SC-DC-65-1796

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Perry Wilkes

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WOODWARD-CLYDE-SHERARD AND ASSOCIATES

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Consulting Engineers and Geologists

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October 11, 1965

[redacted]

Job No. 6828A

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP

CLASSIFICATION CHANGED TO: U	AUTHORITY: R.B. Craner
Carmela Gallegos 11/12/97	RECORD ID: 98SN 0414
PERSON CHANGING MARKING & DATE	
Emilda Solph 11/12/97	DATED: 10/30/97
PERSON VERIFYING MARKING & DATE	

M

Sandia Corporation
P. O. Box 5800
Albuquerque, New Mexico

Attention: Mr. H. W. Benischek, Buyer

Subject: Sandia Rumpler Recovery Operations
Number 261-1

Gentlemen:

In accordance with your request, the recovery operations of Sandia Rumpler shot number 261-1 were observed and a soil investigation was performed at the Tonopah Test Site on September 8 and 9, 1965. Present during the recovery operations were Messrs. E. S. Summons and C. E. Haag from Sandia Corporation, and Mr. F. M. Babcock from this firm. Mr. M. Levish, also of this firm, was present during a portion of the excavation and sampling operations, but left the site before the unit was recovered.

The purpose of the soil investigation was to determine the geometry of the entry hole and the material properties of the loose soil which fell back into the hole after entry. The loose backfill is called "fluff" in this report. The material properties of the natural soil surrounding the entry hole were also to be determined if possible. A summary of the results of the laboratory tests conducted upon selected soil samples is given in Table 1, and the entry-hole geometry and soil log is given in Figure 1.

A 13.4-inch diameter metal sabot, which was originally attached to the unit with shear bolts, was exposed at a depth of 2.4 feet below the ground surface. Mr. Summons carefully

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1st Review Date 10-28-97
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Name W Jaeger
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Determination (Circle Number):
1. Classification Retained
2. Classification Changed to: U
3. Contains No DOE Classified Information
4. Coordinate With:
5. Contains UCAI?
6. Comments: OK for Approved

12p.

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FEB 2 - '66 CG

removed the sabot and the drogue parachute-antenna assembly before sampling was commenced. The sabot was severely damaged; both warping and cracking were evident. A considerable amount of the stiff silty clay appeared to be "compacted-on" the sabot, particularly between the radial fins or stiffeners on the top of the sabot. A sample of this material was obtained. A photograph of the recovery hole after the sabot had been removed is shown in Figure 2.

Several hand-drive samples were obtained in the disturbed soil around the sabot and in the fluff which had filled the vehicle entry hole. The recovery excavation was then deepened by about 1 foot and more hand-drive samples were obtained. For an example of the hand-drive sampling operations see Figure 3, which shows sample 1-6 before it was removed. It was determined at this time that the entry hole had a void in it from a depth of 3.6 to 5.8 feet below the ground surface. A photograph of the void is shown in Figure 4.

A 4-foot diameter recovery hole adjacent to the entry hole was then started with a bucket rig. At a depth of about 8 feet, a tunnel was mined horizontally to the vehicle hole. A photograph of the mined tunnel is given in Figure 5. Although the mining operations probably had some disturbing effect upon the fluff, it was decided that this disturbance was minor. Several more hand-drive samples were obtained in both the fluff and the surrounding soil material at this depth. Although it was originally planned to conduct a plate-bearing test on the fluff, this was not feasible due to the hole diameter and antenna position. Since the plate-bearing tests could not be performed, in-situ shear strengths of the fluff were measured with a torsional shear vane. Shear vane tests were conducted both in a horizontal orientation at a depth of 7½ feet and in a vertical orientation at

[redacted]

a depth of 9 feet. These tests indicated that the fluff had an average vane shear strength of 50 psf. Although the shear vane test is not as accurate as laboratory tests, the results are a rough indication of the very low unconfined shear strength of the fluff.

The unit itself evidenced very little structural damage; very minor bending of the nose point and striations in the paint were observed, and the antenna had broken loose from the unit at the tail. Both static and dynamic laboratory tests were conducted upon selected samples of fluff and soil surrounding the hole. The grain-size distribution curve of the fluff is given in Figure 6. It was determined that the fluff had no strain-rate sensitivity. For example, one composite fluff sample tested at a confining pressure of 0.5 tsf had a maximum deviator stress of 0.184 tsf at a strain rate of 0.25% per second. A similar sample at the same confining pressure had a deviator stress of 0.179 tsf at a strain rate of about 0.02% per second. Thus, although the sample was failed dynamically in the laboratory at a rate 12.5 times as fast as the static test, the strengths remained essentially the same.

A series of calculations for the compression wave (P-wave) velocity as a function of ambient stress was made for the fluff and the results are given in Figure 7. These results indicate that the average velocity is about 100 fps in fluff. This is, in our opinion, the low end of the probable velocity range for fluff; it could range up to about 500 fps at conditions of greater restraint. It should be realized that the seismic air velocity is much higher than the P-wave velocity in the fluff and, in most cases, would dominate the first arrival in a wave-propagation event. Extrapolation of this curve to higher ambient pressures up to

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about 5 tsf should remain fairly valid since the relationship between wave velocity and ambient stress is theoretically a simple power function, a straight line on a log-log plot.

Since the native soil samples were in a brittle and cracked condition, not enough information was in hand to calculate the P-wave velocities for the surrounding undisturbed soils. We feel, however, that these velocities would be well in excess of 1000 fps.

Careful consideration of the problems involved have led us to devise a more comprehensive sampling and testing program to be used after the next Rumpler event. At that time, it is recommended that we conduct a simple seismic traverse to obtain more information on the P-wave velocity of the undisturbed soil.

If we may be of further assistance regarding any of the details contained in this letter, or in the recovery program for Unit 261-1, please feel free to contact us.

Very truly yours,

WOODWARD-CLYDE-SHERARD & ASSOCIATES

F. M. Babcock

F. M. Babcock, R.E. 6095, Colorado

Reviewed by: B. E. Margason

B. E. Margason, R.E. 14201, California

FMB:jmh
Enclosures: 8
cc: Mr. W. N. Caudle

[redacted]

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TABLE I

LABORATORY TEST RESULTS SUMMARY

Sample	Depth (ft.)	Location	Material	Dry Density	Water Content	Strength Angle, Degrees	Cohesion (psf)	Strain Rate Sensitivity
1-1	1.4	on sabot	compacted natural soil	113.3	10.6			
1-2	1.75	11" E. ℄	natural soil	86.9	11.1			
1-3	1.75	20" E. ℄	natural soil	77.7	11.2			
1-4	2.42	8" W. ℄	natural soil	78.0	12.0			
1-5	2.58	8" S. ℄	fluff	39.0**	10.4			
1-6	3.25	2.5" S. ℄	fluff	60.8	8.3			
1-7	7.5	2" E. ℄	fluff	68.1	6.6			
1-8	8.0	2" E. ℄	fluff	75.8	5.6			
1-9	7.7	5.5" S. ℄	natural soil	82.1	10.1			
1-10	7.7	17.5" S. ℄	natural soil	100.4	10.8			
1-5,6, 7,8 composite	0-8.0		fluff	81.4	7.7	8	0	none

* Refers to hole ℄
** Very disturbed sample, density not valid

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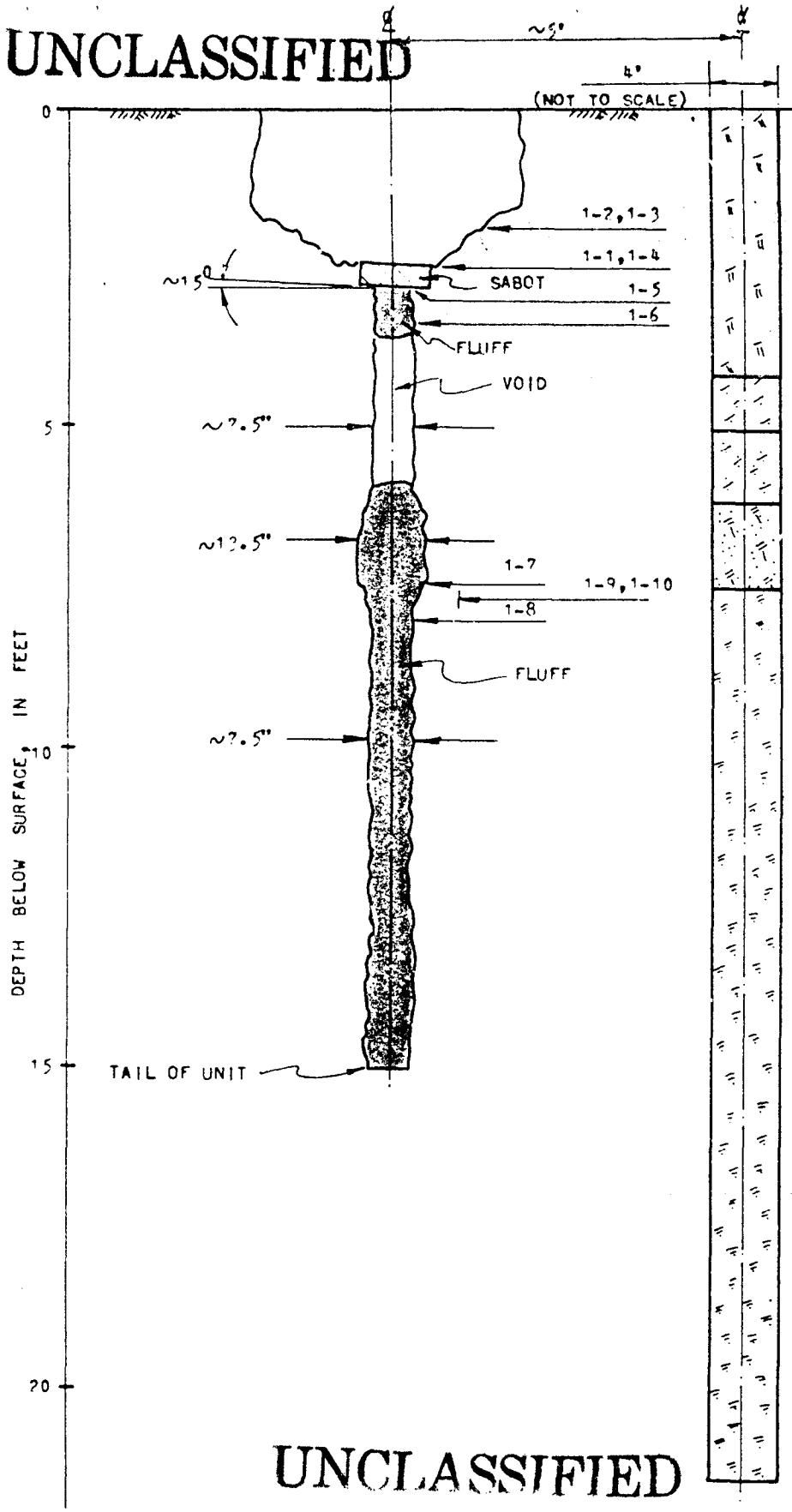

SILTY CLAY

STIFF, DRY, LIGHT BROWN

SILTY SAND

MEDIUM DENSE, DRY, LIGHT BROWN

SILTY SAND & SANDY SILT

INTERBEDDED, MEDIUM DENSE, DRY, LIGHT BROWN

SAND & CLAYEY SILT

CROSS-BEDDED, MEDIUM DENSE, DRY, MEDIUM GREY SAND & LIGHT BROWN SILT

CLAYEY SAND

VERY DENSE, DRY, WELL-CEMENTED, TAN

SAMPLES

SAMPLE	LOCATION	MATERIAL
1-1	ON SABOT	COMPACTED SOIL
1-2	11"E. ∅	NATURAL SOIL
1-3	20"E. ∅	NATURAL SOIL
1-4	3" W. ∅	DISTURBED SOIL
1-5	8" S. ∅	FLUFF
1-6	2.5"S. ∅	FLUFF
1-7	2" E. ∅	FLUFF
1-8	2" E. ∅	FLUFF
1-9	5.5"S. ∅	NATURAL SOIL
1-10	17.5"S. ∅	NATURAL SOIL

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FIGURE 1 - RECOVERY HOLE LOG - SHOT NO. 261-1

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WOODWARD-CLYDE-SHERARD & ASSOCIATES
Consulting Soil and Foundation Engineers

FIG. 1

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FIGURE 2 - RECOVERY HOLE AFTER SABOT REMOVED

SHOT 261-1

[redacted]

[redacted]

FIGURE 3 - HAND-DRIVEN SAMPLE NUMBER 1-6
SHOT 261-1

[redacted]

[redacted]

FIGURE 4 - VOID IN FLUFF FROM 3.6 TO 5.8 FEET BELOW THE SURFACE
SHOT 261-1

[redacted]

[redacted]

FIGURE 5 - TUNNEL MINED HORIZONTALLY AT 8 FEET
SHOT 261-1

[redacted]

PROJECT: SANDIA RUMPLER SHOT 261-1				MECHANICAL ANALYSIS CURVES					
SAMPLE NO.	DEPTH	LL	PI	CLASSIFICATION	SAMPLE NO.	DEPTH	LL	PI	CLASSIFICATION
1-5, 1-6, 1-7, 1-8 COMPOSITE FLUFF									

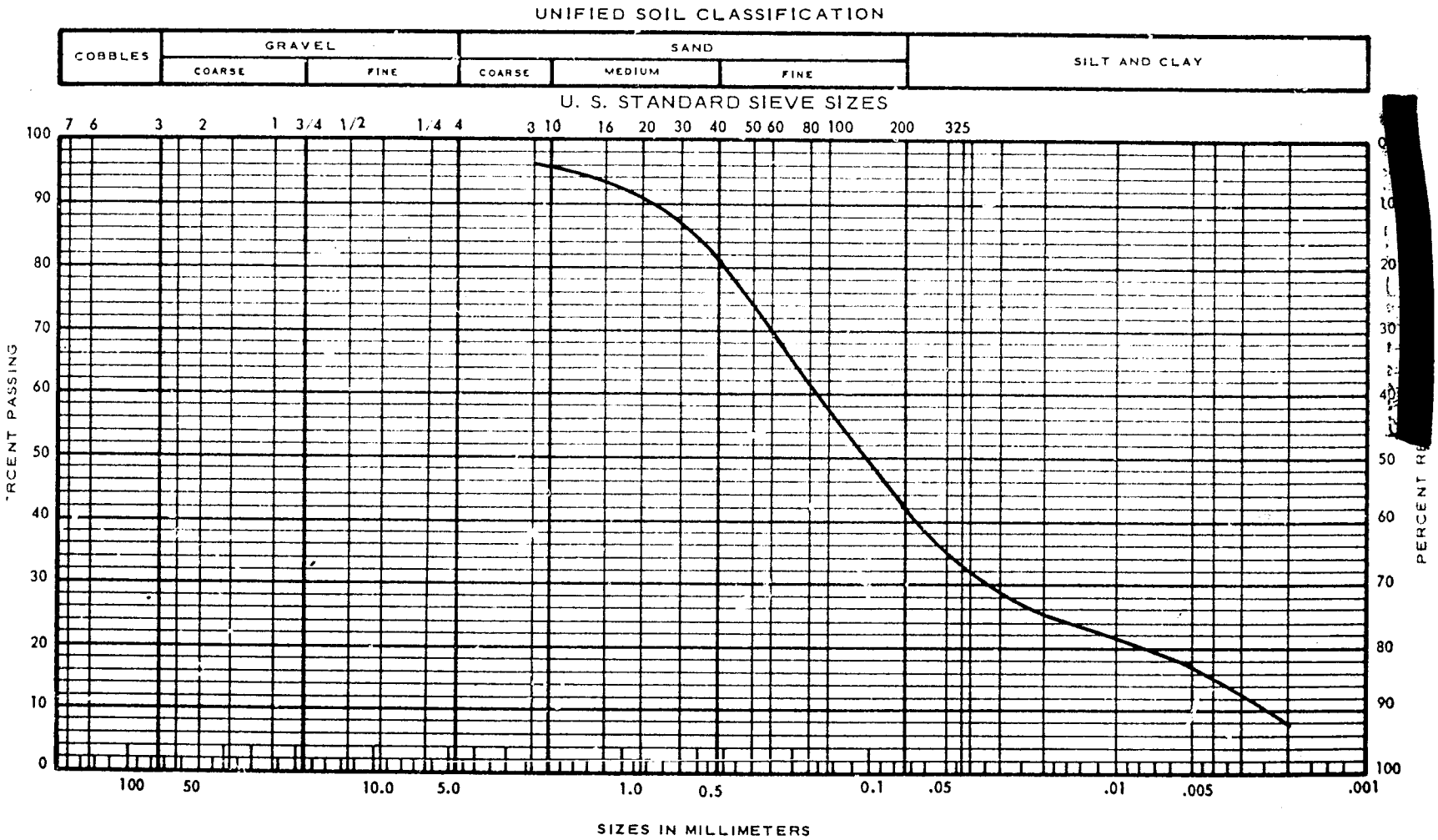

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FIG. 6

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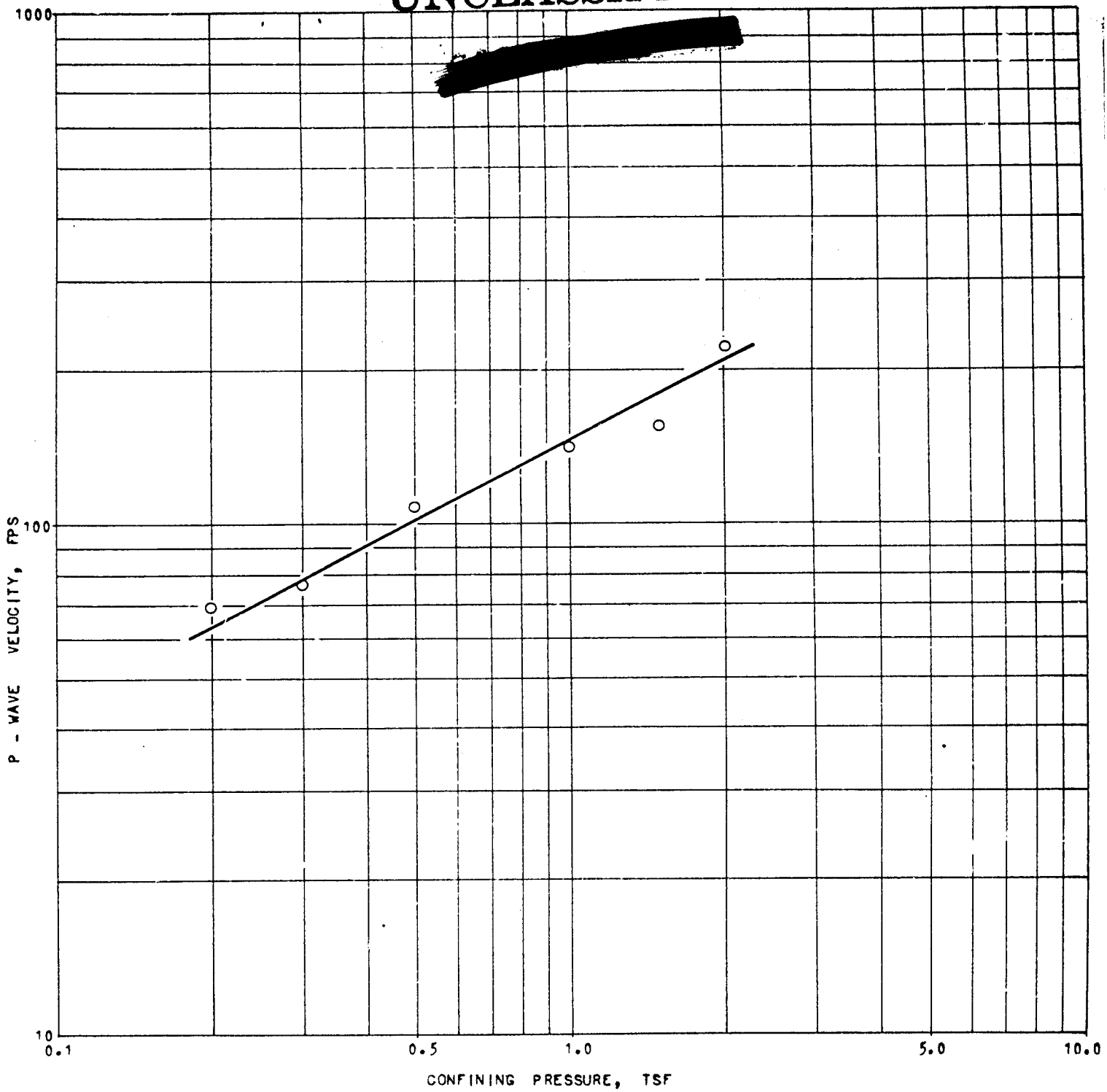

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FIGURE 7 - APPROXIMATE P-WAVE VELOCITY VS CONFINING PRESSURE
COMPOSITE FLUFF SAMPLE 1-5, 6, 7, 8 SHOT 261-1

FIG. 7

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File: 48-3069

22 Oct 65

October 19, 1965

Sandy: Assign JCDC # Clem & Pat

To: W. N. Caudle - 9327

Original Signed By
E. B. BERGQUIST for

From: H. W. Benischek - 4343

Re: Report - Contract 48-3069

We are enclosing four (4) reports dated October 11, 1965 on the Sandia Rumpler Recovery Operations, Number 261-1, submitted by Woodward-Clyde-Sherard and Associates against the above referenced contract, their Job No. 6828A.

HWB:4343:nbr

Enc. as noted

Copy to:
J. G. Wallace, 3411, w/enc.

[redacted]