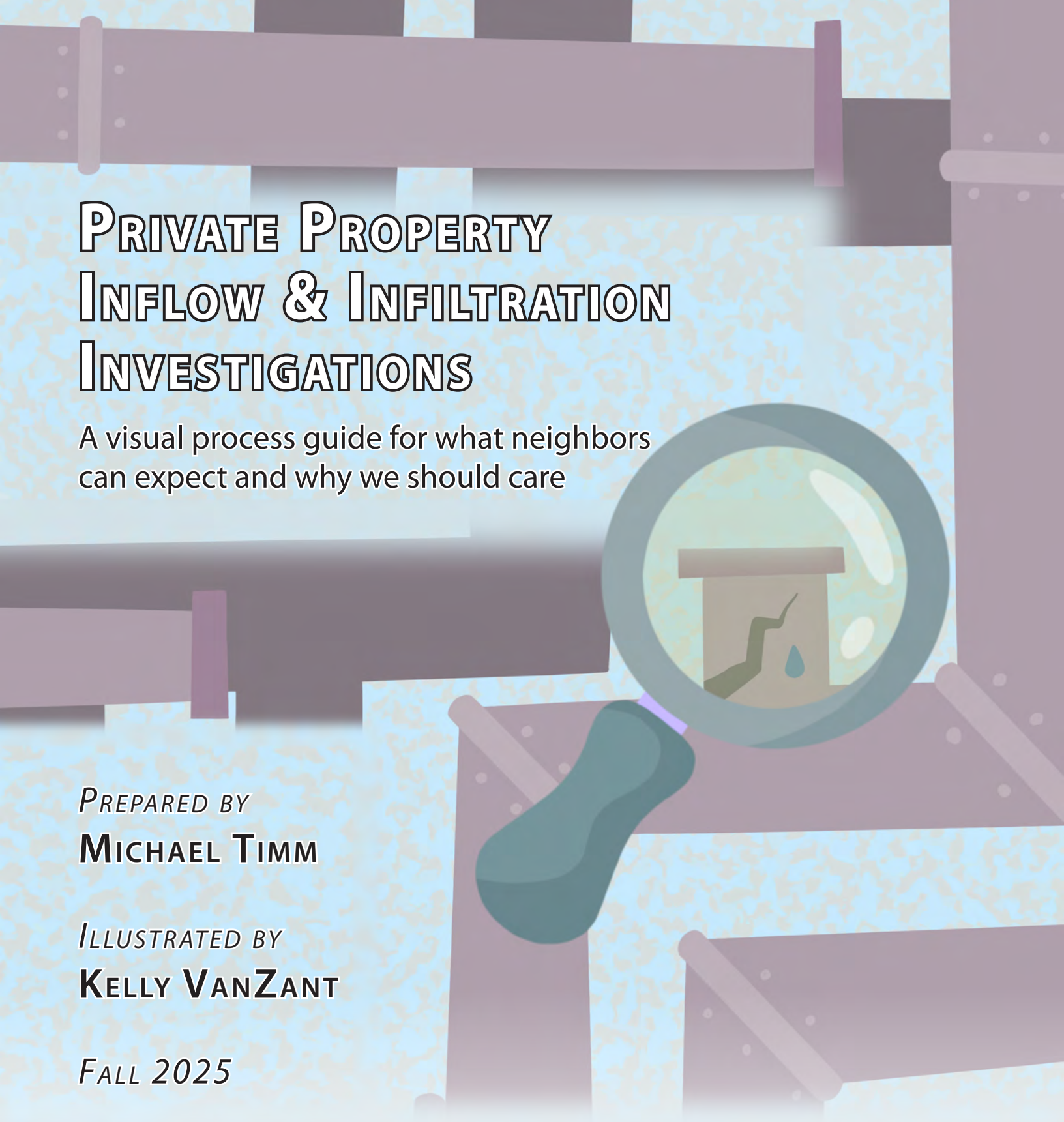


Private Property Inflow & Infiltration Investigations

A visual process guide for what neighbors can expect and why we should care

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MMSD 100

City of Milwaukee

GREENPRINT PARTNERS

PRIVATE PROPERTY INFLOW & INFILTRATION REDUCTION PROGRAM INVESTIGATION PROCESS

Phase 1: Community Organization



- Partner Support Enlisted
- Public Information Sharing
- Neighbors Opt In

Phase 2: Neighborhood Investigations



- Data Gathering
- Stormwater Testing
- Smoke Testing

Phase 3: Home Investigations

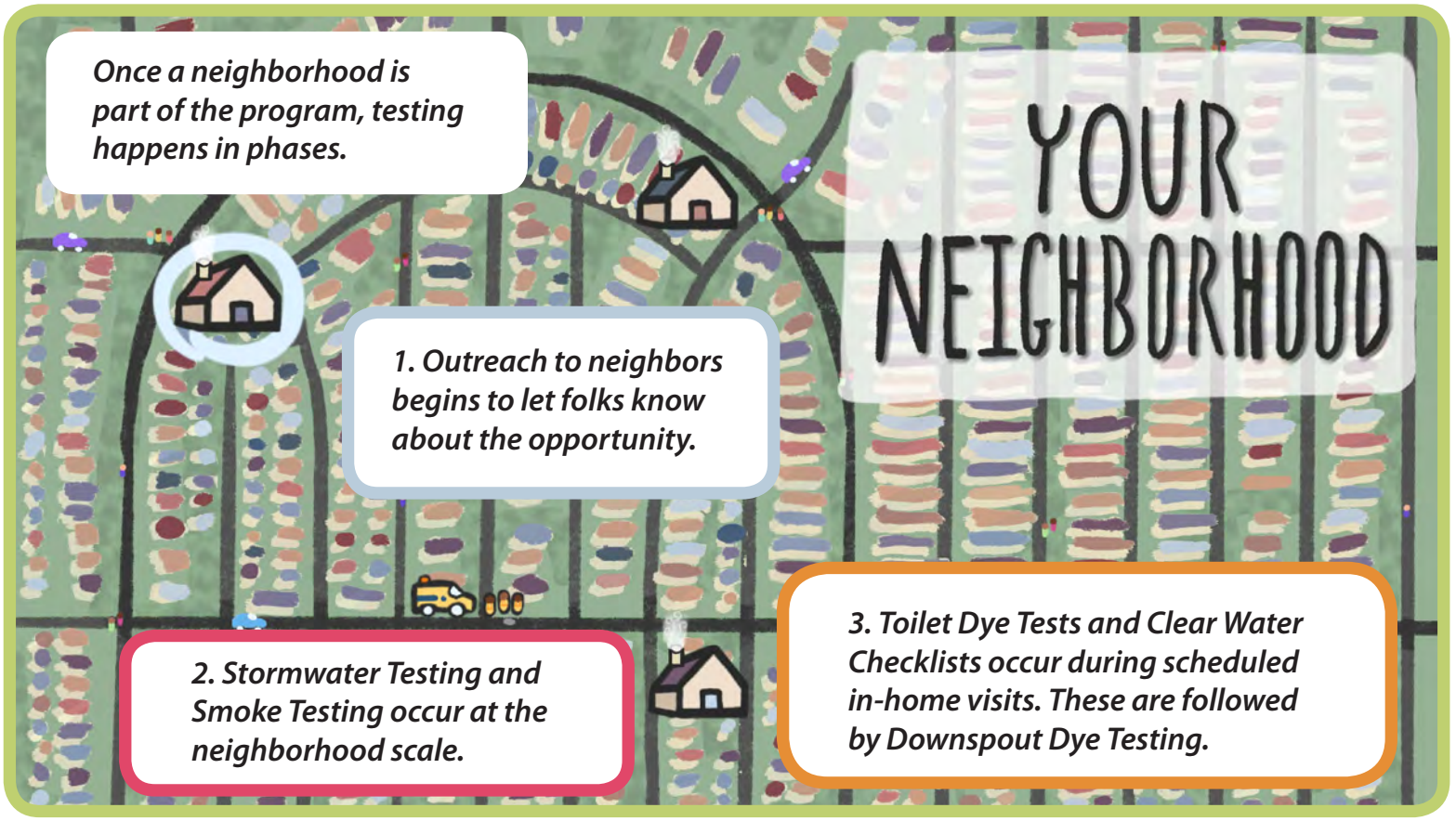


- Toilet Dye Testing
- Clear Water Checklist
- Downspout Dye Testing

Phase 4: Publicly Funded Solutions Recommended



- Sump Pump Installation
- Downspout Disconnection
- Lateral Replacement



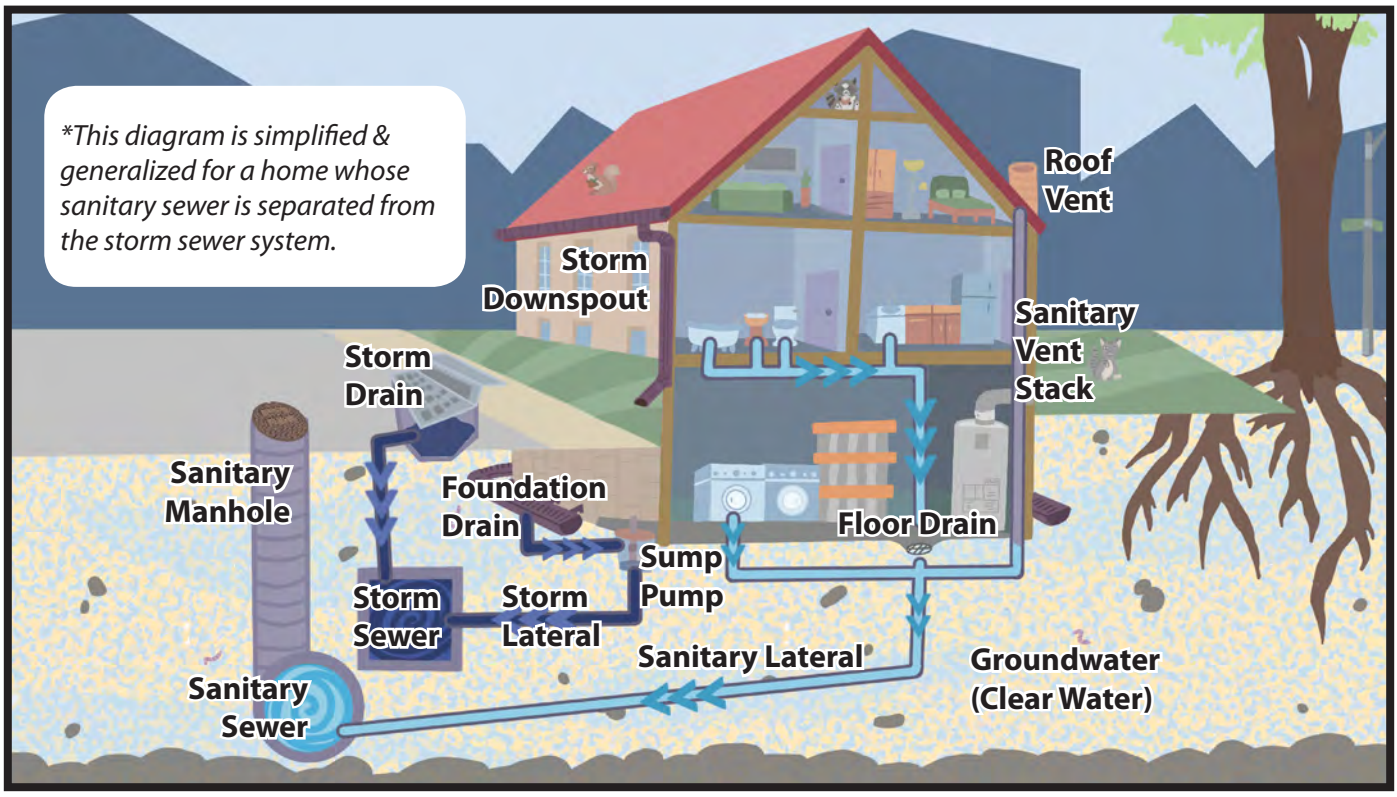
One cause of wet basements in city neighborhoods is when water that is not supposed to be there gets into privately owned pipes. That water can come from many places. To solve the problem, someone must investigate.

The Private Property Inflow & Infiltration Reduction (PPII) program includes these investigations.

This guide outlines the PPII Testing process for City of Milwaukee neighborhoods with real-life photos, stories, and illustrations. The intent is to show what to expect — and why we should care about reducing inflow and infiltration into the sanitary sewers.

The residents of Milwaukee's Grasslyn Manor neighborhood united as a community to "Help Build the Ark" after years of wet basements and flooding concerns. More than half of over 200 neighbors took part in the PPII Testing process in 2025. Their example shows the need to work together to tackle challenges like basement backups.

HOME PLUMBING CUTAWAY DIAGRAM



Everyone's home plumbing is a bit different. Understanding the details is one reason these investigations are important. Recommended solutions need to fit specific situations.

The diagram above is generalized to help show many key terms and relationships.

One thing to pay attention to is the laterals. A *lateral* is an underground pipe on private property connecting a home to the main sewer. (It is so-called because it usually connects at a right angle to the main sewer.)

The *sanitary lateral* connects whatever residents flush down the toilet — or the kitchen sink and garbage disposal — to the *sanitary sewer*.

Problems affecting what happens to water in privately owned laterals is the key concern of this program.

Variations of this diagram will show:

- sources of inflow and infiltration
- how the different tests work
- what observations can tell us
- some possible solutions

KEY TERMS

Backflow Preventer
Installed in some homes, it is a valve designed to keep water from flowing backwards from the *Sanitary Sewer* into your basement via the *Sanitary Lateral*.

Cleanout
An access point to your *Sanitary Lateral* allowing for inspection or cleaning.

Clear Water (Groundwater & Stormwater)
Water in the ground that may get into leaky pipes or home foundations.

Dye Test (Toilet or Downspout)
To trace *Improper Connections*, crews put colored dye into your toilet or downspout and look down *Manholes* or use a sewer camera to see where it shows up.

Floor Drain
On the floor of your basement, it drains to your *Sanitary Lateral*. If the *Sanitary Sewer* fills with too much water, it may back up into your basement here.

Foundation Drain
Around the perimeter of some homes, an underground pipe to drain *Clear Water* away and keep a foundation dry. May add *Inflow* if connected to *Sanitary Lateral*.

Improper Connection
Some older homes may have *Lateral* pipes connected to the wrong sewer. This is one source of *Inflow*.

Infiltration
Clear Water that enters a *Sanitary Sewer* system through leaky or damaged pipes underground.

Inflow
Water that enters the *Sanitary Sewer* system through an *Improper Connection*.

Lateral (Sanitary or Storm)
Underground pipe on your property connecting your home to a main sewer.

Manhole
Vertical access point to a sewer often in street or public right-of-way. *Sanitary* and storm sewers have separate *Manholes* (in the Separated Sewer Area).

PPII Testing
Private Property Inflow & Infiltration Reduction Program Testing Phase for a neighborhood.

Palmer Valve (Swing Check Valve)
In older homes, it connects *Foundation Drain* to *Sanitary Lateral* beneath *Floor Drain*. This adds *Inflow* to *Sanitary Sewer*.

Sanitary Sewer
Designed to carry wastewater flushed down toilet, tub, and sink to the treatment plant, mainly by gravity.

Sanitary Vent Stack
Vertical pipe in your home venting your plumbing through the roof vent.

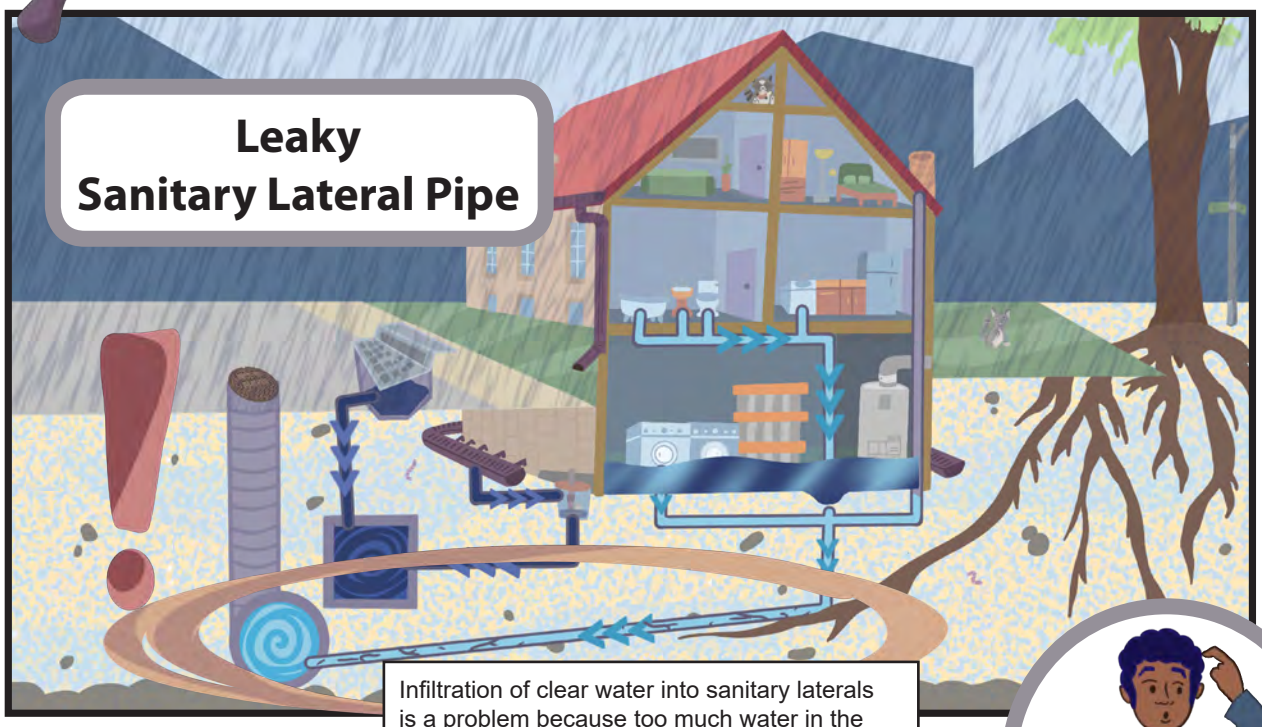
Smoke Test
To trace *Improper Connections*, crews inject harmless smoke into the *Sanitary Sewer* and observe where it comes up. Smoke should appear from each home's *Sanitary Vent Stack* via the roof vent. If smoke emerges from the rain gutter, it signals an *Improper Connection* that adds *Inflow* to the *Sanitary Sewer* system.

Storm Downspout
It drains your roof gutters to the storm sewer or, if disconnected, to your yard. Should not be connected to *Sanitary Sewer* or adds *Inflow*.

Storm Drain
Beneath the street curb grate, it drains to the storm sewer, via an underground catch basin.

Sump Pump
In some homes, it discharges *Clear Water* from your *Foundation Drain* away from your home foundation. Should not be connected to *Sanitary Sewer* or adds *Inflow*.

POSSIBLE PATHWAYS FOR INFILTRATION



Infiltration of clear water into sanitary laterals is a problem because too much water in the system can back up into basements.



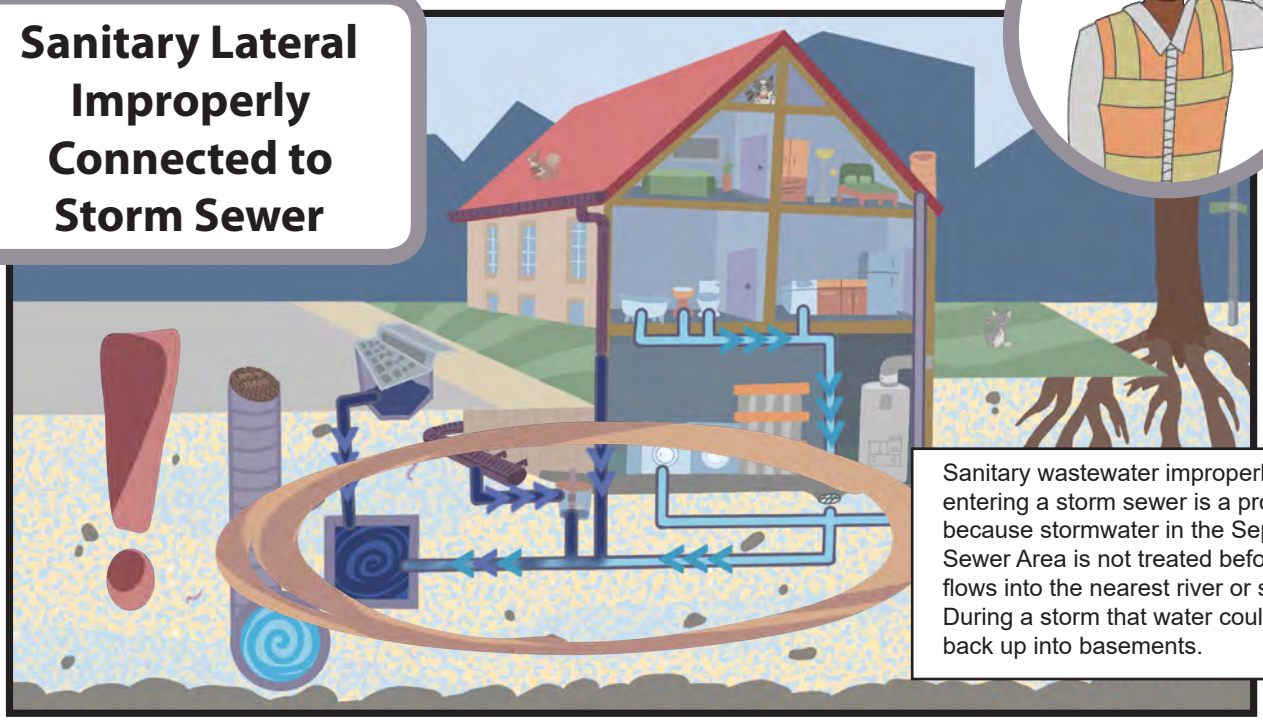


Leaky laterals can allow clear water to infiltrate. Too much water in the sanitary sewer can lead to basement backups.

POSSIBLE PATHWAYS FOR INFLOW

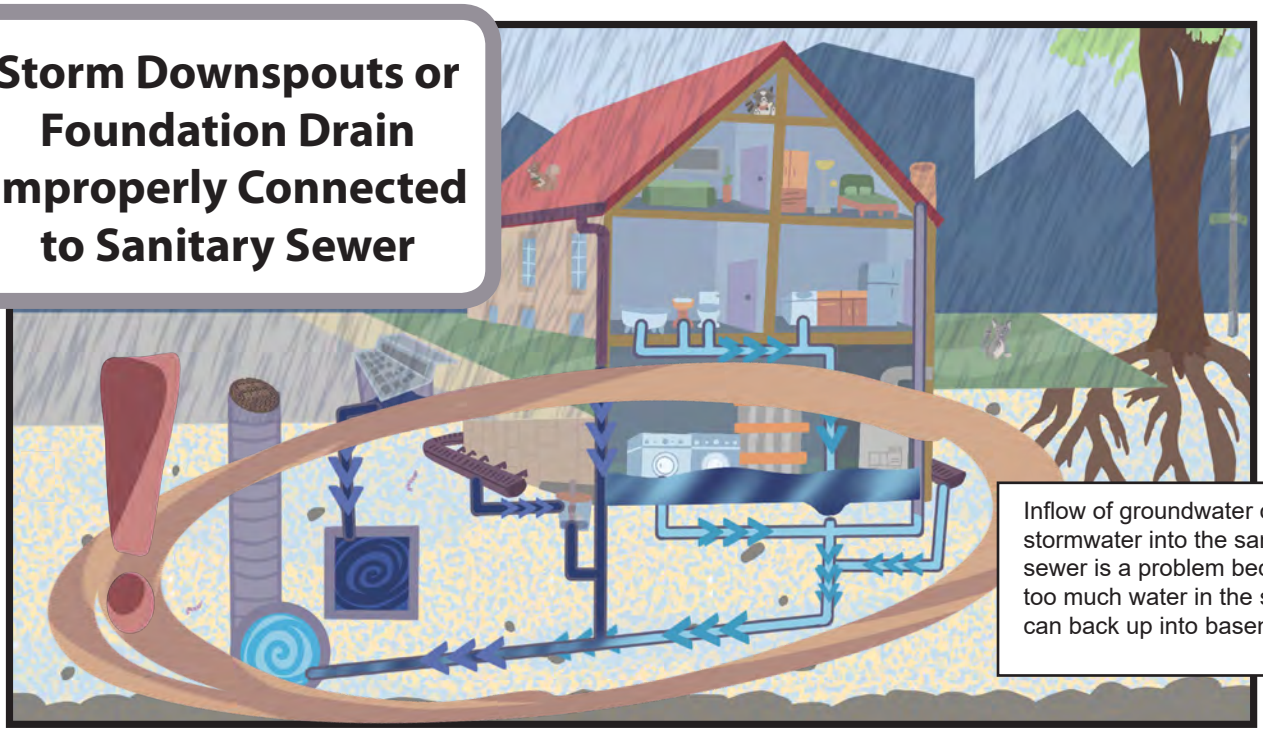


Sanitary Lateral Improperly Connected to Storm Sewer



Sanitary wastewater improperly entering a storm sewer is a problem because stormwater in the Separated Sewer Area is not treated before it flows into the nearest river or stream. During a storm that water could also back up into basements.

Storm Downspouts or Foundation Drain Improperly Connected to Sanitary Sewer



Inflow of groundwater or stormwater into the sanitary sewer is a problem because too much water in the system can back up into basements.

VOLUNTARY NEIGHBORHOOD PARTICIPATION



Grasslyn Manor residents sign up for in-home test visits at a community event.



Grasslyn Manor neighbors show their completed paperwork to enroll in the indoor testing investigation.

This testing program is paid for by the City of Milwaukee with funds provided by the Milwaukee Metropolitan Sewerage District (known as MMSD).

MMSD uses the funds collected through the Municipal Services Bill to treat wastewater flushed down the toilet and manage water to reduce flood risk in our region. Keeping unwanted water out of our pipes helps with both missions.

Heavy rains are a challenge to the whole system. Keeping stormwater out of separated "sanitary" (wastewater) pipes helps to reduce the risk of basement backups. This is easier said than done.

Inflow (pipes connected improperly) and infiltration (leaky pipes letting water in) are two problems that can lead to basement backups during heavy rains.

The program works best when there is widespread participation because water problems for one neighbor can cause problems for the whole neighborhood. Solutions need a neighborly approach.

Frustrated by years of wet basements, the residents of Milwaukee's Grasslyn Manor rallied together to "Help Build the Ark." The neighbors enlisted partners to help.

The City listened and the local alderman formally recommended the neighborhood be the City's target for this work in 2025. The Mayor and Common Council agreed.

As a voluntary program, individual homeowners in the target neighborhood still need to sign up to participate.

Neighbors took the lead in recruitment. The resident Advisory Group held monthly meetings and continue to go door-to-door to build trust. There were five community meetings for everyone.

Why these Milwaukee homeowners said "Yes" to participate



Lynn Thompson

"We all need to stick together. If there's any way to get this flooding to stop, we need to do it."



Percy Burt

"There's not a quick fix, but it's a fix that can happen, I believe, through work and participation."



Cheryl Wendt

"This neighborhood floods. And, as someone who lives on the lower end of the neighborhood, it'd be really nice if we could all have dry basements, dry yards, and help manage water."



Cordelia Robinson

"The more involvement, the more they'll probably do something for us. We've been complaining about it for years, as long as we've been here, and they are just really paying attention to what we are saying."



Fatima Robinson

"This not only affects me, it affects my neighborhood and my community. And it is just sad because people work so hard for their things and then to have 'em destroyed — it's a little sad and disheartening."



Mike Duer

"People had no idea the City cared. This work is important because some people's basements flood and we're trying to stop that."



Bernice Marshall

"Now we have help in the City... The City is not coming in to inspect you. We're actually at the point where the City is involved in helping us."



Steve O'Connell

"Neighbors need help. They can't live this way with the flooding and the mold and everything that comes about after a basement flood. Our neighbors have lived with this for many years and the City and others have kind of wrestled with the issue. But now finally the City is stepping in to help out. That — to me — is a ray of sunshine."

MONTHLY COMMITTEE MEETINGS & ACTION PLANNING

The program works best when it is community-based. In Milwaukee's Grasslyn Manor neighborhood, a dozen residents formed an Advisory Group. They met monthly to learn about the program process, share recommendations and individual stories, and plan how to engage their neighbors. Compensated for their time, the Advisory Group planned when, where, and how to reach out to several hundred neighbors to encourage broad participation.



Greenprint Partners staff organized the meetings, also attended by the local alderman or his staff.



The neighborhood committee met at the local church after work hours and shared a meal together.



Neighbors asked City engineers their questions.



Milwaukee Metropolitan Sewerage District and Department of Public Works staff attended meetings.

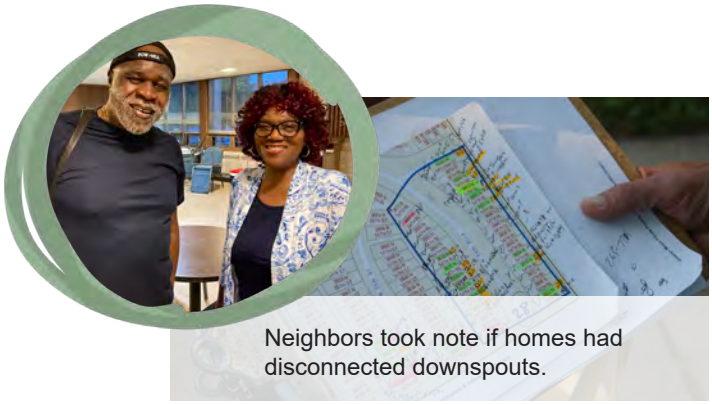


Neighbors living on different streets were able to cover the full project area during door-knocking outreach.



Groups of two canvassed their areas of the neighborhood.

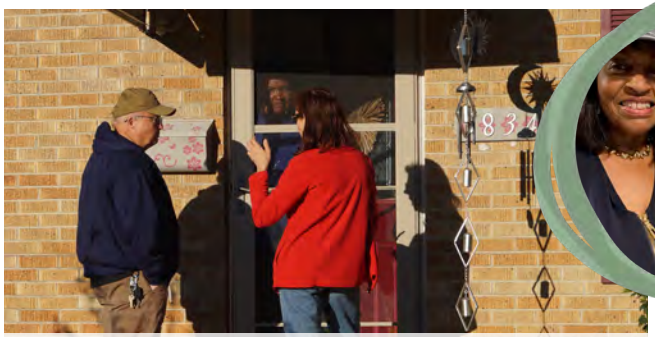
CANVASSING THE NEIGHBORHOOD



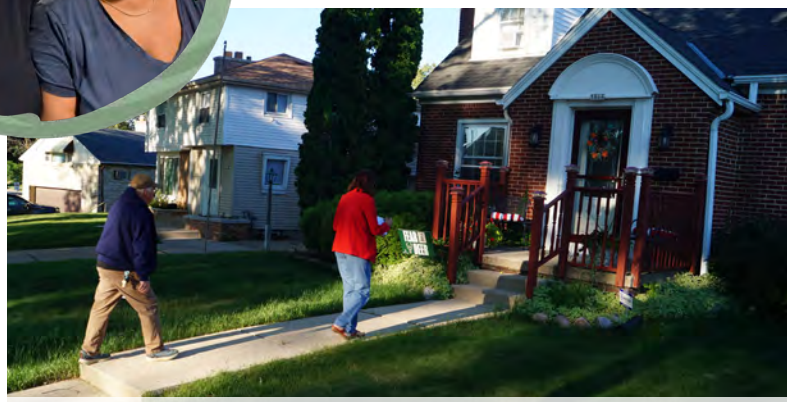
Neighbors took note if homes had disconnected downspouts.



They identified themselves with badges and distributed flyers.



Conversations with neighbors were amicable and focused on sharing facts.



They revisited homes up to three times when neighbors did not answer the door.



They explained City letters neighbors received by mail.

Members of the Advisory Group paired off to knock on doors and spread the word about the opportunity to participate in the free program. They distributed flyers about informational meetings and shared notices about scheduled neighborhood-wide smoke testing. During personal conversations they shared why they care about the program to help reduce wet basements.

WHY SMOKE TEST OUR SEWERS?

The City of Milwaukee Department of Public Works maintains the sewer mains beneath our streets.

Privately owned sewer lateral pipes connect from homes and businesses to these sewer mains.

After we flush the toilet or run the sink or shower, gravity draws this sanitary wastewater down into these pipes. This wastewater flows all the way down into collector sewers owned by MMSD. It is then routed to one of two wastewater treatment plants serving metro Milwaukee: Jones Island and South Shore. Wastewater there is treated and clean water released to Lake Michigan.

The older core of the system is the combined sewer, where what is flushed into sanitary sewers combines with stormwater running off from the streets. All of that water is treated as wastewater.

But much of the system is separated. That means water going down storm drains here finds its way through storm sewer pipes to the nearest river or stream. It is not treated.

Water flowing through sanitary sewers is meant to be separated from storm sewers and groundwater. Inflow from improper pipe connections and infiltration from leaky or aging pipes can add more clear water into the sanitary sewer system.



The Separated Sewer Area within the City of Milwaukee is shown in green. The system here is designed to separate sanitary sewers and storm sewers. This is the primary target for PPII work. This figure is generalized from mapped boundaries.

During heavy rains, all this water causes problems. Extra water in the sewer system can trigger sewage overflows. In people's homes, it can back up into basements through floor drains, overflowing toilets, or other pathways.

The Department of Public Works performs Smoke Tests



The City of Milwaukee Department of Public Works crew conducted smoke testing for about 200 neighborhood properties in Grasslyn Manor in 2025.



Crews arrive in City vehicles and place cones in roadways.



They identify and remove sanitary sewer manhole covers.



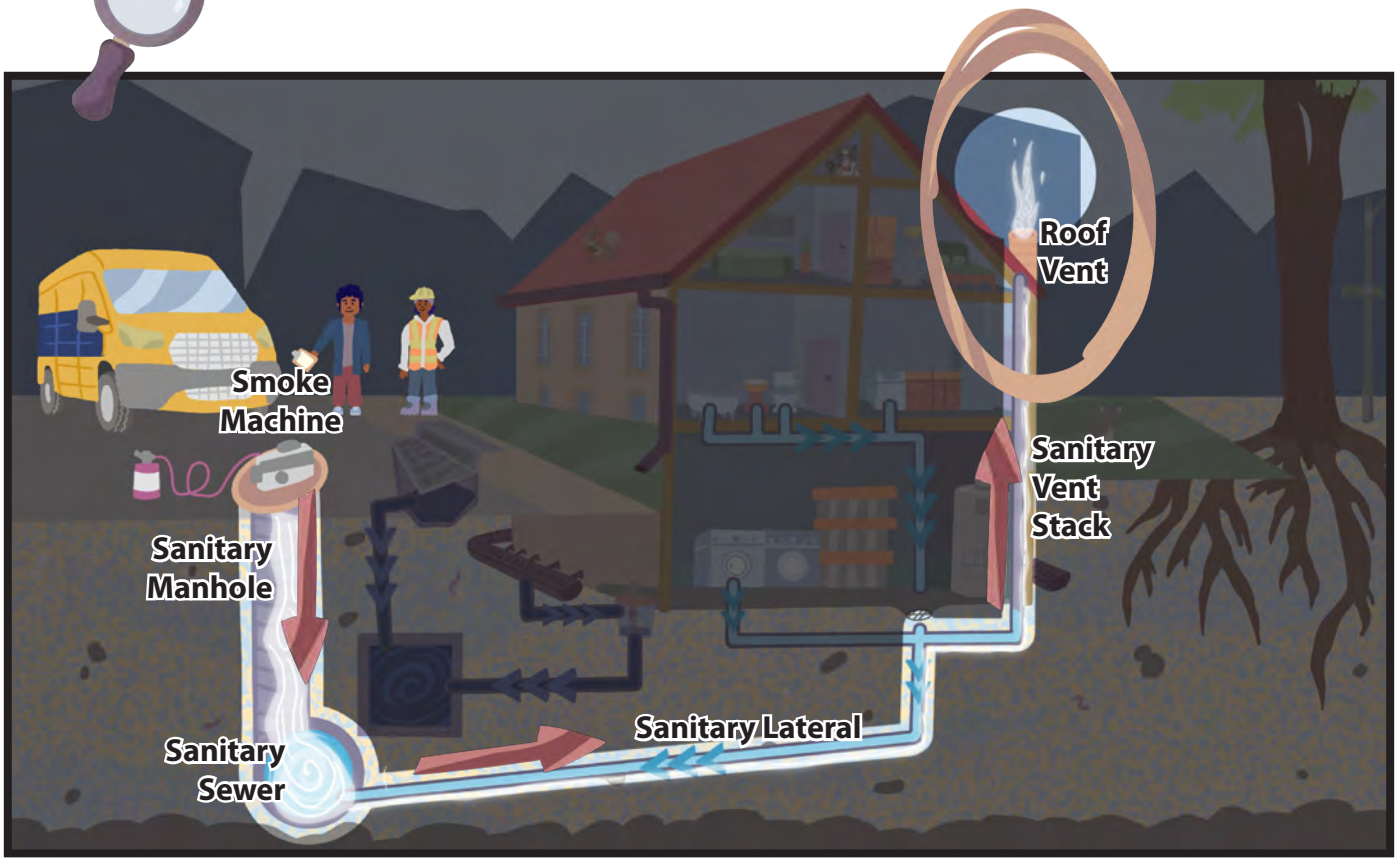
Then they activate the smoke machine atop the open manhole.

Smoke testing is one way to discover improper connections that might add water to the sanitary sewer system.

Prior to the smoke testing, City crews prepare by taking water samples from local storm sewers. They send these to the lab for testing. They call this Stormwater Testing. If they find bacteria associated with human sewage in storm sewers — which should be separated from sanitary sewers — it gives crews a heads-up where in the neighborhood they might expect improper pipe connections during the smoke test.

With that info, they are ready for smoke testing. City crews systematically direct harmless smoke down manholes into sanitary sewers and fan out through the neighborhood to see where it comes up at different homes.

HOW WE SMOKE TEST OUR SEWERS



Smoke testing is a way to identify homes that may have improper pipe connections between sanitary and storm sewers.

Smoke goes down the sanitary manhole and pushes backwards up through the pipes. It should come up through home sanitary vent stacks.



One crew member operates the smoke machine for each area.



Other crew members observe and document homes on their work list.

The Department of Public Works performs Smoke Tests



Smoke from the roof vent means this home's plumbing is properly connected to the sanitary sewer.

The Smoke Test provides important evidence to track down invisible pipe problems that can lead to wet basements. It flags the biggest likely culprits.

But passing the Smoke Test does not necessarily mean underground plumbing is working perfectly. And a failed Smoke Test does not tell precisely what or where problems are.

Smoke Tests have the advantage of City crews not having to enter a home. They can be done outside. City crews send notice to neighbors they will be walking across people's yards looking for signs of smoke. The fire department is also notified in case anyone sees the harmless smoke and calls for help.

Crews look for smoke coming from roof vents — this means the sanitary sewer is properly connected to the house plumbing.

The absence of smoke signals the need for further investigation. Smoke seen from a gutter, storm sewer, or the ground signals an improper connection.

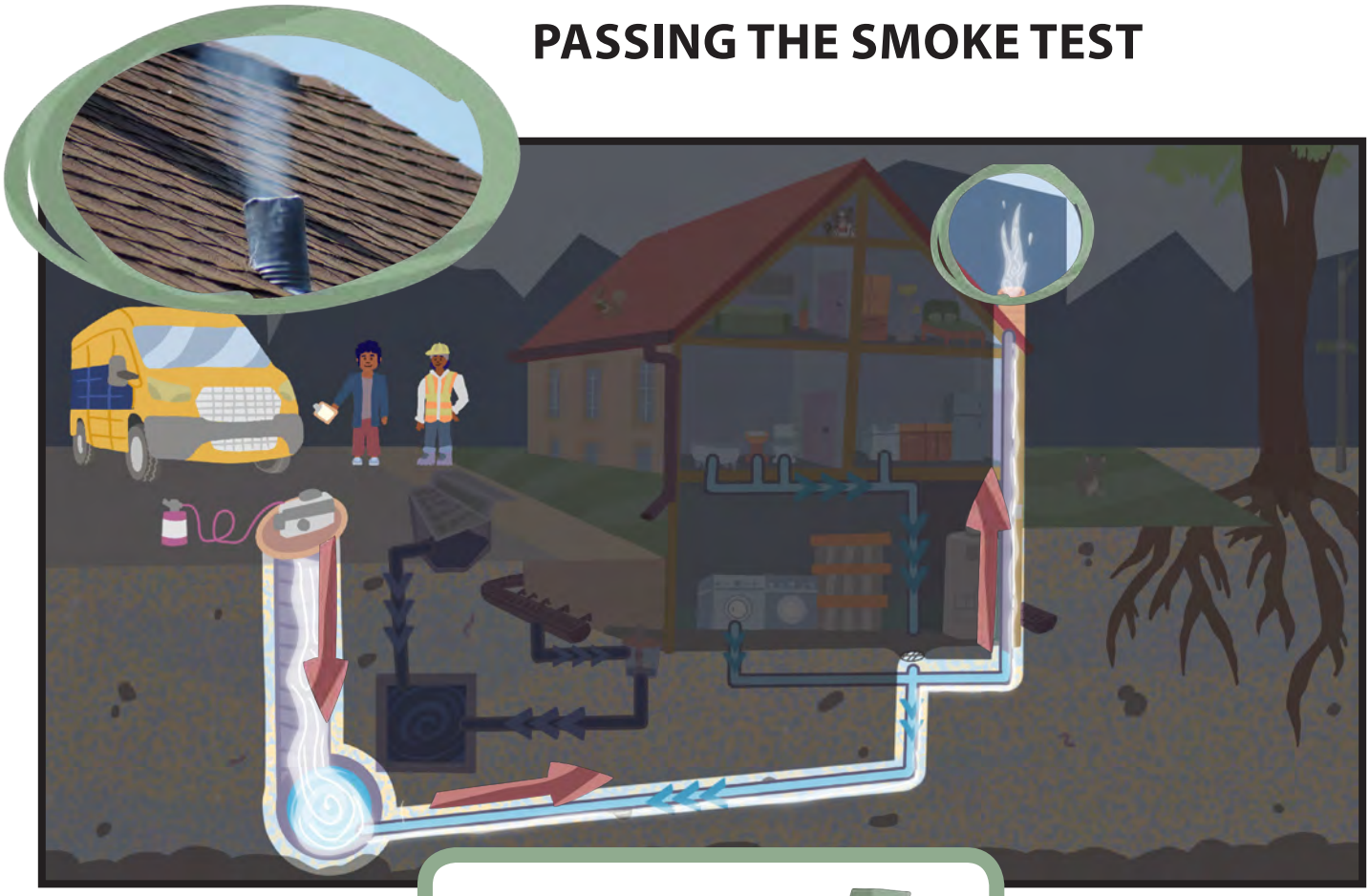


They record where they see smoke on their assigned blocks.



They also note other observations that could impact how water flows.

PASSING THE SMOKE TEST



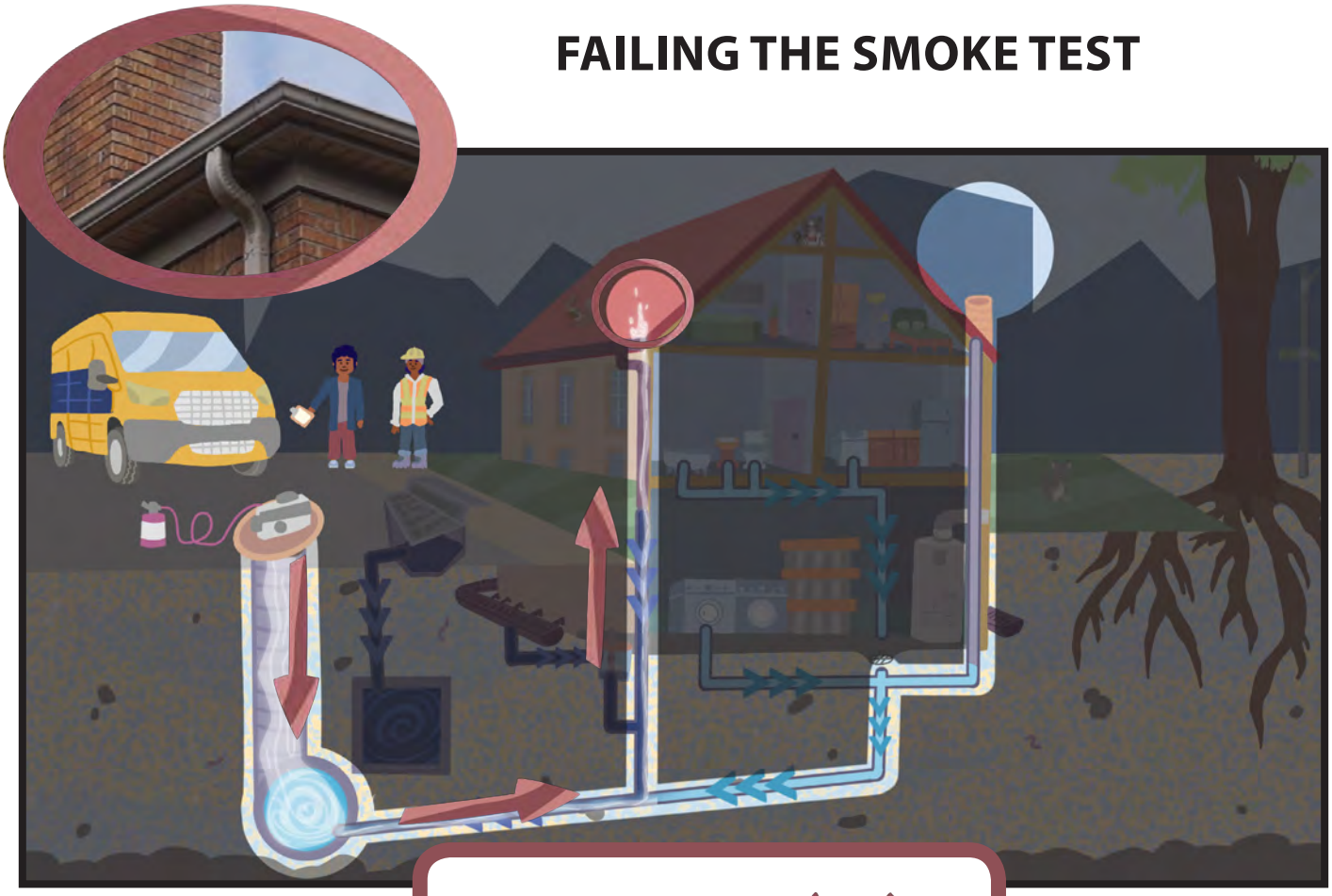


REPORT

- **Observation 1: Smoke is seen from roof stack**
- **Observation 2: Smoke is <u>not</u> seen from gutter**
- **Result: "Pass" – Sanitary lateral is connected to sanitary sewer**



FAILING THE SMOKE TEST



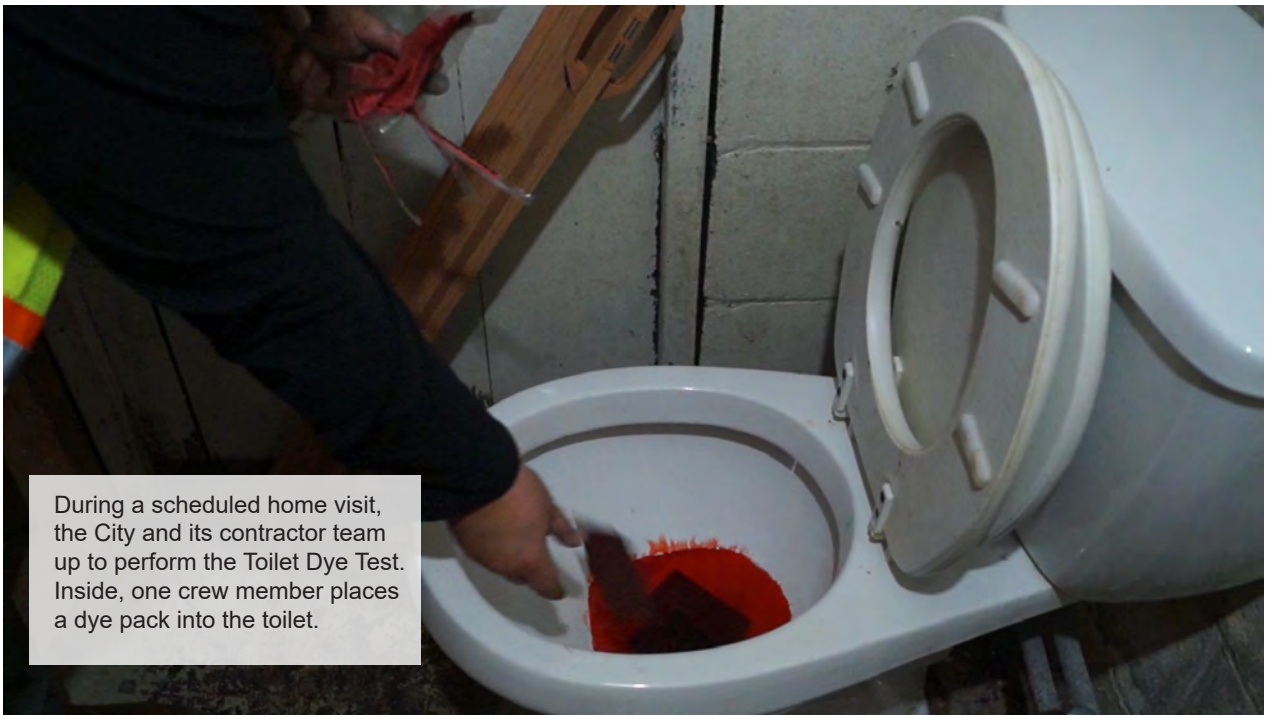
REPORT

- **Observation 1: Smoke is not seen from roof stack**
- **Observation 2: Smoke <u>is seen</u> from gutter and may be seen in the home**
- **Result: "Fail" – Gutter is improperly connected to sanitary sewer**





TOILET DYE TEST TRACKS SANITARY FLOW



During a scheduled home visit, the City and its contractor team up to perform the Toilet Dye Test. Inside, one crew member places a dye pack into the toilet.

Once external evidence is collected from the neighborhood investigations, the next step requires entering homes with property owner permission. Residents sign up to schedule home visits by the City and its contractor.

Tests conducted during this phase include the Toilet Dye Test, the Clear Water Checklist, and later the Downspout Dye Test.

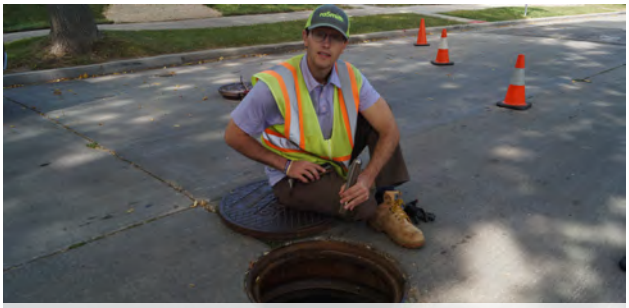
The Toilet Dye Test tracks where water goes when you flush the toilet. During a scheduled home visit, one crew member places dye packets into the toilet, then runs the water to flush the dye down the drain. Meanwhile, another crew member is in the street. With both storm sewer and sanitary sewer manholes open, they look to see where the dye shows up.

Outside, a crew member is in the street.



They open both storm and sanitary manholes.





Observations are communicated by text message.



A flashlight illuminates the sewer below.

This view looks down a sanitary sewer manhole. Flow from the Toilet Dye Test is expected to reach the main sanitary sewer beneath the street in about five minutes. Here, you can see the laterals contributing to the sewer main at right angles.



TOILET DYE TEST TRACKS SANITARY FLOW

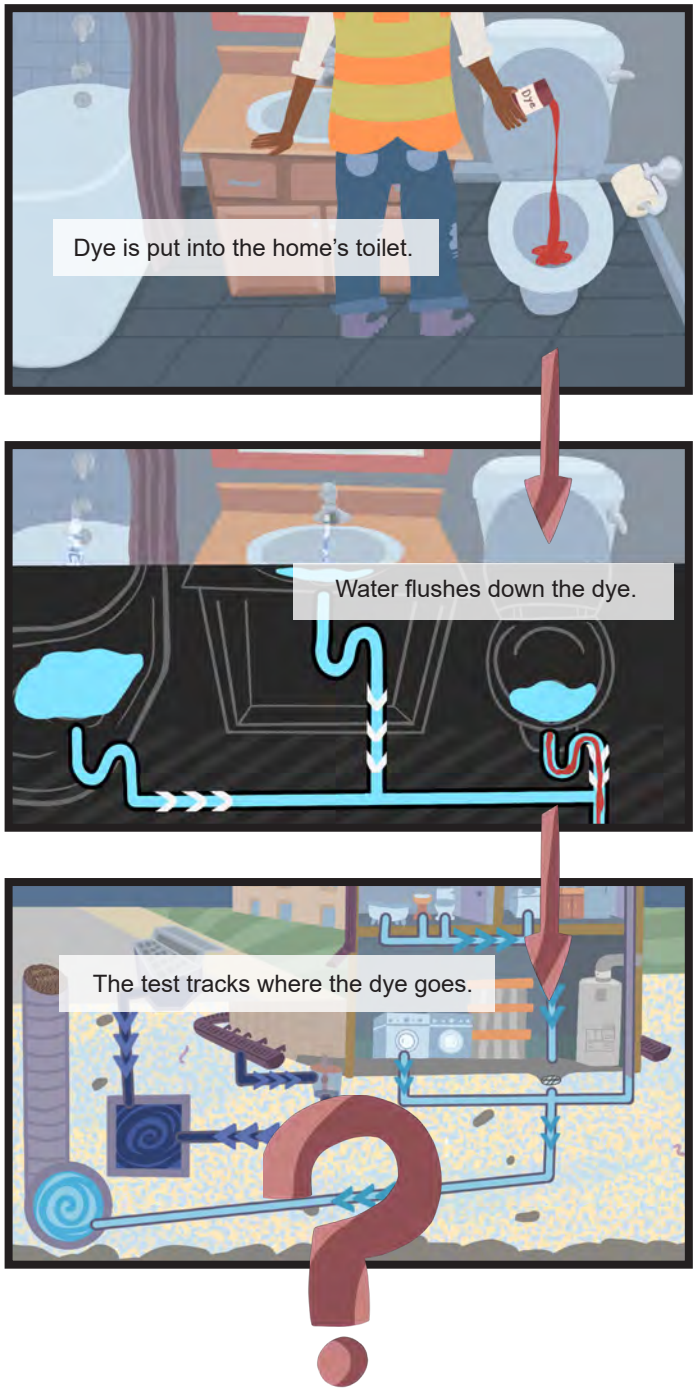
Pouring a vividly colored dye into the toilet or other fixture allows investigators to trace where that water flows. This is a test for an improper connection into storm pipes or problems with the sanitary lateral.

At the same time dye is flushed through the toilet, investigators open the nearby sewer manholes.

Toilet water should show up in the sanitary sewer. If the dye does not show up, there may be a problem.

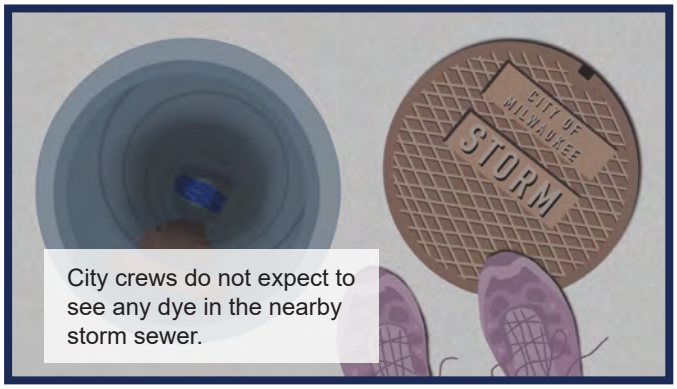
If dye appears in the storm sewer, this shows that the home's sanitary lateral is improperly connected to the storm sewer or another plumbing problem.

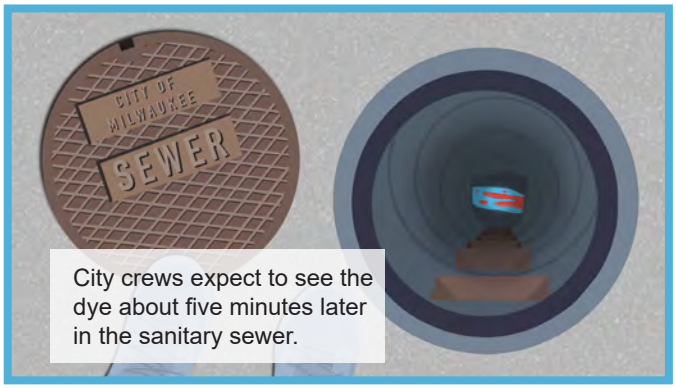




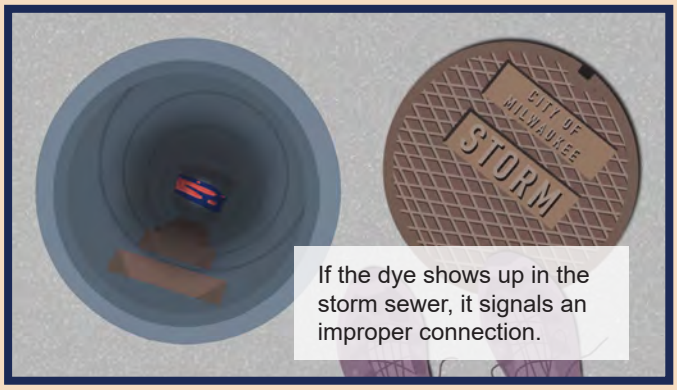


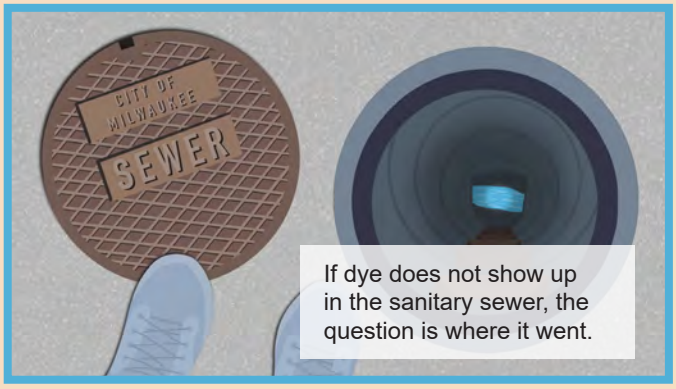
EXPECTED OBSERVATIONS FOR TOILET DYE TEST





OBSERVATIONS THAT SIGNAL A PROBLEM



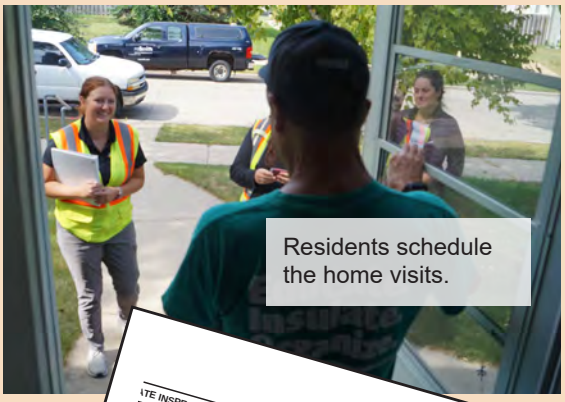


HOME VISITS: CLEAR WATER CHECKLIST

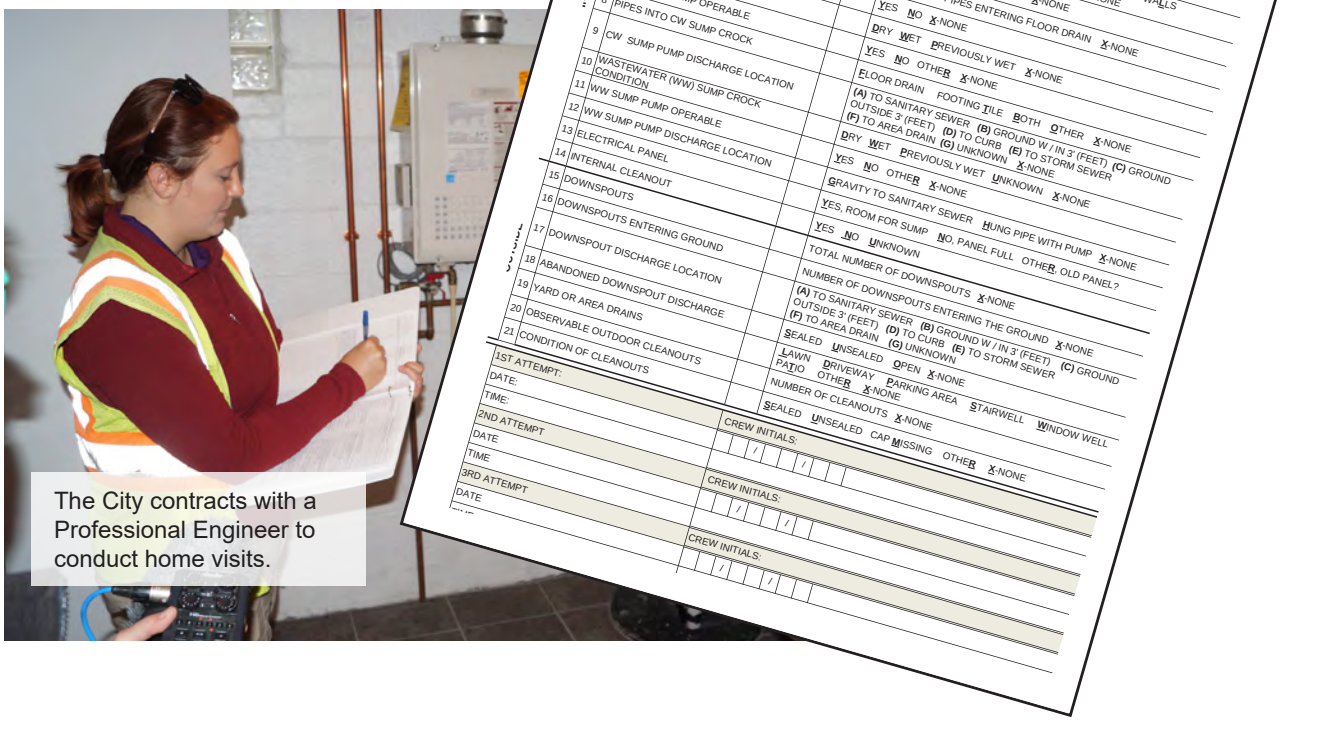
The Clear Water Checklist is a home inspection done at the same time as the Toilet Dye Test.

<u>It is important to note that crews inside the home are not looking for code violations or anything that would result in fines to residents. They are not empowered to do so.</u>

They look at the basement plumbing and in the yard. They check connections to the floor drain, the sump pump (if there is one), backflow preventer (if there is one), foundation drain (if there is one), storm downspouts, sanitary cleanout, and the electrical panel.

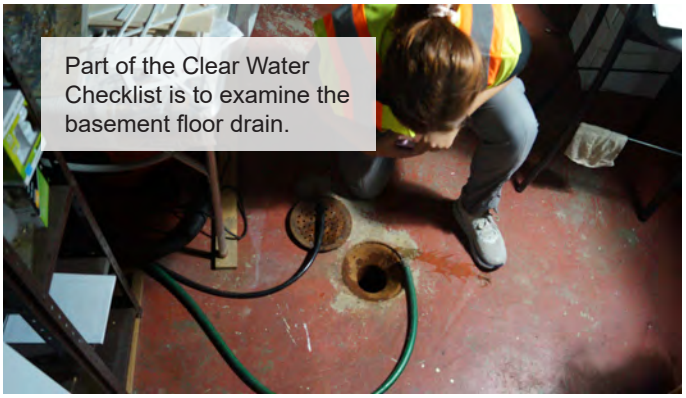


Residents schedule the home visits.

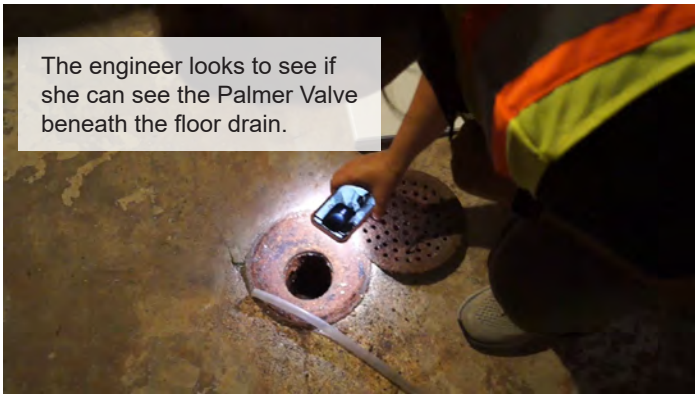


The City contracts with a Professional Engineer to conduct home visits.

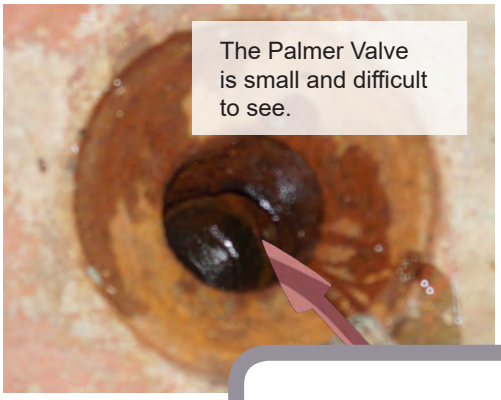
CHECKING FOR THE PALMER VALVE



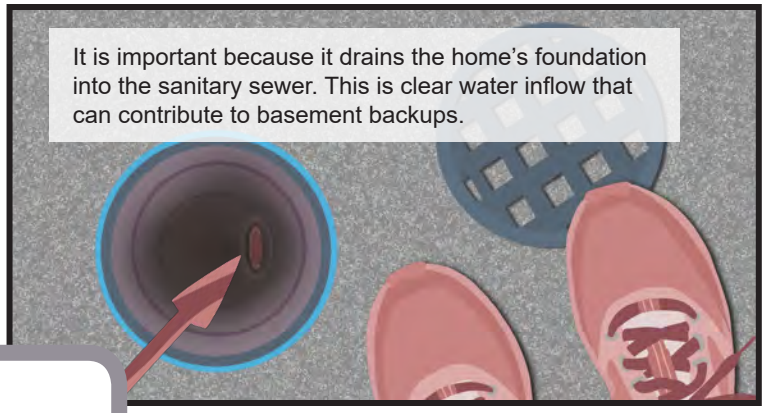
Part of the Clear Water Checklist is to examine the basement floor drain.



The engineer looks to see if she can see the Palmer Valve beneath the floor drain.

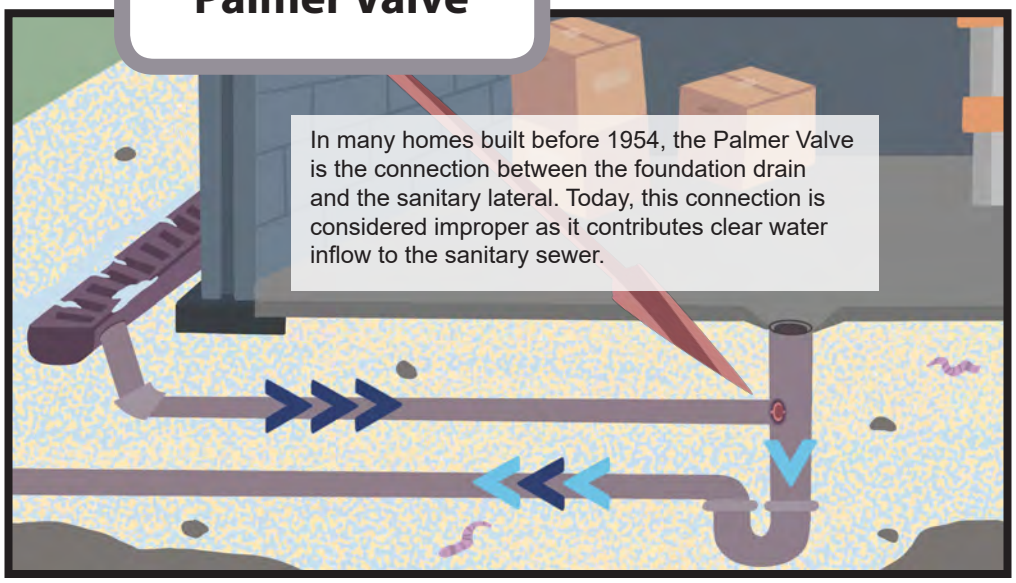


The Palmer Valve is small and difficult to see.



It is important because it drains the home's foundation into the sanitary sewer. This is clear water inflow that can contribute to basement backups.

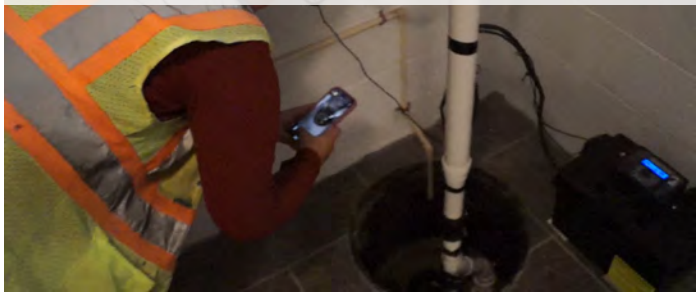
Palmer Valve



In many homes built before 1954, the Palmer Valve is the connection between the foundation drain and the sanitary lateral. Today, this connection is considered improper as it contributes clear water inflow to the sanitary sewer.

CHECKING THE SUMP PUMP

If a home has a sump pump, its job is to move clear water from the ground up and away from the foundation.



The Clear Water Checklist considers the sump pump's function, and tries to identify its inflows and outflows.



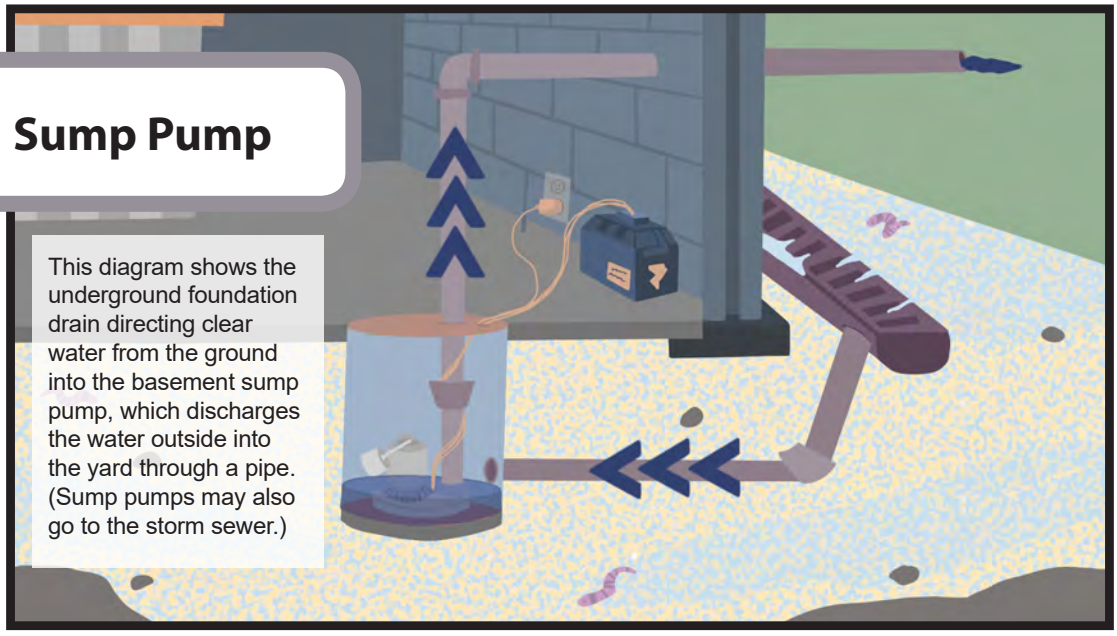
If the power goes out during a storm, the sump pump will stop working unless it has a good battery backup.



The Clear Water Checklist identifies where the sump pump outflows. It should not go to the sanitary sewer.

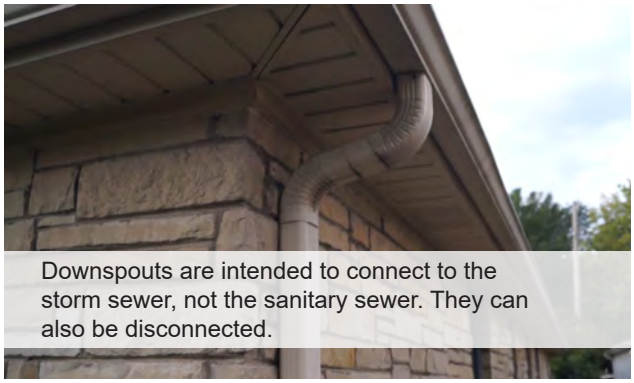


Sump Pump



This diagram shows the underground foundation drain directing clear water from the ground into the basement sump pump, which discharges the water outside into the yard through a pipe. (Sump pumps may also go to the storm sewer.)

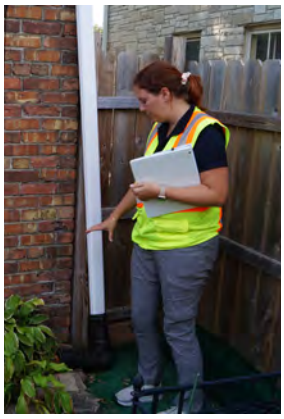
CHECKING THE DOWNSPOUTS



Downspouts are intended to connect to the storm sewer, not the sanitary sewer. They can also be disconnected.



The Clear Water Checklist takes an inventory of the home's downspout locations and information about where each outflows.



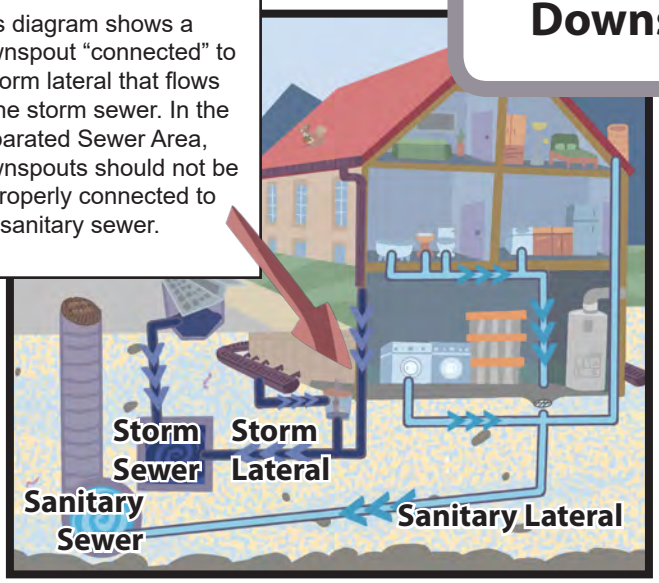
These downspouts are connected to a sewer.

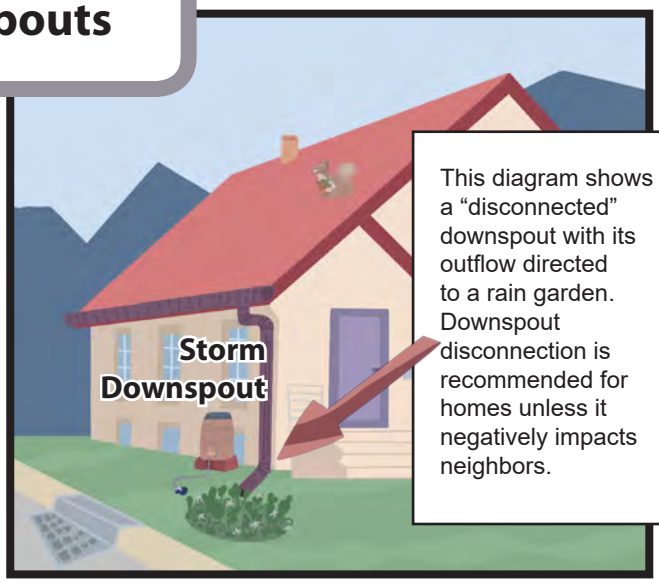
More testing is needed to understand if they properly connect to the storm sewer or improperly connect to the sanitary sewer.



Downspouts

This diagram shows a downspout "connected" to a storm lateral that flows to the storm sewer. In the Separated Sewer Area, downspouts should not be improperly connected to the sanitary sewer.





This diagram shows a "disconnected" downspout with its outflow directed to a rain garden. Downspout disconnection is recommended for homes unless it negatively impacts neighbors.

DOWNSPOUT DYE TEST TRACKS STORM FLOW

The Downspout Dye Test uses dye to see where water flowing down a home's downspout ends up.

Dye washed down a connected rain gutter downspout should flow to the nearby storm sewer (in the Separated Sewer Area). If dye shows up in the nearby sanitary sewer instead, there is a problem. That downspout may be improperly connected — contributing inflow — or the sanitary lateral may be compromised due to damage or age — allowing infiltration.

To investigate, City crews lower a robotic camera into the sanitary sewer under the street. Other crew members go outside from house to house with a hose from a water truck filled with vivid dye. They find where to access each downspout. This may be into the rain gutter or at the ground level where downspouts connect to piping below.

If a home has already disconnected its rain gutters, crews may need to remove concrete seals to access the old connections to get dye down into the former drain pipes. This simulates clear water in the ground, like during a storm.

Meanwhile, the robotic camera waits and watches where each lateral connects with the main sanitary sewer.

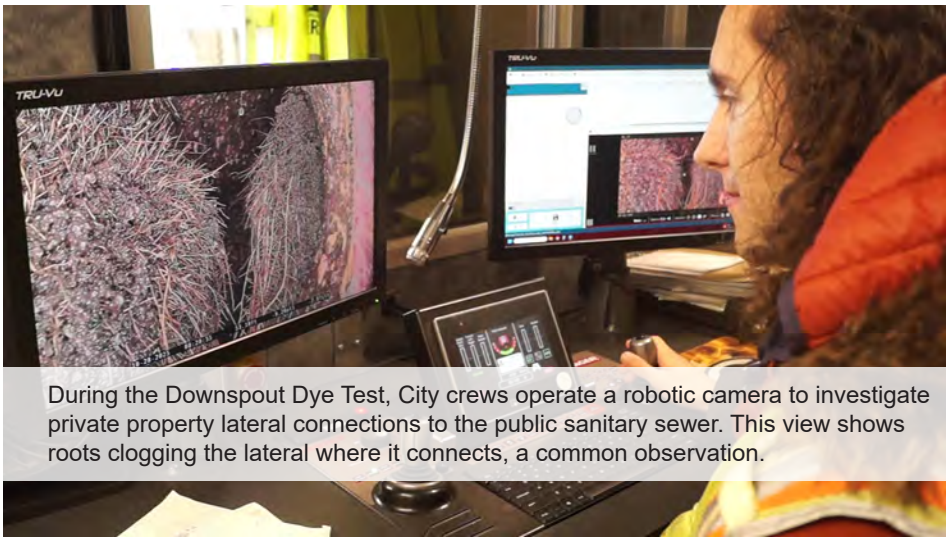

Dye is put into the downspout.


Dye flows down the gutter.

After running the dye water for five minutes, if crews do not see dye enter the sanitary sewer, that private lateral passes the test. If dye does enter the sanitary sewer, that private lateral fails the test. Failure indicates the property is a candidate for lateral replacement or downspout disconnection.

Whether a lateral passes or fails, a common observation is tree roots or debris clogging the lateral, especially in older pipes. Tree roots may block the flow of water or allow clear water into pipes. This is another problem homeowners may want to address.

What does a Downspout Dye Test tell us?

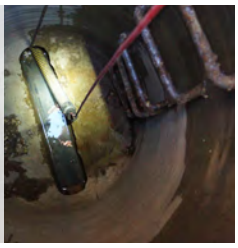


During the Downspout Dye Test, City crews operate a robotic camera to investigate private property lateral connections to the public sanitary sewer. This view shows roots clogging the lateral where it connects, a common observation.



The robotic camera.

The robotic camera is tethered into the sanitary sewer via the manhole.



A hose from a water truck adds dye water into the downspout pipe. It may overflow as the water makes its way down through pipes clogged with debris.

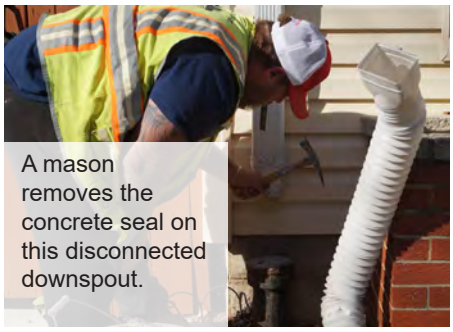




This view from the robotic camera shows green dye entering the sanitary sewer from a private lateral during a Downspout Dye Test failure.



The hose can go into the rain gutter.



A mason removes the concrete seal on this disconnected downspout.



After the test, the concrete seal is replaced.



The hose may also go into the pipe in the ground.

PUBLICLY FUNDED SOLUTIONS

Based on the testing results and the best available knowledge, City of Milwaukee Department of Public Works staff will write recommendations for each home in the program. These recommendations are delivered to each participating homeowner based on their specific test results and observations.

The City and partners encourage residents to participate in the PPII Testing phases because it is the necessary first step to identify the solutions needed that are fully funded through the program.

In 2025, the City of Milwaukee conducted its first targeted neighborhood investigations phase in the Grasslyn Manor neighborhood near 56th and Capitol Drive.

In 2026, the City is expecting to fund its first year of projects based on the investigations. The 2026 budget for solutions is set by the problems identified in the 2025 investigations.

Beyond this program, MMSD invites individual homeowners to explore its Pipe Check program, which offers some funds for homeowners to pursue their own work.



Grasslyn Manor neighbors serving on the Advisory Group posted yard signs after they participated in PPII Testing.



The recommendations for each homeowner will be different based on their test results. Actions to reduce inflow and infiltration are intended to reduce basement backups throughout targeted neighborhoods.

Recommended solutions to inflow & infiltration are zero cost to homeowners.

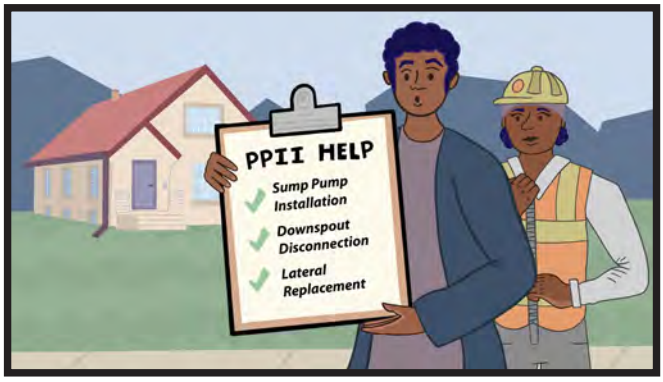
TESTING PARTICIPANTS OFFERED FREE HELP

Recommendations will vary based on specific circumstances. The program currently covers the following activities:

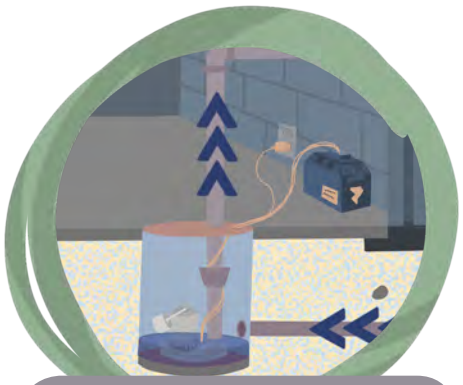
- ***Sump Pump Installation***
- ***Downspout Disconnection***
- ***Sanitary Lateral Replacement***

If testing shows that a private property has a foundation drain connected to the sanitary sewer, then that home may be eligible for the disconnection of its foundation drain and installation of a sump pump. The work takes about one day and occurs in the basement, including excavation of a sump crock.

If testing shows that downspouts are improperly connected to the sanitary sewer, then that home may be eligible for downspout disconnection.



If testing shows that a storm or sanitary lateral is contributing inflow or infiltration to the sanitary sewer, then that home may be eligible for sanitary lateral replacement. The work takes about one day using a method that involves minimal disruption to the yard. Work occurs mainly in the basement as a new lateral is inserted underground from the home's sanitary cleanout.



Sump Pump Installation



Downspout Disconnection



Sanitary Lateral Replacement

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Fall 2025

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