North Dakota LEGENDARY
Public Service Commission

2016 AML PROJECT SUMMARY

October 2016

Wilton Phase 2

Project Type

Drilling and pressurized remote backfilling with cementitious grout

Location

- North Dakota State Highway 36, east of Wilton
- 41st Street, north of ND State Highway 36
- US Highway 200 - about 3 miles east of Underwood (drilling only)

Contractors

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

Total Project Cost

$1,420,947

Contract AM 757-16
(Construction)
$1,376,828

Contract AM-758-16
(Material Testing)
$44,119

Grout Pumping in the north ditch of ND State Highway 36 about 5 miles east of Wilton.

Contents

2016 AML Project Statistics	
Project Dates	June 1– August 21
Project Length (consecutive days)	82
Total Work Days	57
Total Days of Pumping Grout	40
Holes Drilled	364
Holes Cased	110
Feet Drilled	26,272
Feet Cased	6,641
Grout Pumped (cubic yards)	8,494
Grout Pumped (cu. yd.) per Grout Day	212
Holes Pumped	57
Holes filled by Pumping Adjacent Holes	96
Average Grout Take (cu. yd.) per Hole pumped	149
Average Grout Take (cu. yd.) per Hole filled	55
Remaining Void Holes	124

PSC staff are surveying drill holes as drilling continues in the north ditch of Highway 36 just west of the intersection of 52nd Street.

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) set up a federal fund with fees collected on coal mined since that time for the reclamation of abandoned mine lands. 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. Thus the AML Program is a service (not regulatory) program aimed at protecting North Dakotans while reclaiming hazardous abandoned mines. Reclamation eligible mines are either on our inventory, found by exploratory drilling or reported by landowners or other members of the public. The PSC's selection of reclamation projects also requires approval by federal officials. 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 top picture shows grout on the ground in the ditch of Highway 36. While pumping on a hole, the grout found the least resistance 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. The lower right photo shows a crack that opened near the grout pump.

A hole can also "refuse" to take any more grout and the pump can no longer push grout into the hole. At other times, pumping one hole actually fills another hole. The lower left photo shows a hole that was filled when grout was pumped nearby.

After grouting, we drill more holes to find where the grout flowed. Then we take a core sample of the grout. We call this confirmation drilling. Blowouts, cracking, lifting, refusals and confirmation drilling are used 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

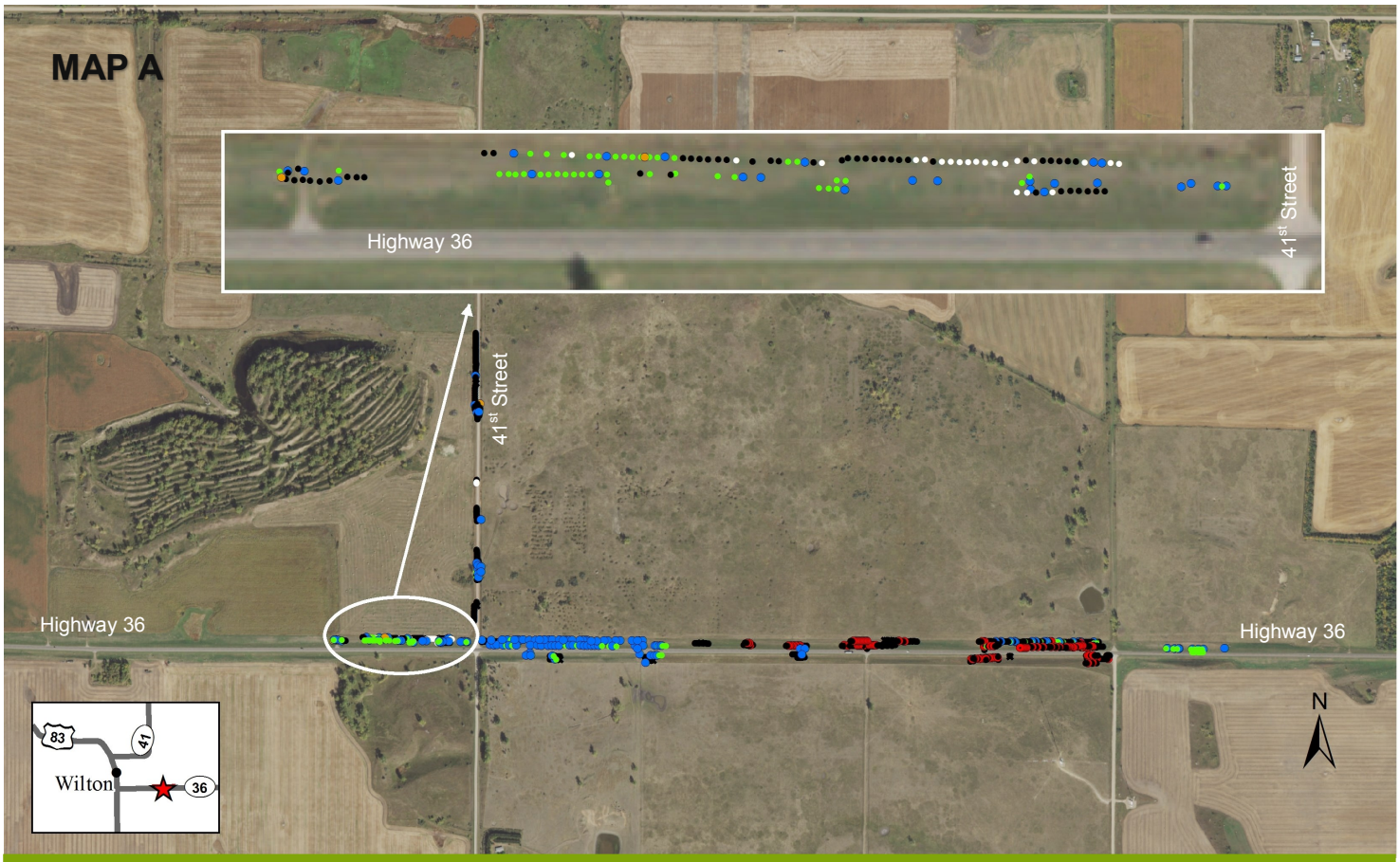
Material testing is an important part of our drilling and grouting projects. The grout must meet certain flowability and strength requirements. The material testing firm is on site during grouting and collects samples to test every 5-7 truck loads.

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 us a grout with slump between 10 - 11 inches.

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 cement 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.



Maps A, B & C: North Dakota Highway 36 runs east and west. The north-south road is 41st Street. Each dot represents one drill hole. **Blue dots** were void holes that were pumped with grout. At **black dots**, drilling encountered solid coal. **Red dots** are holes that intercepted voids and were cased for future grouting. **Green dots** are holes that were filled with grout by pumping on another hole. **Orange dots** are core holes, and **white dots** represent no coal was encountered. All holes were filled with grout on Map A inset and Map B. Additional work is needed in both the north and south ditches of Highway 36 as shown on Map C.

Drilling and Grouting: Wilton Phase 2

In the early 1900s the Wilton Coal Mine was largest underground lignite coal mine in the world. Coal mining at Wilton ended many years ago, but the legacy of surface collapse remains. Several sinkholes have opened in the ditch of Highway 36 over the years. To reduce the formation of hazardous sinkholes, 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.

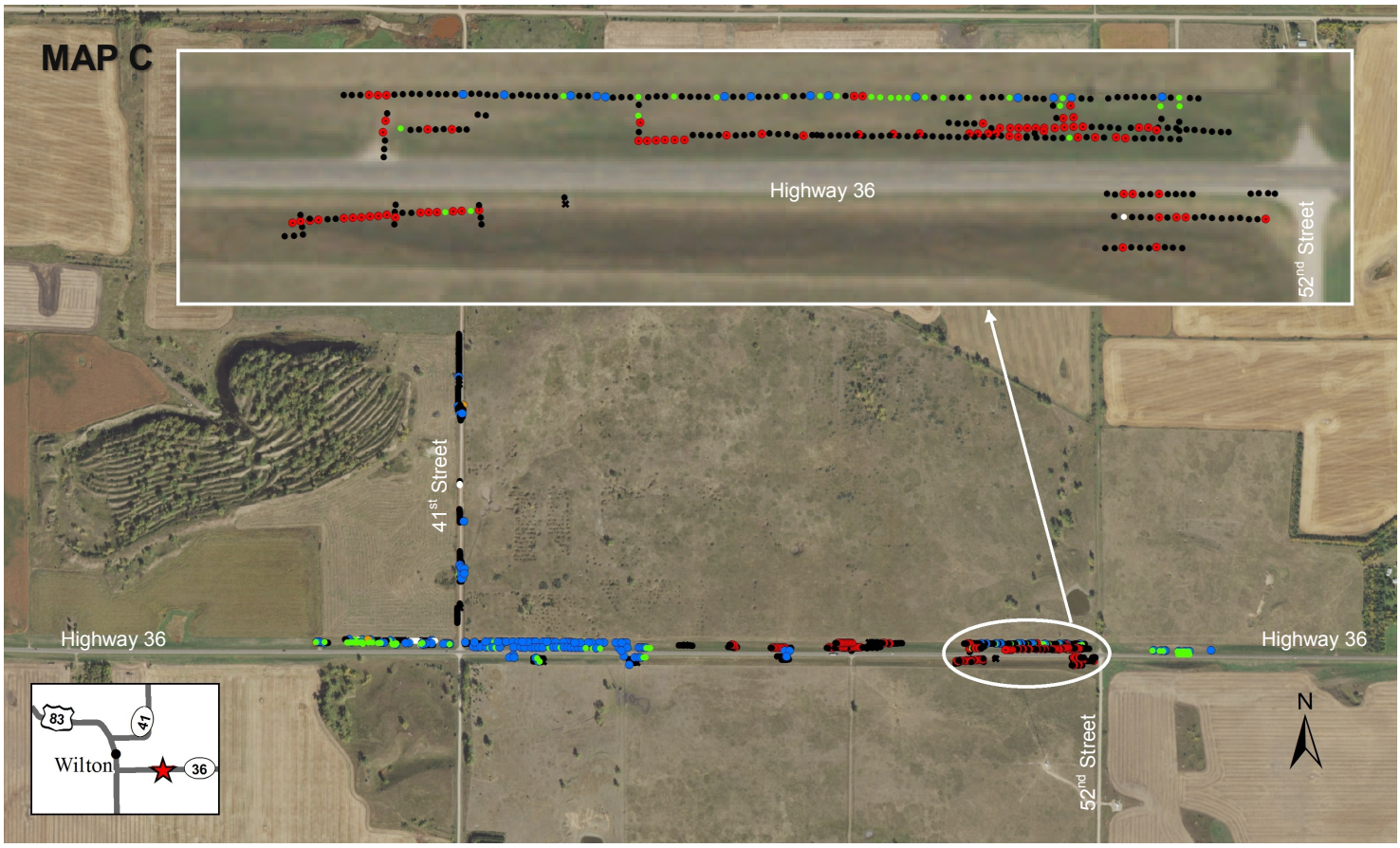
The 2016 Wilton Phase 2 Drilling and Grouting project was a continuation of work that began in 2015 along 41st Street. In 2015, 2,400 cubic yards of grout were pumped into haul tunnels that run under 41st Street. In 2015 an additional 113 cubic yards of grout were pumped on 41st Street to complete the work. We confirm that grout filled voids under the road by drilling additional holes and taking core samples. Three confirmation holes drilled on 41st Street encountered grout.

The focus of the 2016 project was pumping grout in the ditches of the northwest corner of the intersection of Highway 36 and 41st Street (Map A), and the northeast (Map B) and northwest corners (Map C) of the intersection of Highway 36 and 52nd Street. The goal is to reduce the chance of sinkholes forming in the right-of-way Highway 36.

In Map A and C areas barrier walls were built to keep the grout from flowing into the fields and outside the highway right-of-way. To do this holes were drilled near the fence line (these are the holes furthest to the north in the insets). A low-flow grout was pumped into these holes building a barrier to more flowable grout pumped into a second set of holes nearer the highway. The mine workings in the Map A area took over 4,000 cubic yards of grout. In Map C area, over 3,000 cubic yards of low-flow grout were pumped for barrier walls along the fence. Another 120 holes remain to be pumped in Map C area in a future project. Confirmation drilling, grout blowouts and surface cracking verified that the grout filled voids near Highway 36 reducing the likelihood of sinkholes forming.

When pumping grout in the ditch of the area designated by Map B, grout filled holes on the shoulder of the highway. As a precaution, the highway was monitored by a laser level to detect surface lifting of the highway. Careful pumping and constant monitoring prevented any surface lifting of the highway. This area took nearly 900 cubic yards of grout.

The 2016 Wilton Phase 2 Drilling and Grouting project successfully pumped 8,494 cubic yards of grout along Highway 36 to stabilize the highway right-of-way and reduce subsidence hazards. An additional project is scheduled for 2017 to complete the work along Highway 36 and at a near by farmstead.



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 is it 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 has a determination of a "beneficial use" by the ND Department of Health. Our mix also contains un-washed 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.

Figenskau Mine Exploratory Drilling

Early in June, 2016 the Falkirk Mining Company informed us of several subsidence features on the abandoned Figenskau Mine near Highway 200. In 2007, an exploratory drilling project along Highway 200 did not encounter any voids; however the current sinkholes are more than 1000 feet to the east of that project extent. The Figenskau mine is about 3 miles east of Underwood, ND.

The sinkholes were outside the right of way of Highway 200; however the proximity to the highway and unknown extent of mining of the Figenskau mine provided justification of a small exploratory drilling investigation. Forty-one holes were drilled in the north ditch of Highway 200 for a total of 2,317 feet. No mine voids were encountered.

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.

Laser level monitoring Hwy 36 for surface lifting.

Grouting and drilling (background) along Hwy 36

Casing pushed out of the ground by pumping grout 40 ft. away.

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 becoming 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.

This is what happened in the photo. The surface gave way as the truck followed a trail during a sinkhole filling project near Noonan in October 2016. The truck had used this same path many times before. Both the truck and driver are fine.

Contact Us

To report a sinkhole or request more information about our program

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