product of this country; and scattered all through the limestone formations, cedar thickets of great commercial value cover the hillsides. I know of nothing that approximates to a walnut forest; but trees, singly and in families, may be found in every portion of this valley which already yield a rich return to those engaged in their judicious manipulation.

But of the value of the timber interest of this valley no better evidence could be adduced than the healthy existence of the great and growing saw-mill industries of the city of Frankfort. Here, where fifteen years ago there was but one saw-mill of small capacity, seven or eight large ones are now constantly engaged in filling orders, a considerable proportion of which come from other and distant States. One or more of these mills is occupied exclusively in sawing walnut timber, a branch of business steadily tending to increase, notwithstanding the destructive rates of transportation to a market. When the existing dams on the Kentucky River shall have been renewed, even to this point, it will reasonably give such an impulse to these industries that to forecast their ultimate importance with any degree of accuracy would involve the solution of the whole question of the commercial destiny of the great valley of the Mississippi.

Prominent among the many points of interest dotting this valley everywhere in its whole length and breadth, as you leave Frankfort and proceed up the river, are, first, the great bridge of the Cincinnati Southern Railway, a quarter of a mile long and 280 feet above the river surface, stretching across the whole valley of the river, and lightly resting upon the tops of the grand old cliffs on either side. Then comes the village of Irvine, with its fine chalybeate and sulphur springs, opposite the rich coal and forest bearing valley of the station camp, and situated on the edge of the well-known iron belt, which stretches from the river northeast and southwest, and embraces a variety of desirable and popular ores. Higher up we find the Red River Iron Works, long celebrated for its yield of a high grade of car-wheel iron, and only awaiting the improvement of the river to bring into profitable use its magnificent appointments for the production of pig-iron of the finest quality. Next comes Sturgeon Creek, abounding in choice fish, and with a watershed well covered with yellow pine, poplar, and oak, the chosen retreat of deer and other game.

At Three Forks we have the confluence of the North and South Forks of the Kentucky River with Beattyville, the county seat of Lee County, on the north side, and the village of Proctor on the south side. This is a point of peculiar interest, and it suggests ideas of future importance difficult to overestimate. It derives its name from being very nearly at the confluence of the three forks forming the Kentucky River, the mouth of the Middle Fork being but 3½ miles above that of the South Fork. Here is the Gibraltar of the Kentucky Valley; all outward-bound freights must needs pass this point, and every expedition of observation or research finds this the natural starting-point. Command is had here of all the products of the upper Kentucky Valley. The future great lines of railroads, crossing the State from east to west and from north to south in search of a ceaseless flow of freight, will pass this point, and in common with the river will bear away its products of furnace, foundery, and mill, bringing back in return all things that conduce to the higher civilization of a great and active community. We find here, even now, a population anxious and nervously striving to get into such commercial relations with the busy world as seem designed by nature. Many of the descendants of the first settlers still make this their home, and one of the worthy patriarchs of the place, John G. MacGuire, has ever lived on the ancestral estate, and through a long life has steadily increased its value by means of his active labors in shipping coal and timber to market. His extensive mines and those of David Pryse have for thirty years or more yielded constantly and profitably; out of which Mr. Pryse, like Mr. MacGuire, has accumulated an honorable fortune, which he freely spends in the cause of home industries and popular enlightenment.

Beyond the Three Forks we find Jackson, the country seat of Breathitt County, situated in the midst of a rich and beautiful mountain pastoral country, and near the heart of the well-known cannel coal-region of the State. At this place is a water-power obtained by a tunnel of 60 or 70 feet through a rock partition between two points on the river, which are by the course of the river some five miles apart, with a difference of elevation of 8 or 9 feet. At present this fall is but poorly utilized by means of one or two rudely-constructed wooden reaction wheels, but it admits of a development equal to any probable future necessity.

Above Jackson come the villages of Hazard and Whitesburg, the county seats of Perry and Letcher Counties, respectively. Both of these places are in the midst of the great coal-field, and are remarkable for the picturesque beauty of their situations, and, the writer has reason to say, for the generous hospitality of their citizens. Near Hazard, a good many years ago, a number of successful borings were made for salt water, but in time, as competition sprang up, they fell into disuse. At the mouth of Leatherwood, however, some 17 miles above, borings made about the same time have ever yielded a handsome percentage of salt, and are still in successful operation.

In this section, my own conclusions are that the most productive coal-banks are probably found on the waters of Troublesome Creek and Carr's Fork; but where coal is a conspicuous and important ingredient in the constitution of the whole country, no one can foretell in what creek or at what point it may be ultimately found in its richest development.

Leaving the North Fork, the cannel-coal banks on the Middle Fork and the valuable estates on the South Fork, known as the Goose Creek Salt Works, are the remaining objects of interest to which I shall invite attention. The one yields a commodity of great but as yet unascertained commercial value, and the other produces an essential to the life of man so kindly and in such abundance, that the mighty progress of the world in the field of discovery and development has never yet stopped the flow of its pregnant waters, and the manufacture of salt still goes on with an energy which is an earnest of a vastly greater yield whenever the time shall come that slackwater or railroads shall have taken the place of mud pikes and terraced trails.

In considering the question of building dams of stone instead of wood, I have been led to examine reports upon the subject of the building stones of the Kentucky River from all sources whatever, as well as to make such personal observations as my time and means would allow, and have arrived at the fixed conclusion that on the whole length of the river and its tributaries lime or sand stones of a satisfactory quality may be found more or less convenient to the site of every proposed lock and dam. In the lower half of the valley a great variety of limestones are ever near at hand, suitable for the construction of good masonry; while in the upper half sandstones, many of superior excellence, constitute the material of which the river cliffs are formed. Professor Shaler, in his admirable remarks on this subject, says:

"I am satisfied, from the work which has already been done, that the best building stones in the West, when we consider their quality and accessibility to water transportation, lie within our State; and yet, with all this stone, the Federal Government has been compelled to pay half a million dollars for a less enduring stone brought from the distant shores of Maine, over a thousand miles away." And again, "The building stones accessible to water transportation in Kentucky are, on the whole, the best in the West."

"In the month of September the Federal Government awarded a contract for building stone to be used in the new custom-house building in Cincinnati to a firm of quarries in Maine. A safer building stone, more enduring and of far better architectural effect, can be quarried at half the expense of the transportation of building material from that distant point."

The following extract is from the Grocer's Price Current of New York, and is quoted in evidence of the possible great future of the rich hemp-growing district composing a large portion of the valley of the Kentucky:

"Russia's strength is apparent in manufactures. * * * In 1875 her flax and hemp mills (principally in Poland), employing 300,000 hands, produced 150,000,000 rubles, or $120,000,000 worth; while America, in 1870, had 33 bagging-mills, producing less than $3,000,000 worth. In 1875 we imported $25,000,000 worth of linens. Russia spins American cotton, while America spins Russian flax. * * * In 1870 America raised 12,746 tons of hemp; while in 1872 Russia raised 967,444 tons of hemp and 14,500,000 bushels of hemp-seed. * * * America excels Russia in wheat; she could also surpass Russia in flax and hemp."

From the State auditor's report I learn that in the season of 1873 the blue-grass counties, several of the richest of which border on the Kentucky River, produced 21,375,306 pounds of hemp. According to the United States census report for the year 1850, of the 7,000,000 pounds of hemp raised in the United States, 2,000,000, or a little less than one-third, were produced by the blue-grass region of Kentucky.

Up to that time the cultivation of flax had also received considerable attention, and a large proportion of the agricultural population obtained their linens from their own domestic looms. Since then the introduction of cheap fabrics, due to the growth of rival establishments for the manufacture of linen in the Eastern States, coupled with greatly-increased facilities for transportation, has crushed out of existence this primitive method of manufacturing. The transition era of Southern industrial economy is now, however, about to end; and the skilled laborer is gradually taking the place of the passive, unthinking farm hand. Attention is once more directed to the production of flax and its appropriate fabrics. A region celebrated for its abundant yield of the finer grades of hemp, and one singularly well adapted to the growth of flax, is beginning to receive a degree of notice somewhat commensurate with the importance and dignity of the great linen industry of the world. The salubrious and inviting climate of this section, its adaptation to the introduction and maintenance of skilled mechanics, the abundance of ever-present water-power, and the convenience of the raw material, have already attracted the attention of a substantial spinner of the East, and have encouraged him, in association with several Kentucky gentlemen, to erect at Frankfort the "Kentucky River Mills," a factory of considerable capacity, for the present manufacture of carpet yarns and other hemp fabrics, and with the further pur-

pose of encouraging and promoting in the blue-grass section a return to the cultivation of flax, of which it is their design to avail themselves. by adding to their mill, in due time, the machinery necessary to the production of linen fabrics. It is a well-grounded belief that this pioneer enterprise will be followed by others, and that ere long the valley of the Kentucky will resound with the hum of thousands of spindles.

While the tonnage of this proposed water-line would consist principally of the products of the mountain districts, it would by no means be left wholly dependent upon that source of supply. For the river, in nearly one-half of its length, embracing a distance of more than 150 miles, winds its tortuous way through the beautiful blue-grass heritage of the State—an expanse of gently undulating country of surpassing loveliness and excellence, which probably gives as large an annual yield of as great a variety of farm and pastoral products as any of the best portions of the United States, contributing an amount of agricultural and mercantile freightage amply sufficient within itself to justify the creation of slackwater navigation throughout its whole breadth. An approximate estimate of the actual tonnage that would be supplied by this great grain, hemp, tobacco, and stock growing country might, without much difficulty, be obtained; but for the purpose of a preliminary report it would seem to be supererogatory to enter into a detailed exhibit of the probable business to be developed by the proposed improvement, and especially so when the acknowledged productiveness of the countries involved is manifestly equal to the demands of any investment necessary to its relief from commercial thraldom.

In passing from these generalizations to a more particular discussion of the character of the work to be done, and obstacles to be overcome, in effecting the slackwater navigation of the Kentucky River, I find myself, from considerations of prudence, and from a disinclination toward unproved novelties, confined to the presentation of two systems of improvement only—that is, locks and dams of the ordinary type, wherever the character of the river admits of it; and beyond that, merely the removal of such obstructions from the bed of the stream as materially interfere with descending navigation. All other contrivances, such as storage-dams, inclined planes, &c., I gladly leave to the manipulation of those who, being better qualified, command also the necessary funds with which to experiment.

A careful personal examination of the remains of the old locks and dams on the Kentucky River, made last year under the direction of the commissioners of the sinking-fund of the State of Kentucky, together with much critical observation since, has produced on my mind the conviction that, in all cases of rock foundations, dams of the same class, with much smaller cross-sections, properly guarded, would have endured as well as the existing structures.

The immobility of dams of half their section, with the same amount of gravel backing, is more than equal to any demand that can ever be made upon them on this river. In confirmation of which I have only to refer you to the status of the five existing old dams, which, although their lower slopes, or one-half of their original sections, are gone, are still standing as firmly as ever, and except where breaches have been effected by piecemeal through many years of utter neglect, are yet amply sufficient to withstand the utmost force of the opposing waters. Upon a demonstration so practical and incontrovertible, as it relates to this river, I rest the proposition, from considerations of wise economy, to erect dams of a narrower crib or timber base. Of course this reasoning does not obtain in the case of soft or movable foundations, for their increased breadth of base is but an additional and necessary safeguard against the insidious ravages of the underscour. The general type of crib-dams, a plan of which is herewith submitted, upon which the accompanying estimates were made, consists of a structure the base of which is generally equal to twice its height (the foundation being rock), with a lower slope extending from the upper to the lower pool, and an upper slope reaching back only far enough to escape the destructive action of drift on its lower edge. For this purpose 16 feet, on a slope of 1 on 3, is believed to be sufficient.

The inclination of the lower slope is determined by a joint consideration of the lift and necessary width of base. The crib-work is well filled with rock, thoroughly sheeted with two courses of white oak, and backed by an ample covering of gravel. Where the foundation is not of rock the base of the dam is made somewhat broader, either by flattening the lower slope or extending the upper slope. The upper breast is protected by a double row of sheet piling, and the lower breast and bottom by the proper extension of the two lower tiers of timbers so as to form an apron, which is additionally strengthened and secured by means of rows of heavy piles driven along the face of the dam and the outer edge of the apron. As may be seen by reference to Table A, this has been the general idea upon which the accompanying estimates have been made.

But while a plan of such ample dimension has been made the basis of calculation, I am of the opinion that in practice it might be found safe and judicious to adopt a form of wooden dam of still less costly construction, one which would probably effect a reduction of 10 per cent. in the estimates for the whole work. For the purpose of this investigation, I have thought it best to adhere to the general plan of lock already existing on the river, with such modification of minor points as the peculiarities of each particular case may justify or demand. This lock, as may be seen by reference to Table A, has a chamber capacity of 170 by 38 feet, with guard walls 10 feet high. The manifest disparity between the cost of the old locks and the estimated cost of those proposed is mainly due to the present low price at which work may be done, as contrasted with that ruling at the time of the building of the old works; and, secondly, because of a proposed economical reform in the ornamental element of the masonry constituting the walls of the present lock.

Another important cause of difference may be found in the fact that these old works were in process of construction for nearly ten years, often sustaining great damage from floods and other causes, as well as involving all the expense incident to delay, suspensions, and failures. I have allowed for no such extraordinary contingencies in the estimate submitted to your consideration. In the construction of the proposed masonry, it might be found a matter of economy to utilize some of the numerous fine hydraulic limestones referred to in Table H in the manufacture of the necessary cements.

Having reported upon what has been done toward perfecting the survey of the Kentucky river, it is proper to state, that in order to a full and definite comprehension of the whole question of slackwater which shall be effected by such improvements, it remains to ascertain the length of navigation upon Red River and the other numerous smaller tributaries which shall be caused by locks and dams on the main stream; and also to re-examine all routes surveyed by the State of Kentucky beyond the limits of the survey made by the United States engineers in 1829, all maps and notes relating thereto having been destroyed a good many years ago by a fire in the capitol at Frankfort. The maps accompanying this report, together with such as are already on file in the department at Washington City, embrace all work done except those sections, the notes of which were destroyed in the manner as above stated. To reproduce and complete this work would require about eight months of labor, at a cost of $4,800.

The names and duties of the gentlemen assisting me in this work are, principal assistants, M. E. S. Posey and M. H. Jouett; B. R. Turner, assistant leveler; F. M. Pryor, rodman; J. T. Timberlake and Samuel Todd, chainmen. And in closing this report I feel that it would be an ungrateful dereliction of duty not to acknowledge the faithful services of those with whom I shared the labors and hardships of the survey. And while I recall with satisfaction the part performed by each individual member of my party, it gives me peculiar pleasure to commend to the favorable consideration of the profession my two chief assistants, Mr. M. E. S. Posey and Mr. M. H. Jouett, both of whom, by close attention to duty, won the esteem and confidence not only of the whole corps, but, also, the respect and friendship of the citizens along the various routes.

A copy of my report of December 10, 1877, to the governor of Kentucky, on the existing locks and dams on the Kentucky River, is hereto annexed. It sets forth in detail the condition of these works at that date.

Respectfully submitted.

R. H. FITZHUGH,
Engineer.

Maj. WILLIAM E. MERRILL,
Corps of Engineers, U. S. A.

REPORT OF MR. R. H. FITZHUGH TO THE GOVERNOR OF KENTUCKY.

FRANKFORT, KY., *December* 10, 1877.

SIR: By virtue of a contract with the commissioners of the sinking fund, and under instructions received from you on November 22 last, I proceeded, on the following day, to an examination of the condition of the five locks and dams on the Kentucky River, for the purpose of determining the amount and cost of the work necessary to be done in order to put them in a state of thorough and permanent repair; and also the cost of replacing the old dams by new ones, either of wood or of stone.

Having accomplished this work, I have the honor to submit the following as the result of my investigations, to wit:

PRESENT CONDITION OF DAMS.

No. 1.—Middle section of dam gone for a space of 150 feet. River bottom in gap scoured out to a depth of 20 feet or more below the foundation of the dam. Remainder of dam rotten from comb to low-water mark. Abutments in fair condition, but needing repairs. Guide and slope walls out of repair. Gates of lock all rotten and needing renewal. Lock in good condition.

No. 2.—Middle section of dam gone for a space of 175 feet. River bottom in gap scoured out to a depth of 15 or 20 feet below the foundation of the dam. Remainder of dam rotten from comb to foundation. Abutments needing renovating. Guide and slope walls out of repair. Both leaves of upper gate to be renewed. Lock in good condition.

No. 3.—Dam rotten from comb to foundation. Abutment to be entirely reconstructed. Guide and slope walls needing repairs. Both leaves of upper gate to be renewed. Lock in good condition.

No. 4.—Dam rotten from comb to foundation. Guide and slope walls needing repairs. One leaf of lower gate to be renewed. Lock in good condition.

No. 5.—Dam rotten from comb to foundation. Abutment undermined and falling. Guide and slope walls needing repairs. One leaf of lower gate to be renewed. Lock in good condition.

The accompanying tables, I, K, L, and M, exhibit the cost of repairing or rebuilding the dams on several plans.

Believing the science of dam-building to be an eminently practical matter, in the preparation of this report I have been careful to draw freely upon the experience of those who have gone before me, and to this end have sought information, not only at the hands of the accomplished engineers of the United States Army, and from the best authorities of this and other lands, but have also called to my aid the valuable counsel and suggestions of those practical men who have been for many years occupied in the navigation of our slackwater improvements and in the supervision of the repairs and reconstruction of the works which are now under consideration. Upon information thus obtained, combined with my own observations and the ordinary theoretical deductions, I have based the estimates herewith submitted.

The art of dam-building consists in the erection of a structure capable of withstanding the utmost extraordinary force of the floods to which it is to be opposed. It is, therefore, the practice of all competent engineers to make careful theoretical calculations of stability; add to this a large factor of safety, and then, where it is possible, observe how like constructions have stood elsewhere, before finally committing themselves to the adoption of their plans. In the observance of this rule, after a cursory examination of the whole field of experience, I have found no source of information more satisfactory than that afforded by the practice and results on the Kentucky River. The accomplished engineer, Sylvester Welch, esq., who forty years ago planned and executed these works, left but little undone that should have been done; and even that little honestly requires me to say is more easily detected in the issue than it could have been in the origin.

In the building of dams, apart from a due attention to the proper selection of materials and the faithful execution of the plan, the principal points to be observed are: First, the fitness of the foundation; secondly, the inherent stability of the dam; thirdly, the securing of the foundations against the effect of the underscour; fourthly, the protection of the abutting ends of the dam against the direct and reactionary effect of the water; fifthly, the closing of the body of the dam against such an undue flow of water through it as will cause the displacement of the filling, and gradually cut away and carry out the foundation timbers of the lower breast; sixthly, the arrangement of the lower bay slope and apron with reference to a minimum effect of the overfall.

To all these points due attention seems to have been given in the original plans of these works; in the execution, however, the system was less carefully observed at some points than at others, and after standing and battling with the floods for nearly forty years, in a much neglected condition (be it said to the honor of the engineer), these dams, like all human contrivances, have at length yielded, and in yielding have betrayed their weakest points, those points at which the ample safeguards provided in the design failed to be applied. As is now manifest by the present condition of the dams, some of which are standing firmly with one-half their section gone, neither the question of stability nor that of guarding against the underscour by ample breadth of base failed of receiving due consideration. But, on the other hand, the existence of breaches in dams Nos. 1 and 2, in those portions which were not guarded by sheet-piling along the upper, and heavier piling along the lower breast, admonishes us of the danger of neglecting the carrying out of any portion of a well-digested and fully-matured plan. And, again, the washing out of the filling of the cribs, and consequent wearing away and carrying off of the lower timbers of the dam, prove to us beyond controversy the importance of rigidly enforcing every provision for closing the body of the dam against an undue passage of water. Had these two points received their full measure of attention, I feel warranted in saying that, even now, after so many years of sad neglect, there would have been no breaches in these dams.

Beyond these defects, I do not feel justified in pointing out any others as being essentially injurious in the original construction; all other injuries, now noticeable, such as those sustained by the abutments and cribbing, being due to the ravages of

time and unavoidable conditions of site rather than to any defect in the plan or its execution.

In determining the arrangement of the slopes, fastenings, and other important details, the engineer was greatly assisted, in arriving at safe conclusions, by observations upon the effect of several years of warring with the waters in every stage of the progress of the works, from their beginning to their completion. These effects were carefully noted, and in each subsequent renewal of the work such modifications of the plan of construction were made as would best serve to fortify them against any destructive tendency of the waters. Such experience led to the adoption of flat slopes and low breasts, the use of long bolts, binding together the upper and lower portions of the dam, and the ample securing of the abutting ends against both the direct and reactionary force of the water.

How just were his conclusions, and how well observed, is better told by the present condition of the works than by anything I might say; for, after forty years of wearing and washing, the abutments, though in some instances crumbling, are still standing; none are fallen; none are flanked; the connections with the shore are yet unbroken; and the foundations along the faces of the unbroken dams but slightly, if in any degree, impaired. Except in the breaches of Nos. 1 and 2, the foundations of all the dams appear sound and substantial, and surely no better foundations can be found than those which have stood, and grown stronger, for forty years. In all these respects improvement, if possible at all, must be in the matter of economy; it cannot be fairly viewed in respect of effectiveness and permanency. And in considering the question of rebuilding, I could see no safer plan than to follow in the footsteps of my predecessor, adding to his store of knowledge the valuable results and suggestions of later experience. I have, therefore, predicated my estimate of repairs upon the idea of rebuilding upon the old foundations, being careful to incorporate into the plan of the new work such additional elements of safety as have been suggested by the results of experience here and elsewhere.

Crib-dams.—The estimates for new crib-dams contemplate the laying of other and new foundations. This involves greater expense, and, in most cases, greater risk; hence it would seem to be inexpedient to adopt this system, unless it should be developed, upon experiment, that the old foundations are insufficient.

Old dams repaired.—It will be seen by reference to tables Nos. 1 and 2 that the aggregate cost of repairing the dams is only about one-half that of rebuilding on the old foundations. This estimate contemplates a thorough overhauling of the old structure and a renewal of such portions as are radically defective. It is believed that such a plan of renovation, faithfully carried out, would insure the durability of these dams for a term of five years or longer, without material repairs; but with careful watching, and prompt attention to injuries in their early stages, they might be made to stand for many years. Indeed, I cannot see why, with the exercise of proper vigilance and energy, these old dams might not be perpetuated. Under more favorable circumstances, when a more critical examination can be made, and the best system of repairs determined upon, these estimates may be modified and lessened.

Stone dams.—Wherever approved quarries are convenient, and the natural foundations are of rock, stone dams should be used in preference to all others; for although, in first construction, they cost more than the crib-dams, yet, in the economy of subsequent repairs and maintenance they so far exceed the latter that it much more than compensates for the difference in first cost. I am told, by those who have had the supervision of the repairs of the crib-dams on the Kentucky River, that, since their construction, money enough has been spent in renewals to have reproduced the dams two or three times. Had they been of stone, well put together, the bill of repairs, even to this time, would have amounted to but an inconsiderable percentage of the first cost. To apply this system in the reconstruction of the five dams may not be deemed expedient; and yet the substitution of stone dams for those existing at locks Nos. 3 and 4 would involve an expense so comparatively small in excess of the cost of renewing the old works that it presents a question of much interest, and one that should receive ample consideration before it is finally disposed of. The condition of the masonry in all the locks affords the best evidence of the very superior quality of the stone with which they are built, and consequently of the capacity of the adjacent quarries from which it was taken to furnish the best of material for the construction of stone dams, should such be decided upon.

But while a good building-stone is found in close proximity to each of the five dams, only in the case of Nos. 3 and 4 is there certainty of available rock foundations, all the other dams resting in whole or in part upon gravel bottoms, in which cases the difficulty, expense, and uncertainty of procuring safe foundations, either by going down to the rock or by a thorough system of griddle-work and piling, would render it injudicious, under existing circumstances, to advise the adoption of stone dams. Certainly must this view obtain until a more thorough investigation shall prove that rock foundations may be had at no considerable depth below the surface, or until the State is prepared to commit herself to the highest order of work, not counting any

expense judiciously incurred. At Nos. 3 and 4, however, there is a concurrence of all the conditions necessary to the safe and successful adoption of the stone dams along with the necessity for a new dam. We find the base to found upon and the stone with which to build, coupled with conditions for using or dispensing with the coffer-dam of an unusually favorable character.

The plan of stone dam upon which the accompanying estimates have been made is curved in its alignment, presenting a convex surface to the current, with a transverse base equal to the height of the dam, and a thickness at coping equal to three-tenths its height, thus forming a section much stronger than the experimental conditions of stability require.

In an ordinarily favorable season, such dams could be rapidly and economically put up at most points along the Kentucky River; and in the event of the continuation of the slackwater improvement to the Three Forks, or beyond, it is difficult to see how the preponderating force of argument in favor of the adoption of this system can be successfully resisted.

My grateful acknowledgments are due to Capt. Samuel Sanders and Capt. J. J. Robinson for much important service and practical information, and to Col. William E. Merrill and Mr. John R. Procter for valuable contributions of late reports, and other courtesies.

Respectfully submitted.

R. H. FITZHUGH,
Engineer.

To His Excellency Gov. JAMES B. MCCREARY,
Chairman of the Commissioners of the Sinking Fund.

TABLE A.—*Exhibiting all information thus far obtained relative to the locks and dams constructed and projected on the Kentucky River between its mouth and the mouth of Middle Fork, being a distance of 257½ miles.*

Number.	Locality.	Distance from Ohio River.	Height above Ohio River.	Height above sea-level.	Length of pool.	Dams. Foundations.	Dams. Height.	Dams. Length.	Dams. Old, base width.	Dams. New, base width.	Dams. Slopes, base width.	Old dams, cost per linear foot.	New dams, estimated cost per linear foot.	Old dams, estimated cost of repairs.	Total estimated cost per dam.	Locks. Lift.	Locks. Length of chamber.	Locks. Width of chamber.	Locks. Height of guard.	Locks. Old, cost.	Locks. New, estimated cost.	Total cost of work to be done, per lock and dam.	Repairs.
0	Ohio River	0.0	0.0	410.0	4.0									$19,820	$19,820	15	170	38	10	$187,971			
1	Horse-Shoe Bend	4.0			27.0	Gravel	20	500	80		4 to 1	$56 50		18,324	18,324	12	170	38	10	121,104			
2	Six-Mile Ripple	31.0			11.0	Rock and gravel	21	429	80		4 to 1	59 60		11,432	11,432	14	170	38	10	99,769			
3	Cedar Ripple	42.0			23.0	Rock	21	464	66		4 to 1	59 60		9,456	9,456	14½	170	38	10	98,863			
4	Lee's Ripple (Frankfort)	65.0	42.0	452.0	17.2	do	20	530	66		4 to 1	54 00		25,770	25,770	14½	170	38	10	98,891	$65,000	83,500	
5	Steel's Ripple	82.2			13.0	Rock and gravel	25	450	66		4 to 1	66 67			17,500	13	170	38	10		64,000	82,200	
6	Clear Creek	95.2			22.4	Rock	28	350		56	4 to 1		$50 00		19,200	13	170	38	10		67,000	90,200	
7	Shaker's Ferry, High Bridge	117.6			15.6	do	27	400		54	4 to 1		48 00		23,200	14	170	38	10		50,000	64,000	
8	Fugale's Ripple	132.6			16.0	Rock and gravel	25	400		58	3 to 1		58 00		14,000	13	170	38	10		63,000	78,750	
9	Goggin's Ripple	148.6			16.0	Rock	21	350		42	4 to 1		38 00		15,750	14	170	38	10		69,000	91,050	
10	Hind's Creek Ripple	164.6			19.0	do	28	350		56	4 to 1		50 00		22,050	10	170	38	10		59,000	73,000	
11	Muddy Creek Ripple	183.6			11.5	Rock and gravel	27	350		56	4 to 1		63 00		14,000	11	170	38	10		66,000	85,600	
12	Cow Run Ripple	195.1			15.2	Rock	22	350		44	4 to 1		40 00		19,000	12	170	38	10		60,000	74,700	
13	King's Mill Ripple	210.3			9.2	Rock and gravel	24	350		64	4 to 1		56 00		14,700	12	170	38	10		66,000	85,600	
14	Doe Run Ripple	219.5			15.6	Rock	23	350		46	4 to 1		42 00		19,600	14	170	38	10		75,000	99,500	
15	Ross Creek Ripple	235.1			8.3	Rock and gravel	24	350		58	3 to 1		56 00		24,500	11	170	38	10		64,000	81,500	
16	Salt Rock Ripple	243.4			5.3	do	33	350		71	5 to 1		70 00		17,500	9	170	38	10				
17	Crooked Shoals	248.7			8.8	do	22	350		52	4 to 1		50 00										
	Beattyville	253.9	225.6	635.6		Rock																	
	Middle Fork	257.5	228.0	638.0		Rock and gravel																1,074 402	
	Grand total																						

Should the five existing dams be rebuilt instead of being repaired, the above estimate will be increased $75,000. The excessive cost of the old works is principally due to the employment of an ornamental class of masonry, and to the fact that these works were nearly ten years under construction, in which time they suffered repeatedly from high water, and from suspensions due to sickness among workmen, and other causes.

TABLE B.—*Exhibiting all information thus far obtained relative to the establishment of slackwater on the North Fork of the Kentucky River, from the mouth of Middle Fork to the mouth of Leatherwood Creek, in Perry County, being a distance of* 121.3 *miles.*

Division.	Length.	Distance from—		Rise.	Average rise per mile.	Height above—		Average width of channel.	Height of bottom.	Character of foundation.*	Number of locks.	Lockage.	Average cost—			Total cost.	Contingent expense.	Grand total.
		Beattyville.	Ohio River.			Ohio River.	Sea-level.						Per lock and dam.	Per foot lift.	Per mile.			
Middle Fork	0.0	3.6	257.5	0.0	.....	228.0	638.0	225	40	.....	.....	.....	.....	.....	.....	.....	.....	.....
War Creek	24.3	27.9	281.8	43.0	1.8	271.0	681.0	200	40	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jackson	19.6	47.5	301.4	.....	.....	.....	.....	175	40	.....	.....	.....	.....	.....	.....	.....	.....	.....
Troublesome Creek	11.0	58.5	312.4	49.9	1.6	329.9	730.9	150	40	.....	7	99.0	$68,000	$4,800	$8,654	$476,000	.....	.....
Hazard	49.4	107.9	361.8	.....	.....	.....	.....	125	30	.....	.....	.....	.....	.....	.....	.....	.....	.....
Carr's Fork	6.0	113.9	367.8	.....	.....	.....	.....	100	30	.....	.....	.....	.....	.....	.....	.....	.....	.....
Leatherwood Creek } Brashear's Salt Works }	11.0	124.9	378.8	203.9	3.1	524.8	934.8	100	30	.....	14	204.0	56,000	3,840	11,878	784,000	$126,000	$1,386,000

* Rock may generally be found at or near the surface; otherwise gravel.

This table is based solely upon information derived from the reports of State Engineer Sylvester Welch, esq., made in the year 1837, such use having been made of this information as the altered circumstances demanded.

TABLE C.—*Exhibiting all information thus far obtained relative to the improvement of the North Fork of the Kentucky River from the mouth of Leatherwood Creek to the source of the river in Payne's Gap of the Pine Mountain, being a distance of* 43.8 *miles.*

Division.	Length.	Distance from—		Rise.	Height above—			Average rise per mile.	Width of channel.	Height of bottoms.	Character of foundation.	Obstructions.		Grand total.
		Leatherwood.	Ohio River.		Leatherwood.	Ohio River.	Sea-level.					Kind.	Cost of removal.	
Leatherwood Creek	0.0	0.0	378.8	0.0	0.0	524.8	934.8	0.0	100	25	Rock may generally be found at or near the surface, otherwise gravel.	Island	.....	.....
Line Fork	2.9	2.9	381.7	15.6	15.6	540.4	950.4	5.2	100	25		Sharp bend on ripple and rocks in channel	$1,600	.....
Rockery Creek	3.3	6.1	384.9	23.9	39.5	564.3	974.3	7.5	80	25		Mill-dam and large bowlders	700	.....
Rockhouse Creek	3.3	9.4	388.2	20.2	59.7	584.5	994.5	6.1	80	25		Mill-dam and island	800	.....
King's Creek	4.9	14.3	393.1	38.3	98.0	622.8	1,032.8	8.0	80	20		Rocks in channel	1,000	.....
Smoot's Creek	2.4	16.7	395.5	21.9	119.9	644.7	1,054.7	9.1	80	20		Island and rocks	750	.....
Dry Fork, Gum Spring	4.0	20.7	399.5	33.1	153.1	677.9	1,087.9	8.3	80	20		Mill-dam and rocks	900	.....
Sandy Lick	4.8	25.5	404.3	41.2	194.2	719.1	1,129.1	8.6	80	20		.....	.....	.....
Whitesburg	1.2	26.7	405.5	12.0	206.2	731.0	1,141.0	10.0	80	20		Mill-dams and rocks	900	.....
Bottom Fork	6.9	33.6	412.4	60.3	266.5	791.3	1,201.3	8.7	60	15		Wooded islands and drift	2,360	$9,010
Boon's Fork	4.6	38.2	417.0	50.8	317.3	842.1	1,252.1	11.0	30	10		.....	.....	.....
James Craft's	2.4	40.6	419.4	78.3	395.6	920.4	1,330.4	32.6	15	5		Wooded islands and drift	.....	.....
Bentley's Mill	2.0	42.6	421.4	188.9	584.5	1,109.3	1,519.3	94.4	8	5		do	.....	.....
Payne's Gap	1.2	43.8	422.6	369.7	954.2	1,479.0	1,889.0	308.1	0	0		.....	.....	.....
Elkhorn Fork of Big Sandy	0.3	44.1	422.9	.....	902.4	1,427.3	1,837.3	.....	.....	.....		.....	.....	.....
Pound Gap	1.0	45.1	423.9	.....	1,491.7	2,016.5	2,426.5	.....	.....	.....		.....	.....	.....