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THE PUBLIC WATER SUPPLIES OF HUDSON CO., N. J.

Particularly with reference to the Jersey City supply.

Paper read before "The Historical Society of Hudson County"
by Edlow Wingate Harrison,
Thursday evening, November 18th, 1909.

WATER being a prime necessity of life, the works required for its collection, conservation and distribution are among the most enduring of the monuments which mark the progress of the human race all over the earth, and in all periods; in fact back into the darkness before recorded history.

As in the past, so it will be in the future, and when the earth in time becomes a cold, dead globe like the moon, the last monuments to show that it once was the abiding place of man, will be the ruins of massive masonry which formed parts of the water supplies of its former population.

Indeed, if we can judge from what scientists have discovered of the life history of the universe, the last ages of man on the earth will probably be marked by life and death struggles among the peoples for the control of the fast diminishing supplies of water.

There are wells and cisterns, dug before Abraham's time, still in use, and as well known on the great trade routes of Asia and Africa, as Chicago and St. Louis on our railroad lines.

The first artificial water supply in Hudson County, and the State of New Jersey, was probably from three wells.

In 1633 the Dutch East India Company erected two houses, one at Communipaw, occupied in 1634 by Jan Evertsen Bout, and one at Ahasimus, occupied in 1636 by Cornelius Van Vorst, and in the same year, 1633, Michael Paulusen erected a hut on Paulus Hook, where he purchased peltries from the Indians.

As all these locations are on the sand dunes, then surrounded by salt water, it is likely the necessity of potable water for man and beast was satisfied by digging shallow wells into the water bearing substratum, just as the settlers and their forefathers had done in the sand dunes inside the dykes of Holland.

As, before the introduction of a public supply, a good well was seldom abandoned, there must be tradition still in exist-

ence which can locate the positions of these three first marks of civilization in this County and State, and it would be interesting if this Society could obtain the information and preserve the record.

In February, 1643, occurred the atrocious massacre of the peaceful Tappan Indians on the shore of Communipaw Bay, at Jan de Lacher's Hook near the mouth of Mill Creek, by the orders of Governor Keift.

The uprising of the natives, which followed this brutality, brought on an Indian war covering all the country from the Raritan to the Connecticut, and resulted in driving the few settlers then in New Jersey to the protection of the Palisades of New Amsterdam.

On the restoration of quiet, a few settlements were made in the County, it would seem, generally along the shores of the Hudson and Bay, at Pamrepaw, Caven Point, Communipaw and Weehawken, and it is to be presumed that each household had its well.

But it was not until 1660 that Governor Peter Stuyvesant, old soldier that he was, carried into effect his plan of having a central fortified place, in which the settlers could build their houses secure from the attack of enemies, and pass to and from their tillable lands in the outlying country.

This was the foundation of the Town of Bergen, first made up of a square bounded by palisades set along the lines of four narrow streets, at present called Newkirk, Vroom, Van Reypen and Tuers.

In the centre of the open space, now Bergen Square, was dug a public well, which still exists under some feet of filling and paving and the rails of the trolley line.

This well may be considered the first public water supply in the County, and the State.

No better monument could be set up to commemorate the settlement of Bergen, than to dig out this old well, and erect a handsome canopy over it, with the proper inscriptions, and a roster of the first settlers. For about two centuries, this old well was used by the neighborhood.

For nearly two centuries, wells and cisterns furnished the potable water supply of the County, while the change took place from Colony to State, and population slowly grew.

On November 1st, 1847, Messrs. Clerk and Bacot reported

a plan for a public supply to be taken from a small reservoir in the cutting of the New Jersey Railroad, now Pennsylvania Railroad, just west of the present Boulevard crossing. The largest quantity available was about 250,000 gallons per day, which it was proposed to elevate to a distributing reservoir to be made on top of the Hill, not less than seventy-five feet above tide. This lower reservoir had been excavated by the Railroad Company for use in supplying its engines.

By an Act of the Legislature, dated March 18th, 1851, Edwin A. Stevens, Edward Coles, Dudley S. Gregory, Abraham L. Van Buskirk and John D. Ward were constituted a Board to be known as the Water Commissioners for the Township of Hoboken and Van Vorst, and the City of Jersey City.

The members of this Board were empowered to employ engineers, surveyors, and such other persons as they might deem necessary in order to enable them to report on a plan for supplying these places with a sufficient supply of good and wholesome water, with an estimate of the expense of carrying out such plan.

No compensation was allowed the Commissioners.

At this time it was estimated that the population requiring water and likely to use it in the three communities, was about 17,000 in number.

The Commission estimated that the whole space lying east of the Hill in Jersey City and Hoboken, and, on the Hill, lying south of a point sufficiently elevated to form a site for a distributing reservoir, would in time be occupied by 250,000 people.

Their estimate based on experience, probably obtained from English sources, was that an average of thirty (30) imperial gallons a day would be required for each person, and they therefore looked for a supply equal to furnishing seven and one half million gallons. In order that sufficient head should be available for fire purposes, the elevation of the reservoir, it was decided, must not be less than 125 feet above high water.

The supply needed at first was estimated at about 500,000 gallons per day.

They engaged Wm. S. Whitwell, late chief engineer of the Eastern Division of the Boston Water Works, as an expert, and employed Messrs. Clerk and Bacot, city surveyers, to

compile a connected map of the proposed water district, showing the built up portions, and the length and sizes of service pipes required.

To show what Jersey City escaped, it is interesting to read over the different projects seriously proposed and examined into by the Commissioners.

The proposition to use the small reservoir in the railroad cut was rejected, as it was not capable of supplying more than fifteen gallons per head, and also, the water was found, on analysis, to contain sixteen grains of inorganic solids per gallon—about the amount of inorganic solids found in rather thin city sewage to-day.

Examinations were made of the small streams coursing down the west side of Bergen Hill toward the Hackensack River, and a suggestion was considered for using the west slope of the Hill for a gathering ground, catching the rain water in a net work of sub-soil drains, and conducting it to a reservoir from which it could be pumped to a distributing reservoir on the heights.

This plan was rejected, very fortunately, as it was found that the storage required would be abnormal, and the quality of the water not as good as desired.

Rockland Lake in New York State was considered, but objected to as being in New York State, and the supply being only equal to a delivery of two million gallons per day. The expense of the long conduit was also against this plan.

Some one suggested a plan for a dam across the Hackensack River, and the meadows, at a point not far above Newark Avenue, with the idea of keeping the salt water out, and forming a great shallow lake, from which water could be drawn by a side cut to the foot of the hill, and there pumped to the reservoir.

The expense and certainty that the vegetation in the water would render it unfit for potable use, led the Commission to pay little attention to this scheme.

One plan suggested is of interest, because it was almost directly in the line of what has, at last, been done to provide the present supply.

Roswell L. Colt, President of the Society for the Promotion of Useful Manufactures at Paterson, offered to furnish from the canal above the Falls, at a head of 106 feet above tide,

nine and one half million imperial gallons per day of upper Passaic water, at a price of $4,000.00 per annum.

This represents a capitalization to-day, at four per cent, of $100,000.00, or just about one half the rate paid for the diversion of the new supply from the upper Passaic Valley, at a head of 305 feet. This shows that the value of water powers in New Jersey have declined since that day.

Another proposition from the same interests, was to furnish about five million gallons per day from the Passaic River above the then projected Dundee Dam, or from Dundee Lake, at a cost capitalized at four per cent of $75,000.00.

The expense of the long conduit, and the total cost which would have entailed a very heavy burden upon the small community, and also the danger of entering into a contract with the Society as a joint lessee with other parties, led the Commission to reject these offers.

If the first had been accepted, it is possible the whole history of water supply in New Jersey might have been materially changed.

A proposal was considered to take the water from the Bloomfield level of the Morris Canal, at an elevation of 174 feet above tide, and deliver it by gravity in the distributing reservoir on Bergen Hill, at an elevation of 140 to 150 feet. The scheme proposed raising the dam at Greenwood Lake, which was afterward done.

The quantity of water proposed to be drawn was seven million, five hundred thousand gallons per day. The price asked by the Canal Company was $250,000.00, and the estimated cost of works $719,396.00, or a total of $969,396.00.

Doubts were raised as to the right of the Canal Company to use the water in this way without legislation. There was also an objection to becoming possibly involved in joint ownership in water rights, and fear of litigation with owners on the Pompton and Wynokie Rivers.

While these plans were being considered, the engineer, Mr. Whitwell, seems to have been putting in a rather industrious summer, with the result that the Commission finally decided to take the water from the Passaic River at Belleville, pumping it to a reservoir on Barbadoes Neck, or Coppermine Ridge, at an elevation of 150 feet, and then by gravity to the distributing reservoir on Bergen Hill.

The estimated costs, without land damages, for a supply sufficient for a population of 66,666 persons, at 30 gallons per head per day, was $653,359.00. Land damages were estimated, on the basis of the same item on the recently completed Croton works, at 3¼ per cent of the whole, or at $26,131.00, making total estimated cost $679,493.00.

At that time the debt of Jersey City was about $24,625.00. The city property was estimated to be about $33,730.00. The assessed valuation was $7,761,618.00.

The distance the water was proposed to be brought to the distributing reservoir was 41,800 feet.

In the estimate of revenue to be received from sale of water, the following items were included:—

2,500 houses with one bath and one closet;

15 bakeries; 1 brewery; two printing offices;

33 steam engines, 10 horse power each; 6 slaughter houses;

1 soap manufactory; 10 hotels (where are they?); 100 tavern saloons, &c.;

26 ocean going steamers per annum;

15 locomotives;

250 horses and cows.

The direct income was estimated at $42,045.00 per annum. The saving in insurance at $20,000.00 per annum; saving in expense of fire department $1,000.00, and in public cisterns, wells, pumps, $3,000.00. Total—$66,045 per annum.

It was noted that the apparatus for extinguishing fires is more abundant, and the firemen more numerous in Jersey City and Hoboken in proportion to population and value of property exposed, than in New York, and the water was less abundant than it ever was in New York.

The estimated cost, which was not exceeded in construction, was equal to about $37.50 for each individual, computed at 17,500 requiring water. The Croton Works had cost $43.00, and the Cochituate Works at Boston $35.00 per head. The new supply from Boonton will cost, when purchased outright, about $30.00 per head.

Thus the first Board completed their work and reported to the Legislature of 1852.

It is a refreshing commentary on our advance in the science of city government to compare this plan considered and settled upon in one year, involving a burden of $37.50 per head, with

the weary years which it took for the officials who were charged with this duty between 1882, when the demand for a new supply became urgent, and 1899, when the contract was finally let, to formulate plans contemplating a much lighter comparative expenditure, and in the face of a typhoid death rate running four or five times the normal.

The first Commission consisted of the very gentlemen whom we are often told by fervid statesmen of to-day, bartered away the birthright of the city, its water front and streets; placed upon the city the burden of railroads and canals, owned legislatures, and were very much in the over-lord class, but in this work they showed very clearly that they were leaders of men by natural right, and loyally and without cost gave to the public the advantage of the great powers which had proved so successful in their personal enterprises.

On receiving the report, authority was given March 25, 1852, to a new Commission to raise the money and carry out the recommendation.

This Commission, for the first years, was partly appointed, John D. Ward, Dudley S. Gregory, and Moses B. Bramhall; also the President of the Board of Aldermen for the time being, and one person to be elected at the first charter election following.

After 1855, one Commissioner was to be elected each year, the terms being for four years.

The new Board received twenty-two proposals for their first offering of $300,000 six per cent. loan, the aggregate of the offers being $1,434,000.

The bonds brought a premium of a little over two per cent.

Mr. William S. Whitwell, the engineer who had made the preliminary examinations, was appointed chief engineer.

The works were commenced and completed substantially on the same lines except as to the enlargements made from time to time, as they exist to-day, partially abandoned for use.

Work was commenced August, 1852, and the pump was started at Belleville June 16, 1854.

This pumping engine was an interesting feature in the work; it was the largest steam pumping engine in America, and one of the largest in the world, with a steam cylinder 80 inches in diameter; it was of the Cornish type, an improvement upon the Boulton and Watts engines used extensively in Eng-

land for water works service, and had a capacity of raising about 4,000,000 gallons 157 feet in twenty-four hours, at normal speed.

Its net efficient horse power was about 120, and at that time it was looked upon as marking an epoch in water supply engineering.

The engine was built by Robert P. Parrott of the West Point Foundry, who afterward designed and built the celebrated Parrott guns, used extensively in the Civil War.

The choice of this type of engine was brought about by a circumstance which is another instance of the great influence upon American material progress of a well known Hudson County family.

Some thirty years before this Mr. John Stevens, while in England purchasing material for the infant Camden and Amboy Railroad, designed and had rolled and shipped to America the first T rails.

In 1851 Mr. Edwin Stevens, while a member of the original Water Board, was in England, very probably with his yacht the *America*, which that year won the Queen's (now America's) cup. He employed Mr. George A. Phipps, an English engineer, at his own expense, to examine into and report as to the economy and advantages of different types of pumping engines used at the London water works, with the result that the Cornish type was recommended. Mr. Stevens reported in writing to the Commission.

From time to time the works were enlarged until in 1882 their capacity was equal to delivery of about twenty million gallons per day.

A little before this, Hoboken had severed her connection with the supply, and contracted with the Hackensack Water Company for a supply from the upper Hackensack, but this loss was partially made up by a contract with Bayonne, which only lasted a few years on account of the growing polluted condition of the Passaic River at Belleville.

At the time of the installment of the Jersey City works, the Passaic River was justly considered one of the purest sources of supply in the country, based on the then known and accepted standards. Newark was a small town, and did not extend much above the present Turnpike Bridge. A bar in the river below Belleville held back the tidal flow. Passaic was a village, and

Paterson a small town grouped about the mills below the Falls. There were no sewers discharging into the stream.

In 1872 John P. Culver, then chief engineer, called the attention of the Board to the rapidly increasing pollution by sewers. He calls the water still pure, but notes bad taste and odor during the summer.

In 1873 a chemical examination was made by Profs. Wurts and Leeds. This shows in the light of present day knowledge, the river was too greatly polluted for safe use as a supply.

At that time, and for fifteen years afterward, the whole science of bacterial pollution was unknown, or only guessed at.

In 1874 the bar below Belleville had been removed by the U. S. Government with the result that the incoming salt water, with a proportion of Newark sewage, began to show at the intake of the supply.

In 1882 the evil had become glaring and dangerous; the occurrence of a very dry period, and consequent low water in the river, intensified the trouble. Typhoid became prevalent in Newark and Jersey City, and the Water Boards of the two cities commenced agitation for a remedy or a new supply.

Then followed a period of several years of floundering and ignorant mismanagement on the part of the city authorities and their advisers.

The situation was embarrassed by reason of the unsettled state of knowledge as to the effect of sewage pollution upon a water supply. While large volumes of sewage were being poured into the stream at Paterson, the action of the oxygen in the water, and re-aeration below that city, removed the organic before the lower river was reached as far as could be determined by chemical analyses, and some of the greatest chemists in America, and medical men of high standing, as late as 1888 went on record that the supply, though unpleasant in taste and odor, was harmless to health.

In the meantime the typhoid death rate grew, and the gases from the city sewers was ascribed as the cause.

In 1888 Passaic put her sewage into the river and reinforced the partially nitrified water from Paterson with a new dose of organic filth.

Yet in a suit in Chancery to restrain the work, the claim of the appellant city of Newark that, though the chemical analysis showed destruction of organic in the flow of some hours, bacter-

ial examination disclosed the presence of pathogenic germs. This evidence was ignored, and the Court gave an opinion, that the science of bacteriology had not yet established its right to consideration in the Court of Chancery.

In 1891 Newark secured a new and pure supply from the Pequannock water shed, but Jersey City still blundered along, until in 1895 the typhoid death rate had reached eighty (80) in a 100,000. The rate now is about fifteen, and the city was daily losing population and wealth.

Mayor P. Farmer Wanser then performed the most meritorious act which can be credited to any Mayor of Jersey City for a generation, and cutting the knot, made a contract with the East Jersey Company for a temporary supply of pure water, thus saving many hundred lives.

In 1899 a contract was entered into with the Jersey City Water Supply Company for the water rights, land and plant necessary for a present supply of fifty million gallons of water per day, and the rights and lands necessary to extend to seventy million gallons, with gravity delivery from the Rockaway River at Boonton.

Financial troubles of the company delayed the work of construction for two years, but in 1904 the water was turned on and has been used without interruption ever since, though a tedious litigation over minor details of the contract has delayed the actual acquirement of the works by the city.

The contract price of the new works is $7,595,000.00, of which seven million may be fairly taken to represent the cost of the fifty million gallons daily supply, and $595,000.00, the added cost on account of the right to draw the additional twenty million gallons per day.

This is at the rate of $140,000 per million per day for the initial supply, and about $30.00 per head of population.

The first works, exclusive of capitalization of cost of operating pumps, cost about $340,000 per million gallons per day.

The original Croton Works for New York cost $360,000 per million per day, and the original Boston Works, $500,000 per million per day.

The estimate for the new Catskill supply to New York is somewhat over $300,000 per million per day.

Jersey City has no cause to grumble at her bargain. The works could not be duplicated for $12,000,000.00 to-day.

The Jersey City supply presents some interesting and original features of construction.

The aqueduct, about 22.6 miles long, includes 17 miles of six foot diameter riveted steel pipe, at the time of construction the longest steel pipe of as large dimension constructed.

A large part of the pipe is under a pressure over one hundred pounds per square inch.

There are about four miles of reinforced concrete conduit on the line, the first instance of such construction being used for water supply, and an example which has since been followed extensively.

The main dam at Boonton ranks as a structure with the great dams of the world. It is 3,150 feet long, 2,150 feet being of masonry, and 1,000 feet of earth with concrete corewall. Its maximum height is 114 feet, with a width at base of 77 feet, and 17 feet at the top.

There are about 260,000 cubic yards of masonry in the structure. A mass which would make a block which, stood on end, would cover four city lots and tower seven hundred feet in the air.

The masonry of the dam is the first instance in modern engineering of a method of construction which has since been adopted for nearly all the larger dams designed in the United States, including the completion of the Croton, the irrigation dams in the West, and the greatest dam in the world, now being constructed at Shokan for the new supply for New York. This masonry consists of enormous blocks of granite, rough as from the quarry, dropped into a semi-liquid mass of concrete, into which they sink and bed themselves. This form of construction was given the name of Cyclopean Concrete by the engineers, and the name has passed into the language and is now generally used in describing such work. No skilled labor is required in this construction, very rapid progress is possible, and the work is enormously strong and water tight. The daily and monthly records of construction on the Boonton dam exceeded any previous records made up to that time.

The top of the dam is 310 feet above the sea, and the lake empounded is 100 feet deep at the deepest point, over two miles long, and about half a mile wide, and is one of the most attractive bodies of water in the State.

In excavating for the foundation of the dam in the triassic

sandstone, some very interesting fossils were found. Some twenty feet below the rock surface many tracks of dinosaurs appeared in the stone as they had been left in the mud of the ancient sea or lake, and some ten feet deeper numerous layers of fossil fish were found, pressed between the layers of shale, as flowers between the leaves of a book.

An amusing incident occurred apropos of these fossil fish

The State geologist spent some time at the work, making a collection of specimens, and one day a party of Jersey City people visited the ground, accompanied by several reporters.

The fossils were a subject of conversation, and one of the reporters, in search of a story, asked the professor, "About what date were these fish swimming?"

"Date!" was the reply, "we don't reckon geologic periods by years."

"Yes, but I want to make a story—can't you say a thousand years, time of Moses, or Adam, any old time."

"Well," said the professor, "let us see. You know there was a time we call the glacial period. Since that period the great canyon of the Colorado has been cut down a mile or so, and the whole topography of upper North America altered. Well, suppose we say the glacial period was yesterday. Then on the same scale we can say these fish were swimming a week ago."

There is another new thing which has had its origin in the Jersey City works, which is worthy of note, and is, in my opinion, likely to result in enormous advantages to the world.

In the Chancery suit between the city and the company, the question of the true intent of the contract as to the standdard of the purity of the water, and the point where that standard should prevail was at issue.

It was decided by the Courts that the water, as a whole, delivered to the city, complied with the standard of the specifications, but, there were some indications that at some times, for a short period, under a rare combination of circumstances, the water might be a little below this standard, and that it was the duty of the company to prevent this.

The danger was very remote, and to install a bacterial filter plant was equivalent to taking a twelve inch gun to kill a partridge.

The company, through its sanitary officer, Dr. John L.

Leal, and its consulting sanitary engineers, Messrs. Rudolph Hering, George W. Fuller and George A. Johnson, commenced a series of experiments to find a means of insuring the absolute purity of the water at all times.

The result of these experiments has been the discovery that, by the introduction of fifteen one hundredths of a part per million of potential oxygen obtained by the use of five pounds of bleaching powder, per million gallons of water, any pathogenic bacteria in the water could be practically annihilated.

This method has been used now since the latter part of September, 1908, with the result that Jersey City has been receiving a practically sterile water, the bacterial count running below fifty per cubic centimeter, with a total absence of the Bacillus Coli.

To those who fear that this process may have ill effect upon the users of the water, it is reassuring to know, from the highest scientific authority, that, from careful examination for any indication of the treatment in the water, as delivered in Jersey City, it is estimated that a person would have to drink one gallon per day of water, for eight thousand years, to get a medicinal dose of chlorine, such as is sometimes administered to patients suffering from typhoid fever.

The results here have interested the authorities in charge of the water supplies of many cities, and it is very probable that the process will, in a few years, be very extensively used, where the circumstances are similar to those in Jersey City.