

CIPP chemical emissions, environmental significance, occupational and public exposure hazards, plumbing traps, air testing



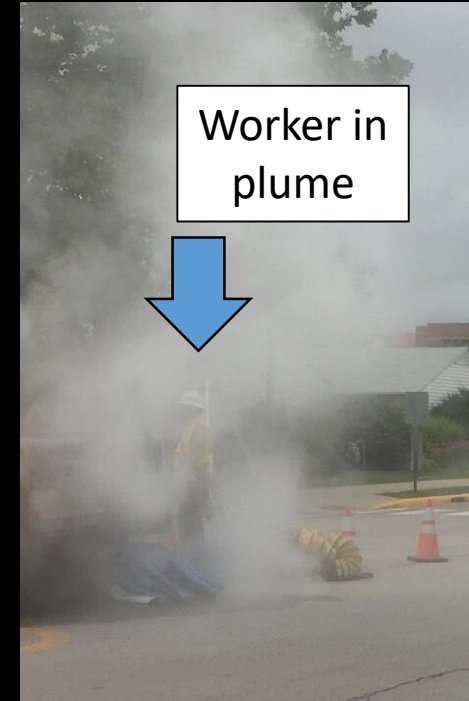
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Visit www.CIPPSafety.org for more information



March 16, 2020

Interactive Government Agency Discussion Meeting:
Sewer Vapor Intrusion and Sewer Repair

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Worker in
plume

Investigating CIPP safety was not an initial focus of our 2016 work, but became a priority when we discovered problems

Teimouri et al. 2017. Worksite Chemical Air Emissions and Worker Exposure during Sanitary Sewer and Stormwater Pipe Rehabilitation Using Cured-in-Place-Pipe (CIPP). OPEN ACCESS. *Env. Sci. Technol. Letters*. <https://doi.org/10.1021/acs.estlett.7b00237>

2005,
The Netherlands
public health
agency (RIVM)
finds styrene in
sewer air
unchanged 0.6
miles downstream

2012,
Consultant: CIPP
chemicals
traveled
“kilometers from
the worksite”
aboveground

2017,
Worksite safety
study shows white
chemical plume at
steam-CIPP sites is
not steam, Worker
and public safety
upgrades needed

2017,
22-yr old CIPP
worker dies on
worksite,
investigation finds
chemical exposure
a contributing
factor

2019,
NIOSH finds
styrene
exposure limit
exceeded at a
CIPP worksite.
Advice
provided.

2019,
Field study shows
100+ air
contamination
incidents, 100+
chemicals found,
Worker and
public safety
upgrades needed

2005,
US ATSDR finds
that CIPP office
building
contaminated
caused a
'public health
hazard'

2006,
The Netherlands
RIVM recommends
all sites have air
monitoring and a
fan installed to
expel chemicals for
at least 24h after
CIPP installation

2017,
California
Department of
Public Health
issues 1st
statewide CIPP
Safety Alert

2017,
California
Department of
Public Health
issues 2nd
statewide CIPP
safety warning

2018,
Environmental
impact critical
review shows a
history of CIPP
associated water
contamination,
spec upgrades
needed

2018,
Environmental
impact field
study shows
CIPP water
contamination,
spec upgrades
needed

2019,
Toxicology study
indicates
potential for
human health
effects. Should
consider not just
styrene and long-
term impacts like
cancer.

There have been 130+ CIPP related chemical exposures in 30 States (that we know about, often unreported)

Buildings Affected

Schools

Homes

Offices

California

Colorado

Connecticut

Florida

Georgia

Hawaii

Illinois

Indiana

Iowa

Kansas

Kentucky

Maryland

Massachusetts

Minnesota

Mississippi

Missouri

Montana

Nebraska

New Jersey

New York

North

Carolina

Ohio

Oregon

Pennsylvania

Tennessee

Texas

Vermont

Virginia

Washington

Wisconsin

Since December 2019, we have been contacted about several new incidents in Illinois, Florida, Pennsylvania

Cancer Care Center of Decatur evacuates due to odor caused by city sewer project

Illinois: Feb 20, 2020

Nathan Hale Middle School evacuated due to construction odor

Connecticut: Dec 16, 2019

City Work Leaves a Bitter Taste For Wicker Park Bakery, Area Residents

Illinois: Jan 16, 2020

Illnesses cause new policy for Seneca Falls sewer pipe repairs

New York: Oct 4, 2019

Pitcairn Propel Evacuated After Fumes Make Multiple Teachers, Students Nauseous

Pennsylvania: Sept 24, 2019

Fumes Force Evacuation Of City Hall Friday Morning

Tennessee: Dec 14, 2018

Odor from sewer work causes teachers to fall ill at Riverview Elementary School

Washington: Oct 10, 2018

Fumes Sicken 28 Pupils at Zamorano Elementary

California: Sept 21, 2017

INCIDENT LIST: <https://engineering.purdue.edu/CIPPSafety/resources/incidents>

Chemical Exposure Symptoms Reported for Persons Associated with Exposure to the Air and Liquid CIPP Wastes

Headache

Nausea

Vomiting

Loss of consciousness

Eye irritation

Nostrils burning

Dizziness

Shortness of breath

Tightness of chest

Lethargy

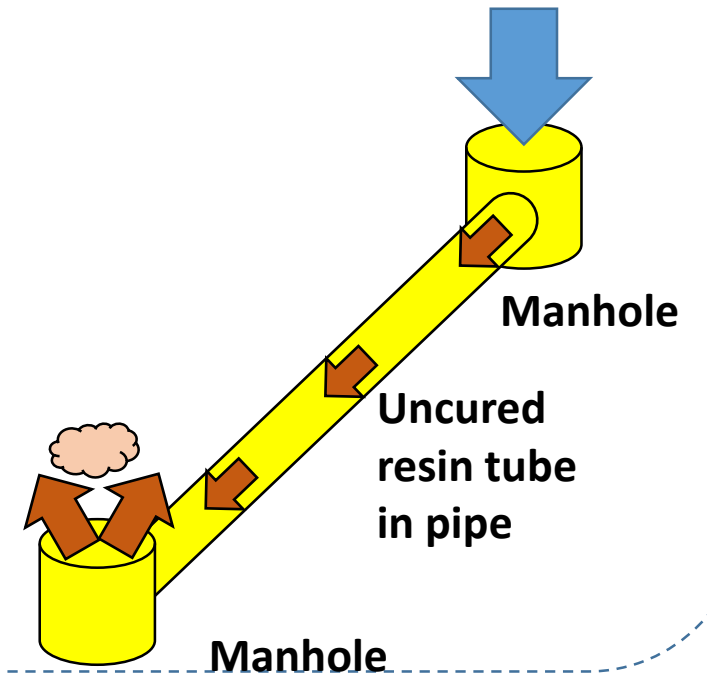
Faint

Gagging

Confusion

Utility/City Property (Worksite only for contractors)

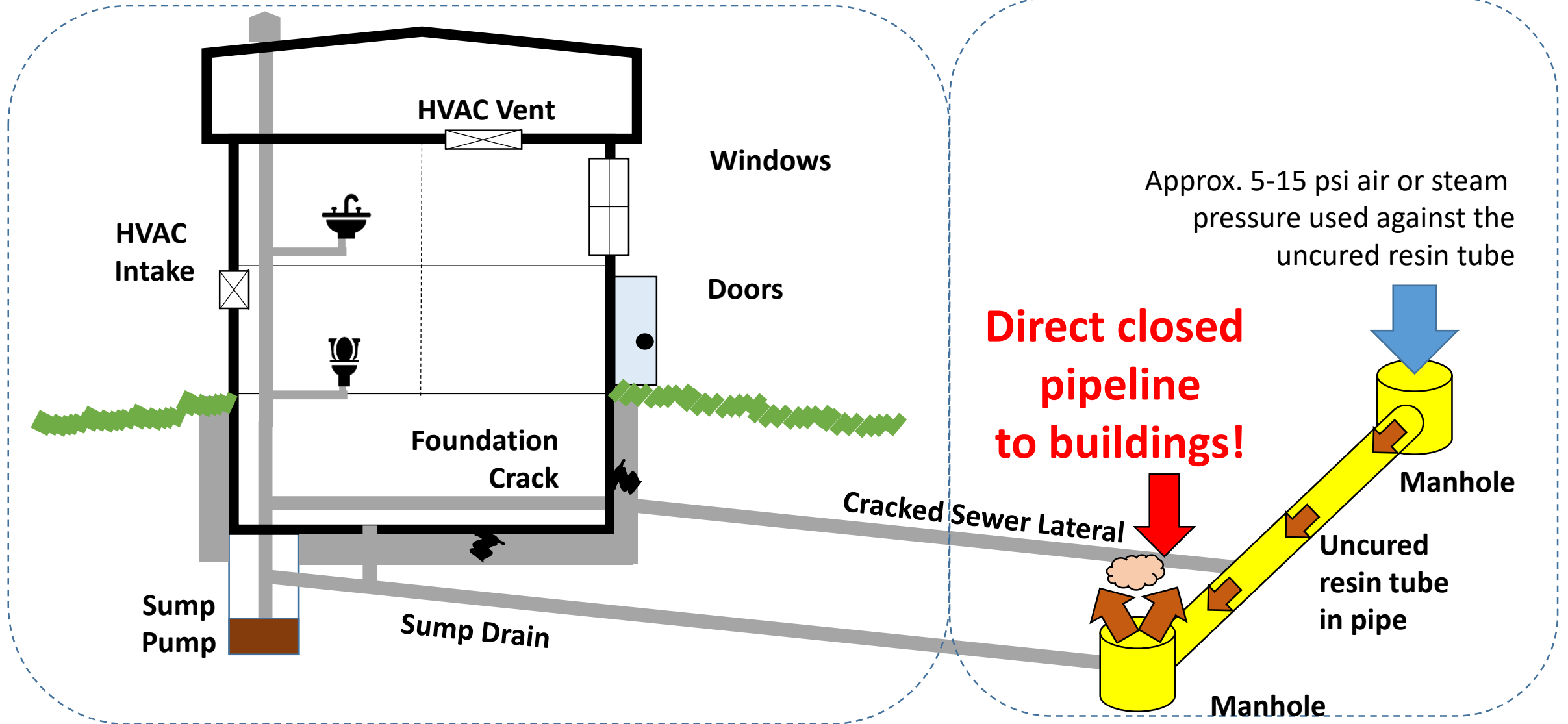
Approx. 5-15 psi air or steam
pressure used against the
uncured resin tube



At the street....

Private Property
(NOT for contractors)

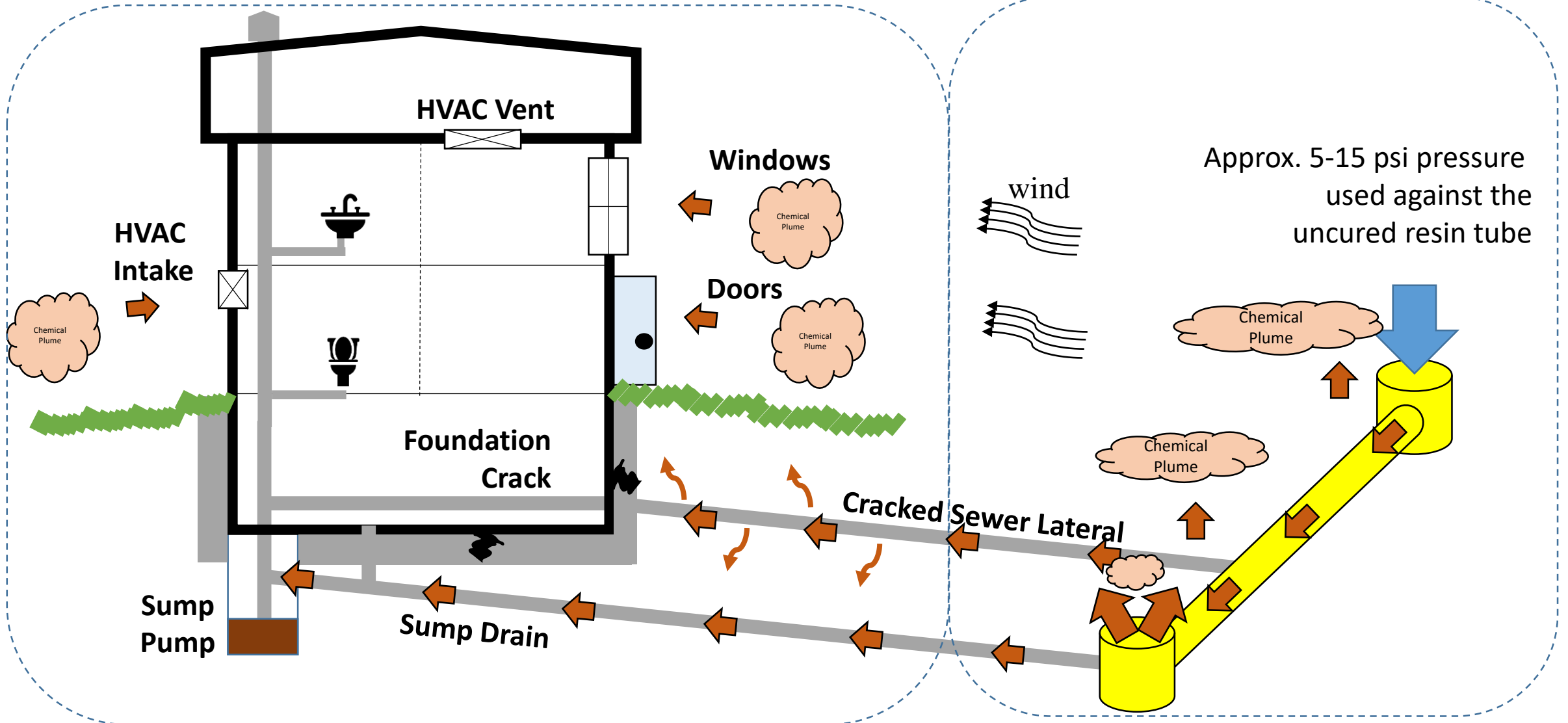
Utility/City Property
(Worksite only for contractors)



While Contractors work at the street....

Private Property
(NOT for contractors)

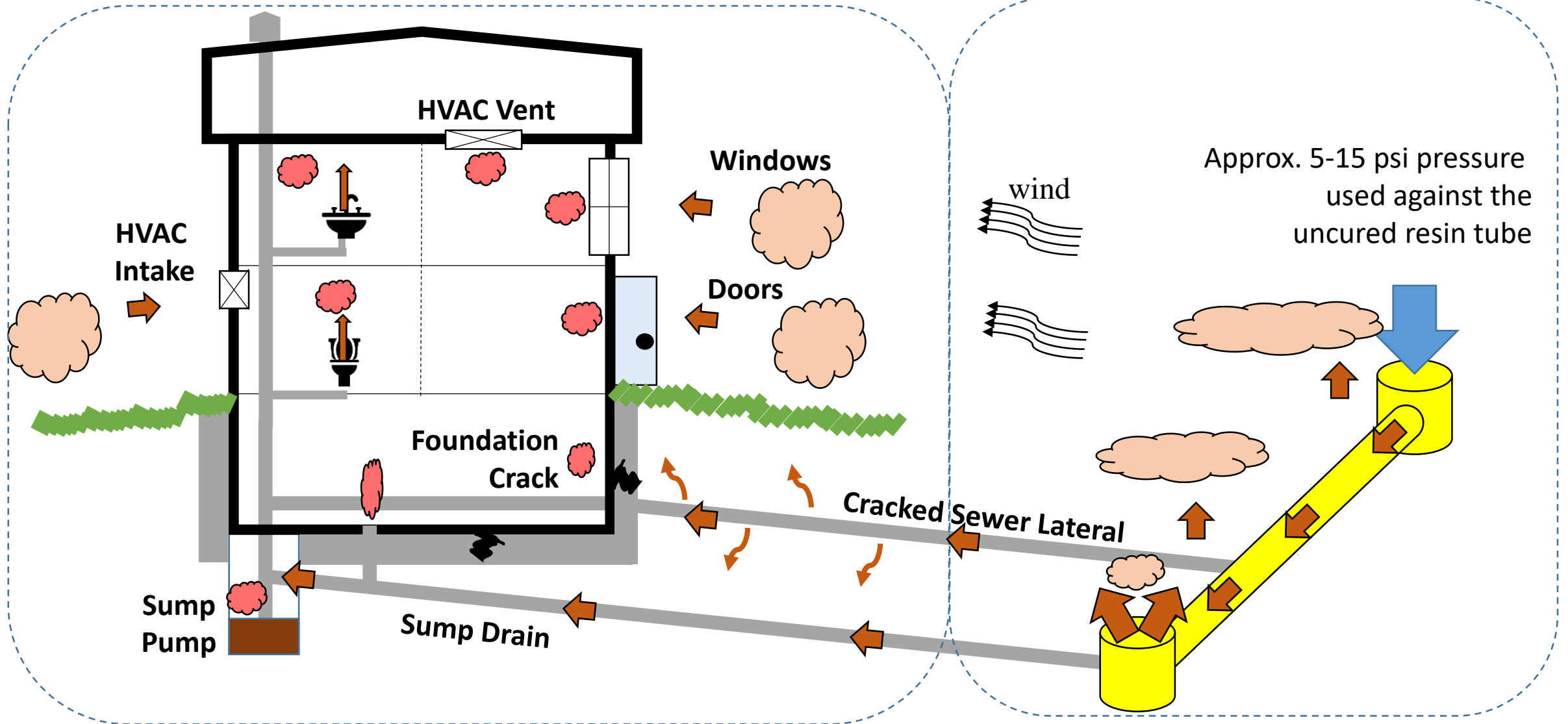
Utility/City Property
(Worksite only for contractors)



Their chemical waste leaves their worksite – traveling above and below ground 9

Private Property
(NOT for contractors)

Utility/City Property
(Worksite only for contractors)



Contractors blow chemical waste into buildings and the environment

News | updated: 10/26/2017 11:28 AM

Worker killed in Streamwood sewer line

Daily Herald



Illuminated by emergency lights and rescue lights, a man reacts after rescue crews pulled the body of a worker from a sewer line on South Park Boulevard in Streamwood Wednesday night.

John Starks | Staff Photographer

October 30, 2016

Reporters: Jake Griffin, Eric Petersen

Photo: John Starks, Daily Herald

22 year old healthy CIPP worker

CIPP was created using steam

After creation, worker entered new CIPP (like others elsewhere)

Victim exposed to 225-275 ppm_v styrene exposure for 4 hours according to post-mortem blood analysis [OSHA]



Layer of
Floating
Organic
Solvents

Emulsion blown
into air:

- Resin
- Water
- Dissolved
VOCs/SVOCs
- Plastic pieces

This is a Multiphase Chemical Mixture, NOT Steam
(particulates, droplets, partially cured resin, etc.)



Since 2018 we have further discovered CIPP associated chemical exposures can be serious

- Material SDSs *do not list* all chemicals of concern released including carcinogens, EDCs, and HAPs
- New chemicals are *created* during CIPP plastic manufacture
- Standard CIPP = Emissions are *-not-* captured. Instead, blown into public spaces, often buildings.
- **Most prior air testing only looked for styrene** in air
 - 1,820+ ppm exiting CIPP liner delivery truck, St. Louis, MO (2019)
 - 86+ ppm & 1+ ppm methylene chloride exiting pipes, Sacramento, CA (2017)
 - 250-1,070 ppm exiting manhole in downtown Los Angeles, CA (2014)
 - 10s-100s ppm exiting pipes, manholes into air for several studies
- **But, non-styrene chemicals are released and can pose risks** [Inhalation Toxicology, Kobos et al. 2019]

If It Was Only Styrene for the General Public

CA OEHHA (2017)
Acute Ref. Exposure
Level = 4.9 ppm

ATSDR (2005)
Acute Level = 2.0 ppm

Odor Threshold
= 0.016 ppm

But it's not just styrene

Several Debunked Safety Claims

“Styrene vapor of at most few ppm” - False

“is not a human health risk” - False

“is safe for people and animals” - False

“it is harmless steam” - False

“no hazardous conditions posed” - False

“don’t be alarmed” - ?

“some people are offended by this odor and are fearful of it; even though the concentrations they smell present no harm”

– If you smell something it may in fact be harmful.



Alexandria, VA

Municipalities and Contractors have issued these statements.

- Don't do it.

2019, *Inhalation Toxicology* study: *In vitro* toxicity assessment of emitted materials collected during the manufacture of water pipe plastic linings, Kobos et al.

<https://www.tandfonline.com/doi/full/10.1080/08958378.2019.1621966>

Study Conclusions

- CIPP emissions likely should not be regulated based on styrene alone and exposure assessments of worksites would benefit from more comprehensive evaluation of emission components
 - Benzaldehyde, Benzoic Acid, Phenol, 1-Tetracecanol were all highest in Site 4 emissions
- Efforts should be made to adequately inform workers and the public regarding emissions as there is a potential for toxicity following inhalation exposure
- Exposures should be minimized and the proper personal protective equipment utilized
- Alterations in operational procedures should further be investigated to mitigate emissions and to understand potential adverse health effects
- Based on our findings future studies should examine cytotoxicity and cell injury, immune responses, fibrosis, and cancer as these were pathways determined to be modified significantly in representative pulmonary cells following exposure

From our review: Some CIPP ingredients (initiators) are designed to react and form new chemicals

Trigonox®

Acetone

Acetophenone

Benzene

Benzoic acid

tert-Amyl alcohol

tert-Butanol

3-*tert*-Butoxyheptane

2-*tert*-Butyloxy-2,4,4-trimethylpentane

Carbon dioxide

3-(1,1-Dimethylpropoxy) heptane

Ethane

2-Ethylhexanoic acid

Heptane

Methane

2-Phenylisopropanol

3,3,5-Trimethylcyclohexanone

Perkadox®

Benzene

Benzoic acid

4-*tert*-Butylcyclohexanone

4-*tert*-Butylcyclohexanol

Carbon dioxide

Diphenyl

Phenylbenzoate

Tetradecanol

N,N-Dimethylaniline

Aniline

Carbon oxides

Nitric oxides

Butanox®

Acetic acid

Carbon dioxide

Formic acid

Propanoic acid

Methyl ethyl ketone

*Many can prompt
inhalation toxicity*

It's NOT just styrene. Many compounds NOT listed on safety data sheets have been found at CIPP worksites and in the air.

Acetone

Acetophenone

Benzaldehyde

Benzene

Benzoic acid

Benzyl alcohol

BHT

2-Butanone (MEK)

tert-Butyl alcohol

tert-Butyl benzene

4-*tert*-Butylcyclohexanone

4-*tert*-Butylcyclohexanol

Chloroform

o-Chlorotoluene

Diallyl phthalate (DAP)

Dibutyl phthalate (DBP)

Diethyl phthalate (DEP)

Di(2-ethylhexyl) phthalate (DEHP)

4-(1,1-Dimethyl) cyclohexanol

4-(1,1-Dimethyl) cyclohexanone

1-Dodecanol

Ethylbenzene

3-Heptanol

Isopropylbenzene

p-Isopropyltoluene

Methylene chloride

N-Propylbenzene

Styrene

Phenol

1-Tetradecanol

Tripropylene glycol diacrylate

Toluene

1,2,4-Trimethylbenzene

1,3,5-Trimethylbenzene

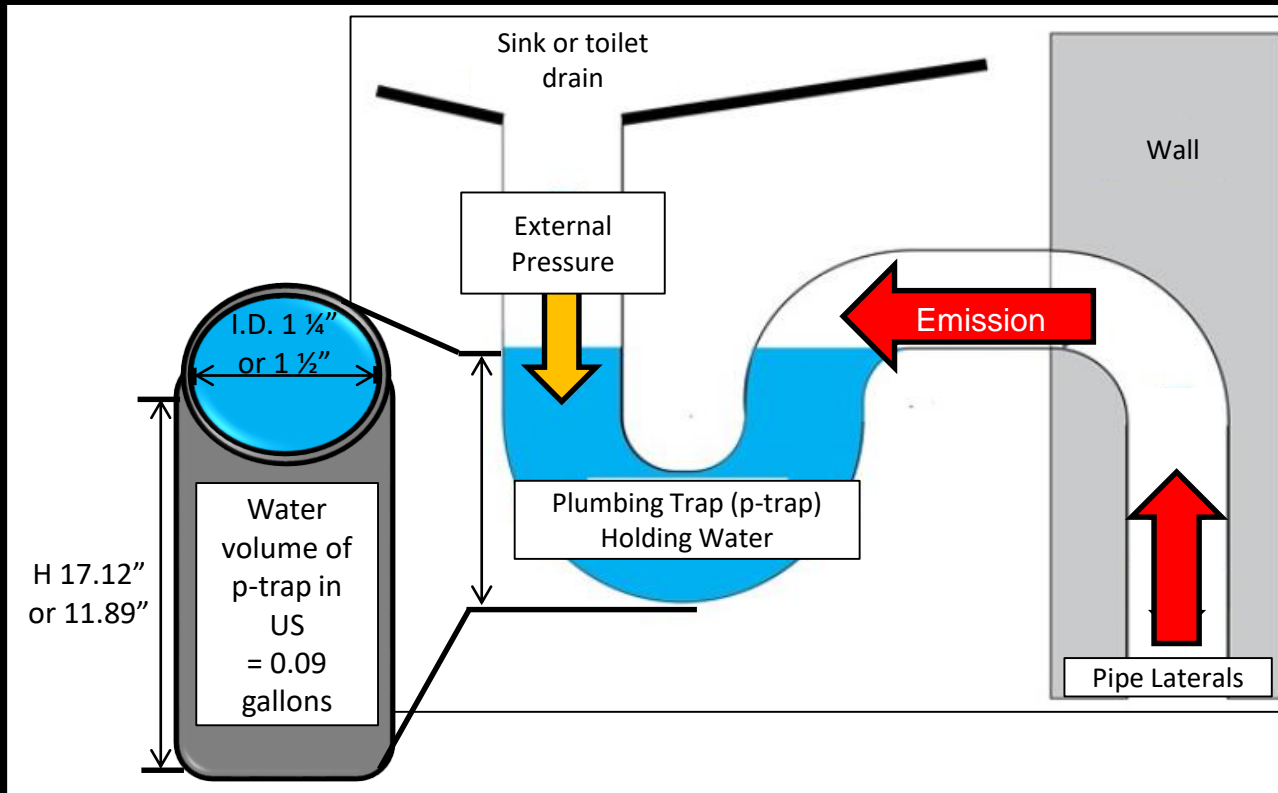
Xylene (total)

And more...

Analytical Issue:

NIOSH (2019) and Purdue (2019) studies found that very high styrene level prevented our abilities to detect and quantify the other chemicals in air.

Pouring water in drains does not prevent exposure during CIPP manufacture



Less than 1 psi pressure
can cause water blowback in an
average plumbing trap (p-trap)

CIPP contractors use
5-15 psi pressure at street

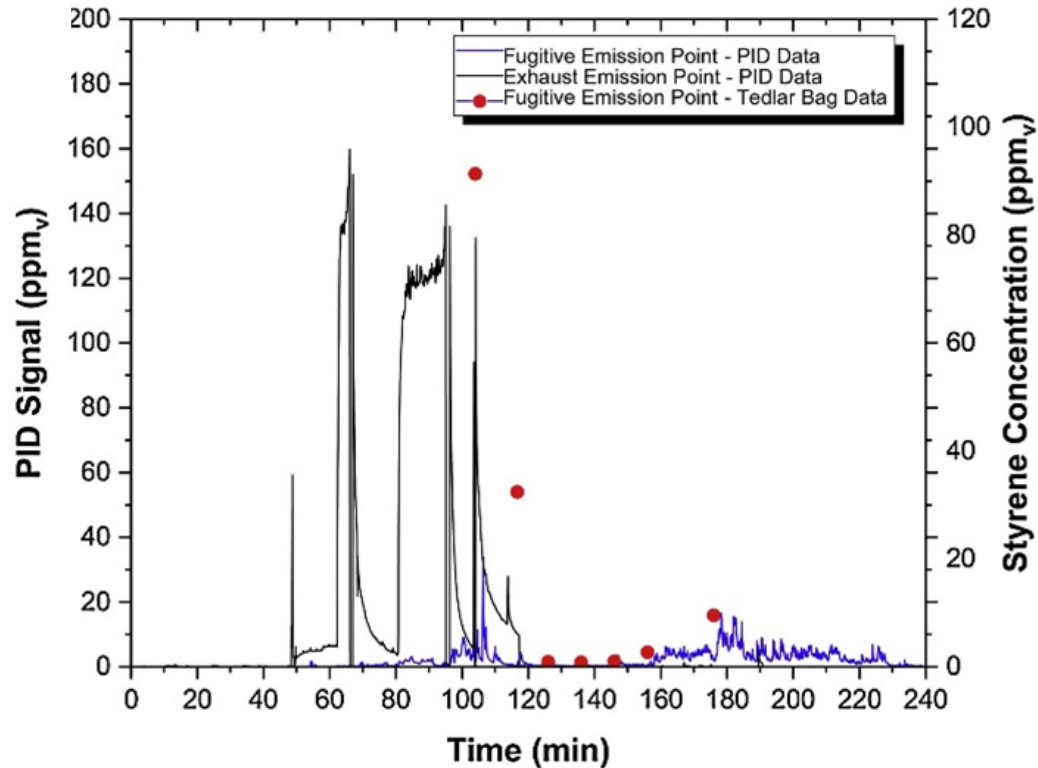
Contractors also have said/say:

- 1) Put a towel in the drains
- 2) Wrap toilet with towel
- 3) Wrap toilet with saran wrap

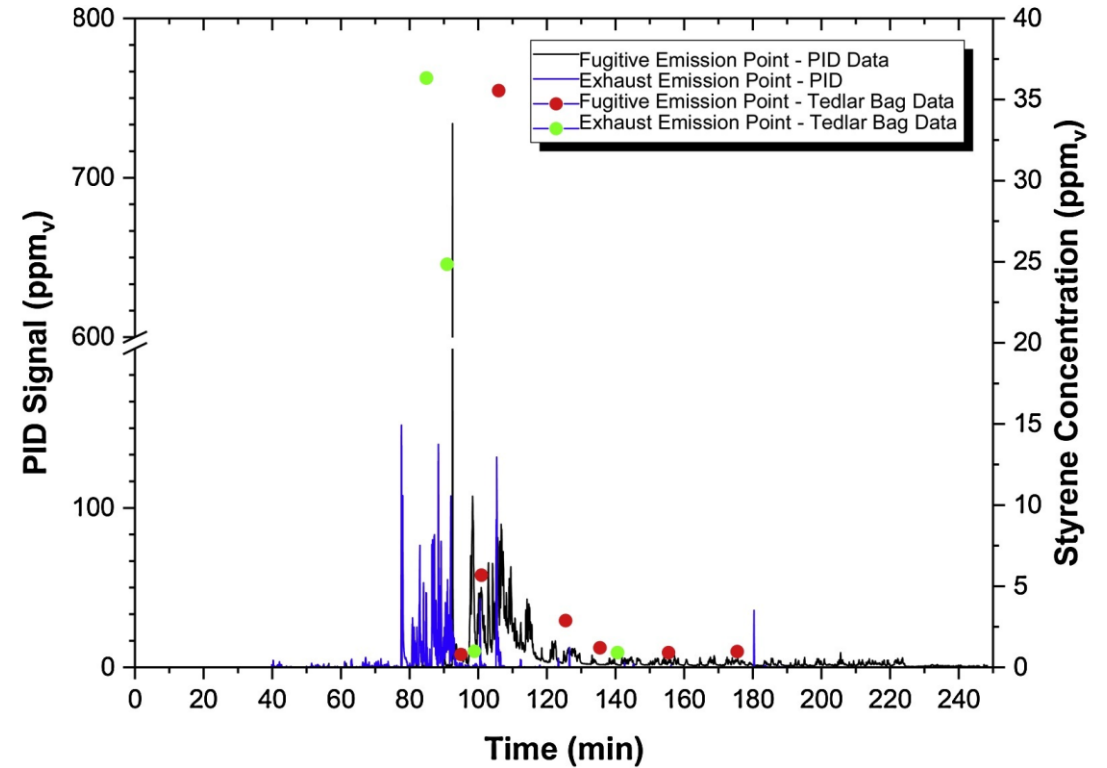
This implies their chemical waste *will* leave
their worksite and enter private property →

4-gas meters are ineffective. Calibrated PIDs can be 10x to 1000x off

PID Signal 130 ppm vs. actual styrene level 86 ppm



PID Signal 200 ppm vs. actual styrene level 37 ppm



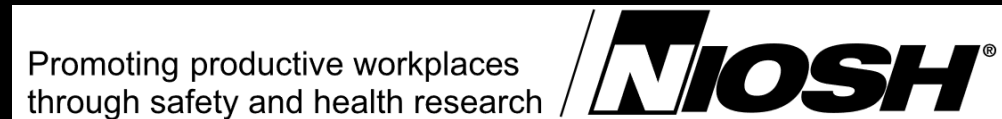
PIDs response to the multiphase mixture and environmental conditions.
It's not just styrene. The PID signal does not represent styrene.

Ra et al. 2019. Considerations for emission monitoring and liner analysis of thermally manufactured sewer cured-in-place-pipes (CIPP). OPEN ACCESS. *Jour. Hazardous Materials*. <https://doi.org/10.1016/j.jhazmat.2019.02.097>

What do we recommend?

What can Cities and States Do? Contact NIOSH for FREE advice and help

Request a –FREE– NIOSH health hazard evaluation (HHE) to better protect your employees and this should improve public safety



National Institute of Occupational Safety and Health

Health Hazard Evaluations help workers learn what health hazards are present at their workplace and recommends ways to reduce hazards and prevent work-related illness.

Dr. Ryan LeBouf, CIH (igu6@cdc.gov)

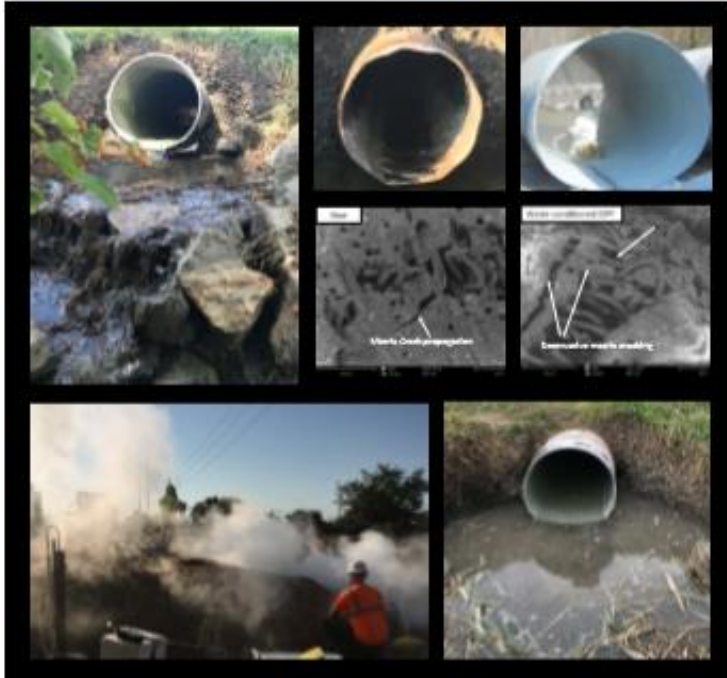
Dr. Rachel Bailey (feu2@cdc.gov)

Today NIOSH is helping:

- 1 UV CIPP company
- 2 state DOTs

Purdue Recommendations for CIPP Construction Specs available [here](#).

Contaminant Release from Storm Water
Culvert Rehabilitation Technologies:
Understanding Implications to the
Environment and Long-Term
Material Integrity



October 31, 2019

Andrew J. Whelton, Kyungyeon Ra,
Seyedeh Mahboobeh Teimouri Sendesi, Md Nuruddin, Xianzhen Li,
John A. Howarter, Jeffrey P. Youngblood, Chad T. Jafvert,
Nadezhda N. Zyaykina

FHWA TPF-5(339) • DOI: [10.5703/1289284317089](https://doi.org/10.5703/1289284317089)

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NEW: FREE “6 STATE LINING STUDY” REPORT

1. Go to the Purdue Libraries website and click on the “JTRP Program Affiliated Reports:

<https://docs.lib.purdue.edu/jtrpaffdocs/>

2. Now click on the report title:

[Contaminant Release from Storm Water Culvert Rehabilitation Technologies: Understanding Implications to the Environment and Long-Term Material Integrity,](#)

REPORT OUTLINE

Executive Summary

Section 1. Project goal & objectives

Section 2. Spray-on lining: Incidents & agency construction spec survey

Section 3. CIPP lining: Incidents & agency construction spec survey

Section 4. CIPP lining: Water quality impacts in multiple states

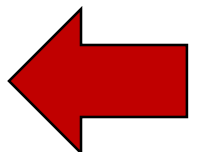
Section 5. Laboratory aging tests for CIPP

Section 6. CIPP safety observations and recommendations

Section 7. Construction spec recommendations

7.1 Spray-on lining

7.2 CIPP lining



Safety Recommendations

1. Mandate chemical emission capture and confirmation by chemical air monitoring. Do not allow waste discharge outside the tube.
2. Require appropriate PPE even for site observers (inspectors, consultants) as determined necessary by NIOSH, or other occupational health and public health regulatory agencies. This may include respirators and chemically resistant gloves, depending on the potential exposure routes (inhalation, dermal).
3. Require a Construction Inspector onsite *for every CIPP project with expertise in environmental testing, occupation hygiene, pollution identification, and plastic manufacture.*

Safety Recommendations (cont.)

4. Minimize your employee and general public chemical exposures by dermal contact and inhalation by restricting site access.
5. Require setback distances, delineate the location of hot zones / chemical fall out zones. The perimeter and setback distance will depend on CIPP process being used, worker practices, environmental conditions, and site conditions. Perimeter and setback distance recommendations can be made by a free NIOSH health hazard evaluation.
6. Contact NIOSH, get FREE PPE advice, request a FREE health hazard evaluation for projects happening in your area (or being paid for or overseen by you).

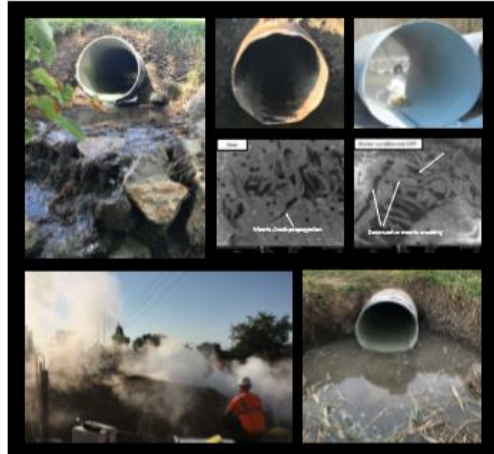
RESPONDING – CIPP associated HAZMAT incidents

1. Most at risk/affected: Children, pregnant women, immunocompromised persons
2. All victims should receive medical assistance onsite, hospital, or elsewhere
3. Exposure symptoms can intensify hours to days later
4. Odor not 100% caused by styrene. Atmosphere is a chemical mixture. Olfactory response can be a combination of analytes present. Chemicals enter the air as a mixture.
5. Emissions can enter buildings by multiple pathways
6. Emissions may enter neighboring buildings on the same street differently
7. Pouring water in drains does not prevent CIPP emissions from entering a building (Myth!)
8. Material SDS's do not list all chemicals present that treating physicians and responders need to understand chemical exposure
9. Outdoor plastic manufacturing process creates NEW chemicals, not listed on material SDS
10. Public works and contractors saying many untrue statements, don't actually understand risk
11. VOCs, SVOCs, levels exceeding immediately dangerous to life and health (IDLH) can be present
12. Carcinogens, endocrine disrupting compounds, hazardous air pollutants
13. White-like waste material discharged into air at steam site is NOT steam. Toxic.
14. 4-gas meters are NOT effective, unable to detect the organic vapors, particulates, liquids in air
15. Calibrated PIDs NOT reliable for steam CIPP sites. Under- and over-estimate styrene signal by 10-1000x [NIOSHs show PIDs readings can be off too]

PREVENTION – CIPP associated HAZMAT incidents

1. Explicitly require air and liquid waste capture in construction contract. Do not permit chemical discharge into the air.
2. Explicitly require air monitoring to PROVE no release of chemicals above and below ground.
3. Require physical setback distances that prevent the public from being near waste discharge points.
4. Do Not Approach worksite unless proper PPE donned. (i.e., respirators, etc.)
5. Require contractors direct any and all complaints to medical professionals.
6. If related odors are in buildings, demand an immediate halt to installation in the name of public safety.
7. Health department should be monitoring each installation and be prepared to respond.
8. Sometimes contractors and public works say untrue statements about exposures to parents and others during response, and never alert health department (city, county, state).

Contaminant Release from Storm Water Culvert Rehabilitation Technologies: Understanding Implications to the Environment and Long-Term Material Integrity



October 31, 2019

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Recommendations here
<https://docs.lib.purdue.edu/jtrpaffdocs/30/>

Ideas of What's Needed

1. Health officials can raise awareness, establish a multi-agency working group, issue notices
2. Health officials can educate Fire/Police Departments, Public Works, Municipalities, Elected Officials about the serious exposures (they maybe permitting them, often unknowingly. They also don't understand chem exposure)
3. Health officials can mandate that chemical waste emissions do not leave the CIPP being created - capture. Or, change process to not emit. Or, find another repair method.
4. Consider air testing, but realize there are many variables. PIDs not reliable.
5. We can help State and County health departments get up to speed on what to look for, test for. We are working with multiple faculty across institutions and agencies.

What we're working on:

Determine if altering CIPP manufacturing conditions can reduce the waste emitted

Better understand the health effects associated with exposure

Guidance for health officials

Help exposure victims, health officials, law enforcement, workers who call and more...

**CIPP chemical emissions, environmental significance,
occupational and public exposure hazards, plumbing
traps, air testing**

Let's Discuss:

What questions do You Have?

What are your thoughts?

**Is there anything you think we and others
would benefit from knowing?**