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COMMUNICATION
FROM ALFRED DUVAL.

BALTIMORE, March 21, 1854.

*To the Hon. Mayor and
City Council of Baltimore :*

GENTLEMEN :

As a citizen of Baltimore, and feeling an interest in whatever tends to benefit our city, I have taken the liberty to address your honorable body with a view to respectfully present for your consideration some suggestions, which I believe will be found worthy of your attention.

Having been lately employed in Peru, South America, for two years, in making various and extended reconnoissance, surveys, plans, &c., on account of private enterprise and for the Peruvian Government, with a view to supplying the city of Payta, on the Pacific Coast, and the city of Piura, capital of the Province of same name, with water, including various extended systems of irrigation, and having devoted my attention for some twenty-five years to the study of mechanics and hydraulics, and the practical construction of various hydraulic and other works embraced within the duties of civil engineering, and from my extensive practical experience in such matters, I believe my opinions, to some extent, may be found worthy of your consideration.

Since my return to Baltimore, I have found there is much interest felt in our city, having an abundant and constant supply of water, both for the present and future, when its population may have quadrupled, or more, its present numbers.

I have read with much interest the report of the Commissioners appointed by your honorable body, to enquire into the most desirable method of procuring for our city an abundant and constant supply of water; and with said Commissioners I fully concur in opinion that the supply should be most abundant and constant, without a too rigid regard to the cost. I have also read the reports of Messrs. Chiffelle and Slade.

Yet while I entertain a high opinion of the report and views of the Commissioners, and the gentlemen Engineers, I respectfully dissent from their opinions in relation to the true and most economical plan by which this city can be furnished with an abundant and constant supply of water; and I believe I shall be able to show to your honorable body that the city of Baltimore can have a far more abundant and constant supply of water, and at a less cost than per any plans heretofore presented for your consideration. And so thoroughly impressed have I been with the opinions I entertained in reference to the matter, that I have at my individual expense made some preliminary surveys to satisfy myself, and the result of my labors have further confirmed my opinions, and that the plans I suggest will, at least, be found worthy of your attention, and from the data I herewith furnish, I believe I shall be able to clearly demonstrate that the lines and plans I suggest are, at least, worthy of the cost of a correct survey, if not sufficiently so to demonstrate that they are the only true ones by which can be had a constant supply of 40 millions of gallons of water per day, delivered within a capacious reservoir of from 50 to 80 acres area, or more if desired, within one mile of the present limits of the city, and without the cost, eventually, of one dollar to the city of Baltimore. As from the data herewith furnished, I believe it will be shown that the surplus water over 40 millions gallons per day that may brought to the city by the plans I propose, will be of a value, and may be disposed of as power for a sum that will more than pay the interest on the costs of construction of the proposed works to the city limits, including damages for water power, right of way, and land for a most capacious reservoir within one mile of the city limits of an area of 80 acres or more if desired, and with the surface of the water in same, at an elevation of 172 to 173 feet above mean high tide, and with an average depth of from 15 to 20 feet that can be conveniently drawn off from same.

That the Gunpowder is by far the largest and most constant stream that runs sufficiently near the city to be thought of, from

which to draw a constant supply of water, every one, I presume will admit. And, in my opinion, the Gunpowder is the only source to which Baltimore can look for an abundant and constant supply at a reasonable cost, and at or near Raven's Rock, already selected as per Capt. Chiffelle's plans, I feel satisfied is the true point from which to draw such supply, *but that by natural flow*. From any point much above or below Raven's Rock, I am satisfied the cost for a corresponding supply, as from said point, would be greatly increased, and subject to serious objections. Taking a lower elevation than Capt. Chiffelle's proposed dam at Raven's Rock for natural flow, the length of tunnel would have to be very greatly increased, and of course a loss of altitude for the supply to be delivered at Baltimore, and consequently a loss of power. Though at the debouch of Mine Bank run, the Gunpowder is much nearer Baltimore than at any other point, and not more in a direct line of from $7\frac{1}{2}$ to 8 miles from the present city limits, but to erect a dam at or near said point, to raise the water to anything near the elevation above tide, as per Capt. Chiffelle's proposed dam, would be absurd to think of, compared with the cost of a dam at Raven's Rock and canal from said point to or near the debouch at Mine Bank run. And assuming any higher point much above Raven's Rock, there arises objections and increased costs; for if going much higher than said point to dam the Gunpowder, say to or near the Warren Factory, the river becomes much diminished, losing the flow of several large affluents, namely, that of Peterson's Run, the stream on which Yellott's Mill is situated, and one debouching near the bridge on the old York road, and the large affluent Overshoot branch, and also the water shed of a large district of country proverbial for the number and constant supply of its springs. And independent of such objections, as a loss of supply if taken from a point, say as high up as Warren, the works for such purpose would be greatly extended, and without obtaining an increased elevation sufficient to convey the water to Baltimore by natural flow per any possible line without a tunnel of considerable length, or an open cut of great depth and corresponding length which would be more objectionable than tunnelling. If, instead of this, I draw the point Raven's Rock, or near it, the most desirable at which to dam the Gunpowder to the elevation as proposed by Capt. Chiffelle, and drawn from thence the supply desired as per plans of Capt. Chiffelle, as far as within some 12 to 1500 feet of the debouch of Mine Bank run, and from thence a continuation of canal as above, and on same plan, or with but slight declination, and nearly in a straight line to the foot of Sater's Ridge, at a point of from 1000 to 1200 feet, S. W. of the dwelling of Dr. Riesteau,

where the line of canal will intersect the first ravine, cutting Sater's Ridge transversely and west of that in front of Dr. Riesteau's dwelling. By assuming the line named for a continuation of canal from a point some 1200 feet above the point of Capt. Chiffelle's proposed site for pump house, the line of canal would cross the valley of Mine Bank run, some few hundred feet west of Dr. Riesteau's barn, and the stream of Mine Bank run above 173 feet above mean high tide, and damming said stream with a low and cheap dam, in line of embankment of canal, and receiving the waters of same, as an additional supply to be conveyed by the proposed works to the city, and which stream, from information had from Dr. Riesteau, I should think it could be safely estimated to flow $2\frac{1}{2}$ millions of imperial gallons per day of 24 hours in dryest seasons.

I have for years looked on the Gunpowder as the only proper source from which Baltimore should procure a sufficient supply of water, and at or near Raven's Rock the true point from which to draw such supply, but that by natural flow by canal as described, and thence by tunnel through Sater's Ridge to intersect the valley of Herring Run, at such point as the level would admit of, and from thence descending said valley to a point some 800 to 1000 feet below Mr. Guthrup's Mill, and including in the line of the proposed works the waters of Herring Run, damming said stream at the point designated below Mr. Guthrup's Mill, and receiving in the pool of same, the waters conveyed from the Gunpowder, and from thence to the most desirable point near the city limits for a capacious distributing reservoir.

I believe that I am the first person who suggested the point Raven's Rock from which to draw a supply of water for our city, and so favorably have I been heretofore impressed with the practicability of a supply of water being procured from said point, by natural flow, and at a reasonable cost, considering the large supply that could thus be conveyed, that previous to my leaving for South America, I had consulted with R. Howard, Esq., and R. Gilmore, Esq., and other gentlemen in relation to making surveys to ascertain the practicability and cost of such enterprise.

But on my return to Baltimore, finding the plans presented for the consideration of your honorable body in relation to procuring for our city an abundant supply of water, are so foreign to what, I am satisfied is the true plan to be adopted for such purpose, I have been induced to make the preliminary surveys referred to, to satisfy myself of the practicability of the plans I suggest, and to ascertain the length of tunnel through Sater's Ridge to the valley of the Herring Run, and the depth of open

cut that could be more economically made than tunnel in said valley, and to arrive to some approximate data on which to base calculations, &c. For such purpose I have run a line of levels from a bench mark, at the level of mean high tide, on one of the piles supporting the second rail road bridge crossing the Harford run above the back basin, and from the point named through the extension of Canal street to its intersection with the Harford road, and from thence, via, said road to a bench mark on a locust post south side of the road, near Willingham's tavern, and from points last named through the upper avenue of Homestead, and crossing the Ridge of Highlands north of Homestead, between the site of the burnt house of Gen'l Smith and Mr. Tiffany's dwelling, and making various bench marks, the elevations of which, with different stations will be hereafter referred to. From the summit of the ridge named, I continued the levels, descended into the valley north of the places of Gen'l Smith and Mr. Tiffany, and through which valley flows a small affluent of the Herring Run, which is crossed by the first bridge on the Hillen road, north of the first toll gate on the Harford road, and the valley through which the affluent referred to flows, I deem the most desirable point or piece of land that can be selected for a cheap, safe and capacious distributing reservoir, as from the elevation at which the water from Raven's Rock can be conveyed into it. I presume that by damming across the valley at a point a little below where the Hillen road crossed the same, the waters would flood an area of some 30 to 40 acres with a mean depth of from 15 to 20 feet, without any excavations, and the point referred to, at which to dam or embank across the valley is narrow, and there could be procured rock abutments on either side, and I believe a rock foundation across the entire line of dam or embankment, and at no great depth below the surface of the earth. After running the levels to the valley referred to, to a point some 12 or 1500 feet above the Hillen road, I continued the same down the valley to said road, and from thence along the road to beyond Mr. Stirling's place, where diverging from the road, I descended to the valley of the Herring Run to a point where the back water of the dam of Mr. Guthrup's Mill forms a pool, and from which point I continued the levels up the main branch of the Herring Run to a bench mark on a tree, the level of which is even with the surface of the water in Herring Run at said point, and where a foot-bridge crosses the stream near the dwelling of Mr. Dourghday's, from which point I run a detached line of levels from the main line, some distance up the small affluent in front and south of Mr. Dourghday's dwelling, and from the bench mark referred to, I continued the main line of levels up the main

branch of the Herring Run, for some distance above the dwelling of Mr. Elijah Taylor, at which point diverging from the stream to the eastward, I continued the levels over the intervening highlands and Sater's Ridge to the valley of Mine Bank Run, to a bench mark on a walnut stump, in the road that crosses the valley of Mine Bank Run, near Dr. Riesteau's, and from the bench mark referred to, I continued the levels to a bench mark on the root of a stump, on the west side of the Gunpowder, and a few feet below the debouch of Mine Bank Run, and which bench mark was made 0.25 of a foot above the surface of the flow of the Gunpowder at that point, on the 17th of the present month, and 146.77-100 feet above the bench mark at tide.

After having determined the elevations as named, by which to know the probable depth of open cut that could be more advantageously made in the valley of Herring Run than tunnelling, and point at which it would be most desirable to commence a tunnel to pass under the intervening highlands and Suter's Ridge from the valley of Herring Run to that of Mine Bank valley, I run by compass and chained, from a point near the dwelling of Mr. Dourghday's, where the elevation of the valley of Herring Run is 221.25 feet above mean high tide to the point designated near Dr. Riesteau's on the north side of Sater's Ridge, at which point the depth of open cut for natural flow from Raven's Rock, (taken the elevation for the crest of a dam at said point, at 179 feet above mean high tide,) would be about fifty-nine feet for the deepest part of said cut, and length of which would be but of short distance, commencing some eight or nine hundred feet back from the point of commencement of proposed tunnel, at a cut of not more than from five to eight feet, and running to the depth named at the point designated.

The distance in a straight line between the point designated, through which proposed tunnel should be made, by my measurement, is 22,800 feet, or 4.3181 miles, though a more correct measurement, and reducing the chaining to the horizontal plane, I have no doubt, will show the distance to be some four or five hundred feet shorter; but I assume the length of tunnel from the valley of Mine Bank Run to that of Herring Run will be as named, 4.3181 miles, terminating in the valley of Herring Run, where an open cut can be more economically made than a tunnel, and where the open cut at said point would be of a depth of fifty-six feet below the surface of the ground to the bottom of tunnel, having nine feet depth of water in same, allowing 0.75 declination for grade line of canal from Raven's Rock to commencement of tunnel, and four feet declination through tunnel to commencement of open cut in the valley of Herring Run,

where the surface of the water in tunnel and open cut would be forty-five feet below the surface of the valley at said point, and 174.25 above mean high tide.

From the formation of the country through which the proposed tunnel would pass, I assume that the entire excavations would be through rock, and of such character that a tunnel cut through same would require no lining or bricking, except at the ends; and assuming that no masonry would be required within the line of tunnel, and the area of a transverse section of same to be forty square yards, and of such form as circumstances would require, would be of an area sufficient when 4-5 filled, with the declination or grade named for tunnel, to discharge two hundred and forty millions imperial gallons per day of twenty-four hours, as it is well known to those acquainted with hydraulics, that large bodies of water, flowing on the same plane, through areas of corresponding form, move at a much greater velocity than small ones.

From the levels I have taken over the highlands, intervening between the valley of Herring Run and Mine Bank valley, I assume the average depth of shafts, allowing twenty-two in number, (eight by twelve feet square,) will be one hundred and seventy-five feet, to the bottom line of tunnel, though in the neighborhood of Sater's Ridge, there will be, probably, some two or three shafts that would require a depth of from two hundred and sixty to two hundred and ninety feet, though I believe a correct survey will show that the average depth of shafting will be much less than I assume, as a large portion of the line of the tunnel will pass under the valley of the main eastern branch of Herring Run.

The length of open cut through the valley of Herring Run to the southern terminus of great tunnel, a part of which would be by the course of the bed or channel of the stream, and would be about one thousand seven hundred yards, counting from the crest of Guthrup's dam, though by the same being removed, which would have to be, if the proposed work should be carried out, the cut would probably commence some fifty to eighty yards above said point, though I assume the distance of open cut will be one thousand seven hundred yards, commencing at zero and running to a point something above the foot-bridge crossing the stream nearly opposite Col. S. Hillin's dwelling, where the cut would probably be thirty-eight feet deep, allowing nine feet depth of water in same, and at a distance of about nine hundred yards from zero, which line, I presume, it would be most desirable to leave an open cut, of say thirty-three feet wide at bottom, with a slope of two to one perpendicular, and which would have a mean depth for the entire cut of about nineteen

feet, continuing the open cut from where the same is proposed to be left open to the southern terminus of tunnel, which I assume will be about eight hundred yards in length, with a width at bottom of thirty feet, if through rock at bottom, or thirty-six feet, if through earth, and a probable mean depth of about forty-seven feet, allowing nine feet depth of water in same and declination for grade as per tunnel; and with a slope for cut of six inches to one foot rise, and the bottom and sides of same walled with stone, and the cut arched over to the intersection of tunnel, though I am satisfied that the entire line of open cut, proposed to be arched, will be found to be rock at bottom, and for some distance up the sides, sufficiently so as to not require side walling, allowing the arch to be sprung from natural rock abutments. And the character of the stone that may be quarried from the cut, will be such as may be adapted, with economy, for such masonry as may be required for walling and arching the cut.

At or near the upper terminus of open cut intended to be left open, I recommend that the waters of Herring Run should fall into it, and to dam the stream at the point named some 1000 feet below Mr. Guthrup's mill, where can be had a rock foundation and abutments for a cheap and permanent dam, and in which I should recommend the construction of gates at a depth of ten to fifteen feet from the crest of dam, or a deep cut on the east side of dam with gates, by which the water could be drawn off from dam and line of works, and by which the wash from the open cut could be got clear of, with but little attention. I also recommend the same arrangement at the crossing of Mine Bank Run, and, at least, in one or more places along the line of open canal between Mine Rank Run and the dam at or near Raven's Rock. From the site of proposed dam across the Herring Run, to the intersection of the valley, I propose should be dammed, to form a distributing Reservoir, the distance is about fourteen or fifteen hundred yards, and the line of works would have to pass through the point of the Ridge of Highland running from Mr. Stirling's to the Herring Run, and through which I should recommend a tunnel which would probably be two or three hundred yards in length, and the balance of the line and open cut of a probably average depth of twenty-seven feet, allowing nine feet depth of water in same; though some of the cutting would be deep, but the line proposed is cut transversely by several ravines which would make the excavations and removing the same much less difficult. For the line of work from Herring Run to Reservoir valley, I propose the tunnel to be of the area named for the great tunnel, and the balance of the line an open cut as named, and of a width at bottom and slope for cut same as cut in the valley of Herring Run, to be arched, and the

cut to be walled at bottom and sides, if necessary, and arched over with stone or brick, and the entire masonry laid in cement, and the cut above the arch re-filled. But I am satisfied there will be required for this line of the work, but very little bottom or side walling, as I have no doubt that nearly the entire line of cut at bottom, and for some distance up, will be found to be solid rock, and of such character as to furnish good stone for arching the same.

For the construction of the distributing reservoir in the valley heretofore described, I recommend the construction of the dam or embankment across the valley as heretofore referred to, and a proper arrangement to draw off the water from the reservoir; and that such excavations should be made as may be found necessary to give an area and depth for reservoir as may be required, and to enclose the entire area with a wall of stone, and the water face of same to be laid in cement, and the back filling of dry work, and the back puddled to the surface of the grade line of the ground around the wall enclosing the reservoir, and for the drain of the valley and water shed around the reservoir, I recommend there should be constructed around the wall enclosing the reservoir a conduit, by which the drain could be kept from the reservoir, except at such times as the water thus furnished might be thought sufficiently pure to be received into the same. I also recommend that the reservoir should be divided into two divisions, the lower receiving the supply from the furnishing conduit, and of but small area, leaving the upper division large, and from which should be drawn the supply for domestic use, as the same could be generally kept filled with a supply of clear filtered water, or to such extent, that a pure supply for domestic use could be furnished for several days.

Allowing the declination named from the crest of dam at Raven's Rock to southern terminus of great tunnel, and from said point to the intersection of reservoir, 1.75 feet declination, would leave an elevation for the surface of the water in distributing reservoir of $172\frac{1}{2}$ feet above mean high tide, and from which elevation could be supplied with water 19-20 of the entire proved property, or that may be improved within the present city limits. The elevation the water will have in the proposed reservoir, would flood some three-eighths of a mile near the city, than the point of intersection of the supply conduit.

From the distributing reservoir, I recommend a cut or cut and tunnel through the highlands intervening between reservoir valley and the city limits, and the line of which, commencing at proposed reservoir, and running up a ravine to the north of Mr. Tiffany's, and from thence in a straight line to the west of

Mr. Tiffany's dwelling, some 300 feet to intersect the valley in which the Homestead is situated, the distance from reservoir to the intersection of Homestead valley, by the line proposed, would be some 6 to 800 yards, and the average depth of cut about 26 feet, allowing 600 feet for tunnel underneath the crest of ridge. The width of cut should correspond to that on the main line intended to be arched, and the entire cut I propose should be walled and arched with stone or brick, including tunnel, as circumstances may show to be best and most economical, and the entire masonry laid in cement. Through the tunnel should be laid down pipes sufficient to furnish the supply of water desired for domestic use, which should be drawn from the upper division of reservoir, though by making the tunnel some four feet wider, and a division wall through same, such an arrangement for keeping the water drawn from upper division of the reservoir, from that drawn from the lower, would perhaps be more economical than using pipes. Near the point where the conduit through the highlands will intersect the valley in which the Homestead is situated, I recommend there should be erected pumping machinery sufficient to elevate five millions or more of imperial gallons if desired per day of 24 hours, to the heights north of Montebello, known I believe, as Gibson's, which I presume are some 280 to 300 feet above mean high tide, and where can be had a good site for a small distributing reservoir, say of capacity of from 10 to 15 millions, and from which could be supplied those parts of the city that could not be supplied from natural flow. The probable distance from the proposed place for pumping to a desirable site for an upper distributing reservoir, would be some 2800 to 3000 feet. For the propose of pumping the supply of water desired to the height named, say to an elevation of 300 feet above mean high tide, a part of the water conveyed through the conduit from the reservoir would be used as power, say under a fall of 32 feet, and under such fall it would require 20 millions gallons to pump five millions 128 feet high, allowing nothing for loss of power in the application of the the water or the friction of the pumping machinery, and the passage of water through the raising main, or about 30 to 35 millions of imperial gallons to produce a useful effect of power sufficient to raised the quantity of water named 128 feet high, and overcome the friction of machinery and passage of water through raising main, say 35 millions, which no doubt is a large allowance, and equal to about 235.69 horse power for the quantity of water named expended in 24 hours, over a fall of 32 feet, allowing 10 pounds to the imperial gallon, but the resistance from friction to be overcome by the passage of water through a

long raising main, unless of very large area in proportion to the supply to be passed is much greater than is generally supposed.

The supply of water used for pumping would be left at an elevation of 150 feet above mean high tide, and could be used as power for propelling machinery, or for domestic purposes. From the terminus of the conduit intersecting the valley of Homestead, a part of the water supplied at that point would be conveyed to the city for domestic purposes, and could, as far as desired, be connected with the present water main or mains that are now laid down, belonging to the Baltimore Water Company, and the balance of the water, or such part of same, as desired, could be used as power for propelling machinery along the valley of Homestead, and thence to Jones' falls; and which power I have no doubt could be advantageously sold or leased, to be used along the valley of Homestead, and thence to the city, though I believe the water power would be of greater value, independent of the cost of conveying it to the city by conduit and pipes to the most central of the wharf property where the same could be advantageously used under a head of 70 feet and upwards, by means of pressure engines, a system adopted to a considerable extent in Europe; and such engines are capable of transmitting a large amount of power, and occupy but little space, and are of a cheap and simple construction, and give as useful effect of the water applied, as the best class water wheels. Persons acquainted with hydraulics and hydrodynamics, know that the application of water power as named, is not only practicable, but a desirable method of applying the same, and also, that water power supplied through pipes under high heads, can be economically used for propelling extensive machinery by means of various water wheels, such as are now used in this country, and that occupy but little space, and transmit a large amount of power, and give a useful effect, corresponding to overshoot wheels.

If it should not be desired to use the entire surplus supply of water, independent of domestic use, furnished from the Gunpowder, through the valley of Homestead, and thence on or by its application along the wharf property in the central part of the city, I would recommend that a large portion of the same should be conveyed from the terminus of the conduit intersecting the valley of Homestead by conduit or otherwise, via, the course of the highlands west of J. Hopkins, Esq., and from thence near the Baltimore Cemetery, and to the east of the Maryland Hospital, to the eastern slope of Loudenslager's hill, south of the Philadelphia road, and from thence to Canton, to be used principally as power, from the south of the Philadel-

phia road to Canton, and by which means the interests, of the south-eastern section of the city, I presume, would be greatly promoted. But if it should not be desired to convey a large portion of the surplus water that may be brought from the Gunpowder, to the neighborhood of Canton, a chapter line could be selected for the conduit through the ridge of highland between the valley selected for the proposed reservoir and the city limits, which line would pass between Montebello and Gibson's heights, through a saddle in the ridge some 10 to 1200 feet northwest of the site of the burnt house of Gen'l Smith's, and the length of line from the reservoir to the intersection of a ravine that connects with the valley lying below Homestead, would be about 6 to 800 yards, and from observation, I should think the depth of cut in the deepest part would not exceed from 40 to 50 feet, and that but for a short distance. The place where the pumping machinery could be situated, if this line should be adopted, would not be more than 1800 to 2000 feet distant from the heights referred to, where could be had a site for an upper distributing reservoir. I presume, the saving by this line over the one through the ridge near Mr. Tiffany's would be some 30 to 40 thousand dollars, including the saving in length of raising main to upper reservoir. But there is an objection to this line apart from having the supply brought through the ridge to the most convenient point for a supply to be cheaply conveyed to Canton, which objection is, that the conduit would intersect the reservoir a considerable distance up from the point of intersection of supply to reservoir, and there could not be much advantage had by a division of the reservoir, by which to allow the water for domestic use to filter, if the division of the reservoir should be made at the point where this line would intersect it, if the surplus supply to be used for power should be conveyed through same tunnel, as the upper division of the reservoir would be left small, unless at the expense of much excavating.

OF THE LEVELS

Taken from a Bench Mark, on a level with Mean High Tide, from a point near the lower end of Harford Run, to the Gunpowder River, near the debouch of Mine Bank Run.

No. of different Stations of Levels.	REFERENCES TO DIFFERENT STATIONS.	Elevations above mean high tide, in feet and hundreds of feet.
22	Station in Harford road, north side, opposite Z. Barnum's gate and telegraph pole, No. 1153,	173.25
24	Station north side of Harford road, near telegraph pole and opposite Dr. Troop's,	160.21
28	Bench mark on locust post, south side of Harford road, near culvert and a little above Willingham's tavern,	149.33
30	Station in upper avenue of Homestead, near Mr. Tiffany's fence, and about 40 feet north of first ravine, counting from Harford road, and about 4 feet above the level of ravine where crossed by avenue,	156.75
36	Station in upper avenue of Homestead, and north side of the principal ravine in Homestead valley, and opposite a notched post in Mr. Tiffany's fence, and about 10 feet north of ravine where crossed by avenue, and some 6 feet above same,	158.97
40	Bench mark on the root of an oak tree, near upper end of upper Homestead avenue,	231.26
42	Bench mark on the root of a sycamore tree, near the pump of Gen. Smith's or Woodland, The bench mark referred to is near the surface of the ground, and some 20 to 25 feet above the crest of the ridge of highland, intervening between said point and Mr. Tiffany's dwelling.	246.68
48	Bench mark on the root of blazed oak tree, and about 200 feet below ice pond at Woodland, And the ravine to the east opposite bench mark some 20 feet lower.	192.70
53	Bench mark on the root of a maple tree in valley proposed for site of reservoir, and a few feet south of affluent flowing through same, and about 1,200 feet to the west and above the Hillen road, and some 6 feet above affluent,	150.68
54	Station in reservoir valley, north side of affluent, and about 800 feet west of Hillen road,	146.39
55	Bench mark on willow stump, on the side of ditch in reservoir meadow, and west of Hillen road, and the instrument swept the hand railing of bridge on Hillen road, and forward site read, 6.72,	142.32

56	Bench mark on top of post of post-rail fence on west side of Hillen road, and about 200 feet north of bridge,	151.53
58	Station in Hillen road, ascending first hill, north of first bridge, and same level swept a little below highland south side of bridge, where southern abutment of dam or embankment crossing reservoir valley, should be located, and a little below the bridge,	170.76
64	Bench mark on the root of a chesnut tree, west side of Hillen road, and nearly opposite Richard's gate,—land to the east, where the line of proposed work would pass through, some 20 to 25 feet lower than bench mark,	219.85
70	Station west side of Hillen road, near the gate entering to Mr. Stirling's dwelling and the summit of the ridge, (at that point,)—the said ridge running down to the Herring run, through the point of which ridge is proposed a short tunnel,	274.10
81	Bench mark on willow tree, west side of Herring run, near the upper part of the pool of Guthrup's dam, and 1.74 feet above the still water of the pool,	183.17
84	Station on rock in Herring run, on the east side, and on a level with the flow of the surface of the water at same point, and nearly opposite a stone quarry of Col. Hillen's,	189.25
86	Station some 150 feet east of the channel of the stream of Herring run, and a little above the foot bridge of Col. Hillen's, crossing same, and on higher ground than the open cut would pass through near this point, and some 7 feet above the flow of the channel of the stream, and a little below the point of where I propose the head of the open cut, intended to be left open, should terminate,	205.50
88	Bench mark on root of birch tree, west side of Herring run, and on a level with the flow of the surface of the stream at that point, and where there is a foot bridge crossing same, near the dwelling of Mr. Dourghday's,	211.13
89	Station some 400 feet east of the Herring run, in the meadow of Mr. Dourghday's, and about 500 feet below the point where the upper end of open cut, intended to be arched, would terminate,	219.31
93	Bench mark on root of white oak tree, some 200 feet east of the channel of the main branch of the Herring run, and some distance above the dwelling of Mr. Elijah Taylor's and north of the road crossing the stream near said point, and 7.25 feet above the surface of the stream, where crossed by the road referred to,	315.34
102	Bench mark on an apple tree, some 200 feet south of Mr. Pindle's barn, and near the road leading to same,	237.59

- 108 Station in road on a stone, (near a blazed chesnut tree,) leading from Mr. Pindle's to the old Harford road, and near the point where the line of proposed tunnel would pass under; and the highest probable point the same would pass under, except Sater's ridge, and some 50 to 80 feet higher than the valley of the eastern branch of the Herring run, to the north of station, and under which the line of tunnel would pass for some two miles, 350.25
- 130 Bench mark on post, east side of old Harford road, nearly in front of Mr. Boozer's store, and about $\frac{3}{4}$ of a mile to the eastward of where would be the line of proposed tunnel, and at an elevation of some 50 to 70 feet above the ground where the proposed tunnel would pass under, to the westward, opposite this station, 377.57
- 137 Bench mark on the root of a chesnut tree, on the heights above Boozer's, near the road leading to the old Harford road, and within some 40 to 50 feet of a station peg of levels taken by the party under Capt. Chiffelle, as I have been informed. 435.89
- 142 Station on south side of Sater's ridge, and north of a small affluent flowing to the Gunpowder, and some $\frac{1}{2}$ of a mile to the eastward, where the probable line of tunnel would pass, and probably some 30 to 40 feet higher than the head of the valley of Herring Run, opposite to this point to the westward, where the probable line of tunnel would pass under, 403.18
- 149 Station on highest part of Sater's ridge where crossed, and some $\frac{1}{2}$ of a mile to the eastward, where the probable line of tunnel would pass under the crest of the ridge near Mr. Shanklen's, and probably some 30 to 40 feet lower than the crest of the ridge at that point, and where the same is narrow, and falls off rapidly on either side, 448.27
- 158 Bench mark on the root of a cherry tree, east side of the road leading down Sater's ridge to Dr. Riesteau's, and at corner of fence, and a little below the dairy of Mr. Siebrey's, 376.15
- 174 Station on rock, west side of road, last referred to, and near a blazed chesnut oak, and 180 feet from the gate entering Dr. Riesteau's dwelling, and nine feet above the ledge of rock in ravine opposite bench mark, 235.07
- 181 Bench mark on root of walnut stump, a few feet south of Mine Bank stream, and in the road leading from Dr. Riesteau's to the lime kilns, and 0.40 of a foot above the flow of Mine Bank Run, where the road crosses the same, and some 100 to 200 feet above the line where it is proposed that the Mine Bank Run should be dammed, 176.55

187		Bench mark on the root of a large oak stump, on the west side of the Gunpowder river, and within a few feet of the debouch of Mine Bank Run, and which bench mark was made 0.25 of a foot above the surface of the flow of the Gunpowder, at that point on the 17th of the present month,	146.27
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It will be seen that the result of the levels taken by me give something more elevation for the Gunpowder, at the debouch of the Mine Bank Run, than the levels taken by the party under Capt. Chiffelle, though there probably may be some error in the levels, I have taken, as I run no test line for proof, yet, I am satisfied there is no material error in my levels, but I have assumed the levels taken by the party under Capt. Chiffelle to be correct, and my calculations for grade, &c., have been based on an elevation for the crest of dam at Raven's Rock of 179 feet above mean high tide.

ESTIMATE OF THE PROBABLE COST

Of Conveying from the Gunpowder River, by Natural Flow, 240 millions of Gallons of Water per day of 24 hours, from the point Raven's Rock to the Valley in which Homestead is situated, as per the plans I propose.

Damages for water rights on the Gunpowder, Mine Bank run, and Herring run, and right-of-way and lands for principal distributing and upper reservoirs,	\$550,000 00
Dam across the Gunpowder at Raven's rock, including waste weirs, gates, gate house, &c.	85,000 00
Canal excavations from Raven's rock to the intersection of proposed tunnel, including masonry, waste weirs, puddling, and dam across Mine Bank run, probable distance three miles,	95,000 00
Walling and arching at commencement of tunnel, including gates, gate house, &c.	12,000 00
Sinking 22 shafts in line of tunnel, 8 by 12 feet square, average depth 175 feet at \$4,000 each,	88,000 00
22 high pressure engines, of an average power of 8 horse each, for hoisting excavations and water from shafts and tunnel, including hoisting and pumping machinery, tram-roads and trucks for removing excavations from shafts, curbing shafts, station houses, &c. all complete, at \$5,500 for each station,	121,000 00
Fuel to generate steam sufficient for 22 engines, to the amount of 8 horse power each, for three years, allowing 313 days to the year, of 24 hours per day, including expense for attending to engines, and assistants to attend to hoisting and pumping machinery, oil, lights, &c., at \$8 per day, of 24 hours, for each station,	165,264 00
Removing excavations from shafts and from tunnel, having tram-roads and trucks, as estimated for 317,689 cubic yards, at 10 cts. per yard,	31,768 90
Excavating 304,000 cubic yards of tunnel, at \$5 50 per yard,—length of tunnel 7,600 yards, area of transverse section of same 40 square yards,	1,672,000 00
Amount carried forward,	

Amount brought forward,	
Excavating of open cut between Reservoir and Homestead valley, including the cut on either side of the dividing ridge, assumed length 500 yards, average depth of cut about 26 feet, and 36 feet at bottom, with a slope of six inches to one foot perpendicular, average area of cross section about 160 square yards, excavations assumed to be $\frac{3}{4}$ earth and the balance rock.	
60,000 cubic yards of earth excavation at 25 cts. per yard,	15,000 00
20,000 cubic yards of rock excavations at \$1 80 per yard,	36,000 00
Tunnel through dividing ridge near Mr. Tiffany's dwelling, assumed length 200 yards, area of cross section of same 50 square yards.	
10,000 cubic yards of excavation assumed to be rock, at \$5 per yard,	50,000 00
Bottom lining, walling and arching of open cut and tunnel leading from the Reservoir to the valley of Homestead, including division wall through tunnel, with stone or brick laid in cement. It is presumed there will be stone sufficient quarried from the cut and tunnel, of good character, for the walling and arching of the open cut, though the estimate is based upon the supposition that the most of the work will be done with brick in the best manner,	105,000 00
Re-filling open cut on either side of ridge between Reservoir and Homestead valley, with 4,000 cubic yards of earth, at 10 cents per yard,	4,000 00
Conduit from terminus of double conduit to place of pumping, including gates, &c.	10,000 00
Pump-house, water wheel, pumping machinery, &c.	35,000 00
3,000 feet of 30 inch raising main — at \$10 per foot,	30,000 00
Reservoir on Gibson's heights, of an area of about four acres, and capacity of about 16,000,000 imperial gallons,	35,000 00
Total cost,	<u>\$4,162,194 86</u>

As it will be seen, I have made no estimates for lining and arching the long tunnel, or the one through the ridge, running from Mr. Stirling's to the Herring run, except at the ends, as I feel satisfied, if the work should be made, that in neither of the tunnels will arching be found necessary or but to a small extent, as I believe the entire line through both tunnels will be found to be rock, of such character as will avoid the necessity of lining. But should it be thought necessary, or circumstances require that the tunnels should be lined, the area of the cross

sections as estimated for, are such as to admit of lining and arching and still be of capacity to pass much more than the minimum flow of the Gunpowder, from the point Raven's rock in time of ordinary drought, and the time of such flow is the basis on which to base calculations for domestic supply, and more particularly for power. But should the excavations through either tunnel result in being in part through earth or rock, such as to require lining and arching, or should it be desired that the tunnels should be lined and arched through the greatest part of their lengths, the probable cost would be from three to nine hundred thousand dollars. But should any of the excavations prove to be of soft rock or earth, such would proportionably reduce the cost of excavations, and from the high price at which the tunnels are estimated at, I am of opinion that the estimates are sufficient for their completion in a perfect manner. And from information kindly furnished by B. H. Latrobe, Esq., through the kindness of Wm. G. Harrison, Esq., and from Messrs. Tyson and Slater, (communications from these gentlemen I herewith submit,) show the estimates I have made for the tunnels, from the data assumed may be relied on. It will be seen by reference to the estimates, that the cost per lineal yard, for excavating and arching the cut in the valley of Herring run, commencing at the southern terminus of the first tunnel, is something higher per lineal yard than the long tunnel, though I deem it more advisable than tunnelling at that point, from the supposition that a part of the tunnel may require to be lined and arched.

On the importance of the surplus supply of water that may be brought to Baltimore by the plans I propose, independent of forty millions of gallons to the city for domestic use, &c., and the value of such supply, and a comparison of the same with steam, &c. &c.

As to the importance of an abundant supply of pure water to our city, every citizen I presume feels interested, particularly if the same can be had without taxation, but independent of a mere supply for domestic use or that of public fountains, there are other important interests that require a large supply of pure water at a reasonable cost, viz: for various manufacturing purposes and for generating steam, a matter that many persons form but little conception of the difficulties and high cost of procuring a pure supply of water for such purposes at the present time. Some twenty-five years ago, there was not more than two or three small steam engines in use in this city, now the number I presume is some hundreds, and the aggregate power some three

thousand horse or more ; and steam as regards its use here, may be said as but commencing. The importance and benefit of using steam power for manufacturing purposes is every day becoming more apparent, as it is thought to be more desirable to use steam in the city for motive power, than a haul by wagon to and from water power from six to eight miles distant, or by railroad from twenty-five to thirty miles. Yet with those considerations in favor of steam as a motive power within the city, against water power at a distance, there is no comparison between water and steam as a motive power when they are similarly located, every one acquainted with such matters will admit. Independent of the uniform steadiness of the power of water over steam, the cost of water engines to transmit power under high heads, as can be used in this city, if the plans I propose are carried out, are at least 50 per cent. cheaper than steam engines of corresponding power, and will not occupy one-tenth of the space of steam engines and boilers, or require room for receiving and storing fuel, or be subject to the caprice or unsteadiness of careless engine drivers, or liable to the enormous tax on steam in the way of insurance, or the cost of expensive smoke stacks.

Of the Cost of Generating Steam for Motive Power,

Which will show the comparative value of water power similarly situated, and from my practical experience in relation to the use of steam as power, I feel satisfied that ten pounds of best Cumberland coal, per hour, per horse power, transmitted clear of the working of engine, is the lowest estimate that can with any safety be relied on, as a sufficient supply of fuel for generating steam power when using the best class boilers and high pressure engines, and working regularly and not exceeding fifty horse power, (high pressure engines of upwards of fifty horse power,) can be probably worked with rather more economy of fuel than the amount stated, though it is doubtful.

And it will be seen from the communications herewith submitted from Messrs. Wells & Miller, and Messrs. Bentley & Larrabee, that the amount of fuel I have named for generating steam is in accordance with those gentlemen's practical experience, and from their extensive practical experience as engine builders, their opinions should be taken as correct data in relation to such matters ; and I am of the opinion that there are few if any engine builders in this city who would furnish boilers and high pressure engines of best class, where less than fifty horse power, and give a satisfactory guarantee, for a less amount of fuel than ten pounds of best Cumberland coal per hour, per horse power, transmitted clear of the working of engines.

And from my personal knowledge of the general application of steam for power in this city, I am satisfied the aggregate for fuel is much more than the amount I have named, but assuming 10 pounds of best coal, per horse power, per hour, which is equal to 240 pounds per day of 24 hours. And valuing coal at \$4 75 per ton delivered at the place of use, would give 50.89 cents per day for the value of fuel for one horse power, say 50 cents, and to which must be added the wages of engine drivers, and extra insurance, and interest on the cost of procuring a proper supply of water from wells where such is practicable, or the exorbitant tax for water rent, under the present system of supply from the Baltimore Water Works, which I have been informed is at the rate of \$10 per horse power, per annum, an amount equal to \$30,000 per annum for the steam power supposed to be used now in this city, assuming all the engines in use, give an aggregate power of 3,000 horse, and were supplied at the rate named from the works referred to, and which is certainly an enormous tax on the manufacturing interests or industrial pursuits, and certainly is prejudicial to the encouragement of such pursuits, and a tax of at least four times the value at which water could be furnished at a profit, for such purposes, and allowing 50 cents per day for fuel for horse power, and to which add the wages of engine drivers, water rent, and excessive insurance, would make the cost at least from 60 to 70 cents per day of 24 hours, per horse power, for non-condensing stationary engines, of the class generally used in this city.

On the flow of the Gunpowder, and value of the surplus water that may be had from same, independent of the supply for domestic purposes, &c.

From the recent gaugings of the Gunpowder, at the point Raven's Rock, and from my personal knowledge of that stream for many years, I assume that the same may be reckoned to flow at the point designated, in times of ordinary drought, (at which time is the true bases on which to base calculations for power,) 155 millions of imperial gallons per day of twenty-four hours, though I have no doubt that in times of extreme drought, the flow may be reduced to from 120 to 140 millions of gallons, but such reduced flow probably does not occur once in five years, and that but for a short period. And assuming the Gunpowder to flow 155 millions of imperial gallons, and the affluent Mine Bank run and Herring run included, five millions of gallons, which I believe is an under estimate for those streams, there would be 160 millions of gallons per day that could be con-

veyed to this city, as I am satisfied the water shed of the country and Long tunnel would be sufficient to compensate for the loss from absorption, leakage and evaporation. Assuming the supply to be 160 millions of gallons per day, from which deduct 40 millions for domestic use, &c., leaves 120 millions of gallons per day of twenty-four hours, to be sold or leased as water power within this city, which amount of water, allowing ten pounds to the imperial gallon, would be equal to 25.2525 horse power to the foot fall, assuming the standard for a horse power at 33,000 pounds, raised one foot high in one minute, 25.2525 being the amount of horse power to one foot fall, which by $172\frac{1}{2}$ feet which will be the elevation of the surface of the water in the reservoir above mean high tide, gives 4,356 (not counting fractions) horse power for the surplus water over forty millions of gallons, and which it is presumed can be leased or sold to be used in the valley of Homestead, and thence to the Falls, or in the city, as per plans heretofore referred to, less 235.69, or say 235, the amount required for pumping, deducting which from the amount above, leaves 4121 horse power, and from which deduct one-fifth, leaves the amount of power for useful effect 3,295.8, or say 3,296 effective horse power, that can be transmitted by ordinary water wheels under a fall of fifteen feet and upwards, and many wheels and pressure engines are capable of transmitting, under high heads, of from eighty-five to ninety per cent. of the power of the water used, and a wheel of late invention is said to give a useful effect of ninety-five per cent. under a head of thirty feet, 3,296 being the effective horse power of the surplus water, and valuing which at thirty-three cents per horse power per day of twenty-four hours, allowing but 300 days in the year to be paid for, would give an annual income of \$326,304, or the interest on \$5,438,400, at six per cent. per annum; and the value assumed for effective horse power to be used along the valley of Homestead to Jones' falls, I presume every one desirous of procuring power for manufacturing purposes, would consider low, and at a value less than such power could be disposed of, and to an extent much greater than the amount of proposed supply. And from information had from various parties interested in employing water power, if the same could be furnished through pipes to the wharf property in the central parts of the city, the value of the power could safely be estimated at forty to fifty cents per day per horse power. And if your honorable body should appoint a committee to enquire into the value and amount of water power that could probably be disposed of within a few years in this city, I feel satisfied the result of such enquiry will confirm the estimates I have made for power, and show that an amount of wa-

ter power to the extent of more than 5,000 horse power could be advantageously disposed of within a reasonable time.

If the data I have assumed on which to base calculations, is admitted to be correct, (and I think on investigation the same will prove so,) there can be no doubt but that I have clearly demonstrated that the city of Baltimore can have forty millions of gallons of pure water per day, without taxing her citizens one cent, and that various industrial pursuits will be greatly benefited.

Any system that looks to pumping for a supply of water to our city, I cannot look upon other than unbecoming the public spirit and enterprise of the citizens of Baltimore, when common sense shows plainly there can be had an abundant and constant supply by natural flow, and from the most desired source, and at a nominal cost; though should it cost \$3,000,000 or \$4,000,000 (three or four millions of dollars,) for a supply of only 40 or 50 millions of gallons per day, by natural flow from the Gunpowder. I am satisfied time will prove that if pumping is resorted to at any point on the Gunpowder or Patapsco, by which to furnish anything near a corresponding supply, the cost will be equal if not more. It is evident the Gunpowder cannot furnish forty millions of gallons per day of 24 hours, by pumping to the height of a hundred and thirty feet, with a fall of thirty-six feet, when the minimum flow is 150 millions of gallons per day of 24 hours, or when less than 240 millions, unless by increased power to pump at times of greater flow, and reservoirs for storing of large capacity, where a constant supply of forty millions of gallons is desired. A system I should say, that does not present itself favorably, particularly when there are other plans of procuring a more abundant and constant supply at a reasonable cost.

In presenting my views in the foregoing, for the consideration of your Honorable body, I know the same will be subject to the scrutiny and criticism of scholars and scientific men, and from the hurried manner and disadvantages under which I have had to prepare the same, and without time to revise, there may be found in the composition some errors that may be criticised, and perhaps some error or errors in the computation of numbers, though I believe there are none. And I herewith respectfully present my views of the matter treated of, without apology, unless I have transcended the privilege of an humble citizen, in presenting his views to a legislative body in matters relating to the public interests.

Very respectfully,
Your ob't servant,
ALFRED DUVALL.

(TRUE COPY.)

BALTIMORE, March 31, 1854.

WM. G. HARRISON, Esq., Pres't B. & O. R. R.

DEAR SIR:

In reply to your note of the 29th, enquiring on behalf of Mr. Alfred Duvall some particulars of the dimensions, cut, &c. of the longest tunnel on the Baltimore and Ohio Rail Road, I respectfully present the following memoranda.

1. The longest tunnel of the Baltimore and Ohio Rail Road is called the Kingwood Tunnel, and is 82 miles west of Cumberland—its length is 4,100 feet.

2. The area of its cross section was intended to be twenty-four feet wide by twenty-two high, at the crown of the semicircular arch, to which the rock would have been cut had that been practicable. The strata however being horizontal and chiefly of slate, the corners above the curve of the arch fell out, and the section became nearly rectangular, and very irregular in its shape, in some cases as much as forty feet high owing to falls from the roof,—the width also was irregular, owing to slips from the sides and other causes.

3. The whole tunnel was cut through slate rock.

4. Three shafts were used; one of them 400 feet from the east end, and the others at about 1,200 feet distant from that and from each other. The section of the shafts is 10 by 15 feet, and they were placed at the *sides* of the tunnel—they were each 180 feet deep.

5. The tunnel and approach cuts took two and a half years to complete,—the *tunnel itself*, after the shafts were *finished*, a little over two years.

6. The contract price per cubic yard was \$3.00 for the tunnel, and \$5.50 for the shafts.

These replies answer all of Mr. Duvall's questions, and hoping they may be useful to him,

I remain, dear sir,

Very respectfully, yours,

BENJ. H. LATROBE.

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BALTIMORE, March 31, 1854.

ALFRED DUVAL, Esq.

In answer to your inquires on the 24th instant, at what price per cubic yard I would be willing to excavate a tunnel through Sater's ridge, of a probable length 4 1-3 miles, and of an area of transverse section of 40 square yards. Supposing the entire excavation to be rock, I would be willing to contract for such work at \$5 50 per cubic yard, and give satisfactory security for the completion of the same within a reasonable time; the shafting for the work being made at distances of from 9 to 12 hundred feet apart, and power and labor furnished, to hoist all excavations and water from tunnel, and removing the same from above the shafts, I only making the excavations of tunnel and delivering the same into the hoisting receivers at bottom of shafts.

Respectfully yours,

WILLIAM SLATER.

Mr. ALFRED DUVAL,

DEAR SIR:

In answer to your inquiry as to the cost of sinking and driving in rock, at the Springfield mine, I would say, our main shaft is 7 x 9 feet,—it is now 250 feet deep and in a hard slaty rock,—we pay \$100 per foot in depth, (6 feet,) for sinking it,—this does not include cost of hoisting the materials.

The drifts or addits are usually about 6 x 4 feet, and cost in hard rock from \$50 to \$80 per foot in length, according to the nature of the rock.

Your respectfully,

JAMES W. TYSON.

P. S. I would state that in sinking the shaft as above stated, six good men will put it down at the rate of about 18 feet per month.

BALTIMORE, April 1, 1854.

Mr. A. DUVAL,

Baltimore, Md.

DEAR SIR:

In answer to your inquiries of to-day, we state from our experience as Engine builders, we would not be willing to furnish a high pressure engine and boilers of best class, and guarantee the same to transmit, clear of friction of engine, one horse power per hour, with less than 10 lbs. best Cumberland coal.

Respectfully, yours, &c.

BENTLEY & LARABEE.

DO NOT CIRCULATE

BALTIMORE, March 20, 1854.

Mr. ALFRED DUVAL,

DEAR SIR:

In answer to your enquiry of this day, from our experience we would not be willing to furnish a high pressure engine and boilers of the best class, of from 20 to 50 horse power and guarantee that it to transmit (clear of the friction of engine,) one horse power per hour, with less than from 10 to 12 pounds of best Cumberland coal per hour per horse power.

And in relation to the advantage of a low pressure engine of less than 50 horse power over a high, to be worked in this city under the present difficulties of procuring a good supply of water, we deem the advantage would only be nominal if an/,—or say from 8 to 10 pounds.

Respectfully yours,

WELLS & MILLER.

DO NOT CIRCULATE