George Washington, Engineer

First published in 1932, this narrative recounts our first President's background and achievements as an engineer, surveyor, agriculturalist and land developer.

EDWARD GROSSMAN

One side of George Washington's career has been sadly neglected by his biographers. Our first President was professionally, and also by aptitude, an engineer. The neglect of this phase of his interesting life is due not so much to lack of interest as to ignorance. Of the five hundred (more or less) biographies of Washington, not one has been written by an author capable of appreciating the significance of his early career and able to reconcile it with his later work.

George Washington wrote voluminously. He left us diaries, copies of letters, journals and ledgers written during his lifetime. Professor Jared Sparks, who first collected Washington's writings (1837), attached little importance to his early journals and diaries. His lead was followed by the later biographers. They did attach importance to his "godlike calm" in the face of disorder, and to his extreme probity. These were the outstanding traits of his character. These were due, of course, to a habit of clear thinking and ability to be honest with one's self. And perhaps his attitude of mind had something to do with it. He was primarily an engineer with a thorough grasp of essentials. Side issues did not matter. This trait made him see political issues in a broad and impersonal way – not a popularizing trait, of course, but conducive to the benefit of the country as a whole. Thus, when the French Revolution broke out, and the notorious "Citizen" Genêt came over here to enlist sympathy, President Washington was almost the only one who did not lose his head. Nearly all his countrymen were clamoring to "pay our debt to France" and help her fight all Europe. The President alone saw the disadvantage of such a course and had Genêt recalled.

Washington alone remembered that it was the French King who, because of hatred for England, helped the Americans. The French people had no more to do with the desire to help the Americans than the Hessians, who were hired out by their masters to fight the colonies.

He was also a great military strategist. If it were not for him we would not be American citizens. The study of this phase of his career is productive of material enough to fill two

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books. We will not dwell upon it, except to state that he conducted the Revolutionary War as a problem in engineering. Certain "key battles" had to be won. In these he was victorious. The British won, time after time, sometimes seriously crippling the American army, yet Washington was victor, because his engineering sense taught him to pick only essentials. The British commanders did not have that attitude of mind and lost the war for their King, although they won more battles for him.

He was the first agricultural engineer in the country. He designed and built his own buildings, devised agricultural implements and conducted an experiment station.

He was the pre-eminent land developer of his time, forever trying to develop the western part of the country, forming development companies, improving communications and settling people on the land.

All that will, however, be told in its turn.

Early Background

George Washington was born on February 22 (new style), 1732, in Westmoreland County, Virginia. His father was Augustine Washington, and his mother Mary (Ball) Washington, who was Augustine's second wife. George was the eldest son of this marriage. Not long after George's birth the family moved to Stafford County on the east side of the Rappahannock River opposite Fredericksburg. There the elder Washington died at the age of forty-nine on April 12, 1743. Augustine Washington had been a thrifty planter and left his family in comfortable circumstances.

To each of his children he bequeathed an estate ranging in size from 2,500 acres, which was Lawrence's portion (he was the eldest), to the 600- or 700-acre tracts left for the younger boys. The mother was left in full charge until the respective heirs came of age.

When George was of proper age he was sent to school. In those days schools were kept for the purpose of teaching only the essentials. The real education was obtained usually in England at public schools and universities. The schools in Virginia at the time were kept by itinerant schoolmasters, parsons and the like.

George's first teacher was a Mr. Hobby, a former indentured servant and tenant on the

Washington estates. Besides his occupations of sexton and occasional farmer, Mr. Hobby was also a schoolmaster, but he could not teach George very much. The latter was then sent to Mr. Williams's school, where he received a severely practical drilling in the execution of business forms, a smattering of miscellaneous education and a great deal of mathematics. Of that Mr. Williams gave as much as the pupil desired.

Although George was a fairly apt pupil in the ordinary course of English and business forms, his greatest delights began when Mr. Williams led him through the mazes of geometry, trigonometry and surveying. He actually loved mathematics, and the more his teacher gave him, the more he desired.

The textbook used by Mr. Williams was the then popular *vade mecum* (see sidebar on the previous page). This book George studied over and over again. From it he completed his education in "Arithmetick," and learned geometry, surveying, farming, medicine and all the other good things promised on the title-page. From the lessons learned in its pages he earned his living during his professional career as a surveyor. He learned how to be methodical and precise, and to think clearly.

The following extracts from the twenty-fourth (1750) edition of this work will no doubt be of interest:

Of Surveying, or measuring Land. Note, that 16 Feet and an half make a Pole or Perch; 160 Square Poles, or 4 Roods, make an Acre of Land; 40 Poles make a Furlong, 8 Furlongs, or 17 yards, make a Mile.

Land is generally measured by a Chain of 4 equal Parts, or Links, 25 of which are a just Pole, or Perch; consequently, 10 square Chains, or 100,000 Links, make an Acre of Land. But though this Chain, called Gunter's Chain, from its Inventor, be commonly used, yet Land may be measured by a Cart-Rope, or a common Pole, 16 Feet and an Half in Length:

How to measure Land by Gunter's Chain. We have already observed that this Chain is 4 Poles in Length, or 22 Yards, which is 66 Feet, or 792 Inches; it is divided into 100 Links, at every 10 Links is a Brass Ring, for the more ready counting it in Measuring, so that it is no matter which End goes foremost; and he who draws it should carry in his Hand 10 small Sticks, to stick in the Earth at every Chain's Length, and he who follows the Chain to gather up the Sticks.

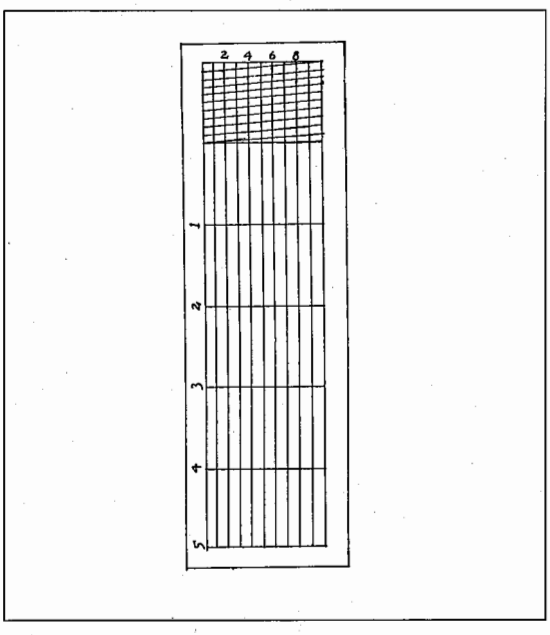


FIGURE 1. Diagonal scale.

A Description of the Diagonal Scale, very useful in plotting, &c. Land. [See Figure 1.] This Scale consists of 11 parallel Lines, equi-distant from one another, so as to include 10 equal Spaces, which are cut by perpendicular Lines, dividing the Scale into equal Parts numbered 1, 2, 3, 4, 5. One of these Divisions, viz. the last on the Right hand, is subdivided by diagonal Lines; so that if one of the Large Divisions represent Chains, a Line may be measured to a single Link, one of the large Divisions being subdivided by the diagonal Lines into 100 equal Parts, the Number of Links in a Chain; and, consequently, any Number of Chains of Links may be set off by this Scale. A little Consideration of the Figure will sufficiently explain its Nature, and render its Use very easy and expeditious. If one of the large Divisions are reckoned 10 Chains, then every one of the smaller Divisions will be 100 Links, and consequently you can only measure within 10 Links of the Truth,

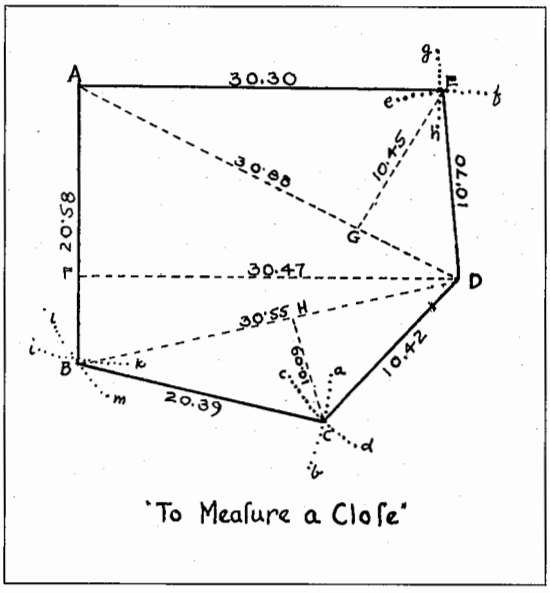


FIGURE 2. Diagram used to measure a field.

every smaller Division, which signifies 100 Links, being subdivided by the diagonal Lines into 10 Parts only. But the Practitioner should always remember to make Use of as large a Scale as possible, especially if he would have his Work exact, and always to reckon one of the large Divisions one Chain only, as the Dimensions of any Field or Parcel of Land may then be plotted with the greatest Accuracy.

To measure a Close or Field by the Chain, plot it on Paper, and find it's Content. [See Figure 2.] Let ABCDE represent the Close or Field to be measured and plotted by the Chain only. In order to do this I begin at the Corner A, and measuring in a straight Line to the Corner D, which I find 30 Chains, 88 Links, and note it down in my Paper. Then I measure along the Side of the Hedge from D to E and find it 10 Chains 70 Links, which I also note down. From thence I measure along the Side of the Fence from E to A, and having found it 30 Chains 30 Links, I note it down; and proceed in my measuring from A to B, which I find 20 Chains 58 Links. From the Corner B I measure to the Corner D, and find it 30 Chains 55 Links. From D I measure to the Corner C, and find it 10 Chains 48 Links: And from C to B 20 Chains 39 Links. Then I have taken all the requisite Dimensions. The next Operation is

To Plot the above Field on Paper. In order to [do] this I draw a Line from A, representing my first Station, of a sufficient Length, and take from my diagonal Scale 30 Chains 88 Links, and placing one Foot of the Compasses in the Point A, set off the Distance to D, which will represent the Corner of the Field I measured to from A. Then I take from my Scale 10 Chains 70 Links, and setting one Foot of the Compasses in D, describe the small Arch *ef.* I also take from the same scale 30 Chains 30 Links, and placing the Point of the Compasses in A, describe with the other the small Arch *gh,* cutting the former in E; and draw the Lines ED and EA. Then I take from Scale 20 Chains 58 Links, and setting one Foot of the Compasses in A, and with the other describe the small Arch *ik.* I also take 30 Chains 55 Links from my Scale, and setting one Foot of the Compasses in D, with the other sweep the small Arch *lm,* cutting the former in B; and draw the Line AB, and the dotted Line BD. Lastly I take 20.39 from my Scale, and from B sweep the same Arch *ab;* and with 10.48 sweep, from D, the small Arch *cd,* cutting the former in C; and draw the Lines BC and DC. Thus is the Plot finished; and every Part of it may be measured by applying it to the same Scale. Nothing now remains but

To find the Content of the Field. The Field is divided by the dotted Lines AD and BD into three Triangles, ADE, ABD, and BCD, and consequently, the Contents of these three Triangles when added together will give the Content of the whole Field: But before these Contents can be found, the Lengths of the Perpendiculars EG, DF, and CD must be measured in the following Manner: Place one Foot of the Compasses in E, and extend the other until it will just touch the Line AD, but not cut it, and measure the Distance between the Points of the Compasses on the Scale, 10 Chains 45 Links. Do the same by the Perpendiculars DF and CH, and you will find the former 30.47 and the latter 10.9 [10.09?]. Having thus found the Lengths of the three

Perpendiculars, the Areas of the three Triangles will be easily found by the Rule laid down for finding the Content of a Triangle, in the Article of Measuring Superficies.

For the Triangle ADE,

```
        3088 Length of the Base
         522 Half the Perpend.
        6176
       6176
     15440
     1611936
```

For the Triangle ABD

```
        2058 Base
        1523 Half Perpend.
        6174
       4116
     10290
     2058
     3134334
```

For the Triangle BCD

```
        3055 Base
         504 Half Perpend.
       12220
     152750
     1539720
```

```
     1611936  1st Triangle
     3134334  2nd Triangle
     1539720  3rd Triangle
Acres  62.85990
            4
Roods   3.43960
           40
Perches 13.38400
```

Thus the Area of the Field is 62 Acres, 3 Roods, and 13 Perches.

Of course, this "course" in surveying was quite meager. Mr. Williams, pleased at the young fellow's desire to learn, helped him out by explaining the use of the surveyor's compass (the transit instrument was a later invention), and encouraged his practicing the art until he was quite proficient.

Young George definitely decided he would like to be a surveyor, and in order to fit himself more thoroughly for his profession he used to run practice surveys in the neighborhood, thus making sure of digesting the teachings of *The Young Man's Companion* and of Mr. Williams. One of his practice surveys is that of Lawrence Washington's turnip field (see Figure 3). A sample set of field notes is the following:

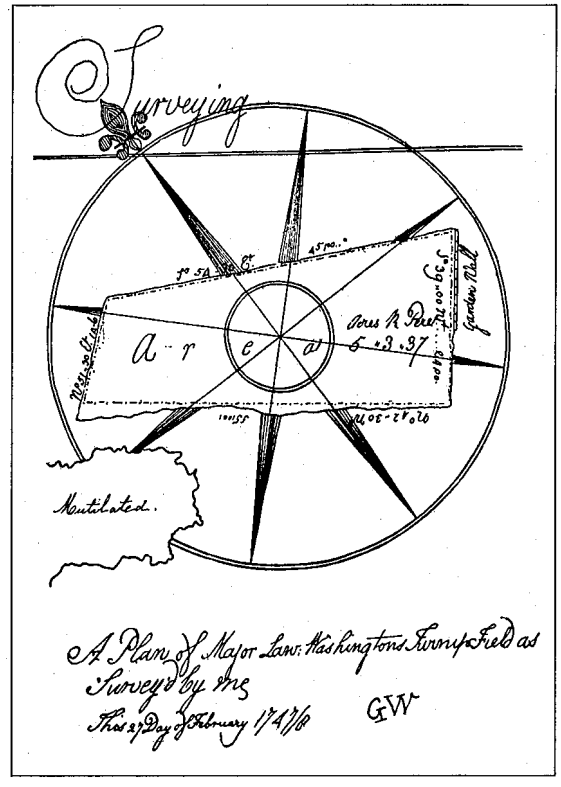


FIGURE 3. Lawrence Washington's turnip field.

> August 18th 1747[.] Then survey'd the following Piece of Land at one Station in the School House old field bounded as pr field Book. Vizt Beginning near a Persimon within ye field Extending thence to a Fence Stake S 15–00 E 165°,, 00′–28 Pole thence S 19–00 W 199°–00′–27.5 Pole thence S 47 W 227° –00′ 18.9 thence S 76–00 W 256°–00′–21.4 thence N 42 W 318°–00′–46.3 thence N 29–00 E 29°–00′–34 Pole.

But let us not laugh at this casual preparation for an engineering career. Organized engineering curricula are of comparatively recent origin.

Of his notes kept at this period one of the most interesting is one copied from those of a

survey by James Genn. The notes are as follows, the plat being Figure 4:

The Mannor how to Draw up a Return when Survey'd for His Lordship or any of ye Family.
March ye 15th 1747–8

Then Survey'd for George Fairfax Esqr. Three Thousand & twenty Three Acres of Land lying in Frederick County on Long Marsh Joyning Thomas Johnstones Land and bounded as follows

Beginning at (A) Three Hickorys Corner Trees to Thomas Johnstones Land & Extending thence along his S 13 W^t One hundred Seventy two Poles to (B) a Locust Johnstones Corner thence along another of his Lines 5 34 E^t 150 po. to (C) a White Oak another of his Corners thence S° 75 E^t 186 po & to (D) a large Hickory thence N° 58 E^t 160 po xing [crossing] a Spring Run to (E) three Red Oak Fx on a Ridge thence N° 30 E^t 436 po to a Hickory an Red Oak Fx at (F) thence N° 60° W^t 90 po to (G) a Large White Oak Fx thence No 7 Et 420 po xing Long Marsh to (H) two Red Oaks and a W: O: Fx in a Bottom in ye afores^d Thomas Johnstones line finally along his line S° 80 E^t one Hundred fourteen Poles to Ye Beginning Containing Three Thousand & twenty three Acres.

p^r JAMES GENN
HENRY ASHBY
RICHARD TAYLOR *Chain Men*
ROBERT ASHBY *Marker*
W^M LINDSEY *Pilot*

N. B. The Distances in ye above Writing ought to be Written in Letters not in figures only I have done it now for Brevity sake.

Other early surveys are illustrated by Figures 5 and 6, showing the country about Mount Vernon house and Hell Hole, respectively. Figure 7 (on page 56) shows another view of the area.

At an early age he thus learned to be methodical. All his affairs were attended to systematically, and full records were kept.

According to Sparks, Washington not only was able to use logarithms in making his calculations, but apparently got up a system of statistical mathematics for himself. On every occasion he reduced information to

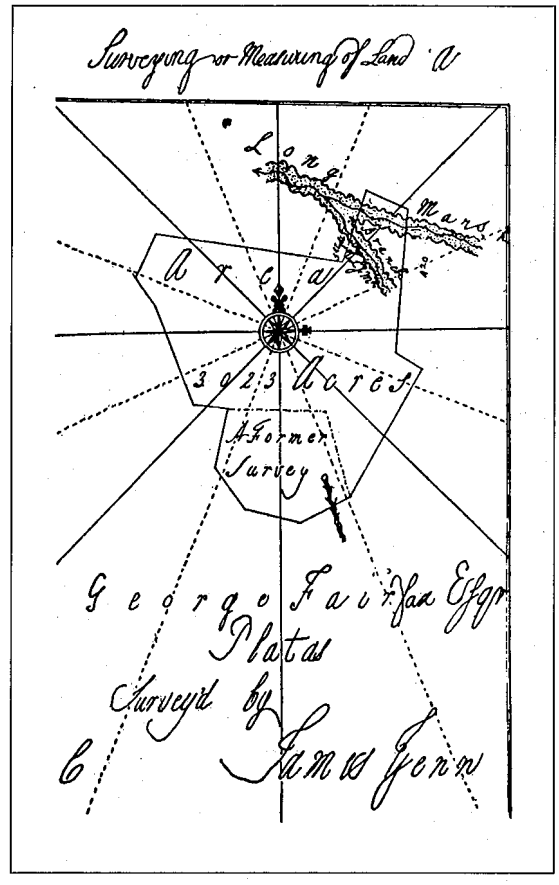


FIGURE 4. A study illustrating "The Mannor how to Draw up. . ."

graphs and tables for the better digestion of the facts:

> The constructing of tables, diagrams, and other figures. . . was an exercise in which he seems at all times to have taken much delight. . .
>
> While at the head of the army this habit was of especial service to him. The names and the rank of the officers, the returns of the adjutants, commissaries, and quartermasters were compressed by him into systematic tables, so contrived as to fix strongly in his mind the most essential parts, without being encumbered with details. When the army was to. . . perform any movement. . . a scheme was first delineated; and at the beginning of an active campaign. . . the line of battle was projected and sketched on paper, each officer being assigned to his

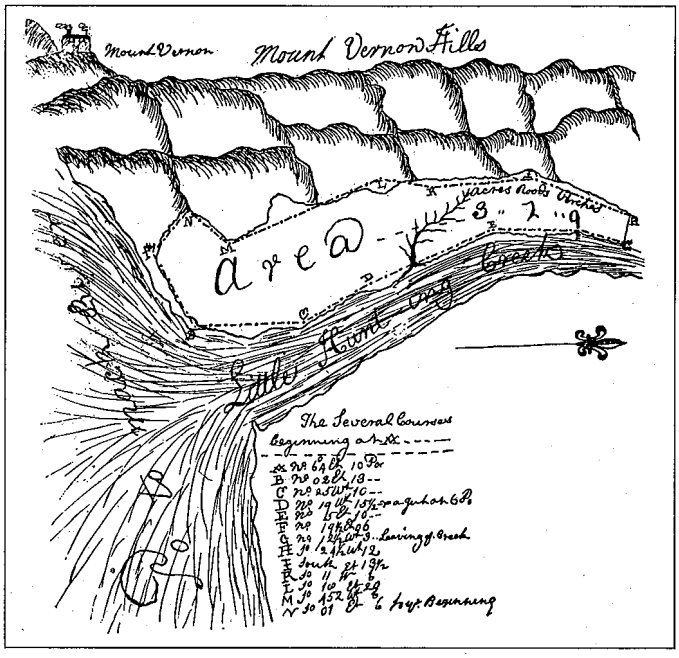


FIGURE 5. Mount Vernon Hills, 1747 (traced from original).

post, with the names of the regiments and strength of the forces he was to command. [An example of this is Figure 8 on page 56.]

During the presidency it was likewise his custom to subject the treasury reports and accompanying documents to the process of tabular condensation... it enabled him to grasp and retain in their order a series of isolated facts, and the results of a complicated mass of figures, which could never have been mastered so effectually by any other mode of approaching them. Such were some of the benefits of those parts of his education, to which he was led by the natural bent of his mind.

But the future President was not a "grind" during his boyhood. His leisure moments he filled with manly sports. There was not a better or a more daring horseman than this tall, husky boy of fifteen who was well to the fore in every fox hunt. He could wrestle with the best of his companions, and as a drillmaster in the mimic warfare which the boys of that day effected he was an acknowledged expert. Withal, George had a reputation for probity which caused all disputes to be left to his arbitration, and no objection was ever made against his decisions.

He had now become almost sixteen years of age. His boyhood was over. Now he was to take his place among men.

He had taken full advantage of his education and had become a competent surveyor as far as theory was concerned. All he needed was practice, and that was soon forthcoming.

Early Career

Lord Fairfax, a neighbor to the Washingtons, was an elderly and affluent bachelor, who, having visited Virginia, forsook his native England and came to live in the New World. He was an enthusiastic huntsman, as was young Washington, and thus they were brought constantly together.

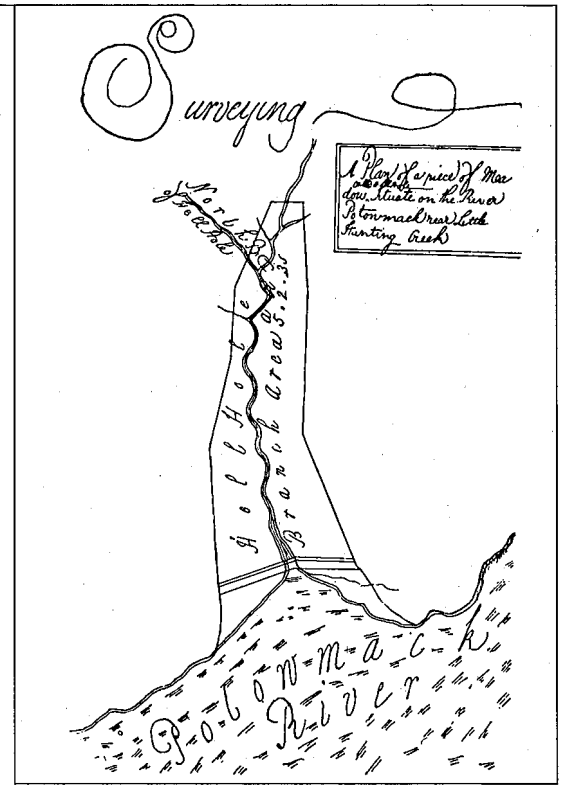


FIGURE 6. Survey of land known as Hell Hole.

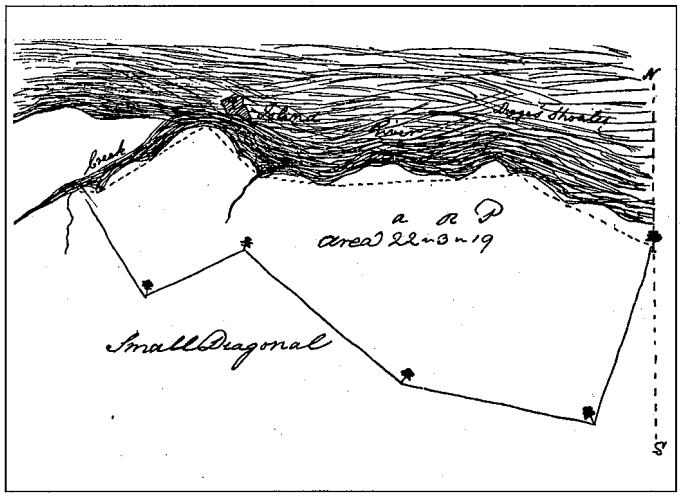


FIGURE 7. Survey of land known as Hell Hole.

Lord Fairfax owned a huge grant of land on the other side of the Allegheny Mountains. This had never yet been surveyed, nor, indeed, been looked after in any way at all. His Lordship decided to survey the land, divide it into lots, and discourage the squatters who were making free there. To George Washington he offered the job of surveyor. Needless to say, the offer was quickly accepted. Preparations were speedily completed, and the party, consisting of George Washington, George Fairfax, a nephew of Lord Fairfax, and some assistants, started out. At Mr. Neville's, in Prince William County, Mr. James Genn, a licensed surveyor, joined them.

It was while on this trip that young Washington first began keeping his diaries, which are now of great historical value. We have room for only a few selections:

> Fryday, March 11th 1747–8. Began my Journey in Company with George Fairfax, Esqr.; we travell'd this day 40 miles to Mr George Neavels in Prince William County.

The double dating of the year was due to the following reason: January 1 was accepted as the beginning of the historical year, while March 25 was held by some to be the

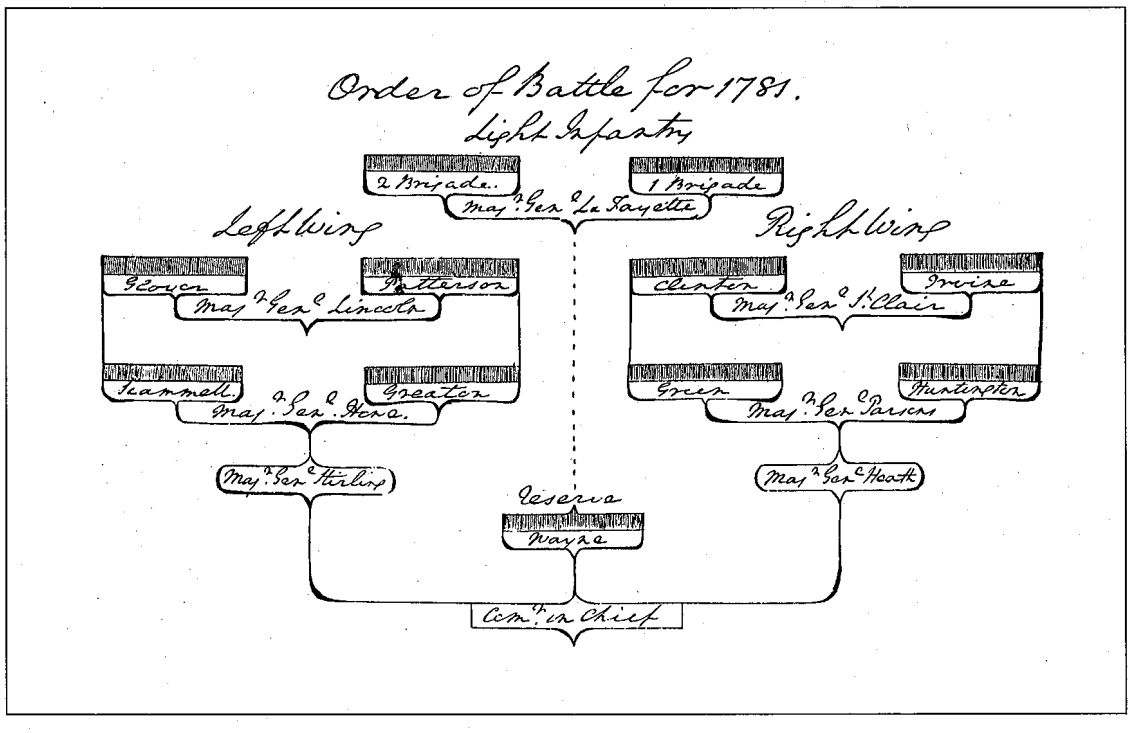


FIGURE 8. An order of battle for 1781.

beginning of the civil or legal year. Double dating was used between January 1 and March 25 of the year, the single date being used the rest of the year. When the Gregorian (new style) calendar was adopted by Britain in 1752 this double dating stopped. The year of this Journal is 1748:

Saturday March 12th this morning Mr James Genn ye surveyor came to us, we travell'd over ye Blue Ridge to Capt Ashbys on Shannondoah River, Nothing remarkable happened.

Monday 14th We sent our Baggage to Capt Hites (near Frederick Town) went ourselves down ye River about 16 Miles to Capt Isaac Penningtons (the Land exceeding Rich & Fertile and all ye way produces abundance of Grain Hemp Tobacco &ca) in order to lay of some Lands on Cates Marsh & Long Marsh.

Work was started promptly the same day, as is testified by the following field notes:

March y. 15th 1747-8. Survey'd for George Fairfax Esqr. a Tract of Land lying on Cates Marsh and Long Marsh beginning on three Red Oaks Fx on a ridge the N° Side a Spring Branch being corner to ye 623 Acre Tract & Extending thence N° 30° Et 436 poles to a Large Hickory and Red Oak Fx near John Cozines House thence N° 60° Wt 90 poles to a Large White Oak Fx thence N° 7° Et 365 poles to Long Marsh 420 poles to 2 Red Oaks and W: Oak in a Poyson'd field by a Road thence N° 65° Wt 134 poles to a W: Oak by ye sd Marsh thence crossing ye Marsh S° 20° Wt 126 poles to another Branch: of Long Marsh 218 po: to a Red Oak Fx thence N° 80° Wt 558 p0: to a Large Red Oak & White Oak Fx in a Valley thence So 25° Wt 144 poles to a Black Walnut in a Poyson'd Field by a Lime Stone Rock thence S° 33½° Et 96 to a White Oak thence S° 80° Et 316 po. to three Red Oaks in a Bottom in Wm Johnstones line thence with Johnstones S° 80° Et 30 po to a Double Hickory Coll°. Blackburns corner 114 po to 3 Hickorys Johnstones corner & corner to ye aforesaid 623 Acre Tract thence along ye lines thereof East 280 poles to 3 Red Oaks finally along another of the lines thereof S° 15° Et 262 po to ye beginning

HENRY ASHBY	
RICHARD TAYLOR	*Chain Men*
ROBERT ASHBY	*Marker*
WM LINDSEY	*Pilot*

The "marker" was probably rodman; the "pilot," instrumentman.

The following notes describe a rectangular lot. Apparently George Washington did not have any difficulties about his closures. Note that the pilot's name is not mentioned. George himself was probably instrumentman.

March 29th 1748. Surveyed for Mr. James Rutlidge ye following a piece of Land Beginning at 3 W. O. in ye Mannor Line by a Path leading to y. Clay Lick & Extending thence N° 44° Wt 164 po. to a White Oak by a Drain at ye foot of a Mountain thence N° 46 Et 487 po. to 2 White Oaks near a Branch call'd Clay Lick Run thence S° 44°Et 164 po. to 2 W. O: & a Hickory in ye Mannor Line Finally along ye Mannor Line Reversed S° 46° Wt 487 po to y. Beginning.

HENRY ASHBY	
RICHARD TAYLOR	*Chain Men*
WM DUNCAN	*Marker*

Washington acquitted himself creditably on the expedition and returned home on Wednesday, April 13, 1748. From the general language of the Journal kept on the expedition, it is clear that he was the Chief of Party — quite a responsibility for a lad of sixteen. It must be remembered that he not only had to survey the tracts, but *find them also*, the general location having been given, but in all probability without a map to guide him.

Having acquitted himself as a man, the young surveyor naturally looked about for permanent employment in his beloved profession. Through the efforts of Lord Fairfax the young man was appointed county surveyor. Being thus licensed, his surveys became clothed with the authority of court records, and — a less desirable state of affairs — he

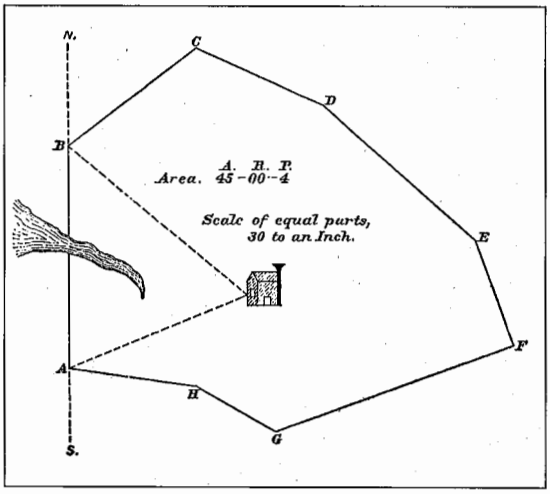


FIGURE 9. Francis Jett's land.

had to pay over part of his fees to William and Mary College, the licensing authority.

For three years in all he practiced his profession. A letter, written by him during this period, describes to some extent his life at the time. The spelling and punctuation are as corrected by Professor Sparks:

DEAR RICHARD: — The receipt of your kind favor of the 2d instant afforded me unspeakable pleasure; as it convinces me that I am still in the memory of so worthy a friend, — a friendship I shall ever be proud of increasing. Yours gave me the more pleasure, as I received it among barbarians and an uncouth set of people. Since you received my letter of October last, I have not slept above three or four nights in a bed, but, after walking a good deal all day, I have lain down before the fire upon a lit-

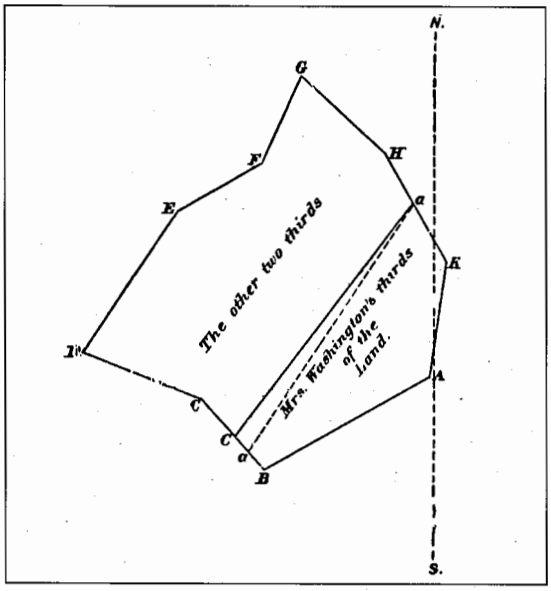


FIGURE 10. Elizabeth Washington's land.

TABLE 1.
Survey Data for Francis Jett's Land

Then Survey'd for Mr Francis Jett the following Tract of Land Bounded as pr Field Book.

[Station]	[Course]	[Poles]
A	N	56.15
B	N 51–00 E	39.19
C	S 65–00 E	34.14
D	S 49–00 E	50.15
E	S 70–00 E	29.00
F	S 70–00 W	62.13
G	N 58–30 W	20.24
H	S 83–30 W	30.00

Remarks ye distance from A to B being Inaccessable I took an angle within ye field from A to a house bearing N 73°–00 E 46 Pole thence to B bearing N 48–00 W.

TABLE 2.
Survey Data for
Elizabeth Washington's Land

Survey'd for Mrs Elizabeth Washington ye Following Tract of Land whose thirds is required to be laid of 20 Pole from H towards K & the Division line to run towards BC.

A	S 54,, 00 E	67,, 00
B	N 45,, 00 W	36,, 00
C	N 76,, 00 W	45,,—
D	N 31,, 00 E	60,,—
E	N 56,, 00 E	35,,—
F	N 21,, 00 E	30,, 24
G	S 51,, 00 E	40,, 20
H	S 34,, 00 E	41,, 60
I	S 04,, 00 W	34,, 20

Area	Acres	Roods	Perch
	52,,	1,,	39,,

tle hay, straw, fodder, or a bearskin, whichever was to be had, with man, wife, and children, like dogs and cats; and happy is he, who gets the berth nearest the fire. Nothing would make it pass off tolerably but a good reward. A doubloon [about $7, 1932 dollars] is my constant gain every day, that the weather will permit of my going out, and sometimes six pistoles [three doubloons]. The coldness of the weather will not allow of my making a long stay, as the lodging is rather too cold for the time of the year. I have never had my clothes off, but have lain and slept in them, except the few nights I have been in Frederictown.

His notes were neatly kept as usual. The following examples will no doubt be of interest. The first example is a survey of Mr. Francis Jett's land (see Figure 9 and Table 1). Note how he measured his line across the stream. Figure 10 and Table 2 illustrate another survey. Figure 11 is the plat of a lot, and is also used as the title-page for a field book:

Survey'd for Richard Barnes Gent^{n} of Richmond County a certain Tract of Waste and ungranted Land Situate Lying and being in the county of Culpeper and Bounded as followeth Beginning at three white Oaks in Normans Line and Corner Trees to (Aaron Pinson's now) Mr Barnes's Land & Extending thence N° 42° 30′ W^{t} Ninety five Poles to a Branch of Flat Run Two hund^{d} and Eighteen Poles to a Large White Oak Corner to Norman thence along another of his Lines N° 39° E^{t} Thirty four Poles to three white Oaks & a Hickory Cor: to the said Norman and John Roberts thence along Robert's Line S° 78° W^{t} One hund^{d} and Eighty three Poles to the Road that Leads over Norman's Foard Two hund^{d} and Sixteen Poles to two white Oaks in a Glade Cor^{r} to the said Roberts and Mr Francis Slaughter thence with the said Slaughters Line S° 5° W^{t} One hund^{d} and Sixty four Poles to three white Oaks in the said Slaughter line thence leaving his Line S° 66° E^{t} Two hund^{d} and thirty Six Poles to three white Oaks amongst a Parcel of Rock

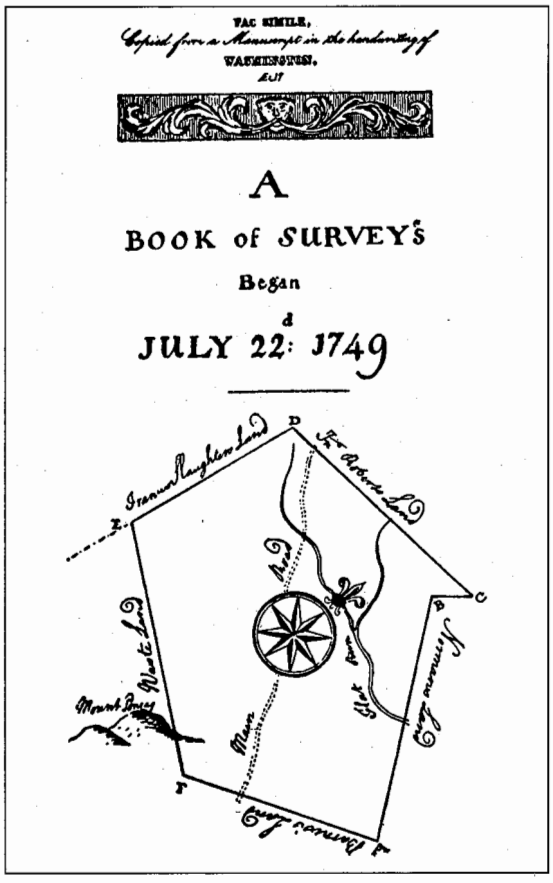


FIGURE 11. Survey for Richard Barnes.

Stones Barnes's Corner thence with his Line N° 53° E^{t} One hund^{d} and Eighty Six Poles to the Beginning Containing Four Hundred Acres this Twenty Second Day of July 1749.

WASHINGTON SCC
JOHN LONEM
EDWARD CARDER *Chain Men*
EDWARD HOGAN *Marker*

"Washington SCC" is supposed to mean "Washington, Surveyor Culpeper County."

Figure 12 represents two lots of a subdivision on the "Cacapehon" or Lost River (so-called because for three miles it is subterranean). They belong to Francis and William McBride. A similar lot belonging to a Robert Denton adjoins it. Figure 13 represents an additional survey on the Lost River.

George Washington did quite a bit of surveying in that region. He was, in fact, a very

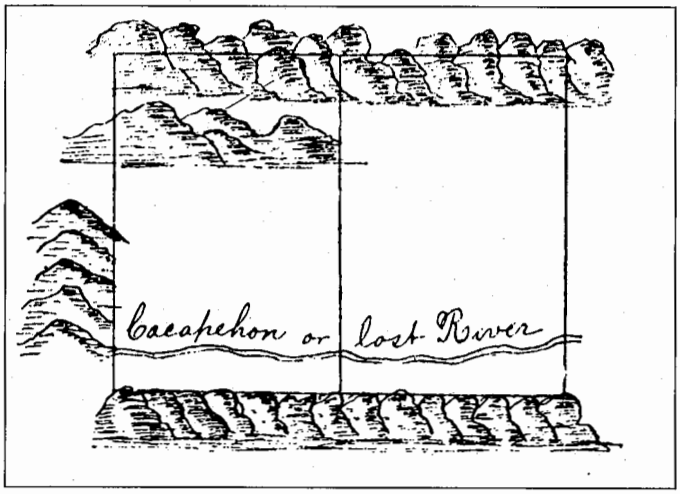


FIGURE 12. The lands of Francis and Williams McBride, Lost River.

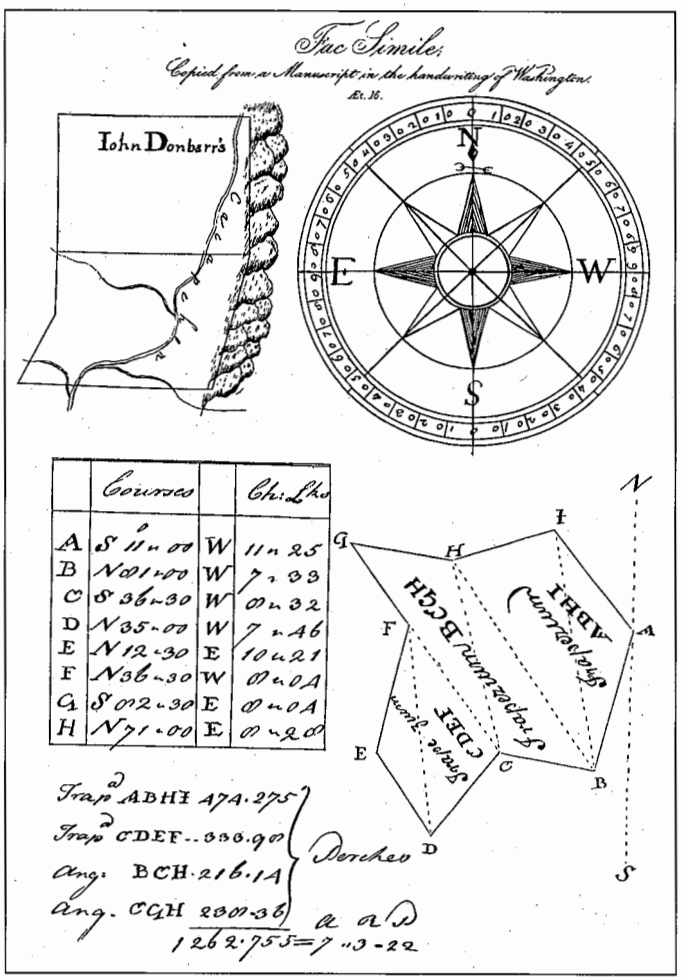


FIGURE 13. Another survey on the Lost River.

popular surveyor, his popularity being due to his exactitude. Later surveys — and even recent ones — could not find any errors in his courses and measurements.

This is all the more remarkable when we remember the numerous sources of error possible with a chain, and that a great deal of surveying in Washington's time was done by means of the chain alone, the angles being laid out by latitude and departure measurements in the field, with the values found in tables of natural functions of angles. If we recollect rightly, "Breed and Hosmer" does not include this method as standard.

But this phase of his career was soon to close. His elder brother Lawrence became ill of pulmonary tuberculosis and went to Barbados to cure himself. George went with him. The tropical air was of no aid to the sufferer, however. Lawrence Washington died. George came back to live at Mount Vernon, the property having become his.

He soon left home to fight in the French and Indian War, having been appointed a major in the provincial forces. He came back, covered with glory and the foremost soldier in the colonies.

At Mount Vernon he stayed from the close of the French and Indian War to the outbreak of the Revolution. During that time he married, became a vestryman, a Burgess, and quite a power in the community. Of his services in the Revolution we need not speak here.

Washington, the Farmer

We will now pay some attention to our first President as an agriculturist. In these days, when there are enough varieties of engineers to make Vitruvius turn over

in his grave, it is rather difficult to forbear enrolling our illustrious subject in the ranks of agricultural engineers.

He designed all his farm buildings, experimented with crops and ran an experiment station of his own, the results of which he put to good use in running his estate. Of his plans for agricultural buildings, Figure 14 shows part of his plan for a sixteen-sided barn, built in 1793. He calculated that 140,000 bricks would be required for it. These were made on the estate. The threshing-floor was 30 feet square with 1½-inch spaces left between the boards so that the grain when trodden out by horses or beaten out with flails would fall through to the floor below, leaving the straw above.

He constantly endeavored to rouse his neighbors from their shiftlessness, but to no purpose. They persisted in their unscientific farming and envied his profits. Lack of space does not permit examples of his minute planning for rotation of crops.

Not only was he the country's foremost agriculturist, but he devised and used much labor-saving machinery. The following extracts from a letter to Theodoric Bland describe and explain the use of a "drill plough" which he devised:

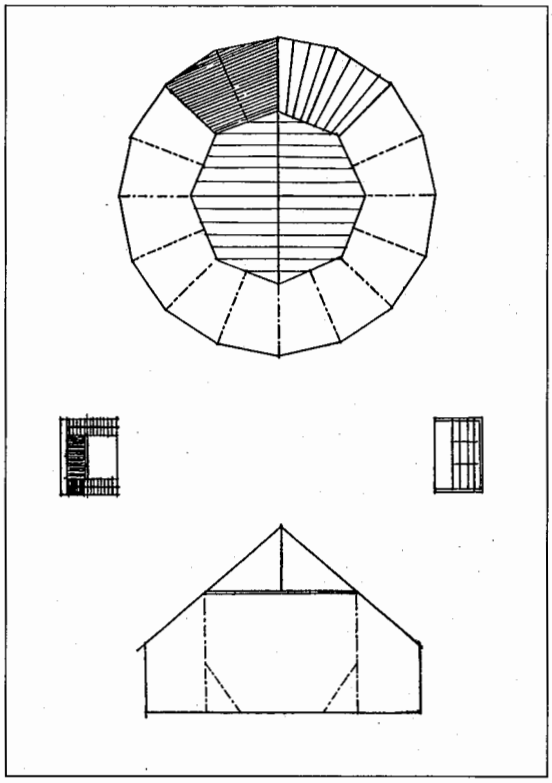


FIGURE 14. Washington's sixteen-sided barn (from his plan).

MOUNT VERNON,
28 December 1786.

DEAR SIR: — I am now about to fulfill my promise with respect to the drill plough and timothy seed. . . .

To give you a just idea of the use and management of it, I must observe that the barrel at present has only one set of holes, and those adapted for the planting of Indian corn, only eight inches apart in the row; but by corking these, the same barrel may receive others of a size fitted for any other grain. To make the holes, observe this rule; begin small and increase the size, till they admit the number of grains, or thereabouts, you would choose to deposit in a place. They should be burnt, and done by a guage, that all may be of a size, and made widest on the outside to prevent the seeds choking them. You may, in a degree, emit more or less through the same holes, by increasing or lessening the quantity of seed in the barrel. The less there is the faster it issues. The compressure is increased by the quantity, and the discharge is retarded thereby. The use of the band is to prevent the seeds issuing out of more holes than one at a time. It may be slackened or braced according to the influence the atmosphere has on the leather. The tighter it is, provided the wheel revolves easily, the better. By decreasing or multiplying the holes in the barrel, you may plant at any distance you please. The circumference of the wheels being six feet, or seventy-two inches, divide the latter by the number of inches you intend your plants shall be asunder, and it gives the number of holes required in the barrel.

By the sparse situation of the teeth in the harrow, it is designed that the ground may be raked without the harrow being clogged, if the ground should be cloddy or grassy. The string, when this happens to be the case, will raise and clear it with great ease, and is of service in turning at the ends of

rows; at which time the wheels, by means of the handles, are raised off the ground, as well as the harrow, to prevent the waste of seed. A small bag, containing about a peck of the seed you are sowing, is hung to the nails on the right handle, with a small tin cup the barrel is replenished with convenience, whenever it is necessary, without loss of time, or waiting to come up with the seed-bag at the end of the row. I had almost forgot to tell you that, if the hole in the leather band, through which the seed is to pass, when it comes in contact with the hole in the barrel, should incline to gape, or the lips of it turn out, so as to admit the seed between the band and the barrel, it must be remedied by riveting a piece of sheet tin, copper, or brass, the width of the band, and about four inches long, with a hole through it, the size of the one in the leather. I found this effectual. I am, dear Sir, &c.

He must have sent a sketch with the letter. The spelling and punctuation are as corrected by Professor Sparks.

Washington kept a diary, from which are taken the following extracts:

January 1st 1760 – Visited my plantations, and received an instance of Mr. F.'s great love of money, in disappointing me of some pork because the price had risen to twenty-two shillings and sixpence after he had engaged to let me have it at twenty. Found Mrs. Washington upon my arrival broke out with the measles.

8th Directed an indictment to be formed by Mr. Johnston against J. B. for a fraud in some iron he sold me.

Evidently Colonel Washington believed in living up to specifications:

February 10th Ordered all the men from the different quarters to assemble at Williamson's quarter in the morning to move Petit's house.

March 6th Fitted a two-eyed plough, instead of a duck-bill plough, and with much difficulty made my chariot wheel-horses plough.

7th – Put the pole-end horses into the plough in the morning and put in the postillion and hind horse in the afternoon, but the ground being well swarded over, and very heavy ploughing, I repented putting them in at all, for fear it should give them a habit of stopping in the chariot.

14th – Mr. Carlyle and his wife still remained here. We talked a good deal of a scheme of setting an iron-works on Colonel Fairfax's land on Shenandoah.

17th – Went to my mill and took a view of the ruins, which the fresh had caused; determined, however, to repair it with all expedition, and accordingly set my carpenters to making wheel and hand barrows.

19th – Peter (my smith) and I, after several efforts to make a plough after a new model, partly of my own contriving, were fain to give it over, at least for the present.

26th – Spent the greatest part of the day in making a new plough of my own invention.

When he had no machinery, he just went ahead and made it himself.

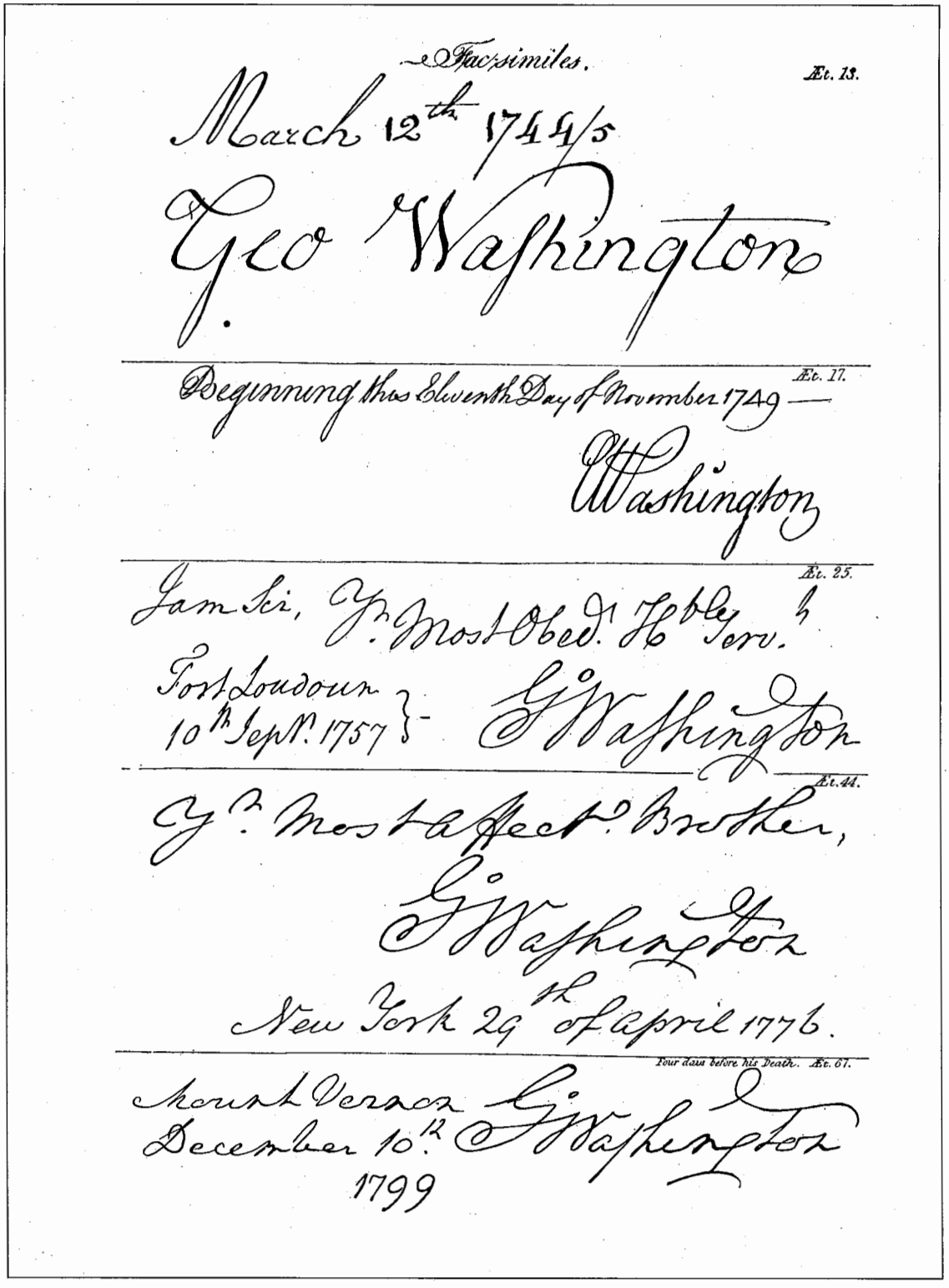
Washington, Land Developer

As a land developer he was way ahead of his time. He knew that the young, lusty Nation must grow. In order to grow, it must have more land. He therefore lent all possible aid to settlers in the West. He bought up a lot of land in the Ohio country, which he tried to rent out to cultivators. A great deal of the land he received for services in the French and Indian War; some he bought; some he staked out from unappropriated lands offered by Virginia.

He organized or took part in several companies whose aims were to develop waste land, such as the Great Dismal Swamp company, the Mississippi Company and others.

Other Interests

Another great interest of his was in opening the navigable streams, so that the western part of the country might be connected by a network of canals with the eastern part. He held that when communications are easy the country can grow and be united.



Facsimiles of Washington's handwriting at 13, 17, 25, 44 and 67 years of age (from top to bottom). The last sample was from four days before his death.

In a letter to Richard Henry Lee, President of Congress, he urged that the western waters be explored, their navigable capabilities ascertained, and a complete map be made of the country; that in all grants for land by the United States there should be a reserve made for special sale of all mines, mineral and salt springs, and that a medium price should be adopted for the western lands, sufficient to prevent monopoly, but not to discourage useful settlers.

It is surprising how modern he was in all his views. The program mapped out to Mr. Lee is in many ways paralleled by recommendations made in recent directors' reports of the various government bureaus in charge of these matters. So far, of course, no systematic schemes have been followed. The country, for example, is not even now completely mapped in accordance with United States Geological Survey Standards. Neither has the Coast and Geodetic Survey been able to set itself a program that would be supported by Congress financially.

That Washington had good judgment on the use of various building materials, with which he was experimenting constantly, may be gathered from the following extract from a letter to Count de Moustier, under date of December 15, 1788:

> I have formerly been somewhat curious in making experiments relative to cements; particularly that which derives its name from Loriot, but have never been able to succeed to my wishes. I was delighted with the idea that the cement used by the ancients had in all probability been rediscovered. Some time in the late war I employed three or four-of the principal French engineers in our army to make some mortar into a consolidated mass [concrete?], according to the printed directions for making Loriot's cement, with a copy of which they were furnished. But the result, after many trials, was infinitely distant from what we have been led to expect. As the process was strictly in conformity to the prescribed rules, I know not to what cause the failure of success should he attributed.

That he knew what good bricks are may be seen from the following instructions to his brickmakers, making bricks for a barn:

> Gunner and Davis must repair to Dogue Run and make bricks there, at the place and in the manner which have been directed, that I may have no salmon bricks in that building.

Several books have been written concerning his supervision of the planning of Washington City by Major l'Enfant, so that no mention need be made here.

During the canalization of the Potomac River, one of the engineers proposed a means of doing away with the locks at the rapids. President Washington's opinion, expressed in a letter to Tobias Lear (December 21, 1794), is most interesting:

> The plan of Mr. Clairborne's engineer, as far as I understand it, is to avoid locks altogether. The vessels are received into a basket, or cradle, and let down by means of a lever and pulleys, and raised again by weight at the hinder extremity of the lever, which works on an axis at the top of a substantial post fixed about the center of the lever. On this principle, but differently constructed, Mr. Greenleaf a few months ago showed me a model of the efficacy of which he seemed to entertain the most exalted opinion. My doubts of the utility of both arise first, from the insufficiency of any machinery of this sort to bear the weight of the cradle when charged with water and a loaded boat therein, and its aptness to get out of order by means thereof; secondly, I do not find that they are in general use; and thirdly, because if I recollect rightly, Mr. Weston has told me, but of this I am not certain, that no method of raising and lowering boats has been found equal to that of locks. Still, as I observed in my last, I should be for hearing the opinions and explanations of any and every scientific and practical character that could be easily got at on this subject, and therefore would hear Clairborne's engineer, as well as Mr. Weston. . . .

He gave great encouragement to James Rumsey, who was working on the invention of a steamboat. Rumsey, however, died in London before he could perfect it.

In 1780 the American Philosophical Society elected him to membership. The following letter to President Reed was written in reply to the announcement of his election:

MORRISTOWN,
15 February, 1780

SIR: — I am much indebted to your Excellency for announcing my election as a member of the Philosophical Society. I feel myself particularly honored by this relation to a society, whose successful efforts for promoting useful knowledge have already justly acquired for them the highest reputation in the literary world. I entreat you to present my warmest acknowledgments and to assure them that I shall with zeal embrace every opportunity of seconding their laudable views, and manifesting the exalted sense I have of the institution. The arts and sciences essential to the prosperity of the State, and to the ornament and happiness of human life, have a primary claim to the encouragement of every lover of his country and of mankind. With the greatest respect and esteem, I am, Sir, &c.

Conclusion

Such are the highlights of the unemphasized parts of George Washington's career. Full justice has not been done, owing to lack of space. It is hoped that enough has been said to make us all proud of George Washington, not only for what the world knows him as — a soldier, statesman and patriot — but also as a high type of engineer.

EDWARD GROSSMAN *was an engineer whose offices were located on Tremont Street in downtown Boston. He published a number of articles in the* Journal of the Boston Society of Engineers *and was elected an Associate Member of BSCE in December 1927.*

NOTES — *This article was reprinted, with minor stylistic changes, from Volume XIX, No. 3, of the* Journal of the Boston Society of Civil Engineers *in March 1932. Spellings and usages from Mr. Grossman's original article have been retained, including those from his source material.*

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