North Dakota LEGENDARY
Public Service Commission

2017 AML PROJECT SUMMARY

February 2018

Wilton Phase 3

Project Type: Abandoned Underground Mine Reclamation

Drilling and pressurized remote backfilling with cementitious grout

Location

- North Dakota State Highway 36, east of Wilton
- Don Sorch, Jr. Farmstead

Contractors

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

Total Project Cost

$1,283,123

Contract AM-780-17
(Construction)
$1,240,688

Contract AM-781-17
(Material Testing)
$42,435

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

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2017 AML Project Statistics

Project Dates	June 19– September 11
Project Length (consecutive days)	78
Total Work Days	50
Total Days of Pumping Grout	42
Holes Drilled	317
Holes Cased	192
Feet Drilled	25,863
Feet Cased	10,650
Grout Pumped (cubic yards)	7,868
Grout Pumped (cu. yd.) per Grout Day	187
Holes Pumped	50
Holes filled by Pumping Adjacent Holes	181
Average Grout Take (cu. yd.) per Hole pumped	157
Average Grout Take (cu. yd.) per Hole filled	34
Remaining Void Holes	86

PSC staff are surveying drill holes in the north ditch of Highway 36 between 41st Street and 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) provides for the reclamation of abandoned mine lands with fees collected on coal mined since that time. 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 can be on our inventory, found by exploratory drilling or reported to us. The PSC's selection of reclamation projects also 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 top right picture shows grout on the ground in the north ditch of Highway 36. While pumping on a hole in the south ditch of Highway 36, 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 lower left 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 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 use a grout with slump between 10 - 11 inches.

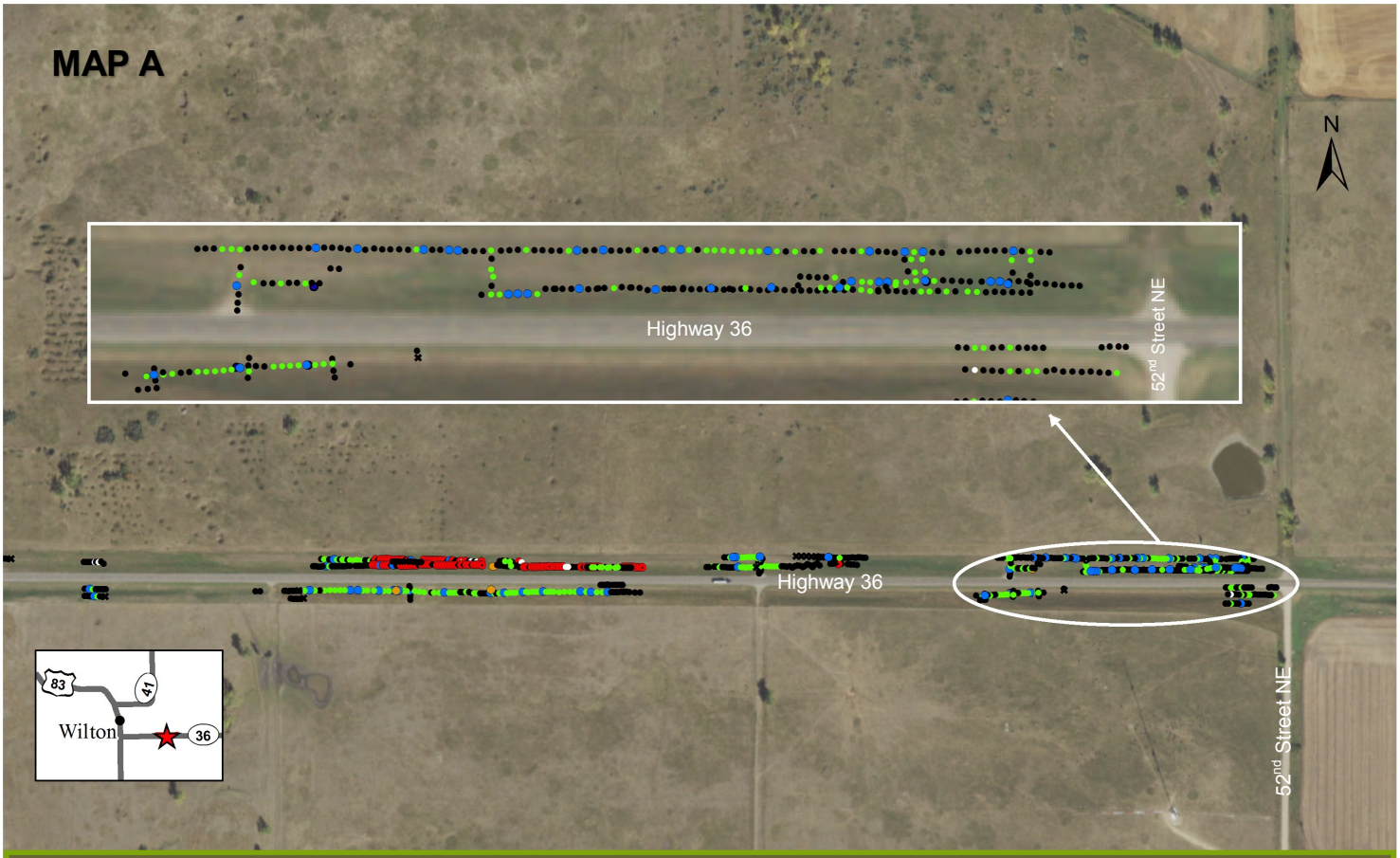
If we have an open void or don't want the grout to travel as far we use a lower slump grout between 6 and 8 inches. Just for comparison, most poured concrete has a 1-3 inch slump-very stiff.

Grout slump test and grout cone

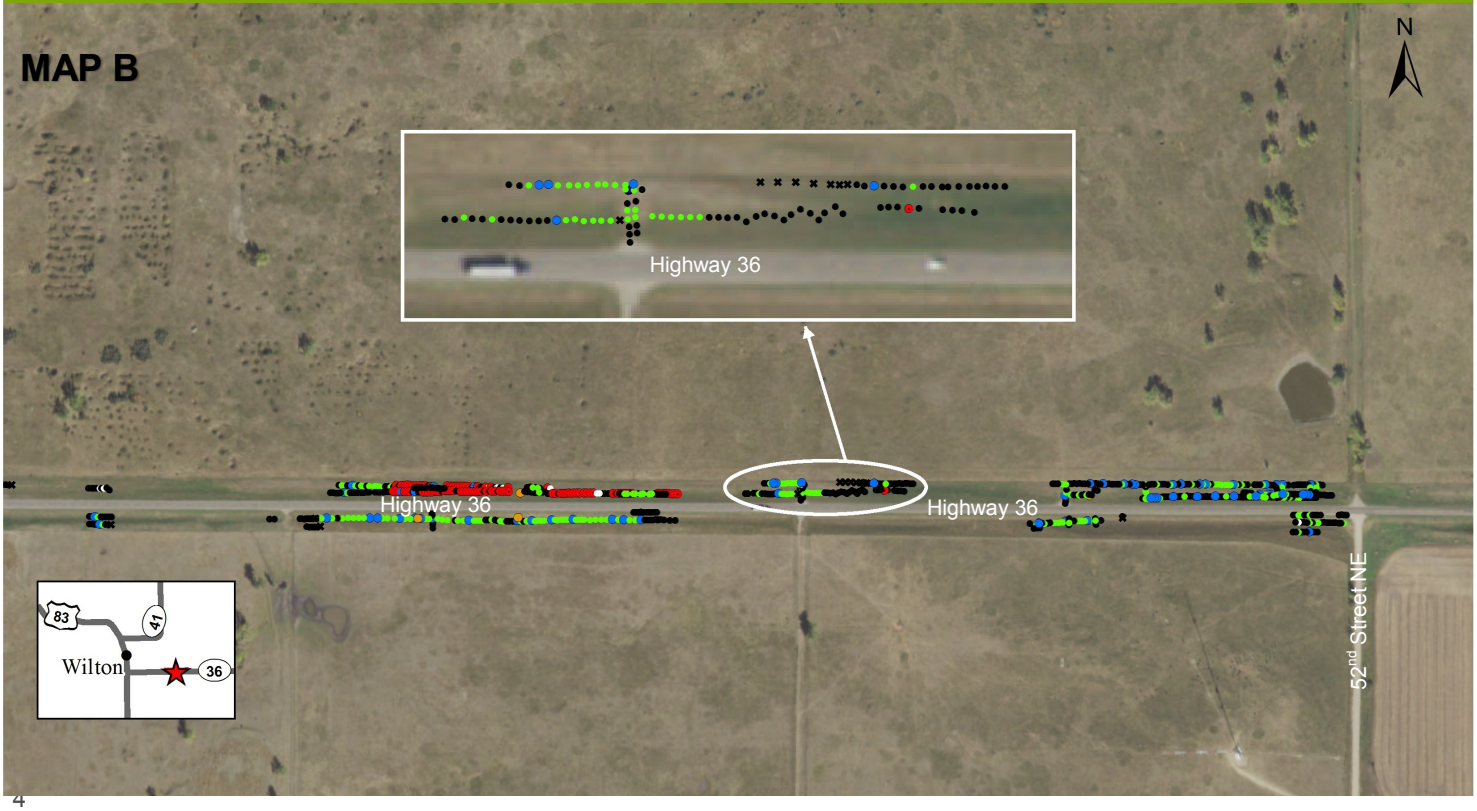
Material testers also measure grout temperature, calculate grout yield and cast grout cylinders. The cylinders are broken by a special machine that measures strength of the grout. Our goal is for the grout to be at least as strong as the coal it is replacing.

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

Grout cylinders waiting for strength testing.



Maps A, B & C: North Dakota Highway 36 runs east and west. The south road is 52nd Street. Each dot represents one drill hole. **Blue dots** were void holes that were pumped with grout. Drilling encountered solid coal at **black dots**. **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. No coal was encountered at **white dots**. All holes were filled with grout on Map A inset. Additional work is needed in the north ditch of Highway 36 as shown by the red dots on Maps B and C.



Drilling and Grouting: Wilton Phase 3-Highway 36

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 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 2017 Wilton Phase 3 Drilling and Grouting project was a continuation of work that began in 2015. In 2015, 2,400 cubic yards of grout were pumped into haul tunnels that run under 41st Street. In 2016, 8,494 cubic yards of grout were pumped on 41st Street and the north ditch of Highway 36 to the east of 41st Street and east and west of 52nd Street.

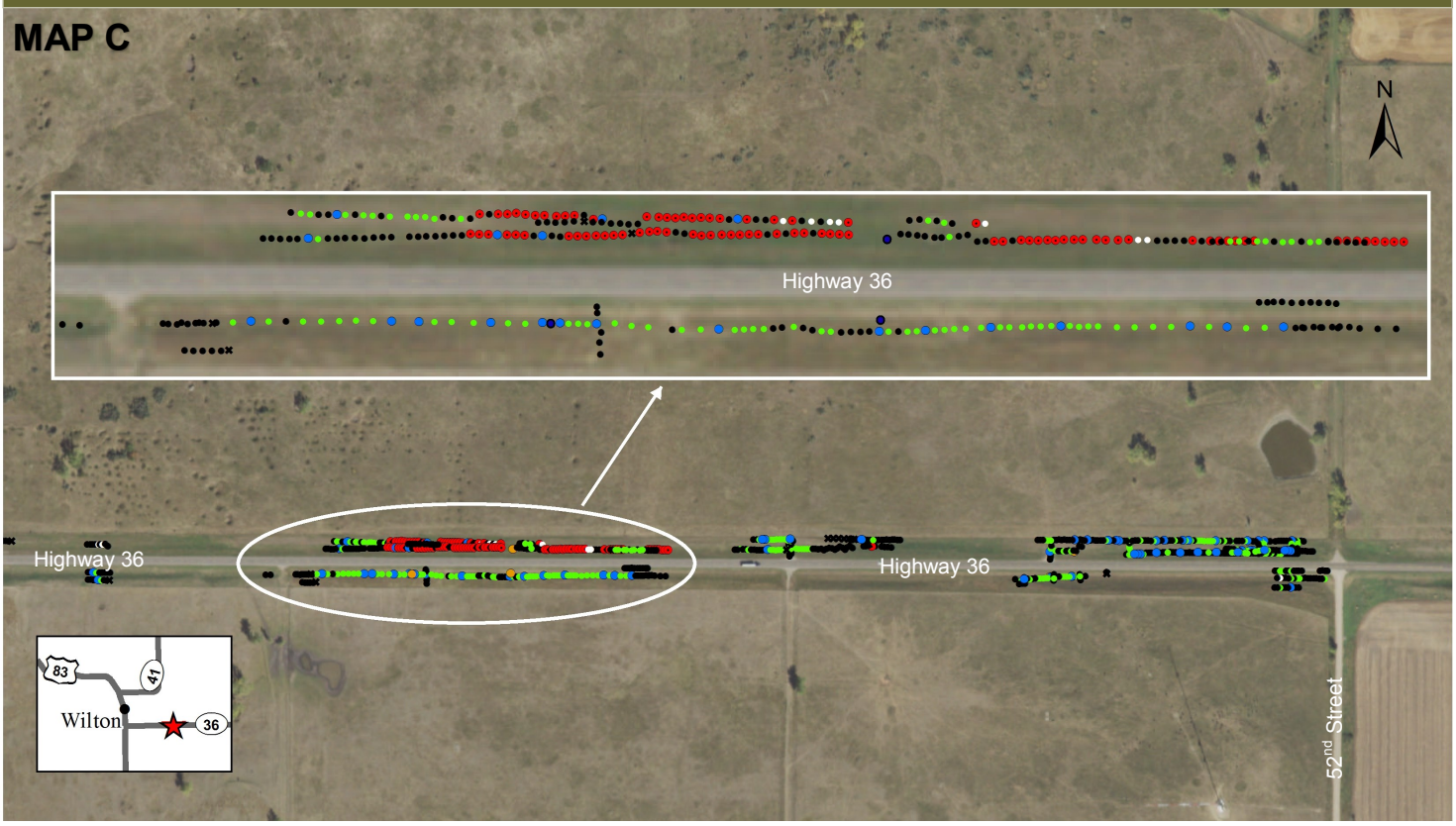
The focus of the 2017 project was to pump grout in the south ditch of the southwest corner of the intersection of Highway 36 and 52nd Street (Map A), the north ditch of Highway 36 starting about 2,000 feet west of 52nd Street (Map B) and the north and south ditches of Highway 36 (Map C) starting about 3,500 feet west of the intersection of Highway 36 and 52nd Street. The goal was to reduce the probability of sinkhole formation on or near Highway 36. The 2017 project also included the Donald Sorch, Jr. farmstead. Discussion of work at the Sorch farm is on page 6 of this brochure.

Map A shows the continuation of work begun in 2016. In 2016 over 3,000 cubic yards of grout were pumped in the north ditch along the fence line to form a barrier to grout flowing into the pasture. In 2017 nearly 2,000 cubic yards of grout were pumped into the remaining holes in the north and south ditch. In two places grout flowed under the highway to fill holes on the opposite side of the highway. No additional work is planned for this area.

The bore holes shown on Map B were drilled in previous projects. About 1,600 cubic yards of grout were pumped into 5 holes to fill rooms and haul tunnels near Highway 36. A void (red dot) was encountered during confirmation drilling signaling a need for additional work. Additional drilling and grouting will be done in this area in 2018.

Another goal was to locate and fill a haul tunnel that runs parallel to south ditch of Highway 36, shown on Map C. Drilling revealed a partially collapsed roof in the 1,200 foot tunnel. This area took over 2,300 cubic yards of grout to fill. In two places grout flowed under the highway to the north ditch. One ended as a blowout in the north ditch. The other filled the very eastern holes (green dots) in the north ditch. While some grout was pumped in the north ditch as shown on Map C (blue and green dots on the western end), more drilling and grouting will be done in the north ditch in 2018.

The 2017 Wilton Phase 3 Drilling and Grouting project successfully pumped 7,176 cubic yards of grout along Highway 36 to stabilize the highway right-of-way and reduce subsidence hazards. An additional project is scheduled for 2018 to complete the work along Highway 36.



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 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.

Drilling and Grouting: Wilton Phase 3-Sorch Farm

A 1997 exploratory drilling project intercepted mine workings in the yard of the Donald Sorch, Jr. farmstead. Around the same time, a sinkhole suddenly opened within a hundred feet of their home. In 2017 an additional 36 holes were drilled with 12 boreholes encountering mine workings in addition to the 6 cased holes from 1997.

With input from the Sorchs, the drilling and grouting equipment came through 2 shelter belts rather than disturb the main entrance to the farmstead. Since the trail led over the abandoned mine, drilling was done and mine workings were encountered along the trail and in the shelter belt closest to the yard.

A total of 1,318 cubic yards of grout were pumped into voids at the Sorch farmstead. Two holes from the 1997 exploratory drilling project took a combined total of 378 cubic yards of grout. One borehole in the shelter belt took 369 cubic yards of grout and filled holes closer to the house. Along the trail, five holes took 571 cubic yards of grout to fill the voids.

Careful pumping and monitoring inside the shop building with a laser level and crack monitors prevented any project related damage to the shop. Drilling began on August 11 and grout pumping and clean-up were completed by September 11. Reclamation at the Sorch farm cost $190,554.

Map showing drill hole locations at Sorch Farm


Pumping grout at Sorch Farm


Drilling rig in tree row of Sorch Farm

Drilling along Hwy 36

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.

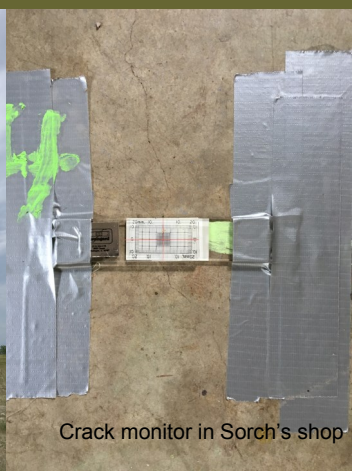
Shaft— A vertical opening from the mine to the surface that may be used for ventilation, drainage or transportation.

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.

Removing casing from filled hole.



Crack monitor in Sorch's shop

Grout gage showing pressure

Drilling

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, a coyote became trapped after falling into a sinkhole. A similar event could happen to you at an abandoned underground mine site.

Contact Us

To report a sinkhole or request more information about our program

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