Trying to Reason with The Hurricane Season

Justin Mouton
PM Construction

Ted Jones, P.E.
GeoTree Solutions

Underground Infrastructure Conference
Construction. Rehabilitation. Asset Management.
March 4-6, 2025 | Houston, TX

Presentation Outline

Geopolymer SAPL Lining Overview

- Materials
- Process / equipment
- Specifications

Texas City Case Study

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

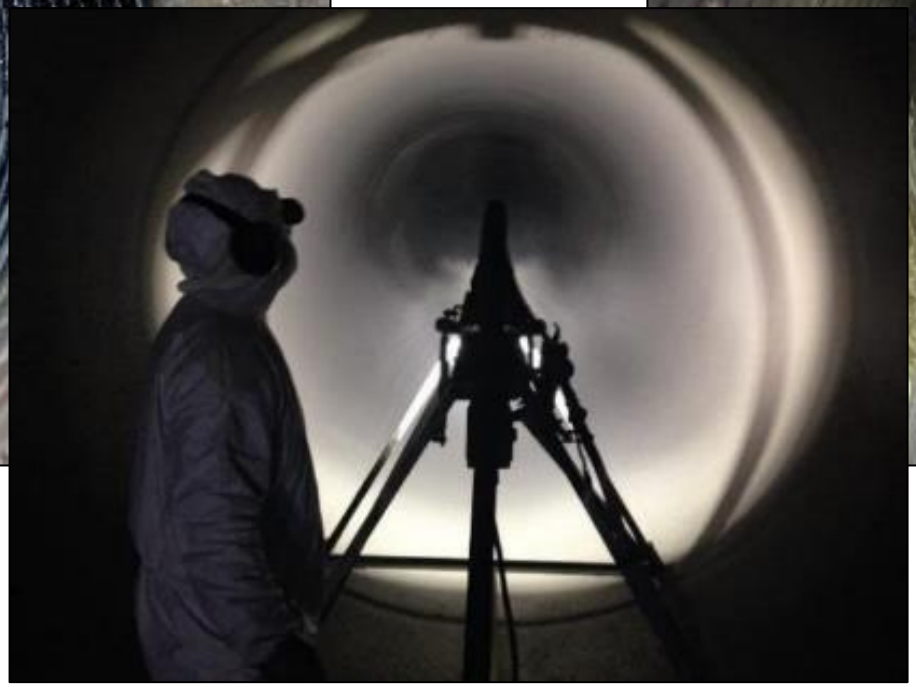
Shape
- Non-round, elliptical, egg shaped
- Manholes, wet-wells, junction boxes

Length
- Short lines, culverts, point repair
- Longer sewer and storm segments

Diameter
- From 24 inches to 22 ft
- Varying diameters in a single run

Ovality
- Ovality greater than 10%
- Box culverts and structures

SAPL Process: Centrifugal Casting



SAPL Process: Hand Spraying

Geopolymer Environmental Benefits

- Fly ash and slag materials are introduced and serve as “alternative cementitious” binders as well as “contributing fillers”, such that every particle within the geopolymer is providing some cross-linking characteristic.

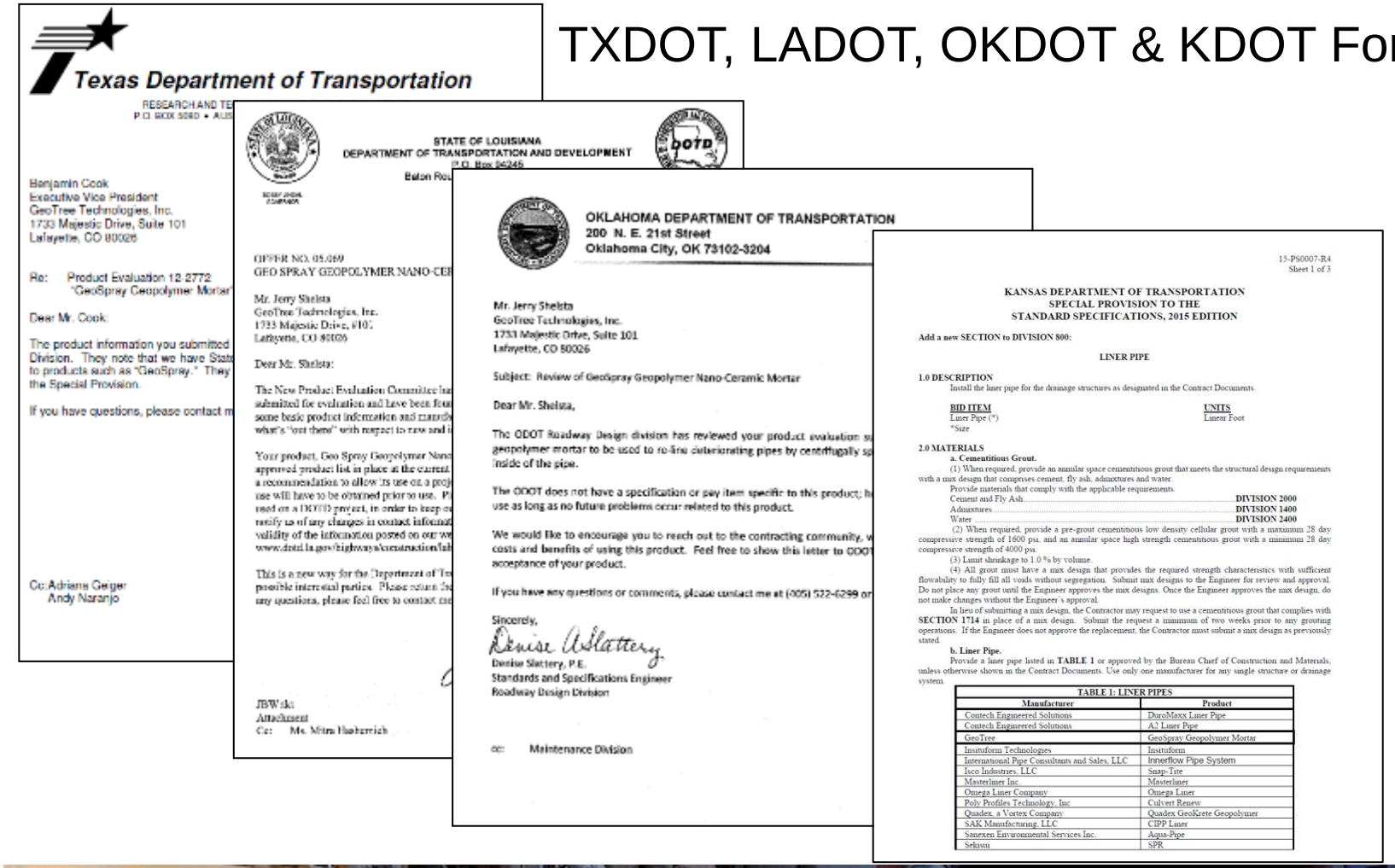
- Geopolymer has between 65% - 90% less CO_2 than standard ordinary portland cementitious materials.

- GeoSpray geopolymer has passed NSF61, WRAS potable water certification, and many other international test standards

Geopolymer Approvals

TXDOT, LADOT, OKDOT & KDOT Formal Approvals Since 2012

AASHTO NTPEP
&
Approved by WRC as a full Structural Repair



Texas Department of Transportation

RESEARCH AND TE
P.O. BOX 5080 • AUS

Benjamin Cook
Executive Vice President
GeoTree Technologies, Inc.
1733 Majestic Drive, Suite 101
Lafayette, CO 80026

Re: Product Evaluation 12-2772
"GeoSpray Geopolymer Mortar"

Dear Mr. Cook:

The product information you submitted
Division. They note that we have State
to products such as "GeoSpray." They
the Special Provision.

If you have questions, please contact m

Cc: Adriana Geiger
Andy Naranjo

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
P.O. Box 94245
Baton Rou

OFFER NO. 05-089
GEO SPRAY GEOPOLYMER NANO-CE

Mr. Jerry Shelsta
GeoTree Technologies, Inc.
1733 Majestic Drive, #101
Lafayette, CO 80026

Dear Mr. Shelsta:

The New Product Evaluation Committee In
submitted for evaluation and have been fou
some basic product information and materia
what's "out there" with respect to new and i

Your product, Geo Spray Geopolymer Nano
approved product list in place at the current
a recommendation to allow its use on a proj
use will have to be obtained prior to use. P
used on a DOTD project, in order to keep o
notify us of any changes in contact informat
validity of the information posted on our we
www.dotd.la.gov/highways/construction/lab

This is a new way for the Department of Tr
possible interested parties. Please return 2
any questions, please feel free to contact me

JBW/ski
Attachment
Cc: Ms. Mitra Hashemieh

OKLAHOMA DEPARTMENT OF TRANSPORTATION
200 N. E. 21st Street
Oklahoma City, OK 73102-3204

Mr. Jerry Shelsta
GeoTree Technologies, Inc.
1733 Majestic Drive, Suite 101
Lafayette, CO 80026

Subject: Review of GeoSpray Geopolymer Nano-Ceramic Mortar

Dear Mr. Shelsta,

The ODOT Roadway Design division has reviewed your product evaluation su
geopolymer mortar to be used to re-line deteriorating pipes by centrifugally sp
inside of the pipe.

The ODOT does not have a specification or pay item specific to this product; h
use as long as no future problems occur related to this product.

We would like to encourage you to reach out to the contracting community, w
costs and benefits of using this product. Feel free to show this letter to ODOT
acceptance of your product.

If you have any questions or comments, please contact me at (405) 522-0299 or

Sincerely,
Denise Slattery
Denise Slattery, P.E.
Standards and Specifications Engineer
Roadway Design Division

cc: Maintenance Division

15-PS0007-R4
Sheet 1 of 3

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2015 EDITION

Add a new SECTION to DIVISION 800:

LINER PIPE

1.0 DESCRIPTION
Install the liner pipe for the drainage structures as designated in the Contract Documents.

BID ITEM	UNITS
Liner Pipe (*)	Linear Foot
*Size	

2.0 MATERIALS
a. Cementitious Grout.
(1) When required, provide an annular space cementitious grout that meets the structural design requirements with a mix design that comprises cement, fly ash, admixtures and water.
Provide materials that comply with the applicable requirements.

Cement and Fly Ash	DIVISION 2000
Admixtures	DIVISION 1400
Water	DIVISION 2400

(2) When required, provide a pre-grout cementitious low density cellular grout with a maximum 28 day compressive strength of 1600 psi, and an annular space high strength cementitious grout with a minimum 28 day compressive strength of 4000 psi.
(3) Limit shrinkage to 1.0 % by volume.
(4) All grout must have a mix design that provides the required strength characteristics with sufficient flowability to fully fill all voids without segregation. Submit mix designs to the Engineer for review and approval. Do not place any grout until the Engineer approves the mix designs. Once the Engineer approves the mix design, do not make changes without the Engineer's approval.
In lieu of submitting a mix design, the Contractor may request to use a cementitious grout that complies with SECTION 1714 in place of a mix design. Submit the request a minimum of two weeks prior to any grouting operations. If the Engineer does not approve the replacement, the Contractor must submit a mix design as previously stated.
b. Liner Pipe.
Provide a liner pipe listed in TABLE 1 or approved by the Bureau Chief of Construction and Materials, unless otherwise shown in the Contract Documents. Use only one manufacturer for any single structure or drainage system.

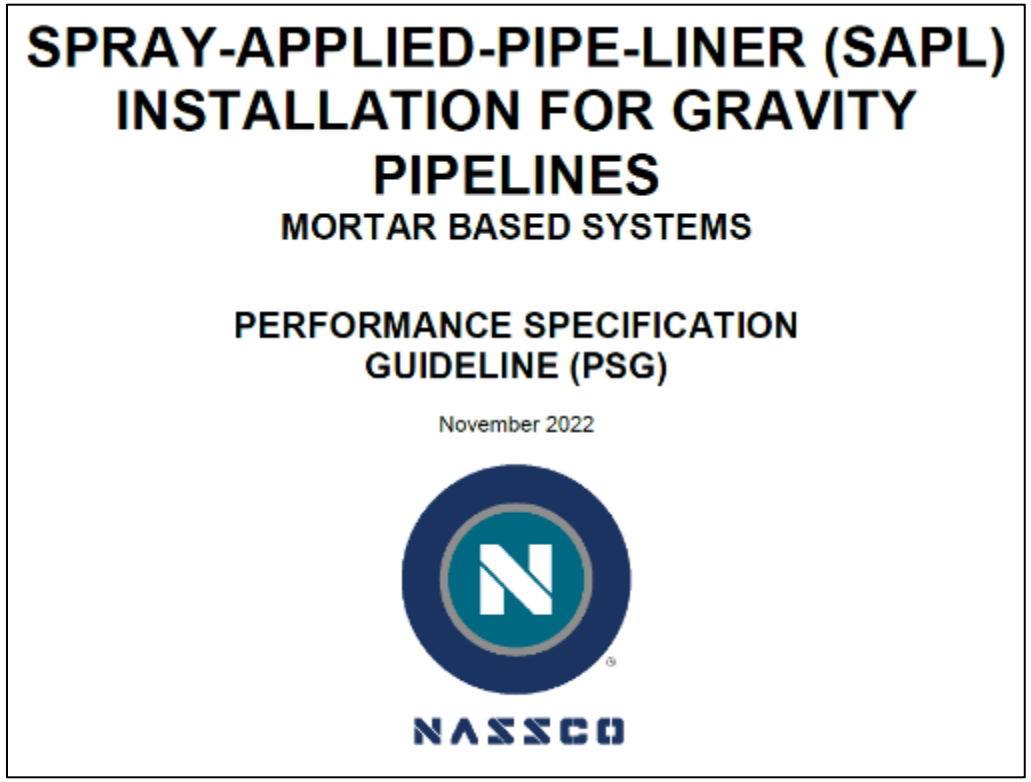
TABLE 1: LINER PIPES

Manufacturer	Product
Contech Engineered Solutions	DuroMaxx Liner Pipe
Contech Engineered Solutions	A2 Liner Pipe
GeoTree	GeoSpray Geopolymer Mortar
Insituform Technologies	Insituform
International Pipe Consultants and Sales, LLC	Innerflow Pipe System
Isco Industries, LLC	Snap-Tite
Masterliner Inc	Masterliner
Omega Liner Company	Omega Liner
Poly Profiles Technology, Inc	Culvert Renew
Quadex, a Vortex Company	Quadex GeoKrete Geopolymer
SAK Manufacturing, LLC	CIPP Liner
Sanexen Environmental Services Inc.	Aqua-Pipe
Sekisui	SPR

SAPL Specification: NASSCO

The SAPL (Spray-Applied Pipe Liner) Guideline Specification

- 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)

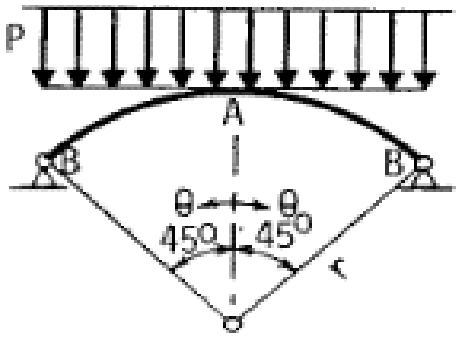
[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.
Current edition approved Nov. 15, 2024. Published December 2024. DOI: 10.1520/F3706-24.

[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

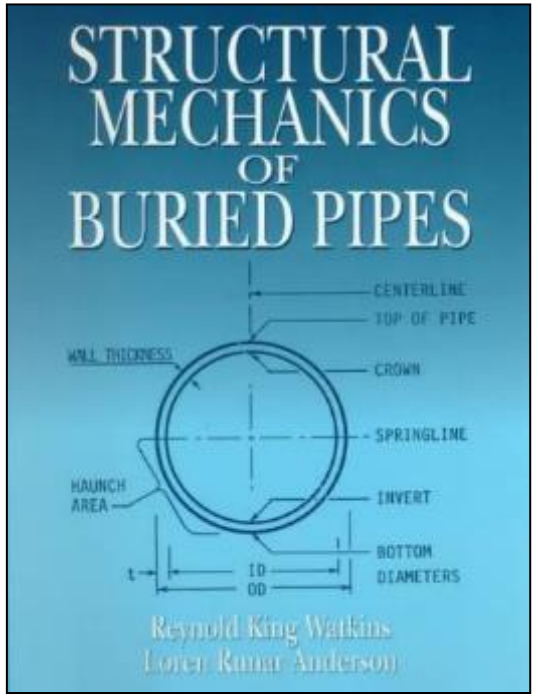
- Flexural strength, ASTM C78 (1500 psi)



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

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

Joseph R. Royer, Ph.D.[1], John C. Matthews, Ph.D.[2]

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[2] Trenchless Technology Center (TTC), P.O. Box 10348 Louisiana Tech University, Ruston, LA 71272, email: matthews@latech.edu

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)

7th Avenue Drainage Improvements

Engineer of Record:

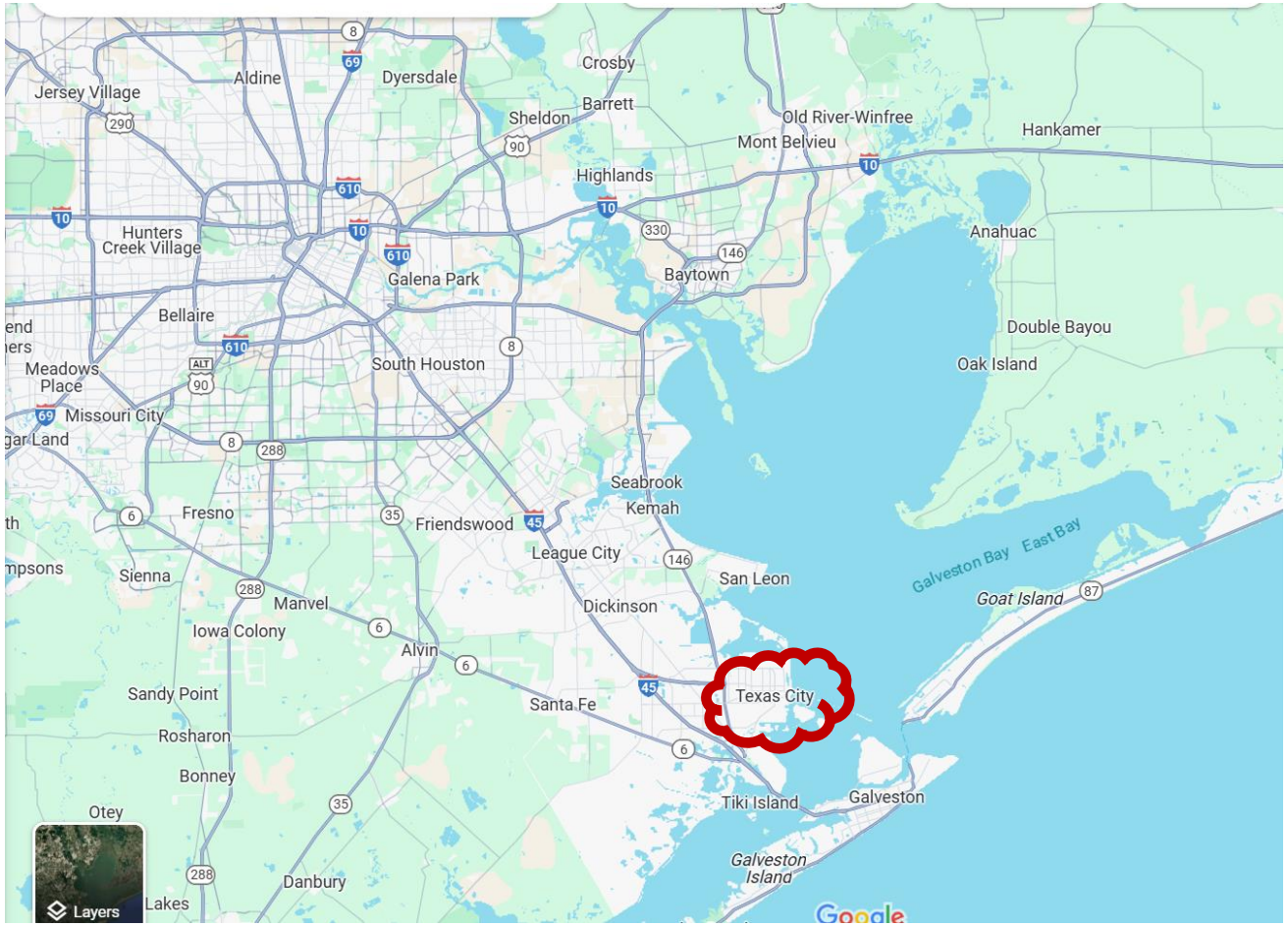
ARKK Engineers

Houston, TX

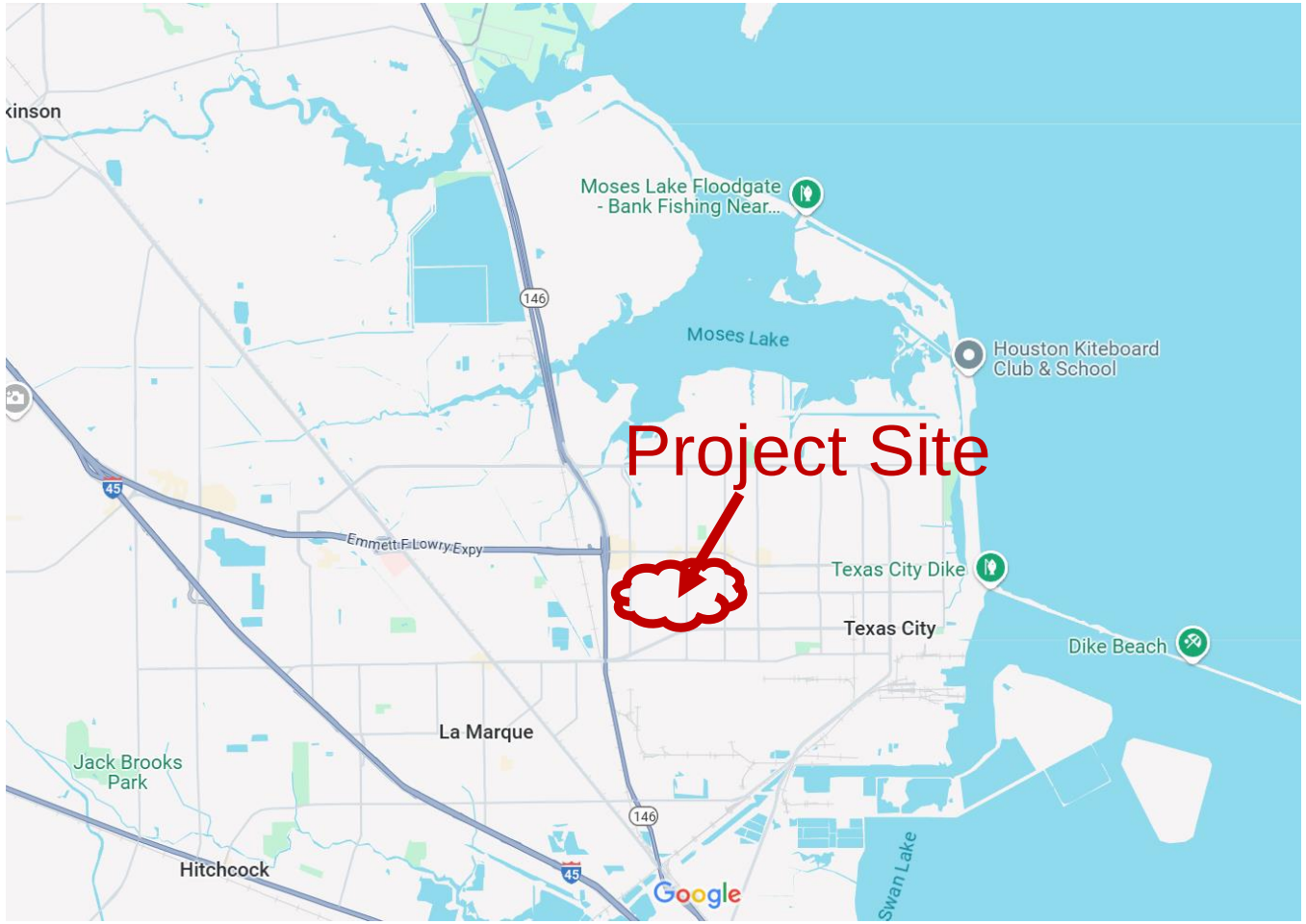
The Challenge

- 1,575 lf of Twin 112”x75” (3,150 lf total) multi-plate corrugated steel arch pipes
- 620 lf of 8’ x 5’ RCB
- Public easements beneath residential backyards
- Structures and significant landscaping modifications directly above
- Hurricane season

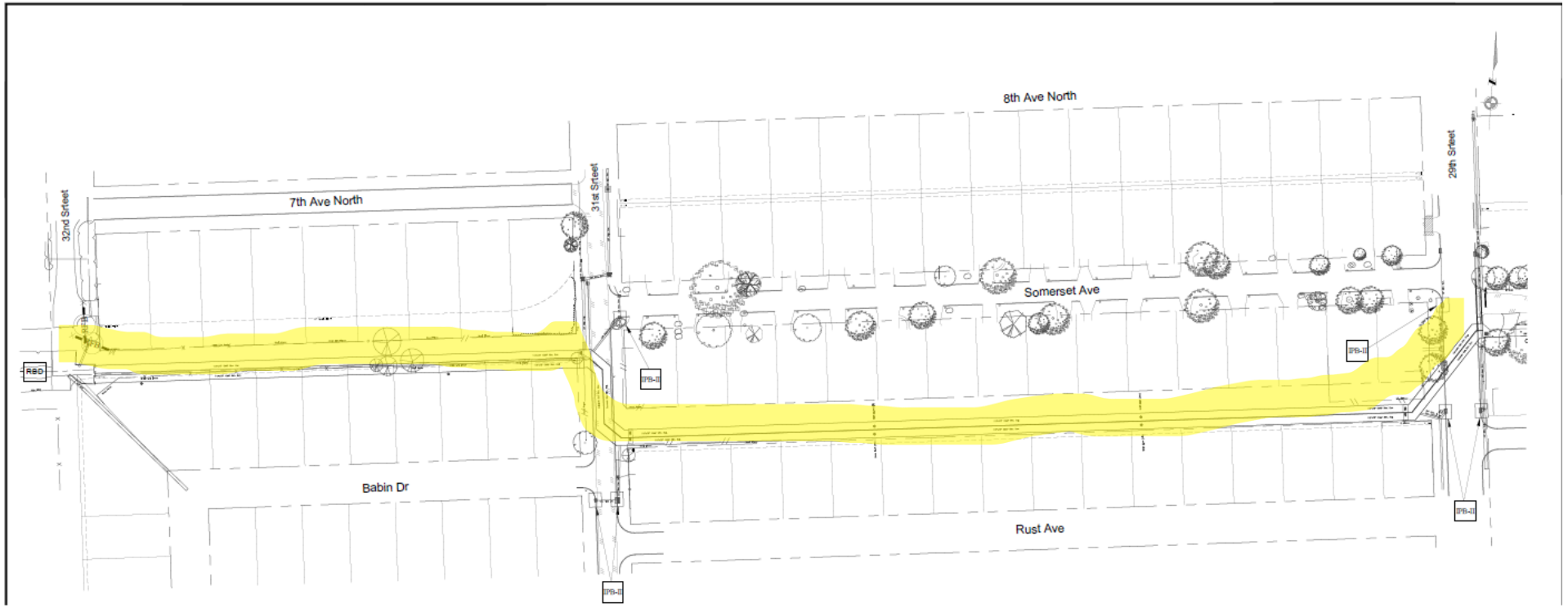
Project Location



Project Location



Site Specifics



Site Specifics

Why a Geopolymer Spray Applied Lining (SAPL)

- Faster cure time of geopolymer lent itself to mitigating storm/flooding risks during hurricane season
- Minimized traffic impact on residential streets
- Access to pipe accommodated landscape modifications and structures

Cleaning

Spraying

- Set Screws used as gage depth for the design thickness
- Geopolymer bonding properties eliminate cold joints

Completed 1 month ahead of Schedule

Questions?

- **Ted Jones, P.E. – GeoTree Solutions**
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  830.832.8560
  GeoTreeSolutions.com

- **Justin Mouton – PM Construction**
  justin.mouton@puriscorp.com
  346.268.0161
  PurisCorp.com