SHAKERHEIGHTS

JULY 27, 2014 STORM FINDINGS

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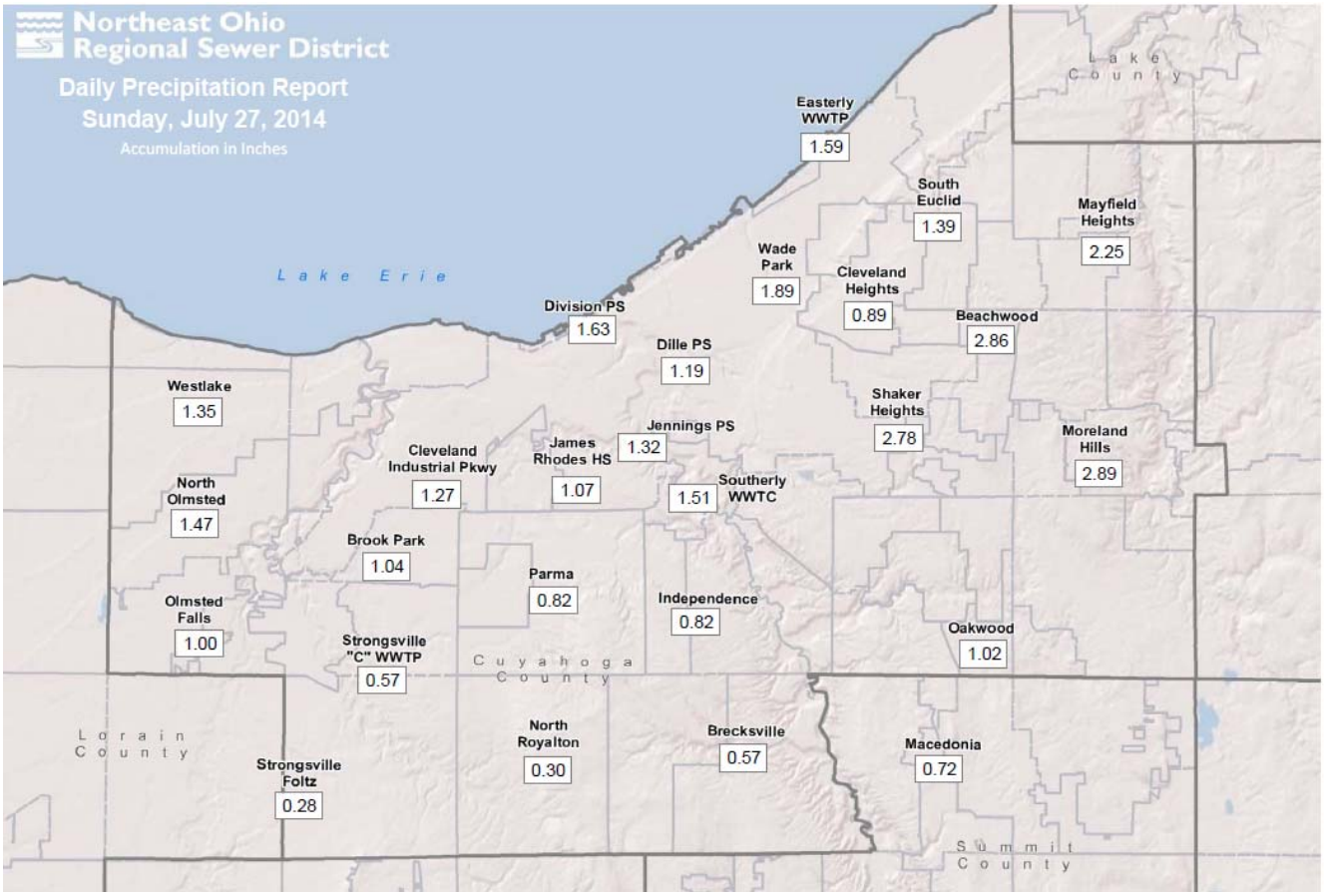
Background Information

1.1 Wet Weather Event

On July 27, 2014 the City of Shaker Heights experienced a significant rainfall event that resulted in a number of homeowners reporting basement flooding. According to data provided by the Northeast Ohio Regional Sewer District (NEORSD), the rain event was classified as a 50-year storm event. The total rainfall was 2.78 inches (see the illustration below).



A 50-year storm event refers to the rainfall totals that have a two percent (2%) probability (or 1 in 50 chance) of occurring at a location in that year. It should be noted that a storm of this magnitude on a given day does not decrease the probability of a similarly intense storm in that same year or in years to follow. The classification for various storm events is based on how much rain falls within a 24-hour period. A common misconception is that once a 50-year storm event has occurred, it will be another 50 years until that area has an event of this magnitude. This is not the case. A similar wet weather event, as experienced on July 27, 2014, can happen again.

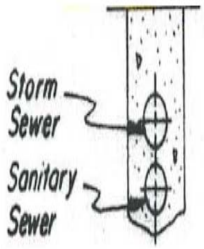
Additionally, it should be noted that the wet weather event on July 26 totaled 0.73 inches. As a result, ground surfaces were saturated causing the July 27 rain to be primarily surface runoff that contributed to flooding of the streets as well as in basements.

1.2 Shaker Heights Sewer Infrastructure

In general, the Shaker Heights sewer system was constructed in the late 1920's and early 1930's. As is standard engineering practice, the sewers were designed for a five-year storm event. Given the amount and intensity of the rainfall that occurred on July 27, the capacity of the sewers was exceeded.

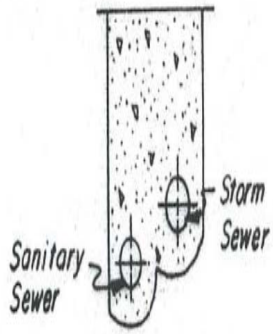
Shaker has a network of different types of sewers. The illustration to the right depicts the most common types of sewers constructed at the beginning of the last century.

When both sanitary and storm water flow are conveyed in the same pipe, this is referred to as a combined sewer. Often, when the combined sewer reaches maximum capacity, it is discharged into the environment. This was a common design feature in the early 20th century. Due to environmental concerns and federal regulatory policies, the City has separated the storm flow from the sanitary in the majority of the combined sewers. The City continues to work with NEORSD and the EPA to eliminate combined sewers within our community.



More common to Shaker Heights are over/under sewers. The storm sewer is either directly above the sanitary or within the same trench. Sewers were constructed in this manner for economic reasons; it was less expensive to excavate one trench for two sewers.

For sewers where the storm is directly above the sanitary, there is generally one common manhole. A removable storm invert plate allows access to the sanitary for maintenance. If the storm invert plate is not positioned correctly or is damaged during a wet weather event, a portion of this flow will enter the sanitary. This additional storm flow will reduce the capacity of the sanitary line.

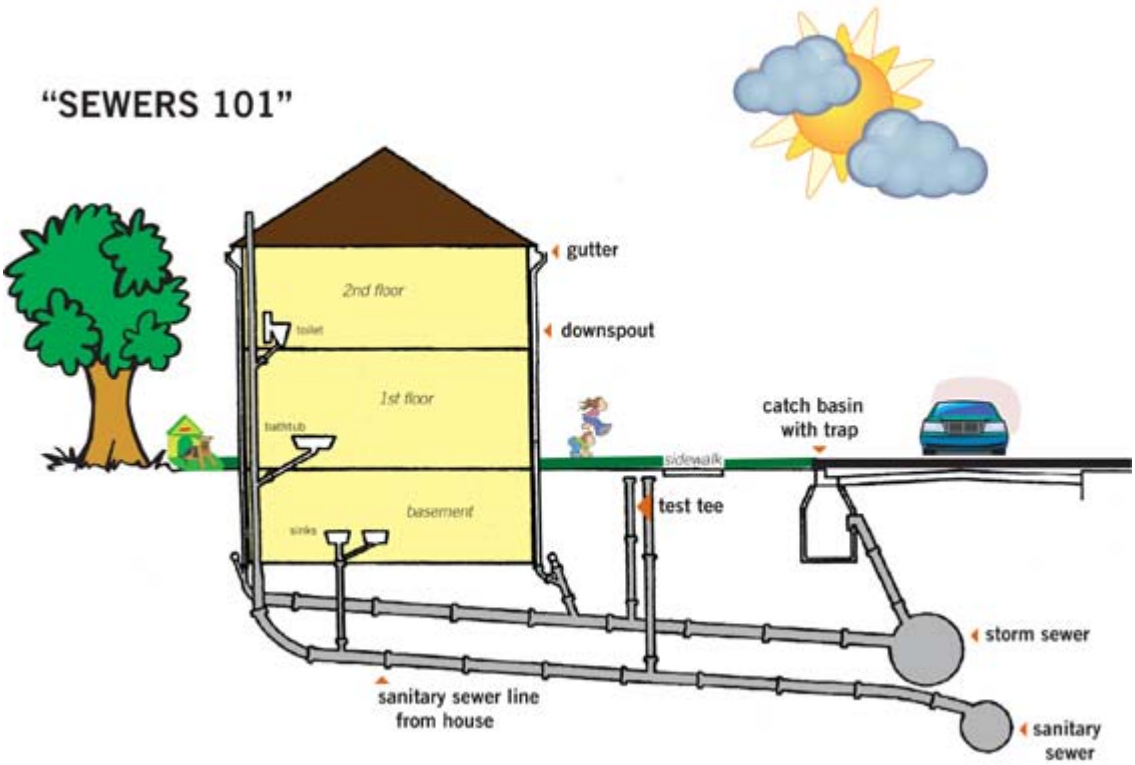


Separate storm and sanitary sewers with a common trench, where the storm is higher but adjacent to the sanitary, will have separate manholes. The majority of the City's sewer infrastructure was constructed using this method of placement.

The material of construction for the sanitary and storm sewers mainly consists of vitrified clay pipe or concrete pipe. In areas where the City has installed new pipes, PVC or reinforced concrete pipe is used. A typical length of pipe is six (6) to eight (8) feet in length and is joined together with a bell and a spigot. Manholes and other access points consist of masonry or concrete.

1.3 Homeowner Laterals

In general, Shaker houses have both a sanitary and a storm lateral. For those homes that connect to a combined sewer, it is not uncommon for the sanitary and storm laterals to combine prior to discharging to the main line sewer. Homeowners are responsible for maintenance of the laterals on their property, which is typically from the house to the sidewalk. The City requires that homeowners install a "test tee," which is a vertical pipe connecting from each lateral to the surface of the ground, providing an access point to the sewers for plumbers and the City. Access to the test tees is to be maintained by the homeowner. The following diagram shows the drainage system for a residential property.



The purpose of the description of the sewer infrastructure and draining of a residential property is to provide those outside of Public Works and residents a common understanding of the terms that will be used throughout the report.

Initial Impacts and Follow-up Action

2.1 Shaker Lakes Dams & Other Infrastructure

During the rain event on the afternoon of July 27, the peak intensity of the storm reached a point where the precipitation fell at 7.20 inches per hour for a duration of one minute. As a result, the

water crested and overflowed the dam at Horseshoe Lake, which is located partly in Shaker Heights and partly in Cleveland Heights.

The Police secured the area until the water had receded. Upon inspection of the dam, it was noted that portions of the rip-rap, which is stone used to armor the shoreline structure from water and ice erosion, had been displaced. Additionally, the trash rack at the inlet pipe on the eastern portion of the dam had filled with debris and was misaligned. Shortly after the storm event, Public Works replaced the rip-rap stone, removed debris and adjusted the trash rack.

During the storm, there was no indication that water overflowed the dams at Green Lake and Marshall Lake.

As with the dam at Horseshoe Lake, the storm caused water to overflow the Lower Lake dam. Part of the lake and all of the dam are located in Cleveland Heights. Cleveland Heights reported that there was considerable flooding along North Park. As a result, a new bio-swale installed by the Doan Brook Watershed Partnership, was washed away.

Overall, the infrastructure of the City remained intact. Public Works employees were deployed during the storm to remove debris from catch basins. There is no evidence that suggests the intensity of the storm damaged any of these structures.

Two exceptions of damage to the infrastructure were the roads at the intersection of Ashby and Milverton and the western portion of North Park Blvd. A box culvert, a rectangular structure that conveys storm water under Milverton, apparently became surcharged, pushing water through the walls of the brick manhole, which ultimately caused the newly resurfaced road to heave. As part of the City's Large Area Repair program, the road was restored within a month of the July 27 storm.

At the western end of North Park Blvd., large patches of the asphalt surface course were peeled off by surface runoff, exposing the intermediate course. Within days of the event, Public Works restored the road.

2.2 Tree Lawn Pickup

In the weeks immediately following the July 27 storm, the City's priority was to provide assistance to homeowners. First, the City provided tree lawn pickup of items that had been damaged by flooding. Public Works divided the City into sectors to accommodate work flow and allocated manpower accordingly.

Approximately 590 residents contacted Public Works to take advantage of this service. Many more residents placed damaged items on their tree lawns without contacting the City. This material was also picked up by City crews. Second, the City started the cleaning, and if necessary, the inspection and repair of the sewer laterals from the test tees to the sewer mains. This will be discussed in further detail on the following pages.

2.3 Inspection of Invert Plates

In conjunction with the tree lawn pickups, the City sent out field crews to ensure that invert plates were positioned correctly in the manholes. As described in Section 1, invert plates are used to separate storm water from the sanitary in over (storm)/under (sanitary) systems. During a rain event, if the invert plate is not properly seated, the storm water will enter the sanitary. As a result, the sanitary will become surcharged. This may lead to water entering basements. There is no way for the homeowner or City to know if an invert plate is improperly sealed without a physical inspection through the manhole. Also, there are a number of potential causes of the invert plates being out of position.

This work was completed in neighborhoods known to have over/under sewer systems and where there were concentrated areas of tree lawn pickups. As a result of this activity, three locations were noted as having improperly aligned invert plates. These locations are:

- Norwood Rd./Traynham Rd.
- Norwood Rd./Lomond Blvd.
- Hildana Rd. (between Chagrin Blvd. & Hampstead Rd.)

These invert plates were re-positioned immediately after the condition was observed.

Inspection of Lateral & Main Line Sewers

3.1 Lateral Cleaning, Inspection & Repair

As a result of the July 27 rain event, 706 residents called to request that their sanitary and storm sewers be serviced. Some of those callers had experienced basement flooding. In cooperation with Cuyahoga County Public Works, the City responded to all residents who called. This work entailed cleaning the laterals on the City side from the test tee to the sewer mains. When necessary, these laterals were televised. Laterals that were noted as damaged on the City side during the lateral inspection were repaired.

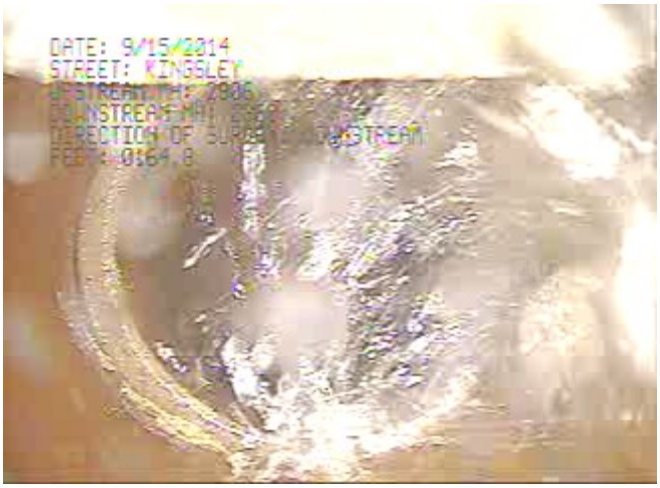
The 706 calls from residents can be broken down into four categories; the categories are as follows:

- **Light Maintenance** included light cleaning that was done from the test tee to the main sewers. No structural or Operation & Maintenance (O&M) issues were noted by the sewer crews under this activity.
- **Structural issues** consist of the lateral being broken, crushed or having missing pipe walls. These may occur for a variety of reasons. Structural issues were addressed as discovered from an internal inspection of the lateral.
- **Operation & Maintenance** issues include heavy roots, mud, sludge, grease or other foreign material that prohibit flow from the house to the main. When these issues are found, they often occur on both the City and homeowner sides of the lateral, and the

materials may originate from the homeowner's property. O&M issues were addressed as discovered on the City side.

- **Known issues on the resident side** include test tees that could not be located, broken test tees and storm traps. Years ago, storm traps were installed when connecting to combined sewers. This was done to mitigate sewer gases from permeating the air at street level. Now that the majority of houses are connected to separate sewers, traps are no longer needed. Additionally, storm traps can be problematic when performing maintenance on the storm lateral.

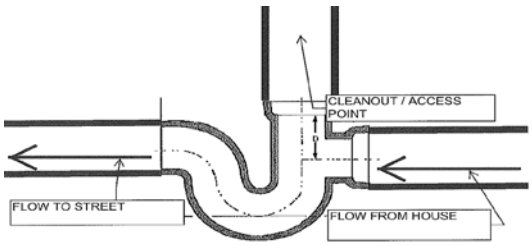
  Homeowners are required to maintain access to their test tees. If the test tees are not located or are broken in a way that sewer equipment cannot enter the laterals, it is the homeowner's responsibility to repair them.



During the investigation, 55 percent (55%) of the requests received were for light maintenance and no structural or operational issues were found. Therefore the basement flooding at these properties was attributed to the severity of the storm. In one percent (1%) of requests, Public Works discovered structural issues; 27 percent (27%) of the requests required maintenance and in 17 percent (17%) of the requests there were issues on the homeowner's side/private property.

3.2 Main Line Inspection

When mapping the addresses of homeowners who reported basement flooding, it appeared that basement flooding throughout the City was fairly random. However, there were some areas that had a higher concentration of reported basement flooding. Based on the data, the City directed the sewer crews to inspect the main sanitary and storm sewers in these areas and, if necessary, clean/jet them as a preventative measure. This work was performed by Cuyahoga County Public Works and a private contractor, both hired by the City. Over the course of two months, 27,300 linear feet of main line sewer were inspected and 31,700 linear feet of main line sewer were cleaned.



The mechanics of a main line inspection are relatively straightforward. A camera mounted on a robotic wagon, also known as a crawler, is lowered into a pipe from a manhole. The camera is able to pan and tilt to observe defects or other items of note. A cable, attached to the camera and a specially-equipped truck, enable the camera operator to control the crawler. The typical rate of speed for the crawler is 30 feet per minute. Crawlers vary in size depending upon the diameter of the sewer. Inspections start at a manhole and typically end at the downstream manhole; this is referred to as a pipe reach.

In general, of the sewers inspected, the majority were in fairly good structural condition given the age of the infrastructure. The majority of defects encountered tended to be Operation & Maintenance issues. These defects varied from debris (mud, sludge, rocks, etc.) in the system to root intrusion and include infiltration.

As described in Section 1, the majority of Shaker Heights sewers consist of over (storm)/under (sanitary) system, in which the storm and sanitary share a common trench. Storm pipes with joints that leak may send part of their flow into the sanitary pipe.

Identifying infiltration includes making a video inspection of the inside of the sanitary sewer during a wet weather event. If the ground is not saturated, and there is no flow in the storm pipe, or there is no break in an adjacent waterline, it is difficult to ascertain from visual inspection if a pipe joint is defective to the point that infiltration could occur. When internal pipe inspections conducted in areas with a high concentration of basement flooding revealed minimal structural or O&M defects, the City purposely surcharged the storm pipes to simulate a storm event.

Recommendations

4.1 Main Line Recommendations

Based on the inspection work conducted, field observations and data collected, Public Works and the GPD Group, the City's consulting engineering firm, have developed the following recommendations:

- Palmerston Rd. (Lomond to Scottsdale boulevards)
  - Sanitary:
    - Structural – pipe wall missing & visible voids
    - O&M – heavy grit, grease & paper products
  - Storm:
    - Structural – cracks & visible voids
    - O&M – heavy debris
  - Recommendation:
    - Spot repairs of broken pipe
    - Installation of cured-in-place pipe
    - Preliminary Cost Estimate = $105,000

- South Woodland Rd. (Attleboro to Torrington roads)
  - Sanitary:
    - Structural – pipe wall missing
    - O&M – infiltration
  - Storm:
    - Structural – pipe wall missing & visible voids
    - O&M – heavy roots & infiltration
  - Recommendation:
    - Spot repairs of broken pipe
    - Installation of cured-in-place pipe

- Preliminary Cost Estimate = $96,000

- Winthrop Rd. (South Woodland Rd. to Shaker Blvd.)
  Sanitary:
  - Structural – cracks in pipe & visible void
  - O&M – none

  Storm:
  - Structural – none
  - O&M – moderate amount of debris

  Recommendation:
  - Spot repairs of broken pipe
  - Installation of cured-in-place pipe
  - Preliminary Cost Estimate = $80,000

- Almar Rd. (Somerset Dr. to Warrensville Center Rd.)
  Sanitary:
  - Structural - none
  - O&M – poor connection of laterals & infiltration

  Storm:
  - Structural - none
  - O&M – infiltration

  Recommendation:
  - Installation of cured-in-place pipe
  - Preliminary Cost Estimate = $78,000

- Glencairn Rd. (Fernway to Berwyn roads)
  Sanitary:
  - Structural – poorly connected laterals
  - O&M – debris

  Storm:
  - Structural - none
  - O&M – debris

  Recommendation:
  - Installation of cured-in-place pipe
  - Preliminary Cost Estimate = $96,000

- Kingsley Rd. (Malvern to Marchmont roads)
  Sanitary:
  - Structural – none
  - O&M – heavy infiltration

  Storm:
  - Structural - none
  - O&M – Heavy roots & debris

  Recommendation:
  - Spot repairs of broken pipe
  - Installation of cure-in-place pipe

- Preliminary Cost Estimate = $150,000

- Fernway Rd. (at Avalon and Kenmore roads)

  Sanitary:
  - Structural – none
  - O&M – infiltration

  Storm:
  - Structural - none
  - O&M – none

  Recommendation:
  - Spot repairs of broken pipe
  - Installation of cured-in-place pipe
  - Preliminary Cost Estimate = $175,000

Spot repairs consist of excavating the road, repairing the damaged pipe and road restoration. Depending on flow conditions, bypass pumping may be required. Cured-in-place pipe (CIPP) is a trenchless technique that is used to provide structural stability to the pipe and mitigate infiltration. In essence, a CIPP liner is a resin-impregnated material that is inverted at a manhole and is pulled through the pipe. The liner is then filled with steam or water to induce curing and provide adherence to the host pipe. The major benefit of CIPP liners is the installation does not require an open excavation of the street. This type of trenchless technology has been used throughout the county since mid-1970 and was recently used on North Moreland and Van Aken boulevards.

4.2 Lateral Recommendations

Throughout the course of the internal inspection of the main line sewers, roughly 30 laterals were noted to have defective connections to the main. The method of repair for this type of defect is similar to a spot repair – excavation of the road, repair of the damaged connection and restoration. The preliminary cost estimate for one lateral repair is $6,000 so a total of $180,000 is needed to make these repairs.

4.3 Sewer Superintendent & Sewer Maintenance Program

Public Works recognizes the importance of sewer Operations & Maintenance and is re-structuring management positions within its existing budget to add a superintendent experienced in asset management, maintenance and rehabilitation of sewers. This individual will be responsible for developing a plan within the available budget to clean and inspect our sewers on a five-year cycle using the Cuyahoga County Public Works Department and outside vendors. The new superintendent will manage the jobs and contractors on a daily basis which will also improve communications. This will enable the City to be proactive in addressing sewers concerns.

Summary

The 50-year storm event on July 27, 2014 had a major impact on the City and its residents. Without diminishing the monetary burden and emotional stress placed on homeowners, overall the infrastructure performed better than one could anticipate in such an intense wet weather event. The dams at Horseshoe, Marshall and Lower lakes performed as expected and show minimal signs of stress. With the exception of two isolated cases, the roads were not severely impacted by the storm.

As a result of the storm and requests from residents, the City undertook an aggressive investigation of the City's sewer system to detect any overarching issues with regard to the sewer system. To summarize, the sewers were found to be in good structural condition. From an Operations & Maintenance perspective, specifically infiltration and poorly connected laterals, the City has an opportunity to improve through the hiring of a new sewer superintendent and an increased cleaning and inspection program. It must be stressed, however, that any community will experience a degree of flooding or related incidents in a storm the magnitude of the one occurring on July 27, 2014.

The cost breakdown for the recommended main line repairs is $780,000 and $180,000 for lateral repairs for a total of $960,000. The City is proceeding to implement these recommendations over the next two years.