

Evaluating Underground Mine Reclamation Projects in North Dakota

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Abandoned Mine Lands Division

September 2013

Presented at the 35th Annual Conference of the National Association of Abandoned Mine Land Programs, Daniels, West Virginia, September 22-25, 2013.

Scranton, ND, Before and After Reclamation



About the North Dakota Public Service Commission and the Abandoned Mine Lands Division

- ✓ The Board of Railroad Commissioners was established by Dakota Territory in 1885. Its name was changed in 1940 to Public Service Commission (PSC)
- ✓ North Dakota has three Public Service Commissioners, each elected to six-year terms.
- ✓ The PSC has jurisdiction over electric and natural gas utilities, telecommunications companies, weights and measures, grain elevators, auctioneers, reclamation of mined lands, siting of energy plants and electric and gas transmission facilities, and railroads.
- ✓ The Commission has about 40 full-time employees. The staff is divided into support services and five divisions that provide direct regulatory oversight and consumer assistance.
- ✓ The Abandoned Mine Lands (AML) Division administers a federal program to remove hazards associated with abandoned coal mines. The AML Division has about 5 FTE's.
- ✓ North Dakota's AML Program was authorized in 1981 under the federal Surface Mining Control and Reclamation Act (SMCRA) of 1977.
- ✓ Program funding comes from a ten cent federal reclamation fee on each ton of lignite coal mined in North Dakota. The state may apply for grants for half the fee, or about \$1.5 million per year.
- ✓ Since AML Program inception in 1981, about \$43 million have been spent to reclaim 24 miles of dangerous surface mine highwalls, 1500 acres of mine subsidence, and a variety of other hazardous abandoned mine features in North Dakota. An estimated \$35 million more are needed to reclaim all remaining high priority AML Sites in North Dakota.

Early Underground Mine R&D Projects 1982-87

Year	Site	Contractor	Acres	Approx. Cost
1982-87	Scranton	Dickinson State	72	\$1,7000,000
1982-83	Lehigh-Dickinson	Dickinson State	10	\$167,000
1983	Urlacher-New England	Dickinson State	7	\$52,000
1983	New Leipzig	Weisz & Sons	20	\$269,000
		Total	109	\$2,188,000

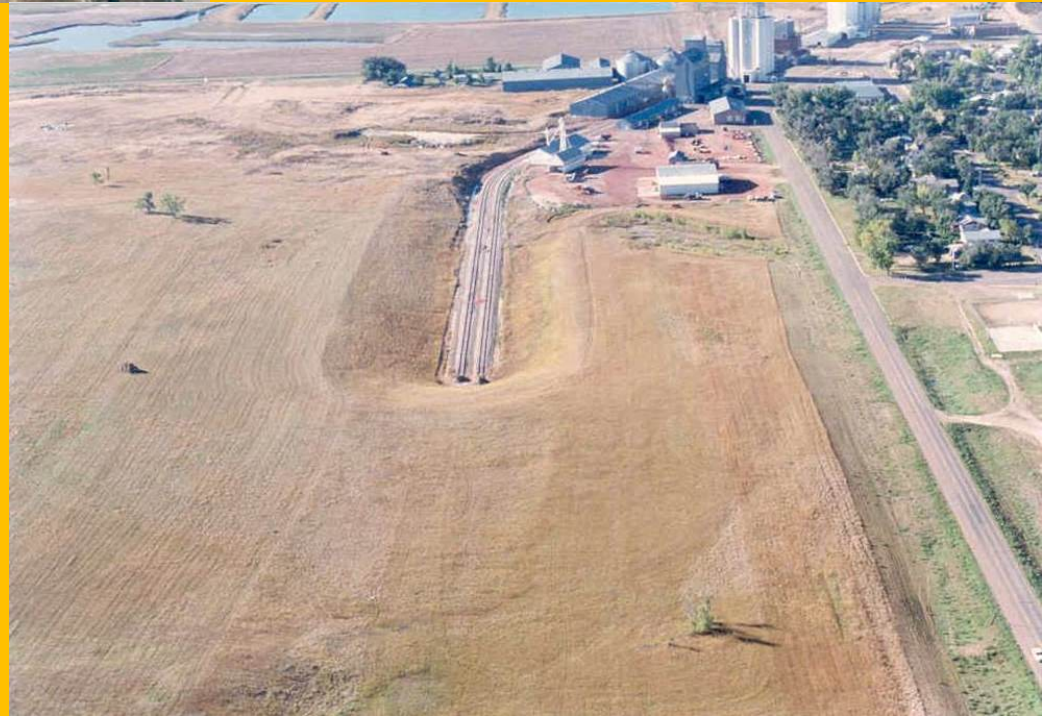
- Some of the first North Dakota AML underground mine reclamation projects were conducted under a cooperative agreement with Dickinson State College. These were research and development projects evaluating the effectiveness of alternative techniques. A 72 acre project near Scranton, ND, conducted from 1982 to 1987, utilized daylighting, blasting, dynamic consolidation, hydraulic jetting (supersaturation), and sinkhole grading in an attempt to collapse and reclaim a large underground mine.
- These early R&D projects encompassed about 110 acres of underground mine subsidence and the total cost was approximately \$2.2 million.



Underground Reclamation at Scranton, ND, 1982-87

- Daylighting, blasting, dynamic consolidation, hydraulic jetting (supersaturation), and sinkhole grading were conducted in an attempt to collapse and reclaim a large underground mine on this 72 acre site.
- The cost of this project was approximately \$1.7 million.

- Daylighting was conducted on the west side of this site. This technique was effective but was also very expensive.
- Techniques like blasting, dynamic compaction, and supersaturation were less effective and also had potential for adverse effects to wells, foundations and groundwater.





This shows a portion of the daylighting project at Scranton in 1983. Large equipment removed all the soils down to the original mine level, approximately 60-70 feet, and replaced it.



This shows blasting to collapse underground mine workings near New Leipzig, ND, in 1983. This method wasn't very effective and had the potential for adverse consequences.

Early Sinkhole Grading Projects 1982-88

Year	Site	Contractor	Acres	Approx. Cost
1983	Beulah	Kjelbertson Const.	12	\$177,200
1983	Garrison	Kjelbertson Const.	13	\$16,240
1984-85	Hanson-Reeder	Dickinson State	30	\$60,400
1984	Wilton	Kjelbertson Const.	60	\$178,400
1985	Beulah	Lindeman Const.	80	\$126,000
1986	Beulah	Holen Const.	45	\$102,000
1986	Lehigh-Dickinson	Kindt Earth Moving	45	\$72,000
1986	South Scranton	Morlock Const.	15	\$41,000
1987	Andrews Lake-Bowman	Schwartz Const.	12	\$26,000
1987	Zenith-South Heart	L.P. Anderson	52	\$68,000
1988	West Williston	Morlock Const	23	\$46,000
		Total	387	\$913,240

- The early R&D projects indicated that area-wide grading was an effective and relatively cheap way to eliminate hazards in large areas with many sinkholes.
- Eleven sinkhole grading projects were conducted in North Dakota between 1982 and 1988. These projects encompassed about 390 acres of subsidence at an approximate cost of \$915,000.
- These projects were relatively inexpensive and effective in eliminating the immediate hazard of the dangerous sinkholes but did not prevent subsequent subsidence.



This shows an area near Beulah, ND, where sinkhole grading was conducted in 1983. Note the high density of sinkholes.



This shows a 60 acre site near Wilton, ND, where sinkhole grading was also conducted in 1983. In this technique, topsoil was stripped from the entire site and saved and the sinkholes were graded with heavy equipment like bulldozers, scrapers and payloaders. After grading, topsoil was replaced and the sites were seeded with locally adapted grass species.

Remote Backfilling (Slurry) Projects 1982-89

Year	Site	Contractor	Approx. Cost
1982	Ward Co. Hwy 20, Sawyer	OSM Emergency	\$800
1983	Mercer Co. Hwy 21, Beulah	OSM Emergency	\$97,000
1983	Sun Valley Court, Beulah	OSM Emergency	\$117,000
1983	Manny's (Boat Dealer & Bar), Beulah	Kjelbertson Const.	\$578,000
1983	Ward Co. Hwy 20, Sawyer	Kjelbertson Const.	\$147,000
1984-86	Highways 200 & 49, Beulah	Gravel Products, et. al.	\$1,154,000
1987	Highway 200, Beulah	R& D Const.	\$84,000
1989	Assumption Abbey, Richardton	Rolac Contracting	\$71,000
1989	Highway 36, Wilton	Hulstrand Const.	\$609,000
		Total	\$2,857,800

- Remote backfilling methods were used in order to prevent dangerous sinkholes before they occurred in high use areas such as residential and commercial areas and public roads.
- Nine slurry-fill projects at a total cost of approximately \$2.85 million were conducted in North Dakota between 1982 and 1989.
- Serious subsidence events subsequent to the gravity fill projects indicated that the mined voids were not completely filled. This technique was discontinued in 1989 and later replaced by pressurized grouting.



This shows a 1985 slurry-fill drilling and grouting project near Beulah, ND. Three large drilling and grouting slurry projects were conducted between 1983 and 1987 in an attempt to stabilize collapsing underground mine workings beneath a complex of commercial buildings and several highways near Beulah between 1983 and 1987.

Remote Backfilling (Pressurized Grout) Projects 1991-present

Year	Site	Contractor	Approx. Cost
1991	Scenic East Subdivision, Williston	Thiem Drilling	\$1,084,400
1992	Eagles Club /SunValley Court, Beulah	Northern Improvement	\$629,260
1992	Highway 36, Wilton	Northern Improvement	\$179,200
1993	Roughrider RV, Beulah	Thiem Drilling	\$493,335
1994	Highway 2/52 Bypass, Burlington,	Thiem Drilling	\$1,102,750
1994	Highway 20, Sawyer	Thiem Drilling	\$293,000
1994	26 th St & 318 th Ave, Wilton	Northern Improvement	\$313,350
1995	Hwy 2/52 & Sub, Burlington Phase 2	Thiem Drilling	\$401,900
1996	Lehigh Road, Dickinson	Northern Improvement	\$445,650
1996	Ruud Farmstead & Hwy 23, Parshall	The Concrete Doctor	\$161,550
1997	Bar & Boat Dealership, Beulah	The Concrete Doctor	\$469,150
1997	Lehigh Road Phase 2, Dickinson	Northern Improvement	\$231,950
1998	Bar & Mobile Homes, Beulah Phase 2	Thiem Drilling	\$311,800
1998	Lehigh Road Phase 3, Dickinson	Northern Improvement	\$265,000
1999	KHOL Radio & Co. 21, Beulah Ph. 3	Earth, Energy & Water	\$307,350
1999	Lehigh Road Phase 3, Dickinson	Earth, Energy & Water	\$215,000
2000	City Residential & Co. 21, Beulah Ph 4	Earth, Energy & Water	\$350,000
2000	Lehigh Road Phase 4, Dickinson	Thiem Drilling	\$221,275
2001	Co. 21 & Hwy 200, Beulah Phase 5	Thiem Drilling	\$314,840
2001	Lehigh Road Phase 6, Dickinson	Thiem Drilling	\$275,400
2002	Highways 37 & 15, Garrison	Thiem Drilling	\$138,250
2002	Highway 200, Beulah Phase 6	Thiem Drilling	\$251,860
2002	Lehigh Road Phase 7, Dickinson	Thiem Drilling	\$278,800
2003	Highway 200, Beulah Phase 7	Thiem Drilling	\$262,100
2003	Lehigh Road Phase 7, Dickinson	Thiem Drilling	\$211,615
2003	Buechler/Garrison, Hwy 23, 37, 13	Thiem Drilling	\$220,000
2004	Snake Road, Burlington	Thiem Drilling	\$231,750
2004	Co. Rd. 13 Zap, Beulah/Zap Phase 8	Thiem Drilling	\$236,500
2004	South Garrison Addition, Garrison 3	Thiem Drilling	\$208,000
2005	Co. Rd. 13 Zap, Beulah/Zap Phase 9	Thiem Drilling	\$267,600
2005	Residential Areas, Garrison Phase 4	Thiem Drilling	\$270,000
2006	Co. Rd. 13 Zap, Beulah/Zap Phase 10	Thiem Drilling	\$285,000
2006	Williams Co. Rd 9, Williston	Thiem Drilling	\$355,000
2007	Williams Co Rd 9 Ph 2, Williston	Thiem Drilling	\$637,600
2008	Williams Co Rd 9 Ph 3 (Res), Williston	B&C Concrete Pumping	\$628,500
2009	Williams Co Rd 9 Ph 4 (Res), Williston	Agri Industries	\$992,200
2010	Co. 13 & Hwy 200, Beulah/Zap Ph 11	B&C Concrete Pumping	\$669,000
2010	Williams Co Rd 9 Ph 5 (Res), Williston	B&C Concrete Pumping	\$230,800
2011	Co. 21N & 60 th Ave, Beulah/Zap Ph 12	B&C Concrete Pumping	\$1,087,500
2012	60th Ave, Beulah/Zap Ph 13	B&C Concrete Pumping	\$730,000
2013	SEE Road, Scranton/Bowman Ph 1	B&C Concrete Pumping	\$883,000*
2013	60th Ave, Beulah/Zap Ph 14	B&C Concrete Pumping	\$951,500*
	*Pending Projects	Total	\$18,092,735

Pressurized Grout Remote Backfilling – Drilling & Grouting 1991-Present

- Pressurized grout remote backfilling is a proven technique for subsurface stabilization of undermined areas in North Dakota.
- In this technique, a cementitious grout is pumped through cased drill holes directly into the mined cavities in order to prevent collapse of mined workings.
- Since 1991, this has been the exclusive method for drilling and grouting to prevent subsidence in North Dakota.
- The grout is composed of (per cubic yard): 100 lbs. Portland Cement, 600 lbs. Flyash, 70 ounces Superplasticizer, approximately 2200 lbs. fine aggregate (sand) as required to meet yield requirements, and approximately 50 gallons of water as required to achieve the desired slump.
- Approximately 43 drilling and grouting projects utilizing pressurized grout remote backfilling, at a cost of more than \$18 million, have been conducted in North Dakota since 1991.
- This has proven to be a relatively effective technique for stabilizing collapsing underground mines before they collapse to the surface and cause sinkholes.
- One of the major disadvantages of pressurized drilling and grouting is the cost. It is an expensive technique and only used in “high-use” areas such as residential and commercial properties and public roads. A second disadvantage is that it is a remote technique and it is difficult to contain the grout within a specific area. A third disadvantage of pressurized drilling and grouting is that it can potentially cause surface lifting that can damage structures such as basements, foundations and roads.





Beulah/Zap Drilling & Grouting 1993- present

- Because of the high cost of drilling and grouting, many projects in ND have been phased over a series of years. In 2013, The Beulah/Zap project was in its 14th phase.
- The 2000 Beulah/Zap Phase 4 project exemplified advantages and disadvantages of drilling & grouting.
- Grout was injected directly beneath city streets and homes to stabilize collapsing underground mines.
- The street collapsed into a sinkhole directly beneath a loaded grout truck.
- Right across the street a few days later grouting caused surface lifting in on the road surface directly across the street causing a large bulge and grout to seep out of cracks in the street.

Garrison Drilling & Grouting 2002-2005

- Sinkhole Filling began near Garrison, ND, in 1983 and since then, more than 100 sinkholes have been filled.
- Four phases of drilling and grouting were conducted in residential areas and along public roads at Garrison between 2002 and 2005.
- In these drilling and grouting projects, more than 86,000 feet were drilled and nearly 5000 cubic yards of grout were injected at a cost of nearly \$750,000. Efforts were made to address all the highest priority undermined areas at Garrison but there is still potential for underground mine collapse.



Sinkhole Filling Projects 2000-2013

Year	Sites	Sinkholes	Contractor	Approx. Cost
2000	Turtle Lake, Wilton, Scranton, Haynes, Havelock, Zap, Beulah	120	Holen Construction	\$49,750
2001	New Salem, Wilton, Burlington, Tioga, Zap, Beulah	200	Basaraba's Excavating	\$80,400
2002	Noonan, Wilton, New Salem, Dickinson, Beulah and Haynes	100	Onsite Improvements	\$33,250
2003	Scranton, Washburn, Wilton, and Beulah	150	Basaraba's Excavating	\$20,030
2004	Beulah, Dickinson, Havelock, Haynes, New Salem, Parshall, Wilton and Zap	80	Quality Construction	\$24,630
2005	Baldwin, Beulah, Dickinson and Wilton	80	C&L Backhoe Services	\$18,330
2006	Hanks, Noonan, Sawyer, Wilton, Haynes, Regent, and Beulah	115	Hanson's Excavating	\$20,000
2007	Hanks, Noonan, Sawyer,	215	Hanson's Excavating	\$21,190
2008	Noonan, Scranton, New Leipzig, Leith, Beulah, Williston Dickinson, New Salem, Wilton, Sawyer, Washburn, Garrison	350	Hanson's Excavating	\$134,075
2009-2010	Beulah, Bowman, Dickinson, Hanks, Cartwright, New Salem, Noonan, Wilton	360	Basaraba's Excavating	\$127,600
2011	Burlington, Noonan, Hanks, Beach, Haynes, Dickinson, Richardton, NewSalem, Parshall, Garrison, Wilton, Washburn	172	Basaraba's Excavating	\$153,250
2012	Haynes, Dickinson, Wilton, Velva, Baldwin	45	Earthworm Excavating	\$61,775
2013	Beulah, Richardton, Dickinson, Williston, Hanks, Noonan, Haynes, Washburn, Wilton	100*	Pleasant & Sons Const.	\$100,000*
	Totals	2087		\$884,280



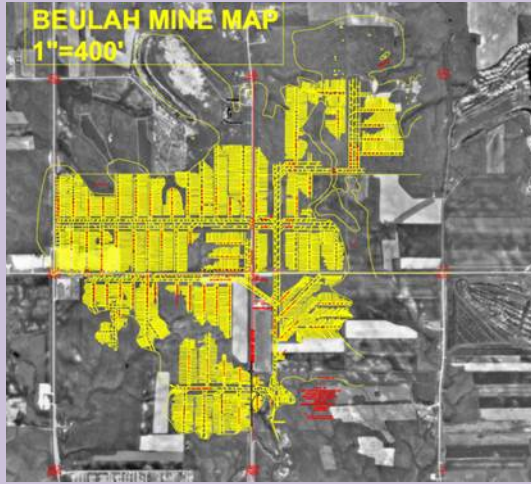


Emergency Underground Mine Reclamation in North Dakota

- Emergency reclamation projects, under the North Dakota Emergency Program, have been conducted when the AML hazard constituted an immediate and extreme hazard to the public.
- Approximately 20 emergency sinkhole filling projects and one emergency drilling and grouting project have been conducted in North Dakota since 1994 at a cost of approximately \$225,000. These have generally been conducted in residential and commercial areas and on public roads.
- The top photo shows the 2001 Beulah (Garner Sailer) Emergency Project in which a tractor was “swallowed” by a sinkhole while parked in a machine shed. The tractor was removed and two sinkholes in the shed were filled
- The middle photo shows the 2001 Lehigh Emergency near Dickinson, ND, in which a 30’ light pole dropped into a sinkhole near a commercial building. This hole and several others were filled with flowable fill grout.
- The bottom photo shows the 2008 Williston (David Njos) Emergency, a drilling & grouting project underneath a commercial building with voids directly underneath the driveway and floor.



Other Underground Mine Reclamation Considerations



Accurate mine maps can make the difference.



Drilling & grouting inside a building at Beulah, 1997.



Geophysical cross-hole radar survey at Garrison in 2003



Confirmation drilling and coring at Beulah in 2000.



Continuous laser level monitoring to detect minute structural movement from drilling & grouting.



Pre- and post-construction neighborhood workshops to discuss projects are important.