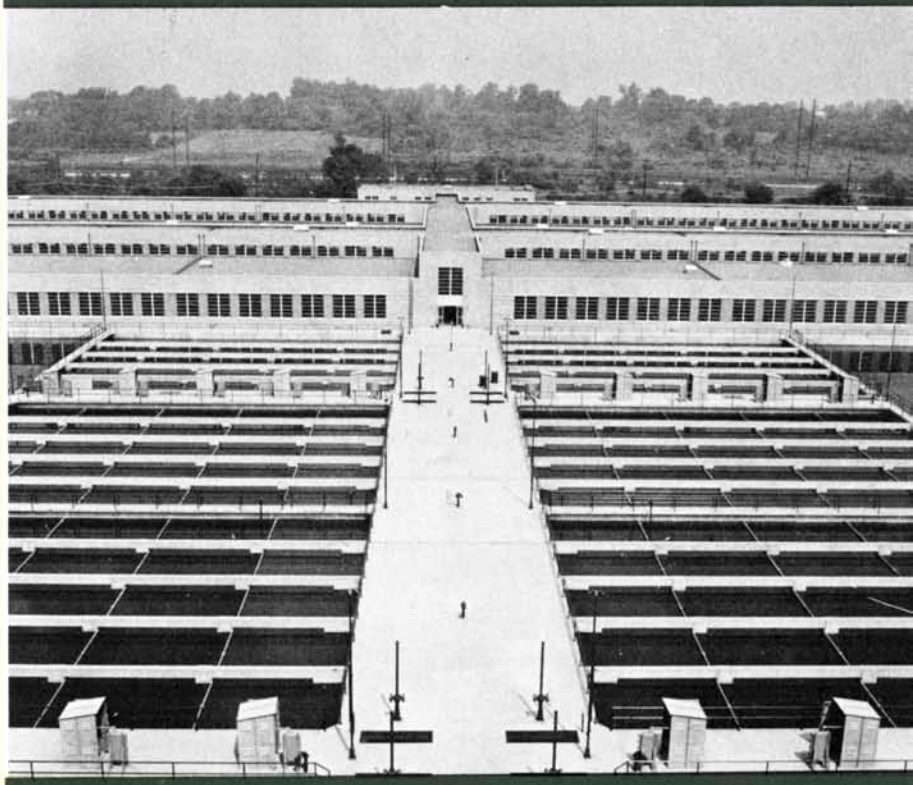
TORRESDALE



The Push-Button Water Treatment Plant

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PHILADELPHIA
WATER DEPARTMENT

RICHARDSON DILWORTH
Mayor of Philadelphia

SAMUEL S. BAXTER
Water Commissioner

CITY OF PHILADELPHIA

WELCOME READER:

Torresdale with its attractive buildings, its buttons and switches, its calm efficiency, beckons to you. This great plant, operating by pneumatic and electronic controls, is the most modern of its type in our country.

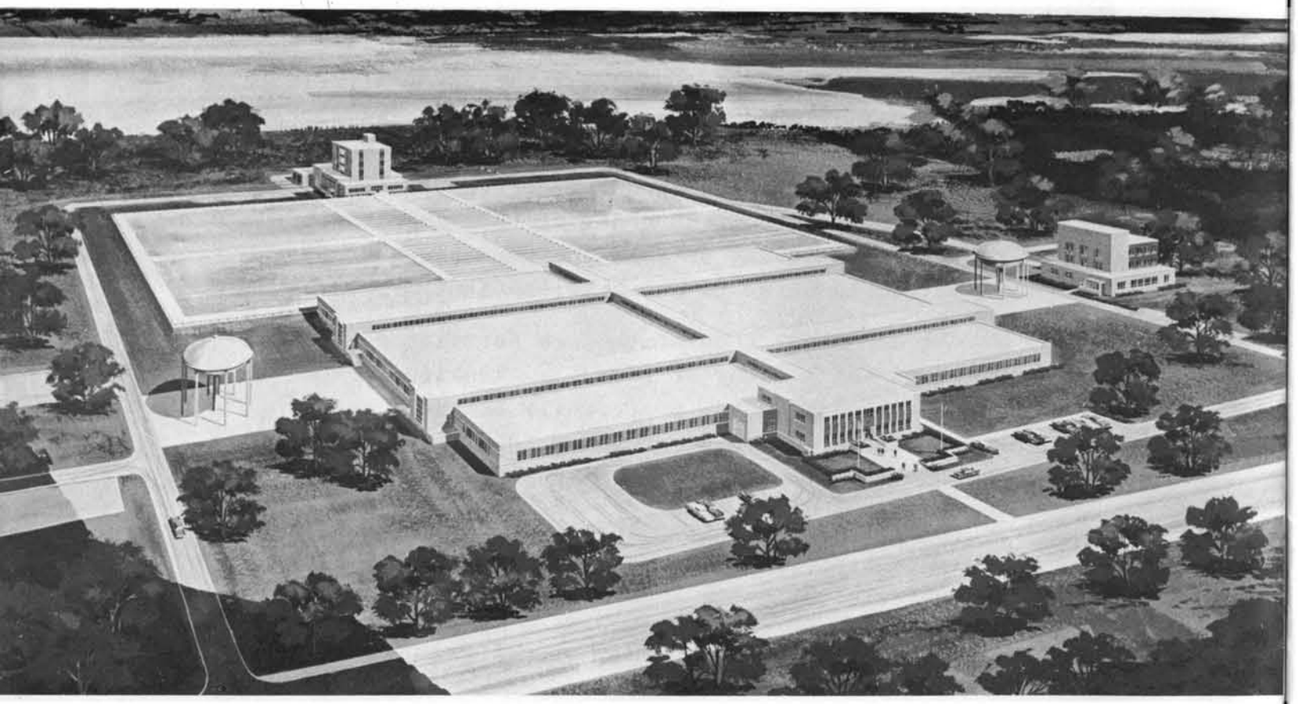
A walk through Torresdale will reward you with sights not easily forgotten . . . the water gushing through the clean filter beds, the paddles stirring noiselessly in the basins, the giant chemical feeders constantly at work, the huge piping with an endless flow of water, the row upon row of console control tables, and the spotless order of the laboratories. Few things emphasize so well the importance of pure and palatable water to our civilization.

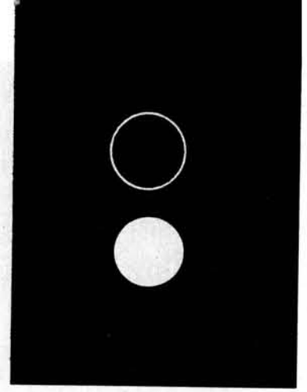
I can speak thus of the new Torresdale, because the plant was a labor of love . . . anxiously discussed and planned, prayerfully watched, as it developed over a period of years into a creation of foremost importance in the water industry.

Twice before Philadelphia's engineering works have made history in the water field—once in 1801 and again in the early 1900's. With the opening of the new Torresdale plant, our city moves to the forefront again.

SAMUEL S. BAXTER
Water Commissioner

Plan of Torresdale: The $25 million plant treats normally 282 million gallons of water daily but is capable of handling 423 million gallons.





TORRESDALE

the Push-Button Plant

Torresdale, one of America's two largest water treatment plants, is a breath taking sight for the visitor. Situated on attractive and spacious grounds overlooking the tree lined Delaware River, this new $25 million plant is the last word in advanced design.

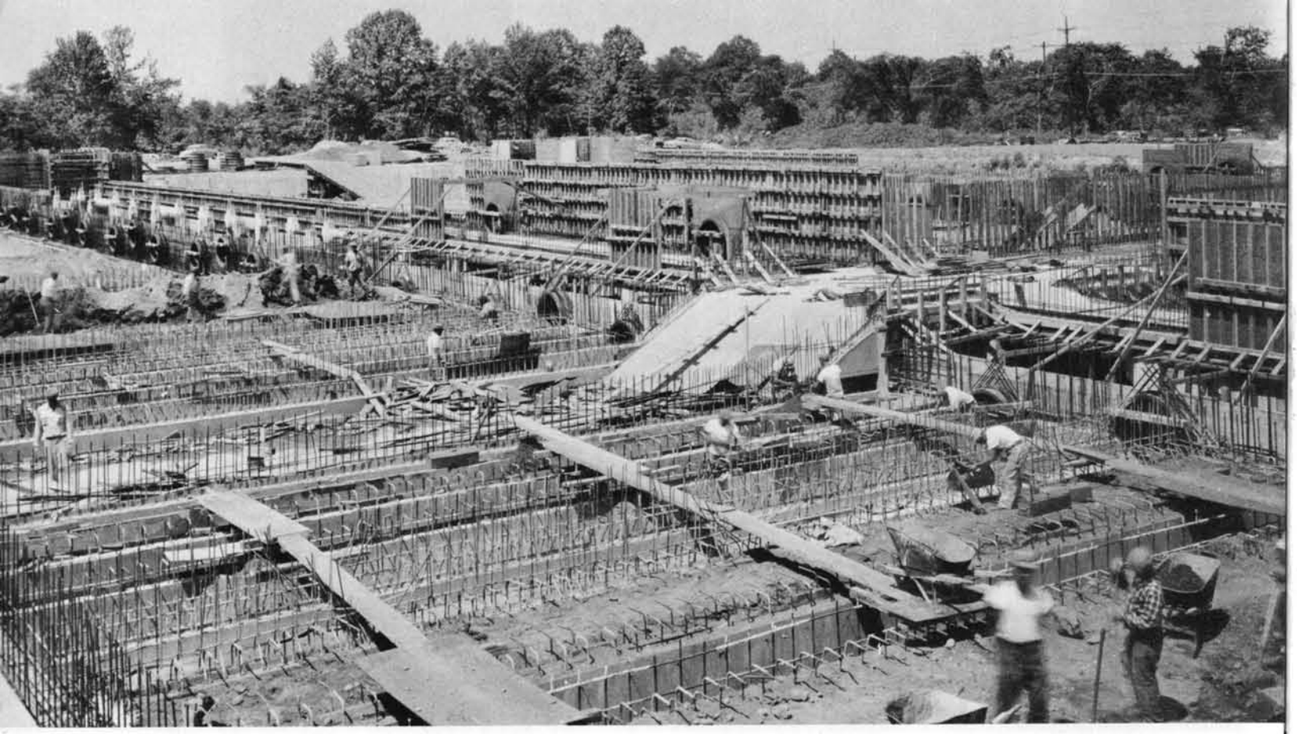
A push-button plant, Torresdale is interlaced with numerous automatic and semi-automatic controls. Water flow, chemical feeding filtration rate, use of facilities—these and various other operations are regulated through an amazingly flexible combination of switches and buttons.

Five years in the building, Torresdale is one of the most significant steps in the fulfillment of a Philadelphia dream . . . the dream of a completely modern water system to serve the city's 2.2 million inhabitants. This dream, which has resulted in the scheduling by the Philadelphia Water Department of $123 million since 1952 for new treatment plants, pumping stations, water mains, storage facilities and electronic control networks, finds its finest expression in Torresdale.

A magnificent showplace with light brick buildings, huge expanses of glass, fluorescent lighting, great outdoor basins, and well equipped laboratories, the new plant is of the rapid sand filter type, complete with preliminary and post treatment facilities.

Designed to provide normally 282 million gallons of pure, palatable water each day, the new Torresdale has a maximum capacity of 423 million gallons. It will supply more than half of the local need, reaching from the northern and northeastern portions of the city southward to the southernmost tip. Eventually parts of the northwest will be linked to the plant.

Filter building: The long galleries of the four and one-half acre structure are lined with console tables which control semi-automatically the flow of water through filter beds.



Maze of materials: The building of Torresdale took five years, and required one and one-half million bricks, 81,000 cubic yards of concrete, 9,000 tons of structural and reinforcing steel.

The new Torresdale plant replaces a half-century old, underground filter works of the slow sand type, with capacity of 200 million gallons daily. Opening of the new plant, together with modernization of the Queen Lane and Belmont treatment plants (now under way), will provide the city with facilities capable of treating an average of 486 million gallons, and a maximum of 678 million gallons, daily by 1962. The old Roxborough works will supply an additional 26 million gallons daily until 1962, when it will discontinue operation and its district will be supplied from Torresdale and Queen Lane.

The extensive modernization of Philadelphia's water system is expected to provide for growing water demand through the next 25 years.

TORRESDALE
a Maze of Materials

The building of Torresdale was one of the most imaginative tasks undertaken by the water industry. Constructed under the supervision of the Philadelphia Water Department, the plant is a complicated pattern of materials.

For the new structures a quiet woodland was cleared away, and in the course of five years approximately 330,000 cubic yards of earth were removed.

Into the plant itself went more than 9,000 tons of structural and reinforcing steel, 81,000 cubic yards of concrete, one and one-half million bricks, 268,000 glazed tiles, 130,000 square feet of plaster, and 8,000 cubic yards of drainage stone. There are four and one-quarter miles of concrete piles.

The intricate water flow is indicated by the 13¼ miles of piping, ranging from a few inches to 10 feet in diameter. Copper tubing adds another four miles. There are 1,200 valves and 48 sluice gates, while air tubing alone amounts to nearly two miles.

A tribute to the elaborate automatic controls are the 57 miles of electrical conduits and 284 miles of electrical wiring. The filter beds use 11,510 cubic yards of sand and gravel. Serving the plant are 4,500 feet of railroad track. Mechanical equipment is worth millions of dollars.

Designed by Morris Knowles, Inc., of Pittsburgh, with the assistance of the Water Department, Torresdale was built by 36 contractors. The architect was Walter Antrim, of Philadelphia.

EFFICIENCY
with Minimum Effort

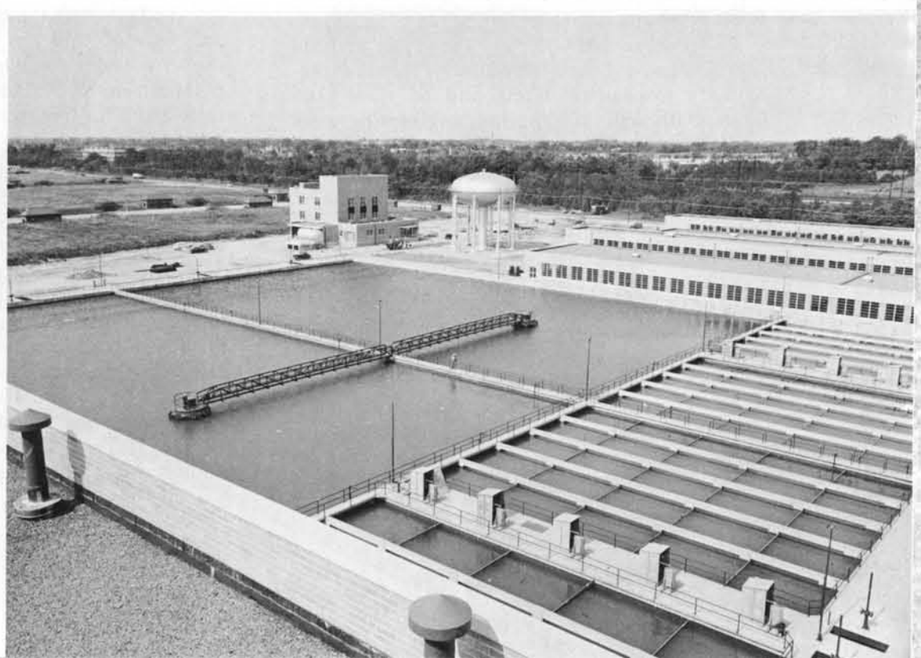
A miracle of compactness and efficiency, the new Torresdale provides for thorough chemical treatment, sedimentation and filtration of water in an area of just 10 acres. This compares with the 60 acres required by the old plant for its filters alone.

The new plant includes a five-story building for preliminary chemical treatment (with eight rapid mixing basins under its entrance), four outdoor flocculation or slow mixing basins, four outdoor sedimentation basins, a one-story filter building with two-story offices and laboratories attached, and a four-story building for post chemical treatment (with eight rapid mixing basins). There are 94 rapid sand filter beds in the main building.

To operate this push-button plant, including several units retained from the old plant, requires just 75 employees. The old Torresdale water works required 100 employees, plus a sand washing detail of 15 to 20 inmates of the City prisons.

Push button controls streamline operations in many ways.

Tons of chemicals are unloaded, weighed, fed and mixed by automatic devices. Sludge is cleared continuously from basins. The rate of filtration can be set centrally or at separate points. Water flow through the plant and to the clear water basin is automatically regulated. Besides the numerous console tables, gauges and switches scattered through the plant, there is a central control station manned by a chief operator. Warning lights, gauges, and automatic chart recording devices inform him of the situation in most parts of the plant. He can take prompt action to improve water flow, alter post chemical feeding, or make other vital adjustments.



View of treatment facilities: Slow mixing basins (foreground), and rear left to right, post treatment building, wash water tank and filter building.

Flexibility is an important feature of the new plant. Chemical feeders in the pre-treatment building are so arranged that, in case of trouble, one-half of the mixing and sedimentation basins could be cut off from water flow while the other half continues to operate.

Rapid sand filters can be operated individually (either automatically or manually), or for most purposes from a central control point.

Chemicals can be applied at various points in the plant—at the pre-treatment building, at several inlets and outlets of the mixing and sedimentation basins, and at the post treatment building.

A special advantage of the new Torresdale is continuity of production. Individual filter beds can be kept working with little interruption. Cleaning of individual filters is performed in a half-hour by a single operator at a console table. By contrast the filters in the old plant required a gang of men with sand washing machines; the process usually took three days to a week, during which the filter undergoing cleaning could not be used.

Bulk delivery of chemicals by rail car or truck under the pre-treatment building is another advantage. Purchase of chemicals in bulk, plus unloading with special equipment, increases efficiency and reduces cost.

WHY
Torresdale Was Built

The built-in efficiency at Torresdale reflects the policy of the Philadelphia Water Department toward its customers. This policy calls for pure and palatable water in adequate supply.

There was a great need for a plant which would meet all the requirements of this policy.

While the old Torresdale plant supplied water of acceptable purity, it often was unable to measure up to the standards of "palatability" and "adequacy."

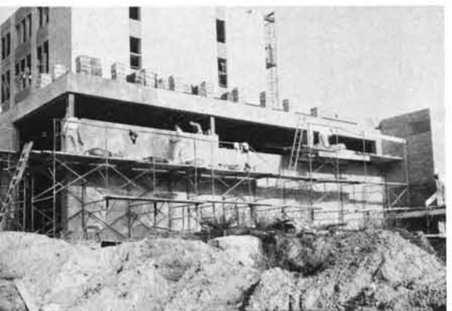
Opened in 1909, the old plant was in good part an underground structure, with 120 preliminary mechanical filters and 65 slow sand filters. Although an important engineering work in its day, it could not keep pace with the growth of the city. As time went on the plant's facilities were subjected to increasing strain. High summer, and even winter, demand forced the obsolete filters to operate at full capacity. Designed for normal operation at 200 million gallons daily, the plant frequently operated at 220 mgd and was sometimes pushed up to 240 mgd for a few hours. Occasionally pumping stations, supplying filtered water to consumers, had to be throttled, because the old plant could not supply water fast enough.

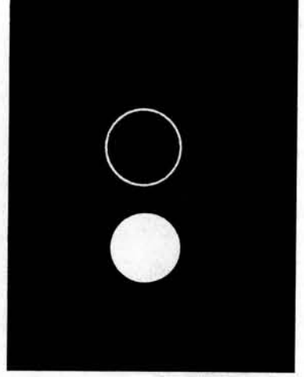
Besides this serious drawback, the old Torresdale lacked efficient pre-treatment and post treatment facilities, and thus could not give Philadelphians the highly treated water that was desirable.

Today—with the building of the new Torresdale—all of this has changed. With its huge capacity and its extensive equipment, the new plant can supply Philadelphians with high quality, taste and odor free, water in more than adequate amount.

When modernization of the Queen Lane plant is completed in 1960 and the Belmont plant in 1962, all Philadelphians will receive service at least as good as that now provided by Torresdale.

Several still useful portions of the old Torresdale plant have been linked to the new. These include an intake mixing chamber, earthen sedimentation basin, and raw water pumping station along the Delaware River, and a 50-million gallon filtered water basin. The preliminary mechanical filters have been abandoned, while it is planned to convert the 65 slow sand filter beds into a 150-million gallon filtered water basin.





HIGH QUALITY WATER
Through Modern Treatment

"Pure and palatable" water for Philadelphians is assured by the modern treatment processes at Torresdale. These processes have been designed to handle a river water heavily loaded with impurities.

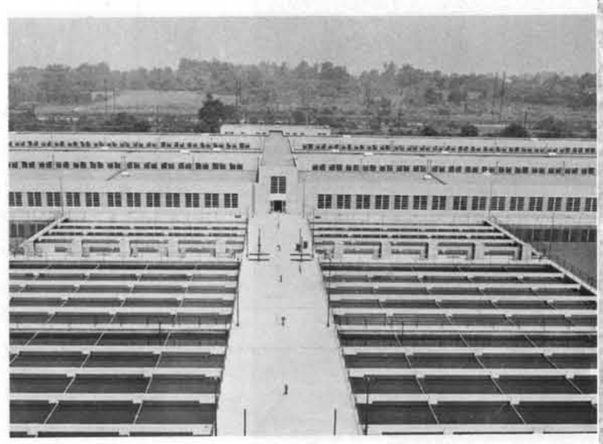
Fortunately, however, the new Torresdale, with its advanced methods, enters upon the scene when Philadelphia has already done much to improve the river water which the plant will treat.

In recent years the municipal Water Department, in combination with the Federal and State Governments, has promoted a vigorous clean up of the Delaware and Schuylkill Rivers, from which the city draws its water supply. Industrial wastes have been progressively eliminated from the rivers; the department has built three sewage treatment plants. In a few short years the rivers have grown cleaner and the water supply better.

The clean up of the Delaware greatly lightens, but does not remove, the task of the Torresdale plant. Better river water, in combination with sound treatment, assures a first class product for Philadelphia's citizens.

Turning out good water at Torresdale follows the classical pattern of (1) preliminary (or pre-) treatment, (2) filtration and (3) post treatment.

Pre-treatment, which includes mixing with chemicals as well as periods for settling, does 90% of the job of purifying and improving the raw water. Filtration provides the polishing touches, while final sterilization with chlorine, as well as some other chemical touches, are given at the post treatment building.

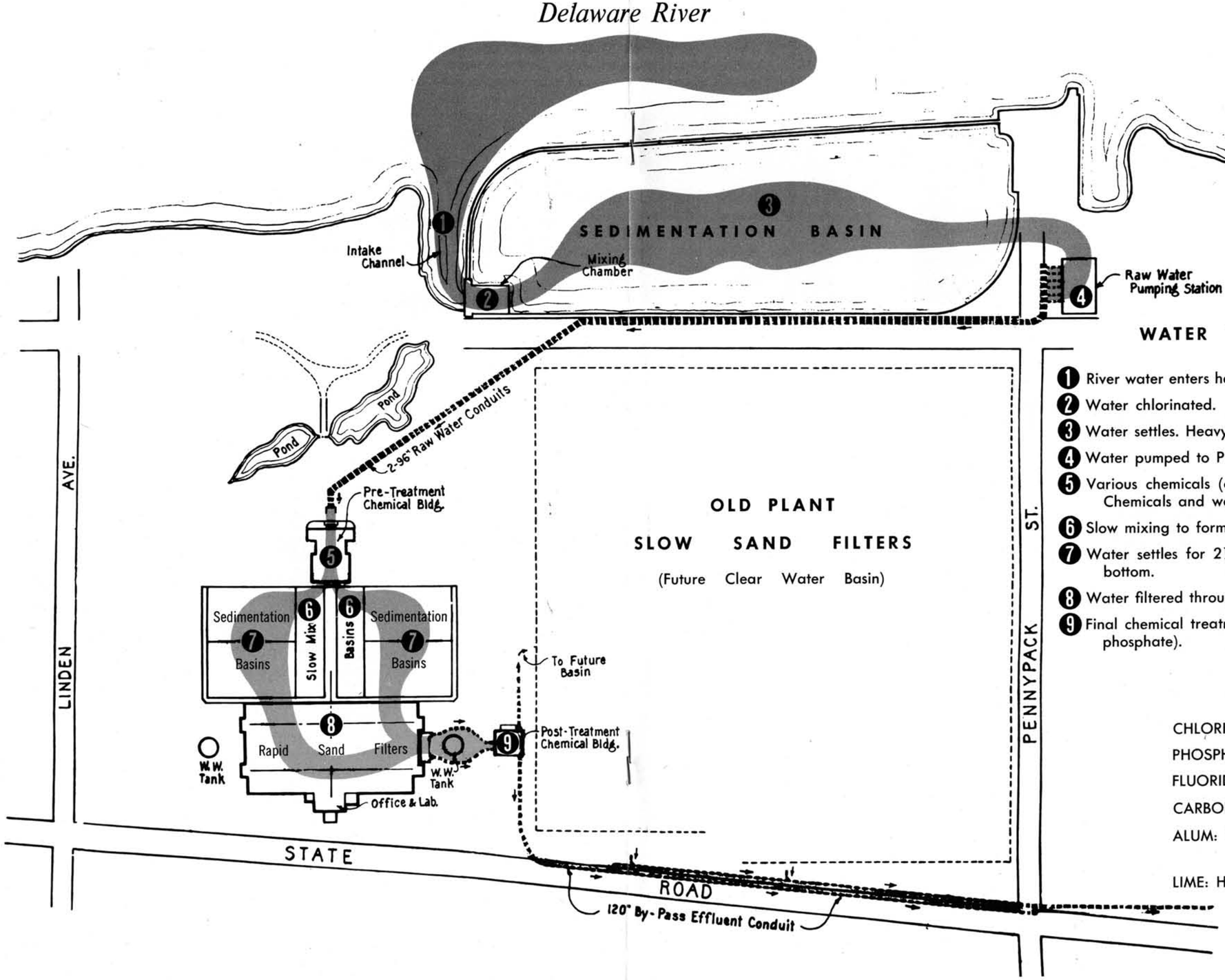


Treatment facilities: Water and chemicals are stirred in slow mixing basins (center) to form snowflake like "floc". Filter building (rear) houses rapid sand filters.

Chemicals play a vital role in treatment. It is estimated that the plant will use more than 13,000 tons of six common chemicals in 1960. These, together with other chemicals, are expected to cost at least a million dollars.

Because the Delaware River, like many other rivers, carries a wide range of impurities, from soil chemicals and dead vegetation to industrial

NEW TORRESDALE WATER TREATMENT PLANT



WATER TREATMENT STEPS

1. River water enters here.
2. Water chlorinated.
3. Water settles. Heavy particles sink.
4. Water pumped to Pre-Treatment Building.
5. Various chemicals (chlorine, alum, lime, carbon) added. Chemicals and water stirred in rapid mixing basins.
6. Slow mixing to form "floc" (see Alum below).
7. Water settles for 2½ hours. "Floc" carries impurities to bottom.
8. Water filtered through 94 rapid sand beds.
9. Final chemical treatment (chlorine, lime, fluoride, phosphate).

PURPOSE OF CHEMICALS

CHLORINE: Destroys organic materials.

PHOSPHATE: Lessens pipe corrosion.

FLUORIDE: Lessens tooth decay.

CARBON: Controls taste and odor.

ALUM: Forms "floc" (snowflakes) to trap impurities

LIME: Helps "floc" formation; Lessens pipe corrosion.

Pipelines: Two giant 96-inch diameter, concrete conduits were laid to carry water from the raw water pumping station (left rear) to the new plant 3,000 feet away.

Flocculation equipment: The slow mixing basins hold 200 paddles for gradual stirring of water to form "floc", which attracts impurities.

and animal wastes, the use of chemicals to destroy or remove such matter is of special importance. Chemicals may be used to burn up organic matter (including bacteria), prevent the growth of taste and odor causing plankton, promote the settling of heavy particles, overcome taste causing industrial wastes, eliminate odors, control tooth decay, prevent pipe corrosion, or simply to improve taste.

TREATMENT STEPS

Filtration: The 94 rapid sand filter beds handle water at the rate of two gallons per square foot per minute, or about three million gallons daily per filter bed.

Sedimentation basins: The 174-foot clarifier arms are used to remove sludge from the bottoms of the one-story tall settling basins.

The basic steps in treating water at Torresdale will be briefly sketched here, with fuller attention later for features embodied in the three principal buildings.

Since portions of the old plant have been linked to the new, the raw water from the river passes through 11 distinct steps, involving pumping, treatment, and storage.

From the river to the clear water basin, the water flows through the plant in six hours under normal operation. The time would be less than three and one-half hours for maximum operation.

1. Intake: The flow to the plant begins at the inlet arm of the river, and occurs twice daily with the incoming tide. The water flows through tide gates and under a small mixing chamber building into an earthen sedimentation basin. The intake flow may reach briefly a rate of 600 million gallons daily when the tide is at its peak. (It is planned to reconstruct the intake facilities in future).

2. Mixing Chamber: As the water flows under the mixing chamber, it receives a dosage of chlorine to promote "break point chlorination", or literally the burning up of organic materials. Before the construction of the new plant, the mixing chamber was used for the feeding of alum and lime to aid settling. This function is now performed by the new plant.

3. Earthen Basin: Preliminary sedimentation occurs in the long river front basin, which holds 176 million gallons at mean high tide. Heavier particles settle to the bottom of the basin, while "break point chlorination" does its work. Retention of the old earthen basin has helped to reduce the work load of the new plant, since many of the heavy impurities settle out before the water reaches the new basins.

4. Pumping Station: The raw water pumping station, near the river's edge, has also been retained from the old plant. Its six electricity driven pumps with capacities of 50 million gallons daily each, will be replaced with more modern equipment in future. The station forces water from the earthen basin into two huge concrete conduits, eight feet in diameter. These conduits, built as part of the new plant, carry the water 3,000 feet to the preliminary treatment building.

5. Pre-treatment Building: The water is measured by Venturi meters as it flows under the preliminary treatment building, and, as it passes, chemicals are applied by automatic weighing and feeding equipment. These chemicals, which can also be injected as the water enters the succeeding mixing basins, may include chlorine, carbon (for taste and odor control) lime (for the control of the ratio of acidity to alkalinity), and alum to promote "floc" formation. Other chemicals may also be used.

6. Rapid Mixing Basins: Both chemicals and water are thoroughly mixed in the eight rapid mixing basins located beneath the westerly threshold of the pre-treatment building. Mixing normally requires 20 seconds and is performed by four-bladed paddles on single vertical shafts.

7. Slow Mixing Basins: Gradual mixing takes place in the four slow mixing (or flocculation) basins, located in the open. The water enters from the rapid mixing basins and is slowly stirred by 200 paddles of the transverse type, driven by equipment set in dry wells. As the mixing proceeds, "floc", which resembles snowflakes, gradually forms. Many of the impurities adhere to this "floc". The water flows through the slow mixing basins in approximately 45 minutes.

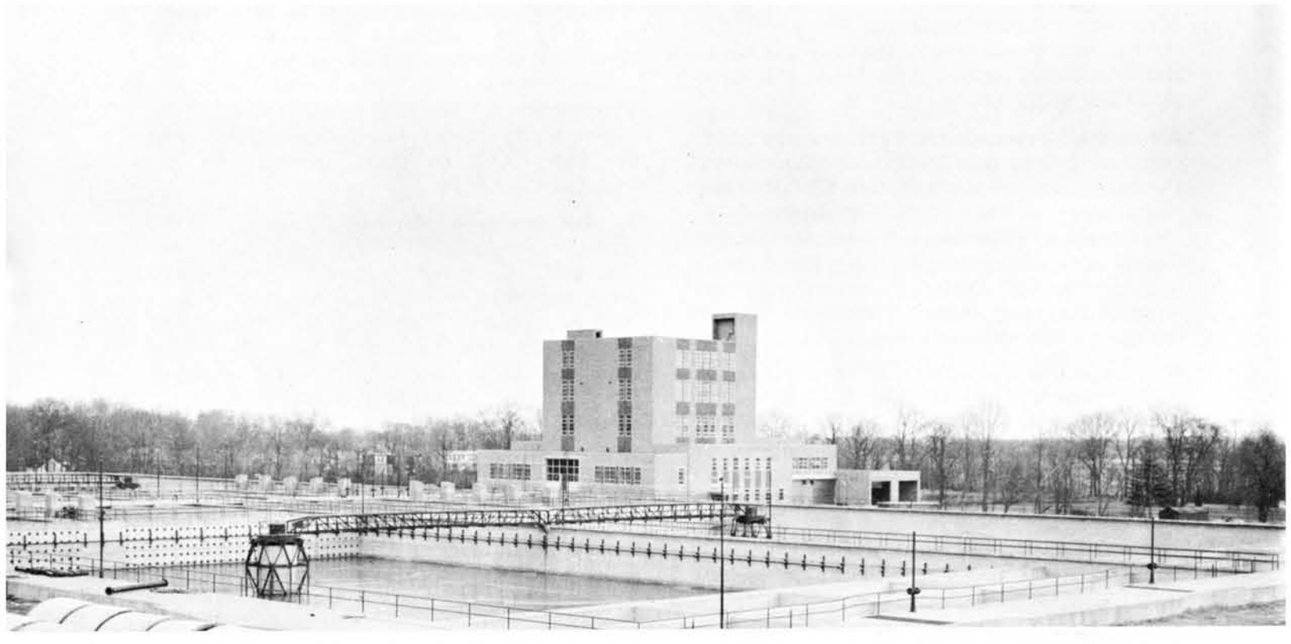
8. Sedimentation Basins: From the slow mixing basins the water, carrying floc, enters the four great sedimentation basins. These basins are a key point in the plant, for most of the remaining impurities and particles settle to the bottoms of these single-story structures. The impurities are dragged down by the snowflake like "floc" and are swept away by giant clarifier arms measuring 174 feet in length. Collected in special chambers, the bottom "sludge" is pumped to a lagoon along the river. With an average water depth of 18 feet three inches, each sedimentation basin holds 10 million gallons. Each basin is 300 feet long and 188 feet wide.

9. Filter Building: A vital step in the treatment process is filtration. This takes place in the main building, which houses 94 rapid sand filter beds. When the water enters the building from the sedimentation basins, it is distributed by a great concrete pipe to the various sub-pipes and filters. The 10 inches of gravel topped by 28 inches of sand in each filter bed give a "polish" to two

gallons of water per square foot per minute, or about three million gallons daily. When the plant is operating at peak capacity, the rate per filter bed is increased to four and one-half million gallons daily.

10. Post Treatment Building: A weir chamber is provided at the southern end of the filters, with conduits leading to the four-story post treatment building. Post treatment is the final step in water improvement through chemicals. The water is chlorinated again, and receives fluoride for control of tooth decay. Lime and metaphosphates may be added to reduce corrosion of pipes. Rapid mixing is performed in eight basins underneath the building.

11. Clear Water Basin: The water is carried from the post treatment building to the 50-million gallon clear water basin by a newly laid, prestressed concrete pipe measuring 10 feet in diameter. From the basin much of the water flows by gravity to the Lardner's point filtered water pumping station, which sends it into distribution lines. A smaller part of the water is pumped directly from the basin into distribution lines by the Torresdale filtered water pumping station.



Pre-treatment: Most of the 13,000 tons of chemicals used annually at Torresdale are applied at the five-story pre-treatment building.

The PRE-TREATMENT BUILDING

A Chemical Wizard

Few sights can be more interesting to the visitor than the view from the roof of the preliminary treatment building. Spread before him are all the buildings and basins of the Torresdale plant, the spacious tree covered grounds, and the ship dotted river.

Yet under his feet are other wonders . . . a kind of chemical wizardry that does not cease day or night.

A five-story light brick structure, with basement, the building houses tall chemical feeders reaching downward through several floors. The process of weighing, measuring and feeding chemicals is automatic and endless.

The 50,000 lbs. of alum used daily at Torresdale is applied to the water shooting under the pre-treatment building; so are most of the 3,000 lbs. of lime and the 15,000 lbs. of chlorine. The 100 tons of carbon consumed annually are pumped as a slurry to mixing basins from the building. Chlorine dioxide is manufactured on the spot.

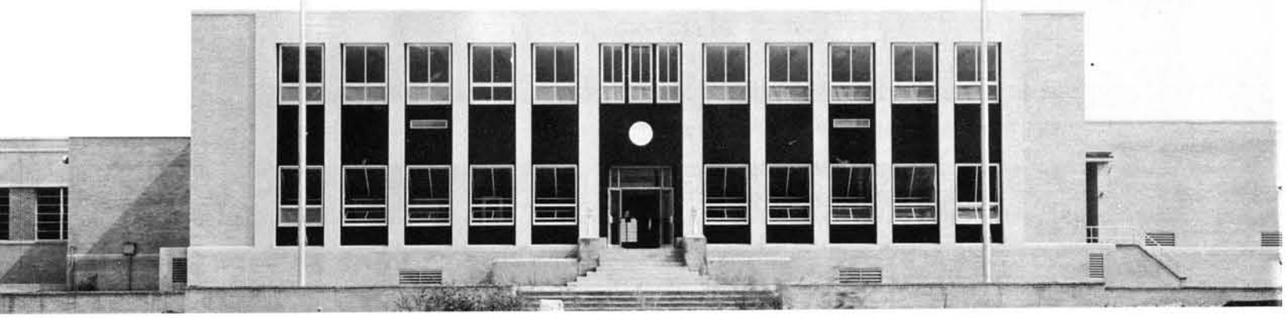
The building's complicated equipment can store and apply enough chemicals to treat 423 million gallons of water daily.

Delivery of chemicals is a streamlined operation. Three railroad spurs and one truck passageway are enclosed by the first floor, thus permitting direct unloading. Railroad cars can be weighed. Bulk delivery of chlorine and carbon by rail makes unloading a smooth operation. Carbon is dumped from the cars into slurry tanks below car level, thus avoiding the messiness so common to carbon deliveries.

Dry alum, pebble lime, and sodium chlorite are brought in by truck, but these and other chemicals, including liquid alum, can be delivered by rail. Powdered chemicals are sucked through vacuum lines to the fifth floor at the rate of 10 tons an hour, and then taken by screw conveyor to storage bins. The fourth and fifth floors house the receivers for alum and lime, while the six storage bins for these chemicals are set at third floor level. Feeding equipment for these chemicals, as well as carbon, is at the second floor. On the second floor are also the chlorinator and evaporator room, the chlorine control room, and the sodium chlorite solution tank and feeder room.

Liquid alum is stored in lead lined tanks beneath the building. On the first floor are a maintenance shop, boiler room, employees' quarters, and temporary storage facilities.

Dust collecting equipment keeps the air free of powdered chemicals.



Filter building: Attractive and modern is the four and one-half acre filter building which houses offices, laboratories and 94 rapid sand filter beds.

The FILTER BUILDING

An Electronic Water Factory

The spotless filter building, with its 94 rapid sand filter beds arranged on each side of two north-south galleries, is a harmony of order and modern method. In this cheerful, well lighted building, the push-button controls that characterize Torresdale are most visible.

Spread out on one level, with a two-story office and laboratory section attached, the filter building covers four and one-half acres.

The heart of the building is a small, glass enclosed control room near the center of the western gallery. Here the chief operator, with an assistant, presides over complex switches and gauges. A master control panel just outside the control room reflects water flow conditions in the filter building and in many other parts of the plant.

Particularly impressive are the 46 console tables which line the galleries. There is one table for each two filter beds. Various operations affecting the two beds can be controlled from this table, either semi-automatically or manually. Rate of water flow through the filters can be set; the filters can be shut down or washed.

As already noted, each filter bed normally handles three million gallons of water daily. The rate of flow through the beds is usually determined by a level regulating device in the 50-million gallon clear water basin located south of the new plant. When the water in the basin rises too high or sinks too low, the device transmits a signal to the master control panel in the filter building and this in turn regulates the flow through the filters. Flow, however, can be regulated independently on the master control panel by the chief operator, or set for each filter bed on its own console table.

Hidden concrete pipes extend from one end to the other of the filter galleries. These bring in water from the sedimentation basins. Other concrete pipes, located at each side of the galleries and below the floor of the filter boxes, carry away the water after it passes through the filters. Filter piping is mostly of steel. Each two filter beds are served by a common influent and wash water gullet, while concrete wash water sewers are located under the galleries.

Washing the Filter Beds

One of the exciting spectacles in the filter building is the washing of filter beds.

Since filter beds collect many impurities, the sand and gravel must be washed periodically. Only in this way can the filters function at maximum efficiency.

Controls for cleansing are usually operated from the 46 console tables, and there are both semi-automatic electronic and manual switches. By setting the appropriate controls on a particular table, a single operator can wash two beds in a half-hour. Washing of the beds can also be regulated on the chief operator's master control panel, but a button must be pushed on the filter bed console table to start the washing.

Approximately 82,000 to 100,000 gallons of water are required to cleanse a single filter bed, and this great volume is supplied by two steel tanks located outside the building. Each tank holds 260,000 gallons of water, and is regularly replenished by four pumps, of 20 million gallons daily capacity each. A maximum of four filter beds can be washed at one time.

In the washing process, water is first drained from the filter bed. Then clean water is shot through nozzles in a mechanical sweep which turns rapidly to spray the sand surface and break up the encrusted foreign matter. Finally clean water is forced up through the gravel and sand, carrying away impurities and debris. Within a few minutes the water turns from a muddy color to crystal clearness.

Office and Laboratories

The two-story office section at the western entrance, facing State Road, is attractive and modern. It serves a variety of purposes. Besides well lighted offices, together with lecture, conference and storage rooms on the first floor, there are modern bacteriological, chemical and physical laboratories on the second floor.

The laboratories keep a constant watch on the quality of water flowing through the plant. This is in line with the Water Department's policy of maintaining standards of water quality far above the minimum prescribed by the State Department of Health.

To assist laboratory personnel in recommending up to the minute changes in chemical treatment of the ever changing river water, a number of special features have been built into the laboratories. Thus samples of water can be drawn by faucet from 16 different points in the plant and on the river. Containing the latest in equipment, the laboratories have two large incubator units for growing bacteria. The staff of 14 consists of chemists, bacteriologists, and helpers.

Boilers and dehumidifying equipment are lodged in the basement. The heating system panel board is of special interest. The system monitors temperature at two points outside the building and regulates the temperature of circulating hot water accordingly. The heating capacity of the Torresdale plant is 30 million BTU's.

The dehumidification equipment keeps the air dry in a basement thickly lined with huge pipes which would otherwise be subject to moisture condensation.

Washing: Rapid sand filters can be cleansed within a half-hour. Pure wash water is forced up through sand and gravel to carry away debris.

The POST TREATMENT BUILDING

Touches for the Consumer

Those final touches which shine up the product for Torresdale's customers are given in the post treatment building.

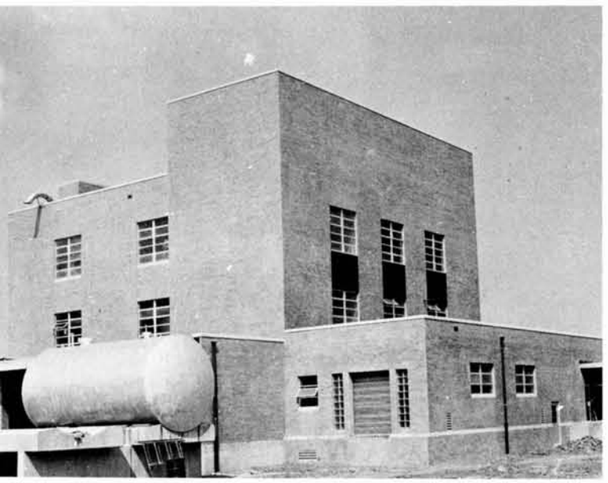
Operated automatically, the post treatment facilities require no personnel on duty. The chief operator in the filter building is able to follow their functioning by means of monitoring equipment in his master control room. When adjustments in chemical feeding must be made, he walks over to the post treatment building to set switches.

A four-story structure, the building contains equipment for feeding and storing of lime, chlorine, fluoride and metaphosphate. Dry chemicals are carried to storage bins by a conveyor system. Fluoride is delivered as an acid by tank truck and pumped into two outside storage tanks and then to the point of application.

Chlorine and chlorine dioxide are applied in the outflowing conduits, while lime is applied at the inflowing conduits. About 800 lbs. of fluoride and 800 lbs. of metaphosphate are used daily.

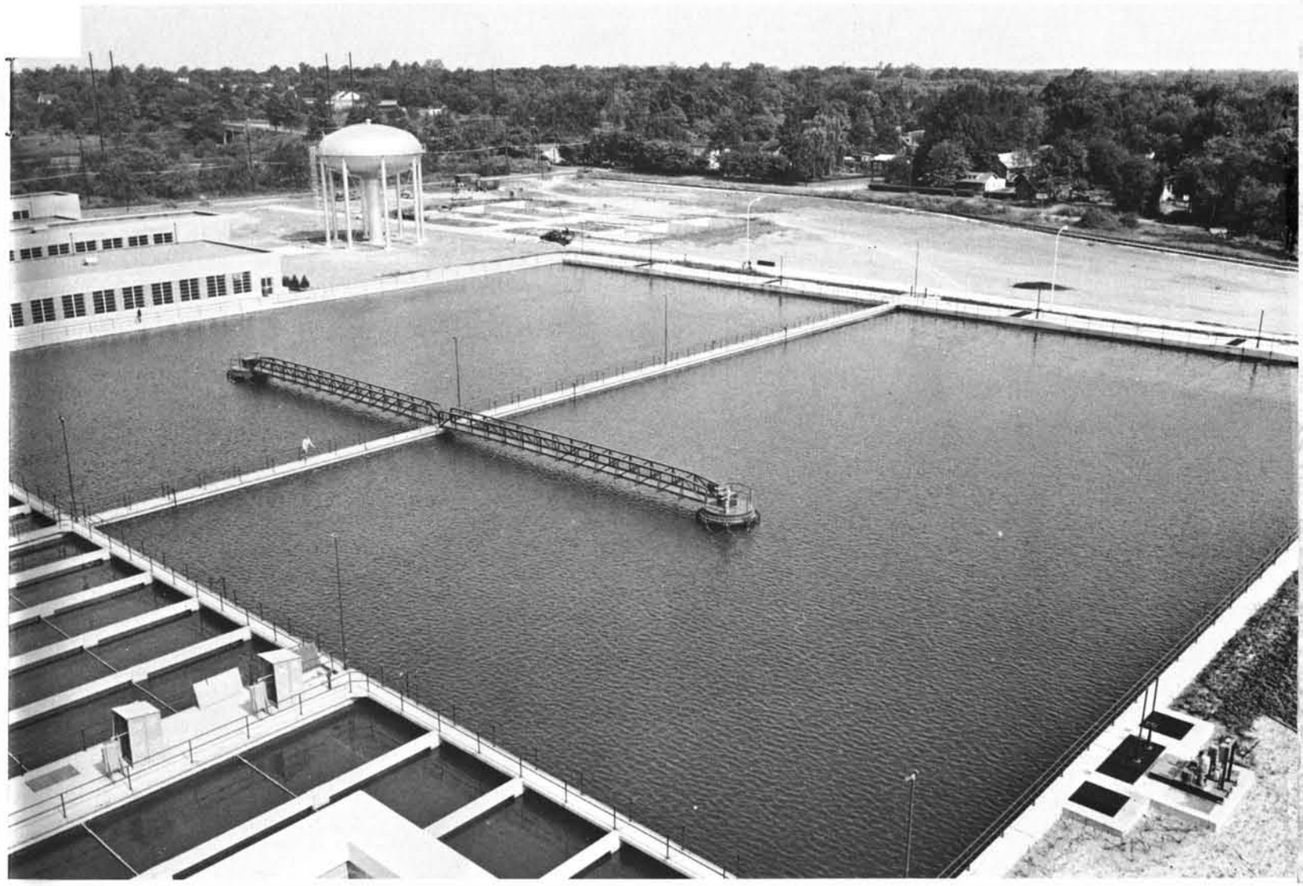
Under the building are eight rapid mixing basins.

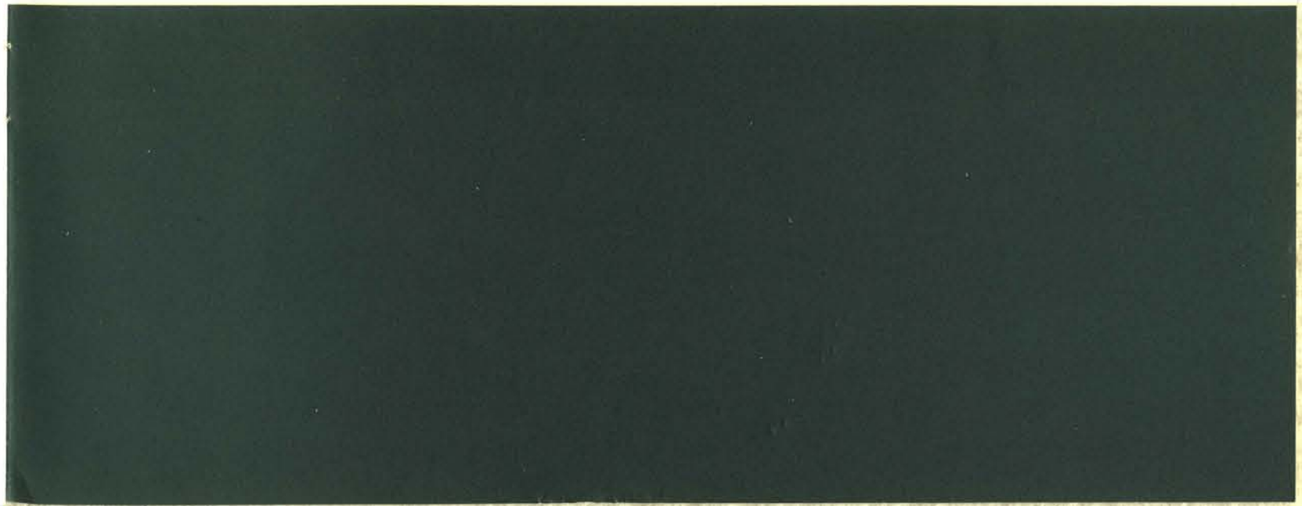
Water flows from the building through a pre-stressed concrete conduit, 10 feet in diameter, to the 50-million gallon clear water basin. Eventually it will also be carried through a conduit, 10 feet x 8 feet in diameter, to the former slow sand filter beds after these are converted into an additional clear water basin, of 150 million gallons capacity.



Final touches: The automatically operated post treatment building provides for chemical treatment just before the water goes to the consumer.

Sedimentation: Heavy particles settle in these $10-million gallon basins before the water flows to the filter building (left). Wash water tank (rear) holds 260,000 gallons.



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