The Pittsburgh Sewer Explosion

BY N. S. SPAGUE* AND CHAS. M. REPPERT†

On Nov. 25, 1913, a serious sewer explosion occurred in Pittsburgh, which is believed by the authors to be the most extensive and disastrous on record. Owing to the increasing frequency of sewer explosions in recent years in different sections of the country, the subject deserves careful consideration and study in order to determine the causes, with a view to adopting preventive measures. The damage wrought by the recent explosion in this city and the consequent clogging of an 8-ft. trunk sewer serving a population of 50,000, with an ordinary dry-weather discharge of 15 million gallons daily, presents a serious situation. Protection of property from flooding, maintenance of traffic in streets and by railroad, continuity of operation of large industrial plants, and safe

Fig. 1. Effects of Explosion on Sassafras St. (Nov. 25, 1913)
Looking west toward brewery. Ditch afterward settled over sewer.

Fig. 2. Damage at Bottling House, Pittsburgh Brewing Co. (Nov. 26, 1913)

Fig. 3. Blowout near Forfar St. Bridge; sewage from upper section flowing into break, Nov. 28, 1913

Fig. 4. The same blowout secured by steel sheeting (Dec. 6) after caving had blocked sewer and undermined crane

Four Views of the Great Sewer Explosion in Pittsburgh
The sewer in which the explosion occurred is the main trunk sewer of a watershed comprising an area of 1700 acres, known as the 33rd St. or Two Mile Run Drainage Basin. This watershed is located in the old city between the rivers, the outlet of its trunk sewer discharging into the Allegheny River about two miles above the “Point.”

The basin includes portions of several of the older residential districts of the city (Shadyside, East Liberty, Bloomfield and Lawrenceville). Along the line of the sewer there are located in the valley a number of industrial plants, and the vicinity of the outlet is exclusively a manufacturing district.

The sewerage system of the basin is on the combined plan. The territory embraced within the watershed is practically all improved and sewered, and has a population slightly in excess of 50,000. The trunk sewer follows the line of a former water-course located for the most part in a valley with rather steep slopes. It extends up 33rd St. from the river a short distance above Liberty Ave., where, turning to the east, it continues up a ravine nearly parallel with the Pittsburgh Junction R.R. and the Pennsylvania R.R., the latter being at a somewhat higher elevation. The sewer on leaving 33rd St. crosses under the right-of-way of the Pittsburgh Junction R.R., thence by a straight line across private property of the Pittsburgh Brewing Co. to Sassafras St., extending to the vicinity of 39th St. Beyond 39th St., the sewer again crosses private property, going under a number of buildings and manufacturing plants, and then follows the line of Neville St., an improved thoroughfare bordering the right-of-way of the Pittsburgh Junction R.R., and continues on this street up the valley. The sewer above Liberty Ave. is hemmed in by buildings and railroads on one side and a very steep hillside on the other.

Both sides of 33rd St., from the river to Penn Ave., are occupied by the Upper Union Mills of the Carnegie Steel Co., while between 33rd and Cayuga Sts., the upper limit of the explosion, the sewer passes under buildings of the Pittsburgh Brewing Co., the Pittsburgh Rivet Co., Pittsburgh Cold Rolled Steel Co., the Petroleum Products Co., and two frame dwellings on Neville St. The location of the sewer in the ravine is remote from built-up sections; steeply inclined hill-sides intervene, and the lateral connections of the sewer extend on sharp grades up the hill-sides to the streets lying beyond. The Pittsburgh Junction R.R., which parallels the sewer, crosses Liberty Ave. at grade and is carried down 33rd St. toward the river on a viaduct supported by columns at the curb line. The lower end of the basin, below Liberty Ave., is comparatively level.
The section of the sewer affected by the explosion extends from the outlet for a distance of approximately 5300 ft. to a point near the intersection of Neville and Cayuga Sts. From the outlet to Penn Ave. the sewer is 10 ft. in width and 8 ft. in height, of brick and stone construction with the exception of a short section of concrete sewer immediately above the outlet, which is an extension of the original sewer. Beyond Penn Ave., the sewer is circular in section, 8 ft. in diameter, and is constructed of three rings of brick, the invert being lined with block stone. The 8-ft. sewer was built in 1891. The hydraulic grade of the sewer is about 10 ft. per 1000; the capacity is estimated at 800 cu.ft. per sec.

Possibly 90% of the public garages of the city are located within the watershed. There are also a number of miscellaneous storage houses, dry-cleaning establishments, and paint-manufacturing shops. The acid waste discharged into the sewer includes the discharge from pickling vats of steel companies. A plant of the Pintsch Compressing Co. is also located near the line of the sewer, at Cayuga and Neville Sts.

The Effects of the Explosion

The explosion occurred about 2:30 p.m. The immediate effects indicated an explosion of great violence, affecting 5300 lin.ft. of the trunk sewer and extending some distance along the lateral connections. Street pavements were heaved, ruptured and torn asunder; manhole lids were blown high in the air; the brick masonry of the manholes was shattered and in some cases demolished; window glass was broken for some distance from the line of the sewer; sections of the sewer collapsed, stopping the flow and causing the street to cave in. Buildings and industrial plants over or in close proximity to the line of the sewer were partially wrecked or damaged, either by the explosion itself or by subsequent settlement. The location of the sewer, the depth of cover, and the topography of the vicinity fortunately operated to confine most of the damage to the sewer itself and the overlying roadways, thus reducing the extent of the damage to private property and the interference to traffic and business.

At the time of the explosion the outlet of the sewer was submerged to within 1¼ ft. of the top, so that the flow was backed up for several hundred feet. The explosion expelled the sewage from the outlet with terrific force.

Damage to Sewer—At a point 230 ft. above the outlet about 20 lin.ft. of the sewer arch immediately collapsed, an opening about 25 ft. square at the surface of the ground resulting; and the arch of about 100 lin.ft. of adjoining sewer was ruptured, requiring its removal. The break occurred at a point where the sewer formerly discharged into the river and where the sewer section changed from brick to concrete. The connection between the two types of construction was probably a plane of weakness. The depth of cover at this break was 14 ft.

Practically all of the manholes and catchbasins in the district below Liberty Ave. were damaged or destroyed, those on the main sewer being the most affected. From the break at the river to Mulberry Alley, where the cover over the sewer decreases to 4 ft., the sewer was undamaged except at manholes. The blockstone paving of 33rd St., from Mulberry Alley to Penn Ave., was heaved and ruptured directly over the sewer and the arch of the sewer itself was split.

Between Penn and Liberty Aves., a distance of 215 ft where the cover ranges from 3 to 4½ ft., the effects of the explosion were more severe. Near the abutment of the viaduct at Liberty Ave., the arch of the sewer was demolished and the ground caved in immediately after the explosion, the opening being about 48 ft. long. The area of the balance of the sewer between Liberty and Penn Aves., was ruptured to such an extent that immediate uncovering of the sewer was made necessary. A ridge several inches in height in the cobblestone paving indicated that the ground over the sewer was raised bodily and split open directly over the crown, the ridge being left as the ground settled back into place. The cast-iron lid of a manhole near the abutment was blown up through the floor of the viaduct above.

Beyond the north line of Liberty Ave., to the manhole near the 33d St. bridge, a distance of 480 ft., the sewer is in deep cut, the depth to the crown ranging from 19 to 15 ft. There were no surface indications of the sewer being damaged between these points, except an extensive opening at the manhole near the bridge. In the vicinity of this manhole for a considerable distance the sewer collapsed and the surrounding ground caved in, opening up a large hole which gradually extended to the settling of the sewer arch continued. A manhole of 33rd St. just above Liberty Ave., was shattered, the brick work (of excellent quality) being cracked and ruptures from the top of the sewer to the surface of the street. The cast-iron cover of this manhole was found 150 ft. away in a horizontal position, embedded an inch in the brick sidewalk. Subsequent investigations showed that the arch of the sewer was either broken or ruptured along the crown from Liberty Ave. to the 33rd St. bridge.

Surface settlement over the sewer where located on private property of the brewery, between 33rd and Sassafras Sts., indicates that the sewer has been more or less damaged, this opinion being verified by an examination at a shaft near Sassafras St.

From the point where the sewer enters Sassafras St. to the end of the explosion, a distance of 2600 ft., the arch of the sewer was blown off, causing the sewer to choke and the pavement and street surface to settle.

Sassafras St. was paved with blockstone on a gravel foundation to 38th St. The street is 40 ft. wide and has an 8-ft. sidewalk on the southerly side. The sewer is located 10 ft. from the south line of the street. The pavement and curb were blown up and rapidly settled, causing a deep depression over the sewer.

Exterior Damage—The bottling house of the Pittsburgh Brewing Co., a substantial two-story brick building, is parallel to and 20 ft. from the center line of the sewer. The stone masonry of the foundation of this building, which extends several feet above the surface of the ground, was badly spalled and the wall was pushed out of line toward the sewer several inches at the eastern end. Some idea of the force of the explosion is conveyed when it is stated that this building was apparently lifted off its foundation, the location of the sewer being 20 ft. distant and 15 to 15½ ft. below the street level.

Between 38th and Cayuga Sts., the sewer, as previously stated, passes in close proximity to (or under) a number of manufacturing plants and frame dwellings.

The plant of the Pittsburgh Rivet Co., a steel-frame mill building with wooden sides, located on Sassafras St., standing 10 ft. from the center of the sewer, was dam-
aged by the explosion. The side next to the sewer was blown from its foundation and a 6000-gal. water tank was moved laterally about 8 in.

Just beyond the plant of the Pittsburgh Rivet Co. is located the steel frame mill building of the Pittsburgh Cold Rolled Steel Co. One of the furnaces of this plant is located partly over the sewer. The explosion entirely wrecked these furnaces and stack, twisted the corrugated-iron sheeting of the building, and damaged the roof. Adjoining this plant is the plant of the Petroleum Products Co. The sewer passes directly under this property and also under and close to a number of large gasoline-storage tanks. A 12,000-gal. gasoline tank, about 10 ft. in diameter and weighing between 24 and 25 tons at the time of the explosion, was lifted about 3½ ft. from its foundation; adjacent tanks were also disturbed.

A freight car standing on a siding directly over the sewer was blown from the track, landing on its wheels at a slight skew with the track.

**Fig. 7 and 8. Work in Lower Section of Exploded Sewer**

(Fig. 7. Operations at break near river. Opening has been excavated, sheeted and braced. Removal of damaged sewer and debris in progress, Dec. 5, 1913.)

Two dilapidated frame dwellings which were unoccupied were totally wrecked.

Beyond the Petroleum Products Co. there is no paving over the sewer. A ditch quickly formed, due to the collapse of the sewer.

Fortunately, only relatively small gas and water pipes were laid parallel to the sewer. These lines were broken. Large water mains (42-, 36- and 30-in.) cross over the sewer at Smallman St., Penn Ave., and Liberty Ave., respectively, and none of these pipes was damaged.

**Invert Undamaged—**Inspections made after uncovering the sewer show that only the arch above the springing line has been damaged. The invert apparently has not been affected. In most places the sewer is found to be split along the crown of the arch, the arch flattened and in some places destroyed entirely.

**The Question of Cause—**The causes of the explosion have not yet been determined, and a statement as to cause cannot be presented until the facts have been ascertained by thorough investigation.

**Emergency Operations**

The breaks in the sewer at certain places and the entire collapse of a long section made it necessary to clear away the obstruction immediately and to devise a plan for bypassing the drainage around the collapsed section on Sassafras St., in order to prevent flooding and consequent damage to property. Ordinances were passed by Council approximating $50,000 and authorizing the letting of an emergency contract on a force account basis.

**The Emergency Contract—**The work included under this contract consisted principally of uncovering the sewer, sheeting and bracing the trench, excavating an open channel, cleaning out the invert of the damaged sewer and other incidental work. The essential features of the contract were as follows:

1. The contractor is required to furnish an adequate force, plant and equipment.
2. Labor, materials and supplies, dumping charges, delivery and removal of equipment, etc., are paid for by the city at actual cost plus 15% for profit and overhead charges. Small tools are furnished without charge.
3. The maximum rates for various classes of work and the rental prices for equipment are stipulated.

4. Transportation of excavated materials by freight is paid for at actual cost.
5. The city assumes the cost of insurance without additional profit, and is responsible for damage or loss of equipment with restrictions as to negligence and defects.
6. Provision is made for furnishing additional labor and equipment at prices to be agreed upon in writing.
7. The books of the contractor are open to audit by the city and the contractor is required to furnish full information daily as to the cost, etc.
8. The contract may be terminated by the city on three days’ notice.

This contract was awarded to John F. Casey Co., of Pittsburgh, the night of the explosion. This contractor had plant and an organization at work on a near-by job, which was readily obtainable and which made it possible to start the emergency work at 7 a.m., Nov. 26. Since the time of starting, a force ranging from 400 to 500 men has been continuously employed day and night.

**Clearing the Outlet—**The break in the sewer near the river obstructed the flow to such an extent that there was imminent danger of the sewer becoming entirely clogged. Had this happened the steam-supply lines to the Carnegie mills would have been submerged, causing the mills to suspend operations and so throwing 2000
employees out of work. Furthermore, the overflowing of the sewer at this point would have made a channel to the river, undermining the railroad tracks and stopping the operation of the road.

The sewer was unobstructed beyond the break. In order to clear the obstruction at the break a shaft was excavated directly below, to the top of the sewer. An opening was made in the sewer inside the shaft with a 3½-ton drop hammer operated from a locomotive crane. This opening released the water, which had backed up to within a few inches of the steam-supply line and about 1½ ft. from the street surface. The excavation was then continued, and by Nov. 29, the sewer was uncovered and the trench sheeted and braced for a distance of about 50 ft. Subsequently the trench was extended and portions of the damaged arch of the sewer and débris were removed and an unobstructed flow secured.

**Fig. 9. Flume Diversion of Sewer Just Above Liberty Ave.**

The length of the trench at this point is 86 ft., the width 16 ft. and the depth to the top of the sewer 14 ft. The trench was sheeted with 2-in. lumber, with 8x8-in. wales and 6x8-in. cross-braces. To avoid imminent danger of flooding in case of rain, it is proposed to let a contract immediately for the permanent repairs, at an estimated cost of $5500; this is easily possible because the repair work at this point is separated from the main work.

**Clearing Intermediate Section—**Work was commenced Nov. 26, uncovering the damaged sewer between Liberty and Penn Aves., and by Nov. 29, the entire section, 220 ft. long, had been excavated and the sheeting driven to the top of the sewer. Since then the excavation, sheeting and bracing of the trench and the removal of the damaged arch and débris in the sewer have been completed. Owing to the presence of the railway viaduct the work at this point was done entirely by hand.

**By-passing Upper Part of Sewer—**At Cayuga St., the upper end of the explosion, the sewer was effectively closed by the settlement of the ground into the sewer. The sewage overflowed and followed down the right-of-way of the Pittsburgh Junction R.R., submerging the tracks and damaging the roadbed. It reentered the sewer at the opening caused by the break near the Forfar St. bridge. The flow into the sewer was partially obstructed, causing the sewage to back up, but the obstruction was not sufficient to divert the flow to Liberty Ave. Had the sewer clogged entirely at this point serious damage would have resulted to property on Penn and Liberty Aves., below this point.

An attempt was made on Nov. 27, to free this opening of obstructions by excavating with an orange-peel bucket operated by a locomotive crane. After working several hours and excavating to a depth of about 18 ft., the sides of the excavation began to cave in, threatening to undermine the track and endanger the crane, compelling the suspension of this work. To safely continue the work it was necessary to support the track upon which to operate the equipment, and pile bents were constructed. The track having been made secure, a coffer-dam of 12½-in. U. S. steel sheet-piling was driven around the opening. This coffer-dam was about 40 ft. long and 20 ft. wide, the piles being 30 ft. long. The prompt delivery of the piles was made possible by the courtesy of the steel mills in changing the rolls and immediately rolling the material, which was delivered upon the work within 12 hr. Driving the sheeting was started on the night of Nov. 29, and finished Dec. 2. By the time the sheet-piling had been driven, the opening into the sewer had become entirely closed. Excavation inside the coffer-dam was started immediately, and after several hours' work the obstruction was removed, releasing the water, which in the meantime had submerged the surrounding locality. The bracing of the coffer-dam with 12x12-in. timbers was now started, and continued as the excavation was started down. To permit the entrance of water, an opening was left in the coffer-dam, and a screen of 12x12-in. timbers set vertically was built.

The uncertainty of the condition of the sewer below the coffer-dam, and the extreme danger of the opening at this point becoming closed in case of a heavy rain, made it advisable to sink another shaft at the manhole on 33d St., just above Liberty Ave., on the opposite side of the railroad, and from this shaft construct a flume leading to a point just above the coffer-dam. The shaft at the manhole is 20 ft. square. The flume is 10 ft. wide and 200 ft. long, with a grade of 1%; the average depth of cut for the flume was about 12 ft.

The flume serves the double purpose of a bypass around the break, to make possible and easy the cleaning out of the sewer above the break, and of providing an additional waterway for storm flow. It was practically completed on the night of Dec. 6. The rain on the night of Dec. 6 and the day following put it to actual test, and demonstrated the wisdom of the extra precaution taken.

While work was in progress in connection with opening up the sewer at the places previously mentioned, the railroad company was busy excavating a ditch along and outside of the tracks, in accordance with previous arrangements. The ditch confined the water, thereby keeping it off the tracks and diverting the flow from the line of the damaged sewer.

A decision having been reached as to the policy to be pursued with respect to permanent repairs (which con-
templated the performance of the work by competitive bidding based upon unit-prices), it was necessary, in order to determine the character and extent of such repairs, to uncover the sewer from the west end of the bottling house on Sassafras St. to Cayuga St. The work of uncovering the sewer between the above points will require (under the most favorable weather conditions) at least two months, and during this interval all drainage will flow in the open ditch. To prevent damage to the railroad property in case of rain during this period, it was considered advisable to enlarge this ditch to regular lines and to sheet and brace the sides. The ditch is 2800 ft. long and 10 ft. wide, with a minimum depth of 6 ft. The sides are sheeted with 2-in. plank, 12 ft. in length, and braced transversely with 6x8-in. timbers.

Additional funds were appropriated, amounting to $60,000, making a total appropriation of $110,000 to cover the cost of the emergency work. The uncovering of the broken sewer from the brewery along Sassafras St. to the end of the stable of the brewery requires the use of a cableway, supported by three towers. The excavated material is loaded into wagons and hauled to a near-by dump, as there is no room on either side of the sewer to store the material. This work, together with the enlargement and sheeting of the open channel, is now in progress. Beyond the stable, where space is available, a different method of excavating and disposal of material will be adopted.

PLANS FOR REPAIRS AND FUTURE CONSTRUCTION

The formulation of a policy for the repair and reconstruction of the damaged sewer was necessarily held in beyance until a more complete knowledge of the condition of the sewer was obtainable. The problem was complicated by the fact that the existing sewer was inadequate in capacity to provide proper drainage for the district served. The trunk sewer and main laterals of the system are surcharged during heavy rains, blowing off manholes, overfloowing, and backing up the sewage into the laterals and connections. For the improvement of the drainage of the basin a study was made two years ago of the drainage requirements and designs were prepared or a relief sewer, which has since been completed, paralleling the existing main between Aiken and Winebiddle ves. It was anticipated that this relief sewer would be extended to the river as funds became available. The capacity of the damaged sewer, as before stated, was 800 i.ft. per sec., while the total required discharging ca-

FIG. 10. FLUME DIVERSION IN YARDS NEAR FORFR St. BRIDGE

FIG. 11. SEWAGE FLOWING ALONG P. J. R.R. TRACKS, NOV. 26, 1913. LOOKING TOWARD 33rd St.

Dr. Samuel G. Dixon, was represented in the consideration of these matters by F. Herbert Snow, Chief Engineer of the State Department of Health. After examining the situation and conferring with the local engineers, a joint report was submitted at the request of the Council, by Mr. Snow and Mr. Sprague. The report makes definite recommendations with regard to the needs for additional drainage facilities in the whole basin, the policy to be followed with respect to repairing the damaged sewer, and the matter of the disposal of the sewage into the Allegheny River.

Aside from relative economy of construction, the following factors entered into the determination of plans for rebuilding and reconstruction. It was necessary to provide at the earliest possible moment a temporary waterway for the sewage to avoid damage from flooding and to relieve unsanitary conditions. The construction of a new sewer 11 ft. in diameter, adequate to carry the entire discharge from the basin, would involve serious delay, pending the procurement of funds by a bond issue. Funds for repairing the sewer to its present size could be readily obtained by tax levy. During the construction of the 11-ft. sewer the flow would have to be maintained in an open channel. The time required to construct the larger sewer would greatly exceed that required to repair the present sewer. Since the invert of the sewer was found to be intact, it is feasible to satisfactorily re-
pair the sewer by constructing a new arch, the flow in the meantime being confined in the old invert. Repairing of the present sewer was further justified by the fact that when so repaired it will have a further life of at least 25 yr.

It was further determined that the cost of permanently repairing the existing sewer with a new arch and subsequently building a 9-ft. relief sewer was less than the cost of building a single new sewer, particularly since the increased cost of maintaining the open channel required by this latter plan would be considerable and the plan itself open to serious objection.

After considering the situation from all standpoints, definite recommendations were made, in the joint report referred to, to the effect that the old sewer be repaired to its original size, at an estimated cost of $350,000, and later, under funds to be provided by bond issue, a relief sewer be provided, the total cost of which work, including additional relief sewers for the main laterals, is estimated at $938,000.

The accompanying general plan shows the existing combination of the basin, relief sewers recently completed or now under construction, and proposed relief sewers, which, with the existing sewers, will provide adequate drainage for the whole watershed.

The question of the treatment of the sewage from the basin was deferred until such time as detailed plans for the comprehensive improvement of the drainage facilities of the basin can be prepared and funds provided for their execution. The probable solution of the problem will consist of a dry-weather diversion and the installation of settling or screening devices, or both, with a submerged outlet extending to the thread of the Allegheny River. The construction of such works will probably be delayed until required by the State Department of Health.

The work is under the supervision of N. S. Spreague, Superintendent of the Bureau of Construction; I. Chas Palmer is Division Engineer. Ottomar Stange, of the firm of John F. Casey, has supervision over the contractor's forces, assisted by G. M. McAllister, Superintendent.

#### Water-Works Improvements at La Crosse, Wis.

**SYNOPSIS**—Modern demands for a better quality of water, better fire protection and improved pumping conditions are leading to an abandonment of the Mississippi River and direct pumping for a supply pumped by electric power from wells in the gravel and sand to a receiving reservoir, from which the water is pumped to a distributing reservoir. The old pumps are being overhauled and moved to a new station near the receiving reservoirs. The well pump houses, the new main pumping station and the two reinforced-concrete covered reservoirs are described.

The city of La Crosse, Wis., is located on the east side of the Mississippi River and is divided into two parts by the La Crosse River, which enters the former stream at this point. The population was about 30,500 in 1910, and is estimated to reach about 40,000 by 1930. The present water-supply system was built by the city in 1877, taking water from the Mississippi River and pumping it directly into the mains. The water is not filtered.

The consumption has averaged nearly 3,000,000 gal. per 24 hr. for about ten years. The most severe conditions were during the very dry summer of 1910, the daily average for July being 5,500,000 gal., with a maximum of 6,800,000 gal. for a few days.

**OLD WATER-WORKS SYSTEM**

The pumping station was located near the Mississippi River, in the manufacturing district of the southern part of the city, closely adjacent to the business center. With such a location it had a rather severe fire hazard.

A change in the source and mode of supply became desirable to secure better water and to avoid the difficulties and limitations incident to a direct-pumping system. Accordingly, Alford & Burdick, consulting engineers, of Chicago, were engaged in 1911 to make investigations for a new supply and for other improvements in the works. They advised that water sufficient for the next 15 or 20 years could be obtained from wells sunk in a 240-acre tract of sand and gravel land in the La Crosse Valley, within the city limits, and that this supply could be enlarged by sinking more wells in adjacent land when needed. They recommended that the water be pumped from the wells by electric power, delivered to a 1,000,000-gal. covered storage reservoir and pumped thence to a 5,000,000-gal. reservoir, from which the city would be supplied by gravity. The plan included moving the old pumping plant to a new station near the receiving reservoir and making some improvements in the large pump.

These recommendations were adopted, and the work is now well advanced. As soon as the works are completed, the river supply will be abandoned. The contracts were let in November, 1912, and the entire system is expected to be completed by January, 1914. The construction has been under the direction of Alford & Burdick, with L. A. Genfel as resident engineer in charge.

The city engineer is Geo. P. Bradtish. The estimate of cost for the new water-supply system was as follows:

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<th>Item</th>
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<td>Land (240 acres)</td>
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<td>Motors, pumping and generators</td>
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<td>Pumping station</td>
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<td>Pumping engine, 8,000,000 gal.</td>
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<td>Pipes, new old engines and boilers, etc.</td>
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*The principal machinery at the old station was as follows: One 10,900,000-gal. Holly vertical triple expansion engine (1895), one 4,000,000-gal. Blake compound condensate direct-acting engine (1884), one 2,500,000-gal. engine of the latter type (1891), three 1,875-hp. internally fired boilers, 8 ft. (1902). The total lift at the old plant was about 168 ft.*
The Eighteenth St. Sewer Explosion at Detroit

BY ROBERT H. McCORMICK

On Jan. 28, an explosion from some unknown cause occurred in the 18th St. sewer. This sewer runs in a northeasterly direction through 18th St., Buchanan St., Calumet and Canfield avenues and Cass Ave. to the boulevard, a distance of five miles. The portion of the sewer from the river to Fort St. is comprised of two 5-ft. cylinders running under the tracks of the Wabash Railroad. From Fort St. north for a ways is an 8-ft. cylinder.

The explosion occurred about 3 p.m. and could be traced from the river to a point about 3½ miles north (see map). Manhole covers along the whole line of sewer were blown off and broken. The greatest damage was done on the shallow portion of the sewer at the Wabash Railroad Yards, where one of the barrels was completely destroyed, and at the Michigan Central Railroad Subway, where the paving of the subway comprised the roof of the sewer, and where the sewer was destroyed for a distance of 100 ft. A portion of the sewer in the subway was a 7-ft. cylinder, composed of three rings of brick. The arch of this portion was blown completely off. Another portion of the sewer at the subway was a special horseshoe section with a concrete slab on top. This slab was lifted bodily and shoved to one side.

At the corner of Calumet and Grand River avenues the fronts of three small stores were blown out. In addition, numerous manholes were shattered and will have to be rebuilt.

CLEARING UP AFTER THE 18TH ST. SEWER EXPLOSION AT DETROIT

The total damage done to the sewer will probably be between $6,000 and $7,000. The cause of the explosion is, at the present time, unknown, although there is little doubt but what it was caused by the presence of gasoline in the sewer. A thorough canvass of the drainage territory tributary to this

sawyer has shown that in it there are quite a number of small garages and automobile factories and one oil company which handles immense quantities of gasoline.

The débris and obstructions in the sewer caused by the explosion were removed inside of 24 hours and the normal flow of the sewer was restored. No effort to repair the damage done to the sewer will probably be made until spring, a temporary covering of plank having been placed over it.

A Cave-in Over a Sewer occurred recently in Baltimore, Md., but the sewer did not collapse, as was reported. We are indebted to Calvin W. Hendrick, chief engineer of the Sewerage Commission of Baltimore, for the following information on the subject:

The cave-in was over the old Harford Run Sewer, which is a 10-ft. sewer built about 25 years ago. The parties who constructed the sewer state that a great deal of fine sand was encountered when the sewer was constructed at this point, in tunnel. Appearances indicated that in tunneling ground was lost, leaving voids above the timber work. The seepage of water through the ground finally caused the cavity to work its way to the street surface, and a section of the street bed dropped. The hole has been refilled.