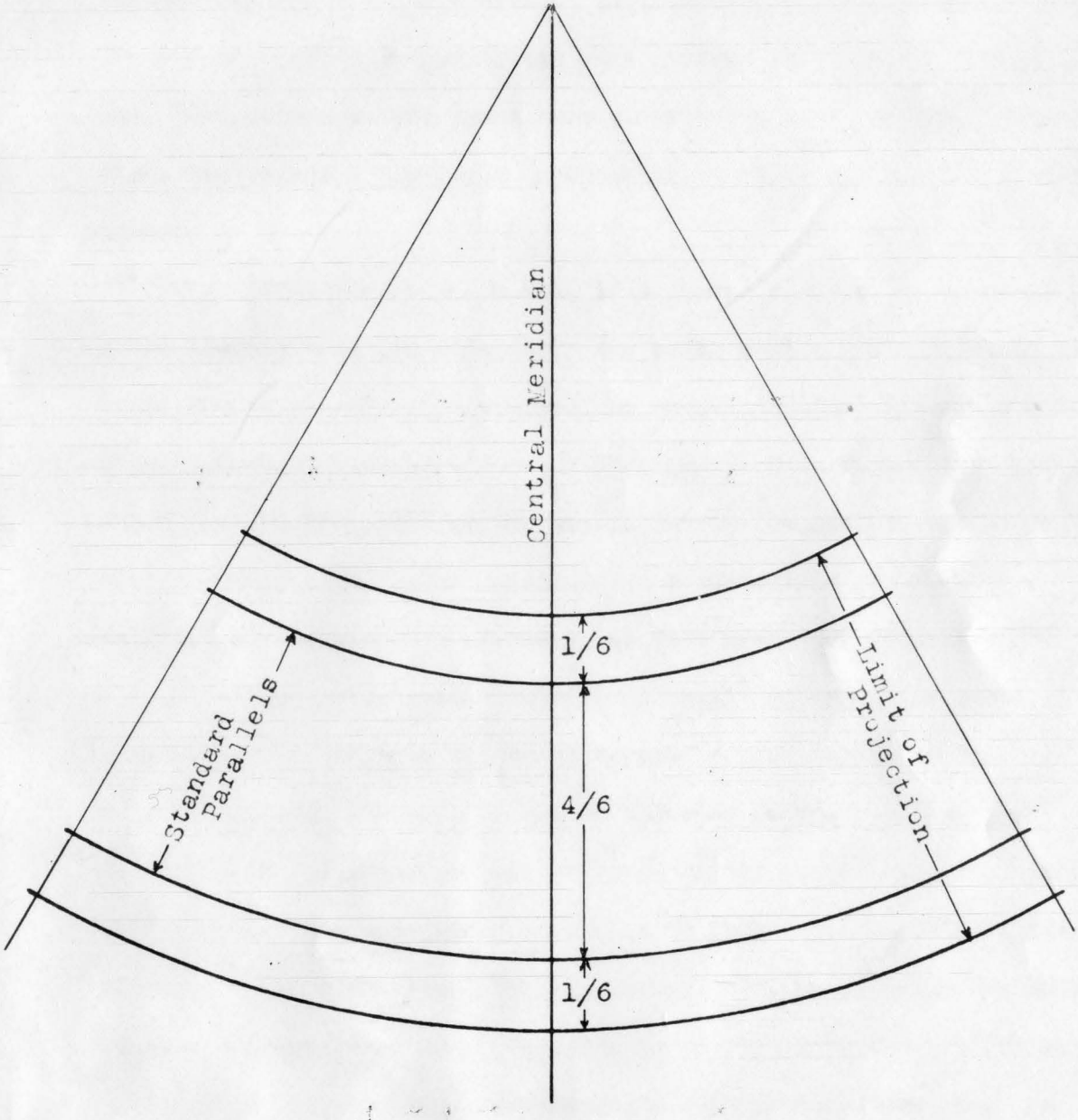

Figure 7. The developed cone

an overlap of the two zones to take care of such cases.

The Virginia Coordinate System is a Lambert polyconic conformal projection based on the Clarke spheriod of 1866. The name means that Lambert devised the conic method, that more than one cone was used for Virginia, that shapes on the cone conform to shapes on the ground, and, that points on the ground are projected onto the cones. Figure 8 shows the standard parallels intersected by the cones for the Virginia system.

The entire surface of a cone is not used for the projection since it is limited to a 158 mile north and south strip. This distance is divided to give 4/6 of it between the parallels and a 1/6 strip outside of them at the top and the bottom as shown in Figure 7. Between the parallels the scale is too small, and in the outside strips the scale is too large, which necessitates a correction for these two conditions when computing coordinates from field measurements.

It takes specialized knowledge and skill to establish plane coordinates for control monuments because a high degree of accuracy is required, but the same degree of accuracy is not required for land surveys. The only change required in the methods of plane surveying to use the coordinate system is to reduce the horizontal distances to grid distances. This is accomplished by reducing the ground distance to sea level by multiplying by an elevation factor, and then multiplying the sea level distance by a grid factor taken from the projection tables. For most counties a single elevation factor and

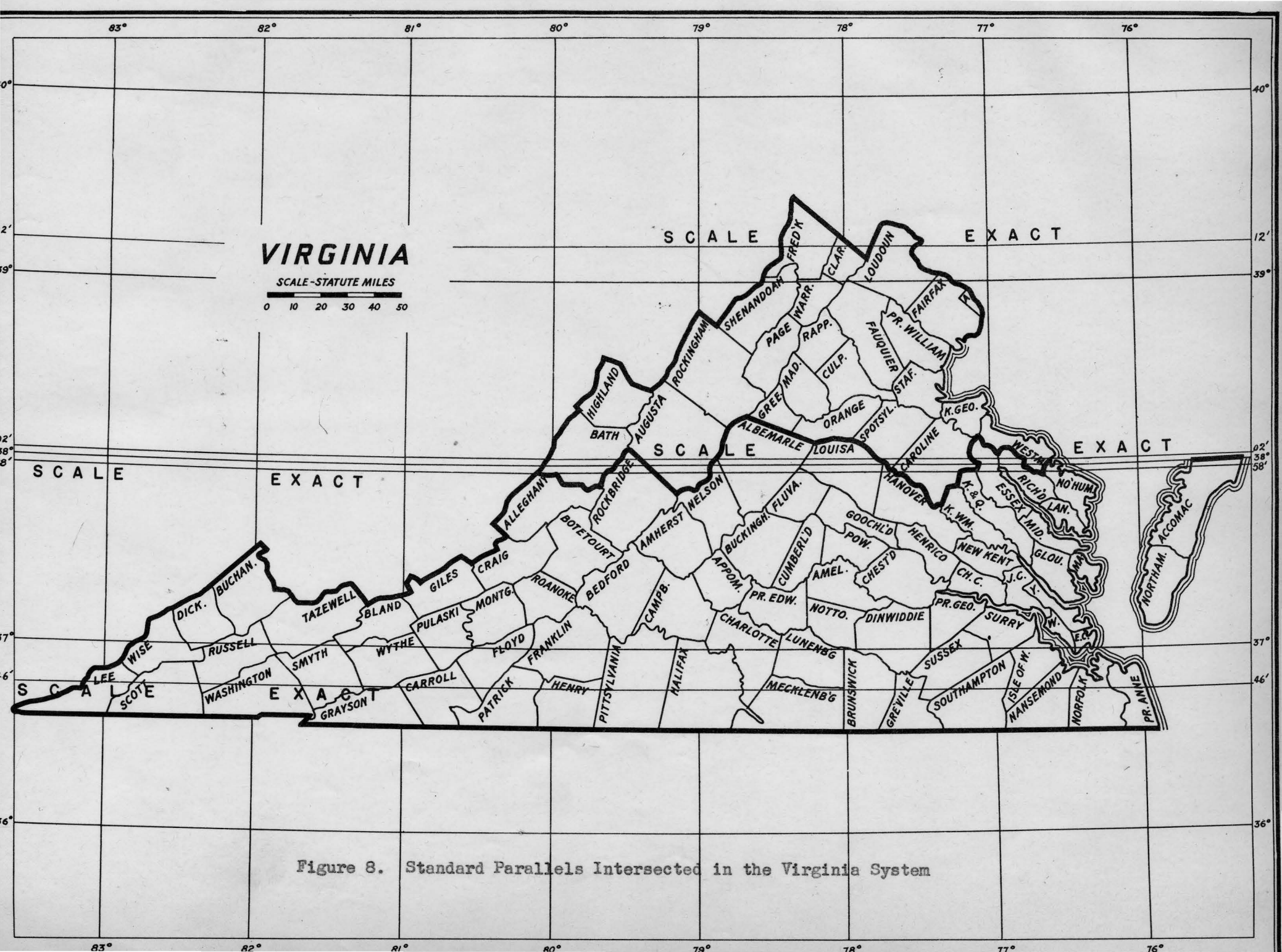

Figure 8. Standard Parallels Intersected in the Virginia System

a single grid factor will give results sufficiently close for land surveys. These two factors can be combined into one factor, or it can be further simplified by converting it into the terms of a correction per 1000 feet.

CHAPTER IV

USES OF RECTANGULAR COORDINATES

Land Surveys

One of the most valuable uses of plane coordinates is to give land boundaries something they have never had before — a permanent and indestructible definition. This function alone is sufficient justification for having the system.

Figures 9 and 10 show the computations for a land survey that has been connected to control monuments. The line was started at A, run through all the property corners and tied back to B, A and B having assumed coordinates. By the application of the latitude and departures coordinates were computed for the property corners, and the traverse error distributed by adjusting these coordinates with a correction proportional to the length of the courses. A reverse operation was performed to find the corrected bearings and distances, which are shown directly beneath the originals. Directions may be given in the terms of grid bearings or grid azimuths but the latter is preferable. The form used is purely a form and not necessarily the best form. Certain changes might be advisable, such as reversing the position of X and Y to place them in their normal order.

There are very few land surveys in which all the corners could be occupied with the instrument as is shown here. In most cases fence posts, trees, or buildings are in the way. This difficulty can be overcome by the use of parallel lines, or by a random traverse

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TRAVERSE COMPUTATIONS

Surveyor: R. L. Jones Location: Montgomery County, Virginia Date: June 19, 1946

Survey: J. C. Brown Land Ratio of Error: 1/3479 Area: 15.74 Acres

Station	Field Angle	Azimuth / Bearing	Distance / Nat. Cos / Nat. Sin	Log. Lat. / Log. Cos Az. / Log. Dist. / Log. Sin Az. / Log. Dep	Latitude	Departure	Plane Coordinates Y	Plane Coordinates X
A	126 - 15	202 - 54	88.04		+ 81.10	+ 34.26	10,361.13	21,633.24
			88.02					
		N 22 - 54 E	.92119					
			.38912					
			(88.04)					
1	140 - 43	163 - 37	595.13		+ 570.97	- 167.86	10,442.23	21,667.50
			595.14				- .01	- .02
		N 16 - 23 W	.95940				10,442.22	21,667.48
		N 16 - 24 W	.28206					
			(683.17)					
2	108 - 30	92 - 07	617.45		+ 22.80	- 617.03	11,013.20	21,499.64
			617.62				- .05	- .19
		N 87 - 53 W	.03693				11,013.15	21,499.45
			.99932					
			(1300.62)					
3	138 - 49	50 - 56	664.28		- 418.64	- 515.75	11,036.00	20,882.61
			664.44				- .10	- .36
		S 50 - 56 W	.63022				11,035.90	20,882.25
			.77641					
			(1964.90)					
4	92 - 45	323 - 41	410.17		- 330.50	+ 242.92	10,617.36	20,366.86
			410.13				- .15	- .54
		S 36 - 19 E	.80576				10,617.21	20,366.32
		S 36 - 18 E	.59225					
			(2375.07)					

Figure 9. Traverse computations

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VIRGINIA POLYTECHNIC INSTITUTE

TRAVERSE COMPUTATIONS

Surveyor: R. L. Jones Location: Montgomery County, Virginia Date: June 19, 1946

Survey: J. C. Brown Land Ratio of Error: Area:

Station	Field Angle	Azimuth / Bearing	Distance / Nat. Cos / Nat. Sin	Log. Lat. / Log. Cos Az. / Log. Dist. / Log. Sin Az. / Log. Dep	Latitude	Departure	Plane Coordinates Y	Plane Coordinates X
5	198 - 12	341 - 53	164.60		- 156.44	+ 51.18	10,286.86	20,609.78
			164.59				- .18	- .65
		S 18 - 07 E	.95043				10,286.68	20,609.13
			.31095					
			(2539.67)			Error	0.19	0.70
B	94 - 46	256 - 39	1000.00				10,130.23	20,660.26
		N 76 - 39 E						
		Ratio of Error	$= \frac{\sqrt{.19^2 + .70^2}}{2539.67} = \frac{1}{3479}$					
5 to 1			1069.72					
		N 81 - 38 E						

Figure 10. Traverse computations

with side shots to the corners. In such cases reference monuments should be set on the property and coordinates established for them.

If long traverses involving several angles and distances are necessary to connect to control monuments these measurements should have an accuracy of not less than 1 part in 10,000. It is desirable to start on one monument and tie back to another, however, it may be necessary to tie back at the beginning as sometimes just one monument has coordinates, an azimuth mark being used to secure direction. A good connection with control monuments can be made by the use of a quadrilateral provided visibility and a strong figure can be obtained. Single line ties should never be used as they are weak in azimuth and distance.

The plan drawing for this survey as shown in Figure 11 has the bearings, distances, and coordinates in tabular form to eliminate the confusing mass of data usually found on the traverse lines and at the corners. This extra space gives room for a more detailed description of the physical marks of the boundary. The type of bearing used is not shown as this would be superfluous information. If grid coordinates are used the bearings cannot be referred to anything except grid north. The ratio of error is given as it is highly important to know the accuracy of the survey.

The written description for this tract may read as follows:

> Beginning at point (1), a concrete post set in the north side of the right-of-way line of route 8 and a corner to C. L. Hall, X21667.48-Y10442.22; thence N 16 - 24 W with the Hall line 595.14 feet to point (2), a concrete post,

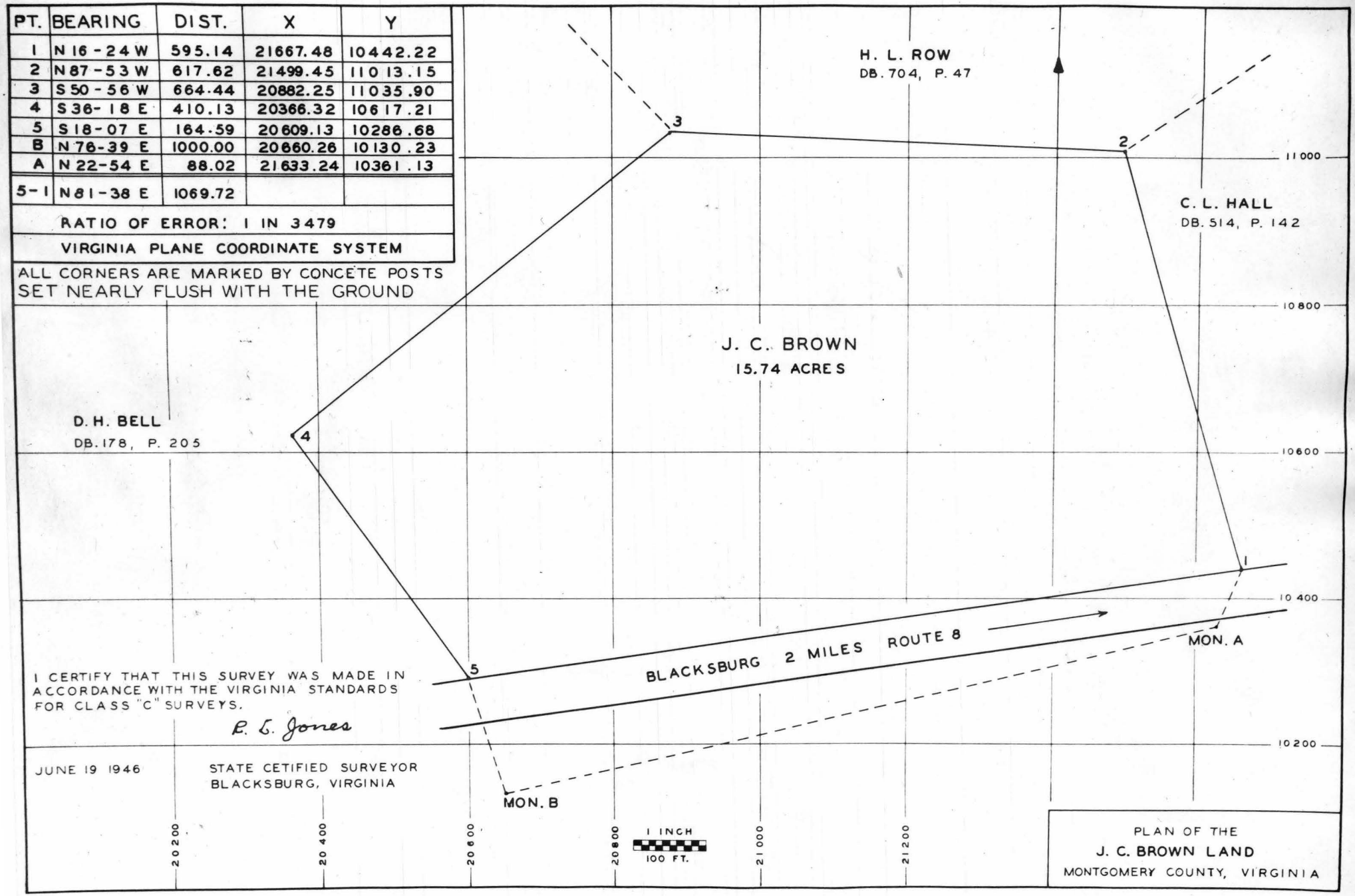

Figure 11. Plan drawing

> X21499.45-Y11013.15; thence N 87 - 53 W with the Row line 617.62 feet to point (3), a concrete post X20882.25-Y11035.90; thence S 50 - 56 W with the Bell line 664.44 feet to point (4) a concrete post, X20366.32-Y10617.21; thence S 36 - 18 E with the Bell line 410.13 feet to point (5), a concrete post in the north side of the right-of-way of route 8, X20609.13-Y10286.68; thence N 81 - 38 E with the north side of the right-of-way of route 8, 1069.72 feet to the beginning; and, containing 15.74 acres.
>
> The coordinates shown herein are based on the Virginia Coordinate System.

As may be noticed, the notorious and charitable phrase "more or less" has not been appended. As a matter of fact this phrase neither helps nor hurts a description, and it was left off here in conformance with the principle of including the essential and deleting the superfluous. Since there is no such thing as an exact measurement every survey is more or less regardless of the accuracy. The ratio of error should indicate how much dependence can be put in the area computation, and this ratio should be shown on every survey.

The coordinates in the written description can be shown in different ways, such as, X = 700, Y = 400; 700 - 400, with X and Y indicated by their position; or X700-Y400, with X and Y used as prefixes to the coordinates. The latter is selected here because of brevity and positive identification.

From an examination of the plan drawing and the written description it seems that either of these give an adequate description without the other, which represents duplication and does not contribute to the simplification of descriptions. Since the plan drawing

gives a very complete description it seems that it might be advisable to eliminate the written description entirely. If this is done, the plan drawing should be made a part of the deed and recorded immediately after it in the deed book. Sometimes a description will be sufficiently simple that a plan drawing is not necessary, in which case the written description should be fully complete.

There are many advantages in using the photostat method of recording deeds instead of typing them as is usually done. It will save time, money, and eliminate transcribing errors. The equipment should be installed in the registry of deeds, and its operation is very simple. The deed would be printed in the negative on both sides of a sheet of paper the same size as the usual deed book page, and without any reduction in the size of the type. The plan drawing would be recorded in a similar manner and filed with the deed. When a drawing is filed by the photostat method a bar scale should be used so that the scale is applicable regardless of the per cent of reduction in size.

The surveyor can save considerable time and money by making the plan drawing on tracing paper and then typing the information on it instead of lettering it by hand. It will be neater, faster, occupy less space, and be more legible. Tracing paper can be folded to go into a typewriter without damage, and the bearings, distances, and coordinates can be put in tabular form. If blue prints are needed for any reason the tracing paper should be backed up with carbon paper when the typing is being done.

Highway Surveys

Control monuments are very advantageous in highway work and if the highways were adequately monumented it would save the state a considerable amount of money. In running traverses and levels for a highway good engineering practice does not permit running a single line because the chances for error are too great, therefore, these lines have to be run in both directions which just about doubles this phase of the work. If there were pairs of monuments spaced about every two miles along the highway a check could be made at every pair for azimuth, distance, and elevation, thus eliminating the necessity for a second run of the line. Any blunders that might be made would be bracketed between the pairs of monuments which would cause them to be quickly found and corrected. From each pair of monuments the survey would be continued with information secured from the pair, which would cause the uniform errors to be dropped or distributed as made and not heavily accumulated at the end. The controls are also very valuable in handling problems of grade and drainage. Every road map sent to the field parties would show the location of each pair of monuments, the azimuth and distance between them, the elevations, and the coordinates. From these coordinates the distance and bearing can be computed between any two monuments even though they are not companion monuments. If highway engineers were to use this type of control for a while they would feel lost without it. For good roads it takes good design, and for good design it takes good basic information.

Other Uses

There are so many practical uses for control monuments that it would be difficult to enumerate them all. They include all types of construction work, drainage, reclamation, irrigation, flood control, water supply, and ground control for aerial mapping. The police department of one city is using plane coordinates very successfully to radio the patrol cars the exact location of wrecks, places of crime, or some disaster.

Judging from the many benefits to be derived therefrom, it seems that there is a valid argument for the establishment of local control monuments.

CHAPTER V

THE VIRGINIA COORDINATE SYSTEM ACT

The 1946 General Assembly of Virginia passed the Virginia Coordinate System Act (Appendix I) giving legal recognition to the rectangular coordinate system devised for the state by the U. S. Coast and Geodetic Survey. Actually, a law was not necessary before coordinates could be used since it is just a surveying method. The purpose of the law was to name and define the system so as to prevent confusion that might arise between the state system and any local system. The act specifically prohibits the use of the name of the state system on surveys, maps, land records, and deed descriptions that are not based on the state system as defined by law. This will enable the courts to determine how much weight to give coordinates when presented as evidence of boundary locations.

Since there is a possibility of misunderstanding the provisions of the act the following points are made for clarification:

1. The law makes the use of plane coordinates permissive and not obligatory. Surveyors who want to establish indestructible boundaries will use them, or, the land owner may request that the survey be coordinated.

2. It does not prohibit the use of existing methods. The registrar of deeds will still record the poorest survey and description that it is possible to make if that is what the people want.

3. It does not replace the present use of land marks but gives them strength in that they can be accurately replaced if destroyed. When a physical mark on the ground can be identified beyond reasonable doubt it is the point, all other evidence to the contrary.

4. The law does not require an appropriation but the coordinate system will not get far without it. There are not enough control monuments for the general use of the system. Surveyors cannot tie their surveys into the state system without something to connect to, therefore, the benefits of coordinates will be very limited until the state establishes more control points.

CHAPTER VI

MAPS

Maps have held a fascination for people throughout recorded history. It probably stems from the curiosity of the human mind to wonder, and to try to learn, what lies beyond the horizon. The early globe trotters made rough sketches of the countries they visited so that they could show the folks back home what they had found, and to guide those who followed. The questions answered by those crude sketches are the same as those answered more eloquently today by more complete maps. They tell the things we want to know, such as, where is it, what is its shape, is it mountainous or a level plane, does it have great rivers and lakes, and, would it be a good place to live? Few people realize the painstaking work that has been necessary in order to answer these questions.

Mapping is a tedious job requiring the utmost care in all phases of the work. Most of the general purpose topographic maps were made in the field with a plane table, which is a slow and costly process. Due to the rapid development of the country these maps quickly become obsolete and are no longer adequate for the purposes they were designed to serve. That is, maps have not kept pace with national development. The federal mapping agencies have done a remarkably good job for the funds that have been made available, but since they have forty-eight states to map these funds have to be spread rather thin. Consequently, most of the country is not adequately mapped for general purposes, and special use maps are in

about the same condition. Recent scientific developments have made it possible to make better and cheaper maps, and to make them in less time.

Long before the development of the airplane people took pictures of the ground from baloons, or with a camera attached to a kite. Others would climb into high trees or buildings in order to get pictures from the air. Obviously, the difficulty was in not being able to stay up in the air at some distance and move around at will. The rapid development in airplanes during the first world war gave considerable impetus to the making of pictures from the air, and there were vast improvements in camera design. Even with these facilities available the second world war caught the country still very poorly mapped. During the war there was further development in the equipment and technique of aerial photography. This equipment, however, has not been refined to the point where it will operate itself. On the contrary, it will require a great deal of money and work to bring the maps of the country up to date.

An aerial photograph is exactly what it says — it is a photograph and not a map. In making a map the horizontal and vertical ground control is plotted first as a frame-work, and then the natural and cultural features as shown by the photograph are plotted in their proper relationship to the ground control. The accuracy of the map is directly dependent upon the density and distribution of ground control, an increase in control resulting in a corresponding

increase in accuracy. At the present time the density of ground control is not adequate for close mapping.

National security alone is sufficient justification for the expenditure of enough money to make good maps of the entire country. Military operations are so dependent upon maps that the nation cannot afford to risk another emergency without them. In order to accomplish this economically there should be a consolidation and reorganization of all federal surveying and mapping agencies to bring about better coordination and eliminate overlapping of activities. There should also be a free exchange of data between federal and state agencies for the very same reason, and to assure that a maximum of public good will be served for every dollar spent.

Although the military value of maps is very great, their economic value for special uses in peaceful pursuits is probably even greater. Aerial photographs tell a different story to different people, depending upon their interests. For instance, the farmer sees the alfalfa field; the geologist, the earth formations; the soil conservationist, the eroded hills; the engineer, a dam site, the highways, or the railways; and, the vacationist, a good place for a week-end of fishing. The advantage of aerial photographs is that all the information is there so that each individual can take what he needs to serve his purposes and ignore the remainder. Some of the special uses for aerial photographs are as follows:

1. Tax Maps

County and city tax maps can be compiled that give a picture of all the land in the tax area. This would enable the assessor to find the land that is lost on the tax books, which would probably yield a return considerably greater than the cost of the maps. Also, some people are paying too much tax while others are paying too little, therefore, the entire tax structure should be put on a more scientific and equitable basis. For instance, by using the information shown on soil survey and land classification maps an index number can be established for each farm, reflecting its relative producing capacity. Land values are based on usefulness and accessibility, therefore, in establishing an index number a weighted factor should be introduced to reflect the influence of accessibility on value.

2. Highway Location

Aerial photographs are particularly useful in the reconnaissance work for highway location. After a tentative route is selected by a study of the photographs a strip is contoured directly from the photograph. The centerline of the highway is profiled from the contour map and a check made on grades. The intelligent use of photographs will secure a more economic location, improve curves, grades, culvert design, and contribute to the esthetic value of the road. Good location and design for highways will eliminate a great deal of expensive relocation a few years later.

3. Base Maps for Soil Surveys

   Soil surveys classify the soil in different areas as to type, which determines its suitability for various plants. A soil association map, Figure 12, is a summary, or smaller grouping of the types shown on a detail soils map.

4. Base Maps for Land Classification

   Figure 13 shows the type of map used for land classification and as a base map for detail soil surveys. Land classification is based primarily on the nature of the surface, while the soil survey deals with the characteristics of the soil.

5. Watershed Study (Figure 14)

6. Regional Planning (Figure 15)

7. Flood Control

8. Vegetation Survey

   To classify the flora of the state.

9. Timber Surveys

   To classify timber and determine quantities.

10. Reforestation

11. Soil Conservation

    Particularly useful in planning erosion control work.

12. The Location of Urban and Cross-country Transmission lines

13. Geomorphic Studies

    Particularly useful in petroleum geology.

14. Geologic Studies

Figure 12. Soil Association map

Figure 13. Land Classification map

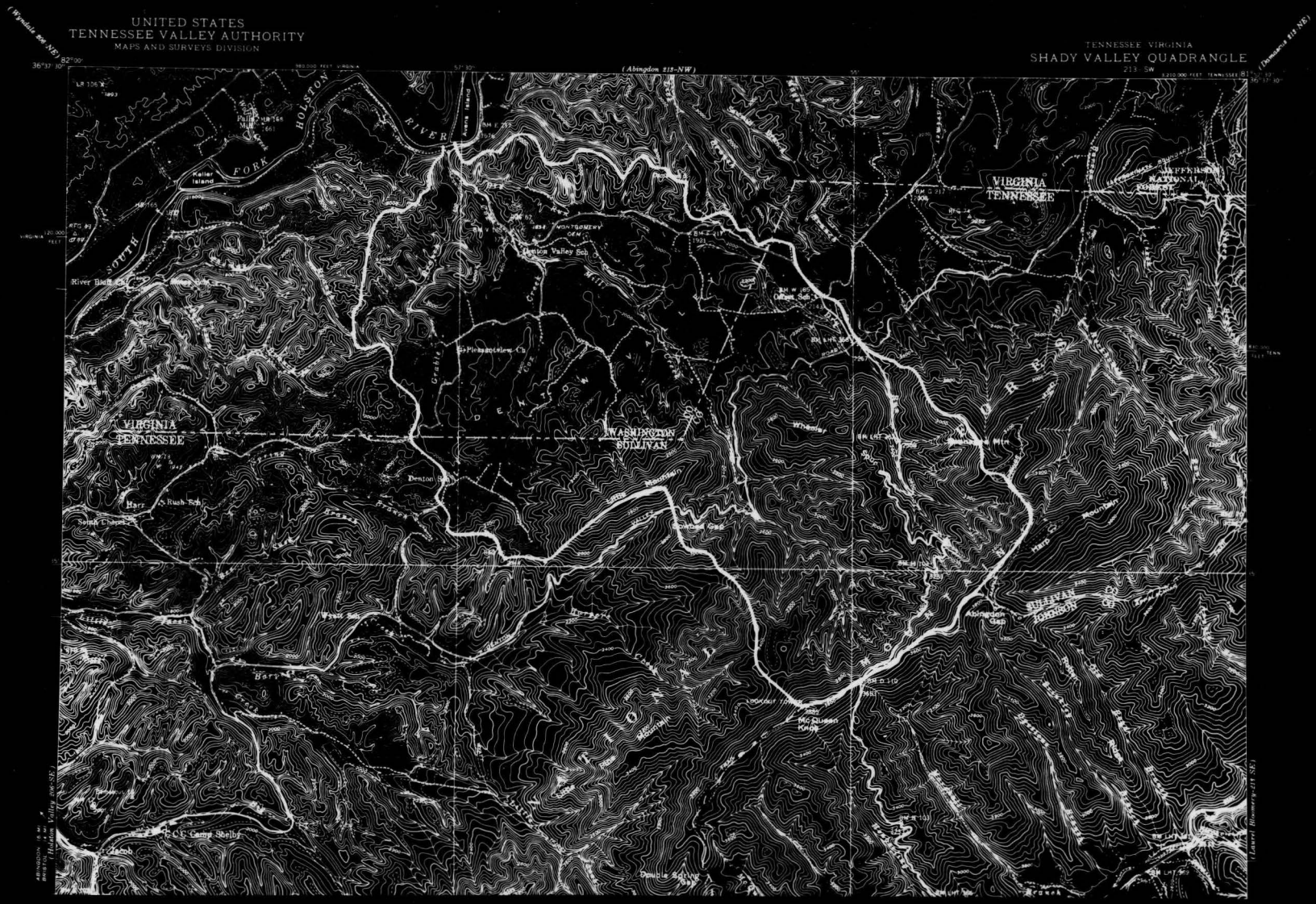

Figure 14. Watershed study

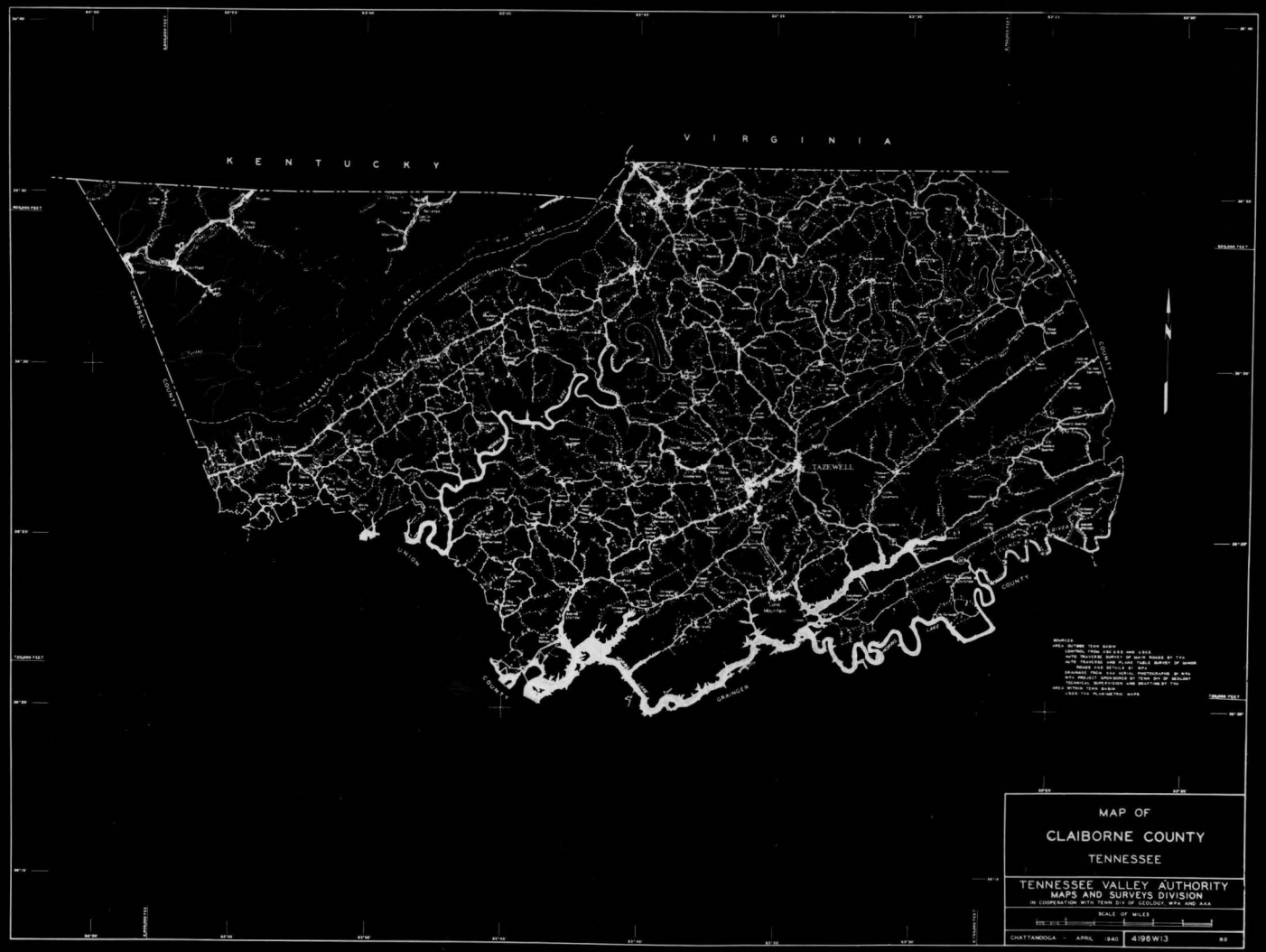

Figure 15. Regional Planning map

15. Locating Dam Sites and Determining the Area Flooded by the Water Back of the Dam.

16. City Work

    Location of sewer and water lines, design of storm drains, location of parks, and for zoning and transportation studies.

17. Development of Recreational Areas

18. Location of Industrial Enterprises

There are probably many more practical applications for aerial photographs, but the list shown here should give a fair conception of their value.

CHAPTER VII

BUREAU OF SURVEYS AND MAPS

It would be the height of blind optimism to believe that the condition of surveys and maps will improve without anything being done to improve them. The do-nothing policy has been followed for years with very bad results, as is evidenced by volumes upon volumes of courthouse records. Appropriate and adequate measures will have to be taken to convert antiquated and inaccurate methods into scientific and business-like procedures that are in keeping with the times.

As a primary and major step to bring order out of confusion, there should be established a state bureau of surveys and maps to perform a multiplicity of services. A few of these functions will be discussed here briefly, and listed as follows:

Local Control Surveys

The lack of control points is a very serious handicap to the surveyor, therefore, the bureau would establish local control points over the state with the highway system being monumented first because the highway department can make immediate use of the information, and because the more valuable land lies on the highways. These monuments would be placed in pairs about two miles apart, care being taken to place them at highway intersections, bridge sites, and in places least apt to be disturbed yet convenient to use. Horizontal and vertical control would be established to

conform to the U. S. Coast and Geodetic Survey specifications for first order work. The horizontal control would be established by traverse and connected to the national triangulation system. The bureau would not enter the field of triangulation but leave it to the federal agencies.

The information shown for each pair of monuments would be the elevation, grid and spherical coordinates, and the θ angle for each monument, and the geodetic and grid distances and azimuths for the pair. As fast as computed this information on all monuments would be sent to the highway department and the U. S. Coast and Geodetic Survey where it would be available to other federal mapping agencies. The information would be sent, without request, to private surveyors and engineers for the monuments in their area of operation. Others would be given the information upon request.

The field parties would be highly mobile so that they could move immediately any monument in the way of construction work. All monuments would be recovered, or inspected, at intervals not greater than three years and redescribed if necessary. It is quite probable that the private surveyors and engineers would be glad to handle this work in their respective areas. A penalty would be provided by law for the willful destruction of monuments.

Mapping

The bureau would maintain a complete photogrammetry laboratory for the purpose of compiling county maps with political sub-

divisions accurately shown, special use maps for all state agencies, and special use maps for private individuals and concerns. There would be aerial photographs of the entire state from which these maps would be made. New aerial photographs would be secured or made as changing conditions required. The making of general purpose topographic maps would be left to the U. S. Geological Survey.

Control for Towns and Cities

Since most town and city engineering departments do not have the equipment or the experience for making precise surveys the bureau would establish control points for them at cost. The city engineers and the bureau engineers, in consultation, would select on an aerial map the points at which control monuments should be placed. The city would set the monuments and then the bureau engineers would run the survey and compute the data.

Specifications for Private Surveys

The bureau would write specifications and procedures for private surveys to be known as the Virginia Standards of Surveying Practice. These standards would cover the measuring of angles and distances, field notes, computations, plan drawings, and written deed descriptions. This would include the designing of a field note book and a computation form.

It is suggested that these standards be set up in four classifications, A, B, C, and D, with accuracy limits of 1 in 10,000 for A, 1 in 5000 for B, 1 in 3000 for C, and 1 in 2000 for D.

Class D surveys would represent the minimum legal requirements for surveys that were to be used in deed descriptions. Among other things, these minimum requirements would limit the use of the compass to securing initial directions, and to locating boundries previously described by magnetic bearings. They would also require the measurement of all angles, the computation of the ratio of error, the balancing of the survey by latitudes and departures, and the computation of the area by the double meridian distance method or by coordinates.

Service to Private Surveyors

The private surveyors are definitely in need of help and leadership, therefore, the bureau would hold annual meetings for them to discuss problems of common interest in the profession. One of the problems would be to establish standard fees so that each surveyor would give about the same price on any given piece of work. Underbidding has practically destroyed all ethics of the profession, as well as hurt the quality of work. A contract form should also be devised that would show the work to be done, the classification of the survey, and the compensation that the surveyor would receive upon completion of the survey. This contract should constitute a promise to pay and the surveyor should not start any job without it. This would give a strong legal basis for collection, which quite frequently is very difficult.

Since there are many surveyors who know too little about their

profession, particularly computations, and practically nothing about the plane coordinate system, the bureau would operate periodic short courses to correct this deficiency. The engineers of the bureau would also advise with surveyors and others at any time on special problems arising in the field of surveying and mapping. Other services to be rendered would include standardizing measuring tapes, adjusting instruments, supplying standard field note books, computation forms, and contract forms, all at cost.

Administration of the Plane Coordinate System

If the plane coordinate system is not properly administered, and by competent personnel, land surveys will be in just as much of a mess with coordinates as they are without them, therefore, the bureau would administer the coordinate system, and its approval would be required before state coordinates could be used in deed descriptions. This approval would be contingent upon the accuracy of the survey and the strength of the connection to control monuments. The minimum requirement for the use of the system would be that the survey conform in every respect with the Virginia Standards for Class C surveys, or better.

The bureau would appoint a deputy surveyor in each county to check Class D surveys and his approval would be required before the recorder registered a deed. The deputy would be given special instructions on how to check surveys and deed descriptions.

Surveyor's Manual

The bureau would prepare a surveyor's manual to cover the following points:

1. Complete specifications for class A, B, C, and D surveys, including samples of standard forms.
2. Mapping symbols as approved by the Federal Board of Surveys.
3. How to use plane coordinates.
4. The cardinal points of law in boundary surveying.
5. The legal responsibilities of land surveyors.
6. Sample contract form.
7. Professional ethics.

Survey and Map Information

The bureau would serve as a repository for all survey and map information established by federal and state agencies, and this information would be available to the public upon request.

Organization and Administration of the Bureau

The bureau would operate under the general direction of a six-man advisory board composed of the following:

1. Dean of Engineering, Virginia Polytechnic Institute
2. State Commissioner of Highways
3. Head, State Department of Conservation and Development
4. Director, Virginia State Planning Board
5. A representative of private surveyors and engineers
6. A representative of the Virginia Bar Association

The work of the bureau would be under a director with three supervisory assistants, one for field operations, one for office computation, and one in charge of mapping and the photogrametry laboratory. Other personnel would be employed to carry on the work of the bureau as the needs indicated.

The advisory board would select the state agency under which the bureau would be operated and the location for it. It is important for it not to be under an agency that uses survey data and maps in order to eliminate the probability that the agency would serve its own interests to the neglect of the interests of others. It would be quite plausible for the bureau to be operated at Blacksburg under the Engineering Extension Division of the Virginia Polytechnic Institute. This plausibility being in the fact that the college is already engaged in work of a similar nature, that there are excellent facilities for conventions and short courses, and that graduate students would be afforded the opportunity to pursue advanced work in geodesy and photogrammetry under the personnel of the bureau. The improvement of property surveys is a field for much needed engineering extension work that could be very well handled by the land grant colleges.

CHAPTER VIII

LAND COURT

Real property is just as heavily laden with legal entanglements as it is with inadequate descriptions, and the uncertainty of title is on a comparable basis to uncertainty of boundaries. Careful dealers in real estate usually have an abstract of title made to see whether or not there might be something in the chain of title that would invalidate the deed. This is a very tedious task and it is easy to fail to find some pertinent fact. It requires checking all the transfers for a long period of years to see that they conform to law and that there are no encumbrances in the chain of title. This operation may be performed repeatedly for the same piece of land as each purchaser may request an abstract of title. The property description is a very important part of the title since a weakness is introduced unless it is perfectly clear just what the title covers. These legal and engineering difficulties hamper transfers and keep real estate from being sufficiently negotiable as compared with other types of property. A state bureau of surveys and maps will eliminate the engineering difficulties, so the next logical step is to devise a system to solve the legal problems.

A number of foreign countries and a few states have established land courts patterned after the Torrens land registration system as devised for Australia by Sir Richard Torrens in 1857. This system has been very successful where used and should no longer be considered as being experimental. The land court is a system of land

registration designed to strengthen title and simplify transfer. These objectives are accomplished by the creation of indefeasible titles warranted and guaranteed by the state, and by making transfers by certificates of title to the exclusion of all other methods. The registration of land is not made obligatory by law but is voluntary on the part of the land owner.

In order to put the ownership and transfer of land on a sounder and simpler basis a land court should be established in conjunction with the bureau of surveys and maps. The land court would have statewide jurisdiction, and would operate as follows:

Organization

The land court would be headed by a judge with two associate judges and a recorder. In each registry of deeds there would be a land court section for registered land, with the registrar of deeds acting as a deputy recorder for the court. In each registry district the court would appoint an attorney-at-law as examiner to abstract titles. The county sheriff would also be a deputy of the court. The engineering work of the court would be handled by the bureau of surveys and maps, and its deputy surveyor in each county.

Procedure for Registering Land

The process of registering land is initiated by the land owner petitioning the land court to register a certain tract of land. With this petition is sent a plan drawing based on a survey made in

accordance with the Virginia Surveying Standards. A description on the Virginia Coordinate System would be required and an accuracy conforming to class A, B, or C surveys. The class of survey required would be governed by the value of the land. Class D surveys would not be eligible for registration. There would also be sent the names of adjoining owners, a list of any existing easements or prescriptive rights, and the names of any adverse claimants. No land would be eligible for registration unless the owner held a fee simple title.

When the land court receives the petition it notifies the official examiner in the registry district in which the land is situated to make a title search and to verify the adjoining owners with the tax assessor. The examiner would be given about two weeks to complete this work. Then the adjoining owners are sent a notice by registered mail stating that registration proceedings had been initiated and that the plan drawing would be in the hands of the deputy surveyor for a period of thirty days for examination by any interested person. If requested to do so the deputy surveyor would visit the site to point out boundaries as shown on the plan. The sheriff would post a notice on the land similar to the one sent to the adjoining owners, and this notice would be published once a week for four weeks in a newspaper of general circulation.

If at the end of thirty days no one challenged the petition, the court would proceed with registration. If the petition is challenged the court would hold an informal hearing and try to adjust differences

by agreement. If this fails the court would hold a formal hearing and render a decision on the points at issue. Any disputant dissatisfied with this decision would be given a period of ten days to file notice of appeal to a superior court, and failure to file notice in this time would constitute acceptance of the decision of the land court by all concerned and registration procedures would continue. If the decision of the land court is reversed by the superior court this reversal would be accepted and registration procedures would continue.

With the investigational phase of registration completed the court would issue a decree setting forth the basis upon which the land is registered and authorizing the issuance of a certificate of title. This decree would list existing easements and prescriptive rights which would run with the land. After the land is registered additional rights by prescription could not be gained, and the law of title by adverse possession would be inoperative. As a part of the decree there would be a decree plan drawing of the land prepared by the bureau of surveys and maps from the preliminary drawing and the survey notes. The boundaries would have to conform to the boundaries of any adjoining land previously registered. This drawing would be made to a scale large enough to secure good execution and photostatic copies made on a standard size sheet, after which the drawing could be destroyed. The certificate of title would give a written description of the property and a reference to the plan drawing. There would be space provided to list existing encumbrance, as well as any future encum-

brances. Any encumbrance would not be valid unless it is recorded with the land court. The original decree and certificate of title, with the photostatic plan drawing would be filed in the land court records by the official recorder. Photostatic copies of these would be sent to the district deputy recorder to be filed in the land court section of the registry, and a photostatic copy of the certificate would be sent to the land owner. This certificate would be held in suspense for a period of two years after the date of issue, but after the expiration of this period the title would automatically become absolutely and truly indefeasible. The land owner would be protected by bond during this two year period.

Transfers

The first objective of the land court, the strengthening of title having been accomplished, the second objective, to simplify transfer, will be considered.

On the reverse side of the certificate of title there would be a transfer form with a place for the name of the grantee and the conditions of sale. If a partial payment is made, it should be shown how the remainder will be paid, and whether or not a vendor's lien is being retained. The first payment and evidence of remaining indebtedness is given to the grantor by the grantee, and the grantor signs the transfer, the signature being notarized and seal affixed. The transfer form is then delivered to the grantee. This transfer form does not constitute a title in favor of the grantee, but a

basis upon which a certificate of title may be secured. The grantee mails the transfer to the land court and a new certificate is issued to him with the remaining indebtedness and vendor's lien, if any, shown in the certificate as an encumbrance. The original of this certificate is kept in the land court records, a photostatic copy is sent to the grantee, and a copy to the district deputy recorder to be placed in the records of the land court section.

A tract of land would continue to be transferred on the decree survey and description until the increase in the value of the land required a higher class of survey, or until a subdivision is made. In the case of a subdivision the grantor surrenders his certificate and new certificates are issued to the new owners. A person holding separate certificates for two adjoining tracts would be permitted to surrender the two certificates and get one certificate to cover both tracts, but if the tracts are not joined separate certificates would be required.

Indemnity Fund

Every person registering land would pay into an indemnity fund an amount equal to one-tenth of one per cent of the assessed value of the property to compensate any person suffering a loss through the operation of the system. This would cover negligence on the part of any official or deputy of the court, as well as certain other conceivable circumstances. After this fund, invested at interest, reached $200,000 all over this amount would be used to defray the expenses

of the land court. If a valid claim were presented before the fund was large enough to pay it, the difference would have to be met by the state, and the state be reimbursed by future income. In view of the extreme care taken in registering land these cases would be very rare. It is important to note that even though a valid claim is established it does not disturb title as the claim is against the state and not the holder of the title.

Land Disputes

In addition to registering land and handling transfers, the land court would settle land disputes referred to it by the circuit court. It would probably not be wise to put all land disputes under the jurisdiction of the land court since a great many of them would be relatively simple and could be settled just as well in the local court. The more complicated cases would be referred to the land court, for which there are two very good reasons.

The law of boundaries is a special field of law in which there are very few attorneys well versed. The judge of the land court and his two associates would be well qualified in this respect to dispense justice according to the law. The second advantage of a land court hearing is that the bureau of surveys and maps would have aerial photographs available to the court upon which could be examined the boundaries in dispute. Quite frequently an old line can be seen on a photograph that cannot be found by an examination of the ground. Photograph interpretation is also a specialized field and would be

handled by the engineers of the bureau of surveys and maps. With land disputes being handled by those well prepared in law and in engineering the decisions of the land court should merit great confidence and respect on the part of the public.

RECAPITULATION

Consideration has been given to certain undesirable conditions that exist in regard to real property, and a plan has been formulated to correct these conditions. The picture as a whole has been so beclouded by detail that it might be helpful to make the following statements for the purpose of clarification:

1. It is notoriously true that real estate boundaries and titles are too uncertain, and that the method of transfer is cumbersome.
2. A state bureau of surveys and maps is recommended for the purpose of correcting the engineering deficiencies of real property descriptions by improving surveys.
3. A land court is recommended for the purpose of correcting the legal deficiencies of land titles by the strengthening of titles and the simplification of transfers.
4. It is recommended that the bureau of surveys and maps and the land court be operated jointly for the purpose of convenience, efficiency, and economy.
5. These recommendations are rather comprehensive, but they are in proportion to the evils they are designed to correct. To delete part of the provisions would be merely following the old system of doing things half-way, which is responsible for the weak status of real property.
6. It will cost considerable money to put this plan into effect,

which is an argument for it rather than against it. If it didn't cost anything it probably wouldn't be worth anything.

7. It is an economy plan since, in the long run, it will save the state and the people more money than it cost. It is entirely reasonable to expect the highway department alone to save $50,000 or more a year by the use of control points and aerial photographs, as well as, secure better location and better design.

8. A plan of this nature will have to be put into operation eventually, but when is problematical. It is not the lack of money but a false economy, and the lack of vision and leadership that will delay it.

9. No organization is any better than its personnel, therefore, if this plan is adopted extreme care should be used in selecting the administrative agency and the personnel in order to put the quality of work on a comparable basis with that of the federal surveying and mapping agencies.

APPENDIX I

THE VIRGINIA COORDINATE SYSTEM ACT

Be it enacted by the General Assembly of Virginia, as follows:

1. Section 1. The system of plane coordinates which has been established by the United States Coast and Geodetic Survey for defining and stating the positions or locations of points on the surface of the earth within the Commonwealth of Virginia is hereafter to be known and designated as the "Virginia Coordinate System."

For the purpose of the use of this system the State is divided into a "North Zone" and a "South Zone."

The area now included in the following counties shall constitute the North Zone: Arlington, Augusta, Bath, Caroline, Clarke, Culpeper, Fairfax, Fauquier, Frederick, Greene, Highland, King George, Loudoun, Madison, Orange, Page, Prince William, Rappahannock, Rockingham, Shenandoah, Spotsylvania, Stafford, Warren, and Westmoreland.

The area now included in the following counties shall constitute the South Zone: Accomac, Albemarle, Alleghany, Amelia, Amherst, Appomattox, Bedford, Bland, Botetourt, Brunswick, Buchanan, Buckingham, Campbell, Carroll, Charles City, Charlotte, Chesterfield, Craig, Cumberland, Dickenson, Dinwiddie, Elizabeth City, Essex, Floyd, Fluvanna, Franklin, Giles, Gloucester, Goochland, Grayson, Greenville, Halifax, Hanover, Henrico, Henry, Isle of Wight, James City, King and Queen, King William, Lancaster, Lee, Louisa, Lunenburg, Mathews, Mecklenburg, Middlesex, Montgomery, Nansemond, Nelson, New Kent, Norfolk, Northamp-

ton, Northumberland, Nottoway, Patrick, Pittsylvania, Powhatan, Prince Edward, Prince George, Princess Anne, Pulaski, Richmond, Roanoke, Rockbridge, Russell, Scott, Smyth, Southampton, Surry, Sussex, Tazewell, Warwick, Washington, Wise, Wythe, and York.

Section 2. As established for use in the North Zone, the Virginia Coordinate System shall be named, and in any land description in which it is used it shall be designated, the "Virginia Coordinate System, North Zone".

As established for use in the South Zone, the Virginia Coordinate System shall be named, and in any land description in which it is used it shall be designated, the "Virginia Coordinate System, South Zone".

Section 3. The plane coordinates of a point on the earth's surface, to be used in expressing the position or location of such point in the appropriate zone of this system, shall consist of two distances, expressed in feet and decimals of a foot. One of these distances, to be known as the "x-coordinate", shall give the position in an east-and-west direction; the other, to be known as the "y-coordinate", shall give the position in a north-and-south direction. These coordinates, on the Virginia Coordinate System, of the triangulation and traverse stations of the United States Coast and Geodetic Survey within the Commonwealth of Virginia, as those coordinates have been determined by said survey.

Section 4. When any tract of land to be defined by a single description extends from one into the other of the above coordinate zones, the positions of all points on its boundaries may be referred

to either of the two zones, the zone which is used being specifically named in the description.

Section 5. (a) For purposes of more precisely defining the Virginia Coordinate System, the following definition by the United States Coast and Geodetic Survey is adopted:

The Virginia Coordinate System, North Zone, is a Lambert conformal projection of the Clarke spheroid of eighteen hundred sixty-six, having standard parallels at north latitudes 38° 02' and 39° 12', along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 78° 30' west of Greenwich with the parallel 37° 40' north latitude, such origin being given the coordinates: x = 2,000,000 feet, and y = 0 feet.

The Virginia Coordinate System, South Zone, is a Lambert conformal projection of the Clarke spheroid of eighteen hundred sixty-six, having standard parallels at north latitudes 36° 46' and 37° 58', along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 78° 30' west of Greenwich with the parallel 36° 20' north latitude, such origin being given the coordinates: x = 2,000,000 feet, and y = 0 feet.

(b) The position of the Virginia Coordinate System shall be as marked on the ground by triangulation or traverse stations established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first-order and second-order work, whose geodetic positions have been rigidly adjusted on the North American datum of nineteen hundred twenty-seven, and whose coordinates have been com-

puted on the system herein defined. Any such station may be used for establishing a survey connection with the Virginia Coordinate System.

Section 6. No coordinates based on the Virginia Coordinate System, purporting to define the position of a point on a land boundary, shall be presented to be recorded in any public land records or deed records unless such point is within one-half mile of a triangulation or traverse station established in conformity with the standards prescribed in section five of this act; provided that said one-half mile limitation may be modified by a duly authorized State agency to meet focal conditions.

Section 7. The use of the term "Virginia Coordinate System" on any map, report of survey, or other document, shall be limited to coordinates based on the Virginia Coordinate System as defined in this act.

Section 8. Nothing contained in this act shall require any purchaser or mortgagee to rely on a description, any part of which depends exclusively upon the Virginia Coordinate System.

Section 9. If any provision of this act shall be declared invalid, such invalidity shall not affect any other portion of this act which can be given effect without the invalid provision, and to this end the provisions of this act are declared to be severable.

Section 10. The State Planning Board is herewith designated as the authorized State agency to collect and distribute information, to authorize such modifications referred to in section six

of this act, and generally to advise with and assist appropriate State and Federal agencies and individuals interested in the development of the provisions of this act.

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