City of Houston-Briar Hill: Trenchless Sewer Rebuild

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Presentation Outline

Geopolymer SAPL Lining Overview

- Materials
- Process / equipment
- Specifications
- Briar Hill Case Study
  - ➢Challenges
  - ➢Material Selection
  - ➢Installation Techniques

Geopolymer SAPL: New Pipe Within A Pipe

Geopolymer Materials

Not a Plastic

- Not HDPE/PVC/Epoxy

Looks and feels like cement/concrete

- Workability
- Material Properties
- Service Life

Chemical structure like natural stone

- Monolithic
- Durable
- Corrosion Resistant

SAPL Flexibility

Shape

- Non-round, elliptical, arch
- Manholes, wet-wells, boxes

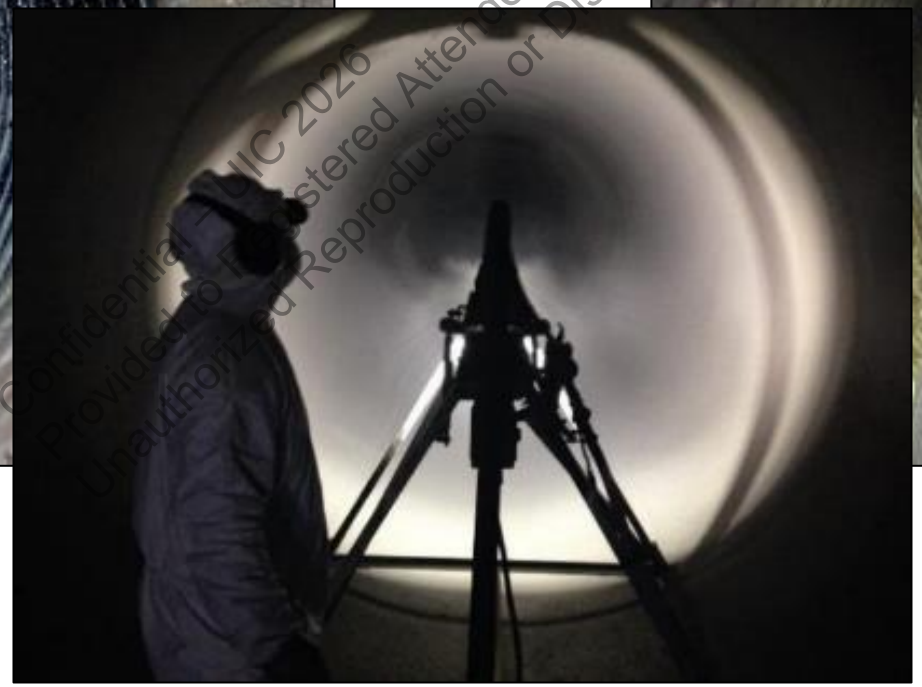
Length

- Short lines, culverts, point repair
- Routinely over 500 ft

Diameter & Alignment

- From 24 inches to 22 ft
- Varying diameters in a single run
- Changes in horiz or vert alignment
- Ovality greater than 10%

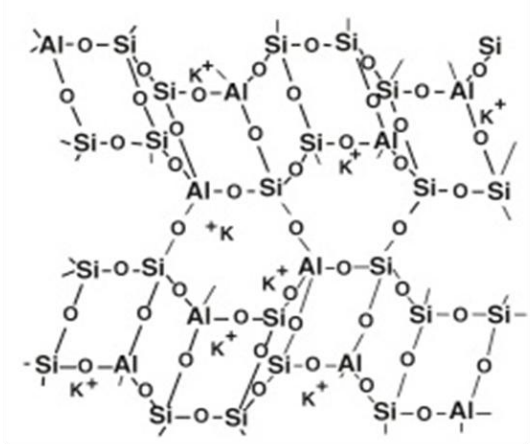
SAPL Process: Centrifugal Casting



SAPL Process: Hand Spraying

Geopolymer Environmental Benefits

- SCM like Fly Ash, slag and silica fume
- Geopolymer has between 65% - 90% less CO_2 than standard ordinary portland cementitious materials.
- GeoSpray geopolymer has passed multiple national/international test standards



Typical Geopolymer Structure

WRAS
WATER REGULATIONS ADVISORY SCHEME

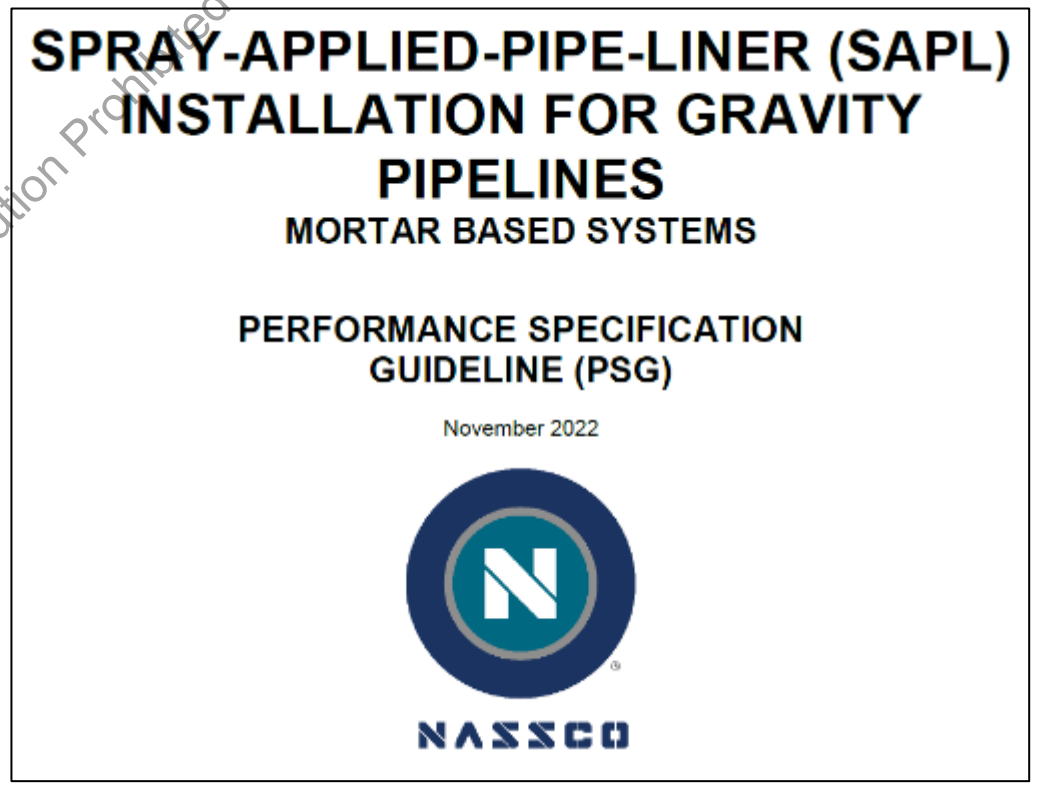
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NSF
Certified to NSF/ANSI 61

CLEAN TECH OPEN 2011 FINALIST

SAPL Specification: NASSCO

- First Published November 2022
- Covers MORTAR / CEMENTITOUS/ GEOPOLYMER Based Systems ONLY
- Does not cover plastic/polymeric systems
- Developed by the Pipeline Rehabilitation Committee
- Approved by the TAC



SAPL Specification: NASSCO

If you want to have a competitive geopolymer specification, we recommend you limit the amount of CaO – which will be closely linked to Portland Cement content & include the following language:

- *The SAPL geopolymer mortar should be composed of at minimum 70% Pozzolanic material selected from the list of: SiO_2, MgO, Al_2O_3, Fe_2O_3 and be verified by third party certified X-ray Fluorescence (XRF) testing. Use Test Method - ASTM C-114 based on 100% of material*

Be cautious if a material supplier is attempting to spec a proprietary chemical formulation that is specific to *their product,* and creating a sole source specification

ASTM F3706-24

STANDARD PRACTICE FOR IN FIELD SPRAY APPLIED MORTAR LININGS FOR LARGE DIAMETER STORMWATER AND SEWER CONDUITS

- First Published December 2024
- Covers MORTAR / CEMENTITOUS/ GEOPOLYMER Based Systems ONLY
- Companion document with NASSCO
- References ASTM C114 XRF Testing

Designation: F3706 – 24

Standard Practice for
In Field Spray Applied Mortar Linings for Large Diameter Stormwater and Sewer Conduits[1]

This standard is issued under the fixed designation F3706; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the procedures to structurally or non-structurally reconstruct, seal, and protect existing large diameter conduits with spray application mortar linings in the field. Applications include applying prepackaged cementitious or geopolymer liner materials that may function as a fully structural, partially structural, or protective conduit repair or restoration. A fully structural lining shall be designed to support all imposed loads independent of the host pipe or conduit structure. A uniform high-strength, fiber-reinforced cementitious or geopolymer mortar shall be manually sprayed or centrifugally cast in a uniform, prescribed thickness to all cleaned, interior surfaces of the host pipe or conduit. The cementitious or geopolymer liner may be applied to host pipes constructed of brick, concrete, block, and steel, and can be used in a variety of gravity or low-pressure applications such as sanitary sewers, storm sewers, low pressure force mains, and process piping. Application of lining may be applied by centrifugal casting, hand sprayed or hand trowelled.

1.2 A manufacturer's approved applicator shall furnish the complete application of the reconstruction process using pre-packaged cementitious or geopolymer liner material. All cleaning, preparation, and application procedures shall be in accordance with the manufacturer's recommendations.

1.3 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C78/C78M Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens)
C114/C114M Test Methods for Chemical Analysis of Hydraulic Cement
C172/C172M Practice for Sampling Freshly Mixed Concrete
C309/C309M Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C494/C494M Specification for Chemical Admixtures for Concrete
C496/C496M Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
C497/C497M Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile
C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing (Withdrawn 2024)[3]
C882/C882M Test Method for Bond Strength of Bonding Systems Used With Concrete By Slant Shear
C1090/C1090M Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
C1138M Test Method for Abrasion Resistance of Concrete (Underwater Method)

[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.
Current edition approved Nov. 15, 2024. Published December 2024. DOI: 10.1520/F3706-24.

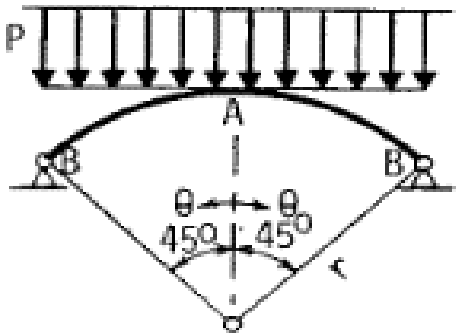
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

SAPL Design

Based on Experimental Testing

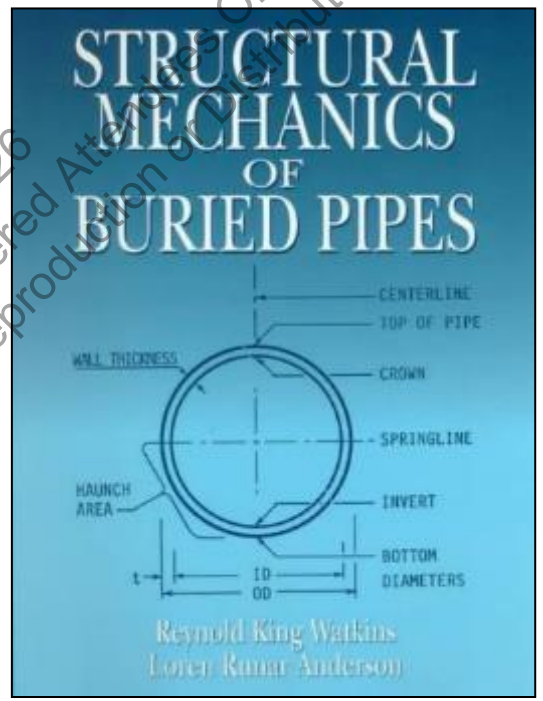
- Flexural strength, ASTM C78 (1500 psi)



$$T_A = 0.8323Pr$$
$$M_A = 0.0062Pr^2$$

The resultant solution for this case is:

$$t = \sqrt{\frac{0.0744\,P\,r^2}{S_F}\frac{N}{C}}$$



Exploration of Engineering Design Methods for Cementitious Spray Applied Liner Systems

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ABSTACT

Over the past decade cementitious spray applied mortar linings have gained increasing popularity due to their competitive cost structure for large diameter pipe rehabilitation as well as other installation considerations. However, the engineering community, and especially bodies such as ASCE, ASTM and others, have yet to define a standard design methodology. This paper reviews the increasingly large number of scientific studies that have been conducted to reline existing pipe structures and determine a proper design method. The test data from five different engineering studies is analyzed. The experimental methods of each study are reviewed, and the limitations for each set of data are noted. Straightforward conservative design methodologies are presented and compared to the failure modes for each pipe type based on the material properties of the sprayed liner system and form a consensus on the design method. The results are also compared to a CANDE finite element model.

INTRODUCTION

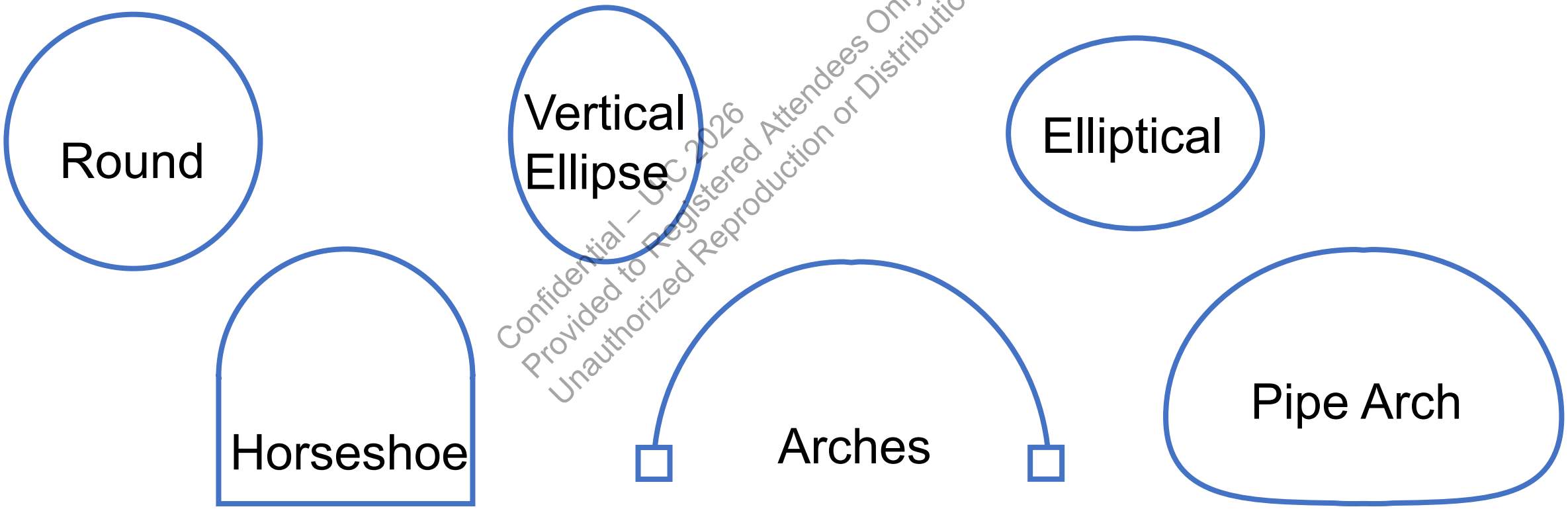
As trenchless technologies have continued to develop and improve over the past 50 years, the average rate of system renewal is still not adequate to keep up with the increasing needs of utilities (Selvakumar and Matthews, 2017). To meet these needs, many wastewater utilities are seeking innovative trenchless technologies to repair larger portions of their systems. Over the more recent past, cementitious spray-applied liners (SAPL) have gained in popularity as a rehabilitation method for large-diameter gravity conduits. Multiple commercial vendors sell either ordinary portland cement (OPC) based or geopolymer mortars. To date, well over 500,000 liner feet of large diameter pipe has been rehabilitated with this technology. Unfortunately, there exists no current industry standards that specify the proper design methodology (Kouchesfehani et al., 2021) and while spray applied concrete has been used for more than 80 years in these applications much of the design is ad hoc and based on estimated rules of thumb.

In the recent past several efforts have been made to develop models based on engineering testing including Kang & Davidson (2013), Garcia & Moore (2015), and Royer & Matthews (2019). As these efforts have been undertaken an ever expanding data set of experimental results has been developed in the academic literature. Herein the data from five (5) different investigations are examined with engineering models predicted, and conservative results are developed and discussed.

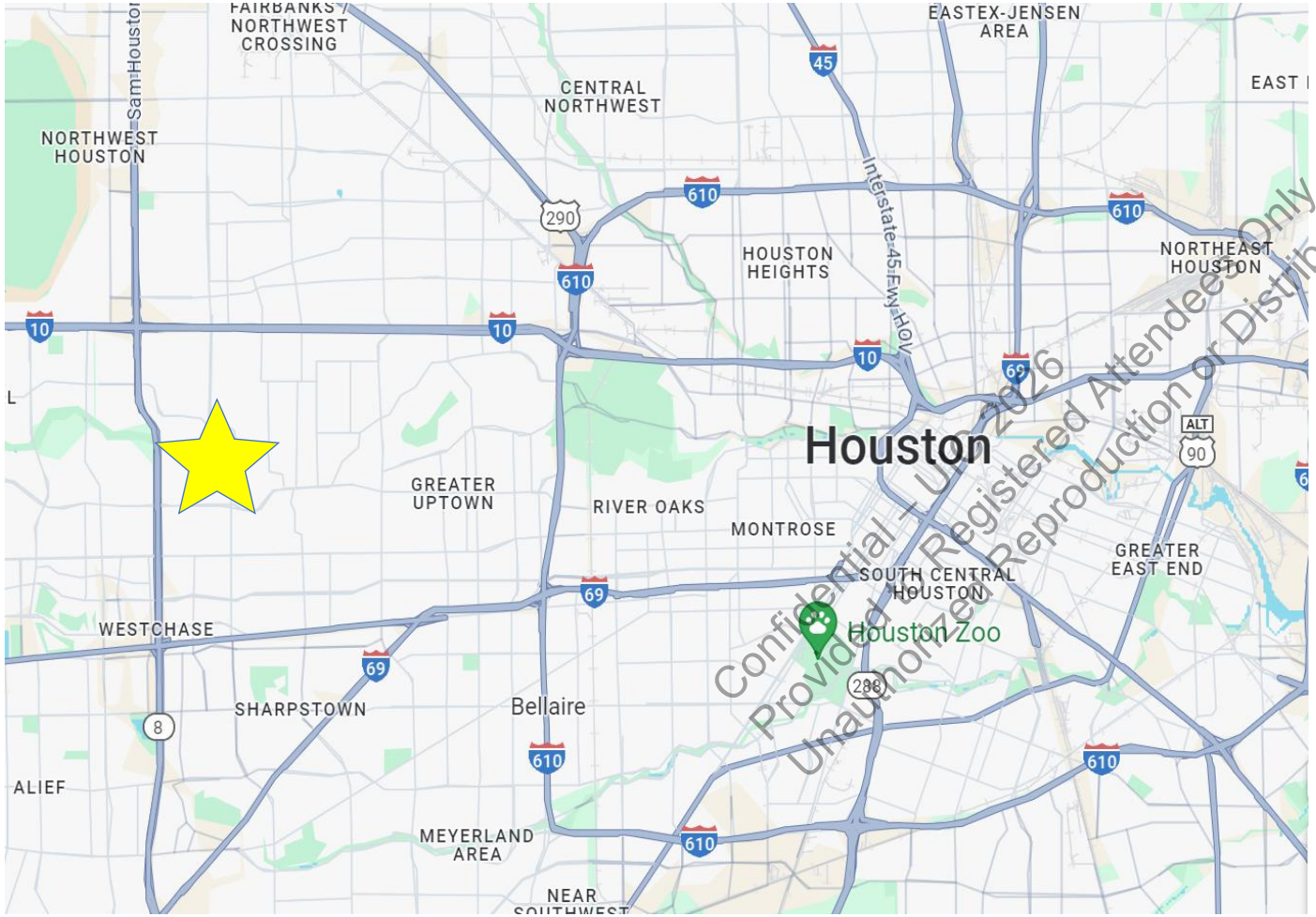
ASCE Pipelines, Matthews & Royer (2022)

Distributed Load Across a Fixed Arch

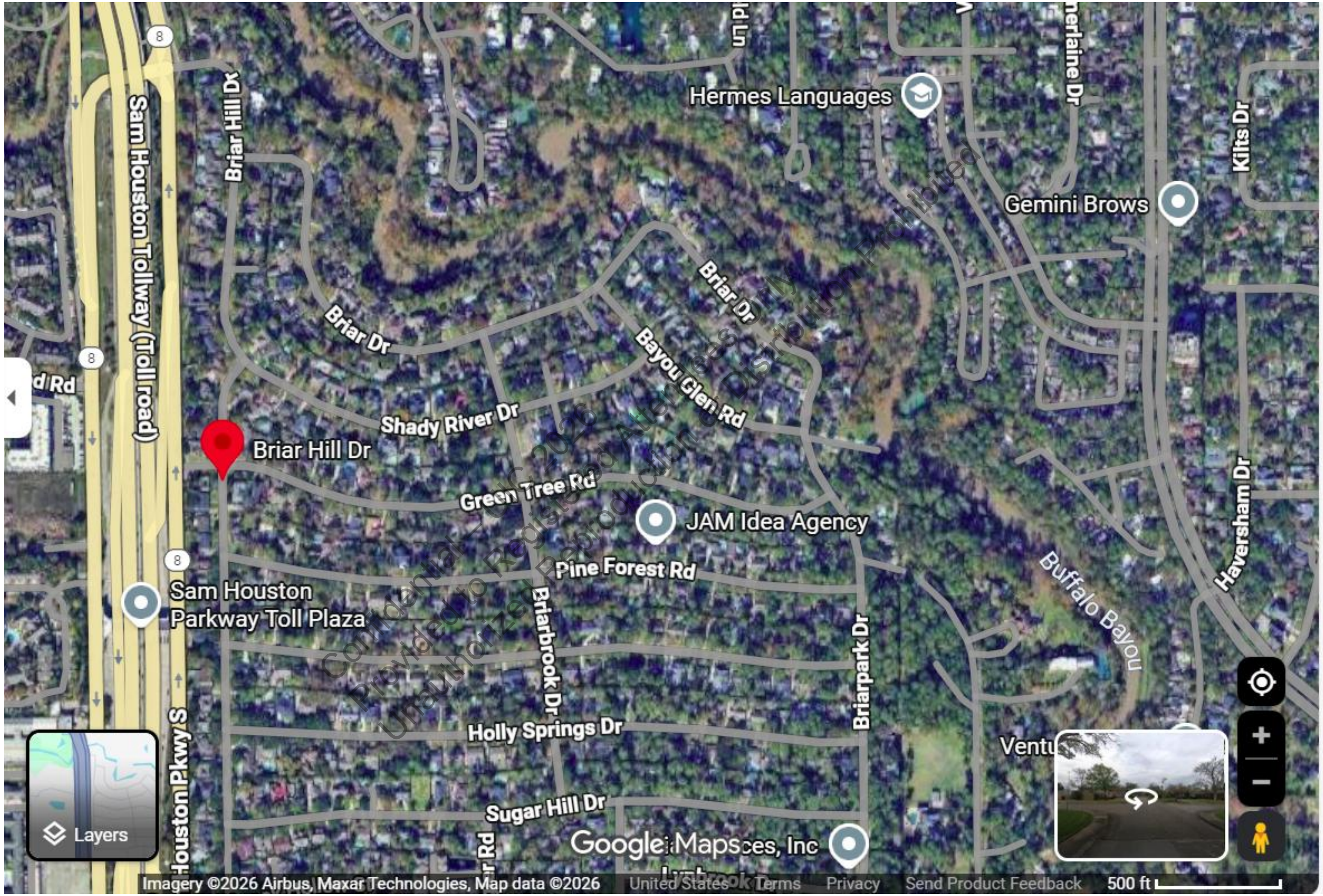
The Design Method is not specific to Round, but valid for any arched structure



Briar Hill Project Location

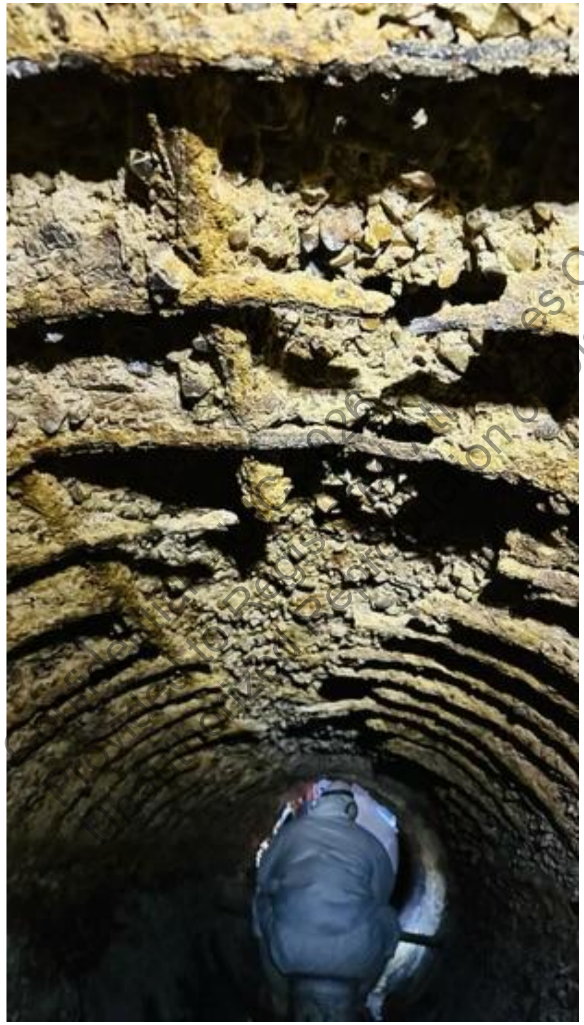


- > 3,000 lf of 48-inch RCP
- Due to deterioration actually up to 56-inch diameter


Hermes Languages
Gemini Brows
Kilts Dr
Briar Hill Dr
Sam Houston Tollway (Toll road)
Briar Dr
Bayou Glen Rd
Shady River Dr
Briar Hill Dr
Green Tree Rd
JAM Idea Agency
Pine Forest Rd
Sam Houston Parkway Toll Plaza
Briarbrook Dr
Briarpark Dr
Buffalo Bayou
Haversham Dr
Holly Springs Dr
Sugar Hill Dr
Sam Houston Pkwy S
Layers
Google Maps
Imagery ©2026 Airbus, Maxar Technologies, Map data ©2026
United States
Terms
Privacy
Send Product Feedback
500 ft

Typical Street View in the project area

Existing Condition



Considerations

- Pipe condition was too deteriorated for CIPP
- Due to lengths/weights of some CIPP runs would have been over the weight limit requiring over the hole wet out
- Numerous Voids and only other option most likely open cut
- Multiple manholes on the Sam Houston Pkwy – with SAPL better access with man entry and less traffic control needed / less footprint

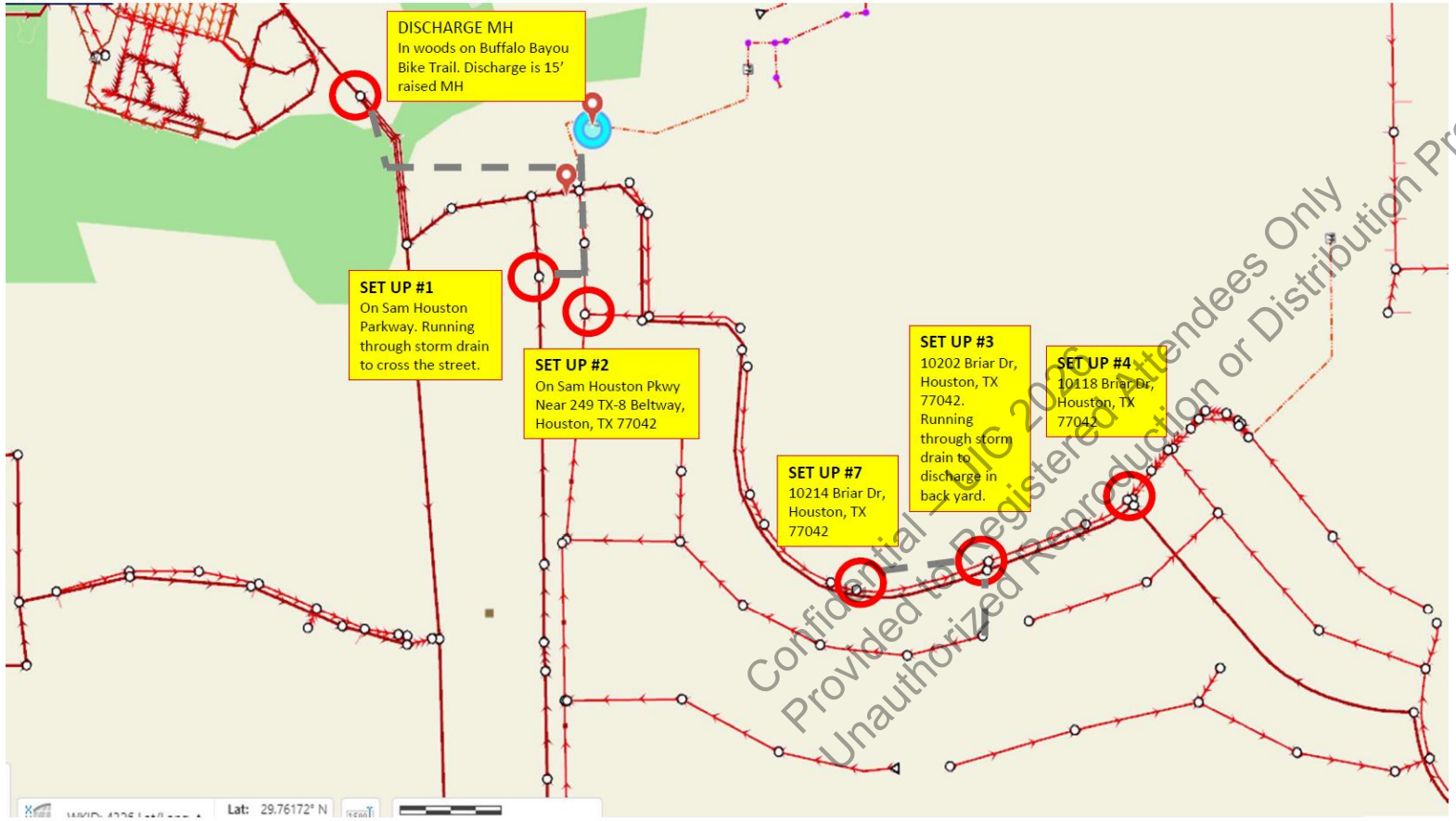
Geospray application advantages:

Footprint

- All required equipment is housed in a single 24ft box truck, with hopper & material storage.
- All repair equipment fits down a standard 24-inch manhole.

CIPP over the hole wet out: footprint

Bypass Setup



- Over 5,000 LF of bypass piping
- 7 set ups & 15 pumps
- Running 24 hours for over 6 months
- Running along Westheimer

- In some areas it needed over 5” of build back with GeoStrong

- Pipe was supposed to be 48”, due to deterioration they were 52”-56”

- Final 1.5-inch Layer was enhanced corrosion resistance

Questions?

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