

Worksite Chemical Air Emissions and Exposures During Pipe Rehabilitation Using Cured-in-Place Pipe

Mahbubeh Teimouri

Kyungyeon Ra, Emily Conkling

Nadezhda Zyaykina, Ph.D.

Brandon Boor, Ph.D.

Md Nurrudin

John Howarter, Ph.D.

Jeff Youngblood, Ph.D.

Lisa Kobos

Jonathan Shannadan

Chad Jafvert, Ph.D.

Andrew J. Whelton, Ph.D



Today, Cured-in-Place-Pipe (CIPP) Technology is used to repair water pipes in the USA

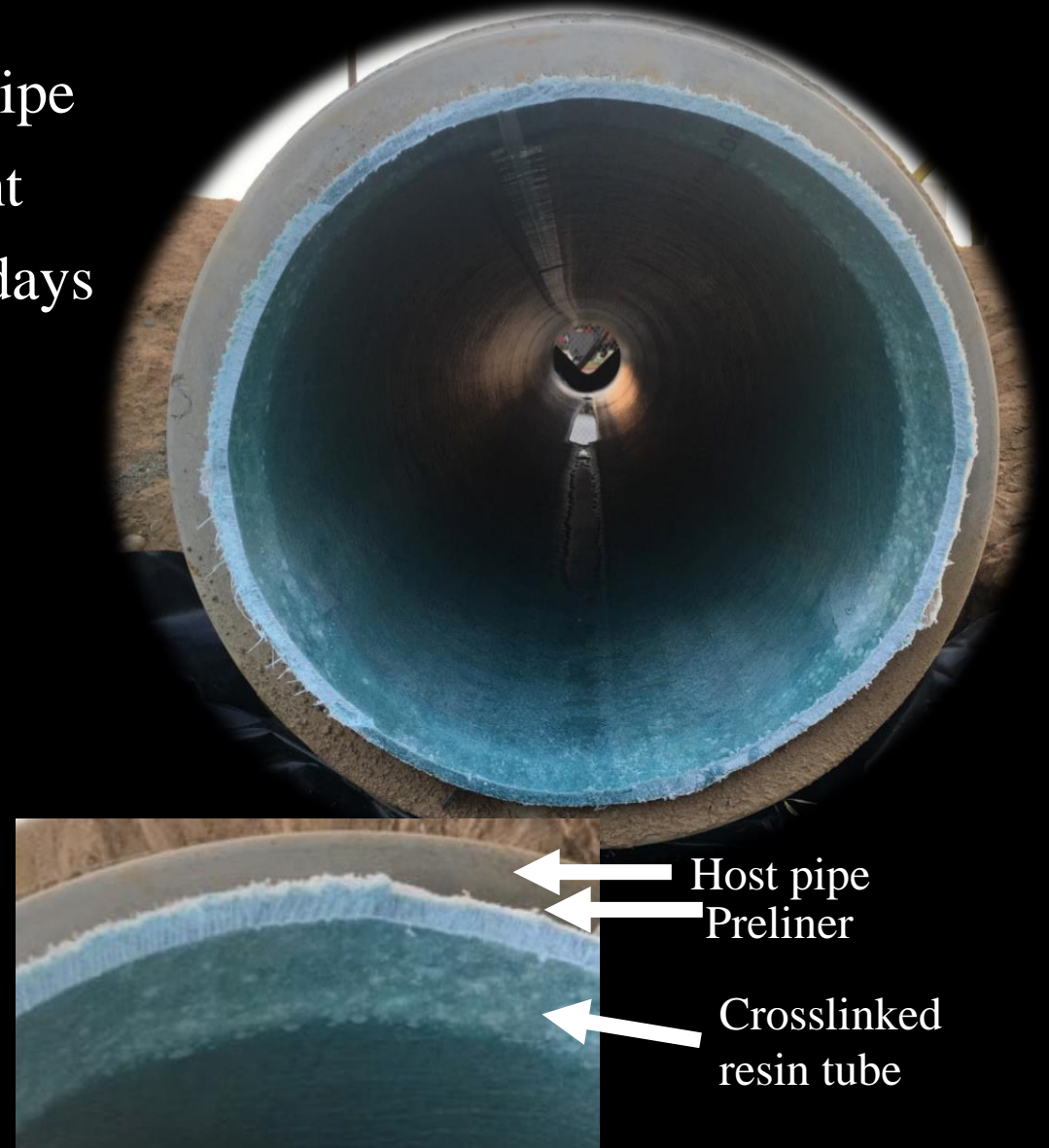
Resin impregnated tube hardened inside a broken pipe

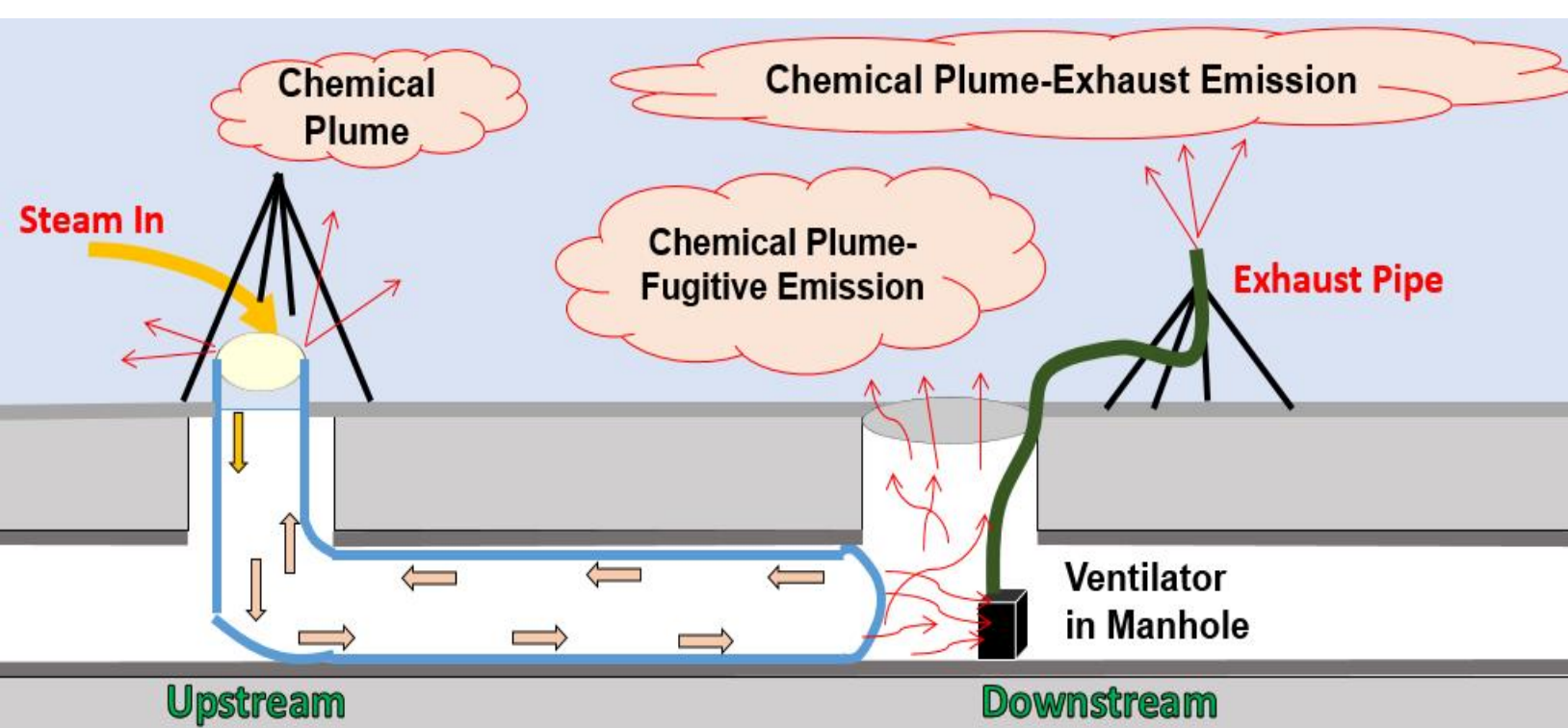
Curing methods: Hot water, Steam, UV light

Deliberate curing time: Hours to many days

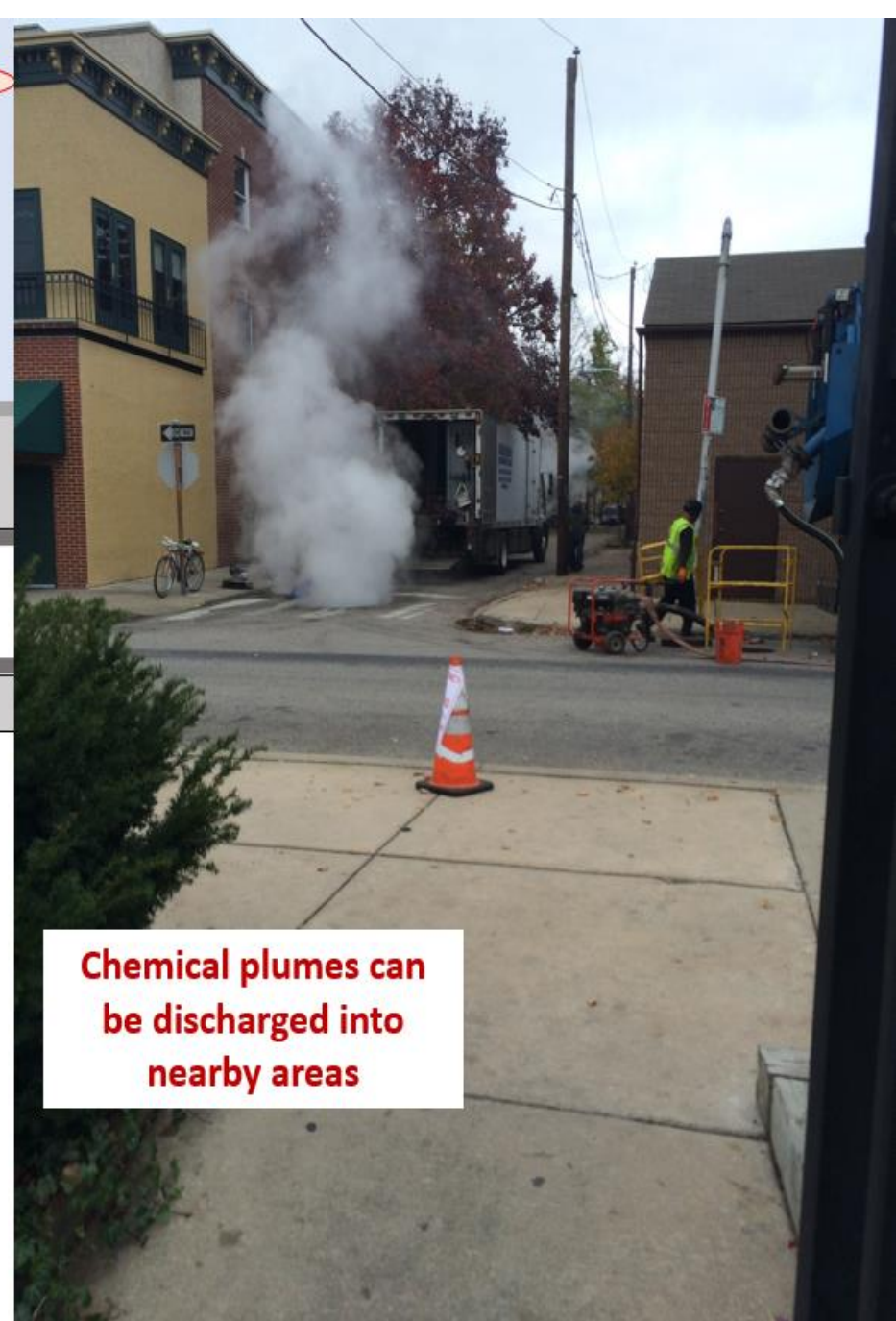
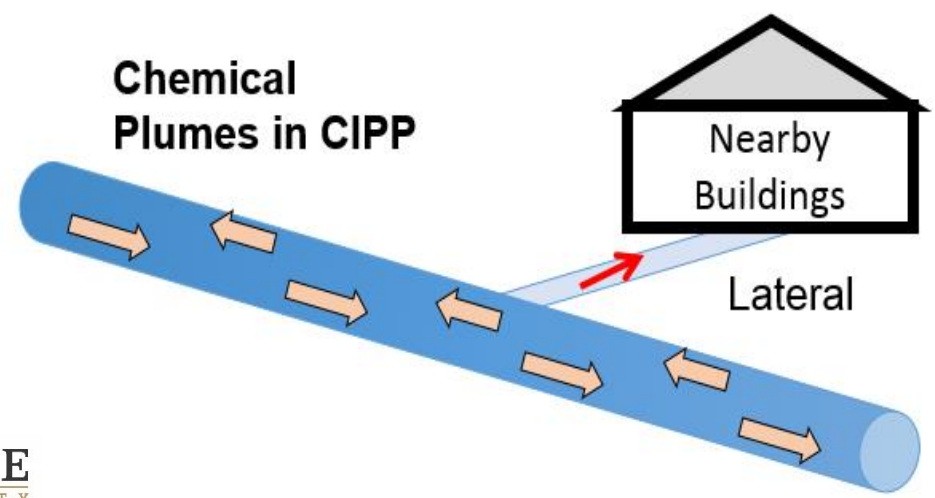


PURDUE
UNIVERSITY



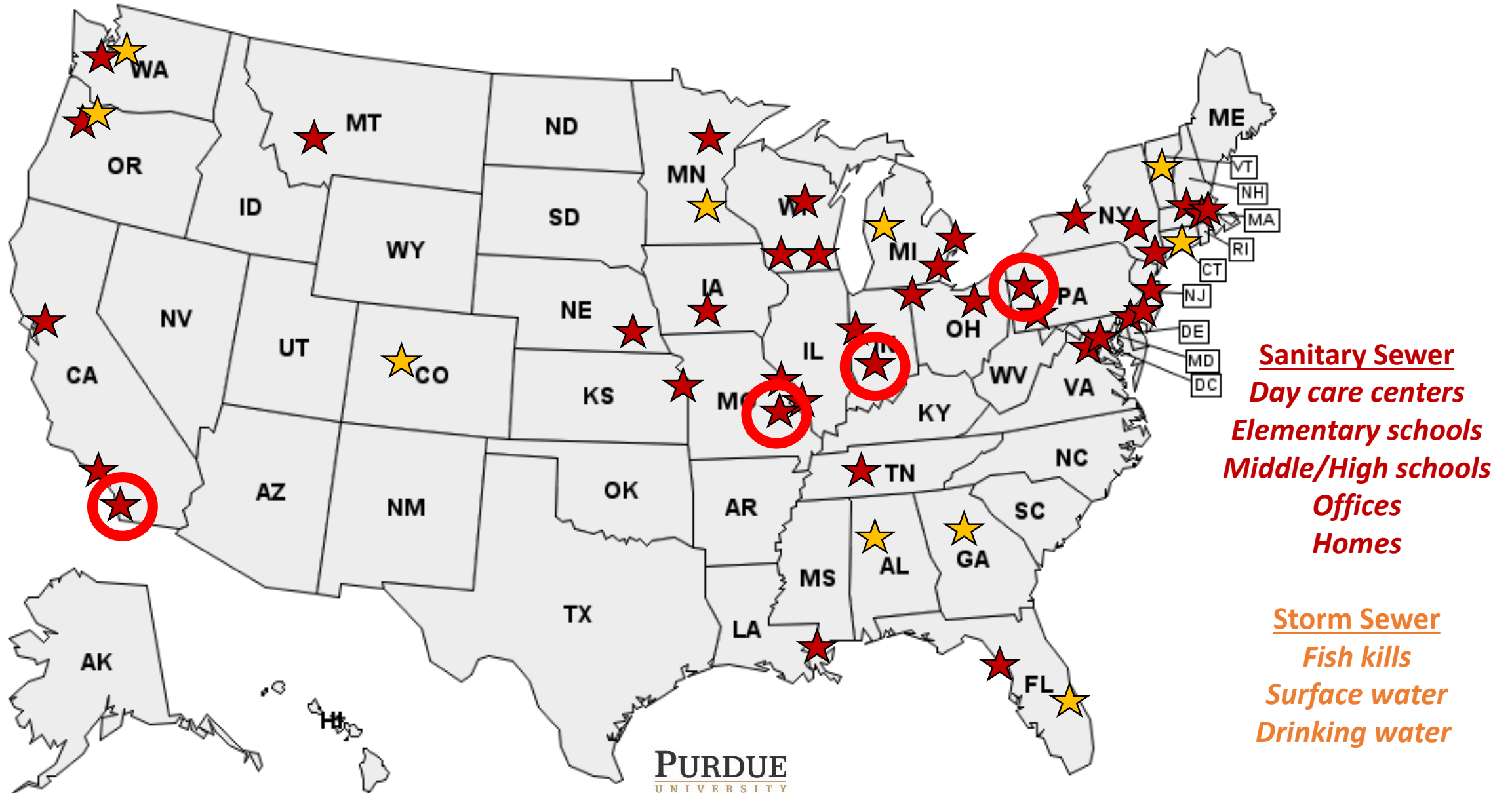


Chemical Plumes Generated by CIPP can Escape the Pipe Being Repaired



Chemical plumes can be discharged into nearby areas

CIPP Air and Water Contamination Incidents We Know About



Contractor and Municipality Statements to the Public

“styrene vapor of at most few ppm”

“is not a human health risk”

“is safe for people and animals”

“it is harmless steam”

“no hazardous conditions posed”

“don’t be alarmed”

“50 ppm styrene is the safe exposure level”

“open windows to allow ventilation”

“place plastic bags filled with water and wet towels over
drains/sinks/toilets”

“pour 1 gallon, 1-2 cups water down drains”

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



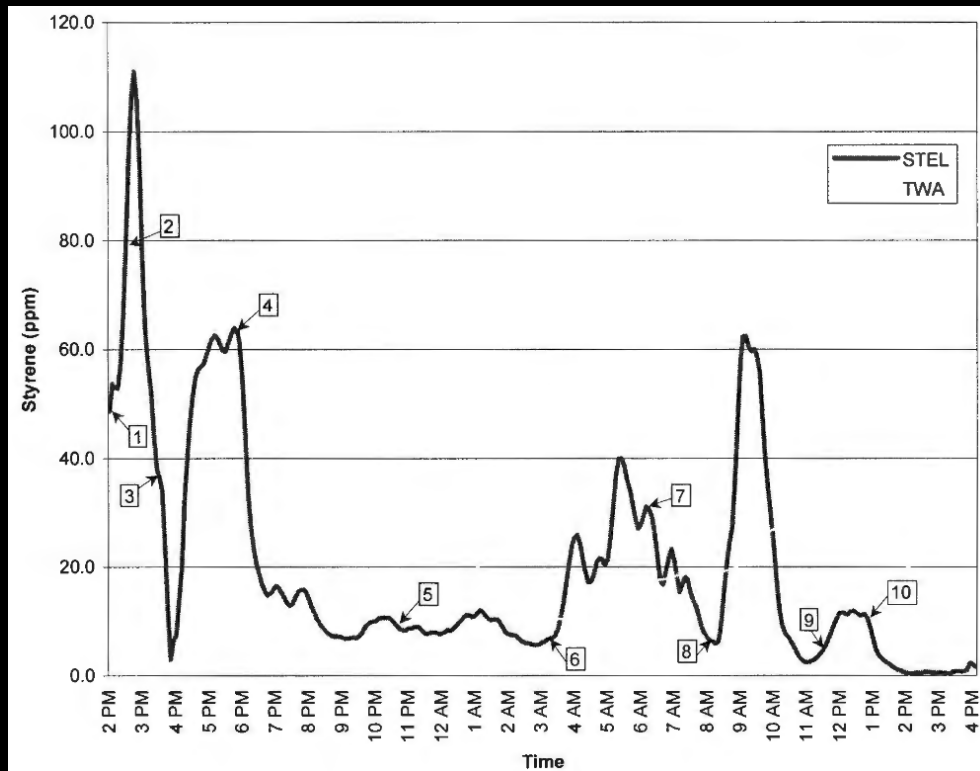
Only 4 CIPP air monitoring studies have been conducted in the past 16 years

A Report on the Monitoring of Styrene in Toronto Homes During the Cured in Place Pipe (CIPP) Process for Sewer Pipe Rehabilitation by Insituform

PROJECT NO. 041-6742

Prepared for
Toronto Works & Emergency Services
2700 Eglinton Avenue West
Toronto, Ontario
M6M 1V1

AirZone, Inc. (2001)



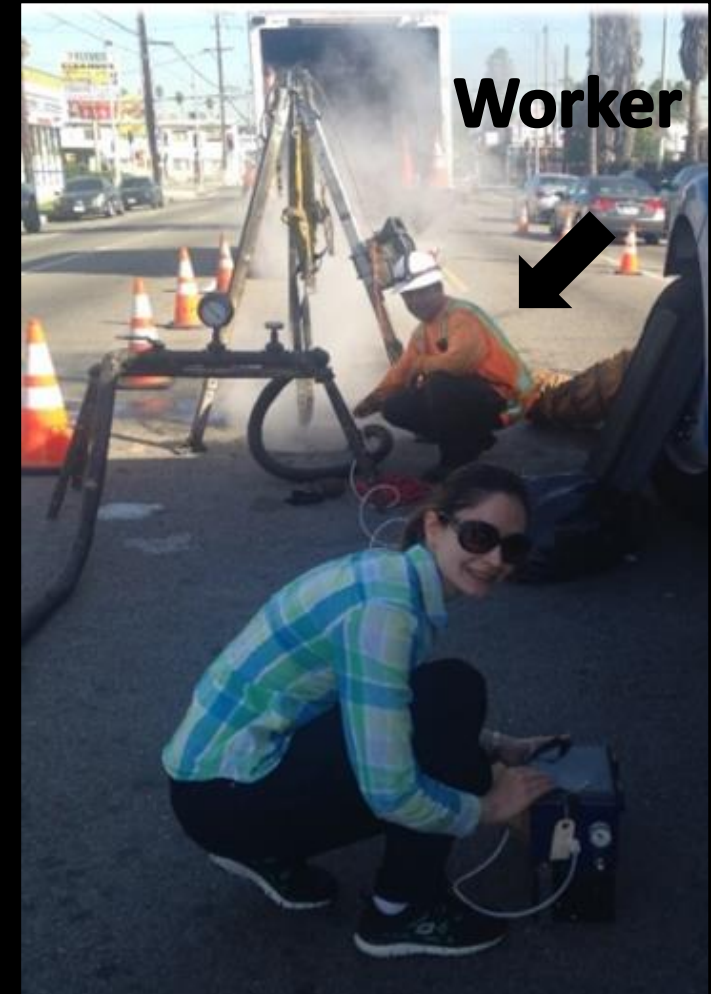
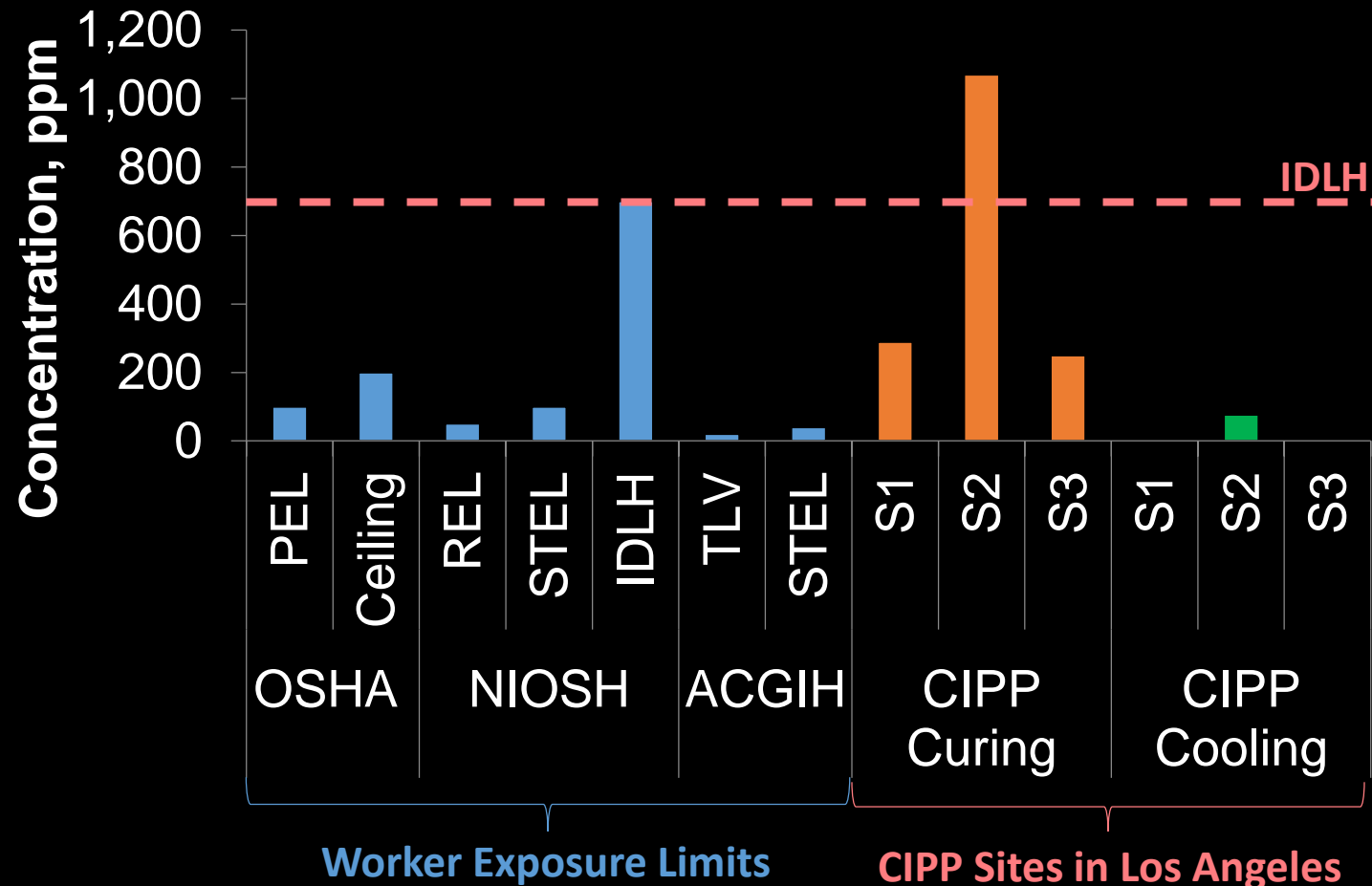
Bauer (2004)



ATSDR (2005)

2015, Styrene Exiting a CIPP Sewer Manhole Exceeded the NIOSH IDLH

IDLH: a concentration from which a worker could escape without injury or without irreversible health effects in the event of respiratory protection equipment failure



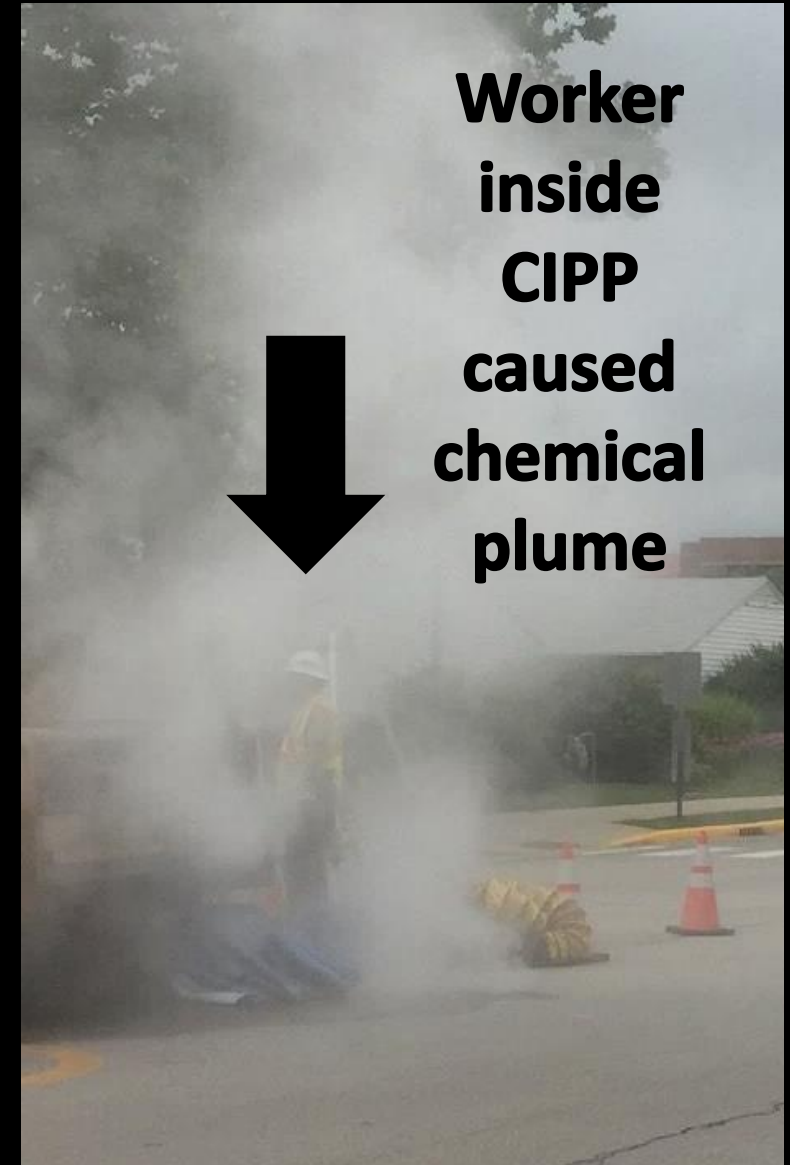
Adjari (2016)

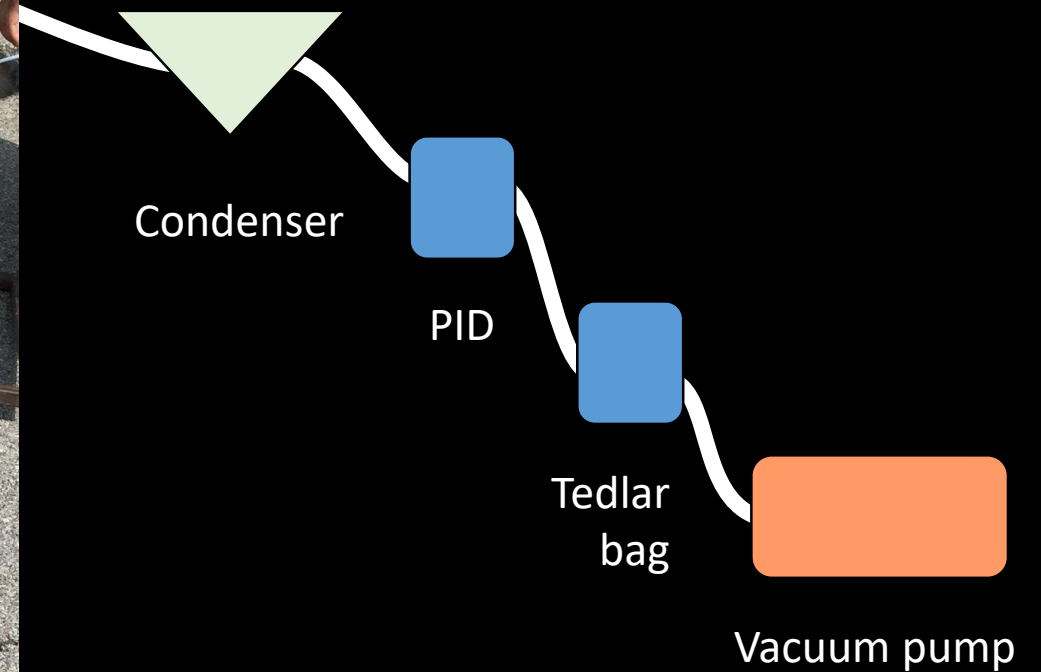
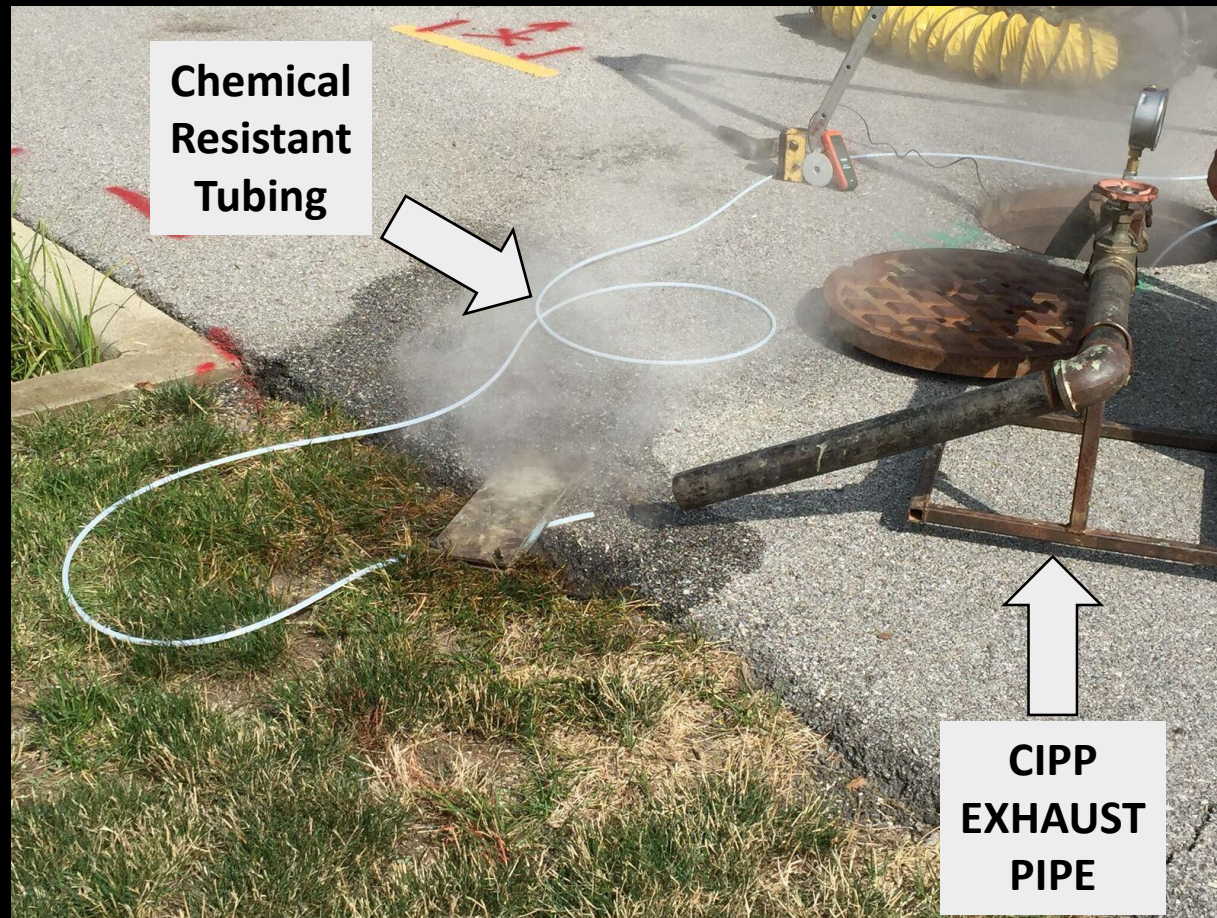
2016 NSF RAPID Response Study

To better understand materials emitted from CIPP sanitary sewer pipe and storm water pipe repair installations and their potential toxicity

Objectives

- 1) Conduct air sampling and analysis for 7 steam CIPP installation sites that use non-styrene and styrene resins
- 2) Characterize the raw materials, materials emitted, and their magnitudes
- 3) Evaluate chemical plume toxicity to mouse lung cells
- 4) Identify worksite safety issues and provide recommendations on future technology use





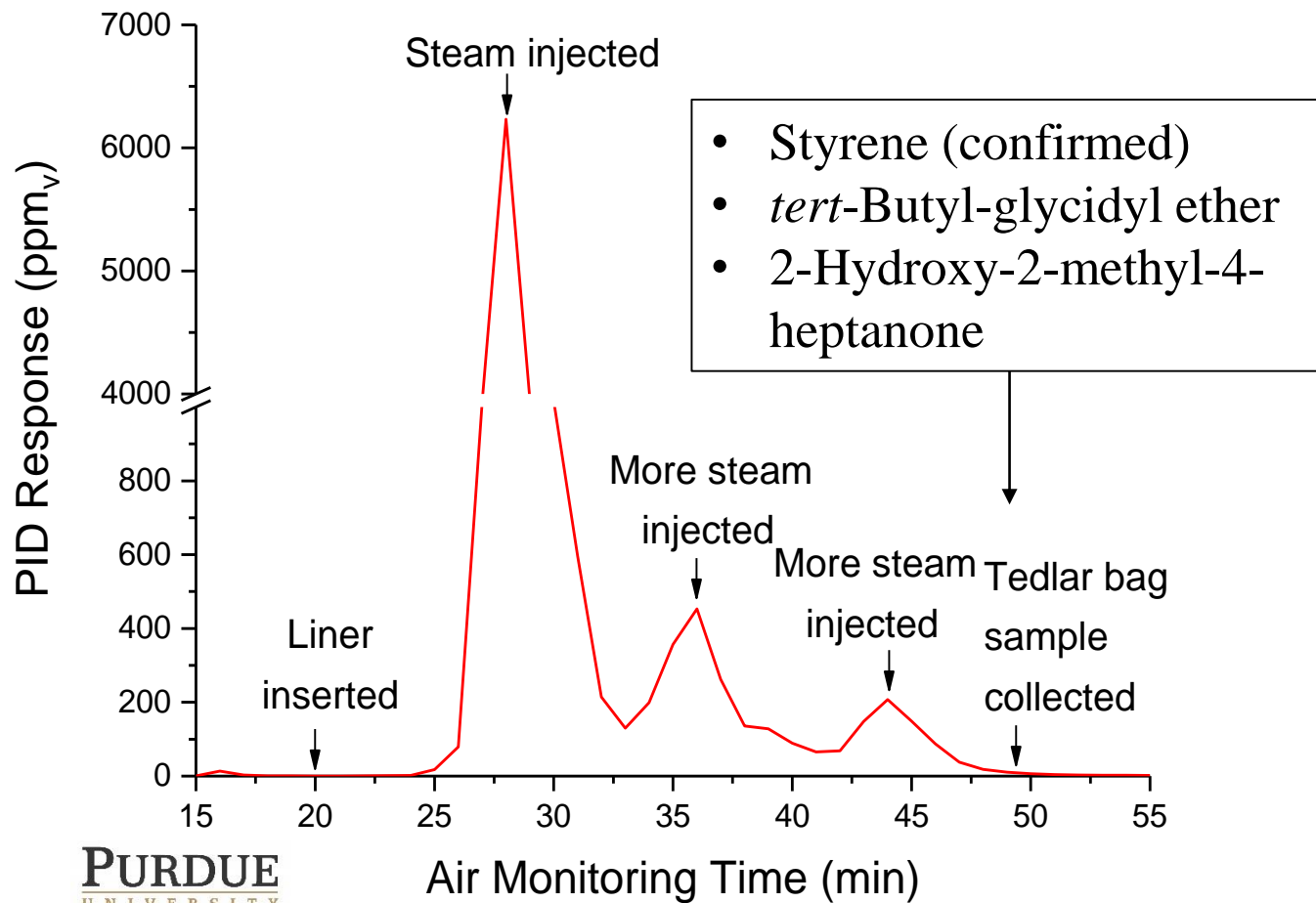
Methods: Conducted air sampling in the field at the exhaust pipe located at a CIPP sewer pipe repair site



**PID
response:
1,361 ppm_v**

Before uncured resin tube was cured

Results: Chemicals were emitted from the uncured resin tube *before* installation and from the downstream manhole *during* installation





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

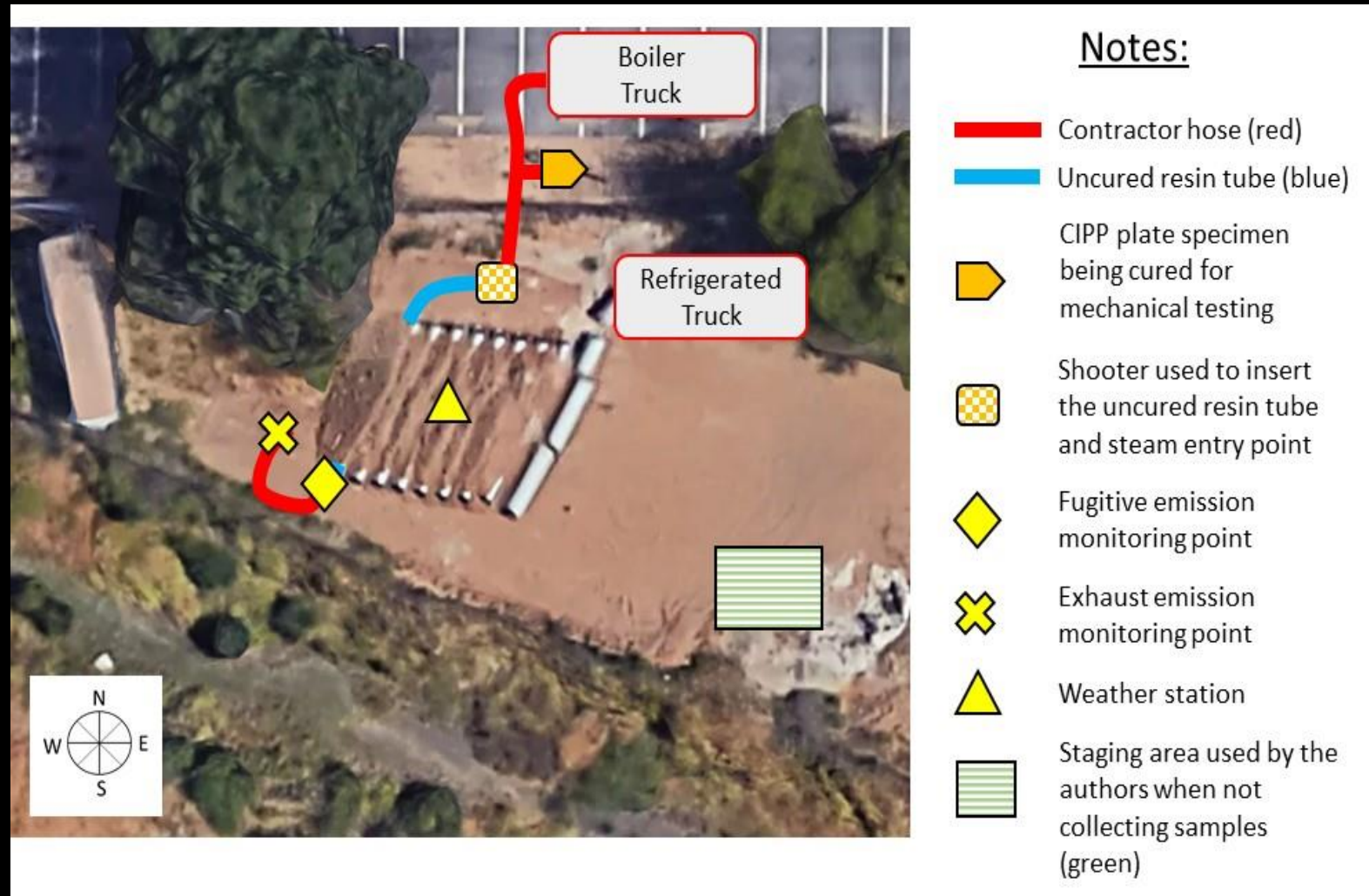
5 CIPP Installations in California were Monitored

Resins Evaluated

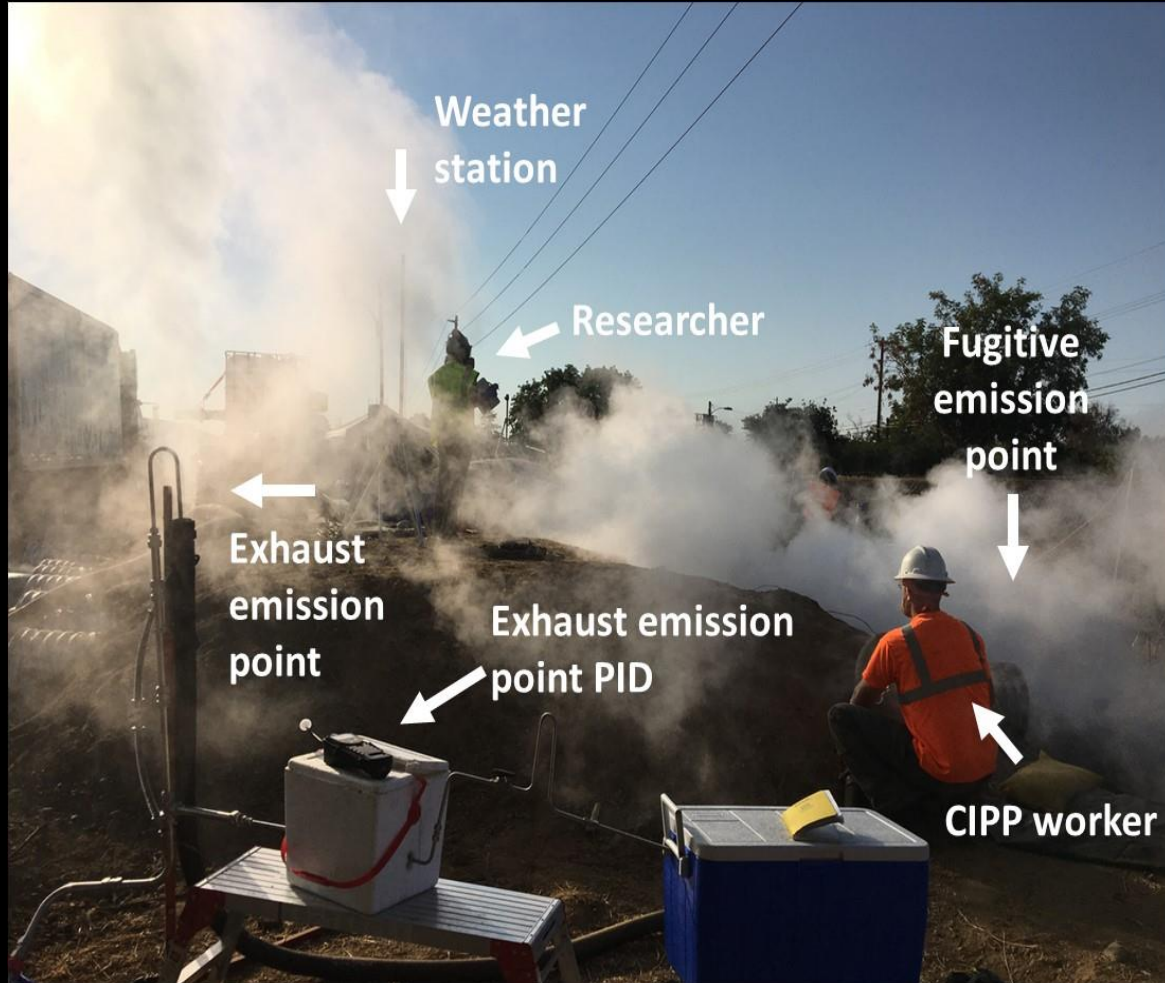
AOC: Styrene based
EcoTek: Non-styrene

Sites

AOC Resin: 1,3,4,5
EcoTek Resin: 2



Methods: Fugitive and exhaust emissions are shown for one CIPP installation in California



Field Work and Laboratory Analysis

Sampling and Monitoring

- Unacured resin tubes soaked in solvents
- Photoionization detectors (PID)
- Glass jars
- Stainless steel emission capture

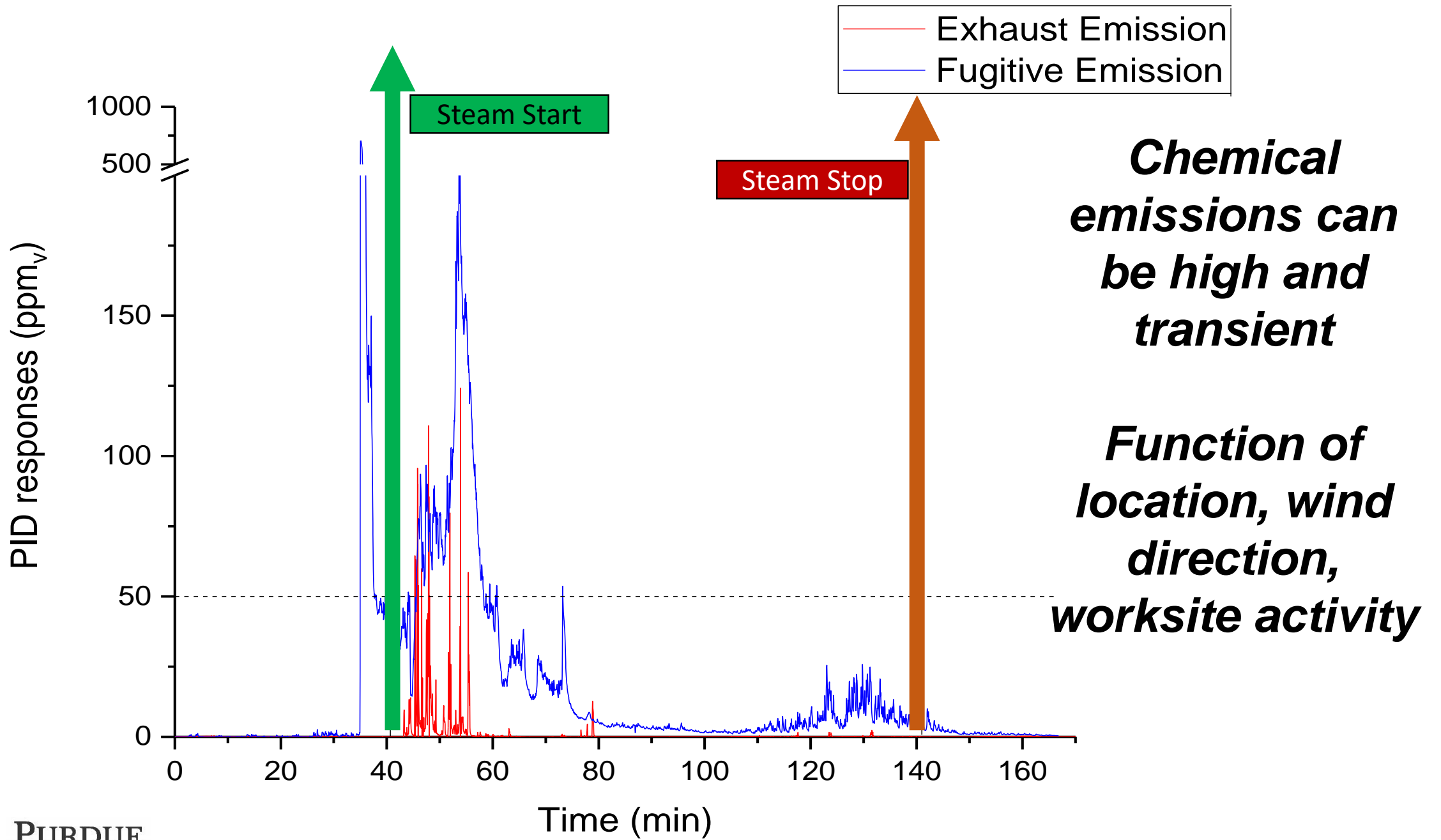
Equipment

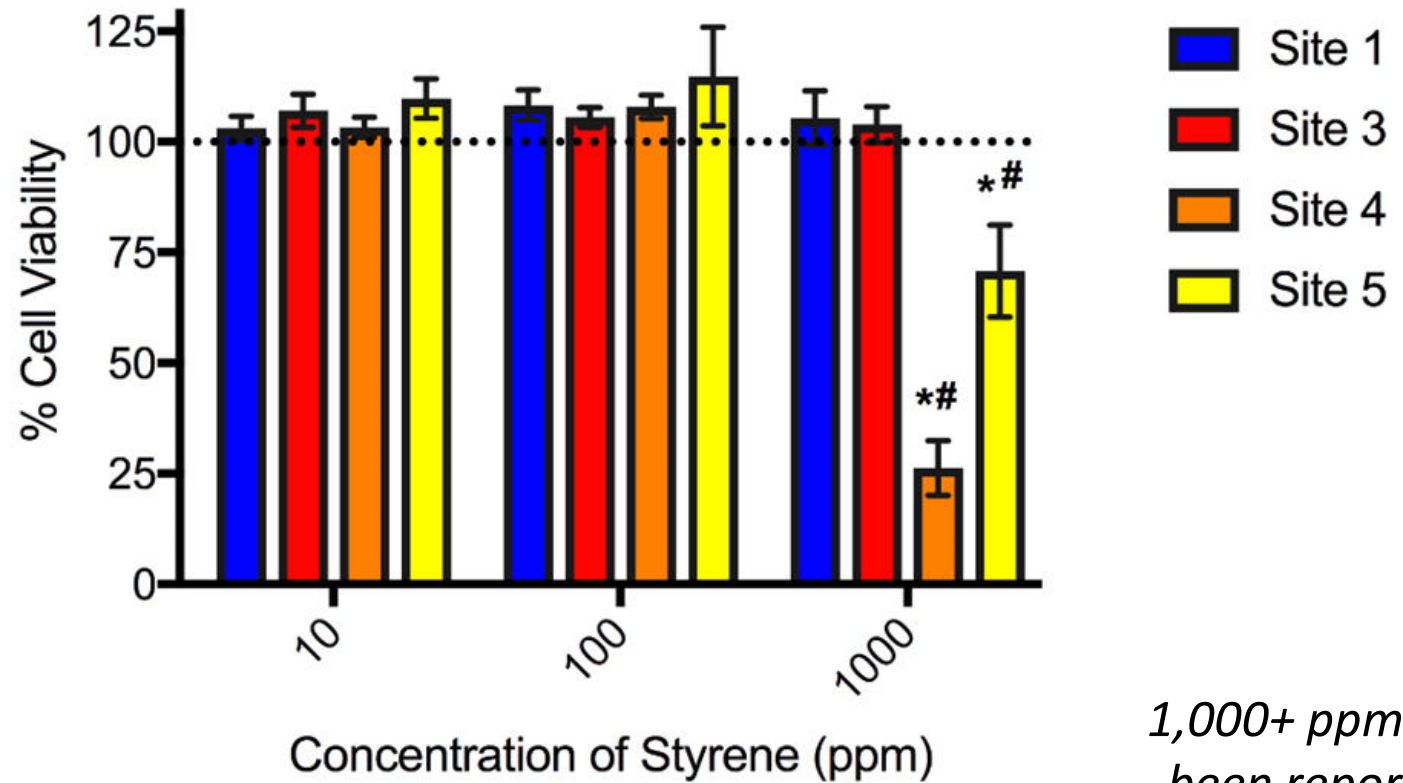
- Gas Chromatograph (GC)/Mass Spectrometry (MS)
- Thermogravimetric Analysis (TGA)
- Differential scanning calorimetry (DSC)
- ^1H Nuclear Magnetic Resonance (NMR)

We Found Several Compounds Emitted into the Air at the CIPP Sites and Some, but Not All, were Present in the Uncured Resin Tubes

Acetone	
Acetophenone	Hazardous Air Pollutant
Benzaldehyde	
Benzoic acid	
BHT	
4- <i>tert</i> -Butylcyclohexanone	
4- <i>tert</i> -Butylcyclohexanol	
Dibutyl phthalate	Hazardous Air Pollutant / EDC
Phenol	Hazardous Air Pollutant
Styrene	Hazardous Air Pollutant/ Ant. Carcinogen*
1-Tetradecanol	
Tripropylene glycol diacrylate	
1-Dodecanol	

Additional literature indicates that the emission of other HAPs, carcinogens, EDCs, and compounds may occur





1,000+ ppm has been reported at a CIPP site

Mouse lung cell experiments indicated that toxicity occurred and future health impact investigations are necessary

This is an open access article published under a Creative Commons Non-Commercial No Derivative Works (CC-BY-NC-ND) Attribution [License](#), which permits copying and redistribution of the article, and creation of adaptations, all for non-commercial purposes.



Letter

Worksite Chemical Air Emissions and Worker Exposure during Sanitary Sewer and Stormwater Pipe Rehabilitation Using Cured-in-Place-Pipe (CIPP)

Seyedeh Mahboobeh Teimouri Sendesi,[†] Kyungyeon Ra,[‡] Emily N. Conkling,[‡] Brandon E. Boor,[†] Md. Nuruddin,[§] John A. Howarter,^{‡,§} Jeffrey P. Youngblood,[§] Lisa M. Kobos,^{||} Jonathan H. Shannahan,^{||} Chad T. Jafvert,^{†,‡}  and Andrew J. Whelton^{*,†,‡} 

[†]Lyles School of Civil Engineering, Purdue University, West Lafayette, Indiana 47907, United States

[‡]Division of Environmental and Ecological Engineering, Purdue University, West Lafayette, Indiana 47907, United States

[§]School of Materials Engineering, Purdue University, West Lafayette, Indiana 47907, United States

^{||}School of Health Sciences, Purdue University, West Lafayette, Indiana 47907, United States

FREE Download: A new air monitoring study report, its Supporting Information file that lists 59 chemical exposure incidents, and download the five videos.

Visit <http://pubs.acs.org/doi/ipdf/10.1021/acs.estlett.7b00237>

Published: July 26, 2017



News

In the News

[Scientific report files & associated video files, *Environmental Science & Technology Letters*, July 2017](#)

[Frequently Asked Questions \(FAQ\)](#)

- [General Questions](#)
- [What Can I Do?](#)
- [Questions about Chemicals in the Air, in Building, and Exposure](#)
- [Questions about CIPP Technology](#)
- [Worker Safety](#)

[Incorrect assertions about the CIPP study](#)

In 2016, Purdue researchers began investigating chemical emissions and exposures caused by cured-in-place-pipe (CIPP) water pipe repair sites. CIPP is the most popular water pipe repair technologies used in the U.S. Because this technology uses raw chemicals in the field and manufacturers a new plastic pipe inside an existing damaged water pipe, chemicals can be emitted into the environment and enter nearby buildings. CIPP is used for sanitary sewer, storm sewer, and drinking water pipe repairs.

Questions? Contact us at CIPPSafety@purdue.edu

More information can be found at

<http://CIPPSafety.org> or <https://engineering.purdue.edu/CIPPSafety>

A September 2017 Document was Also Posted “Additional Considerations”



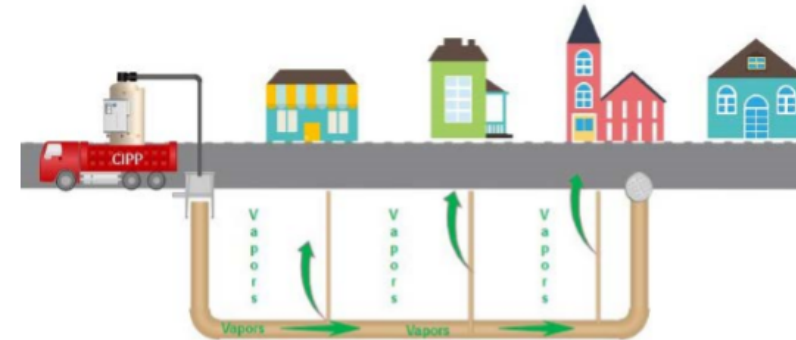
Cure-In-Place Pipe (CIPP) Additional Considerations for Municipalities



Background

CDPH Alert


The CDPH Cure-In-Place Pipe (CIPP) Safety Alert, issued in July 2017, is not a comprehensive engineering guide for controlling chemical releases; rather, its purpose is to raise awareness and provide some steps that should be considered by municipalities permitting CIPP projects in their jurisdiction.




Concerns

Studies of chemical releases during the installation and curing of CIPP are limited and protocols for controlling exposures have not been developed. Safety Data Sheets (SDS) do not describe all of the compounds present in the raw materials or emitted into the air during CIPP installation.

Workers should Learn More

 Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

SEARCH 

<https://blogs.cdc.gov/niosh-science-blog/2017/09/26/cipp/>

CDC A-Z INDEX ▾

NIOSH Science Blog




Home
Posts by Category +
Posts by Month +
About This Site +


Search the blog
Search for:

Search

Cured-in-Place-Pipe (CIPP): Inhalation and Dermal Exposure Risks Associated with Sanitary Sewer, Storm Sewer, and Drinking Water Pipe Repairs

Posted on September 26, 2017 by Andrew J. Whelton, PhD; Jonathan Shannahan, PhD; Brandon E. Boor, PhD; John A. Howarter, PhD; Jeffrey P. Youngblood, PhD; and Chad T. Jafvert, PhD.



 EH Topics | Professional Development | News & Events | Publications | Membership & Communities | About NEHA 

Cured in Place Piping (CIPP)

<http://neha.org/node/59303>

 SHARE  PRINT

What is a Cured in Place Pipe?

Cured-in-place pipe (CIPP) pipe lining is one of several methods used to repair existing pipelines that don't require that you dig up the pipes. CIPP is a jointless, seamless, pipe-within-a-pipe with the capability to repair pipes ranging in diameter from 4-110 inches. Lining the pipes is less expensive and more efficient than traditional open cut replacement methods, normally installed with little or no digging. The CIPP process involves installing a resin-saturated felt tube that later hardens into a strong "pipe-within-a-pipe."

The use of CIPP for water and sewer line repair and replacement is widespread across the US. There is a possibility of residual chemical release during the process. Most of the studies to date have focused on the environmental impacts of styrene, a major ingredient in the curing process. However, vapors and their effects on indoor air quality are important considerations for utility workers and residents. Many residents notice a smell like that of new plastic during the pipe repair process. This odor may be caused by ingredient used to make the CIPPs or compounds created during the in-situ manufacturing process. One chemical that has received scrutiny is [styrene](#), but other chemicals are also emitted.



Where we are today

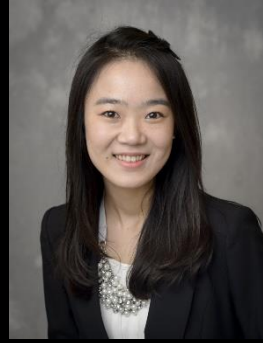
- Water pipes still need to be repaired
- CIPP technology use has caused harm and impacted the environment, we are uncertain about the frequency, scale, and extent of impacts
- Workers and the public not appropriately informed about what the emissions are and consequences of exposure

Recommendations

- 1) Emissions, public and occupational health risks should be investigated
- 2) Minimize dermal and inhalation exposures,
- 3) Monitor emissions,
- 4) Use appropriate personal protective equipment (PPE), and
- 5) Capture emissions and confirm this by monitoring.



Andrew Whelton,
Civil/Environmental
Eng.



Kyungyeon Ra
Environmental Eng.



John Howarter,
Materials Eng.



Md Nurrudin
Materials Eng.



Brandon Boor,
Air Quality Eng.



Chad Jafvert,
Civil/Environmental
Eng.



Nadya Zyaykina,
Civil/ Environmental
Eng.



Mabi Teimouri
Civil Eng.



Jonathan Shannahan,
Toxicology



Lisa Kobos
Health Sciences



Emily Conkling
Environmental Eng.



Jeffrey Youngblood,
Materials Engineering

+ 26 other people at Purdue University

Thank You.

Please contact us if you have any questions.

Andrew Whelton, Ph.D.
awhelton@purdue.edu

Financial support provided by

- National Science Foundation RAPID grant CBET-1624183
- Public donations through crowd funding
- Purdue University Lyles School of Civil Engineering

