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THE DESIGN OF A DAM AND THE INVESTIGATION OF A WATER SUPPLY FOR THE CITY OF ROLLA, MISSOURI.

Frank X. Nachtman.
Ernst Lorenze Chamberlain.

1909.

Approved

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THE DESIGN OF A DAM AND THE INVESTIGATION OF A WATER SUPPLY FOR THE CITY OF ROLLA, MISSOURI.

INTRODUCTION.

The object of this paper is to investigate a means of supplying the City of Rolla with better water at as reasonable a price as possible.

The elevation and distance of the supply from the city were very important factors, also the most economical position for the dam was to be considered.

After examining several drainage basins with the above purposes in mind we selected one just west of the City on account of its convenience and high elevation.

The water shed includes an area of over eight hundred acres and is divided into two parts which come together in a narrow valley between two prominent hills.

At this position we decided to build the dam; since no more drainage of considerable amount comes to the stream for quite a distance below. Only a small dam is required at this point to store a large amount of water and practically all of the drainage area is covered with a growth of oak brush, thus preventing the loss of any large amount of water by evaporation.

A traverse of the drainage basin shown in Plate I was made with a surveyor's compass and the area determined by the Double Meridian Distance Method to be approximately eight hundred thirty-seven acres, as shown in Plate IV.

Plotting the rainfall data kept for the past ten years by Professor P. J. Wilkins, Plate II, it was found that there is one peak from March to June and another during August and September, and only during November, December, and January does the rainfall fall below the amount needed for these months. The shortage can be supplied during the months in which the peaks are present. Even during the year 1901 there was nearly sufficient amount to supply the demands, allowing fifty percent loss due to evaporation.

The dotted lines in Plate II show the amount of rainfall which would supply a population of ten thousand, allowing fifty per cent for loss. Since there is a population of only twenty-five hundred at present and such a year as 1901 is an out-of-the-ordinary one, the rainfall would be sufficient, and enough water to last through the dry seasons could easily be stored.

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Assuming 10,000 population

50 per cent loss by evaporation and run off

100 gallons per capita per day

$$\frac{10{,}000 \times 100 \times 365 \times 2}{7.5} = 800 \times 43560 \times X$$

$X = 2.8$ feet per year

or

$\frac{X}{12} = 2.8$ inches per month

It was found by making a careful survey of the reservoir basin by transit stadia method as shown in Plate III, that the reservoir was capable of holding nearly twenty-nine million cubic feet, which would supply a town of ten thousand population over four months, allowing fifty per cent loss due to evaporation.

$$\frac{10{,}000 \times 100 \times 365}{12 \times 7.5} = 4{,}000{,}000 \text{ gallons per month.}$$

4,000,000 gallons equals the average consumption per month.

The area enclosed by each contour, Plate III, was measured after plotting by means of a planimeter and the volume calculated by Simpson's formulae:

$$\text{Volume} \quad \left\{ \frac{y}{2} + y_2 + y_3 - \quad - \quad - + \frac{y_n}{2} \right\} x$$

in which y equals the area enclosed by each contour line and x equals the vertical distance between the contours.

SPECIFICATIONS FOR BUILDING DAM NUMBER ONE FOR ROLLA WATER WORKS.

PLANS.

The contractor is to furnish all material and to do all work necessary to build the dam on the Frisco branch of Little Beaver, located one and one-half miles west of the City of Rolla, Missouri, in Section ten, Township thirty-seven, Range eight, west of the fifth principal meridian. The dam is to be in accordance with plans signed by F. X. Nachtman and E. L.Chamberlain, and filed at the office of the City Mayor. The work will also be done in conformity with these specifications: These plans show only the general character of the work and during its progress such working plans will be furnished from time to time by the engineers as they may deem necessary.

BORINGS.

The character of the material to be encountered in excavating for the foundation must be determined by the contractor.

WORK TO BE DONE.

The work to be done consists in a general way in stripping the site of the dam of all soil and loose material, laying all concrete, doing all pumping or other temporary work in connection with the permanent work and

delivering over to the said City of Rolla the whole structure in a complete condition with the concrete all faced, with the dam completed for services, in accordance with the plans and these specifications.

LINES, GRADES, LEVELS, AND PLANS.

All work during its progress and on its completion must conform truly to lines, grades, and levels to be determined and given hereafter by the engineers and no excess work will be paid for unless ordered by the engineers.

TOOLS.

The contractor is to furnish all material, tools, implements, machinery, and labor necessary for doing the work herein contracted for, with safety to life and property in accordance with this contract and within the time specified.

EXCAVATION.

All excavation paid for under Article ----------for earth rock will be measured in excavation.

EARTH.--Earth excavation is to be made for the foundation of the dam, down to solid rock, and for spillway where it is required.

ROCK.--All rock which, in the opinion of the engineers, cannot be removed by picking, and all boulders of one cubic yard or more in size, shall be classified as rock excavation.

The prices bid for excavation shall include the work of hauling and depositing the material where ordered by the engineers; provided the haul does not exceed one hundred yards.

Rock excavation in the spillway channel and elsewhere as designated by the engineers is to be made with explosives of moderate power and not with high explosives. Black powder may be ordered by the engineers to be used in special cases.

TEMPORARY WORK.

The contractor will be required at his own expense to take care of all water which may come down the stream during the progress of the work and to make good any damages done to the dam by freshets or other actions of the water or of the elements.

All timber or other material used for temporary work in construction of the dam shall be furnished by the contractor at his own expense.

CONCRETE.

The concrete shall consist of a thorough machine mixture of one cubic foot of cement, two cubic feet of sand, and four cubic feet of broken stone. One sack of cement weighing not less than ninety-three pounds shall be considered equal to one cubic foot.

CEMENT.--The cement shall be of a Portland brand, sound, and free from sulphur. To insure its good quality all cement furnished by the contractor will be subject to inspection and rigorous tests and if found to be of inferior quality will be branded and must be immediately removed from the work, and not returned. The character of the tests are to be as follows: Neat cement shall have a tensile strength of five hundred pounds per square inch after seven days' set and shall show other satisfactory qualities when submitted to the standard tests of the American Society of Civil Engineers. The contractor shall at all times keep in store at some convenient point in the vicinity of the work, at least seven days supply of cement to allow time for the tests to be made without delay to the work of the construction. The engineers shall be notified at once of each delivery of cement. The cement shall be stored in a tight building. Each cask or bag must be raised several inches above the ground by blocking or otherwise.

WATER.--The amount of water used for making the concrete shall be approved or directed by the engineers.

SAND.--The sand used must be clean and sharp, free from clay and foreign materials.

STONE.--The stone used in concrete shall be compact, clean limestone, free from shale and shall not exceed two inches in its greatest diameter.

LAYING.--The concrete shall be laid immediately after mixing and shall be thoroughly compacted throughout the mass by ramming. No walking over the concrete will be allowed while it is setting.

When the concrete is set the surface of it shall be wet with a plaster of neat cement before new work is added.

The moulds and forms shall not be removed until the concrete has set for at least fourteen days.

PLASTER.--The up-stream face of the dam and such other surfaces as the engineers may direct shall be plastered with a half-inch coat of Portland cement plastering put on in two portions as follows: Next to the concrete a thick coating of Portland cement mixed with an equal volume of sand, rubbed to a uniform surface and left rough. Over this shall be spread a coat of neat Portland cement and thoroughly worked to make a perfectly water-tight surface. The surface of the concrete shall be thoroughly wet before applying the mortar.

SPILLWAY.

The spillway shall consist of an overflow weir and a channel to carry the water past the dam.

The weir shall be twenty-five feet in width, with the crest of the weir 3.6 feet below the level of the top of the dam, and one hundred fifty feet from its upper face.

The weir shall be constructed of concrete plastered with mortar, the concrete and mortar to conform to the previous specifications for concrete and mortar.

The channel shall be rectangular in cross-section ten feet wide beginning at the overflow weir at a depth so as to give the water a drop of 3.5 feet from the weir into the channel and continue at a grade of one per cent to the point of discharge which is approximately four hundred fifty feet from the weir.

The channel shall be paved with granite blocks where the water drops into it and shall be lined with concrete at all other places where the excavation is through earth.

The concrete lining shall be four inches in thickness and shall conform to the specifications for concrete.