

**09/30/2021**

# GEOTECHNOLOGY



## **FIELD TEST EVALUATION MINE REMEDIATION AT STREETS OF WEST PRYOR LEE'S SUMMIT, MISSOURI**

Prepared for:

**STREETS OF WEST PRYOR, LLC  
OVERLAND PARK, KANSAS**

Prepared by:

**GEOTECHNOLOGY, LLC  
OVERLAND PARK, KANSAS**

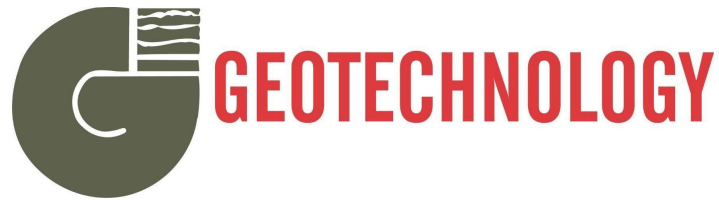
Date:

**SEPTEMBER 1, 2021**

Geotechnology Project No.:

**J035637.02**

**SAFETY  
QUALITY  
INTEGRITY  
PARTNERSHIP  
OPPORTUNITY  
RESPONSIVENESS**



September 1, 2021

Mr. David Olson  
Streets of West Pryor, LLC  
7200 W 132<sup>nd</sup> Street, #150  
Overland Park, Kansas 66213

Re: Field Test Evaluation  
Mine Remediation at Streets of West Pryor  
Lee's Summit, Missouri  
Geotechnology Project No. J035637.02

Dear Mr. Olson:

Presented in this report are Geotechnology, LLC's (Geotechnology) observations, summary and conclusions regarding the initial field test of the mine remediation technique planned for the Streets of West Pryor development. This document was prepared based on field observations, discussions with Drill Tech Drilling and Shoring, Inc. (DTS) personnel, and engineering calculations and assessments. The summary and conclusions are related to the initial field test and should not be considered a comment on the process to date.

## **1.0 BACKGROUND AND PROJECT INFORMATION**

Geotechnology was retained to evaluate a development over subsurface space in Lee's Summit, Missouri. Current plans are for an 11.2-acre surface development. Details can be found in our report "*Revised Mine Remediation Plan, Mine Filling at Streets of West Pryor*" (*Remediation Plan*) dated May 6, 2021.

*Remediation Plan* details included a discussion of anticipated production borings for rock placement and the specifications for backfill material. In addition, the *Remediation Plan* also provided details as to quality control and assurance for the mine backfill. As part of the *Remediation Plan*, a field test was proposed using an existing vent shaft that extends to the underground space. The vent shaft is approximately 19 inches in diameter and cased to a depth of 64 feet, which is within 1.5 feet of the mine roof. In addition, the plan also discussed the need to confirm the relationship between the surface survey and the subsurface; this was to verify that the surface staked locations correspond to the center of the mine rooms. This confirmation included planned advancement of three production borings. Field measurements would be taken at the mine level to verify the accuracy of the staked locations.

Per the *Remediation Plan*, backfill materials are to have a specific gradation. Deleterious materials within the backfill are not permitted. The backfill used in the field test generally consisted of crushed limestone from on-site stockpiles and some import material. The contractor providing crushing services is Industrial Demolition and Salvage (IDS).

---



Placement of backfill in the mine space is performed by DTS. The method described in the *Remediation Plan* includes mechanically dispersing the backfill via centripetal force using a proprietary tool (i.e., *rock slinger*).

Verification of the performance of the rock slinger and rock gradation was proposed. Verification includes entering mine space to observe the resultant backfill and laboratory testing of the mine backfill.

The field test was conducted July 12 through 15, 2021 at the location shown on the attached figure (provided by DTS). The existing shaft was offset approximately 5 feet south-southwest of the room center. The roof beam in this area measured approximately 30 feet from pillar to pillar. At the time of backfill placement, the room was inundated with approximately 2 feet of water.

The field test consisted of (1) lowering the rock slinger to a distance of 1 foot below the mine roof, (2) dumping crushed limestone down the vent shaft, and (3) mechanically spinning the rock slinger. Specifics of construction and operation of the device are included in Appendix A. During the test, adjustments to the position of the rock slinger, revolutions per minute (RPM), feed rate of the conveyor, and material gradation were performed to improve the backfill technique. Mine backfilling was observed from both the surface and the underground space. Backfilling was performed intermittently to allow further observation of the crushed limestone pile.

## **2.0 FIELD OBSERVATION**

### **2.1 Prepared Aggregate**

The prepared aggregate shall consist of 2-inch minus crushed limestone with less than 20% fines and free of organic matter. Existing on-site materials and some import were crushed at the site. Initially, two streams of material were produced. Bulk samples were collected and gradation tests were performed. Based on the results of the initial gradation test a screen was introduced as part of the crushing operation. This produced three stockpile streams, one being termed 2-inch minus, the second being termed ½-inch minus, and the third consisting of rock flour. It is recognized that the tested gradation does not necessarily correlate to the terminology used. One sample was collected prior to the introduction of the screen (Sample ID 1185-Crushed Limestone). Two additional samples were obtained after re-processing of materials, one from the 2-inch minus and one from ½-inch minus stream. Test results are included in Appendix B. Gradation testing was not performed on the rock flour. While the test results did not explicitly meet the specifications, aggregate placement did perform in general accordance with the specifications. Refinement of the crushing process is being considered and will continue as the project progresses.

### **2.2 Rock Slinger Operation**

Representatives of Geotechnology observed the field test. Site activities and observations were documented in Daily Field Reports (DFRs). Intermittent observations and measurements of the rock pile were made during the filling process. Documentation of variations of material placed, rotational speed, feed rate, and other modifications were noted on the DFR. For this field test,



two different size slingers were used. The smaller diameter slinger was used to place the first approximately 75 cubic yards of fill. The larger diameter slinger was used to place the remainder of the backfill. The initial smaller slinger was abandoned for use of the larger slinger. Discussion of the two types of slingers tested is limited to this report. Photographs and diagrams are included in Appendix C.

Mine filling activities commenced with the smaller diameter rock slinger. The smaller diameter slinger created a stockpile of material with a diameter of approximately 15 to 20 feet with an angle of repose of approximately 20 degrees. The second slinger was introduced and backfill placement continued. Use of the larger diameter slinger resulted in a stockpile of material with a diameter of approximately 30 feet or more with an angle of repose of 15 to 30 degrees. The resultant stockpile was biased to the southwest corner of the mine room. Observed higher clay content within the backfill created a steeper angle of repose as expected. Further evaluation is necessary to understand the effect of clay content as part of the allowable fines.

Materials placed ranged in size between 2-inches and ½-inches. The sequence of material placement requires further refinement to verify volumetric fill potential. Filling operations ceased when the fill pile extended to the roof and the slinger could no longer be rotated. The remainder of the shaft was gravity filled with 0.5 inch and 2-inch material. Segregation of materials in the backfill pile were not observed in the test fill. Settlement of the backfill was not observed as of July 23, 2021 by means of visual inspection of the top of fill materials relative to the ground surface.

The resultant pile was measured and had a diameter of approximately 4 to 5 feet against the mine roof. The base of the fill pile extended to the approximate mid-point of the mine room defined by the adjacent pillars. Average distance from the midpoint of the pile slope to the roof is approximately 5 to 10 feet. Based on observation of the rock slinger field test, it appears the rock slinger effectively spreads rock in a relatively uniform manner. The existing shaft did not did not clog nor “choke” during fill placement.

### **2.3 Survey**

For survey confirmation, three holes were advanced by means of rotary hammer to the mine level. These three holes were planned to confirm the survey and then to be used as production holes. These holes are designated A-7, A-11 and A-13 and were drilled at the locations the Figure. Measurements at the mine level were taken by Geotechnology and BHC, Inc. (BHC) (project surveyor) to evaluate the proximity of the holes to the center of the mine room. Field measurements and observations indicated that the holes were not located in the center of the rooms and were offset an approximate distance of 10 feet south, southwest. Two additional holes were advanced, designated as A-10 and A-12, to further establish the correlation between the surface and subsurface surveys. These holes when drilled were found to be staked off-center of the room. At this time, additional survey information is recommended to establish the relationship of the subsurface and surface surveys. The additional survey should include the advancement holes C-55 and C-57, and a correction to the surface survey as it relates to the subsurface survey should be made.





practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions.

### **ENCLOSURES**

The following attachments are included in and complete this report:

- |            |   |  |
|------------|---|--|
| Figure     | - | Field Test Location  |
| Appendix A | - | Draft Memorandum (Prepared by Drill Tech Drilling & Shoring, Inc.) |
| Appendix B | - | Laboratory Test Results  |
| Appendix C | - | Photographic Log   |
| Appendix D | - | Calculations   |

\* \* \* \* \*

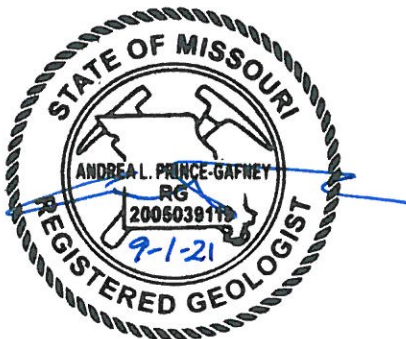
It has been our pleasure to provide geotechnical services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact the undersigned if you need further information about this document.

Respectfully submitted,

**GEOTECHNOLOGY, LLC**

Andrea Prince, P.G.  
Senior Project Manager

ALP:MHM:alp\ljd





### **3.0 ANALYSIS OF PERFORMANCE**

The estimated volume of fill placement per room in the study area is approximately 390 cubic yards using the typical room dimensions over the area. This volume is based on the equation of a truncated cone, with a base radius of 25 to 30 feet, a top radius of 2 feet, and a height of 12 feet. This assumes an average pillar to pillar spacing of approximately 35 feet and a typical 12-foot-high room. Further discussion is included in Appendix A. Approximately 337 cubic yards of crushed limestone backfill was actually placed, which corresponds to 86 percent of the calculated volume. Calculations with intimate roof contact are included in Appendix D. The factor of safety against roof beam overstressing increased since the unsupported distance of the beam was reduced by 50 percent. It is anticipated that the mine space will have an increase in long-term stability with an increase in room filling as the unsupported length of roof beam has decreased.

### **4.0 CONCLUSIONS AND RECOMMENDATIONS**

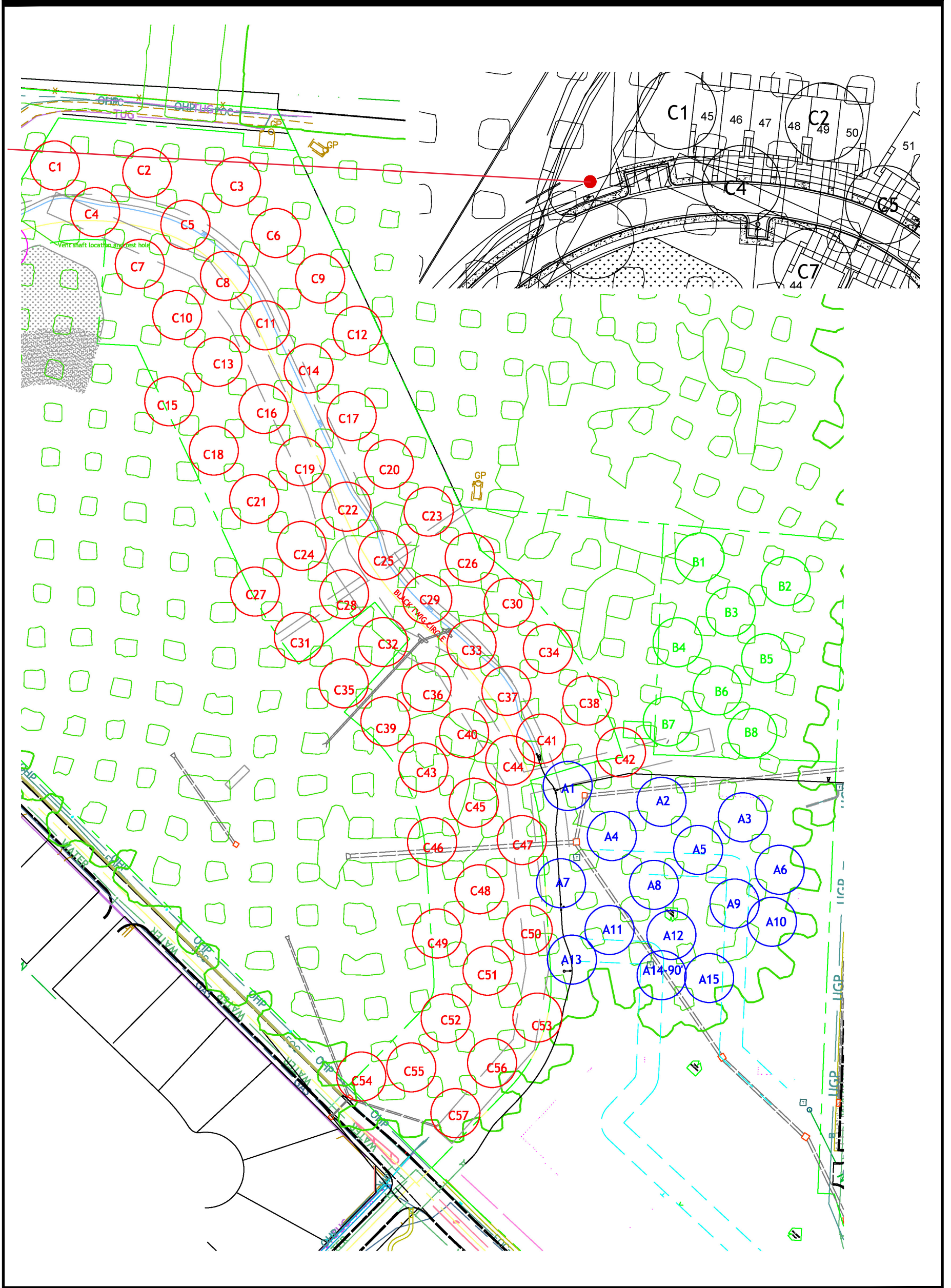
Based on the results of the field test, it is our opinion the rock slinger device is suitable for use in backfilling the mine space beneath the Streets of West Pryor development. While the initial test performance did not achieve the exact results anticipated, it is noted that this is the first time that this method has been employed. Refinements in the overall placement, fill materials, and methods are to be expected. Additional test fills should be performed to ensure repeatable results. We recommend that at least three additional test fills be conducted with the following rationale:

- The location of the additional test holes should correspond to the center of the mine rooms.
- Backfill placement should be conducted with production sized holes (14.5-inch ID) which are smaller in diameter than the existing shaft.
- Modifications of the feed rate and rotational speed of the rock slinger should be made to further evaluate the dispersion of the placed aggregate.
- Sequential placement of materials and various gradation of materials should be further investigated and refined as filling progresses.
- Additional holes might be required to 1) optimize fill placement within a room or 2) place fill in additional, adjacent rooms.

### **5.0 LIMITATIONS**

This report has been prepared on behalf of, and for the exclusive use of, the client for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently



NOTES

- 1. Base map provided by BHC, 2021.

LEGEND

- Existing Vent Shaft  
Field Test Location

Drawn By: ALP	Ck'd By: ALP	App'vd By: MHM
Date: 7-17-21	Date: 7-17-21	Date: 7-21-21
<div><div></div><div>GEOTECHNOLOGY</div></div>		
Streets of West Pryor Lee's Summit, Missouri		
MINE REMEDIATION FIELD TEST LOCATION		
Project Number J035637.02		FIGURE

## **APPENDIX A**

Memorandum Prepared by Drill Tech Drilling & Shoring, Inc.





7/15/21

**By:** Patrick Carr, P.E.  
913-378-2575  
Patrick.Carr@DrillTechDrilling.com

#### **RE Test Hole, Streets of West Pryor Mine Stabilization**

A test was performed to verify the performance of the crushed rock placement to improve the mine stability at the Streets of West Pryor site. The test was performed on an existing 19.5" ID vent shaft on the north end of the site. The floor of the mine was 79 feet below the surface and the room is ~12.5 feet tall.

**Setup:** Crushed rock was placed in the hole and distributed using a spinning disk with fold-out arms to increase the radius of the placed stone. The tool is referred to as a "slinger." The tool was designed to operate on 3.5" OD drill steel in a 14.5" drill hole. There are two centralizer bearings to stabilize the drill string and slinger. The first bearing was installed 10' above the slinger and the 2<sup>nd</sup> bearing at a depth of 25 feet. The tool was lowered in the hole on a rotary drill with a variable speed drive. The drill is equipped with a tachometer to display rotation speed. The crushed rock was fed with a gated aggregate hopper equipped with a belt speed counter for placement rate and volume. The loader buckets of aggregate were counted as a determination of the volume placed. Rock was provided by others from on-site material stockpiled near the vent hole. The rock was segregated into 2" and 1/2" size. The rock was loaded into the gated hopper with a Hyundai 4 cy loader. The specifications for the loader bucket are 3.5 cy struck full and 4 cy heaped. 3.75 cy per bucket was used for the volume calculations.

We built 2 designs of the slinger. Both units open to create a 26" diameter plate. The first slinger used utilizes air to expand the plates. The second design uses centrifugal force to expand the plates.

**Observation:** Access was provided inside the mine through the Star Excavation quarry on the north side of I470. We were able to witness the performance of the equipment and process as well as the results. It was necessary to drive a portion of the way into the mine where it became flooded. A boat was then used to travel the rest of the way to and through the tunnel under I470 to access the vent shaft on the south side of I470. Safety protocols are established and are being utilized with Star Excavating.

We were able to talk between the mine and the surface with high-powered handheld radios with the signal presumably passing through the drill hole. This greatly improved our efficiency as the travel time between the surface and the mine is 20 minutes.

The vent hole was not centered in the room. It was offset about 7 feet to the southwest of the center.

**Production:** On 7/12/21 we lowered the first tool design into the hole and ran 7.5 cy (2 buckets) of rock to verify everything worked. On 7/13/21 we placed 135 CY (36 buckets) of material using the first designed slinger with the air activated plates. During the placement, we tried varying rotation speeds of the slinger and varying flow rates. In the test hole, we were unable to spin it more than 230 rpm due to

the wobbling of the drill rod in the larger hole. The feed hopper worked best when it was run at a speed where we emptied a loader bucket with an average time of 1.3 minutes. Faster rpm speeds produced a larger radius of rock distribution. We tried the 2" and the ½"- rock to compare performance. The 2" rock was cleaner and distributed better than the smaller rock. The smaller rock had clay mixed in.

Attached are photos of the equipment and process and videos are available. On 7/14/21 we placed 195 cy (52 buckets) with the centrifugal expanded spinner until the cone reached the mine roof and choked the spinner. A total of 337 cy was placed in the hole.

**Results:** The goal was to place the majority of the rock in a 25 +/- foot diameter ring. There was some stone at a distance of 30' from the center of the vent hole and the majority of the stone was placed at or inside the 25' radius. We anticipated the fill would take the shape of an inverted W with the center filling somewhat slower. This was not the case and the material built up in the center more like rock was dropped and made a natural cone, though the angle of repose was much flatter due to the slinger distributing the stone. We ended up with 4 to 5-foot diameter contact with the roof and a cone of material with a 27 or 28-degree angle of repose measured midway up the pile, though it varied from shallower at the base to steeper at the top.

The volume of a truncated cone with a top radius of 2.5 and an angle of repose of 27 degrees gives a base diameter of 27 feet and a volume of 390 cy, which reasonably approximates the volume placed, considering the base is at a flatter angle.

There was clay mixed in with the smaller rock which was detrimental to the process. The clay would stick to the spinner and clods formed in the rock pile.

**Discussion:** During placement of the rock it was obvious the cone was flatter at the north and west side of the pile. The slinger was biased to the NW side of the drill hole and from watching the process I am confident the slinger was able to distribute the rock better when the rock was dropped closer to the center of the slinger. The system was designed to work in a 14.5" diameter hole. The vent hole was 19.5" in diameter. I didn't anticipate the hole diameter would make a difference in the performance of the slinger or we would have cased the hole to match the production hole diameter. The extended diameter of the paddles on the slinger is 26" diameter. If centered the slinger would only be 3" larger than the hole diameter reducing its effectiveness.

**Conclusions:** This is the first time this process has been used and refinement is required. As with any process, the performance and production will improve with experience. It is our goal to provide stone fill with a sufficient volume to prevent mine roof failure from propagating to the surface. We had anticipated an as much as a 10' diameter peak of the stone cone relatively close to the mine roof. Generally on mine stabilization projects verification of the results is by exploratory borings or with cameras lowered down inspection holes. We have an excellent opportunity to observe the results of this project and we will continue to improve the process.

We have an excellent opportunity to refine the rock placement and improve the results. Our plan to increase the volume placed per hole by 10 to 15% is as follows.

1. We expect the smaller drill hole will direct more of the material at the center of the slinger allowing more contact with the paddles which will impart more horizontal energy.

2. The smaller hole diameter may allow faster rotation speeds because the bearings will be better confined. It was demonstrated, as expected, the faster the rotation speed the further the distribution radius.
3. We will experiment with other placement sequences and processes to increase the volume placed at each location. These might include placing the smaller stone first without the use of the slinger and placing the larger stone with the slinger or the use of a vibrating or percussion to flatten out the truncated cone near the top.
4. Test placing the smaller stone first, followed by the larger stone which travels farther to increase the stone volume per drill hole.

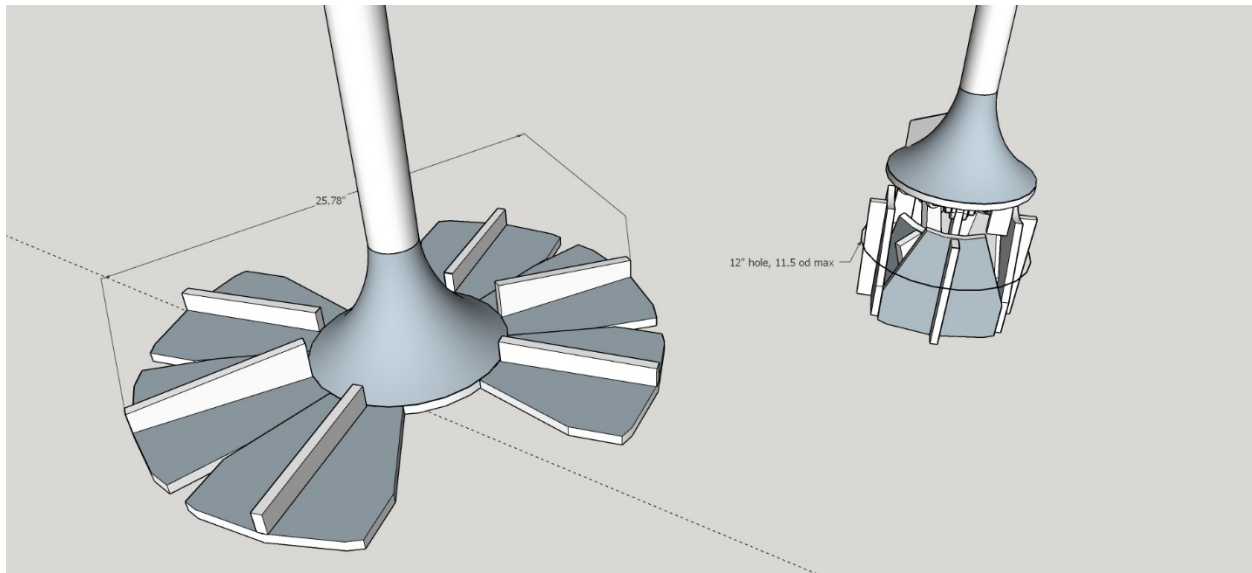
We recommend that we proceed with the process in the production holes in the 7A area and continue to observe and improve the results with experience and utilization of different methods.



**PROJECT:** 21068 Streets of West Pryor

**Location:** Lee's Summit, MO

7/15/21 Page 4 of 9



*Drill Tech Drilling & Shoring, Inc. is an Equal Opportunity Employer*

2200 Wymore Way – Antioch, CA 94509-8548 – (925) 978-2060 – Fax: (925) 978-2063



**PROJECT:** 21068 Streets of West Pryor

**Location:** Lee's Summit, MO

7/15/21 Page 5 of 9



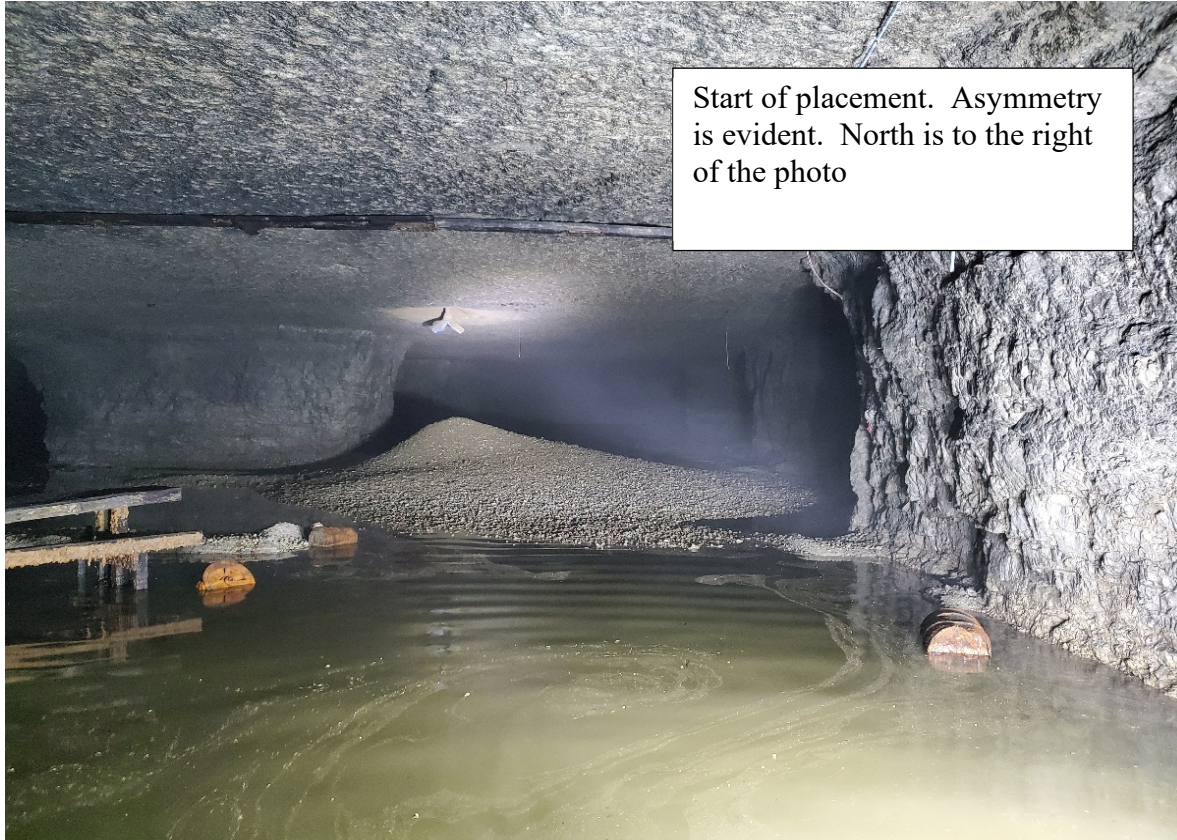
*Drill Tech Drilling & Shoring, Inc. is an Equal Opportunity Employer*  
2200 Wymore Way – Antioch, CA 94509-8548 – (925) 978-2060 – Fax: (925) 978-2063



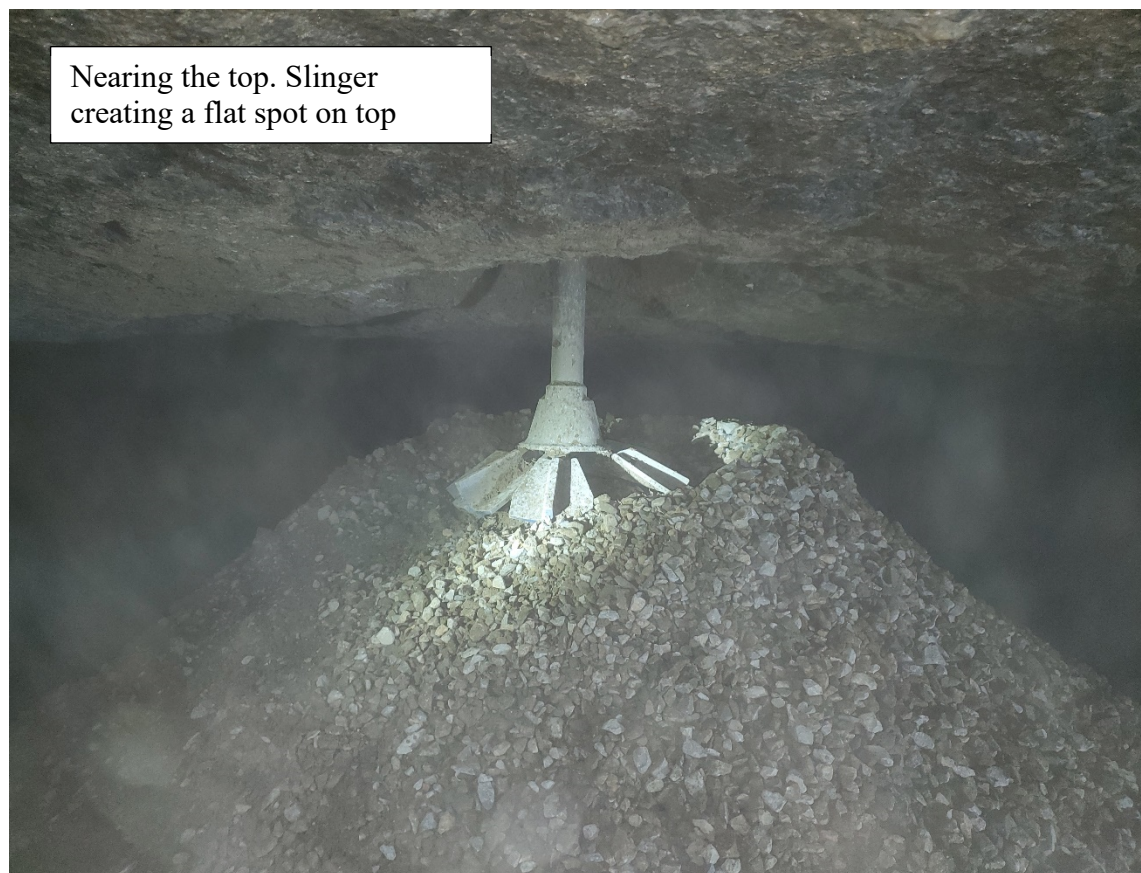
**PROJECT:** 21068 Streets of West Pryor

**Location:** Lee's Summit, MO

7/15/21 Page 6 of 9









**PROJECT:** 21068 Streets of West Pryor

**Location:** Lee's Summit, MO

7/15/21 Page 8 of 9





**PROJECT:** 21068 Streets of West Pryor

**Location:** Lee's Summit, MO

7/15/21 Page 9 of 9



*Drill Tech Drilling & Shoring, Inc. is an Equal Opportunity Employer*

2200 Wymore Way – Antioch, CA 94509-8548 – (925) 978-2060 – Fax: (925) 978-2063

BY: R DATE: 7/15/21

SHEET: \_\_\_\_\_ OF \_\_\_\_\_

CHECKED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

FILE #: \_\_\_\_\_

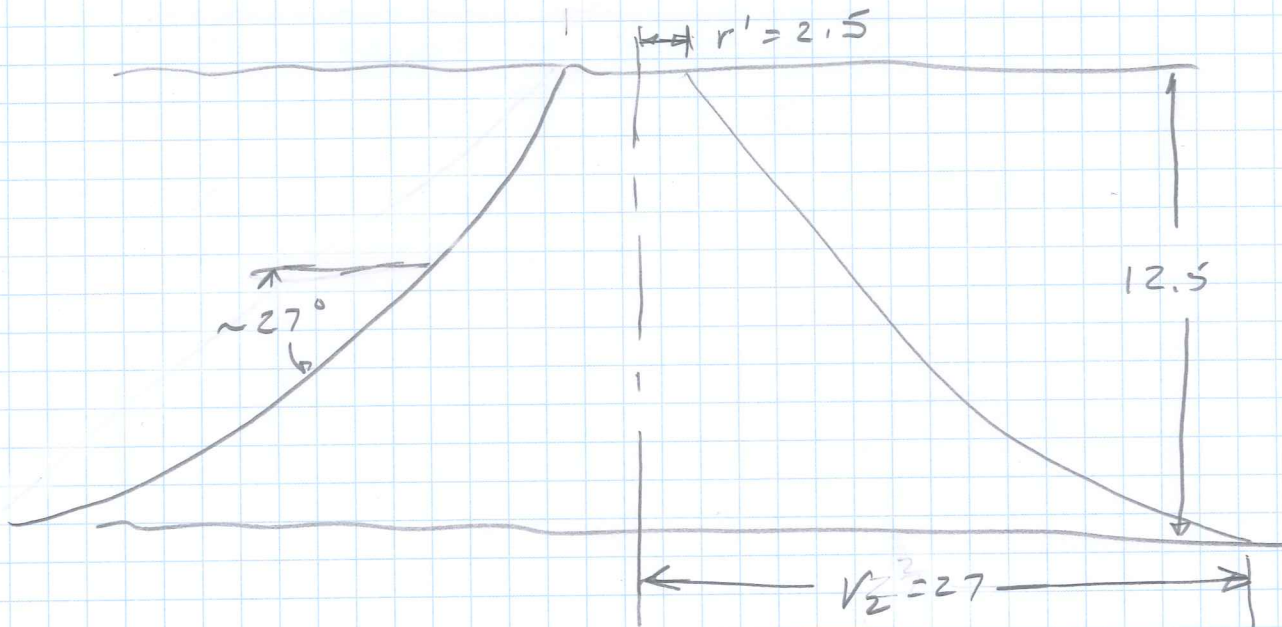
REVISION1: BY: \_\_\_\_\_ DATE: \_\_\_\_\_

PROJECT: STREETS OF WEST PRYON

REVISION2: BY: \_\_\_\_\_ DATE: \_\_\_\_\_

SUBJECT: CONE VOLUME

### TEST HOLE VOLUME CALCULATION



$$V = \frac{1}{3} \pi (r_1^2 + r_1 r_2 + r_2^2) h$$

$$V = 1.047 (2.5^2 + 2.5(27) + 27^2) 12.5$$

$$V = 1.047 (6.25 + 67.5 + 729) 12.5$$

$$V = 1.047 (802.75) 12.5$$

$$V = 10506 \text{ CFT} = 399$$

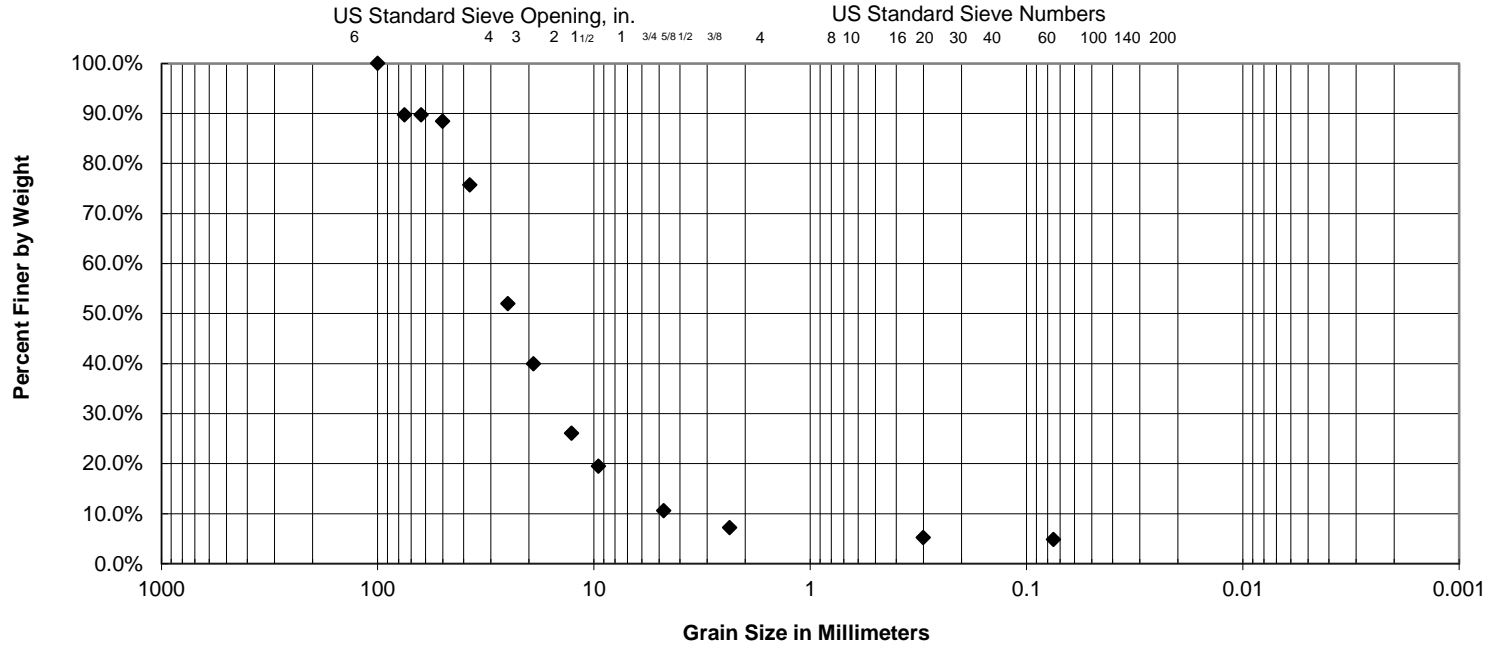


## **APPENDIX B**

### Laboratory Test Results



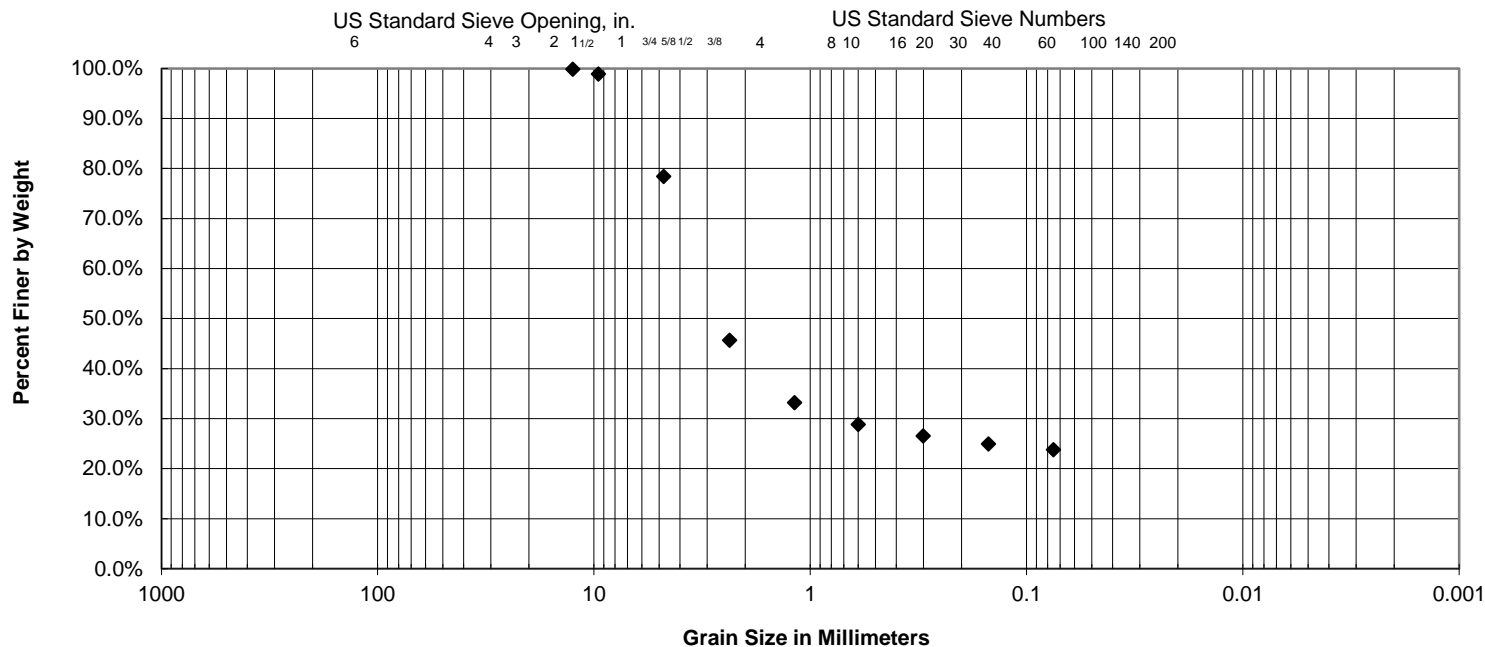
**Mine Filling at Streets of West Pryor J035637.02**  
**Streets of West Pryor, LLC**  
 Grain Size Analysis ASTM D6913



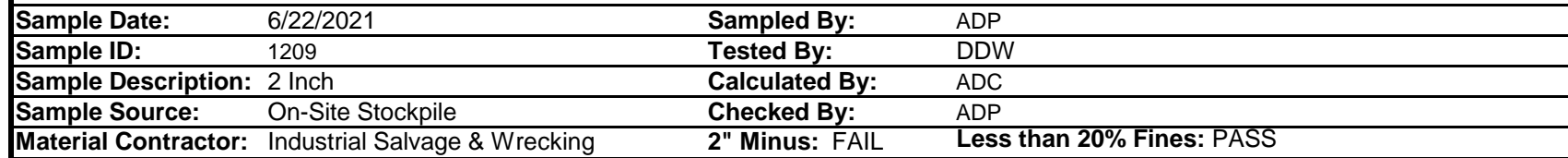
<b>Sample Date:</b>	6/11/2021	<b>Sampled By:</b>	ADP
<b>Sample ID:</b>	1185	<b>Tested By:</b>	DDW
<b>Sample Description:</b>	Crushed Limestone	<b>Calculated By:</b>	ADC
<b>Sample Source:</b>	Stock Pile for Test Hole	<b>Checked By:</b>	ADP
<b>Material Contractor:</b>	Industrial Salvage & Wrecking	<b>2" Minus:</b>	FAIL
		<b>Less than 20% Fines:</b>	PASS



**Mine Filling at Streets of West Pryor J035637.02**  
**Streets of West Pryor, LLC**  
 Grain Size Analysis ASTM D6913



Sample Date:	6/22/2021	Sampled By:	ADP
Sample ID:	1208	Tested By:	DDW
Sample Description:	1/2 Inch	Calculated By:	ADC
Sample Source:	On-Site Stockpile	Checked By:	ADP
Material Contractor:	Industrial Salvage & Wrecking	2" Minus:	FAIL
		Less than 20% Fines:	FAIL



## **APPENDIX C**

Photographic Log



**Description:**  
Surface setup.

**Date:**  
July 12, 2021



**Description:**  
Bottom of the test hole.

**Date:**  
July 12, 2021







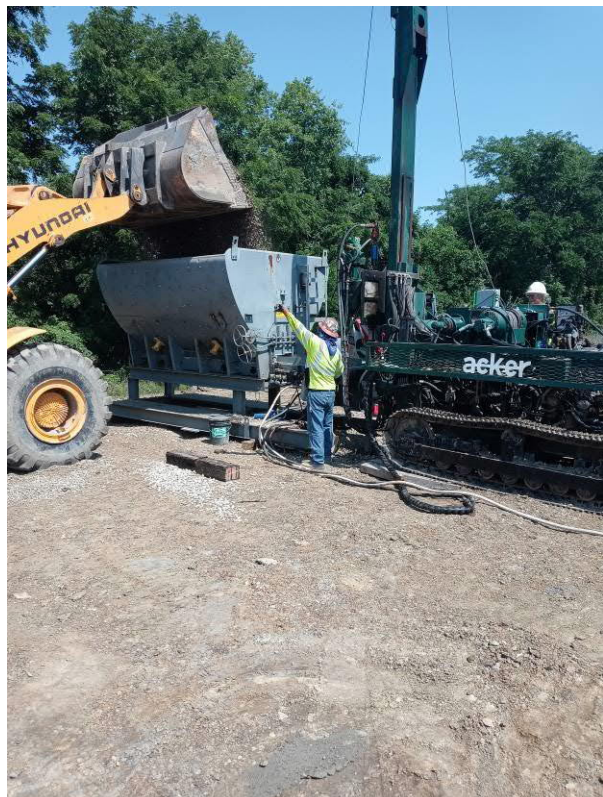
**Description:**  
Stockpile – crushed aggregate.

**Date:**  
July 13, 2021



**Description:**  
Loading hopper.

**Date:**  
July 13, 2021







**Description:**

Initial fill – note bias.

Date:

July 13, 2021



**Description:**


Initial fill.


Date:

July 13, 2021





<p><b>Description:</b> Test fill.</p>	
<p><b>Date:</b> July 13, 2021</p>	

<p><b>Description:</b> Test fill.</p>	
<p><b>Date:</b> July 13, 2021</p>	



**Description:**

Test fill – mid height.

Date:

July 14, 2021



**Description:**

Test fill – mid height.



Date:

July 14, 2021









<p><b>Description:</b> Test fill.</p>	
<p><b>Date:</b> July 14, 2021</p>	
<p><b>Description:</b> Test fill – completion.</p>	
<p><b>Date:</b> July 14, 2021</p>	



<p><b>Description:</b> Test fill.</p>	
<p><b>Date:</b> July 15, 2021</p>	

<p><b>Description:</b> Test fill.</p>	
<p><b>Date:</b> July 15, 2021</p>	



**Description:**  
Survey confirmation hole A-7.

**Date:**  
July 15, 2021



**Description:**  
Survey confirmation hole A-7.

**Date:**  
July 15, 2021



## **APPENDIX D**

### Calculations



VALUES USED IN THE FOLLOWING CALCULATIONS ARE FROM THE "MINE REMEDIATION PLAN" DATED MAY 6, 2021 APPENDICES C AND G

$$\sigma_{zmax} = \frac{\gamma L^2}{2z} \quad \text{WHERE } \gamma = 163 \text{ pcf}$$

$$L = 35 \text{ ft}$$

$$z = 4.5 \text{ ft}$$

FOR A 35 ft SPAN

$$\sigma_{zmax} = \frac{163 \text{ lb/ft}^3 (35 \text{ ft})^2}{2(4.5 \text{ ft})} = 154 \text{ psi}$$

FOR A 15.5 ft SPAN - REMEDIATED ROOM WITH ~4' INTIMATE CONTACT

$$\sigma_{zmax} = \frac{163 \text{ lb/ft}^3 (15.5 \text{ ft})^2}{2(4.5 \text{ ft})} = 30 \text{ psi}$$

SHEAR STRESS

$$\tau = \frac{3\gamma}{2} \left( \frac{L}{2} - x \right)$$

FOR A 35 ft SPAN

$$\tau = \frac{3}{2} \left( \frac{163 \text{ lb}}{\text{ft}^3} \right) \left( \frac{35 \text{ ft}}{2} - 0 \right) = 30 \text{ psi}$$

FOR A 15.5 ft SPAN

$$\tau = \frac{3}{2} \left( \frac{163 \text{ lb}}{\text{ft}^3} \right) \left( \frac{15.5 \text{ ft}}{2} - 0 \right) = 13 \text{ psi}$$

UNCONFINED COMPRESSIVE STRENGTH = 10000 psi

ESTIMATED TENSILE STRENGTH = 6.5% UCS = 650 psi

ESTIMATED SHEAR STRENGTH = 10% UCS = 1000 psi

TENSION  $\frac{650 \text{ psi}}{154 \text{ psi}} = 4.2$        $\frac{650 \text{ psi}}{30 \text{ psi}} = 21.6$

SHEAR  $\frac{1000 \text{ psi}}{30 \text{ psi}} = 33$        $\frac{1000 \text{ psi}}{13 \text{ psi}} = 76.9$