The Allegheny Portage Railroad. Washington said the inclined planes were "neither steep nor very long." It is difficult to remind ourselves there was no locomotive engine in existence in 1825 that could haul a payload up a slope like this one. It is one part of the Allegheny Portage Railroad, which continues in service as a residential street near Lilly, Penn. (McCullough and Leuba 1962). In 2007, an average motorist, traveling in a private automobile, can traverse one of the inclined planes of the railroad in a minute, almost without being aware of it.

of most of us, at first impress of the new home, yet we were all so glad to be under our own roof tree once more, and have regular meals and regular hours for sleeping that there was no audible grumbling—The house was small for so many[21]—before everything was regulated there were many bickerings, and divisions of opinion.

My father was not there, he did not arrive for a month being busy on the Delaware aquaduct—The work at Trenton he directed by correspondence—Swan had a small force of carpenters & laborers putting up buildings and machinery—

The East was then very different from the West as Pittsburg was still called. There was no coal smoke.[22] Houses and atmosphere clean and clear—Trenton was perfectly flat and we had been used to hills—The belated equinoctial was ushered in by a howling NorthEaster which was a revelation to us, such storms being unknown in Saxonburg. The weeds were different also the woods the crops and the people. plenty of niggers[23]—the busy Canal and the many R.R. trains were novelties, especially the propellers[24]—something new then—

In the marketing there was a great difference—Sweet potatos were plenty and cheap and a favorite dish. It was also a great peach year, they sold for a shilling a basket. In Saxonburg they had brought a cent a piece so my mother set them all at stewing and preserving them and making dried peaches. And as for fish, my good old grandmother was in ecstacies—she had been raised in a fish town, but never a one had she seen in Saxonburg for 18 years and here the markets groaned with them I really had more than I wanted—**[129]** It was too late that fall to make garden or raise anything, the garden was laid out however and crops decided on for next year—

The market being so near it was no longer necessary as it had been in Saxonburg to lay in supplies of provisions—neither did we board the men any more, which made it easier for my busy mother[25]—In October my father came down from the Lackawaxen and stayed awhile. We children had seen so little of him for a year or so that we had become a little wild and did not take kindly to the restraint—I was promptly packed off to school with the Hon. Dr. Ewing,[26] a gentleman of the old school, resembling old Benj. Franklin with his silk knee breeches and embroidered vest—the queue had only recently been discarded—His rooms in chancery court accommodated perhaps 20 pupils—There I

[21] Three married couples and six children living in 1,320 square feet of space surely would involve some crowding. Apparently, the two Kunze men had to find their own accommodations elsewhere in Trenton.

[22] In Trenton, the primary fuel was anthracite, which creates much less smoke when burned compared to the bituminous coal of western Pennsylvania.

[23] Human slavery was abolished by law gradually in Pennsylvania, starting in 1780, but it remained completely legal in New Jersey until 1846. Two-thirds of all remaining slaves of the Northern states were in New Jersey at this time (Trenton 1929).

[24] This is a reference to one of several mechanical systems used for pulling canal boats.

[25] Presumably, Mrs. Swan and Mrs. Herting assisted the pregnant Mrs. Roebling with household work.

[26] Dr. Francis A. Ewing (1806–1857), a local physician, was educated at Princeton and the University of Pennsylvania and had been principal of the Trenton Academy from 1844 to 1847. He operated a small school in his home at Chancery Court (Trenton 1929).

commenced all over again with the latin primer grammar and geography, no further ahead than I was at Henne's school, three years before. This simply proves that I should have been allowed to stay in Saxonburg a few years longer.

My father now began to push the rope works with much energy, orders were accumulating, and the rope making at Saxonburg would stop for good with close of navigation. There was one long rope for the South Carolina state road where they cross the Blue Ridge by a plane 3300 ft long (long since abandoned) which was ~~in~~ specially urgent.[27] Vancleve & McKean of the Trenton machine works were behind in their machinery and when it was tried the belts slipped and would not drive, so that everything had to be rearranged causing another months delay. Another trip had also to be made to the aquaducts before close of navigation, to settle affairs for the winter, which proved to be a severe one [**130**] On the 12th of Dec. 1849 Mr. Roeblings third son Charles was born, all the previous children having been born in Saxonburg. This boy as he grew up was more like his father than any of the others—he resembled him more in features, stature, walk, manner and mental peculiarities, exhibiting much of the same intensity and force of action, but while he had a kinder heart after it was formed, he lacked a certain breadth of mind, polish of manner, and that comprehensive intellect, which stamped Mr. Roebling senior a great man among his fellows. Of course, there was a great difference between their respective early environments and circumstances, yet my observation tells me that 9/10th of all mental characteristics are inborn and that both parents influence it—

Shortly before Christmas a very serious accident happened to my father by which he ~~very~~ nearly lost his life and was permanently injured—The rope making machinery had been successfully started. while watching its operation he stood near the weight box of the countertwist machine—unconsciously seizing hold of the wire rope which pulls it up, his left hand was drawn in, into the groove of the rope sheave. His cry of agony was fortunately heard by Swan who happened to stand near the engine—he instantly reversed the machine, and the mangled arm was slowly liberated, then he fell backwards into the pit apparently lifeless—After a time he rallied. Dr. Coleman[28] attended to the crushed wound which had lacerated the tendons of his left hand & fingers—

[27] John had promised to ship the rope at the end of September, but it was not finished until mid-November (Schuyler 1931). Washington was confused about the end use. The inclined plane was located in the Savannah River valley in Aiken, South Carolina (Derrick 1930).

[28] James B. Coleman (1805–1877), who had been trained at Yale Medical School, was the foremost surgeon in the city of Trenton. There were no emergency hospitals in the United States at that time, although hospitals for treatment of the poor and the insane had been established in Philadelphia and New York (Trenton 1929).

The fingers remained stiff for life, while the movement of the hand at the wrist was much impaired. Recovery was tedious, much of his water cure was applied, to Dr. Coleman's **[131]** great disgust, who insisted on it that a certain amount of pain & inflammation was necessary to promote healing. After a month he walked about again in the house and in February was able to travel—I went along to help dress him and act as a sort of young nurse, a part I played for 2 or 3 years—The mental shock of such an accident was so great, as so much depended at that time on his personal health, and he could not know how his wound would heal—He attributed his recovery entirely to the water treatment—The same treatment killed him twenty years later—

All flute playing & piano playing (except with the right hand) came to an end, while drawing was more difficult and many actions were seriously impaired—and yet it was after he had been handicapped in this way that he accomplished his greatest engineering works—aquaducts

The Delaware & Hudson Canal served to connect the anthracite coal regions of the Susquehanna and Lackawanna valleys with the tidewater of the Hudson at Rondout—The 4 Suspension Aquaducts were commenced in the winter of 1848 and completed in 1850—Their dimensions were as follows:

Lackawaxen aquaduct,	2	spans of	115	ft.	each &	two	7	inch	cables		
Deleware	"	4	"	"	134	"	"	"	8	"	"
High Falls	"	1	"	"	145	"	"	"	8-1/2	"	"
Neversink	"	1	"	"	170	"	"	"	9-1/2	"	"

They are essentially permanent works,[29] only the trunk requiring occasional renewal—They were built in contract[30]—**[132]** The Lackawaxen aquaduct was first commenced,[31] then followed the Delaware aquaduct (or dock as they are called for short)—They were located very near each other, the first one crossing near the mouth of the Lackawaxen and the other crossing the Delaware perhaps half a mile below. Hence one general office answered for both—This country at that time was very wild and unsettled. Wolves could be heard howling at night—The Erie R.R. was then being built, the Delaware section using all rock-cut and very expensive. The track reached the aquaducts before they were finished. The wire was mostly furnished by Crocker of Sheffield England—and masonry built from stone nearby—Cement of course came from Rondout.[32]—The same process of

[29] All four aqueducts were still in use when Washington wrote this manuscript. They were all abandoned in 1898.

[30] These words seem to have been added hastily at the bottom of the page as a reminder. Stonework for the aqueducts was not part of John's contract. Washington refers only to the cables and woodwork (Osbourne 1984).

[31] The papers of Russel F. Lord indicate that the Delaware Aqueduct was commenced first, early in 1848, followed by the smaller Lackawaxen Aqueduct later that year. Both were completed by April 1849 (Osbourne 1984).

[32] During the original construction of the Delaware and Hudson Canal in 1826, a natural cement industry, afterward known as Rosendale, was established near Rondout. This cement was not the same product as Portland cement (Wakefield 1971).

cable making was pursued as at the Pittsburg aquaduct, light footbridges being first thrown across—

David Rhule Jonathan's brother, was Master Carpenter and boss cable maker, the latter business he had to learn, having had no experience—David remained with my father for the next 18 years.[33] While he was not a very able man, he possessed the faculty of getting along with him ~~father~~ , a rare quality. He was conscientous, faithful and honest. Coming from old German stock in the 7th generation already, he still possessed the straight-forward simple mindedness of the South German, who need a mastermind to guide him—Born in Blair Co. Penna. 1807 died of old age in his 83d year—
Pa. dutch water cure

Being so much with my father he of course had to espouse the cause of hydropathy. The two spent their leisure hours in packing each other in sweat packs, douching, squatting in tubs and indulging in the latest fads of Priessnitz—

David talked Penna. Dutch. My father was German, hence many of the men were German—some from [**133**] some from Saxonburg who could handle wire, several from Mühlhausen who drifted finally to Trenton—I can recall Barney Ermeling who died only last year after working there over 40 years

The laborers had to be boarded and housed in shanties. Rhule was a good one to look after the commissariat, just to everyone and down on the beats—I have heard my father complain of the utter loneliness of his surroundings in the upper Delaware, no society, no habitations or farms—all woods and rocks——The neighborhood of Neversink aquaduct was more civilized. This dock crossed the Neversink Creek 3 or 4 miles from Port Jervis,[34] a canal town named after old Mr. Jervis first engineer of the Del. & Huds. canal, of the Croton aquaduct, Highbridge, ~~etc~~ Hudson river R.R. etc—The few houses at the northern end of this aquaduct were dignified by the name of Cuddebackville—the principal and only citizen being Mr. Rose[35] with whom my father boarded—The Neversink dock was in some respects the heaviest work—It had the longest single span while the 9-1/2" cables were considerably larger than any of the others—The valley of the Neversink is attractive, with good farming lands along its middle and upper part, settled largely by original Dutch and their descendants—Life here was more endurable, communications better, provisions and labor more plenty, while the village

[33] Washington refers to the period between the commencement of the aqueducts at Lackawaxen and the conclusion of cable making on the Ohio River bridge.

[34] The actual distance is about 8 miles.

[35] Apparently, this was William Rose, who was in communication with Russel Lord at that time regarding the progress of the Neversink Aqueduct (Osbourne 1984).

of Port Jervis was always a scene of bustling activity—Towards the latter part of February 1850, my father had recovered sufficiently to allow him to think of making a [**134**] much needed trip to the Neversink—

the shock of his accident had been so great that for a time he could not write with his right hand even, so that I served as a very poor amanuensis, writing from dictation. I was only 12-1/2 years old, with an underdeveloped handwriting of my own, the cause of much parental complaint—There were no stenographers in those days—The journey was commenced in very cold weather—I went along to help him—Leaving New york we went by boat to Piermont on the Hudson, the terminus at that time of the Erie R.R. Here we saw at least a dozen wire ropes for the Del. & Hudson and Penna. Coal Co—waiting for cars ~~to be transported~~ Taking the train Otisville was reached in the afternoon. Then came a sleighride of three miles down the hill to the Neversink in the face of a driving Northern sleet storm—Having no overcoat or underclothes I nearly perished from cold—never shall I forget that ride—At Rose's house we were finally thawed out and provided with a substantial supper—Mr. Rose was division Supt. of the canal, the aquaduct being in his district—

We found that a few of the laboring men had remained in the shanties over the winter—these were banked up with earth and resembled underground dwellings to keep out the cold. A couple of stonecutters were cutting the top courses of the anchorages and abutments, there was our blacksmith—John Knoch of Saxonburgh—also some carpenters busy at the Woodwork of the trunk and a couple of caulkers. Two days sufficed for the inspection, the weather having moderated, the return trip by rail was not so uncomfortable. David was at High Falls so we did not see him. Mr Rose was as loth to part with his visitors as I was to go. His family was charming—the scenery novel and entirely different from flat Trenton—I returned to the Classic shades of Dr. Ewing's schoolroom in Chancery court.

[**135**] 2d visit to High falls

In May following Mr. Roebling was ready for a trip to the High Falls Aquaduct, which crosses the Rondout 18 miles S.W. of the town of Rondout—Taking the boat we reached this place in the evening and were ready for an early start next morning—Several Del. & Huds officials were along—for some reason the crowd in the stage was so great that there was no room for

me—The hotel proprietor proposed that I should ride an ox—The beast came duly saddled and haltered with split shoes on his hoofs. No sooner was I hoisted on him, when he started to run away—the stage following full tilt. I stood it for 3 miles when I rolled off his round back and he turned and made back for home—The motion is like that of a dromedary producing sea sickness and spinal concussion—I have never been on an ox since—I got a lift from a friendly team and arrived at the falls about as soon as the stage—Here it was beautiful, fine scenery and surroundings, the aquaduct forming a conspicuous feature[36] in the landscape—It was about finished, ready for the water in a few days. David and a couple of Saxonburgers were there yet—We ~~did not~~ remained ~~very long~~ over night and pushed on next morning toward Ellenville, past the summit so as to reach the house of Mr. Pugh the Supt. of the eastern division where we arrived ~~before~~ after dark—

He and his family entertained us with the most cordial hospitality in their comfortable country home, embowered in trees & surrounded by gardens and orchards—I had to be rubbed with grease to assuage the pain of the ox galls—We stayed here two days. There was much business to attend to—final payments and estimates on acct, the aquaduct contract etc—
[**136**] land slide.

On the way we had passed Napanock, a charcoal forge where they made the best of Ulster iron—all the anchor bars for the aquaducts were made at this forge, those for Niagara likewise[37]—Napanock maintained its existence for many years, even after Bessemer Steel began to replace everything—

Mr Pugh was in great trouble. A week before, a tremendous landslide[38] had occurred a mile from his house, carrying away bodily about 500 feet of the canal including one entire lock. When we arrived on the scene fully 500 Irishmen were at work digging the dirt away—The hill, part of which had slid down was by no means high or very steep but the strata of water soaked clay lay ~~on~~ on a talcose substratum, a lubricant in itself—a whole orchard had moved down the hill without upsetting, but at the foot of the slope, everything was turned upside down. This slide delayed the opening of the enlarged canal a month so that the aquaducts were completed long before they were needed. I noticed plenty of black eyes, and sore heads, and learned that a few days previous there had been a grand fight between the

[36] At High Falls, the canal shifted to the opposite bank of Rondout Creek. An older stone aqueduct was already in place. Although the older structure was well built, it was being bypassed because it was too narrow.

[37] In his Niagara report, cited in Chapter 8, John stated that four of the chains were "made at Napannock, Ulster County NY by Mr. Frederick Bange." The other four were made by Everson in Pittsburgh (Roebling 1855).

[38] This section of the canal was afflicted repeatedly with wash-outs and other similar problems (Wakefield 1971).

two irish factions, the Corkonians and the Far downers, the latter coming from the counties south of Belfast—the battle waxed so hot that priests had to be sent for to stop it—Resuming our journey towards Port Jervis, along the Neversink, we stopped for a few hours at the Neversink aquaduct, finding it completely finished—We remained at Port Jervis over night and then returned to Trenton via New York, stopping at the Astor house for a day—

One good feature about those aquaducts consists in having the anchor chains project beyond the masonry so that the cable connections are always easily accessible for painting and examination. No rusting has taken place there yet, although older than the larger bridges which are somewhat affected[39] at that spot—The wrappings of the cable have also been taken off [**137**] here and there, no defects were found in the wire beneath—

It has often occurred to me that if the Allegheny aquaduct had been built, or could have been built 10 or 12 years earlier, my father would have built at least 20 or 30 of them—They are much more economical than the other styles of aquaduct either of the stone arch type or the wooden—the latter always rotting away in a few years owing to the constant leakage—

The fact that long spans become possible is the salient feature. It does away with the numerous piers that now fill up the beds of streams, and are constant sources of anxiety. The location of the canal can often be placed to better advantage when a long span is possible—But in 1845 the canal systems had reached their climax—The Rail Road was coming. In place of building new ones the old ones were soon to be abandoned—Thus it happens that no Suspension aquaducts have been built since those of the Del. & Huds. were completed—

During the years 1850 and 1851, time was taken up more with the factory at Trenton than with Engineering; Small highway Susp. bridges were built occasionally,[40] but they did not require much attention, they were located mostly along the region of the upper Delaware in N.Y. & Penna—

Wire drawing was not such a simple art as it seemed to be. It had to be annealed, pickled in acid to remove scale, and coated with rice flour or lease or lime to make it fit for drawing. In none of these processes had Mr. Roebling had any experiences. They were the results of the English practices of a century or more, resulting more from rule of thumb than from scientific

[39] As of 1894, his father's two largest bridges, over the Niagara and Ohio rivers, had been rebuilt by other engineers, partly because of cable connection problems. Washington returns to this subject again in greater detail at **[232]** in Chapter 12.

[40] See a discussion in Appendix B.

Delaware Aqueduct Anchorage. The anchorages of the Delaware River Aqueduct are still in place after 160 years of service. Although they were previously exposed to view for many years, reconstruction of a replica has caused them to be covered.

deductions. [**138**] One of the stumbling blocks was the brittleness of even the very best quality of Swedish iron immediately after it was drawn into wire—It was naturally attributed to the acid used in taking off the scale. This was supposed to penetrate the pores of the iron and remain in there for a considerable period. It was found that time remedied the trouble to a large extent, in fact in six months all brittleness had disappeared—hence all the wire was piled away upstairs above the rope shop for that length of time—This was expensive and caused a loss of interest on capital—His friend Overmann came up from Philadelphia, ~~and~~ to see what he could do to remedy the trouble—Various methods of pickling were suggested & tried, so as to do away with the vitriol, such as pickling in potash, in soda, the use of mechanical scourers, sand, gravel, lime, etc. to get rid of the scale—All these proved failures and a waste of money. The wire was allowed to lie as usual, with lime sprinkled over it, under the mistaken idea that it would absorb acid—

Ten or twelve years later we learned from English sources that by subjecting the wire to a heat of 500 or 600 degrees for a few hours all brittleness would disappear, a baker was accordingly put up, this proved so efficacious that the wire could be used the following day after it was drawn, doing away entirely with the storing of it—About the same time the true theory of the trouble began to be understood—In 1854 already Prof. Graham of London[41] had discovered what is termed the occlusion of gases by metals, when presented to their nascent state—Among metals Palladium possessed the greatest capacity and among gases hydrogen. The quantity recorded for Palladium was so great that Graham called it an alloy and even assumed [**139**] that the hydrogen might be in the solid state—Mr. Crace of Manchester, a chemist to Richard Johnson & Bro.[42] wire makers, followed up this clue in regard to iron and found that the vitriol attacked the wire beneath the scale, thus loosening it, but in the formation of the Sulphate ~~ato for~~ iron one atom of hydrogen was set free, which in the nascent state (and that state only) would enter the pores of the wire, making it brittle—

Another matter of much concern was the construction of proper annealers for annealing the wire without burning the wire and without destroying the annealers themselves by too much heat. He took much satisfaction in the construction of a double annealer, with one firing place—While it answered very

[41] Thomas Graham (1805–1869), the noted Scottish chemist, was a professor at University College, London, in 1854. He became Master of the Royal Mint in 1855. He formulated Graham's law of the diffusion of gases in 1833, but his paper, "Molecular Mobility of Gases," cited by Washington was published in 1864 (Williamson 1869).

[42] Washington apparently had notes on one of numerous scientific papers written by the famous British chemist Frederick Crace Calvert (1819–1873) but failed to recall Calvert's name correctly.