NORTH Dakota Be Legendary.™ | Public Service Commission

2018 AML PROJECT SUMMARY

March 2019

Wilton Phase 4, Shell Lake and Williams County Road 9 Phase 6

Project Type: Abandoned Underground Mine Reclamation

Drilling and pressurized remote backfilling with cementitious grout

Locations

- North Dakota State Highway 36, east of Wilton
- Wally Lee Farmstead—Shell Lake
- Parcels near Williams County Road 9

Contractors

B & C Concrete Pumping, Inc. of Williston (S & S Drilling, Williston-Subcontractor)
GEOSERV, Inc. of Bismarck, North Dakota (Material Testing)

Total Project Cost: $1,577,793

Contract AM-795-18
(Construction)
$1,545,750

Contract AM-796-18
(Material Testing)
$51,200

Inspectors, Chris Brown and Shawn Nixon, keeping track of the drilling in the north ditch of ND State Highway 36 about 5 miles southeast of Wilton.

Contents

2018 AML Project Statistics

Project Dates	June 19 – December 14
Project Length (consecutive days)	78
Total Work Days	50
Total Days of Pumping Grout	42
Holes Drilled	773
Holes Cased	144
Feet Drilled	52,290
Feet Cased	6,180
Grout Pumped (cubic yards)	6,074
Grout Pumped (cu. yd.) per Grout Day	121
Holes Pumped	107
Holes Filled by Pumping Adjacent Holes	119
Average Grout Take (cu. yd.) per Hole Ppumped	57
Average Grout Take (cu. yd.) per Hole Filled	27
Remaining Void Holes	7

Above: The view down a bore hole. Right: a crack monitor set up inside the shop at Williston. It tracks the lateral movement of the crack in the concrete.

North Dakota Public Service Commission and Abandoned Mine Lands

North Dakota has records for about 1,700 abandoned coal mines which are mostly in the western half of the state. The Surface Mining Control and Reclamation Act of 1977 (SMCRA) provides for the reclamation of abandoned mine lands with fees collected on actively mined coal. In 1981, the North Dakota Legislature approved an Abandoned Mine Lands (AML) Program to be administered by the Public Service Commission (PSC) on behalf of the State of North Dakota.

ND PSC AML Mission

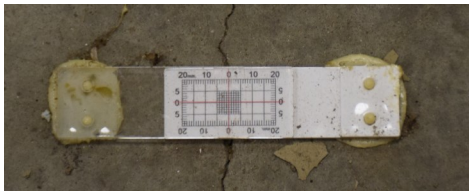
The AML Program is charged with eliminating existing and potential public hazards resulting from abandoned surface and underground coal mines. The AML Program is a service (not regulatory) program aimed at protecting North Dakotans while reclaiming hazardous abandoned mines. Reclamation eligible mines can be on our inventory, found by exploratory drilling or reported to us. The PSC's selection of reclamation projects is based on prioritizing the hazards and requires federal approval. Emergency projects are conducted when AML problems are an immediate and serious danger to the public.

Program Funding

Reclamation costs are covered through a federal fee on actively mined coal. The current rate for lignite coal is 8¢ per ton. The federal government, through the Office of Surface Mining Reclamation and Enforcement (OSMRE), reallocates the money to each state or tribe with an AML program. North Dakota's allocation is about $3 million per year. Federal fee collection is scheduled to end in 2021 unless reauthorized by the United States Congress.

Drilling and Grouting

Reclamation by drilling and grouting involves drilling through the overburden into the coal to locate areas where the coal was removed. When these openings (voids) are found, a cement-like grout mixture is pumped into the void to fill the space left when the coal was removed. The goal is to stabilize the mine and reduce the likelihood of the mine collapsing. This will reduce the chances of sinkholes forming at the surface. Drilling and grouting projects are expensive and are reserved for use around public roads or residential and commercial areas.



Filling Up the Mine

We pump grout into the mine workings to prevent the mine from collapsing and forming sinkholes at the surface. But how do we know when the mine is full? Well, we don't know really. We do use different indicators that tell us we have done the best job possible.

The picture below shows grout on the ground in the north ditch of Highway 36. While pumping, the grout found the least resistant path which led to the surface. We call this a "blowout". At times pumping can cause the earth to move either by lifting the surface or causing it to crack.

When a void is full, it can "refuse" to take any more grout so the pump cannot push more grout into the void.

At other times, grout pumped into one hole flows to another hole and pushes the casing out of the ground. This is what happened to the casing in the upper right photo . These holes are sometimes many feet apart.

After grouting, we drill more holes to find where the grout went. Then we take a core sample of the grout as shown in the picture on the right. We call this confirmation drilling.

Blowouts, cracking, surface lifting, refusals and confirmation drilling are used to determine the success of our grouting. That said, we cannot guarantee that sinkholes won't form over the reclaimed mine in the future.

Material Testing

Material testing is an important part of our drilling and grouting projects. The grout must meet certain flowability and strength requirements. The material testing firm is on site during grouting and collects samples once for every 50 yards of grout pumped.

Grout slump test with a grout cone

For our grout projects, flowability is measured with a slump test. The higher the slump the more flowable the mixture. When we want the grout to flow a long distance or into the rubble of a collapsed portion of the mine, we use a grout with slump between 10 - 11 inches.

Grout cylinders waiting for strength testing.

If we have an open void or don't want the grout to travel as far we use a lower slump grout between 6 and 8 inches. Just for comparison, most poured concrete has a 1-3 inch slump-very stiff.

Material testers also measure grout temperature, calculate grout yield and cast grout cylinders. The cylinders are broken by a special machine that measures strength of the grout. Our goal is for the grout to be at least as strong as the coal it is replacing.

Material testers also inspect the grout raw materials and the batch operation.

Drilling and Grouting:
Wilton Phase 4

In the early 1900s, the Wilton Coal Mine was the largest underground lignite coal mine in the world. Coal mining at Wilton ended many years in 1946, but the legacy of mining is evident by surface collapse today. To reduce the formation of hazardous sinkholes near roads and structures, the AML Division of the North Dakota Public Service uses pressurized remote backfilling with cementitious grout to stabilize underground mines. The grout is pumped through cased holes to fill voids in mine workings and replace the coal that was removed by mining.

The 2018 Wilton Phase 4 Drilling and Grouting project was the final phase of work that began in 2015 to reduce the likelihood of sinkhole formation on or near Highway 36. Over 18,000 cubic yards of grout were pumped in the previous three phases along Highway 36 and 41st Street.

The focus of the 2018 project was to pump grout in the north ditch of Highway 36, about a quarter of a mile east of the intersection with 41st Street (the west half of Map A).

This area took 1,434 cubic yards of grout. Confirmation drilling in both the north and south ditches on the east end of the project area (the east half of Map A) intercepted grout that had been pumped in previous years. Several cores confirmed that grout flowed far beyond the hole that was pumped. During the four phases of drilling and grouting projects 19,434 cubic yards of grout were pumped along 41st Street and in both the north and south ditches of Highway 36 between 41st and 56th Street. The grout will stabilize the highway right-of-way and reduce subsidence hazards. No additional work is planned along Highway 36.

In the 1990s drilling and grouting were completed along 26th Street and 318th Avenue. Approximately 5,000 cubic yards of grout was placed into the mine workings at that time. The prevalence of sinkholes near the right-of-way on both roads indicated additional drilling was needed to confirm the condition of the mine.

Drilling conducted in the right of way of 26th Street between Highway 36 and 318th Avenue and the north ditch of 318th Avenue west of 26th Street as shown on Map B. No mine workings or grout were encountered along 26th Street. Grout was encountered along 318th Avenue as indicated by the orange dots on Map B. No grout was needed and no additional work is planned for this area.

Maps A & B: North Dakota Highway 36 runs east and west. Each dot represents one drill hole. Drilling encountered solid coal at **black dots** . Grout was pumped into holes at **Blue dots** and **orange dots** are holes filled by pumping grout into a different hole. **White dots** are core holes.

2018 Wilton Project Statistics

Project Dates	June 19– July 21
Project Cost	$429,321
Holes Drilled	306
Holes Cased	35
Feet Drilled	20,701
Feet Cased	1,735
Grout Pumped (cubic yards)	1,434
Holes Pumped	24
Holes Filled by Pumping Adjacent Holes	43
Average Grout Take (cu. yd.) per Hole Pumped	61
Average Grout Take (cu. yd.) per Hole Filled	22
Remaining Void Holes	0

Removing casing from a completed hole

Drilling and Grouting:
Shell Lake

The reclamation work done at the Shell Lake portion of the project is one of those instances where a property owner notified the Public Service Commission of a possible mine on his property. The Public Service Commission has limited information on the abandoned mine that is on the Wally Lee farmstead. The name of the mine may have been Spiegel and operated in the 1930s. With no available mine map, the location of the mine is based on exploratory drilling done in 2017 and reports from Mr. Lee. Mr. Lee thought an air shaft may be near one of the shop buildings, and an entry shaft was near an area used for hay storage. No entry or mine workings were discovered near the stored hay although coal fines on the surface were found in the area. The top of coal lies about 62 feet below the surface and the seam is 7-8 feet thick.

In a 2017 Exploratory Drilling project, 17 of 48 holes encountered rubble from collapse of the mine, all near the two shop buildings (See map below). About half of these

(Continued on page 7)

Shell Lake –Wally Lee Farmstead. Each dot represents one drill hole. Drilling encountered solid coal at **black dots** and no coal at **black triangles**. Grout was pumped into holes at **Blue dots** and **orange dots** are holes filled by pumping grout into a different hole.

(Continued from page 6)

holes showed upward migration of the voids to within 35 feet of the surface. Without reclamation, the collapsed portion may reach the surface, causing a sinkhole to form. These holes were cased in 2017 for future grouting. In the 2018 Drilling and Grouting project, eleven additional holes were cased in the driveway south of the shops. No true open voids were discovered and it is thought that the mine has collapsed over the years.

Since the mine was so close to outbuildings, the perimeter of all the buildings, including the house, was drilled to identify the extent of the mine workings. To prevent damage to the landscaping, all drilling fluids were contained when drilling on the lawn. One hole near the northeast corner of the house was thought to encounter the mine, but grouting later revealed that it was geologic gravel and not mine related. The mine looked to be contained in the area near the two shop buildings. A total of 123 cubic yards were pumped on the project. Most of that went into one hole to the southwest of the shop buildings. This may have been a shaft opening to the mine.

The project was successfully completed and no additional work is planned at the site.

2018 Shell Lake Project Statistics

Project Dates	July 16– August 31
Project Cost	$167,641
Holes Drilled	130
Holes Cased	12
Feet Drilled	9,337
Feet Cased	528
Grout Pumped (cubic yards)	123
Holes Pumped	4
Holes Filled by Pumping Adjacent Holes	25
Average Grout Take (cu. yd.) per Pumped	31
Average Grout Take (cu. yd.) per Hole Filled	4
Remaining Void Holes	0

Above: The grout pump is set up waiting for the mixer truck while the drillers are working on the east side of the shop. Left: A mud pit is used to protect the lawn while drilling.

The white flags mark the locations for drill holes at the Wally Lee farmstead.

Drilling and Grouting:

Williams County Road 9 Phase 6

In the spring of 2017, the Public Service Commission was notified of a sinkhole on the Shift Services, Inc property at 5140 134th Avenue NW. Upon investigation, the PSC was directed to a sinkhole at the Sand Draw property to the south of Shift Services. In addition, the floor of the shop at Sand Draw contained a bowl-shaped depression approximately 2 inches deep, and the attached office appeared to be pulling away from the main shop building (see photos 1 and 2 below and next page). The site was immediately added to the 2017 Exploratory Drilling project. Of the 59 holes drilled, 33 encountered mine workings and were cased for future work. Drilling logs indicated that much of the mine was in various stages of collapse. Due to the potential risks to people and equipment, the tenant vacated the property which provided an optimal opportunity to conduct a reclamation project. The site was included in the 2018 Drilling and Grouting AML Project.

The abandoned Williston Coal & Ice Co. operated the mine at this site between 1913 and 1936. For a time, the Williston Coal and Ice Company mined two coal seams and produced an average of 14,000 tons of coal annually. The bottom seam is about 140 feet below the surface and does not appear to extend under the project site. The top seam is 65-75 feet below the surface and is the cause of the sinkholes at the surface. While a mine map of the Williston Coal and Ice Co. mine is available, it lacks details. Only a haul tunnel is mapped in the project area. All other areas are marked “Exhausted”.

Due to the lack of a detailed map, the Sand Draw property was drilled using a grid pattern with rows 20 feet apart and holes spaced10 feet apart. In 2018 another 337 holes were drilled and 104 holes were cased. Like in 2017, the drill logs indicated that much of the mine had collapsed and voids were migrating toward the surface.

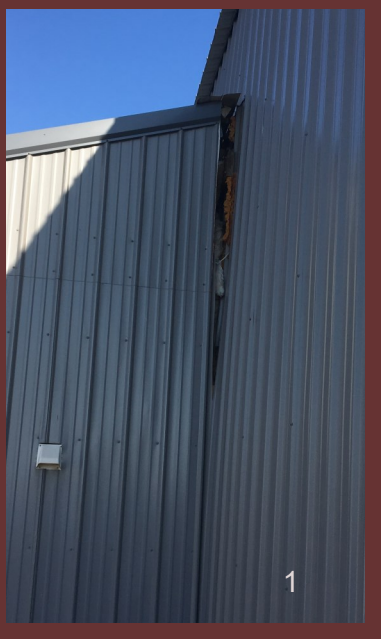
During the project, three voids did reach the surface creating sinkholes. One hole is shown in photo 3 on the next page. The void was 35 feet below the surface in 2017; well above the coal seam at 68 feet. In late May 2018, the surface around the hole was intact, but by early July 2018, the void migrated to the surface and created a sinkhole (photo 4). White PVC casing is visible in the hole. This hole was filled while pumping on the adjacent hole. In another instance during the 2018 project, a driller backed up his rig and felt the rear sink. He quickly pulled forward. Looking into the small hole the truck tire created revealed a much larger opening underneath. This sinkhole was immediately filled with over 42 cubic yards of grout. The one blue dot on the north apron of the shop building on the map on page 9 was another sinkhole that started as a hole the size of a dinner plate as shown in photos on the back page. Over 15 cubic yards were pumped under the apron into the hole.

The shop building was another challenge in the project. A portable sonic drilling rig on tracks was used for drilling inside the shop building. Five of the seven holes filled inside the shop were pumped with grout. These holes took over 270 cubic yards of grout. The shop owner chose to remove the sunken bowl-shaped portion of the floor inside the shop. Once the existing concrete was removed, they discovered a void directly under the floor. The concrete company estimated that they poured at least 8 cubic yards of concrete into the hole before finishing the floor.

2018 Williston Project Statistics

Project Dates	September 1–December 14
Project Cost	$980,831
Holes Drilled	337
Holes Cased	97
Feet Drilled	22,292
Feet Cased	3,974
Grout Pumped (cubic yards)	4,490
Holes Pumped	79
Holes Filled by Pumping Adjacent Holes	51
Average Grout Take (cu. yd.) per Hole Pumped	57
Average Grout Take (cu. yd.) per Hole Filled	35
Remaining Void Holes	7

In the 2.5-acre project area, nearly 4,500 cubic yards of grout was pumped. Two additional parcels to the north are also undermined by the Williston Coal and Ice Company mine and an additional phase of work is planned for the summer of 2019.


1

Williams County Road 9, also called 134th Avenue NW, runs north and south. Drilling encountered solid coal at **black dots** and no coal at **black triangles** . Grout was pumped into holes at **Blue dots** and **orange dots** are holes filled by pumping grout into a different hole. **Red dots** show holes that need grout.

What is Grout?

Grout, concrete and mortar have similar components. Each contain cement, water and aggregate. Generally, the difference between grout and concrete or mortar is the water to cement ratio, in other words its flowability. Concrete is very stiff and not very flowable. It stays where it is put. Mortar is less stiff and grout is the most flowable.

Grout is a commonly used flowable fill in reclamation of abandoned underground coal mines. The North Dakota AML Division uses cementitious grout exclusively to remotely fill mine workings in reclamation projects.

Our grout mix contains Portland cement, water and flyash. The flyash is considered a “beneficial use” by the ND Department of Health. Our mix also contains unwashed aggregate (size less than 3/8 inch). We have found that this “dirty” sand adds to the flowability of the grout.

Flowability in grout is essential for our projects. The grout is pumped into the void spaces in the mine. These spaces can be very large or very small. In either case, the grout must be flowable enough to fill all the void spaces left when the coal was removed. Our grout formula is designed to mimic the strength of the coal it is replacing.


1

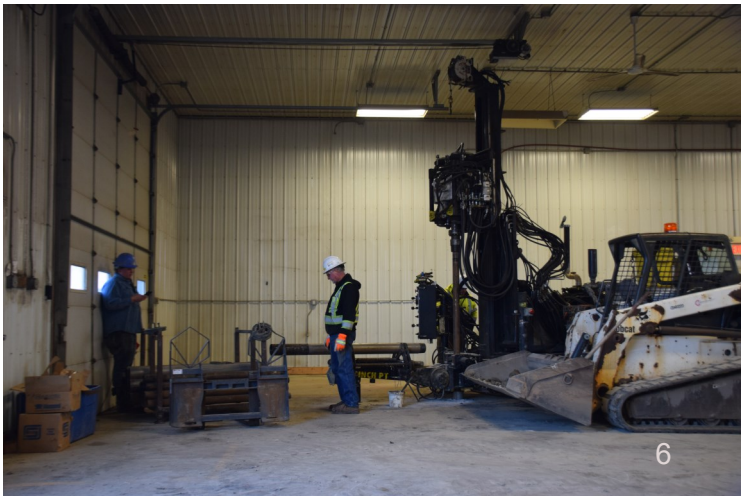

2


3

4

1. A core sample at Wilton. The black is coal. The grey is a grout-clay mix.
2. “Blow out” under the Bobcat. Since we pump grout with pressure, grout finds the path of least resistance. Even after the pump is shut off, grout will continue to flow out of the crack.
3. Inspector Chris Brown near the depression inside the shop at Williston.
4. Safety is always at the forefront of our reclamation projects.
5. & 6. A portable sonic drilling rig was used to drill inside the Williston shop.
7. The material tester set up on the apron on the north side of the shop building in Williston. Two cones mark the sinkhole under the apron as shown on page 12. A drilling rig is set up to the west of the shop.
8. We work until the job is done; sometimes in poor weather. The snow melted by the end of the day.


5


6


7


8

Glossary of Terms

Backfill— Material used to fill an opening, void or depression. Material placed in the mine void to support the mine roof.

Casing—A tubular structure installed in a drill hole to prevent the wall of the hole from caving and to provide a conduit for grout.

Core—A cylindrical sample taken from a formation for analysis. Usually a core barrel is substituted for the drilling bit and it procures a sample as it penetrates the formation.

Cribbing— Timbers laid at right angles to each other, sometimes filled with earth, as a roof support or as a support for machinery.

Drift mine— An underground coal mine that enters a coal seam horizontally usually from a coal outcrop.

Haul Tunnel— Any underground entry or passageway designed for transport of coal, other material, personnel, or equipment.

Highwall— The unexcavated face of exposed overburden and coal in a surface mine.

Mine Workings— The entire system of openings in a mine.

Overburden— Layers of soil and rock covering a coal seam.

Pillar—The part of coal left between individual rooms and entries to support the overlying strata.

Rob— To mine or remove coal pillars left for support.

Roof —The stratum of rock or other material above a coal seam; the overhead surface of a coal working place.

Roof Fall— A coal mine cave-in.

Room and Pillar Mining— A method of underground mining in which a portion of the coal is left in place to support the roof of the active mining area. Large "pillars" are left while "rooms" of coal are extracted.

Rubble— Debris encountered when drilling into mine workings that may indicate mine collapse or roof fall.

Seam— A stratum or bed of coal.

Shaft— A vertical opening from the mine to the surface that may be used for ventilation, drainage or transportation.

Slope— An inclined connection to the surface from underground workings used for transportation, drainage and ventilation.

Slump—In material testing it is a measure of consistency of concrete or grout on a scale from 0-12. The higher the number the more liquid or flowable the mixture.

Void— A general term for openings in rock. In mine reclamation-the open space remaining after coal was removed by underground mining.

PLACE
STAMP
HERE

North Dakota Public Service Commission
Abandoned Mine Lands Division
600 East Boulevard Avenue, Department 408
Bismarck, ND 58505-0480

When a Hole Is Not Just a Hole

Underground coal mining was common in Western North Dakota in the early part of the twentieth century. After WWII, surface mining became more economical, and many underground mines ceased operation and became abandoned. The legacy of abandoned underground mining is the potential for surface collapse.

If you live or work near an abandoned underground coal mine, please use caution. The ground can give way without warning. In this photo, workers had been parking on the concrete when they noticed a small hole. Upon looking into the hole, they found a large opening. Over 15 cubic yards were pumped into the hole. Always be aware on an abandoned mine site. A similar event could happen to you.

Contact Us

To report a sinkhole or request more information about our program

North Dakota Public Service Commission
Abandoned Mine Lands Division
600 E. Boulevard Avenue
Department 408
State Capitol 13^{th} Floor
Bismarck, ND 58505-0480

(701) 328-2400
(877)-245-6685

ndpsc@nd.gov

Visit us on the web at www.nd.psc.gov