

## PRESSURIZED GROUT REMOTE BACKFILLING AT AML SITES NEAR BEULAH AND ZAP, NORTH DAKOTA

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**Abstract:** The Abandoned Mine Lands (AML) Division of the North Dakota Public Service Commission (PSC) is charged with the reclamation of hazardous abandoned mine sites in North Dakota. Several underground lignite coalmines were operated near the cities of Beulah and Zap, North Dakota, from the early 1900's until about 1955. Coal seams in this area were relatively thick and the overburden generally shallow. As these mines have deteriorated with time, deep collapse features, or sinkholes, have surfaced in many areas. These features are very dangerous, especially when they occur at or near residential and commercial areas and public roads. In the past five years, sinkholes have surfaced beneath a commercial building (boat dealership, lounge, and gas station) and beneath a nearby occupied mobile home north of Beulah. Sinkholes have also surfaced near KHOL Radio Station in Beulah and in the right of way of a public road south of Zap. The AML Division has conducted several emergency sinkhole-filling projects in these areas. In 1995-97, the AML Division conducted exploratory drilling which confirmed the presence of collapsing underground mines at these sites. The remediation of these sites around Beulah/Zap will take place over several years and involve three or more separate contracts due to budget considerations. In 1997, the AML Division began reclamation at these sites utilizing pressurized grout remote backfilling. In this technique, a cementitious grout is pumped through cased drill holes directly into the mine cavities to fill them and thereby stabilize the surface from collapse. The successful contractor for Phase One of the project was The Concrete Doctor, Inc. (TCDI). This paper will concentrate on Phase One of this work performed from June through September 1997. This project is especially interesting because grout was pumped through holes drilled inside the occupied commercial building. Grout was also pumped through angled holes that intercepted mined workings directly beneath the structure. Several specialized monitoring techniques were used to alert contractor if any movement in the structures occurred during grouting activities. Informational meetings were conducted by TCDI and PSC held with landowners, business owners, residents and road authorities before, during and after the project.

**Additional Key Words:** Underground Coal Mining, Subsidence, Hazard Mitigation, Exploratory Drilling, Specialty Drilling, Structural Monitoring, Pressure Grouting

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### Introduction

Pressurized grout remote backfilling is a proven technique for subsurface stabilization of undermined areas (Beechie 1993). In this technique, a cementitious grout is pumped through cased drillholes directly into the mined cavities in order to prevent collapse of mined workings. In 1997, the Abandoned Mine Lands (AML) Division of the North Dakota Public Service Commission (PSC) began a multi-year, multi-phase, large-scale pressurized grout remote backfilling reclamation project at three sites near the cities of Beulah and Zap, North Dakota. This project was designed to reduce the chances of dangerous subsidence events beneath high-use commercial and residential areas and public roads. The project is ongoing at the time of this publication. This paper will concentrate on the first phase of remediation that was completed in 1997.

This entire project will be the conclusion of a systematic process leading to reclamation of these hazardous abandoned underground mine workings. This process included site selection, public input, emergency remediation of dangerous subsidence features, exploratory drilling, and pressurized grout backfilling.

### Lignite and Lignite Mining in North Dakota

It has been estimated that fifteen billion tons of mineable lignite coals lie beneath the surface of western North Dakota (Oihus 1983). Lignite is a dark-brown to black, low-grade coal that is softer than bituminous coal. It has been mined commercially in North Dakota since the 1870s. Underground room and pillar mining was the predominant method until about 1940. In this method, coal was removed from an underground "room" about 100-300 feet long and 10-20 feet wide. Solid coal pillars of about the same dimension were left on either side of the room to support the roof, and the mine advanced by alternating rooms and pillars.

Many small commercial mines were developed in the early 1900's and the number of coalmines in North Dakota peaked at about 320 in 1940. Steam shovels and draglines made large-scale surface (strip) mining economically attractive and by 1966, strip mining was the exclusive method in North Dakota. Presently, more than 30 million tons of lignite are strip-mined annually

in North Dakota to fuel several large electrical generating plants and a coal gasification plant.

The cities of Beulah and Zap, about 85 miles northwest of Bismarck in west central North Dakota, have always been important centers of lignite coal production. At least 50 commercial lignite mines have been located within a 20-mile radius of these two cities (Kjos and Schreiner 1984). Most of these mines were small underground room and pillar mines, but a few were surface (strip) mines and some were quite large. Two of the currently operating strip mines in the state are located within 10 miles of Beulah, the Coteau Properties Company Freedom Mine and Knife River Coal Mining Company Beulah Mine. The Freedom mine fuels two electrical generating plants and the Great Plains Coal Gasification Plant. It produces about 15 million tons annually, about half the state's tonnage of lignite coal.

### Subsidence Hazards From Abandoned Underground Mines

The coal seam in the Beulah and Zap area ranges in thickness from about 10-20 feet and the overburden is relatively shallow - about 40-100 feet of mostly unconsolidated material. As the underground mines have deteriorated with time and begun to collapse, deep vertical subsidence features (sinkholes) have surfaced in many areas. These features can be more than 20 feet in diameter and 20 feet deep and can occur instantly. Sinkholes can be extremely hazardous when they occur at or near developed areas or roads (see photo 1). To my knowledge, no deaths have occurred in North Dakota as a result of collapsing underground mines. However, sinkholes have frequently surfaced in residential and commercial areas and road rights-of-way. During the winter of 1995-6, a man was seriously injured when he ran his snowmobile into a deep sinkhole a couple miles northeast of Beulah.

### Reclamation of Abandoned Mines in North Dakota

The Abandoned Mine Lands Division of the North Dakota Public Service Commission has been charged with reclamation of abandoned mine lands in the state since 1981. The State Reclamation Plan contains an inventory of all known abandoned coalmines in North Dakota. Of the 616 mines originally inventoried, eighty-seven were considered as Priority 1 or 2 sites:

hazardous to public health, safety and general welfare. Several more sites have been added since the original inventory. The Beulah sites represent some of the highest priority AML problems in the state.

### The 1997 Beulah/Zap AML Project

#### Site Characterization

The 1997 Beulah/Zap AML Project was to be conducted at three undermined sites near the cities of Beulah and Zap. These include:

- Manny's Sports Center Complex, a commercial building containing a boat dealership (recently vacated), bar, and gas station/convenience store, and several nearby mobile homes, located at the intersection of U.S. Highway 200 and N. D. Highway 49, about 1 mile north of Beulah.
- KHOL Radio Station building and portions of Mercer County Highway 21, located about 1 mile northeast of Beulah.
- A segment of Mercer County Highway 13, a gravel farm to market road located about 1 mile south of Zap.

Ultimately, the 1997 project was limited to the Manny's Sports Center and immediate surrounding areas. The remaining two sites will be the target of 1998 and 1999 projects.

The Beulah sites are underlain by portions of the Knife River Underground Mine. This mine began as the Black Diamond Mine, a single entry underground mine, on the outskirts of Beulah, in about 1915. It increased in production steadily, went through several changes in ownership, and by 1922 was operating as the Knife River Coal Mining Company. An electric power plant was built nearby in 1925 and by 1928 annual production was over 315,000 tons, making it one of the largest mines in the state. In 1950, Knife River began a strip mine at another location near Beulah and in 1953 the underground operation closed. Knife River and its predecessors operated the underground mine for nearly 40 years and removed about ten million tons of coal. It undermined an area of well over 1000 acres immediately north and east of Beulah.

The Zap site is underlain by portions of the Lucky Strike and Dry Flint Mines. These were commercial underground, room and pillar mines that operated between about 1917 and 1937. Whereas relatively

accurate data and maps are available for portions of the Knife River Mine, information on the Lucky Strike and Dry Flint Mines is sketchy at best.

Subsidence has occurred at or near Beulah and Zap for many years. Several AML reclamation projects, at a total cost of over four million dollars, have been completed near Beulah. Gravity fill remote backfilling projects have been completed near Manny's, on adjacent segments of Highway 200 and on County Road 21 near Beulah. In this technique, slurry, usually consisting of sand, water and sometimes flyash, was "poured" from cement trucks down drilled holes into the mine workings. This works adequately when the mine is relatively open; but when the mine has begun to collapse and is rubbleized; it is not very effective. Serious subsidence events subsequent to the gravity fill projects indicated that the mined areas were not completely filled and the hazard had not been abated.

Surface backfilling and grading of sinkholes has been undertaken on other areas near Beulah. This method is relatively cheap but, since it is done after subsidence has occurred, it does not provide protection to roads and structures that are undermined. A number of emergency and maintenance sinkhole filling projects have also been done near the Beulah and Zap sites. In 1993, a serious subsidence event occurred directly under the Manny's building complex (see figure 1). The resultant sinkhole was approximately 20 feet in diameter and 10 feet deep. This broke water lines, damaged air conditioning units and shut off power to the building. The AML Division responded and had the sinkhole repaired immediately under the state's emergency program. In 1996, a sinkhole surfaced beneath and near an occupied mobile home about 300 feet north of Manny's and this was also repaired under the emergency program. Other emergency projects were conducted within 500 feet of the KHOL Radio building in 1994 and 1995. One of these included backfilling a sinkhole that was more than 100 feet long and 20 feet deep. A large sinkhole also occurred in the road right of way of County Road 13 south of Zap and it was repaired in 1995.

Two previous pressurized grout remote backfilling projects have been completed near Beulah. One was conducted in 1992 at the Beulah Eagles Club. In this project, approximately 16,000 cubic yards of grout were pumped into mine cavities beneath and near the Beulah Eagles Club Building and parking lot (Beechie 1993). The other project was done in 1993 near and beneath Roughrider Mobile Homes, Inc., a recreational vehicle dealership located directly east of Manny's.

Approximately 18,000 cubic yards of grout were pumped into mine cavities during this project.

#### Exploratory Drilling and Project Design

Exploratory drilling was conducted at the Beulah and Zap sites under separate contracts during the winters of 1995-6 and 1996-7. This was accomplished with rotary drilling equipment utilizing forced air and injected water to bring drill cuttings to the surface. The intent of exploratory drilling was to determine the depth to mined voids and rubble zones, coal extraction methodology, size and extent of the mined workings, integrity of mined workings (intact, collapsing, etc.), the presence or absence of groundwater, and site specific lithology.

Exploratory drill holes were approximately 5 inches in diameter, were usually spaced at ten-foot intervals and were drilled to the bottom of the coal seam or the mined cavity or rubble zone. These intervals and depths were designed so that drilling intercepts any mine cavities or rubble zones in the area. The relatively close spacing of drillholes is required because haul tunnels are typically 10 feet wide and a spacing of more than 10 feet may miss the targeted mined workings. Drillholes that intercepted mined workings were cased from the surface to the top of the mined void or rubble zone with three-inch inside diameter Schedule 40 PVC Pipe. Casing allows mine inspection with a borehole camera, where conditions allow, and cased drillholes can be used as injection holes into the abandoned underground mine.

Approximately 150 exploratory holes, at an average depth of 95 feet, were drilled near the Manny's building complex and nearby mobile homes. About 60 of them intercepted mined workings and were cased. Approximately 160 exploratory holes were drilled near KHOL Radio and adjacent segments of Mercer County Highway 21, at an average depth of about 80 feet. About 50 of these intercepted mined workings and were cased. Approximately 230 holes, at an average depth of 55 feet, were drilled along Mercer County Highway 13, south of Zap. Five of these holes intercepted mined workings and were cased.

Exploratory drilling was not conducted inside the buildings or underneath the mobile homes. However, systematic drilling around the perimeter of the structures and available mine maps provided information needed to extrapolate information about the mine and mining sequence under the structures.

The objective of this pressurized grout remote backfilling project was to fill the mine cavities underneath the structures and roads with as much grout as possible and thereby reduce the chances of collapse and subsidence. The key to project design was to provide for a method of delivery of grout into the mine cavities underneath the structures and roads in a manner that is safe and minimizes disturbance to the users. There is probably as much art as science in estimating the quantity of grout required to fill the mine cavities. It depends on knowledge of the mine and mining methods, the overburden, capabilities of equipment utilized and other site-specific factors. The grout quantities estimated for reclamation of the three Beulah/Zap sites were as follows: Manny's Site - 5500 cubic yards, KHOL Site - 3000 cubic yards, Zap Site - 750 cubic yards.

Making accurate estimates of required grout quantities for this project was especially difficult. Previous gravity flow backfilling projects had been done at two of three sites. Also, the mines in the project area were in a state of intermediate collapse and mine cavities had subsided upward and were rubblized as indicated by sinkholes and many of the drillholes. Several assumptions were made to accommodate these factors. The initial grout quantity estimate was made based on the volume of each mining room and haul tunnel in the project area. These figures were then modified by factors such as previous backfilling and swell from the rubble that had collapsed into the mine workings.

#### Contractor Selection

In order to bid on this project, contractors were required to be pre-qualified. To be pre-qualified, a contractor (or his project superintendent) must have successfully completed at least two projects within the previous five years that demonstrate capability to provide the drilling, grout injection, and coring applicable to this method of reclamation. The same information was required for anticipated subcontractors. The contractors also had to list and describe all equipment intended to be utilized.

A pre-bid, on-site conference was held at the project sites approximately one week before the bid opening. This was to afford an opportunity to prospective bidders to receive clarification related to the project. Contractor attendance at this conference was mandatory. The grouting contractor for this project, The Concrete Doctor, Incorporated, (TCDI) of Lincolnshire, Illinois, was selected by competitive

sealed bidding on June 13, 1997. TCDI had successfully performed similar projects in North Dakota and other states. Material testing was contracted separately and the successful bidder was Maxim Technologies, Inc., of Bismarck.

### Public Participation

Public input and participation was an important factor because of the "high-use" nature of the project sites. Several public meetings have been held in Beulah in the past fifteen years to discuss AML problems and plans for reclamation. A public meeting was held November 25, 1996 to discuss this particular project. The AML Division has been in contact with landowners and property occupants within the project area for the past several years and has tried to accommodate their needs as much as possible. Right of Entry forms were signed by each property owner, the Mercer County Highway Department and the North Dakota Department of Transportation.

The contractor was required, as a provision of the contract, to plan and conduct a minimum of two informational workshops near the project area. These provided information and established agreement and collaboration between the contractor and all other interested parties. Interested parties included land and property owners or residents, the project foreman, subcontractors, material testers, the AML project manager, and any other appropriate state or local authorities. The initial workshop addressed: 1) a general discussion of the project and project timetables; 2) goals, objectives, and concerns of all parties; 3) roles and communication framework; and 4) a procedure for rapid resolution of disputes to minimize conflict. Based on information received in the initial meeting, the contractor developed an outline to identify goals and objectives, timetables, and a communication and issue resolution framework. Subsequent workshops were held as needed, including a post-construction workshop to evaluate the success of the project in meeting goals and concerns.

### Project Drilling

To supplement the exploratory drilling, the contractor drilled approximately 20,000 feet of rotary drilling, approximately 1000 feet of specialty (interior) drilling and 100 feet of coring. Rotary drilling near structures and along roadways was angled up to 15 degrees from vertical in order to diagonally intercept mined workings under the structures that were reachable from the exterior perimeter of the structures. Due to the fixed

most type of drill rig utilized for the exterior drilling, the angle holes were accomplished by placing bridge planks under the drilling rig's leveling jacks. Figure 2 shows angle drilling near an occupied dwelling.

Interior drilling was required to access certain voids located beneath the Manny's building complex. Figure 3 shows interior drilling inside a commercial building. Vertical and angle drilling could not intercept all mined cavities beneath the building complex. Approximately 20 holes will be drilled inside and through the floor of the building. Special drilling equipment capable of drilling under an eight-foot ceiling was used for this work.

Interior drilling and grout pumping was generally conducted during non-business hours in consultation with the business owners. The contractor was required to protect property by isolating drilling and grouting equipment with plastic sheeting, tarpaulins, and plywood sheeting. Drilling equipment exhaust was vented outside the building. The contractor was liable for any damages caused to any property as a result of drilling or grouting activities. This included even reasonable and normal damage during the course of work. Interior restoration was required at conclusion of the project. The imminent remodeling of a major portion of the Manny's building to accommodate a new tenant made it more practical for TCDI to come to a cash settlement in lieu of certain portions of restoration.

### Grout Injection

The estimated volume of grout required to complete this project was 9250 cubic yards. However, due to budgetary constraints the grout volume specified in the 1997 contract was 5500 cubic yards. Ultimately, the contract was adjusted to 6746 cubic yards. This was done without a substantial contract price adjustment mostly by reducing the quantity of drilling footage.

Grouting will began in the Manny's parking lot and driveway in order to allow the contractor to get a "feel" for safe and allowable pressures. The contractor determined grout injection pressures and was responsible for any damages caused by grouting activities. Injection pressures in non-critical areas were as high as 400 pounds per square inch (psi). However, injection pressures directly under buildings did not exceed 100 psi. Surface lifting or "jacking" is a very real hazard in this technique. If this occurred in the driveway it's not a serious problem, but if it occurred inside the building complex it could ruin the foundation and result in difficult and costly repairs for the

contractor. The contractor was required to submit a detailed, quick-response plan of action in the event sudden surface jacking occurs during pressure grouting activities.

The grout utilized in this project was 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 80 gallons of water as required to achieve the slump requirements. Each component of the grout mix has its specific requirements. Cement must meet industry standards. Flyash from only two generating plants in North Dakota was approved for use by the North Dakota Department of Health. Sand must meet gradation requirements with 100% passing a 3/8-inch sieve, 90% passing a 4-mesh sieve, 40-80% passing a 30 mesh sieve, and 5-15% passing a 200 mesh sieve. The superplasticizer used in this formulation (ASTM C-494 Type F) is a high range water reducer that improves flowability and set-up strength, and only one brand, Conchem SPL, was approved for use by the State Department of Health. Wald and Beechie (1996) described the research that led to development of the grout formulation presently used for pressurized grout remote backfilling in North Dakota. This paper provides details on each component of the grout mix and physical and chemical characteristics of the grout in a simulated wet mine environment.

The grout formulation was designed for maximum flowability and adequate set-up strength. Grout was required to attain an unconfined compressive strength of at least 150-psi within 28 days. Slump, or thickness of the grout mix, is adjustable by adding or reducing water. Generally a fairly thin mix, in the range of 6-11 inch slump, was utilized because a thicker, or lower slump, mix would have been less flowable and may have caused plugging of the injection pipe or poorer fill of the mine cavity.

Material testing for this project was conducted by the engineering firm, Maxim Technologies, Inc. The material tester sampled all components of the grout mix, made regular batch plant inspections, and also sampled the grout at least every 50 cubic yards for slump and for compressive strength. Samples for compressive strength were divided into three specimens and are broken at predetermined time intervals to determine strength. Payment for grout depended on compressive strength of the samples. If they do not achieve strength of at least 150 psi within 28 days, payment is reduced. If the strength is less than 80% of

this standard, no payment is made for the 50 cubic yards of grout represented by that sample.

Grouting equipment included mixing and batching facilities, a pump specifically designed for pressure injection of grout, and pipe, hose, and fixtures to convey the grout into the mine cavities. Figure 4 shows a portable batch plant and grout pump. Calibration of all equipment was required before beginning work. The grout pump must have a liquid-filled diaphragm in-line gauge so that pressures can be continually monitored. The general method for grout injection was to bottom-up tremmie grout. In this method, the grout pipe (tremmie) is lowered to the bottom of the mine cavity and the cavity is filled progressively in two-foot increments from the bottom to the top. This method may be varied depending on site-specific conditions. Grout pumping continued either until refusal (when no more grout can be pumped), until surface jacking occurs, or until grouting pressures reach a predetermined maximum. Confirmation drilling and coring was done after grouting to ensure that mine cavities were completely filled.

#### Structural Surveys and Stress Monitoring

The possibility of surface jacking and damage to buildings and structures posed by pressurized grout remote backfilling necessitated detailed structural surveying and a comprehensive system of monitoring. The material testing firm was required to conduct pre- and post-construction interior and exterior inspections of the Manny's building complex. Any evidences of stress such as cracking, settlement, or any other structural imperfections or deformities will be measured and recorded graphically, photographically and in narrative form. The contractor by contract assumes all responsibility for such damage regardless of cause.

Crack monitors (see Figure 5) were installed in predetermined locations on visible cracks in structures or foundations and these were monitored periodically during proximal grout pumping. TCDI was also required to install an interior laser level inside of the building during grout pumping to monitor movement in the structure. This type of laser level is capable of detecting very minute structural movements and multiple targets can be used to monitor a fairly large area. If any monitoring equipment detected structural movement, grout pumping was immediately be discontinued in that area. The inspections and installation of crack monitors was done by or under the supervision of a certified professional engineer. After

the project, the engineer submitted a report containing all observations, measurements, maps, sketches and photographs, and indicated whether grouting activities have caused any significant damages.

#### Project Results

The final project quantities and statistics are contained in the attached Tables 1, 2, and 3. Verification drilling and core sampling of the mine interval determined the success of the actual pressure grouting. The core samples showed extensive grout penetration into the mine voids including the rubbleized zones. Although minor movement of the ground and the structure was detected during the project, no damage to the structure or underground utilities occurred.

#### Conclusion

Pressurized grout remote backfilling is an effective reclamation technique for subsurface stabilization of undermined roads, buildings and other structures. It is a relatively high cost technique. Therefore, it is only practical in areas where underground mine subsidence presents a serious hazard to the public such as high-use commercial and residential areas and public highways. This technique has been used successfully in North Dakota since 1991.

This was a case study of a pressurized remote backfilling reclamation project that was conducted near the city of Beulah, North Dakota. This project marked the remediation step in a process of identifying, classifying, investigating, and reclaiming some serious AML hazards. The project was notable because a

number of different approaches were used and because drilling and grouting activities were conducted inside a commercial building. Participation of affected parties and continual structural monitoring during all phases of the project were especially important. Phase One (1997) of the project was completed at the time of this publication and subsequent projects are anticipated for the next several years. Work done thus far certainly reduce the likelihood of death or injuries to property owners and the public resulting from collapse of underground mine workings. The approximate total contract costs for this project were \$450,000.

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1997 Beulah/Zap AML Drilling Information

TCDI/JL Drilling								ALL HOLE SPACINGS 10' UNLESS NOTED
Hole	Date	Coal	Void	Rubble	Tot Ft.	Cum	Cased	Comments
Manny's Site								
200	16-Jul	84-99			100			note 200-213 located on S-N line 7' E of bldg
214	16-Jul	81-99			100	200		loc. 18'S of hole 5, S of bldg.
215	16-Jul	87-99		82-87	100	300	82	loc. 40' E of point between 5 & 6
201	17-Jul			71-99	100	400	71	86-89 hard, 89-99 firm, first hole thru sidewalk
202	17-Jul	86-93		93-99	100	500	86	
216	17-Jul				20	520		loc. 40' E of 9, bad hole, fill material too loose to drill
217	17-Jul			75-96	100	620	75	loc. 20' E of 9, 75-87 firm, 87-89 hard, 89-91 loose, 91-96 firm
209.5	18-Jul	87-89		89-103	105	725	88	89-103 loose
211	18-Jul	87-100			100	825		
212	18-Jul	89-100		83-87	100	925	83	firm, lost circ., east of bldg, first hole N. of sidewalk
213	18-Jul			71-99	100	1025	70	9' from prev. (to avoid elec. line), 71-79 poss. fill
218	18-Jul			78-99	100	1125	78	loc. 40' E. of pt btwn 14/15 app. 55'N, 10'W of NE corner
219	18-Jul		68-73	73-100	100	1225	68	40' E of 18, approx. 90'N, 10'W of NE corner of bldg.
203	21-Jul	85-99			100	1325		
204	21-Jul	85-99			100	1425		
208	21-Jul	85-100			100	1525		
209	21-Jul			76-99	100	1625	76	76-86 very loose, 86-92 firm, 92-97 tight, 97-99 loose
28A	21-Jul	87-100			100	1725		approx. 3' W of 28 (redrill of 28)
205	22-Jul	87-99		89-99	100	1625	89	89-94 loose, 94-95 firm, 95-99 loose
206	22-Jul			88-99	100	1925	88	88-90 firm, 90-94 loose, 94-95 tight, 95-99 loose, poor returns
207	22-Jul	85-99			100	2025		
220	22-Jul				40	2065	14	220-225 in W-E line N side bldg, 220 loc. 55'W, 6'N of NE corner
221	22-Jul				30	2095		blowing out 220 at 12', not cased, like 220 loose near surface
222	22-Jul			67-98	100	2195	67	
223	23-Jul			77-99	100	2295	76	
224	23-Jul			78-100	100	2395	78	loose/firm/loose/firm/loose some regain of circ @ 96-100
225	23-Jul	87-92		92-100	100	2495	92	last one on N. slab, loc 5'W, 6'N of NE corner, poor returns
226	23-Jul			86-105	105	2600	86	loc. 40'E of pt. btwn 21& 22, poor returns
227	23-Jul			80-100	100	2700	80	loc. 40' E of 25/26, loose/firm/loose, some regain circ @ 96-100
228	24-Jul	86-102			103	2803		loc. 10' N of prev. approx 175'N, 10'W of NE corner bldg.
229	24-Jul	85-100			100	2903		10'N of prev
230	24-Jul			86-100	100	3003	86	10'N of prev
231	24-Jul		68-71	71-100	100	3103	68	10'N of prev
232	24-Jul			82-100	100	3203	82	40' E of 30/31
233	24-Jul		77-78	78-100	100	3303	78	40' E of 34/35
234	24-Jul	89-95			106	3409		40' E of 37/38, hard grout 95-98, coal & clay 98-105, good circ.
205.5	25-Jul		72-75	75-100	100	3509	72	angled 14 deg., 5' N of 205, 75-86 tight, 86-100 loose
END PAY #1					3509		1633	
209.5	28-Jul		73-76	76-100	100	3609	73	angled 14 deg., 5' N of 209, 76-84 loose, 84-96 firm, 96-100 loose
235	28-Jul			78-100	100	3709	78	angled 6 deg., along S. side bldg (10'W/7'S of SE corner) heading W
236	28-Jul			79-100	100	3809	79	angled 6 deg., (20'W of prev) 79-90 loose, 90-100 firm
237	28-Jul			60-96	100	3909	60	angled 7 deg., (10' W of prev) loose/firm/loose/firm
238	28-Jul	84-86	86-87	87-100	100	4009	86	angled 6 deg., (10' W of prev)
239	29-Jul			73-100	100	4109	73	angled 6 deg., (10' W of prev)
240	29-Jul	82-98			100	4209		angled 8 deg., (10' W of prev)
241	29-Jul			69-100	100	4309	69	loc 40' E. of 99/100
242	29-Jul	87-100		52-87	100	4409	51	loc 40'E of 95, loose firm/loose firm/loose 87-100 like coal
243	29-Jul			72-100	100	4509	72	loc 40'E of 90, loose/firm/hard/loose/firm
244	29-Jul	86-87		87-100	100	4609	87	loc 40'E of 82/83, loose/firm w/some circ. (coal) loose/firm
245	30-Jul				40	4649		bad hole, blowing out 244 at ~10' depth
246	30-Jul	86-100			100	4749		
247	30-Jul	86-89		89-100	100	4849	89	loc 24'E of 245, approx 1' from corner of pad by diesel pump
248	30-Jul			90-99	100	4949	90	loc 60'E of 78
248A	30-Jul			76-98	100	5049	76	loc 22'E of 248
249	30-Jul				40	5089		bad hole loc 20' S of 248
249A	31-Jul			75-100	100	5189	75	loc 15' E of 249 & 250: comm w/ 250
250	31-Jul	82-87	81-82	97-99	100	5289	81	loc 10'N of 251
251	31-Jul	82-99			100	5389		loc 10' N of 252
252	31-Jul			70-97	100	5489	70	loc 45'N of 253
253	31-Jul	82-99			100	5589		loc 40'E of 66&67, 22' N of Shop
253A	31-Jul	82-86			100	5689		loc 7'S of 253; hard grout 86-96
254	31-Jul				100	5789		loc 40'E of 50&51
256	31-Jul	81-99			100	5889		loc 40'E of 58&59
255	1-Aug		65-70	70-100	100	5989	65	loc 40'E of holes 54&55, S of shop
257	1-Aug			82-97	100	6089	82	loc 27'E of 252 near NW corner of bait shop
258	1-Aug	81-85			100	6189	81	loc 18'E of 253A, 8'W of storm, hard grout 85-97, sand & gravel
259	1-Aug	84-91		75-98	100	6289	75	loc approx 25' W of front door to baitshop
260	1-Aug			42-100	100	6389	42	loc 10' N of 253, 68-73 hard like grout, remainder very loose
					6389		3387	
Pay#2					2880			
261	14-Aug	82-96			97	6486		redrill of No1



262	14-Aug	82-96			97	6583	rednll of No 2
263	14-Aug		72-74	65-97	97	6680	65 rednll of No 5
264	14-Aug			89-97	100	6780	86 on concrete slab S of Shop 40' E of #60, 23'E/10'S of SW corner
270	14-Aug			86-100	100	6680	86 40'E of 244
271	14-Aug		69-75	75-99	100	6980	67 40'E of 243
272	14-Aug			75-100	100	7080	75 40'E of 242
273	14-Aug			70-100	100	7180	70 40'E of 241
274	15-Aug	89-100			100	7280	20'E of 234
275	15-Aug	89-105			108	7388	20'E of 233
276	15-Aug	89-100			100	7488	90 20'E of 231, broken coal 93-96
277	15-Aug	89-100			100	7588	90 20'E of 227, broken coal (some returns) 90-100, comm. w/227
278	15-Aug			78-100*	100	7688	80 20' E of 226, grout 78-80, clay/grout 80-86, firm (poor circ) 86-100
279	15-Aug	88-100			100	7788	93 20'E of 219, broken coal 93-100
279A	15-Aug	86-100			100	7888	10'N of 279
280	15-Aug	95-100		86-95*	103	7991	86 20'E of 218, clay/coal 86-95, no loss of circ.
265	18-Aug	94-97		63-68*	108	8091	20' W of 260, grout 63-68, clay 68-94, good circ, not cased
266	18-Aug	85-98			100	8191	20' W of 250
266A	18-Aug	85-88		88-100*	100	8291	10'N of 266, clay/coal 88-98, good circ, not cased
266B	18-Aug	84-89			100	8391	10'S of 266
70A	18-Aug	82-87		87-97*	100	8491	rednll of 70, grout 87-89, clay/coal 92-97 w/ good circ, no cased
267	18-Aug	83-98			100	8591	80'W of 250
267A	18-Aug	82-89		89-99*	100	8691	10'S of 267, grout 89-95, clay 95-99, good circ, not cased
268	19-Aug	85-100			100	8791	10'N of 248A
269	19-Aug	85-100			100	8891	20'N of 248A
269A	19-Aug	85-100			100	8991	30'N of 248A
259A	19-Aug			22-35	35	9026	21 18'W of door to HLS, 7'E of 259, angled 6degN
281	19-Aug		42-50	36-97	100	9126	42 haul tunnel, 100'N of 200-1 (which is on N. shoulder hwy 200)
282	19-Aug			85-97	100	9226	85 haul tunnel, 200'N of 200-1 (which is on N. shoulder hwy 200)
283	19-Aug			86-100	100	9326	86 haul tunnel, 300'N of 200-1 (which is on N. shoulder hwy 200)
284	19-Aug			86-100	100	9426	86 haul tunnel, 400'N of 200-1 (which is on N. shoulder hwy 200)
285	20-Aug			75-100	100	9526	75 haul tunnel, 500'N of 200-1 (which is on N. shoulder hwy 200)
286	20-Aug		60-64	54-100	100	9626	54 haul tunnel, 600'N of 200-1 (which is on N. shoulder hwy 200)
287	20-Aug	82-88		88-96	100	9726	88 haul tunnel, 100'N of 200-2 (which is on N. shoulder hwy 200)
288	20-Aug		65-67	67-97	100	9826	65 haul tunnel, 200'N of 200-2 (which is on N. shoulder hwy 200)
289	20-Aug	84-84		84-100	100	9926	84 haul tunnel, 310'N of 200-2 (which is on N. shoulder hwy 200)
290	20-Aug	85-90		90-100	100	10026	90 haul tunnel, 400'N of 200-2 (which is on N. shoulder hwy 200)
291	20-Aug	86-90		90-100	100	10126	90 haul tunnel, 500'N of 200-2 (which is on N. shoulder hwy 200)
292	20-Aug	89-95	95-97	97-104	105	10231	95 haul tunnel, 600'N of 200-2 (which is on N. shoulder hwy 200)
220A	21-Aug			94-100*	115	10346	15'N of 220, angled 11degS, clay/coal mix, not cased
10A	21-Aug	81-96			98	10444	near 10 (trying to core), clay/coal 81-84, lost/regained circ
C-10-B	21-Aug				60	10504	CORE 60-70 (pulled ~3' of broken grout)
215A	21-Aug	82-98			99	10603	near 215 (trying to core)
22A	21-Aug			58-100*	100	10703	near 22 (trying to core), grout 58-59, clay 59-80, clay/rub-100
28B	21-Aug	87-100			100	10803	5'E of 28
247A	22-Aug	88-91		91-100*	100	10903	near 247 (trying to core), clay/coal 91-100
270A	22-Aug	98-94		94-100*	100	11003	near 270 (trying to core), clay 94-100
C-82.5	22-Aug	85-89			89	11092	CORE 89-92 (pulled ~3' of broken grout)
19A	22-Aug			63-100*	100	11192	near 19 (trying to core) 63-100 clay
C-19-B	22-Aug			65-67*	70	11262	CORE 67-72 (pulled 4.5' of broken grout)
		PAY #3			4873		
		Total No. of holes (incl. specialty)			127		
		No. of holes cased (incl. specialty)			77		
		Total footage drilled (incl. specialty)			12048		
		Total footage cased (incl. specialty)			5882		
		Total footage cored			18		
<b>Specialty Drilling</b>							
S-1	30-Jul			80-93	93		82 loc in shop 3' E of W wall, 17' N of south wall, coal-grout fragments 80-93
S-3	31-Jul			79-94	99	192	79 20' E of prev
S-5	31-Jul			80-96	99	291	80 20' E of prev
C-1	4-Aug	81-99			99	390	81 In Showroom 66.5' E of W wall, 35.5' N of S Wall, fractured coal
C-2	4-Aug			75-99	99	489	81 16.5'E of prev
C-3	4-Aug			80-99	99	588	81 26.5'E of C-1
B-1	4-Aug			79-99	99	687	81 In bar, 6'E, of W wall, 37' N of S Wall
B-2	4-Aug			65-99	99	786	81 In Bar 18'E of prev
					786		646

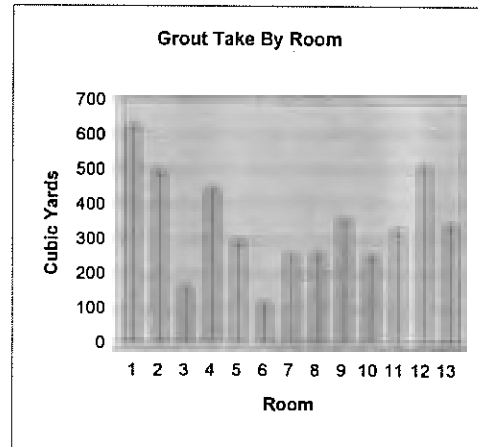
**Grout Injection Information Sheet**  
**1997 Beulah/Zap Project, Contract 338907**

Date	Hole No.	Approx. Location	Inj. Depth (feet)	Inj. Press. PSI Range	Volume (cyd)	Total (hole)	Total (daily)	Cumulative	Comments
15-Jul	31	220'N,50'W of NE corner	46	0-50	42		42	42	North of Black Diamond
16-Jul	31		46	0-275	37	79			refused -pushed pipe up & grout within 5' of surface
	34	250'N,50'W of NE corner	55	0-50	245	245	282	324	refused water next morning
17-Jul	35	260'N,50'W of NE corner	58	0-250	50	50			refused-pushed pipe & inj header
	37	280'N,50'W of NE corner	42	0-100	344		394	718	
18-Jul	37		42	0-250	0	344			refused immediately
	26	170'N,50'W of NE corner	90	0-175	256	256			ground cracking 10-30'W of hole
	22	130'N,50'W of NE corner	50	0-50	8		264	982	
21-Jul	22		50	25-175	353	361	353	1335	refused water next morning
22-Jul	19	100'N,50'W of NE corner	90	0-175/50B	264	264			50 lbs back press., ground cracking, grout oozed from hole for 30 min.
	17	80'N,50'W of NE corner	57	0-200	0				refused immediately
	15	60'N,50'W of NE corner	78	0-50	56		320	1655	
23-Jul	15		78	0-200/25B	208	264			grout blowing out holes 14&218, ground cracking
	10	15'S,50'W of SE corner	86	0-100	160		368	2023	South of Manny's
24-Jul	10		86	0-100/10B	336	496			discontinued when grout appeared in hole 201, 59'NE
	215	50'S,10'W of SE corner	82	0-50	64		400	2423	
25-Jul	215		82	0-75	328	392	328	2751	refused water next morning
28-Jul	51	95'S,17'W of SW(shop)	84	100	0	0			refused water immed.
	55	55'S,17'W of SW(shop)	90	0-400/200B	264	264			quit - hi pressure (surging)
	63	25'N,17'W of SW(shop)	85	0-150/5B	10	10			grout coming out 64 & pushed 30' pipe out
	50	105'S,17'W of SW(shop)	85	0-100	14		288	3039	
29-Jul	50		85	0-150/20B	96	110			refused-pushed casing out hole & oozed grout
	233	255'N,10'W of NE corner	78	0-100	217		313	3352	N of Mannys, 40' E of point between 34 &35
30-Jul	233		78	100+	0	217			refused water immediately
	232	215'N,10'W of NE corner	82	0-200/50B	248	248	248	3600	loc. 40'E of 30/31, quit pumping to save grout for bldg.
1-Aug	S-1	Shop; 3'E, 17.5N of SW corner shop	82	0-40/20B	1.5	1.5			interior hole;refused immediately, grout up annulus
	S-3	Shop; 23'E, 17.5N of SW corner	82	0-80/60B	1.5	1.5			same as prev
	S-5	Shop; 43'E, 17.5N of SW corner	82	0-80/60B	1	1			same as prev
	239	7'S, 60'W of SE corner (S. side)	73	0-80	92	92	96	3696	on sidewalk S of Bldg.; also filled 238,237,236
4-Aug	235	7'S, 8'E of SE corner (S. Side)	78	0-100/40B	48	48			quit - hi pressure
	202	13'N, 7'W of SE corner (E. Side)	86	0-120	26	26			refused, grout up annulus
	220	7'N,60'E of NE corner (N. Side)	12	0	10	10			quit - approx 1/4" movement on level
	222	7'N, 40'E of NE corner (N. Side)	67	0	20		104	3800	quit - end of shift
5-Aug	C-1	Showroom; 66.5E,35.5N of SE corner	81	0-40/5B	56	56			Interior hole; quit - hi pressure
	C-2	Showroom 16.5' E of prev.	81	0-50/40B	9	9			refused, maintained 40B for 4 min
	C-3	Showroom; 26.5E of C-2	81	0-10	39	39	104	3904	refused water next morning
6-Aug	205.5	48'N, 7'E of SE corner (E.Side, angle)	72	0-40/20B	200	200	200	4104	Quit - ground cracking & 1/8" movement on level
7-Aug	B-1	in bar; 6'E, 37'N of SW corner	81		1	1			refused immediately, grout up annulus
	B-2	in bar; 18'E of B-1	81	0-40/5B	143	143	144	4248	quit - end of shift, refused next day
11-Aug	209.5	88'N, 7'E of SE corner (E. side, angle)	88	0-60/20B	150	150			quit - grout out 209&210 and slight surface movement in bar
	222	7'N, 40'E of NE corner (N. Side)	67	0-45/10B	90	110	240	4488	quit - water up 224&225 and 1/8" ground movement
12-Aug	205	43'N, 7'E of SE corner (5'S of 205.5)	89	0-200/50B	114	114			quit - high pressure
	212	113'N,7'E of SE corner (N of sidewalk)	83	0-20	0	0			refused immediately
	258	8'W of baitshop, 15'N of shop	81	0-5	0	0			refused immediately
	66	6'N of fence, 75'W of baitshop	82	0-300/100B	14	14			quit-hi pressure, grout out 67
	257	7'S, 2'E of NE corner baitshop	82	0	72		200	4688	on vacuum
13-Aug	206	53'N, 7'E of SE corner (5'N of 205.5)	88	0-175/100B	26	26			quit - hi pressure
	257	7'S, 2'E of NW corner baitshop	82	0-75/5	326	398	352	5040	quit - end of shift, refused next morning
14-Aug	259	20'W, 15'S of NW corner baitshop	75	0-275/100	80	80			quit - hi pressure
	250	20'W, 25'N of NW corner baitshop	81	0-125/20B	280	280	360	5400	quit - end of shift, refused next morning
15-Aug	247	110'N,5'W of NW corner Baitshop	89	0-50	408		408	5808	
18-Aug	247		89	0-100	232	640			quit - ground cracking
	244	145'N,45'W of NW corner Baitshop	87		0	0			filled during pumping of 247
	270	145'N,5'W of NW corner Baitshop	86		0	0			filled during pumpint of 247
	82	110'N,80'W of NW corner Baitshop	88	0-150	0	0			refused immediately
	83	120'N, 80'W of NW corner Baitshop	70	0-100/5B	114	114			quit-ground cracking
	78	80'N, 80'W of NW corner Baitshop	88	0	30		376	6184	quit - end of shift
19-Aug	79		88	0-75	96	126			quit-ground cracking
	78	70'N, 80'W of NW corner Baitshop	86		0	0			filled during pumping of 79
	77	60'N, 80'W of NW corner Baitshop	86		0	0			filled during pumping of 79
	259A	18'W of front door Baitshop	20	0	8	8			quit-lifting concrete slab
	255	25'E, 55'S of SW corner shop	65	0-100/50B	72	72			quit-ground cracking
	264	23'E, 10'S of SW corner shop	86	0-200/100B	56	56	232	6416	quit-blew out injection pipe
20-Aug	263	40'W,65'S of SE corner Manny's	65	0-250/5B	232	232			quit-grout to surface 45'E in repaired sinkhole
	281	40'E,110'S of SE corner Manny's	42	0-50	96	96	328	6744	quit-end of shift
21-Aug		backfilling solid holes sev locations					2	6746	
<b>SUMMARY STATISTICS</b>									
Total grout injected (cyd.)					6746.00				
Number of injection holes					52.00				
Average injection depth (ft.)					74.72				
Average volume per hole (cyd.)					129.69				
Ave. volume/day (excl. #21)					269.76				

Grout Take per Room at Manny's in 1997

West Side, Beginning at South Fence and heading north

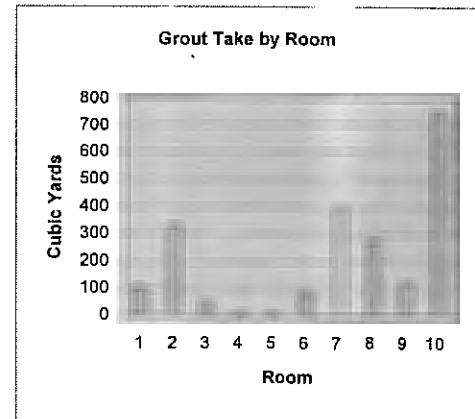
	<u>Injection Holes*</u>	<u>Grout (cyd) Notes</u>
1	5,6, <b>215,263</b>	624
2	8,9, <b>10,216,217</b>	496
3	201, <b>202,235-239</b>	166 South edge of building
4	<b>205,205.5,206,C1,C2,C3</b>	444 Interior of building
5	209, <b>209.5,210,B1,B2</b>	294 Interior of building
6	212,213, <b>220-225</b>	120 North edge of building
7	14, <b>15,218</b>	264
8	17,18, <b>19,219</b>	264
9	21, <b>22,226</b>	361
10	24,25, <b>26,227</b>	256
11	28,30,31,230,231,232	327 Possibly 2 rooms included
12	<b>34,35,233</b>	512
13	<b>37,38,234</b>	344
	Subtotal	4472
	Average	344



281 96 Haul tunnel southeast of building  
 Total West 4568

East Side, Beginning at South Fence and Heading North

	<u>Injection Holes*</u>	<u>Grout (cyd) Notes</u>
1	<b>50,51,254</b>	110
2	54, <b>55,255</b>	336
3	58,59,60, <b>264</b>	56 South edge of shop
4	62, <b>63,64,S1,S2,S3</b>	14 Interior of shop
5	<b>66,67,258</b>	14 North edge of shop (east of HLS)
6	70, <b>259,259A,260,265</b>	88 East of HLS, near fuel islands
7	<b>252,257</b>	398 Northeast of HLS, near fuel islands
8	<b>250,249A,266A</b>	280 Northeast of HLS, near fuel islands
9	77,78, <b>79,248A</b>	126 Northeast of HLS, near fuel tanks
10	82, <b>83,84,247</b>	754 Northeast of HLS, near fuel tanks
	Total East	2176
	Average	217.6
	Total All	6744
	Overall Average	289.0



\* Note: **Bolded Numbers** are those injection holes that actually accepted grout

1997 Beulah/Zap AML Drilling Information								
TCDWJL Drilling								
Hole	Date	Coal	Void	Rubble	Tot Ft.	Cum	Cased	ALL HOLE SPACINGS 10' UNLESS NOTED Comments
Manny's Site								
200	16-Jul	84-99			100			note 200-213 located on S-N line 7' E of bldg
214	16-Jul	81-99			100	200		loc. 18'S of hole 5, S of bldg.
215	16-Jul	87-99		82-87	100	300		82 loc. 40' E of point between 5 & 6
201	17-Jul			71-99	100	400		71 66-89 hard, 89-99 firm, first hole thru sidewalk
202	17-Jul	88-93		93-99	100	500		86
216	17-Jul				20	520		loc. 40' E of 9, bad hole, fill material too loose to drill
217	17-Jul			75-96	100	620		75 loc. 20' E of 9, 75-87 firm, 87-89 hard, 89-91 loose, 91-96 firm
209.5	18-Jul	87-89		89-103	105	725		88 89-103 loose
211	18-Jul	87-100			100	825		
212	18-Jul	89-100		83-87	100	925		83 firm, lost circ., east of bldg, first hole N. of sidewalk
213	18-Jul			71-99	100	1025		70 8' from prev. (to avoid elec. line), 71-79 poss. fill
218	18-Jul			78-99	100	1125		78 loc. 40' E. of pt btwn 14/15 app. 55'N, 10'W of NE corner
219	18-Jul		68-73	73-100	100	1225		68 40' E of 18, approx. 90'N, 10'W of NE corner of bldg.
203	21-Jul	85-99			100	1325		
204	21-Jul	85-99			100	1425		
208	21-Jul	85-100			100	1525		
209	21-Jul			76-99	100	1625		76 76-86 very loose, 86-92 firm, 92-97 light, 97-99 loose
28A	21-Jul	87-100			100	1725		approx. 3' W of 28 (redrill of 28)
205	22-Jul	87-99		89-99	100	1825		89 89-94 loose, 94-95 firm, 95-99 loose
206	22-Jul			88-99	100	1925		88 88-90 firm, 90-94 loose, 94-95 light, 95-99 loose, poor returns
207	22-Jul	85-99			100	2025		
220	22-Jul				40	2065		14 220-225 in W-E line N side bldg, 220 loc. 55'W, 6'N of NE corner
221	22-Jul				30	2095		blowing out 220 at 12', not cased, like 220 loose near surface
222	22-Jul			67-88	100	2195		67
223	23-Jul			77-99	100	2295		76
224	23-Jul			78-100	100	2395		78 loose/firm/loose/firm/loose some regain of circ @ 98-100
225	23-Jul	87-92		92-100	100	2495		92 last one on N. slab, loc 5'W, 6'N of NE corner, poor returns
226	23-Jul			86-105	105	2600		86 loc. 40'E of pt. btwn 21 & 22, poor returns
227	23-Jul			80-100	100	2700		80 loc. 40' E of 25/26, loose/firm/loose, some regain circ @ 96-100
228	24-Jul	86-102			103	2803		loc. 10' N of prev, approx 175'N, 10'W of NE corner bldg.
229	24-Jul	85-100			100	2903		10'N of prev
230	24-Jul			86-100	100	3003		86 10'N of prev
231	24-Jul		68-71	71-100	100	3103		68 10'N of prev
232	24-Jul			82-100	100	3203		82 40' E of 30/31
233	24-Jul		77-78	78-100	100	3303		78 40' E of 34/35
234	24-Jul	89-95			106	3409		40' E of 37/38, hard grout 95-98, coal & clay 98-105, good circ.
205.5	25-Jul		72-75	75-100	100	3509		72 angled 14 deg., 5' N of 205, 75-88 light, 88-100 loose
END PAY #1					3509		1833	
209.5	28-Jul		73-76	76-100	100	3609		73 angled 14 deg., 5' N of 209, 76-84 loose, 84-96 firm, 96-100 loose
235	28-Jul			78-100	100	3709		78 angled 6 deg., along S. side bldg (10'W/7'S of SE corner) heading W
236	28-Jul			79-100	100	3809		79 angled 6 deg., (20'W of prev) 79-90 loose, 90-100 firm
237	28-Jul			80-96	100	3909		60 angled 7 deg., (10' W of prev) loose/firm/loose/firm
238	28-Jul	84-86	85-87	87-100	100	4009		86 angled 6 deg., (10' W of prev)
239	29-Jul			73-100	100	4109		73 angled 6 deg., (10' W of prev)
240	29-Jul	82-98			100	4209		angled 6 deg., (10' W of prev)
241	29-Jul			69-100	100	4309		69 loc 40' E. of 99/100
242	29-Jul	87-100		52-87	100	4409		51 loc 40'E of 95, loose firm/loose firm/loose 87-100 like coal
243	29-Jul			72-100	100	4509		72 loc 40'E of 90, loose/firm/hard/loose/firm
244	29-Jul	86-87		87-100	100	4609		87 loc 40'E of 82/83, loose/firm w/some circ. (coal)/loose/firm
245	30-Jul				40	4649		bad hole, blowing out 244 at ~10' depth
246	30-Jul	85-100			100	4749		
247	30-Jul	85-89		89-100	100	4849		89 loc 24'E of 245, approx 1' from corner of pad by diesel pump
248	30-Jul			90-99	100	4949		90 loc 60'E of 78
248A	30-Jul			76-98	100	5049		76 loc 22'E of 248
249	30-Jul				40	5089		bad hole loc 20' S of 248
249A	31-Jul			75-100	100	5189		75 loc 15' E of 249 & 250; comm w/ 250
250	31-Jul	82-87	81-82	97-99	100	5289		81 loc 10'N of 251
251	31-Jul	82-99			100	5389		loc 10' N of 252
252	31-Jul			70-97	100	5489		70 loc 45'N of 253
253	31-Jul	82-99			100	5589		loc 40'E of 66&67, 22' N of Shop
253A	31-Jul	82-86			100	5689		loc 7'S of 253; hard grout 86-96
254	31-Jul				100	5789		loc 40'E of 50&51
256	31-Jul	81-99			100	5889		loc 40'E of 56&59
255	1-Aug		65-70	70-100	100	5989		65 loc 40'E of holes 54&55, S of shop
257	1-Aug			82-97	100	6089		82 loc 27'E of 252 near NW corner of bait shop
258	1-Aug	81-85			100	6189		81 loc 16'E of 253A, 8'W of store, hard grout 85-97, sand & gravel
259	1-Aug	84-91		75-98	100	6289		75 loc approx 25' W of front door to baitshop
260	1-Aug			42-100	100	6389		42 loc 10' N of 253, 68-73 hard like grout, remainder very loose
					6389		3387	
Pay#2					2880			
261	14-Aug	82-96			97	6486		redrill of No1

262	14-Aug	82-96			97	6583		redrill of No 2
263	14-Aug		72-74	85-97	97	6680	65	redrill of No 5
264	14-Aug			89-97	100	6780	86	on concrete slab S of Shop 40' E of #60, 23'E/10'S of SW corner
270	14-Aug			86-100	100	6880	88	40'E of 244
271	14-Aug		69-75	75-99	100	6980	87	40'E of 243
272	14-Aug			75-100	100	7080	75	40'E of 242
273	14-Aug			70-100	100	7180	70	40'E of 241
274	15-Aug	89-100			100	7280		20'E of 234
275	15-Aug	89-105			108	7388		20'E of 233
276	15-Aug	89-100			100	7488	99	20'E of 231, broken coal 93-96
277	15-Aug	89-100			100	7588	90	20'E of 227, broken coal (some returns) 90-100, comm. w/227
278	15-Aug			78-100*	100	7688	80	20' E of 226, grout 78-80, clay/grout 80-86, firm (poor circ) 86-100
279	15-Aug	88-100			100	7788	93	20'E of 219, broken coal 93-100
279A	15-Aug	86-100			100	7888		10'N of 279
280	15-Aug	95-100		86-95*	103	7991	86	20'E of 218, clay/coal 86-95, no loss of circ.
285	18-Aug	94-97		63-68*	100	8091		20' W of 260, grout 63-68, clay 68-94, good circ, not cased
286	18-Aug	85-98			100	8191		20' W of 250
286A	18-Aug	85-88		88-100*	100	8291		10'N of 266, clay/coal 88-98, good circ, not cased
286B	18-Aug	84-99			100	8391		10'S of 266
70A	18-Aug	82-87		87-97*	100	8491		redrill of 70, grout 87-89, clay/coal 92-97 w/ good circ, no cased
267	18-Aug	83-88			100	8591		80'W of 250
267A	18-Aug	82-89		89-99*	100	8691		10'S of 267, grout 89-95, clay 95-99, good circ, not cased
268	19-Aug	85-100			100	8791		10'N of 246A
269	19-Aug	85-100			100	8891		20'N of 246A
269A	19-Aug	85-100			100	8991		30'N of 246A
259A	19-Aug			22-35	35	9026	21	18'W of door to HLS, 7'E of 259, angled 6degN
281	19-Aug		42-50	36-97	100	9126	42	haul tunnel, 100'N of 200-1 (which is on N. shoulder hwy 200)
282	19-Aug			85-97	100	9226	85	haul tunnel, 200'N of 200-1 (which is on N. shoulder hwy 200)
283	19-Aug			86-100	100	9326	86	haul tunnel, 300'N of 200-1 (which is on N. shoulder hwy 200)
284	19-Aug			88-100	100	9426	88	haul tunnel, 400'N of 200-1 (which is on N. shoulder hwy 200)
285	20-Aug			75-100	100	9526	75	haul tunnel, 500'N of 200-1 (which is on N. shoulder hwy 200)
286	20-Aug		60-64	54-100	100	9626	54	haul tunnel, 600'N of 200-1 (which is on N. shoulder hwy 200)
287	20-Aug	82-88		88-96	100	9726	88	haul tunnel, 100'N of 200-2 (which is on N. shoulder hwy 200)
288	20-Aug		65-67	67-97	100	9826	65	haul tunnel, 200'N of 200-2 (which is on N. shoulder hwy 200)
289	20-Aug	84-84		84-100	100	9926	84	haul tunnel, 310'N of 200-2 (which is on N. shoulder hwy 200)
290	20-Aug	85-90		90-100	100	10026	90	haul tunnel, 400'N of 200-2 (which is on N. shoulder hwy 200)
291	20-Aug	86-90		90-100	100	10126	90	haul tunnel, 500'N of 200-2 (which is on N. shoulder hwy 200)
292	20-Aug	89-95	95-97	97-104	105	10231	95	haul tunnel, 600'N of 200-2 (which is on N. shoulder hwy 200)
220A	21-Aug			94-100*	115	10346		15'N of 220, angled 11degS, clay/coal mix, not cased
10A	21-Aug	81-96			98	10444		near 10 (trying to core), clay/coal 81-84, lost/regained circ
C-10-B	21-Aug				60	10504		CORE 60-70 (pulled ~3' of broken grout)
215A	21-Aug	82-88			99	10603		near 215 (trying to core)
22A	21-Aug			58-100*	100	10703		near 22 (trying to core), grout 58-59, clay 59-80, clay/rub-100
28B	21-Aug	87-100			100	10803		5'E of 28
247A	22-Aug	88-91		91-100*	100	10903		near 247 (trying to core), clay/coal 91-100
270A	22-Aug	98-94		94-100*	100	11003		near 270 (trying to core), clay 94-100
C-82.5	22-Aug	85-89			89	11092		CORE 89-92 (pulled ~3' of broken grout)
19A	22-Aug			63-100*	100	11192		near 19 (trying to core) 63-100 clay
C-19-B	22-Aug			65-67*	70	11262		CORE 67-72 (pulled 4.5' of broken grout)
		PAY #3			4873			
		Total No. of holes (incl. specialty)			127			
		No. of holes cased (incl. specialty)			77			
		Total footage drilled (incl. specialty)			12048			
		Total footage cased (incl. specialty)			5882			
		Total footage cored			18			
<b>Specialty Drilling</b>								
S-1	30-Jul			80-93	93		82	loc in shop 3' E of W wall, 17' N of south wall, coal-grout fragments 80-93
S-3	31-Jul			79-94	99	192	79	20' E of prev
S-5	31-Jul			80-96	99	201	80	20' E of prev
C-1	4-Aug			81-99	99	390	81	In Showroom 66.5' E of W wall, 35.5' N of S Wall, fractured coal
C-2	4-Aug			75-99	99	489	81	16.5'E of prev
C-3	4-Aug			80-99	99	588	81	26.5'E of C-1
B-1	4-Aug			79-99	99	687	81	In bar, 6'E, of W wall, 37' N of S Wall
B-2	4-Aug			65-99	99	786	81	In Bar 18'E of prev
					786		646	

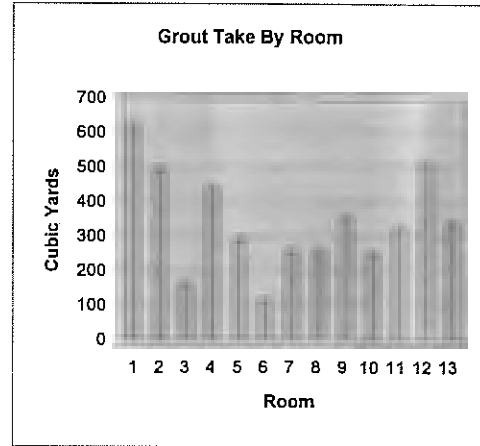
**Grout Injection Information Sheet**  
**1997 Beulah/Zap Project, Contract 338907**

Date	Hole No.	Approx. Location	Inj. Depth (feet)	Inj. Press. PSI Range	Volume (cyd)	Total (hole)	Total (daily)	Cumulative	Comments
15-Jul	31	220'N,50'W of NE corner	46	0-50	42	42	42	42	North of Black Diamond
16-Jul	31		46	0-275	37	79			refused -pushed pipe up & grout within 5' of surface
	34	250'N,50'W of NE corner	55	0-50	245	245	282	324	refused water next morning
17-Jul	35	260'N,50'W of NE corner	58	0-250	50	50			refused-pushed pipe & inj header
	37	280'N,50'W of NE corner	42	0-100	344		394	718	
18-Jul	37		42	0-250	0	344			refused immediately
	26	170'N,50'W of NE corner	90	0-175	256	256			ground cracking 10-30'W of hole
	22	130'N,50'W of NE corner	50	0-50	8		264	982	
21-Jul	22		50	25-175	353	361	353	1335	refused water next morning
22-Jul	19	100'N,50'W of NE corner	90	0-175/50B	264	264			50 lbs back press., ground cracking, grout oozed from hole for 30 min.
	17	80'N,50'W of NE corner	57	0-200	0				refused immediately
	15	60'N,50'W of NE corner	78	0-50	56		320	1655	
23-Jul	15		78	0-200/25B	208	264			grout blowing out holes 14&216, ground cracking
	10	15'S,50'W of SE corner	86	0-100	160		368	2023	South of Manny's
24-Jul	10		86	0-100/10B	336	496			discontinued when grout appeared in hole 201, 50'NE
	215	50'S,10'W of SE corner	82	0-50	64		400	2423	
25-Jul	215		82	0-75	328	392	328	2751	refused water next morning
28-Jul	51	95'S,17'W of SW(shop)	84	100	0	0			refused water immed.
	55	55'S,17'W of SW(shop)	90	0-400/200B	264	264			quit - hi pressure (surging)
	63	25'N,17'W of SW(shop)	85	0-150/5B	10	10			grout coming out 64 & pushed 30' pipe out
	50	105'S,17'W of SW(shop)	85	0-100	14		288	3039	
29-Jul	50		85	0-150/20B	96	110			refused-pushed casing out hole & oozed grout
	233	255'N,10'W of NE corner	78	0-100	217		313	3352	N of Mannys, 40' E of point between 34 &35
30-Jul	233		78	100+	0	217			refused water immediately
	232	215'N,10'W of NE corner	82	0-200/50B	248	248	248	3600	loc. 40'E of 30/31,quit pumping to save grout for bldg, interior hole;refused immediately, grout up annulus
1-Aug	S-1	Shop; 3'E, 17.5N of SW corner shop	82	0-40/20B	1.5	1.5			same as prev
	S-3	Shop; 23'E, 17.5'N of SW corner	82	0-80/60B	1.5	1.5			same as prev
	S-5	Shop; 43'E, 17.5'N of SW corner	82	0-80/60B	1	1			same as prev
	239	7'S, 60'W of SE corner (S. side)	73	0-80	92	92	96	3696	on sidewalk S of Bldg.; also filled 238,237,236
4-Aug	235	7'S, 8'E of SE corner (S. Side)	78	0-100/40B	48	48			quit - hi pressure
	202	13'N, 7'W of SE corner (E. Side)	86	0-120	26	26			refused, grout up annulus
	220	7'N,60'E of NE corner (N. Side)	12	0	10	10			quit - approx 1/4" movement on level
	222	7'N, 40'E of NE corner (N. Side)	67	0	20		104	3800	quit - end of shift
5-Aug	C-1	Showroom; 66.5E,35.5N of SE corner	81	0-40/5B	56	56			Interior hole; quit - hi pressure
	C-2	Showroom 16.5' E of prev.	81	0-50/40B	9	9			refused, maintained 40B for 4 min
	C-3	Showroom; 26.5E of C-2	81	0-10	39	39	104	3904	refused water next morning
6-Aug	205.5	48'N, 7'E of SE corner (E.Side, angle)	72	0-40/20B	200	200	200	4104	Quit - ground cracking & 1/8" movement on level
7-Aug	B-1	in bar, 8'E, 37'N of SW corner	81		1	1			refused immediately, grout up annulus
	B-2	in bar; 18'E of B-1	81	0-40/5B	143	143	144	4248	quit - end of shift, refused next day
11-Aug	209.5	88'N, 7'E of SE corner (E. side, angle)	88	0-60/20B	150	150			quit- grout out 209&210 and slight surface movement in bar
	222	7'N, 40'E of NE corner (N. Side)	67	0-45/10B	90	110	240	4488	quit - water up 224&225 and 1/8" ground movement
12-Aug	205	43'N, 7'E of SE corner (S'S of 205.5)	89	0-200/50B	114	114			quit - high pressure
	212	113'N,7'E of SE corner (N of sidewalk)	83	0-20	0	0			refused immediately
	258	8'W of baitshop, 15'N of shop	81	0-5	0	0			refused immediately
	66	6'N of fence, 75'W of baitshop	82	0-300/100B	14	14			quit-hi pressure, grout out 67
	257	7'S, 2'E of NE corner baitshop	82	0	72		200	4688	on vacuum
13-Aug	206	53'N, 7'E of SE corner (5'N of 205.5)	88	0-175/100B	26	26			quit - hi pressure
	257	7'S, 2'E of NW corner baitshop	82	0-75/5	326	398	352	5040	quit - end of shift, refused next morning
14-Aug	259	20'W, 15'S of NW corner baitshop	75	0-275/100	80	80			quit - hi pressure
	250	20'W, 25'N of NW corner baitshop	81	0-125/20B	280	280	360	5400	quit - end of shift, refused next morning
15-Aug	247	110'N,5'W of NW corner Baitshop	89	0-50	408		408	5808	
18-Aug	247		89	0-100	232	640			quit- ground cracking
	244	145'N,45'W of NW corner Baitshop	87		0	0			filled during pumping of 247
	270	145'N,5'W of NW corner Baitshop	86		0	0			filled during pumpint of 247
	82	110'N,80'W of NW corner Baitshop	88	0-150	0	0			refused immediately
	83	120'N, 80'W of NW corner Baitshop	70	0-100/5B	114	114			quit-ground cracking
	79	80'N, 80'W of NW corner Baitshop	88	0	30		376	6184	quit- end of shift
19-Aug	79		88	0-75	96	126			quit-ground cracking
	78	70'N, 80'W of NW corner Baitshop	86		0	0			filled during pumping of 79
	77	60'N, 80'W of NW corner Baitshop	86		0	0			filled during pumping of 79
	259A	18'W of front door Baitshop	20	0	8	8			quit-lifting concrete slab
	255	25'E, 55'S of SW corner shop	65	0-100/50B	72	72			quit-ground cracking
	264	23'E, 10'S of SW corner shop	88	0-200/100B	56	56	232	6416	quit-blew out injection pipe
20-Aug	283	40'W,65'S of SE corner Manny's	65	0-250/5B	232	232			quit-grout to surface 45'E in repaired sinkhole
	281	40'E,110'S of SE corner Manny's	42	0-50	96	96	328	6744	quit-end of shift
21-Aug		backfilling solid holes sev locations					2	6746	
<b>SUMMARY STATISTICS</b>									
Total grout injected (cyd.)			6746.00						
Number of injection holes			52.00						
Average injection depth (ft.)			74.72						
Average volume per hole (cyd.)			129.69						
Ave. volume/day (excl. 8/21)			269.76						

Grout Take per Room at Manny's in 1997

West Side, Beginning at South Fence and heading north

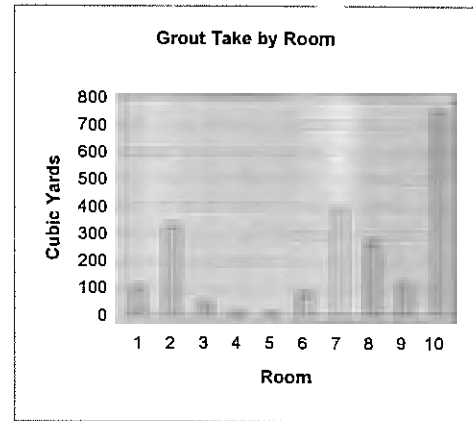
	<u>Injection Holes*</u>	<u>Grout (cyd Notes</u>
1	5,6, <b>215,263</b>	624
2	8,9, <b>10,216,217</b>	496
3	201, <b>202,235-239</b>	166 South edge of building
4	<b>205,205.5,206,C1,C2,C3</b>	444 Interior of building
5	209, <b>209.5,210,B1,B2</b>	294 Interior of building
6	212,213, <b>220-225</b>	120 North edge of building
7	14, <b>15,218</b>	264
8	17,18, <b>19,219</b>	264
9	21, <b>22,226</b>	361
10	24,25, <b>26,227</b>	256
11	28,30, <b>31,230,231,232</b>	327 Possibly 2 rooms included
12	<b>34,35,233</b>	512
13	<b>37,38,234</b>	344
	Subtotal	4472
	Average	344



**281** 96 Haul tunnel southeast of building  
 Total West 4568

East Side, Beginning at South Fence and Heading North

	<u>Injection Holes*</u>	<u>Grout (cyd Notes</u>
1	<b>50,51,254</b>	110
2	54, <b>55,255</b>	336
3	58,59,60, <b>264</b>	56 South edge of shop
4	62, <b>63,64,S1,S2,S3</b>	14 Interior of shop
5	<b>66,67,258</b>	14 North edge of shop (east of HLS)
6	70, <b>259,259A,260,265</b>	88 East of HLS, near fuel islands
7	<b>252,257</b>	398 Northeast of HLS, near fuel islands
8	<b>250,249A,266A</b>	280 Northeast of HLS, near fuel islands
9	77,78, <b>79,248A</b>	126 Northeast of HLS, near fuel tanks
10	82, <b>83,84,247</b>	754 Northeast of HLS, near fuel tanks
	Total East	2176
	Average	217.6



Total All 6744  
 Overall Average 289.0

\* Note: **Bolded Numbers** are those injection holes that actually accepted grout