



FLYROCK **CAUSE & PREVENTION**

KURT GLEASON

RMS, LLC

Definitions

(Blasters' Handbook)

The “*blast area*” is defined as the area in which concussion, flying material or gases from an explosion may cause injury to persons, equipment or property.

The “*clearance zone*” is the zone around a blast beyond which no injury or damage should occur, and beyond which all personnel and equipment must be evacuated.

Blasted material projected beyond the clearance zone is called “*flyrock*”. (KY -1/2 the distance)

Flyrock



Flyrock is generated close to the air/rock interface, either from the free face of a bench blast or from the collar region of a borehole.

Flyrock emanating from a vertical free face will travel in a direction forward of the face, and frequently at quite low trajectories.

Flyrock emanating from a borehole collar will travel vertically, in all horizontal directions, at typically high trajectory angles.



BLASTING INCIDENT REVIEWS

- Bench Conditions
- Drill Logs
- Design Parameters
- Explosive Products Used
- Loading Conditions
- Timing
- Blast Area Security
- Pre/Post Blast Conditions

**The following are excerpts
from past casework**

Croton WTP – 2007

New York, NY

Blasting for removal of the access ramp

Geology: Schist

Bench Conditions: Elevated



DESIGN PARAMETERS

Hole Diameter: 3"

Hole Depth: 12'-0"

Spacing: 6'-0"

Burden: 6'-0"

of Holes: 9

Product Used: Emulex 2-1/2x16 (3.33 #/stk)

Total Wt. of Explosives Detonated: 120 lbs **(36 sticks)**

Timing: Not recorded



Massive
Formation



3_08_07ProgressPhotos 003

#2

PRE-BLAST

- Abandonment of Blast Plan Recommendations
 - Remove all equipment and personnel from pit
 - Blaster positioned at top of ramp
- Original Blaster Replaced
 - Would not compromise his principles
 - Program advancing too slowly
- Schedule Issues
 - Expedite blasting by allowing equipment and personnel to remain in the pit during blasts.
- Utilization of non-blasting personnel for signaling
 - Labor Foreman for the rock anchor crew

Location of the blast

Location where
during the blast.

was standing

Approx. 325 feet







ELIMINATES FREEZING OF
COMPRESSED AIR EQUIPMENT
ER SYSTEMS, INC.





Supervisor's Report of Accident Investigation
Personal Injury and Property Damage

Injured/Owner: Michael Kulik SS#: 092-548660 Birth Date: 6/27/60

Address: 99 station Ave Phone: () _____ Job Title: Foreman

Staten Island NY 10309 Employer: Schaume

Check one: Contractor ☒ Subcontractor _____ Vendor on site _____ Other _____

Accident Date: 3/9/2007 Time: 12 00 AM PM
NOON

Accident Locations (Specific): 3701 Jerome Ave Bronx NY 10467

What Happened? (Describe operation, conditions, and how accident or loss occurred. Use separate sheet & diagram, if necessary.)

Mike was soundy Blast Hammer went to take ~~go~~ cover Blast
went off Fly Rock came toward Him and hit his back

Primary Cause (condition or act that caused the accident): Fly Rock

Recommended Corrective Action: (Describe - use a separate sheet & diagram, if necessary)

clear area totally

Contract No.: CRO-311

Location: Croton Filtration Plant

Date: 2/28/07

Resident Engineer: URS-MP JV.

Note: No Hauling on 311 : On Rock Pile 988H, 155AX

Miscellaneous: 1200, 966G, 322T, Cranes, WA380, 320,

In MEP: 800 hoe ram, 750, 345C, 345B w/ hoe attach, 275AX, 200LC,

78, 2 Terex, 2 Man lifts, 1300 cfm a/c and water line on west wall hooked to down tubes

Drills: 1 @ grid K-8 (east wall), 1 @ J-16, 1 on south bench (K-18), 2 @ C-15, 1 @ A-5, 2 @ D-10-11

Blasting (Russell)

1st at grid C-15-16 time: 10:17 used: 7 cases = 350 lbs

2nd at grid J-15-16 time: 12:05 used 1 case = 50 lbs

3rd at grid J-15-16 time: 12:56 used 5 cases = 300 lbs

Note: driller runner injured during blasting operations (hit by rock in head) taken to hospital

1 fore (Paul), 5 dock builders, 5 laborers, 345B, 200LC, 78 on south bench:

Scale and excavate on east end of south bench, build concrete forms, hang wire mesh in trench

1 fore (Mike), 5 laborers, man lift: on west wall tension & grout rock bolts: W8-9 thru W8-6, W7-7, W7-6

3 laborers, man lift on south wall with 750: pour concrete into repair (Casa Trucking #65)

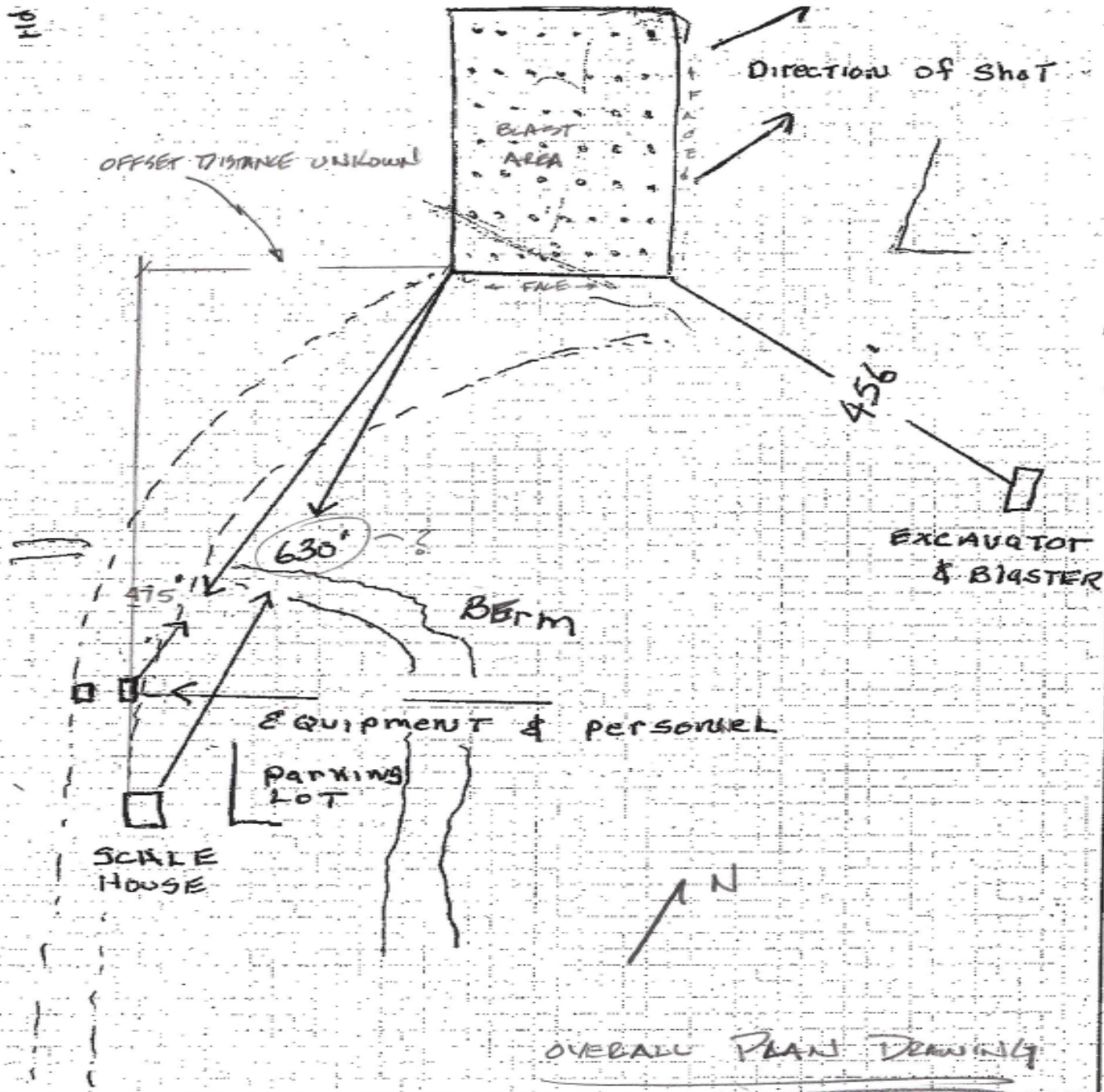
From shot looking at scale house, Excavator Hoe 475 feet by GPS



Non-metal Surface Mining
Bradford Co., PA
December 2011

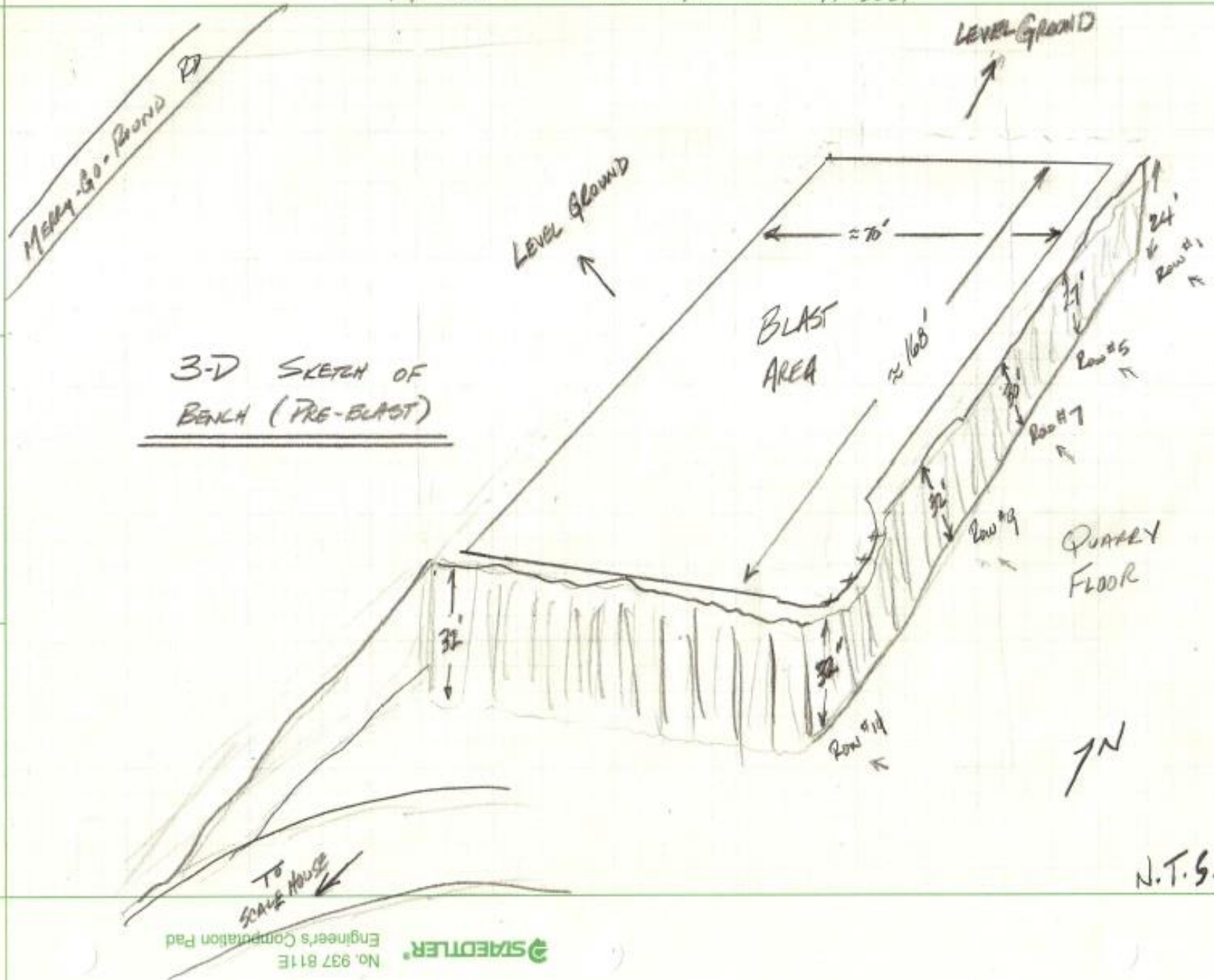
Geology: Shale
Bench Condition: As Shown

MERRY-GO-ROUND RD



OVERALL PLANT DRAWING

VANDERPOOL - PRIVILEGED WORK PRODUCT



DESIGN PARAMETERS

Hole Diameter: 4"

Hole Depth: 24'-0" to 32'-0"

Spacing: 12'-0"

Burden: 10'-0"

of Holes: 103

Stemming Column Height: 8' to 16'

Total Wt. Detonated: 9,000 lbs (8,300# ANFO; 700# Pkg
Emulsion)

No. 0933 P. 2

By: _____

825 Reading Road • PO Box 528
Bowmansville, PA 17507
445-4571 • FAX (717) 445-7789
www.brubacher.net

www.brubacher.net

BRUBACHER

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5/10/74

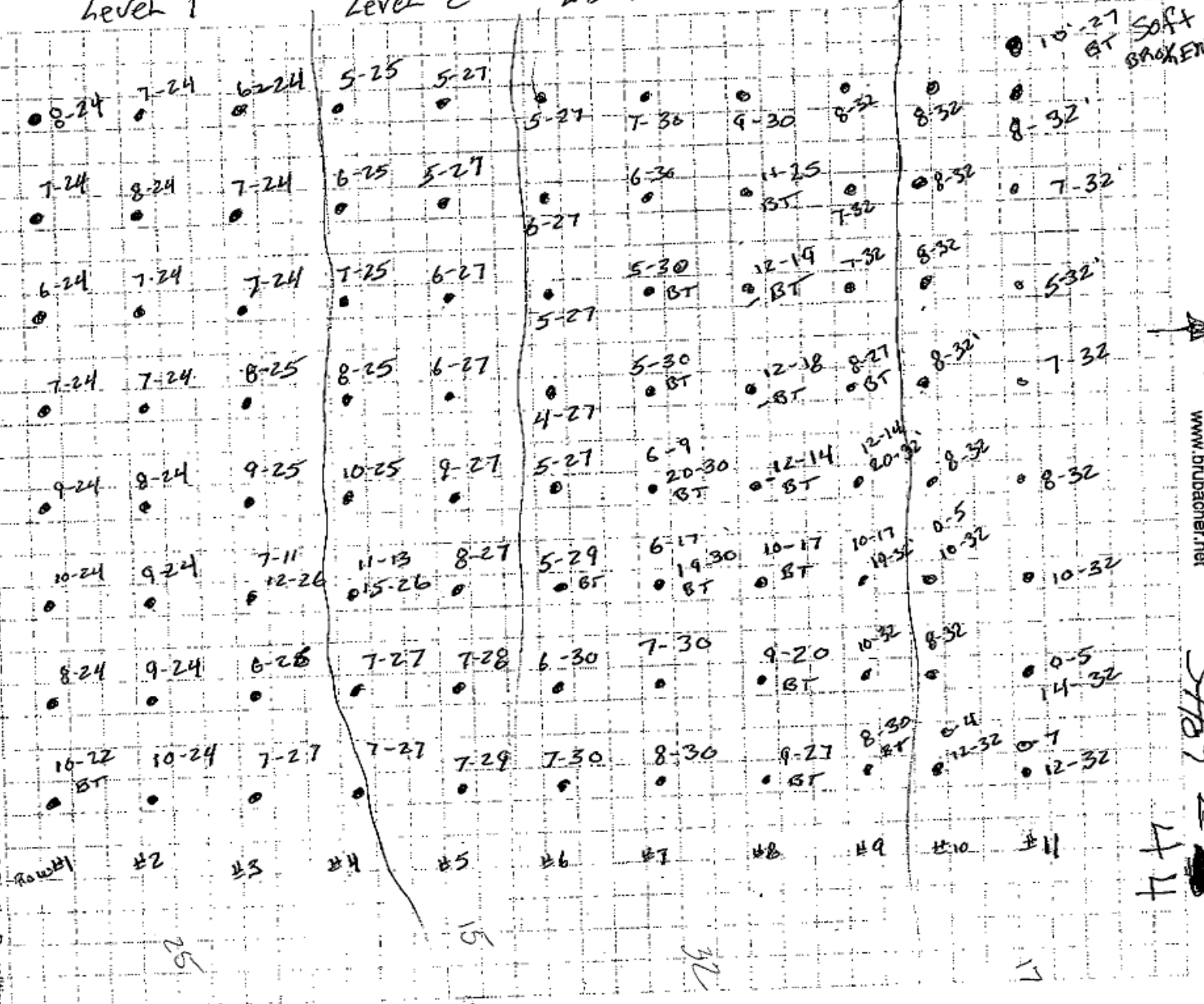
44

LEVEL
4

SOFT
BROKEN

LEVEL
4

★ Land Clearing ★ Excavating ★ Grading, Curbing, Paving ★ Underground Utility Installation ★ Drilling & Blasting Demolition



No. 0933 P. 3

BRUBACHER EXCAVATING INC.

By: _____

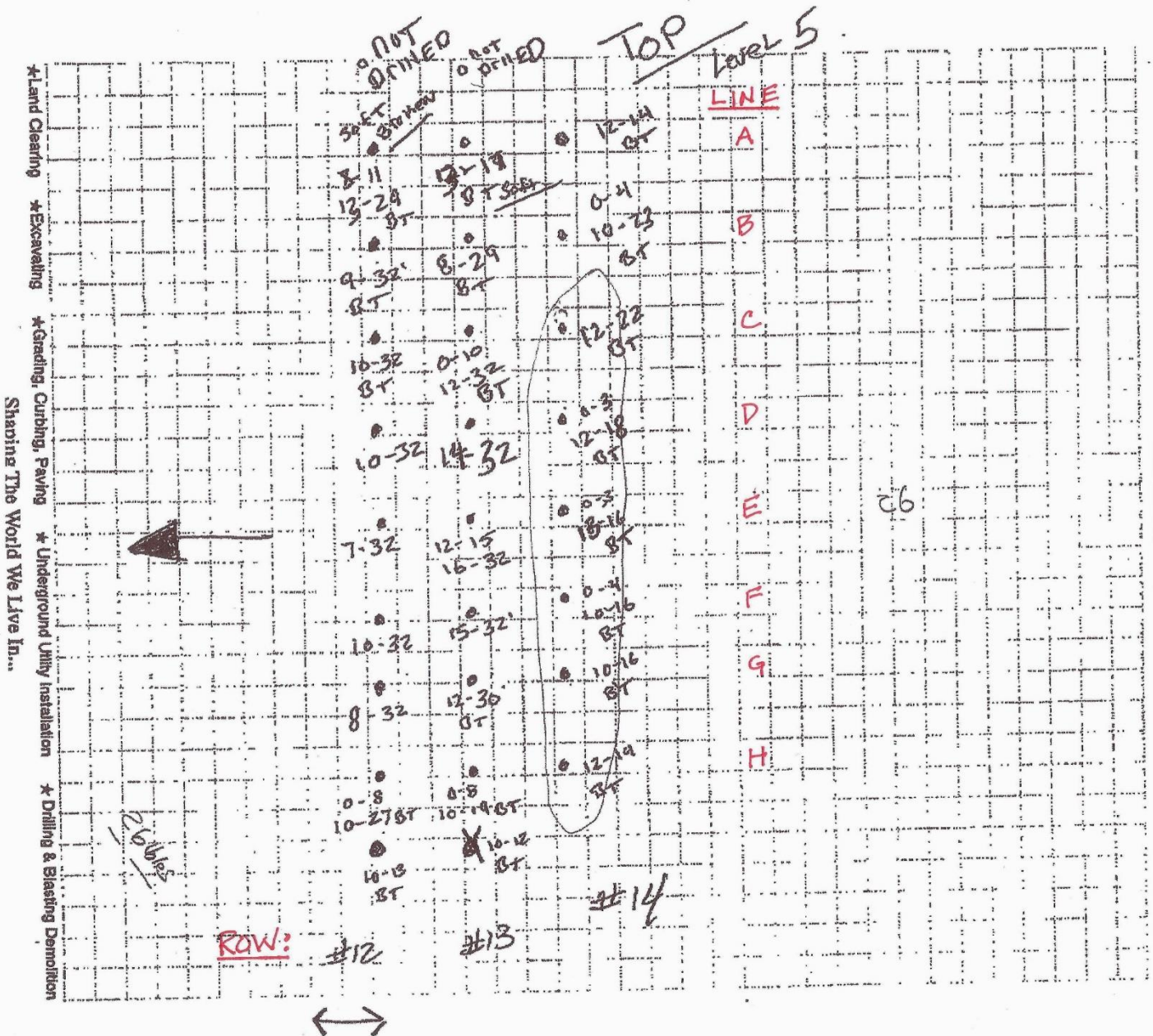
Sheet 1 of 2

BRUBA GHER

EXCAVATING, INC.

115 Holes Drilled

www.brubacher.net

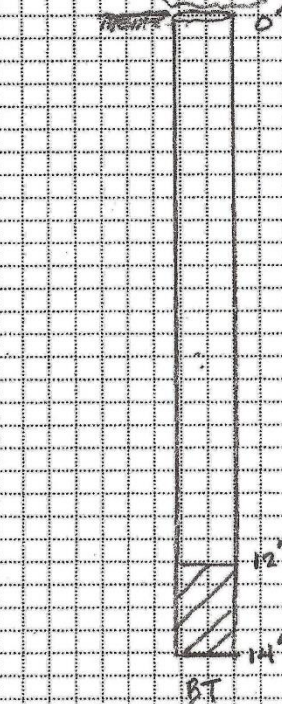


BOREHOLE PROFILE - Row # 14

32'-0" DRILLED DEPTH

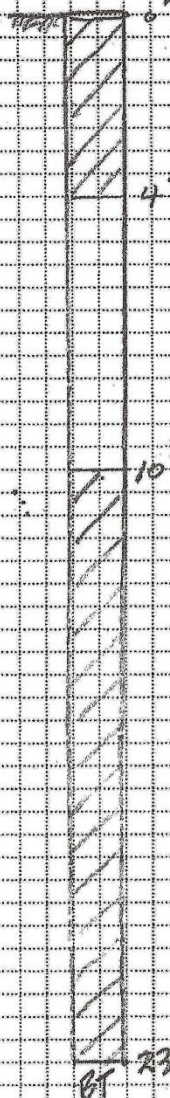
Hole #: 14A

TIMING: NOT LOADED



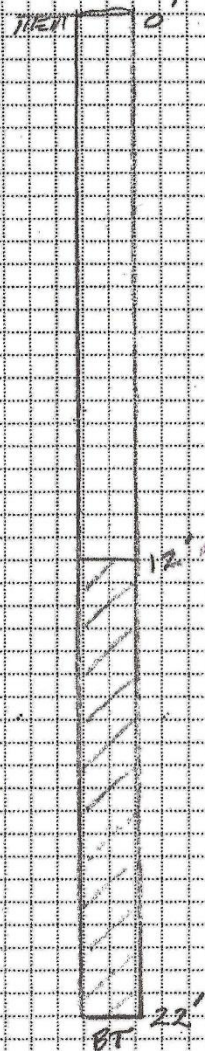
14B

896ms



14C

921ms



14D

9146ms



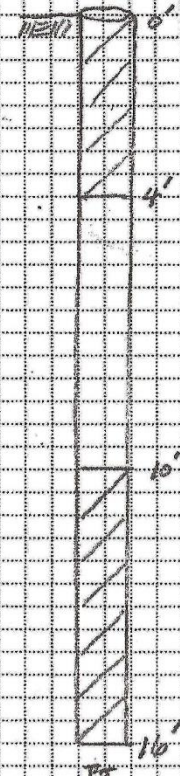
14E

NOT LOADED



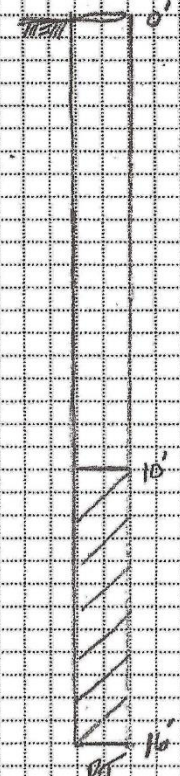
14F

996ms



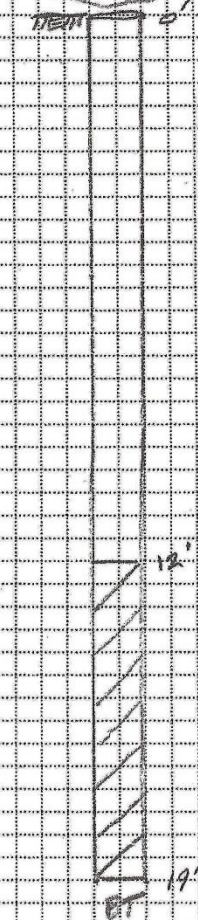
14G

1021ms



14H

NOT LOADED



LOCATION OF ROCK

OVERBURDEN/
MUD SEAM / VOID

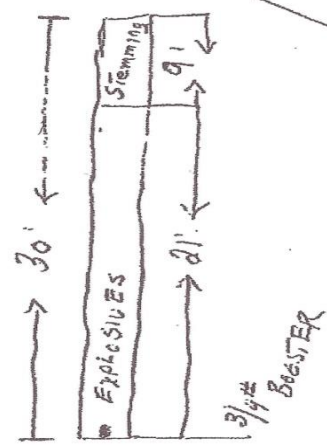
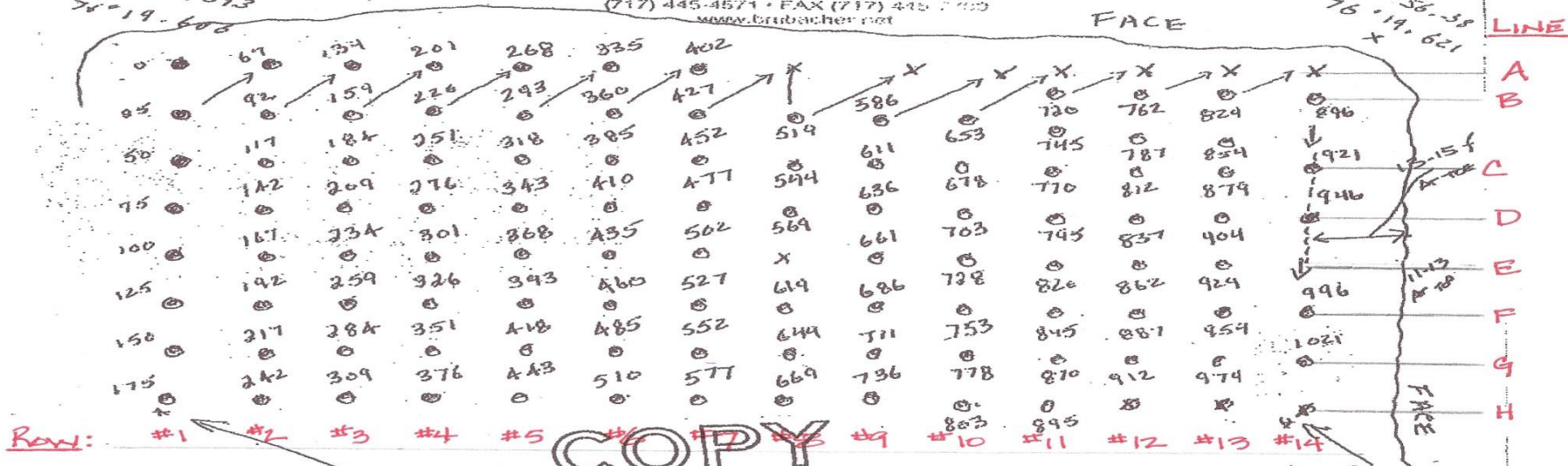
BT - BLOW THROUGH

Date: 12-19-2011
 Job Number: C-11-90-006

EXCAVATING, INC.
 825 Reading Road • PO Box 528
 Bowmansville, PA 17507
 (717) 445-4571 • FAX (717) 445-7400
 www.brubacher.net

John H. Stearns
 Sheet 1

Job Name: COLE Quarry
 N 41°51'39"
 W 76°19'00"



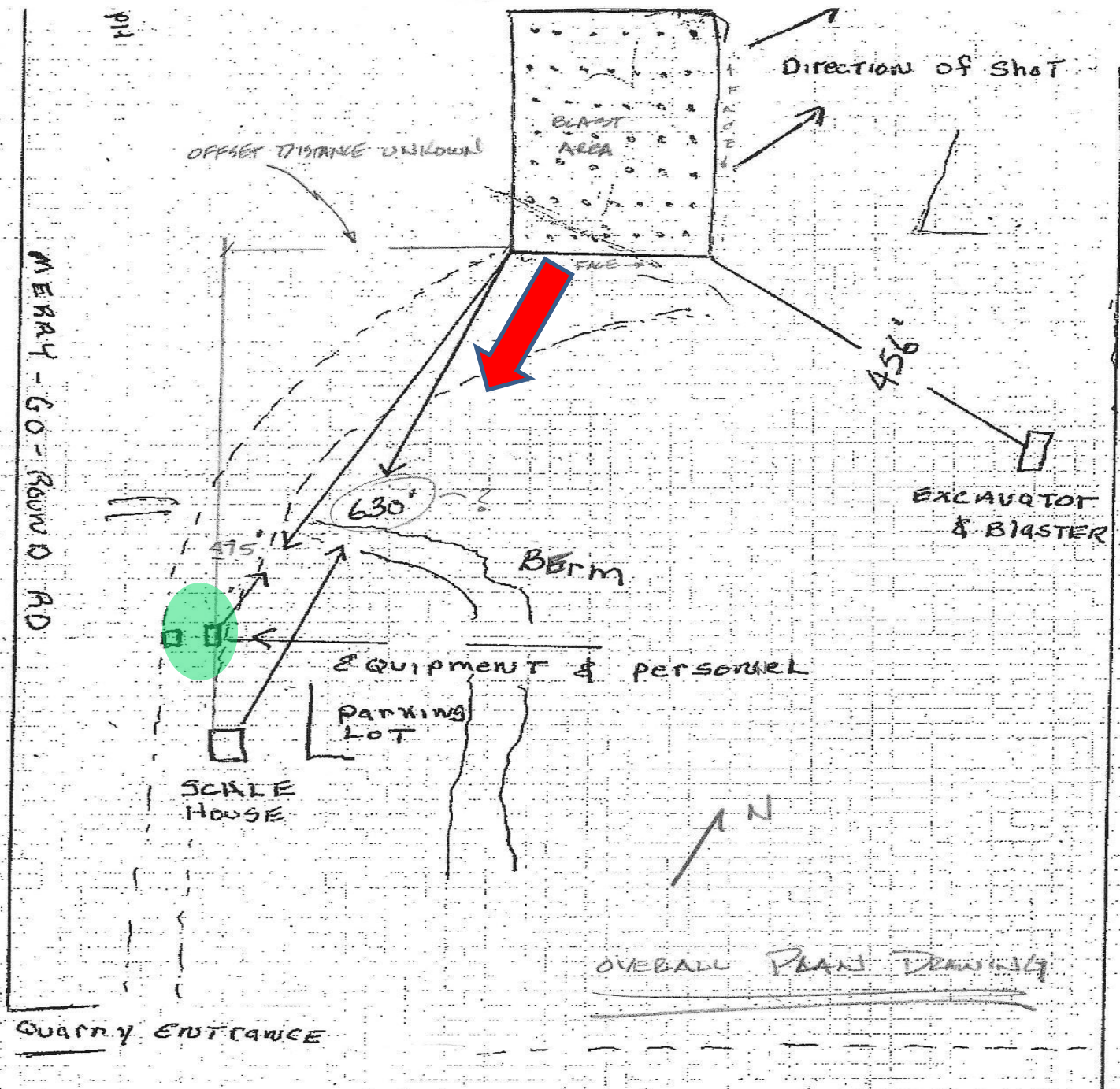
*1 and Clearing *Excavating *Grading, Curbing, Paving *Underground Utility Installation *Fill

Shaping The World We Live In



PRE-BLAST

- Site Safety Plan required personnel to be staged at entrance to quarry (+ 1,000' from blast)
 - Personnel were staged between the scale house and the blast less than 500' away
- Loaders, with operators in cab, staged at the scale house to block entrance to pit
- Personnel standing between and in front of loaders
- Third party dumps staged behind loaders







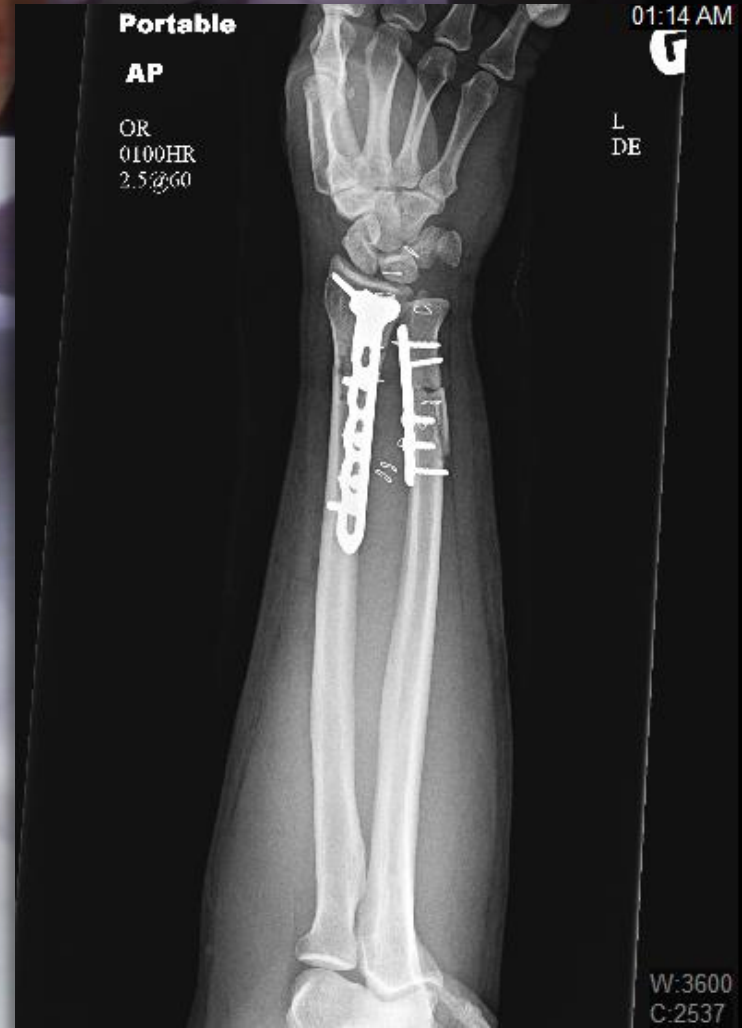


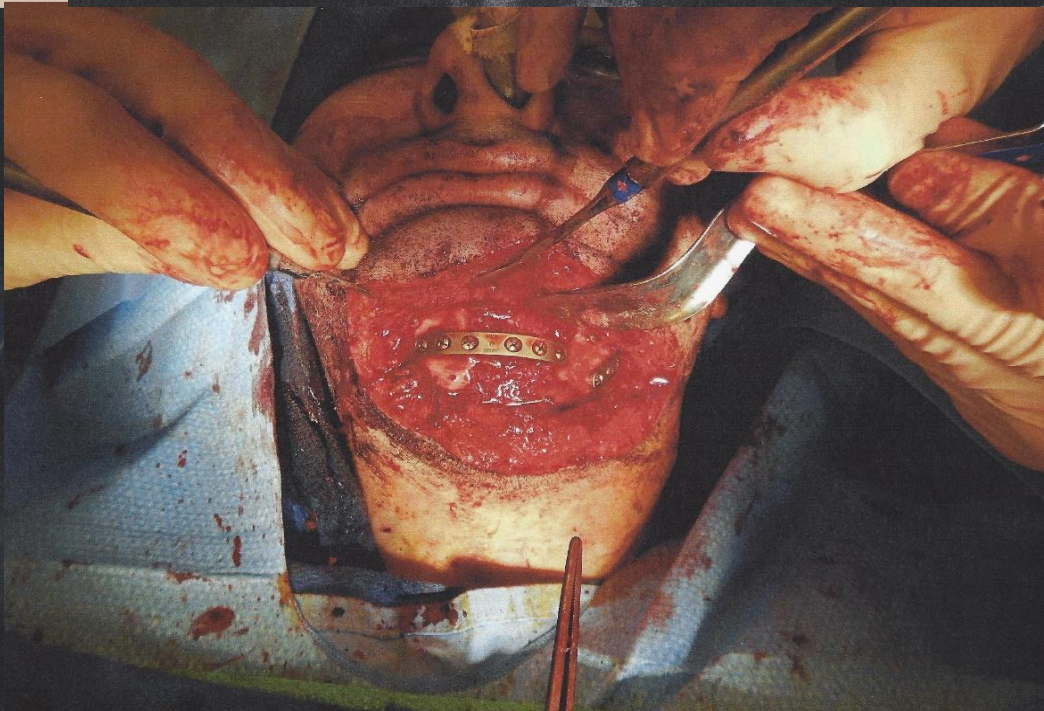
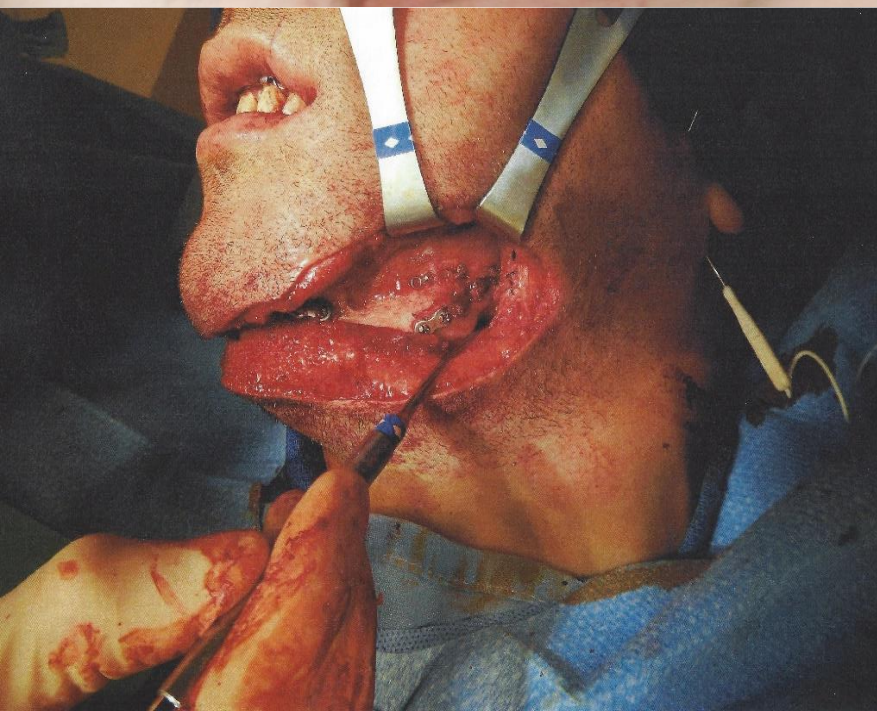
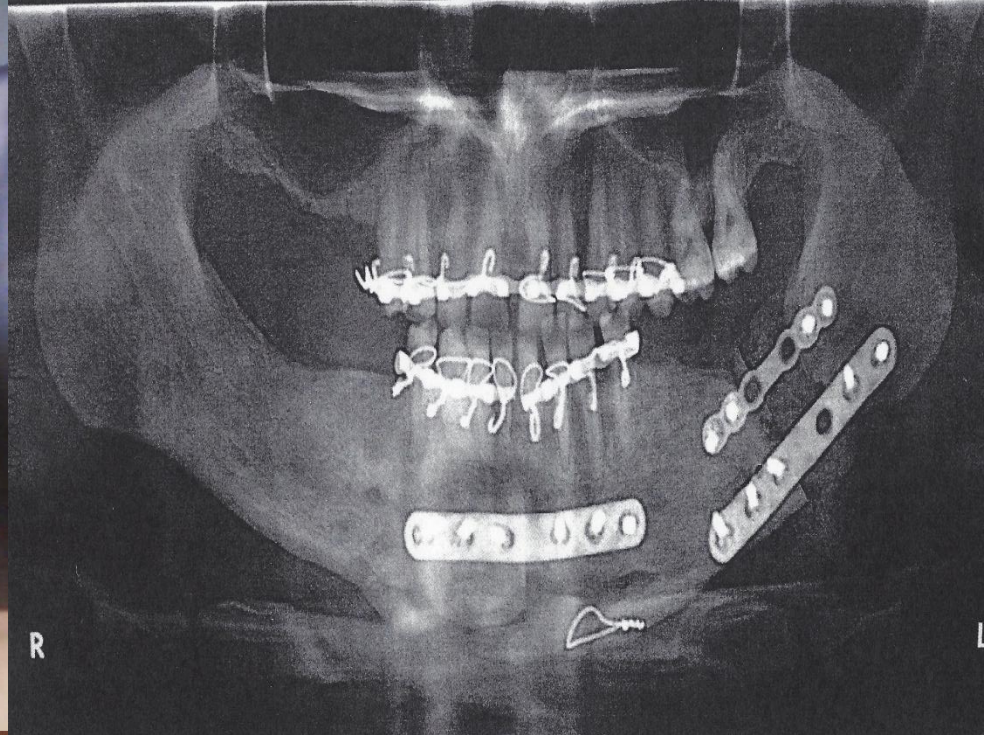
WARNING

THE FOLLOWING PHOTOGRAPHS ARE
EXTREMELY GRAPHIC IN NATURE

1002

01:13 AM





December 28, 2011

The evidence available to DEP indicates that the blast of December 19, 2011 caused flyrock to be ejected from an area near the southern corner of the blast for several reasons. Photo 1 was taken from the area where the flyrock is believed to have been ejected from. The position of the workers who were struck relative to the blast supports my conclusion that the rocks that struck them were ejected from the southern corner of the blast because equipment located in close proximity to the workers was also damaged. The employees that were struck were standing near the John Deere loader shown in Photo 4. Photo 3 shows a service truck that was also in the vicinity of the workers who were struck. Windows in both pieces of equipment were broken by flyrock ejected from the blast.

The seismograph report indicates that there was a strong release of airblast energy from the blast at approximately 800 to 900 ms. During that time period, there were four holes designed to detonate at 870 ms.

This flyrock incident could have been prevented if the blaster had not loaded and detonated holes next to an area where rock is known to be incompetent. I recommend that the design for future blasts detonated at this quarry take into consideration how far loaded holes are positioned next to unloaded holes in incompetent rock. I also recommend that the number of rows with respect to burden be limited based on how much open area there is surrounding a blast to ensure horizontal movement, and that the blasts continue to be designed to minimize the

risk of ejection of flyrock vertically. Additionally, I recommend that all employees retreat to a safe distance of at least 1,000 feet from all blasts, and that they do not position themselves near any open or partially open faces.

detonate at 870 ms, 873 ms, 912 ms, and 914 ms was in the direction of the holes that were drilled in incompetent rock (toward the south west corner of the blast) and where the workers that were struck were standing, to the south, southwest of the blast site.

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December 28, 2011

risk of ejection of flyrock vertically. Additionally, I recommend that all employees retreat to a safe distance of at least 1,000 feet from all blasts, and that they do not position themselves near any open or partially open faces.

PHOTO 1



Catastrophic Failure



**Non-Metal Surfacing Mining
Earlham, IA**

March 2016

Geology: Limestone

Bench Condition: As Shown

Wendling Quarries, Inc. Drill Log

Drilled by: Ross

Last Date Drilled: 3-22-16

Crushing Dept./Owner Martin M Quarry EARLHAM P.O.#

Hole Diameter 3 1/2 Hole Spacing 10X13 Drill# 1511

| Date Drilled | 3-21 | 3-22 | | | | | | Totals |
|-----------------|------|------|--|--|--|--|--|--------|
| # of Holes | 73 | 69 | | | | | | 142 |
| Depth | 11 | 11 | | | | | | 11 |
| LO Drilled Feet | 803 | 759 | | | | | | 1562 |
| RE Drilled Feet | | | | | | | | |
| Fuel Gals | | | | | | | | |

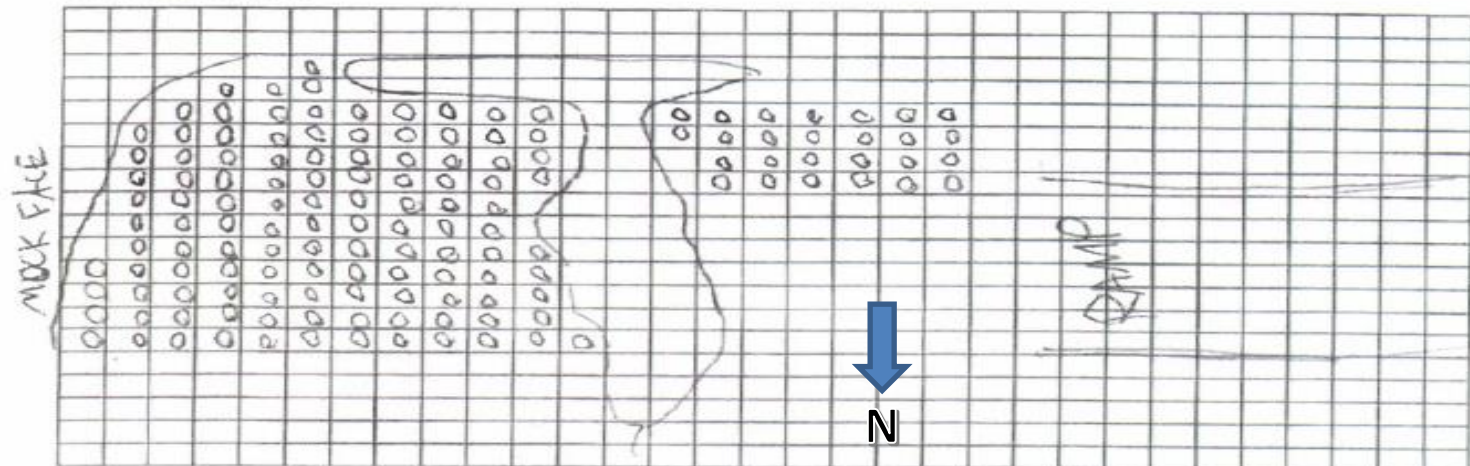
Feet of Sub Drill: 0 Ledges: CAP

Superintendent Signature: _____

Sketch shot pattern below and list by each hole the depth. If there was anything found while drilling that may contribute to a blast problem; i.e., clay seams, punky cap rock, hole close to face, etc., note hole and identify problem. Driller leaves this copy with crushing superintendent, blaster or scale house. Superintendent crushing location will be required to send to office with shot report.

Middle of 5, 6, 7th rows have bad seam that appears to
run between holes, also mud seam in 10, 11, 12 area

Indicate North on sketch



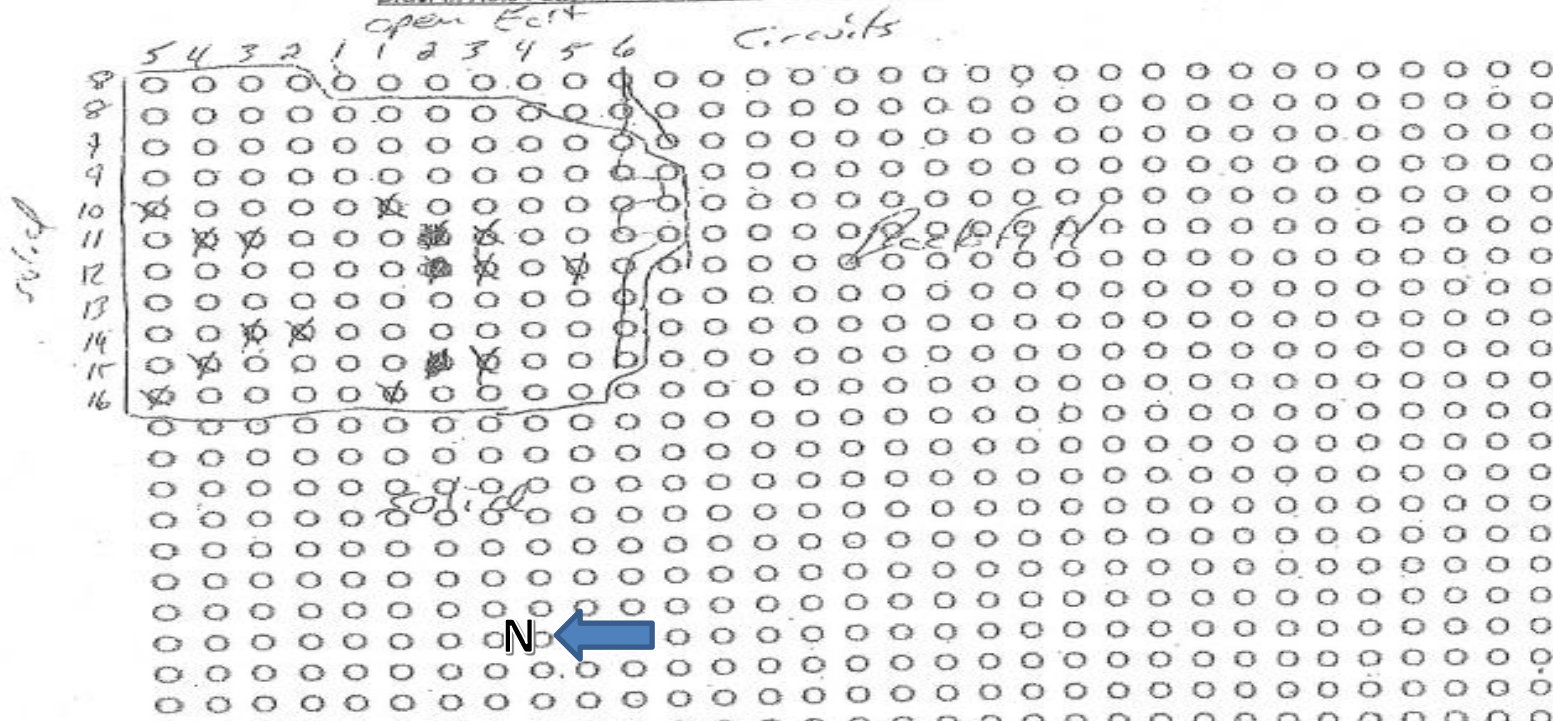
0 = 12

DESIGN PARAMETERS

| | |
|------------------------|--------|
| Borehole Diameter | 3-1/2" |
| Burden | 9'-0" |
| Spacing | 13'-0" |
| Depth (Hole Length) | 11'-0" |
| Stemming Column Height | 42" |
| Stemming Size | 1" |

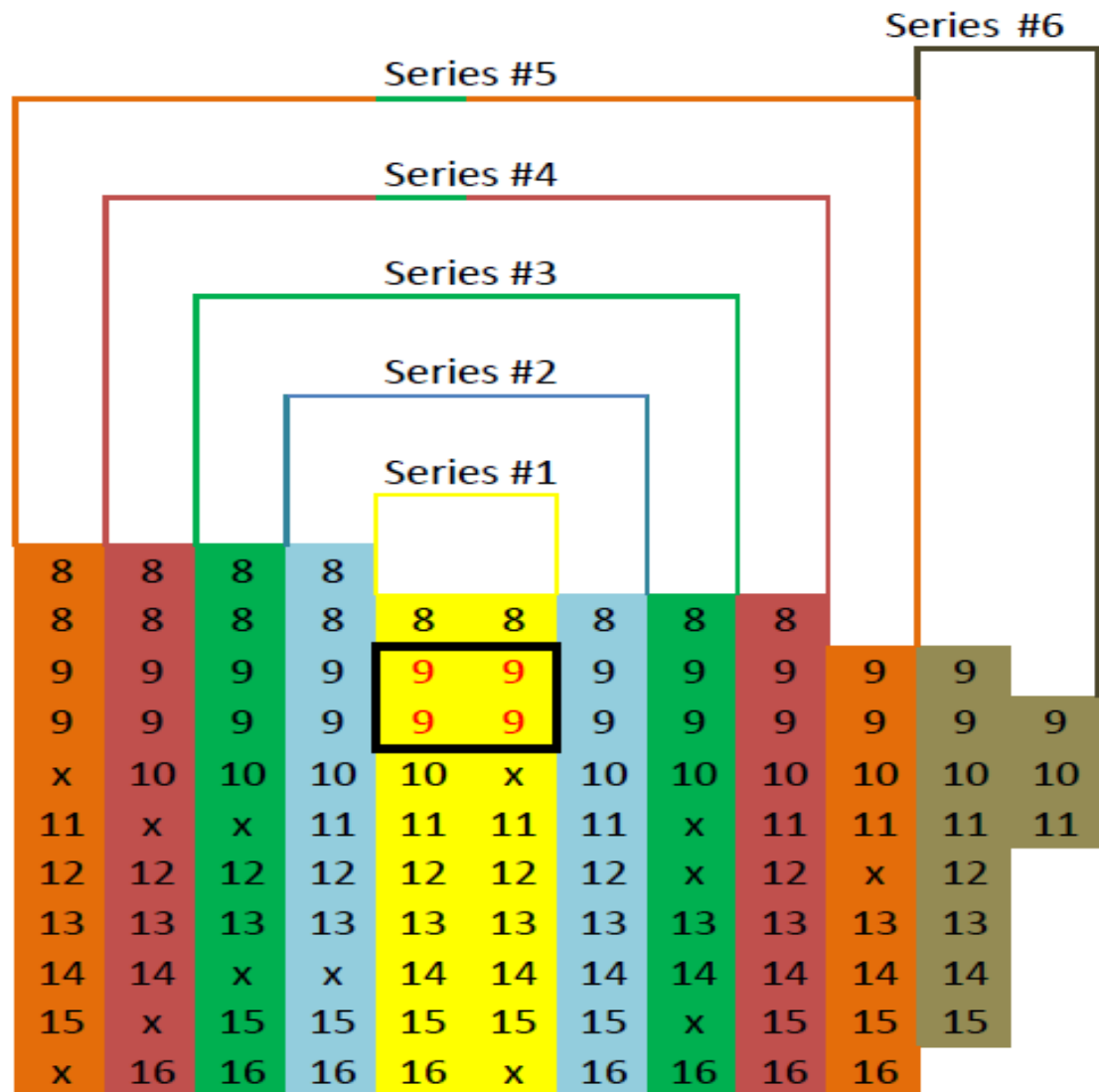
Seismograph Record

21. Seismograph Location: N/A
 22. Distance to Blast: _____ Direction Toward Blast: _____ Seismic data: PPV= _____; Air (Dbl)= _____; Tape/Disc/Event No. _____
 23. Seismograph Model/Serial No.: N/A Operator: N/A
 24. No. holes per delay: 5 MAX EXPLOSIVES LBS. PER DELAY: 254.75 Min delay time between any two holes: _____
 25. Scaled distance = Distance to nearest non-quarry bldg. (Line 5) = 262.2
 Sq. Root of Max. Lbs. per delay (line 24) (14.9)
 26. Blast Diagram (Must Be Complete)
 Draw in Hole Pattern, Cap Layout, Timings Per Circuit, and Any Other Comments



| | |
|--|-----------|
| Total Design Weight of Explosives | 3,833 lbs |
| Total Loaded Weight of Explosives in the Blast (Centra Intense) | 4,495 lbs |
| Average Net Charge Weight Loaded per Hole (4,495 lbs. / 100 holes) | 45 lbs. |

N <-----



PRE-BLAST

- MSHA on site all day conducting inspections
- Blasting crew arrived at quarry at noon
- Access to bench constructed by 2 PM
- Lead blaster primed holes while helper charged with a pumpable emulsion
- Improper stemming size (Should be $0.1 \times \text{BH dia.}$)
- Quarry Supt. sounded siren and proceeded north away from blast
- Site safety plan required a (2) minute delay after sounding of final warning signal



Location/Photo Description: over view of blast looking north to south



Location/Photo Description: over view of blast looking north to south



Location/Photo Description: overview of blasted bench looking northeast





Fatalgram



METAL/NONMETAL MINE FATALITY – On March 22, 2016, a 42-year old lead man with 6 years of mining experience was fatally injured at a surface limestone mine when he was struck by fly rock from blasting operations. The lead man was parked in his pickup truck at a location to prevent others from accessing the blasting site. He was approximately 1,200 feet from the blast area.



Best Practices

- Review and follow site specific blast plan prior to loading any explosives.
- Utilize technology, such as face profilers and borehole probes, to obtain specific geometric details of the material to be blasted.
- Adjust stemming depth and/or decking to maintain adequate burden on all sections of the blast hole.
- Develop a drill pattern by considering geology, face geometry, and surface topography.
- Clear and remove all persons from the blast area unless suitable blasting shelters are provided to protect persons from flyrock. Allow at least 15 seconds after a blast for any flyrock to drop.
- Examine blast site geology, communicate with the driller and review the drill log for angles, voids, competency of rock, loss of air, etc., prior to the loading any explosives. Make appropriate adjustments to ensure that the holes are not overloaded.
- Ensure blasting and fly rock areas are properly calculated to ensure the blast site is clear of all persons.
- Determine the actual burden for all face holes along their length and adjust the explosive power factor along the borehole accordingly.

Additional information on blasting safety can be found at:
http://arlweb.msha.gov/Accident_Prevention/categories/drillblast.htm

This is the 3rd fatality reported in calendar year 2016 in metal and nonmetal mining. As of this date in 2015, there were 6 fatalities reported in metal and nonmetal mining. This is the 1st Blasting and Breaking Agents fatality in 2016. There were no Blasting and Breaking Agents fatalities in the same period in 2015.

The information provided in this notice is based on preliminary data ONLY and does not represent final determinations regarding the nature of the incident or conclusions regarding the cause of the fatality.





MH/Madison Co Sheriff 21

WARNING

THE FOLLOWING PHOTOGRAPH IS
EXTREMELY GRAPHIC IN NATURE



SAFETY SAFETY SAFETY

- COMMUNICATE/COORDINATE WITH ALL PARTIES AFFECTED
- CLEAR THE BLAST AREA YOURSELF
- SIGNALING – AS PRESCRIBED
- POSTED PERIMETER
- EMPLOY/ENTRUST ONLY TRAINED PERSONNEL
- SHELTER – YOURSELF AS WELL AS OTHERS

*DO NOT BECOME COMPLACENT!
DESIGN FOR THE BEST POSSIBLE RESULTS, AND
SECURE AGAINST THE WORSE POSSIBLE
OCCURANCE.*