Project Summary
2014 Beulah/Zap Phase 15
Contracts AM-695-14 & AM-396-14

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

March, 2015

North Dakota Public Service Commission
2014 AML Project Summary

Beulah, North Dakota

Project Type:	Drilling and Pressurized Remote Backfilling with Cementitious Grout
Primary Locations:	60th Ave SW; HWY 200 and Michaelson drive
Project Dates:	September 5 — October 23, 2014
Contractor: Grouting Contractor: Material Testing	B & C Concrete Pumping, Inc. of Williston (S&S Drilling, Williston-subcontractor) GEOSERV of Bismarck
Total Project Cost:	$783,406.60 Drilling & Grouting $ 29,268.75 Material Testing

The Public Service Commission administers the Abandoned Mine Lands (AML) Program on behalf of the State of North Dakota. The AML Program is charged with eliminating existing and potential public hazards resulting from abandoned surface and underground coal mines. It is funded by a production tax on lignite coal mined in the state.

Over 25 major projects and several smaller ones have been conducted around Beulah since 1980 at a total cost of over $12 million. The drilling and grouting project for 2014 represents the 15th phase (i.e. 15th season) of work in the Beulah/Zap area. Previous projects have focused on areas along Highway 200 from the junction with Highway 49 east about 1 1/2 miles; north of the Highway 200/49 junction about 1/2 mile; along 60th Ave SW north about 2 miles from Highway 200; and within the city of Beulah.

The Black Diamond Coal Mine began operation in 1915 as a single shaft entry underground mine. From 1917-1922 the mine was know as the Beulah Coal Mine and operated as a double entry shaft underground mine. Finally, in 1923 it became the Knife River Mining Company. At this time it became a drift and slope, double entry, room and pillar operation. Underground mining ceased in 1953 when the mine converted to surface mining. A power plant was associated with the mine that originally provided electricity to light the mine and run the water pumps. Ultimately, the plant was operated by Montana-Dakota Utilities and provided electricity to rural cooperatives and cities from Dickinson to Bismarck. The underground portion of the mine consistently produced 300,000 tons of coal annually at an average of more than 1000 tons per day. About two-thirds of the coal was shipped for use outside the local area. The mine regularly employed 100-200 people making a substantial contribution to the local economy. The Knife River Mine is one of over 50 known mines in the area. The coal in this area lies anywhere from 40-120 feet below the surface and the coal seam ranges from 11-21 feet in thickness. An average of 7-11 feet of the coal seam was mined.

Cover Photo: *Grout being pumped into a cased hole along the north ditch of Highway 200 just west of 60th Ave. SW.*

Work Summary

Pressurized grout remote backfilling is a reclamation technique where a cementitious grout is pumped under pressure through holes drilled into the mine voids to fill them and reduce the likelihood of collapse. The grout is composed of cement, flyash, sand, water, and a high range moisture reducing admixture to increase grout flowability.

Grout injection for the 2014 Beulah/Zap Phase 14 AML project began September 5, 2014 on 60th Ave SW approximately 1/4 mile from the intersection with Highway 200 and near the tree rows on the ND Game and Fish property. At this location, four haul tunnels run perpendicular to 60th Ave. (Map 1) In 2013 and 2014, cased holes in the ditches (except 7W and 6E) were pumped as barrier walls. Barrier walls are comprised of lower slump (thicker and less flowable) grout creating a barrier to grout flow. The goal was to confine as much grout as possible under the road. Many of the casings for the holes on the road were blocked or broken and the sandy subsurface proved difficult to get casing cleanly into any newly drilled holes. Hole 6E, in the east ditch, was pumped with high slump highly flowable grout rather than as a barrier wall. This hole took 1,080 cubic yards of grout. Hole 5R2 (a redrill of 5A) was still taking after 1,364 cubic yards of grout in spite of the barrier walls and needs to be completed in the next phase. Confirmation drilling indicated that additional work needs to be done near Holes 7 and 7B (on the road).

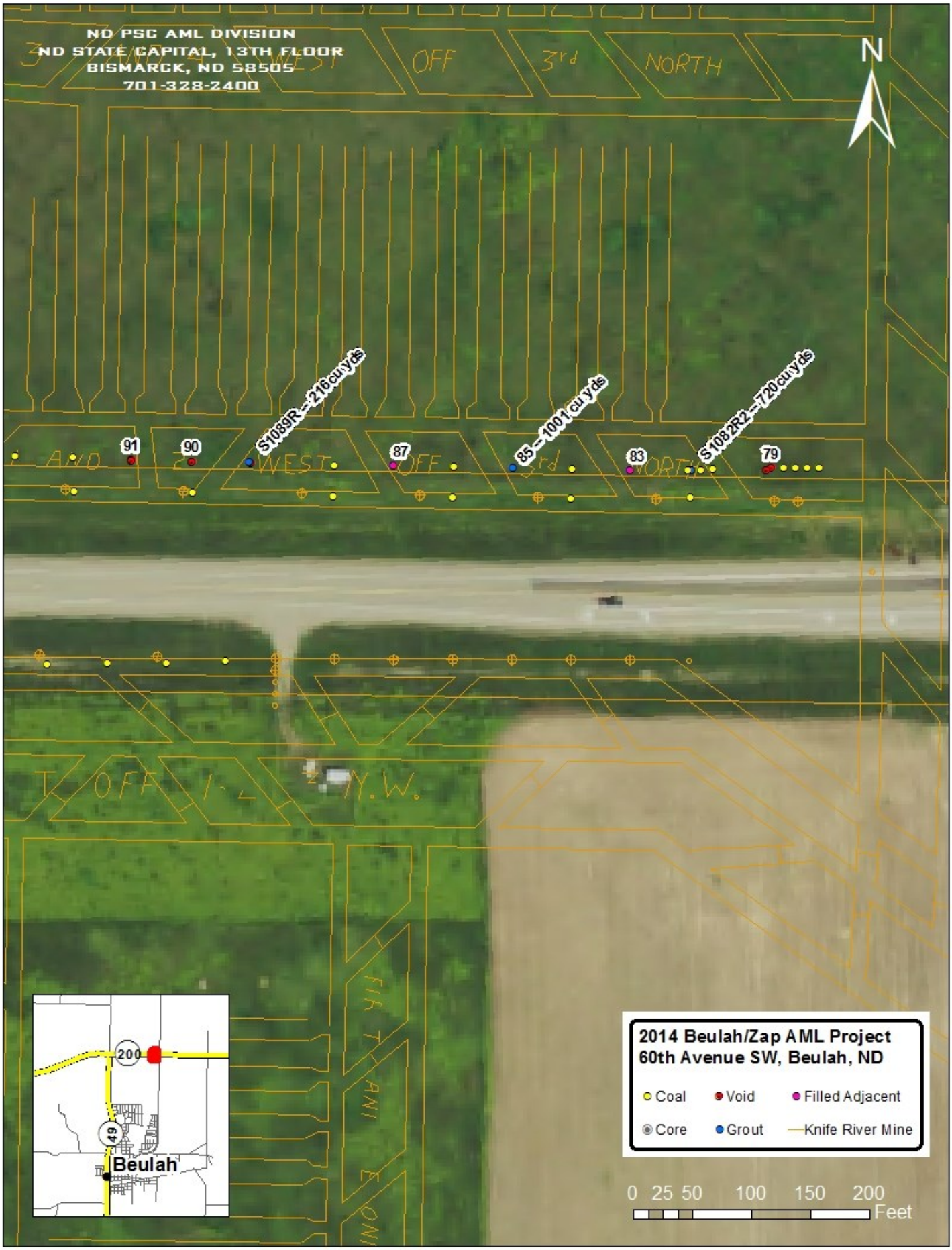
Grout was also pumped on a series of holes that were drilled in 2010 near Highway 200 (Map 2). The original holes were drilled at an angle toward the ditch. As along 60th Avenue SW, many of the casings that were installed in 2010 were plugged and were redrilled at an angle. Over 1900 cubic yards of grout were pumped into 3 holes and a total of 5 holes were filled. Holes 79, 91 and 91 will be worked on in the next phase.

Project drilling was done at the fence line on the Game and Fish property, west of 60th Avenue SW about 2000 feet north of Highway 200 where the mine map indicates rooms endrd near the road (See Map 3). One void was intercepted in this area and it took 144 cubic yard of grout. Drilling continued in the north ditch of Curt Michaelson's driveway starting at the bottom of the hill and moving toward 60th Avenue SW. Of the 21 holes drilled on the driveway, 5 intercepted voids. (Map 4). These will be grouted in the next phase. Confirmation drilling of work done in 2013 on 60th Avenue indicated good grout contact under the road.

GEOSERV from Bismarck, ND conducted field-testing of grout and collected samples at 50 cubic yard intervals throughout the project. These were cured and lab tested for compressive strength. The compressive strength requirement is 150 pounds per square inch (psi) after 28 days of curing. All samples except two met or exceeded this requirement.

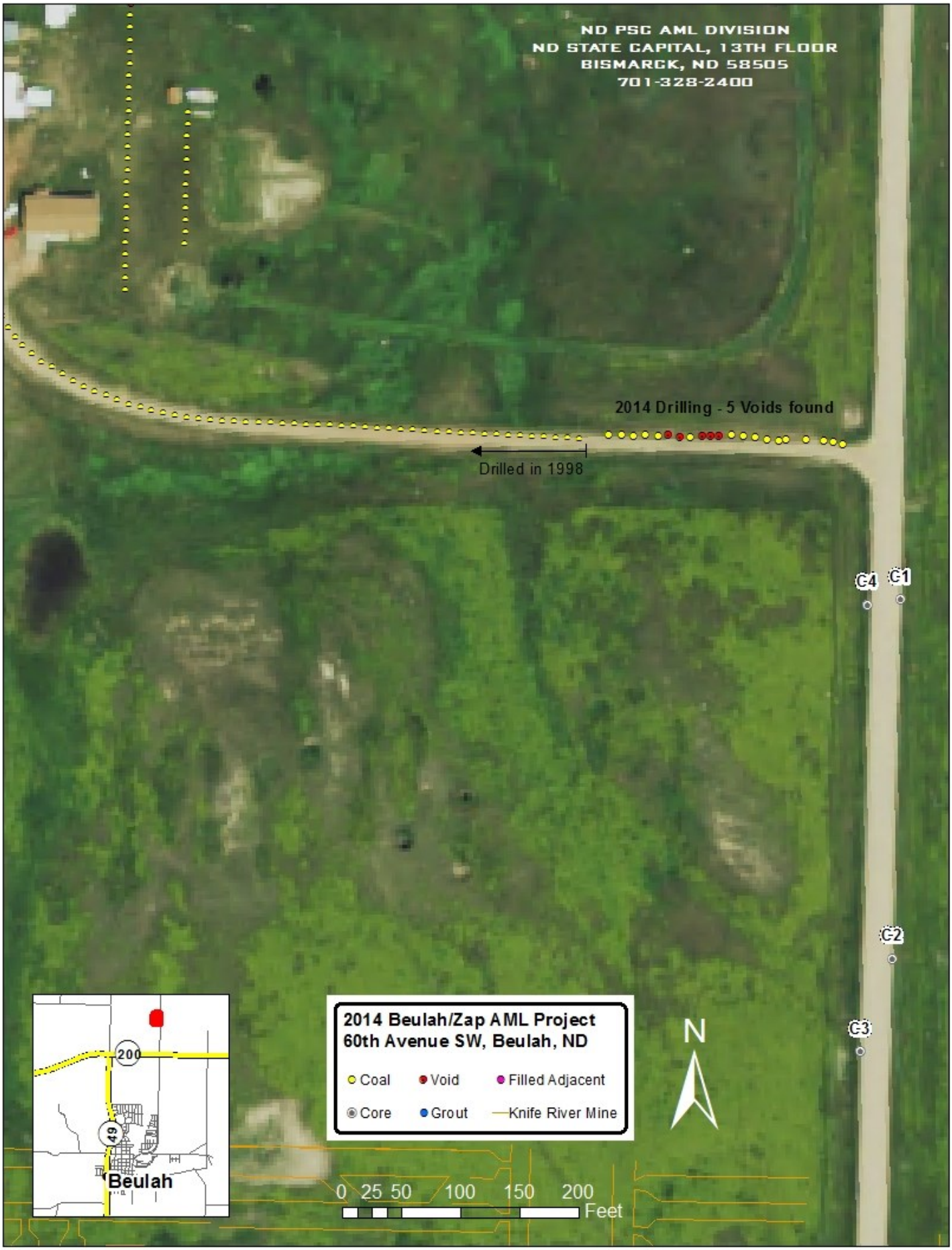
This AML Project reduced the likelihood of death or injuries to property owners and the public and of property damage by stabilizing undermined segments of public roads. Budgetary constraints required this work to be conducted in phases at the Beulah and Zap sites and additional phases will be needed in the future to continue stabilizing underground mines in high-use areas near Beulah.

Map 1: 60th Ave. SW, just north of HWY 200 & between Sec. 13 (T144N, R88W**) Sec. 7 (**T144N, R87W**).**



Map 2: HWY 200 just west of 60th Avenue SW.

Map 3: 60th Avenue SW, between Section 13 (T144N, R88W**) and Section 7 (**T144N, R87W**).**



Map 4: Curt Michaelson's Driveway off 60th Ave. SW. C1, C2, C3, C4 are confirmation drilling.

Beulah/Zap Phase 14 AML Project Statistics

Project Dates	September 5 — October 23, 2014
Project Length (consecutive days)	49
Total Work Days	26
Holes Drilled	59 plus 12 redrills
Feet Drilled, Regular	7,025
Feet Drilled, Specialty	1,393
Feet Cased	1,701
Grout Pumped (cubic yards)	5,260
Grout Pumped (cubic yards) per Project Day	107
Grout Pumped (cubic yards) per Day Worked	202
Holes Pumped	10
Holes filled by Pumping Adjacent Holes	5
Average Grout Take (cubic yards) per Hole pumped	526
Average Grout Take (cubic yards) per Hole filled	350
Slump-Project Average (inches)	10.2
Yield-Project Average	27.2

2014 Beulah/Zap Phase 14 AML Project

Drill Hole Data

Hole_ID	DrillDate	Upper coal	Lower coal	Void	Rubble	Drilled	Cased	Comments
5R	9/15/14	27-31		103-114	114-120	120	83	redrill of 5 (same as 5A)
5BR	9/15/14	27-31		109-116	116-120	120	116	redrill of 5B
6ER	9/15/14	24-27	105-112		112-120	120	105	redrill of 6E
7R	9/15/14	27-31	107-110		110-120	120	113	redrill of 7
7BR	9/15/14	27-30	107-110		110-120	120	109	redrill of 7B
8BR	9/15/14					80		Abandoned. Loose sand, could not drill by water injection
S1079R	9/22/15	42-47	118-126	126-132	132-140	140	126	Drill log named S10-B79AA
S10B82R	9/22/15	43-47	119-140			140		Drill Log named S10-B82A: Non-Void hole
S10B82R2	9/22/15	43-47	119-129	129-133	133-140	140	129	Drill log named S10-B82B
S1089R	9/22/15	45-49	119-126	126-132	132-140	140	126	Drill Log named S10-89A
S1090R	9/22/15	46-51		109-113	113-120	120	109	Drill Log Named S10-90A
S1091R	9/29/14	46-51	114-120	120-126	126-140	140	120	Drill Log named S10-91A
14-1	9/29/14	24-29	104-125			126		Inside of fence on G&F property on the West side of 60th Ave
14-2	9/29/14	25-29	104-124			125		
14-3	9/30/14	25-29	104-124			125		
14-4	9/30/14					0		skipped. Underground phone lines
14-5	9/30/14	25-29	104-124			125		
14-6	9/30/14	25-29	104-124			125		
14-7	9/30/14	25-29	104-124			125		
14-8	9/30/14	25-29	104-124			125		
14-9	10/1/14	25-29	105-125			126		
14-10	10/1/14	25-29	106-126			127		
14-11	10/1/14	26-30	106-126			127		
14-12	10/1/14	26-30	107-127			128		
14-13	10/1/14	26-30	107-110	110-115	115-128	128	105	
14-14	10/2/14	27-31	108-128			129		
14-15	10/2/14	27-31	108-128			129		
14-16	10/2/14	28-32	109-129			130		
14-17	10/2/14	29-33	109-129			130		
14-18	10/2/14	29-33	109-129			130		
14-19	10/3/14	30-34	110-130			131		
14-20	10/3/14	30-34	110-130			131		
14-21	10/7/14	30-34	110-130			131		
14-22	10/7/14	30-34	110-130			131		
14-23	10/8/14	30-34	110-131			132		
14-24	10/8/14	30-34	111-131			132		
14-25	10/8/14	30-34	111-131			132		
14-26	10/8/14	30-34	111-131			132		6 degree angle to get to S11-87
14-27	10/8/14	30-34	111-131			133		6 degree angle to get to S11-87
14-28	10/9/14	31-35	112-132			133		
14-29	10/9/14	31-34	112-132			133		
14-30	10/9/14	48-52	119-139			140		
14-31	10/9/14	48-52	119-139			140		
14-32	10/9/14	48-52	119-139			140		
14-33	10/9/14	48-52	119-139			140		
14-34	10/10/14	48-52	119-139			140		

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Drill Hole Data

Hole_ID	DrillDate	Upper coal	Lower coal	Void	Rubble	Drilled	Cased	Comments
14-35	10/10/14	48-52	119-139			140		
14-36	10/10/14	48-52	119-139			140		
14-37	10/10/14	48-52	119-139			140		
14-38	10/10/14	48-52	119-139			140		
14-5R2	10/14/14	27-31	110-119		119-130	130	119	
14-85	10/14/14	30-51				52		Michaelson Driveway.
14-86	10/14/14	30-51				52		Michaelson Driveway.
14-87	10/14/14	32-52				53		Michaelson Driveway.
14-88	10/14/14	33-53				54		Michaelson Driveway.
14-89	10/14/14	36-56				57		Michaelson Driveway.
14-90	10/14/14	39-46		46-56	56-60	60	41	Michaelson Driveway.
14-91	10/14/14	41-48		48-58	58-60	60	43	Michaelson Driveway.
14-92	10/14/14	41-61				62		Michaelson Driveway.
14-93	10/14/14	42-52		52-58	58-60	60	47	Michaelson Driveway.
14-94	10/14/14	44-54		54-61	61-64	64	49	Michaelson Driveway.
14-95	10/15/14	46-55		55-62	62-66	66	50	Michaelson Driveway.
14-96	10/15/14	47-67				68		Michaelson Driveway.
14-97	10/15/14	47-67				68		Michaelson Driveway.
14-98	10/15/14	50-71				72		Michaelson Driveway.
14-99	10/15/14	52-72				73		Michaelson Driveway.
14-100	10/15/14	53-73				74		Michaelson Driveway.
14-101	10/15/14	54-74				75		Michaelson Driveway.
14-102	10/16/14	59-79				80		Michaelson Driveway.
14-103	10/16/14	59-79				80		Michaelson Driveway.
14-104	10/16/14	60-80				81		Michaelson Driveway.
14-105	10/16/14	61-81				82		Michaelson Driveway.
14-C1	10/20/14	70-72				72		grout 2" in end of bit. Made a second attempt came back with empty corebarrel.
14-C2	10/20/14	78-80				80		grout in corebarrel
14-C3	10/20/14	79-82				82		coal in core barrel packed with mud. No grout
14-C4	10/20/14	69-72				72		no grout-solid coal. Across from C1
14-C5	10/20/14	107-110			111-118	110	111	110-120 core
14-C6	10/23/14	105-108				108		No grout

Above: Material tester, Max Tschosik (GEOSERV) is measuring the slump of the grout. Grout is tested every 50 cubic yards for slump, yield and temperature, and cylinders are cast for compression strength testing.

Below: Casing being removed in the east ditch of 60th Ave. SW. Once grouting is complete on a hole, the casing is removed.

Above: Grout pump set up on Hole 5 on 60th Ave. SW (see Map 1). This hole took 1364 cubic yards of grout.

Below: Cured test cylinders waiting for compressive strength testing.

Upper Left: The pressure can often reach 50-100 psi when pumping grout into underground mine voids as shown by the pressure gage in the picture.

Upper Right: Grout being discharged from the concrete mixer truck into the grout pump.

Lower Left: Drill rig and water truck on Curt Michaelson's Driveway looking east. The orange cone marks one of the 5 cased holes (see Map 4).

Mud pit attachment to the drilling rig. A slurry of “mud” is injected into the hole to keep the hole from collapsing which was a problem for the holes on the southern end of 60th Ave. SW.

Solidified grout in the core barrel tip. The remainder of the core barrel was filled with coal. This area was grouted in 2013