State Department of Geology and Mineral Industries

702 Woodlark Building
Portland, Oregon

EUGENE SAND FOUNDRY TESTS

W.D. Lowry and R.S. Mason

Introduction:

The sand used in this series of tests was washed from the north bank of the old Eugene Fire Clay Products Company pit located in Lane County in the NW¼ sec. 36, T. 17 S., R. 4 W., approximately three miles west of Eugene. This deposit is described in R. C. Treasher's "Preliminary Report on a Possible Molding or Glass Sand", Oregon Department of Geology and Mineral Industries, 1943, unpublished. In this report, he states that the bank material at this pit contains approximately 35% clay and 65% quartz sand with a minor amount of mica, and was used in the manufacture of no. 2 refractory brick. Sand for this test was washed from bank material by hand and was not screened.

The following data were compiled from the foundry tests made at Crawford & Doherty Foundry, Portland, Oregon, from October 7-11, 1943. Crawford & Doherty's plant is a semi-steel foundry; their product is known as "Meehanite".

The purpose of these tests was to determine the durability of this sand. To accomplish this, the sand was subjected to a series of pourings of a semi-steel (55% steel rail) casting made at a temperature of 2700° ± F. Samples of the sand were taken before and after each pouring. The sample selected after each pouring was taken from that part of the facing sand which was thought to have been subjected to the greatest heat and stress. The A.F.A. clay was removed from each sample and the material then screened. The accompanying record sheets show the various mixes used, their properties, the screen analyses and accompanying graphs of the sand before and after each pouring made. Miscellaneous information is also included. The tests were discontinued when someone on the foundry night shift unknowingly mixed the sand being tested with the regular foundry heap sand.

Properties of the sand:

Chemical analyses:

(1) R. G. Bassett (from Treasher's report)

SiO_2	95.8 %
Ignition loss	2.3
	98.1 %

(2) L.L. Hoagland (Assayer, Oregon Department of Geology)

A.F.A. clay and plus 30 mesh fraction removed before analyzing - Sample No. P-1767.

SiO_2	96.39 %
H_2O	1.3
	97.69 %

Spectrographic analysis (by H.C. Harrison, Oregon Department of Geology):

Sample No. P-1829; Spectrographic Laboratory No. 773.
(A.F.A. clay and plus 20 mesh fraction removed.)

QUALITATIVE SPECTROGRAPHIC ANALYSIS
(Quantities estimated to nearest power of ten)

Elements present in concentrations over 10%.
Silicon

Elements present in concentrations 1% - 0.1%.
Iron, Aluminum, Titanium

Elements present in concentrations 0.1% - .01%.
Zirconium, Calcium, Magnesium.

Petrographic analysis (by W.D. Lowry, Oregon Department of Geology):

The various sieve fractions of this sand were examined petrographically. The following paragraph summarizes its character:

The sand is made up predominantly (about 96%) of subangular to angular grains of quartz whose surfaces are somewhat frosted. The plus 40 mesh (U.S. Bur. Standards) fractions (1.5 ± %) are dominantly aggregate grains composed almost entirely of subangular grains of quartz approximately 0.4 mm in diameter, cemented together with clay. The grains of the smaller sieve fractions (minus 100 mesh) tend to be angular. Of the quartz grains, from 3-7% (probably about 6%) are either strained, cracked, or aggregate. Some of the surfaces of the quartz grains are partially coated with a thin film of clay. About 4% of the sand are chalcedonic aggregates; the minus 70 mesh (U.S. Bur. Standards) sieve fractions have a higher percentage of chalcedonic grains. Mica flakes constitute less than 1% of the total.

Screen analysis:

Approximately 1500 lbs. of Eugene sand was sampled. Fifty grams were dried, the A.F.A. clay removed, and the sand redried before screening.

Size (U.S. Bur. Standards)	Weight	Percent	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	0.00 g.	0.00 %	0.00 %	0.00 %
" " 30 "	0.10	0.20	0.21	0.21
" " 40 "	0.83	1.66	1.79	2.00
" " 50 "	8.66	17.32	18.71	20.71
" " 70 "	23.73	47.46	51.23	71.94
" " 100 "	8.82	17.64	19.09	91.03
" " 140 "	2.33	4.66	5.04	96.07
" " 200 "	0.83	1.66	1.79	97.86
Pan	0.99	1.98	2.14	100.00
	46.29 g.	92.58 %	100.00 %	
A.F.A. clay	1.75	3.50		
Loss (drying & screening)	1.96	3.92		
	50.00 g.	100.00 %		

EUGENE SAND FOUNDRY TEST

No. 1 Pour Oct. 8, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. The casting is 55% steel (steel rail) poured at about 2700° F.

Number of casting:

1 and 2

Mix used:*

Eugene sand	600 lbs.
Water	24 lbs.
Bentonite	30 lbs.

*This mixture has too much "body", due to excess bentonite.

Properties of mix:

Moisture*.	6.2%
Green permeability	165
Green compression strength**	8.6

* Sand as furnished contained approximately 2% moisture

** No green shear or tensile values were measured as their ratio to the green compression strength for practical purposes are said by H. Ries to remain fairly constant.

Molding characteristics:

The pattern used was made of 3 pieces. These fitted together very poorly and the surface of the pattern was in several places quite rough as some poorly fitting cardboard lagging had been used. The molder said the above mix was "easy to work and required no nails". The molder rammed this mix the same way he was accustomed to ramming the sand commonly used by the foundry - a sand of much lower permeability. The character of the casting later proved that the sand had not been rammed hard enough.

Pouring characteristics:

Poured quietly

Remarks:

The casting was poor, very rough. The breakaway of the sand from the casting was poor. Lack of ramming permitted metal to run into the facing sand.

EUGENE SAND FOUNDRY TEST

Pour No. 1 (cont.)

Screen analyses*:

Sample No. 1
(Original mix)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.285 g.	.64 %	.64 %
" " 40 "	.715	1.61	2.25
" " 50 "	8.270	18.62	20.87
" " 70 "	23.400	52.61	73.48
" " 100 "	7.780	17.49	90.97
" " 140 "	2.120	4.64	95.61
" " 200 "	.835	1.87	97.48
Pan	1.120	2.52	100.00
	44.525 g.	100.00 %	
A.F.A. clay (10.550%)	5.275		
	49.800 g.		

Sample No. 2
(Sand from facing of casting no. 1, first pour)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.324 %	.324 %
" " 30 "	.170	.366	.690
" " 40 "	.865	1.864	2.554
" " 50 "	9.190	19.140	21.694
" " 70 "	23.325	50.670	72.364
" " 100 "	8.460	18.390	90.754
" " 140 "	2.425	5.230	95.984
" " 200 "	.900	1.920	97.904
Pan	.975	2.096	100.000
	46.460 g.	100.000 %	
A.F.A. clay (5.840%)	2.920		
	49.380 g.		

* For comparative curves of these screen analyses see page 5a.

page 5

EUGENE SAND FOUNDRY TEST

Pour No. 2 Oct. 9, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

3

Mix used:

Sand recovered from first pour. No new bond added. Water added which brought moisture up to 9%.

Properties of mix:

Moisture	9%
Green permeability	85
Green compression strength	10.1

Molding characteristics:

Sand was rammed much harder. Molder says, "too wet". Mold, after pattern was removed, looked rough in places due to inadequate ramming.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 3 fair, much improved over nos. 1 and 2. After removal from rattler mill, casting was quite smooth. The sand broke away from the casting better than from casting nos. 1 and 2.

page 6

EUGENE SAND FOUNDRY TEST

Pour No. 2 (cont.)

Screen analyses*:

Sample No. 3
(Sand used for casting no. 3, previously used once, before pouring)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.205 g.	.460 %	.460 %
" " 30 "	.185	.420	.880
" " 40 "	.605	1.372	2.252
" " 50 "	6.875	15.610	17.862
" " 70 "	22.435	50.894	68.756
" " 100 "	8.650	19.635	88.391
" " 140 "	2.520	5.720	94.111
" " 200 "	.935	2.121	96.232
Pan	1.660	3.768	100.000
	44.070 g.	100.000 %	
A.F.A. clay (10.520%)	5.260		
	49.330 g.		

Sample No. 4
(Sand used for casting No. 3, previously used twice, after pouring, taken from face of casting)
A.F.A. clay removed before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.328 %	.328 %
" " 30 "	.180	.394	.722
" " 40 "	.795	1.706	2.428
" " 50 "	8.525	18.600	21.028
" " 70 "	22.325	48.600	69.628
" " 100 "	7.910	16.640	86.268
" " 140 "	2.755	5.840	92.108
" " 200 "	1.195	4.092	96.200
Pan	1.730	3.800	100.000
	45.565 g.	100.000 %	
A.F.A. clay (8.50%)	4.250		
	49.815 g.		

* For comparative curves of these screen analyses see page 7a.

page 7

EUGENE SAND FOUNDRY TEST

Pour No. 3 Oct. 11, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

4

Mix used:

150 lbs. sand from second pouring
150 lbs. sand from first pouring
(left over as only one casting poured second day)
15 lbs. sea coal
Water added which brought moisture up to 6.8%

Properties of mix:

Moisture	6.8%
Green permeability	112
Green compression strength	8.6

Molding characteristics:

Too hard to ram well as result of excessive bentonite at above moisture content.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 4 improved over no. 3 but still rough in places. Sand broke away from the casting a little too hard. Foundryman said casting no. 4 "somewhat improved".

page 8

EUGENE SAND FOUNDRY TEST

Pour No. 3 (cont.)

Screen analyses*:

Sample No. 5
(Sand used for casting no. 4, before pouring -
Half of this sand previously used once; half, twice)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.215 g.	.488 %	.488 %
" " 30 "	.300	.684	1.172
" " 40 "	.805	1.832	3.004
" " 50 "	6.790	15.450	18.454
" " 70 "	21.410	48.776	67.230
" " 100 "	9.055	20.630	87.860
" " 140 "	2.675	6.080	93.940
" " 200 "	1.025	2.280	96.220
Pan	1.660	3.780	100.000
	43.935 g.	100.000 %	
A.F.A. clay (12.10%)	6.050		
	49.985 g.		

Sample No. 6
(Sand used for casting no. 4, after pouring, taken from face of casting -
Half of this sand previously used 2 times; half, used 3 times)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.185 g.	.420 %	.420 %
" " 30 "	.375	.852	1.272
" " 40 "	.860	1.956	3.228
" " 50 "	6.495	14.750	17.978
" " 70 "	21.485	48.864	66.842
" " 100 "	9.245	21.010	87.852
" " 140 "	2.685	6.104	93.956
" " 200 "	.960	2.182	96.138
Pan	1.700	3.862	100.000
	43.990 g.	100.000 %	
A.F.A. clay (11.850%)	5.925		
	49.915 g.		

* For comparative curves of these screen analyses see page 9a.

page 9

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix A) Oct. 12, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

5

Mix used:

200 lbs. new sand
100 lbs. from second pouring (used 2 times)
30 lbs. sea coal
10 lbs. water
7 lbs. bentonite

Properties of mix:

Moisture	4.6%
Green permeability	158
Green compression strength . . .	6.7

Molding characteristics:

Molder says rammed much better but sand stuck to pattern upon removal due to heat generated by excessive mulling.*

Pouring characteristics:

Poured quietly

Remarks:

Casting no. 5 was good with exception of lower portion where sand stuck to pattern during molding. Sand broke away easily from casting. Superintendent said casting no. 5 was good.

* This mix had to be mulled twice. First batch too dry and too low in bond and required remulling.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix A

Screen analyses*:

Sample No. 7A
(Sand used for casting no. 5, before pouring)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.275 g.	.604 %	.604 %
" " 30 "	.485	1.068	1.672
" " 40 "	.960	2.106	3.778
" " 50 "	7.050	15.496	19.274
" " 70 "	22.410	49.238	68.512
" " 100 "	9.715	21.360	89.872
" " 140 "	2.440	5.360	95.232
" " 200 "	0.725	1.592	96.824
Pan	1.445	3.176	100.000
	45.505 g.	100.000 %	
A.F.A. clay (8.80%)	4.400		
	49.905 g.		

Sample No. 10
(Sand used for casting no. 5, after pouring,
taken from face of casting)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.160 g.	.324 %	.324 %
" " 40 "	.700	1.418	1.742
" " 50 "	8.980	18.220	19.962
" " 70 "	24.930	50.482	70.444
" " 100 "	8.900	18.000	88.444
" " 140 "	2.750	5.536	93.980
" " 200 "	1.500	3.040	97.020
Pan	1.470	2.980	100.000
	49.390 g.	100.000 %	
A.F.A. clay (1.15%)	0.575		
	49.965 g.		

* For comparative curves of these screen analyses see page 11a.

page 11

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix B) Oct. 12, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting of 55% steel (steel rail) poured at about 2700° F.

Number of casting:

6

Mix used:

900 lbs. sand from third pouring
(half of this sand previously used twice; half, 3 times)
15 lbs. sea coal
7 lbs. water

Properties of mix:

Moisture	4.6%
Green permeability	138
Green compression strength	10.17

Molding characteristics:

Rammed well. Possibly a little too dry but poor pattern was largely to blame for slight damage to mold when the pattern was removed.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 6 not quite as good as no. 5 due to slight flaring out at bottom of casting. This may have been caused by lack of ramming near base of mold. Sand broke away readily from casting.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix B

Screen analyses*:

Sample No. 8A

(Sand used for casting no. 6, before pouring -
Half previously used twice; half 3 times)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.425 g.	.968 %	.968 %
" " 30 "	.525	1.194	2.162
" " 40 "	1.150	2.604	4.766
" " 50 "	6.600	15.030	19.796
" " 70 "	20.050	45.650	65.446
" " 100 "	9.410	21.440	86.886
" " 140 "	2.725	6.210	93.096
" " 200 "	1.025	2.334	95.430
Pan	2.030	4.570	100.000
	43.940 g.	100.000 %	
A.F.A. clay (11.86%)	5.930		
	49.870 g.		

Sample No. 9

(Sand used for casting no. 6, after pouring -
Half of sand has now been subjected to 3 pourings; half to 4 pourings)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.035 g.	.072 %	.072 %
" " 30 "	.125	.260	.332
" " 40 "	.530	1.104	1.436
" " 50 "	6.740	14.040	15.476
" " 70 "	24.565	51.092	66.568
" " 100 "	9.900	20.600	87.168
" " 140 "	2.870	5.960	93.128
" " 200 "	1.150	2.392	95.520
Pan	2.150	4.480	100.000
	48.065 g.	100.000 %	
A.F.A. clay (3.87%)	1.935		
	50.000 g.		

* For comparative curves of these screen analyses see page 13a.

702 Woodlark Building
Portland, Oregon

MEMORANDUM ON THE EUGENE SILICA SAND *

Eugene, Oregon

Location:

The deposit is about 2 miles west of Eugene which is approximately 120 miles south of Portland, Oregon. It makes up most of Wallace Butte, a low elongate hill in secs. 34 and 35, T. 17 S., R. 4 W.W.M., and can be reached via 11th Street. The Silica Products, Oreg., Ltd. plant, which washes and dries the sand, is located about 1 mile north of the deposit on the Coos Bay branch of the Southern Pacific Railroad.

Ownership:

The southwestern part of Wallace Butte, which includes the pit area from which sand is being mined, is owned by the Silica Products, Oreg., Ltd., 808 Couch Building, Portland, Oregon. Their holdings comprise 38 acres plus a smaller acreage to the east. The remaining part of the hill is held by several home owners.

Composition of the sand:

The pit material from which the sand is recovered is about two-thirds quartz sand and one-third fire clay with a minor amount of mica.

Chemical analyses of the washed sand made by the Oregon Department of Geology and Mineral Industries show it contains about 98% SiO_2.

---

* Prepared by the Oregon Department of Geology and Mineral Industries, June 15, 1946.

The main impurity is alumina which occurs largely as a clay film on the grains. A spectrographic analysis of the sand made by the Oregon Department is given below:

<u>Qualitative Spectrographic Analysis</u>
(Quantities estimated to nearest power of ten)

1.	Elements present in concentrations over 10%	Silicon
2.	Elements present in concentrations 0.1 - 1%	Aluminum Iron Titanium
3.	Elements present in concentrations 0.01 - 0.1%	Calcium Magnesium Zirconium

Chemical analysis of a sample of the sand scoured in a small ball mill showed it contained 0.095% Fe_2O_3. Determinations of the silica and alumina content of the sample have not yet been completed.

Petrographic analysis of the sand shows it is made up predominantly (about 96%) of subangular to angular grains of quartz. Chalcedonic quartz grains constitute about 4% of the sand and mica flakes less than 1%. The grain size of the sand is remarkably uniform and accounts for its high permeability. The 70 mesh (U.S. Bur. Standards) fraction makes up more than half of the sand and together with the 50 and 100 mesh fractions constitutes more than 90%.

A screen analysis of a hand-washed sample of the Eugene sand is given on the following page.

Screen Analysis of Eugene Sand

Size (U.S. Bur. Standards)	Percent	Cumulative Percent
Retained on 12 mesh	0.00	0.00
" " 20 "	0.10	0.10
" " 30 "	0.50	0.60
" " 40 "	2.92	3.52
" " 50 "	24.22	27.74
" " 70 "	54.30	82.04
" " 100 "	14.30	96.34
" " 140 "	2.60	98.94
" " 200 "	0.62	99.56
" " 270 "	0.22	99.78
Pan	0.26	100.04

The average of the screen analyses of samples from 30 cars of washed sand shipped by the Silica Products company is given below. As some of the finer sand grains are removed in the washing process, the analysis differs slightly from that given above.

Screen Analysis of Eugene Sand
Marketed by Silica Products, Oreg., Ltd.

Size (U.S. Bur. Standards)	Percent	Cumulative Percent
Retained on 40 mesh	4.00	4.00
" " 50 "	23.46	27.46
" " 70 "	55.27	82.73
" " 100 "	14.61	97.34
" " 140 "	1.62	98.96
" " 200 "	0.65	99.61
" " 270 "	0.13	99.74
Pan	0.20	99.94

Size of the deposit:

An auger drilling project carried out by the U. S. Bureau of Mines in 1943 (War Minerals Report 199) failed to delimit the deposit both as to depth and areal extent. As the alluvial overburden is thicker on the flanks of the hill, the sand was not encountered in the shallow auger holes put down on some of the lower slopes. However the drilling did show that the sand deposit is surprisingly uniform in character. The U. S. Bureau of Mines estimated on the basis of their drilling results that 93,500 tons of measured sand, free from clay, and an additional 307,500 tons of indicated sand are available. An old well on the Silica Products tract is reported to have encountered 75 feet of sand, whereas the deepest auger hole which the Bureau of Mines was able to put down was less than 25 feet. The sand is also known to be present across the road south of Wallace Butte. A similar but slightly lower grade sand deposit, known as the Hawkins locality, lies about 1 mile to the southeast and suggests that the areal extent of the Wallace Butte deposit is much greater than indicated by the auger drilling.

A chemical analysis made by the Oregon Department of a hand-washed sample of the Hawkins sand is given below:

Hawkins Sand

Silica (SiO_2)	92.46 %
Iron oxide (Fe_2O_3)	0.81
Alumina (Al_2O_3)	5.7

Another sample of this sand with the minus 100 mesh fraction removed was found to contain 94.38% SiO_2. The Hawkins deposit was auger drilled in 1945 by the U. S. Bureau of Mines and it is reported that a substantial tonnage is indicated.

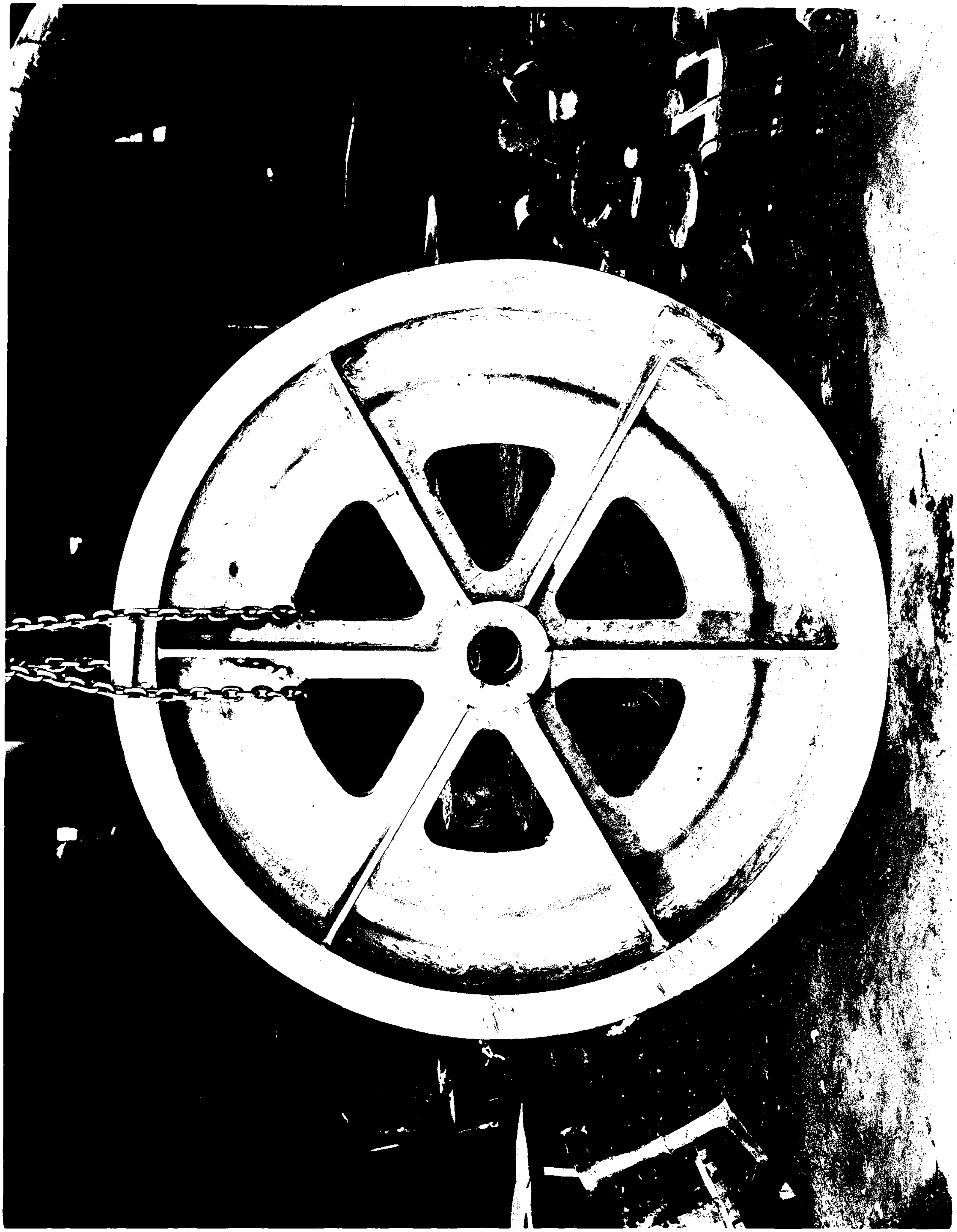
Economic aspects of the deposit:

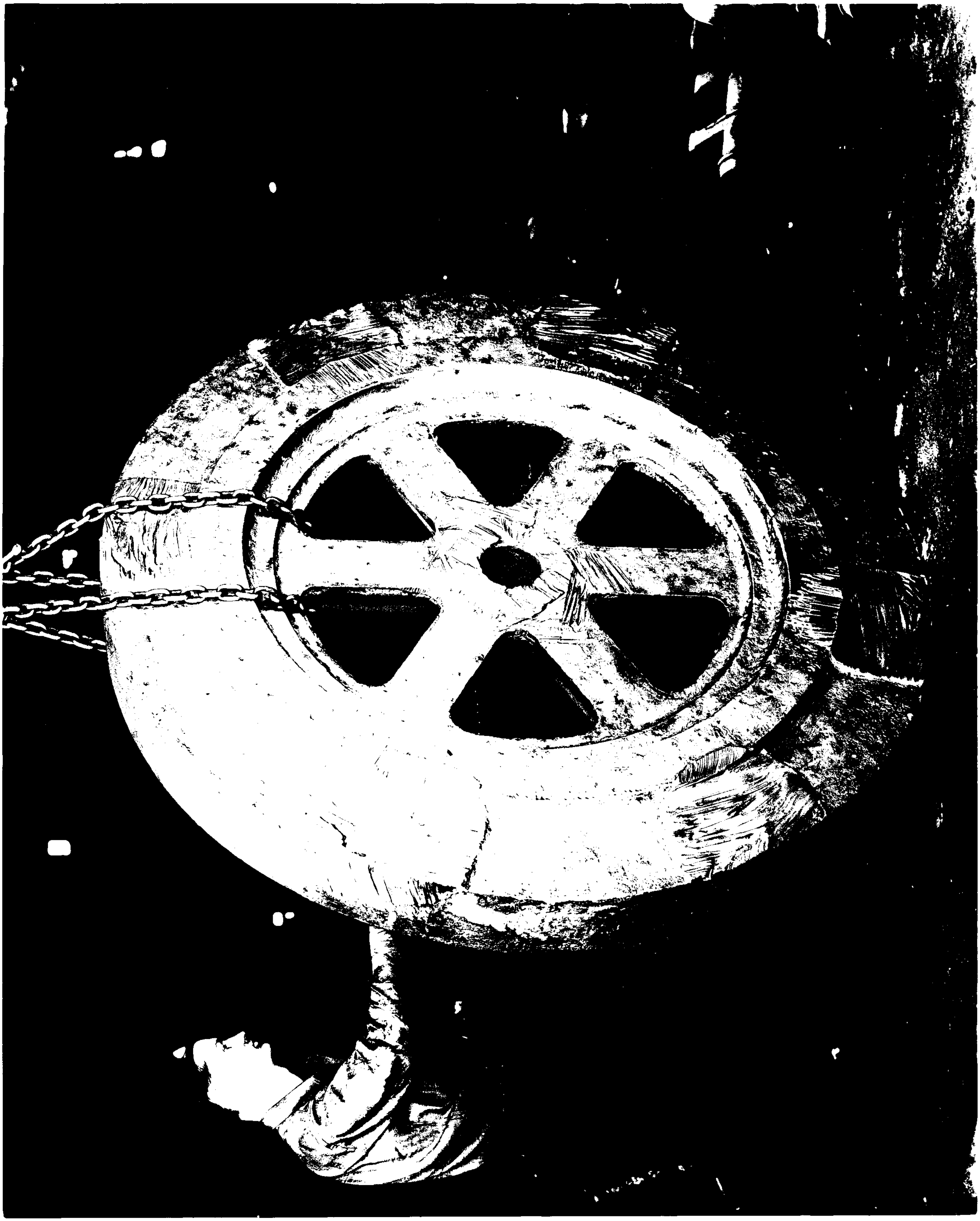
The washed and dried sand is now being marketed in Portland at $8.75 a short ton. In Seattle it sells for $9.00 and in San Francisco for $9.25. Its main user has been the foundry trade.

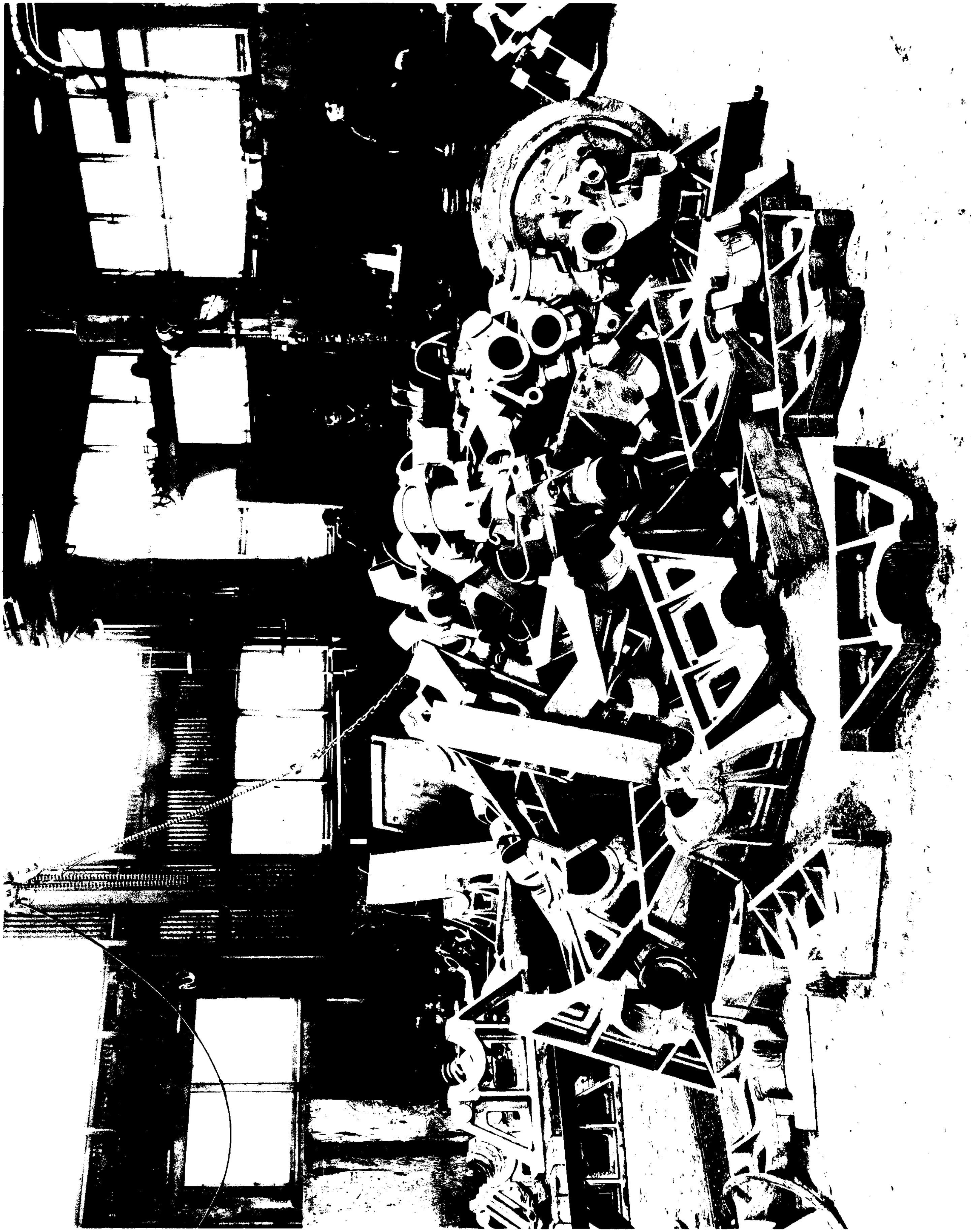
The clay removed in the washing process is being collected in settling ponds. The clay is a kaolin with a P.C.E. value above cone 31. The pit material was formerly used for making fire brick. Test work on the clay suggests its suitability for a number of uses. As yet none of the clay has been marketed. A chemical analysis of the clay made by the Oregon Department is given below:

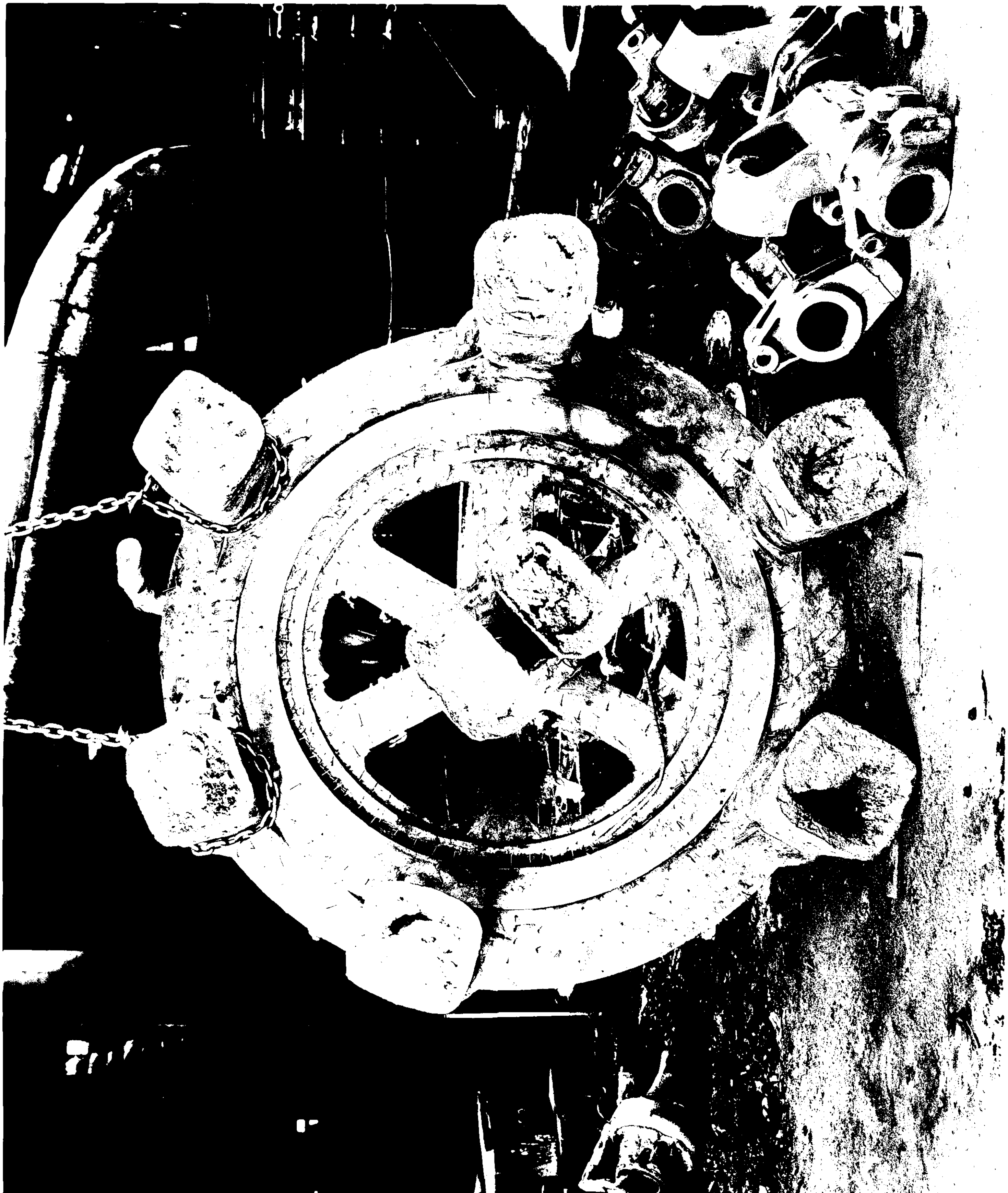
Eugene Clay

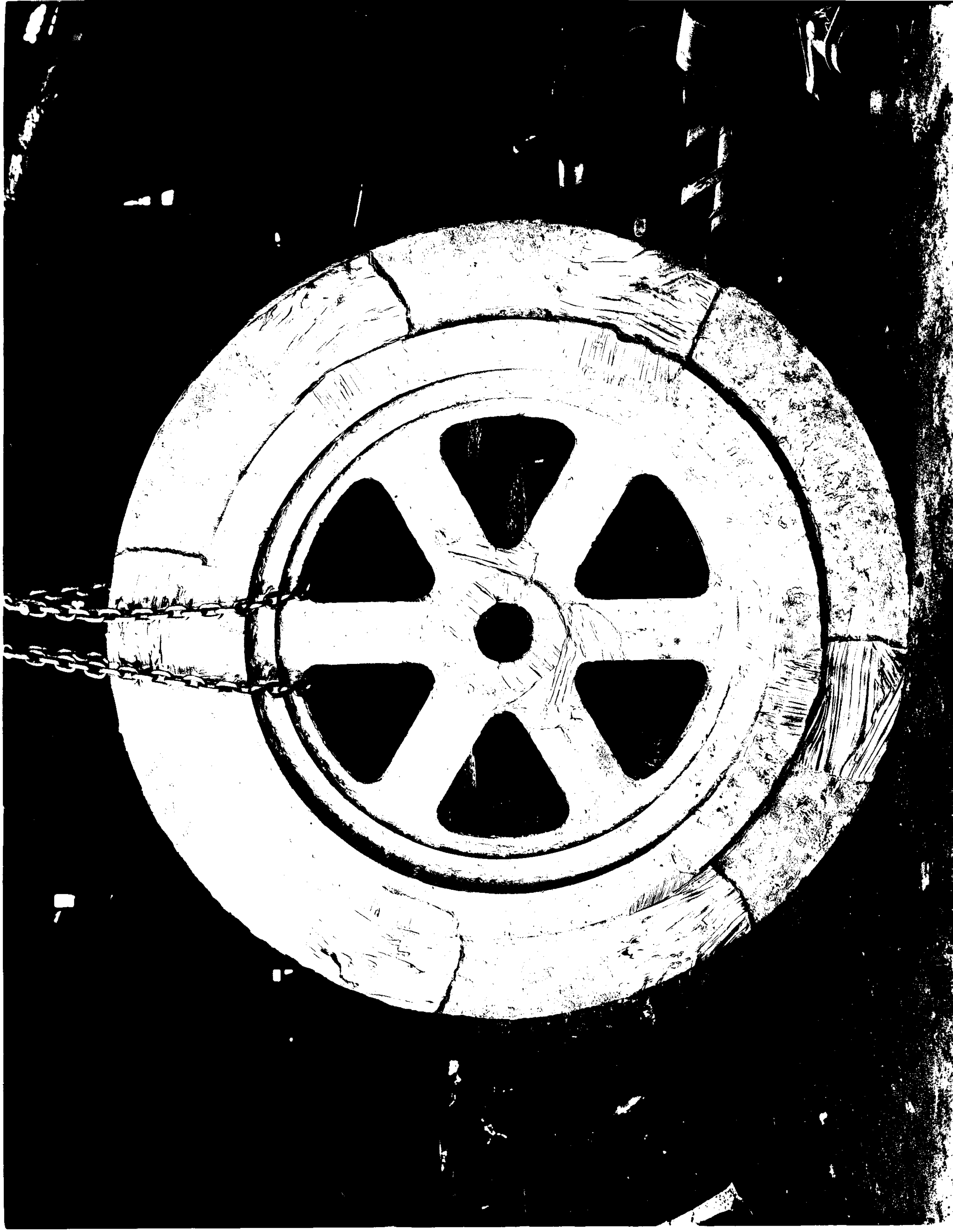
Alumina (Al_2O_3)	35.0 %
Silica (SiO_2)	51.4
Iron oxide (Fe_2O_3)	1.6
Ignition loss	Not determined











702 Woodlark Building
Portland, Oregon

PRELIMINARY REPORT ON A POSSIBLE MOLDING SAND OR GLASS SAND

PHYSICAL TESTS

Ray C. Treasher

Clayey sand from the Eugene Fire Clay Products pit near Eugene was given preliminary tests which might indicate its suitability as foundry sand, and glass sand. The sand contains approximately 34 percent clay and 64 percent sand, with very minor amounts of mica. The sand grains are all quartz, and sized principally between 20 and 100 mesh. The tests suggest that the clayey sand has distinct possibilities as "sharp" foundry sand, if washed. The clayey sand has been used to manufacture No. 2 refractory brick.

Introduction

Purpose

The purpose of these tests was to get a general idea of the percentage of sand and clay, the size and shape of the sand grains, the alumina-iron-silica analysis of the clay, and the silica analysis of the sand. It was felt that these tests would give some general ideas regarding uses for the clayey sand.

Location of the Sample

The sample came from the pit of the Eugene Fire Clay Products Co., in the NW¼ sec. 36, T. 17 S., R. 4 W., about 2 miles south of Eugene on the extension of south 11th Street.

History

The locality was visited in 1938 in connection with a survey of refractory clays of western Oregon (Wilson & Treasher 38:65-66) and was reported as Locality no. 31. The pit had been opened to supply material for a no. 2 refractory brick, largely used in fireplace construction and for lining donkey boilers. Later, some of the clayey sand was shipped to Portland for molding sand. The pit has not been worked in the last few years except for occasional truck loads to the brick plant at Monroe when that plant wished sandy clay.

The property was visited on February 28, 1943, for the purpose of collecting samples. A representative sample was taken from the west side of the pit. The clay is similar to that discussed in the quotation below:

702 Woodlark Building
Portland, Oregon

Molding Sands (2)

(Wilson & Treasher 38:65-66)

"The clay is removed from a pit several hundred feet square in area, and while hand labor is used at present, it could be obtained easily by means of a dragline scraper.

"Two samples of sandy clay were taken from the company's pit near the barn on the northeast side of the bank, and another sample from the storage pile in the shed. Analysis of the latter gave onlyonly 15.6 percent alumina, and 79.5 percent silica, with 0.74 percent ferric oxide. The clay contained too much quartz sand to produce a strong plastic mass, but a low grade of siliceous refractory material was indicated by the P. C. E. values of cone 28 to cone 30-minus for the three samples. The calculated free quartz content from the analysis was close to 60 percent, and it is possible that a greater commercial value could be obtained from this material by washing the sand free of clay and using it for the purer forms of silica sand, which are not abundant in this part of Oregon. More permeable foundry sands for larger casting could be made with smaller clay contents, and it is possible that the washed quartz will have sufficient purity for steel foundry service. Tests for particle size, particle shape, and resistance to abrasion and thermal shock should be continued".

Procedure

The clayey sand was dried to a constant weight and the lumps broken with the fingers so as to aboid crushing and "scrubbing" the sand grains. The material was washed by stirring a small quantity in a large beaker of water and letting it settle for a few seconds and decanting the clay. The heavy portion (principally sand) was washed to remove any remaining clay and mica. Some very fine sand was lost.

It was found that the decanted clay still contained sand, so the process was repeated with this material. The sand was added to the first batch.

Both clay and sand were dried. A sample of the clay and of the sand was analyzed (see "chemical tests"). The sand was screened in a set of Tyler screens, 20, 48, 65, 100, 150, - the only sizes abailable. The sized fractions were examined microscopically.

Data

Weight of original sample (clay and sand)----------------1195 grams.

Weight of the sand****----------------------------------- 766 grams.

Percent of sand ------- 64 percent

Screen Sizing

State Department of Geology and Mineral Industries

702 Woodlark Building
Portland, Oregon

Molding Sands (3)

Screen Sizing
(see also Tyler Screen Data Sheet)

Weight of sample 765 grams.

Retained on mesh	Grams.	Percent	Cumulative Percent
20	0	0	0
48	360	47.0	47.0
65	282	37.0	84.0
100	90	11.8	95.8
150	17	2.2	98.0
Through 150 mesh	16	2.1	100.1

84 percent is minus 20, plus 65 mesh

96 percent is minus 20, plus 100 mesh

Microscopic Examination

The sized portions of the sand grains were examined under a biological microscope, the only instrument available. It was found that the plus 100 mesh sand had similar characteristics, except size, and that the minus 100 mesh sand was slightly different. The observations may be grouped as follows:

Plus 100 mesh

1. Practically all quartz
2. Grains subangular
3. Grains frosted
4. No opaques
5. Small amount of surface clay and iron oxide
6. Very occasional pink grains (garnet?)

Minus 100 mesh

1. Practically all quartz
2. Grains angular
3. Grains frosted
4. Infinitesimal amount of opaques
5. Slightly more surface clay and iron oxide
6. Very occasional pink grains (garnet?)

Characteristic grain shapes

702 Woodlark Building
Portland, Oregon

Tèchnology

The discussion of technology is degested from Cole 23:27-29 Reis 37:749-762, and Weigel 27:95-101, the only research literature (private) available to the Assay Laboratory.

Weigel states that naturally bonded sand is sometimes called "Foundry Sand", "Iron Molding Sand", or just "Molding Sand". Sand to which a bond is added is known as "silica sand". The term"Strong" is applied to sand with strong bonding properties and "sharp" is applied to sand which usually is high in silica. On the basis of the above definitions, the Eugene sand, as tested, is a sharp silica sand.

These sands are used to make molds for casting metals. If used for molds, they are molding sands. If used for cores, they are core sands bonded with oil, cereal binders, resin, pitch, and so forth.

The important properties of these sands are:

1. fineness
2. bonding strength
3. permeability
4. sintering point
5. durability

These are all physical properties. Chemical properties are important only as they affect the physical properties. Chemical data, however, are important as they help evaluate the physical properties.

1. Fineness. The American Foundry Association (A.F.A.) classes as clay, material finer than 20 microns, while the larger sizes are referred to as grains. Coarse sands are those in which coarse grains predominate, and fine sands are those in which fine grains predominate. The degree is expressed by the brain fineness number which represents approximately the number of mesh per inch of the sieve that would just pass the sample if the grains were all of uniform size. The various "classes" are a function of grain fineness and percentage of clay. The fineness of the sand affects permeability and strength, as well as smoothness of the casting.

According to the table "Weigel 27:97), the Eugene sand, as tested,corresponds to the grade"FS"(fine sand),).10 mm to).25 mm.

2. Bonding strength, is expressed in terms of compression, tension, or shear. Green (moist) strength depends on the quantity and quality of the clay. The optimum amount of water used, also is important. No facilities are available for bonding strength tests.

702 Woodlark Building
Portland, Oregon

3. Permeability, is the physical property of the sand that permits the passage of gases. Fine sands have low permeability and coarse sands have high permeability, as a rule. Permeability is measured by the rate of flow of air through a standard specimen of the sand.

No facilities are available for permeability tests. However, the relatively uniform grain size and subangularity suggest that the Eugene sands should have fair permeability.

4. Sintering point, is the point at which fusion of the sand begins. Facilities are not available for such testing, but previous work (Wilson & Treasher 38:65-66) shows that the clay and sand has refractory properties, so it is assumed that the sintering point is rather high.

5. Durability, is the ability of the sand to regain most of its green bonding strength after use. No facilities are available for such tests.

Conclusions on Physical Tests

The Eugene clayey sand appears to have qualities that may permit use of the washed sand as silica sand for foundry use. Bond may be added artificially, using a percentage of the Eugene washed clay. Excess clay could be used for refractories, or for alumina manufacture.

1. Fineness of 48-100, suggests A.F.A. grade of "FŚ" for medium sized iron foundry castings. Eugene sand compares favorably with similar sands. (see tables).

2. Bonding Strength. No test

3. Permeability. No test. Uniform grain size and sugangular grains suggest fair permeability.

4. Sintering Point. No test. Wilson & Treasher (38:65-66) tests show refractoriness of the material.

5. Durability. No test.

The high silica content of the sand (95.8 SiO_2 + 2.3 ignition loss, total 98.1 percent) and low iron suggest possibility of use as a glass sand for ordinary bottle glass and window glass.

We believe that these preliminary tests show enough promise to justify additional field and laboratory work, if facilities are provided.

Molding Sands (6)

702 Woodlark Building
Portland, Oregon

CHEMICAL TESTS

R. G. BASSETT

SAMPLES

Samples as received were of the sand and clay fractions of the original material. Untreated clay was not submitted for analyses. Pulp for assay of the sand was prepared by mixing weighted portions of each screen product. Analysis of the sand includes all substance retained on 100 mesh; analysis of the clay includes material obtained by washing and screening to minus 100 mesh. At the time it was found advisable to make preliminary tests none of the sample taken was abailable. However, since similar samples had been assayed in the past, further work at this time did not seem necessary.

Procedure

Since only comparative results were required, and since the samples themselves were taken and prepared without proper facilities for close work, it was thought best to spend a minimum of time on assaying. Methods were therefore used that, though tested and proved, were not as highly accurate as the usual exact silicate rock analyses. In spite of handicaps, careful attention was paid each detail. No attempt was made to determine the minor elements.

Data

Results of both past and present analytical work are tabulated together on the following form. The pit sample was analyzed by a private laboratory. (Wilson & Treasher 38:84).

Element		Pit Sample	Clay only	Sand only
Alumina	Al_2O_3	15.63	35.0	%
Silica	SiO_2	79.54	51.4	95.8
Ferric Oxide	Fe_2O_3	0.74	1.6	
Titanium Oxide	TiO	0.13		

702 Woodlark Building
Portland, Oregon

Molding Sands (7)

Lime	CaO	70.32		
Magnesia	MgO	0.31		
Ignition Loss		3.23		2.3
Totals		99.90	88.0	98.0

Silica, alumina, and ferric oxide in the unwashed-unscreened clay were not determined in the Grants Pass Laboratory, but were caluclated from the clay and sand data using a 36 to 64 ratio for these constituents. These data are compared with the pit sample analyses below:

Comparison of Calculated and Actual Analyses

Sample	Silica	Iron & Aluminum oxides
Clay*	18.5%	13.2%
Sand*	61.3	1.2
Total*	79.8	14.4
Pit	79.5	16.3

* Calculated percentage in original sample.

Note that the totals calculated from sand and clay check closely with the figures or the pit sample which was run as received. The pit sample was taken on the northeast side (Wilson & Treasher 38: 65-66) and the other on the west side of the deposit, a factor that would cause slight variation in results. It is to be expected that, some of the finer clay minerals have been lost in washing, the amount of alumina and iron found would be slightly low. In view of these conditions, better checks could not be expected.

702 Woodlark Building
Portland, Oregon

Visually, the residue from the determination of the silica in the sand appeared low in iron. An approximation, based on experience, would allow between 0.1 and 0.2 percent ferric oxide in the sand. Examined microscopically, the iron-bearing clay substance was seen to be attached putty-like to the quartz grains. Washing tests to determine the possibility of removing iron from the quartz would be desirable. Log washers or similar machines might be used to effect a cleaning, and their usefulness should be investigated.

Silica, calculated to an after ignition basis, assays 97.7 percent in the sand. The remainder is largely iron oxide and alumina, mostly the latter by a large margin. These quantities agree nicely with those of various glass sands. Compare this Eugene sand with the specifications from Ries 37:757, Table 6.

It would seem, from the known data, that the Eugene sand would make seventh quality glass sand with but the simplest washing. Scrubbing and more thorough cleaning should make a fifth or sixth quality product or better.

It was demonstrated by grinding in an agate mortar that the sand grains were extremely hard and tough. Pressure that would pulverize the usual rocks would not touch the quartz grains. This, coupled with the angular to subangular quality of the particles, indicates possible use as an abrasive sand.

SELECTED BIBLIOGRAPHY

Cole 23

Cole, L. Heber; Silica in Canada; its occurrence, exploitation, and uses: Canada, Dept. of Mines, Mines Branch, no. 555, pp. 27-29, 1923

Ries 37

Ries, H.; Special Sands; Industrial Minerals & Rocks; A. I. M. E., pp. 749-762, incl. bib., 1937.

Weigel 27

Weigel, W. M.; Technology and uses of silica and sand: U. S. Bur. Mines, Bull. 266, pp. 95-101, 1927.

Wilson & Treasher 38

Wilson, Hewett, and Treasher, Ray C.; Refractory clays of western Oregon: Oreg. Dept. Geol. & MineralIndustries, Bull. no. 6, pp. 65-66, 1938.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
Technical Publication No. 2058
Class H, Mining Technology, March 1947
DISCUSSION OF THIS PAPER IS INVITED. Discussion in writing (2 copies) may be sent to the Secretary, American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York 18, N. Y. Unless special arrangement is made, discussion of this paper will close June 1, 1947. Any discussion offered thereafter should preferably be in the form of a new paper.

Foundry Sand Produced Near Eugene, Oregon

By W. D. Lowry*, Junior Member AIME

(Los Angeles Meeting, October 1945)

As most of the industrial activity of Oregon is centered in the Portland area, the foundries there consume the bulk of the foundry sand produced in Oregon. Although a number of the larger towns scattered throughout the state have gray-iron foundries, the sand used by most of them is of local origin. The yearly consumption of foundry sand of all types for the past few war years in Oregon is estimated to have been approximately 40,000 tons valued at about $285,000, of which an estimated 18,000 tons was shipped in from the Ottawa, Ill., district for use largely by the steel foundries. Until 1945 much of the silica sand consumed by the steel foundries in the Pacific Northwest, approximately 50,000 tons in 1944, came from Ottawa, Ill. and surrounding regions. Although some silica sand was shipped in from Belgium in the past, none is known to have been imported in recent years. Early in 1945, a very promising high-grade silica sand being produced near Eugene, Oregon, was introduced, and all but two of the Portland steel foundries are using this new sand.

Until a few years ago, the search for good local (Oregon) foundry sands was carried on largely by the foundry supply houses. Recently the Oregon Department of Geology and Mineral Industries has investigated a number of deposits and has carried on and fostered research on the most promising deposit near Eugene, about 120 miles south of Portland. High-grade silica foundry sand from this deposit is now being marketed in Oregon, Washington, and British Columbia. The Eugene sand is one of the very few outstanding western steel-foundry sands.

Field investigations by the Oregon Department show that there are relatively few deposits of sand in Oregon suitable for foundry use. A knowledge of the geology of the state makes this readily understandable. The only major primary sources of the quartz present in sandstones in Oregon are the intrusive masses of granite, granodiorite, and quartz diorite of late Jurassic or early Cretaceous age found in the Siskiyou Mountains of southwestern Oregon, a part of the old Klamath Mountain highland, and in the Blue Mountains of northeastern Oregon.

Transportation militates against the development of any possible deposits of foundry sand found east of the Cascade Mountains in central and eastern Oregon because few railroads traverse that area. East of the Cascades, which separate western from eastern Oregon, many of the older sediments of Paleozoic and Mesozoic age have either been metamorphosed or contain much volcanic eruptive material, and even if some of the Mesozoic sediments are highly quartzose in places, they are in relatively inaccessible areas. All the Tertiary sediments there are of continental origin and contain much ash and other volcanic debris, for there was great volcanic activity during much of that period.

In western Oregon much the same is true of the Paleozoic and Mesozoic rocks

Manuscript received at the office of the Institute Nov. 12, 1945, revised Sept. 25, 1946.

* Associate Geologist, Oregon Department of Geology and Mineral Industries, Portland, Oregon.

Mountain highland following the emplacement of acid intrusives in Mesozoic time.

As deep weathering is common over most of western Oregon, many of the formations give rise to loose sand, but most of them contain a high percentage of feldspar, lava fragments, and tuffaceous material that cannot withstand the temperatures reached by steel foundries. Although a few of the more quartzose Tertiary sandstones are poorly cemented, they have been exposed to weathering so recently in geologic time that their clay content is too low to give the sand sufficient bonding strength for use as a natural molding sand. At the same time these sands contain too much feldspar for steel-foundry use. Thus far, only an upper Eocene sand near Corvallis and the Eugene sand of Oligocene age have been utilized to any great extent as molding sands in foundries.

Dune sands are common along the Oregon coast, and those near Florence (Fig 1) have been rather widely employed for making cores in foundries handling gray or cast iron or semisteel in Oregon and Washington. However, feldspar is the commonest mineral in most of the dune sands and the quartz content of only a few is more than 50 pct, and that of those along the northern Oregon coast is much less, for here they show contributions from sands being brought to the ocean by the Columbia River. The Columbia River sand carries an appreciable amount of magnetite derived from the lavas of the Columbia plateau.

Although highly quartzose sands usually are the only ones considered satisfactory for use in a steel foundry, some research has been done on crushed olivine sand.[1] However, because only the high-magnesia varieties of olivine ($(Fe, Mg)_2SiO_4$) are as refractory as quartz, and because they are relatively uncommon and largely from relatively inaccessible regions in the United States, the work has not led to any commercial use within the author's knowledge. Much of the breakdown of quartz sands used in steel foundries is due to thermal shock, which is caused by the various inversions and the accompanying volume changes experienced by the quartz grains. The use of crushed olivine sand for molding might eliminate this breakdown, although the olivine would need to be carefully sized to give the permeability required for certain types of foundry work. As Oregon is one of the few states in which olivine-rich rocks are common, it is possible that further field investigation will disclose a high magnesia olivine deposit near enough to good transportation facilities to become of commercial importance.

People not connected with the industry do not realize the importance of foundry sand in the casting of metals. Various grades of foundry sands are employed to make the multitudinous steel, iron, bronze, brass, aluminum, and magnesium castings. Many of the more progressive foundries have installed reclaiming units for the recovery of the sand grains that have not broken down. Others add new sand to that previously used, to bring it up to the required standard, but this necessitates the addition of much more new sand than is needed to replenish the fraction that would be removed by a reclaiming unit.

The Eugene Sand

Of the Oregon deposits shown on the index map (Fig 1), the Eugene sand is really outstanding and has great potential importance, especially for steel-foundry use. The Eugene sand is being produced by Silica Products, Oreg., Ltd., with headquarters in Portland, and the first shipments were made to Portland in January 1945. Since then, the sand has been employed by seven Oregon (six in Portland) and six Washington foundries. All but two of these are steel foundries, which

[1] References are at the end of the paper.

formerly used sand from the Ottawa, Ill., district or surrounding regions. The Eugene sand was able to displace the Ottawa sand during wartime, when cost of materials was of no particular importance and when management hesitated to make a change that might involve alterations in established foundry practices. Because of its outstanding qualities and economic advantages, it should find wider use in the future.

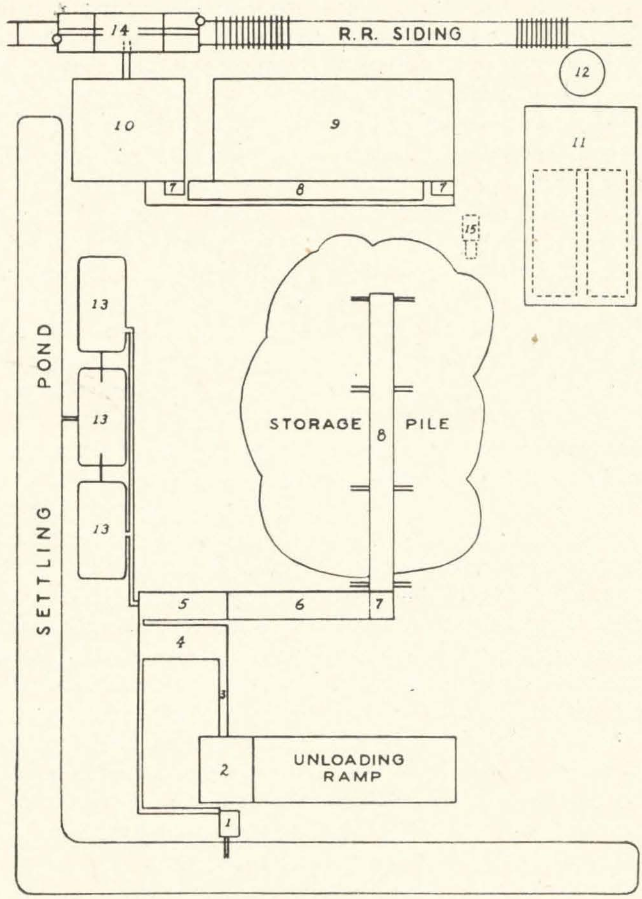


FIG 2—FLOWSHEET OF SILICA PRODUCTS, OREG., LTD. SAND PLANT.

1. Pump.
2. Hopper.
3. Conveyor.
4. Log washer.
5. Classifier.
6. Drag.
7. Bucket elevator.
8. Belt conveyor.
9. Steam drier.
10. Screens and bin.
11. Boiler house.
12. Coal silo.
13. Settling ponds.
14. Box car.
15. Scoopmobile.

The Silica Products' plant, financed by the Defense Plant Corporation at a cost of approximately $175,000, was designed and built by K. E. Hamblen, consulting engineer, and L. E. Bufton, construction engineer. The plant is about one mile north of the deposit, which is about 2 miles west of Eugene. The deposit makes up most of the low elongate hill known as Wallace Butte and can be reached via 11th Street. The deposit is the result of the intensive weathering of an Oligocene quartz-feldspar sandstone in which the feldspar has been converted to kaolin.

As the pit material is about two thirds quartz sand and one third fire clay with a minor amount of mica, it contains too much bond to be used as a natural molding sand. The clay is washed from the sand and collected in settling ponds. As the clay is refractory with a P.C.E. value above cone 31, it too may prove to be of considerable value. Although its buff color makes it unsuited for use as a paper filler, testing work is being done to determine a satisfactory market.

The washed sand, with only a trace of clay in the form of films on the grains, is shipped to the foundries, which bond it to suit their particular needs. Such synthetic foundry-sand mixes, made by adding a bonding agent or agents and sometimes silica flour to a sharp or clay-free sand, are displacing naturally bonded sands.

The raw sand is dug from the pit by dragline, loaded directly into trucks, and hauled 1½ miles to the plant, which is on the Coos Bay branch of the Southern Pacific Railroad. The flowsheet of the plant, which has a washing capacity of about 200 tons per 8-hr shift, is given in Fig 2. At the plant the sand is dumped directly into a hopper, from which it is conveyed to a log washer; there water is added and the material is beaten up and emulsified to a pulp density of approximately 50 pct. The conditioning time is important in effecting the proper separation of the clay from the sand grains. This is controlled manually by the operator by maintaining the proper proportion of feed and water. The overflow from the log washer falls directly into a launder and is carried by gravity to a large duplex Dorr classifier. Approximately 80 pct of the clay is removed by the classifier and is carried in the overflow through launders to the settling ponds. The sand passes directly from the classifier into a 50-ft sand drag, where the remainder of the free kaolin is removed in the overflow. Water consumption is approximately 1200 gpm at plant capacity. An adequate water supply was developed with the digging by means of dragline, tractor, and carry-all of an L-shaped pond, with a total length of 1330 ft and a water storage capacity of 7 million gallons. The gravel as excavated was wasted on the plant site proper to form a fill 6½ ft higher than the surrounding land, placing the plant site well above danger of flood water. In all, approximately 100,000 yd of gravel was excavated and deposited on the pile at a cost of about $15,000.

The partially dewatered sand is lifted by bucket elevators to a 160-ft belt conveyor mounted horizontally on a trestle over a concrete slab. The washed sand is dumped into piles on the slab, where the sand drains to approximately 12 pct moisture under normal weather conditions.

From the open stock pile, the sand is transported by Scoopmobile to a bucket elevator, which lifts it to a belt conveyor over the top of a steam drier with a capacity of about 6 tons per hour. The dried sand is removed from the drier by a series of pan feeders and is dumped directly onto a belt conveyor, from which it is elevated to the screen house, where oversize foreign material is screened out. The screened sand falls directly into bunkers and flows from them by gravity into cars on the railroad siding.

The original plans for the plant called for generation of steam with fuel oil but war restrictions necessitated the installation of coal-burning facilities. The coal used has a rating of about 9000 Btu and costs $7 per short ton delivered. The cost of the fuel for drying is estimated at 40¢ per ton. The cost of the Eugene municipal electric power consumed is less than 10¢ per ton of finished product.

History of the Deposit

The Eugene deposit was first described in 1923, in a report by Paul W. Cook,[2] a student of geology at the University of

Oregon, while the deposit was formerly being worked. The raw sand from the pit was then used in the manufacture of a No. 2 grade firebrick but the deposit lay idle for a number of years before the present operators acquired it in 1943. Although the raw sand has been used at various times by gray-iron foundries, its high clay content makes it rather unsatisfactory. (However, a blend of the raw and washed sands should make a satisfactory mixture for molding gray iron.)

In 1938, Ray C. Treasher, geologist with the Oregon Department of Geology and Mineral Industries, investigated the deposit, and in a preliminary report in collaboration with Hewitt Wilson, of the U. S. Bureau of Mines, on some of the refractory clays of western Oregon[3] suggested washing the sand for use in making glass and for molding in steel foundries. Additional investigation by Treasher, and a later report by him[4] in 1943 dealing only with the Eugene deposit, led to an actual foundry test at the Electric Steel Foundry for Messrs. Hamblen and Bufton, the present operators. The Electric Steel Foundry reported that the castings made with the Eugene sand were fully as good as those made with the Ottawa sand, but the life of the Eugene sand under repeated use was questioned. In order to determine its durability, tests were conducted at the Crawford and Doherty foundry, Portland, by the writer and Ralph Mason, also of the Oregon Department. The results obtained were quite satisfactory, as shown in Fig 3. These results were published and copies of this report[5] and a later memorandum[6] by the writer were sent to most of the Portland foundries.

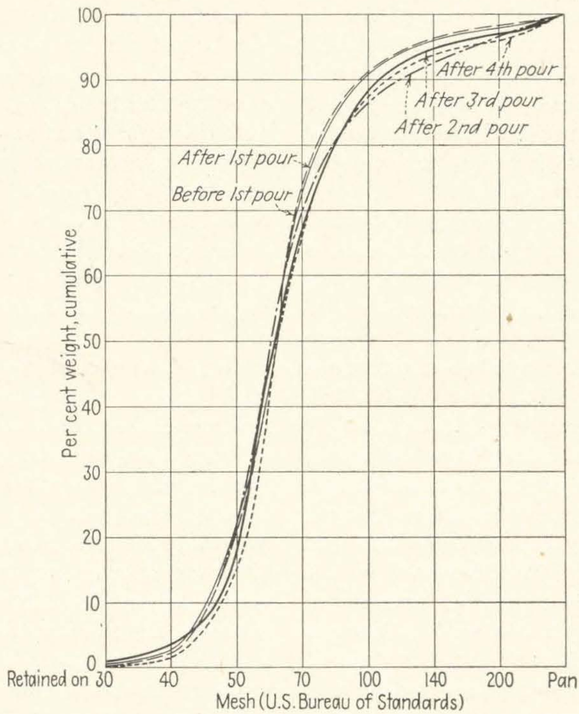


FIG 3—COMPARATIVE DISTRIBUTION CURVES OF EUGENE SAND BEFORE AND AFTER FOUR SUCCESSIVE POURINGS AT 2700°F, CRAWFORD AND DOHERTY FOUNDRY, PORTLAND, OREGON.

War Minerals Report 199 was issued in 1944 by the Bureau of Mines,[7] whose drilling in the latter part of 1943 proved several hundred thousand tons of Eugene sand of uniform grade. On the basis of the encouraging results obtained from the various tests, and upon the suggestion of H. Ries (communication to author) and the Oregon Department of Geology and Mineral Industries, further foundry tests were made by the Naval Research Laboratory, Washington, D.C.[8] These tests showed the Eugene sand to be very satisfactory and strikingly similar to one of the leading New Jersey steel-foundry sands.

In May 1945, a memorandum report[9] was issued by the Oregon Department on the casting results obtained with the Eugene sand under repeated use by the Oregon Steel Foundry in Portland.

Geology of the Deposit

As first pointed out by Cook in 1923, the Eugene sand is a residual deposit formed by the weathering of an indurated sandstone in the Eugene formation of Oligocene age. A similar clay and sand deposit, known as the Hawkins locality, occurs about one mile to the southeast. However, the Hawkins deposit contains some undecomposed feldspar grains and compound sand grains, which indicate that it has not been so thoroughly weathered. This is also indicated by its somewhat lower clay content. The probable equivalent parent rock of these sand deposits crops out near the top of the hill immediately south of the Hawkins locality. It is an indurated, massive, light-colored, quartz-feldspar sandstone.

Reconnaissance geologic mapping by the writer in the southern part of the Eugene quadrangle indicates that these sands occur at or near the base of the Eugene formation, where they disconformably and possibly unconformably overlie the Fisher formation of older Oligocene or Upper Eocene age. Both strike approximately northwest and dip several degrees to the northeast. The presence of fossil wood near the contact with the underlying tuff breccias of the Fisher formation, as well as field relationships, indicates that these sands were laid down when the Eugene (Oligocene) sea first invaded the region. The uniform grain size of the sand suggests that it may have been derived from near-by older sandy formations such as the Spencer or Tyee of Eocene age, which in turn were derived probably from the old Klamath Mountain highland. Such reworking, plus possible transportation by wind to form dunes, as suggested by field observations, may explain the unusually uniform grain size of the Eugene sand.

Characteristics of Eugene Sand

The properties of the Eugene sand for steel-foundry use are somewhat similar to those of the Ottawa sand. However, as pointed out in the report by the Naval Research Laboratory, Washington, D.C., the Eugene sand is strikingly similar in fineness and other properties to a sand from the Millville, N. J., area, which is used extensively by steel foundries in the East Coast region. The A.F.A. fineness number of the Eugene sand given in that report is 52.5 and that of the Millville sand, 52.4. The Eugene sand is somewhat finer than the Ottawa Fed. 17 grade, which was commonly employed formerly by most Pacific Northwest steel foundries; and, as further noted in that report, both the Eugene and the Millville sands are even somewhat coarser than the average sand used for steel moldings in eastern foundries.

The trend of foundry practice in the East appears to be toward the employment of finer sand. In spite of its somewhat finer grain size, the permeability of the Eugene sand is nearly equal to or greater than that of Ottawa Fed. 17. This is attributable to its greater uniformity of grain size, as illustrated in Fig 4. Ottawa

Fed. 17 is a product of screening whereas the Eugene sand is naturally graded and does not require screening. This surprising uniformity of the grain sizes of the Eugene

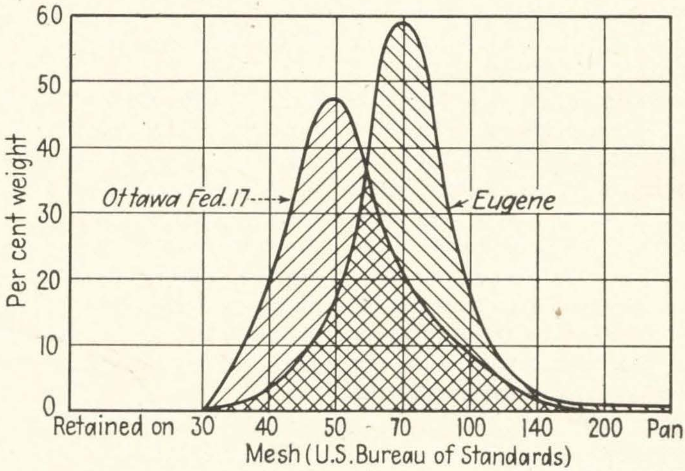


FIG 4—COMPARATIVE DISTRIBUTION CURVES OF EUGENE AND OTTAWA FEDERAL 17 SANDS.

sand is its outstanding characteristic. As permeability is directly related to porosity, the high permeability of the Eugene sand is suggested by the fact that a ton of Eugene sand has about one fifth greater volume than the Fed. 17 grade of sand from the Ottawa, Ill., district.

Unlike the grains of the Ottawa Fed. 17 sand, which tend to be rounded, those in the Eugene deposit are subangular and like those of leading eastern sands. Advantages of the Eugene sand over the Ottawa Fed. 17 are that it permits the use of a finer sand without loss of permeability, which makes for cleaner castings, and it makes a stronger mold, as its subangular grains tend to interlock whereas the Ottawa sand grains do not. Actual measurements gave greater strength for the Eugene sand, and its dry shear strength, which probably is most important, was more than twice as great as that of the Ottawa. The partial film of clay left on some of the Eugene sand grains after washing may be partly responsible for its greater strength. Not only is the actual strength of molds made with Eugene sand greater, but, as pointed out by both the Naval Research Laboratory report and by the Oregon Steel Foundry, the Eugene sand has great hot strength. When a silica foundry sand is subjected to the temperatures at which steel is poured, the quartz grains experience inversions accompanied by volume changes. A mold made with a subangular sand, such as the Eugene, is thought to change less in volume than one made with a rounded sand, as adjustment by slight rotation of the grains is possible in a subangular sand. In addition, the grains of a subangular sand, by their very shape, are better suited than rounded ones for absorbing the thermal shock resulting from the volume changes.

Foundry Results

The first full-scale foundry tests on the Eugene sand were made by the Oregon Steel Foundry under the direction of Roy Simpson, who deserves much of the credit for the rapid adoption of the Eugene sand by other foundries. The Eugene sand has been in continuous use by the Oregon Steel Foundry since March 1, 1945. It is used for making both molds and cores.

The foundry reports that, roughly speaking, considering both large and small castings of types, those made with Eugene sand require 30 to 40 pct less cleaning time than those formerly made with Ottawa sand. On a blank casting for a 13,000-lb steel gear made with Eugene heap sand, the cleaning time was about 2 hr as against at least 10 hr with those made with Ottawa. The direct labor costs in finishing several hundred of these large castings was $20.10 per casting with Ottawa Fed. 17 and $9.13 with Eugene. Savings on other castings are comparable. The foundry also notes that the Eugene sand comes off castings more easily, leaving them cleaner, so that flaws can be detected more readily.

Molders at the Oregon Steel Foundry say that they like the Eugene better than any sand they have ever used for steel molding because it can stand more heat in drying and more abuse. They say that the Eugene sand has greater strength than the Ottawa and requires fewer nails, and that they no longer use bottom boards when rolling the molds over, even those measuring as much as 5 ft in diameter.

In regard to the life of the Eugene sand, the Oregon Steel Foundry reports that it adds 30 to 35 pct less new Eugene sand after repeated use than it formerly had to add to Ottawa sand. Only rarely is new sand added to the heap sand, even for facing the molds. As pointed out by Simpson, who is now with Pacific Steel Foundry in Portland, the common practice of using new sand for facing is unwise if the heap sand has the necessary permeability and strength.

The only new Eugene sand added to the circuit at Pacific Steel Foundry is that introduced from the core room. Figures at Pacific Steel show that for each ton of castings produced, 0.15 ton Eugene sand is consumed, whereas formerly 0.2 ton of Ottawa sand was used—a saving of 25 pct with Eugene sand. Since changing from Ottawa to Eugene sand, the foundry has been able to eliminate nails on all mold surfaces, regardless of size. The Eugene sand has proved highly satisfactory for blowing cores and is preferred to Ottawa by Pacific Steel because high-production small cores made with Eugene sand dry in their limited oven space in 1½ hr whereas Ottawa cores require 2½ hr (450°F). Proportional savings in drying time are made on larger cores.

Casting results similar to those being obtained by the Oregon Steel and Pacific Steel foundries are being reported by other steel foundries as well as some gray-iron foundries using Eugene sand.

Economics

Although the Eugene sand has not entirely displaced that being brought into the Pacific Northwest from outside, the prospects for its continued use there are favorable. In carload lots Ottawa sand sells in Seattle, Portland, and San Francisco for $9.84 a short ton. The Eugene sand is being marketed in Portland at $8.75 a short ton, in Seattle at $9.00, and it may be obtained in San Francisco for $9.25. As foundry sand is used on a volume basis, the comparative cost of the Eugene sand is actually even less, as a ton of it has about one fifth greater volume. Figured on this volume basis, the cost of the Eugene sand would be approximately $7.30 in Portland, $7.50 in Seattle, and $7.70 in San Francisco. The operators may be able to lower the present price of the Eugene sand when greater quantities are sold, for the production costs per ton are now relatively high. Utilization of the clay being collected may aid in this desired reduction.

As has been pointed out, the lower initial cost of the Eugene sand is only one of its advantages over Ottawa sand. Less Eugene sand is consumed because of its longer life. Its high permeability, somewhat finer grain size, much greater dry shear strength, and excellent refractory qualities and hot strength result in cleaner castings, which require much less cleaning time. The Eugene sand is easier to mold and very little, if any, new facing sand need be used. Molds made with Eugene sand can stand more abuse in handling and dry faster, and because of their greater strength most castings can be poured hotter.

Although no accurate figures on the savings made by using Eugene sand could be obtained from the Oregon Steel Foundry because of the difference in the types and sizes of castings made over comparable periods of time, it appears that the savings effected might well pay for much of the sand used.

References

1. O. C. Ralston and Others: Use of Olivine as a Foundry Sand. U. S. Bur. Mines *R. I.* 3427 (1938).
2. P. W. Cook: A Preliminary Report on the Geology and Economic Geology of the Wallace Butte Quartz Sand Deposit, Lane County, Oregon; an Appendix to A Preliminary Report on the Geology of the Eugene Quadrangle, Oregon, by H. G. Schenck, master's thesis, University of Oregon, 1923.
3. H. Wilson and R. C. Treasher: Preliminary Report on Some of the Refractory Clays of Western Oregon, *Bull.* No. 6, Oregon Dept. of Geol. and Min. Ind. (1938).
4. R. C. Treasher: Preliminary Report on a Possible Molding or Glass Sand. Oregon Dept. of Geol. and Min. Ind., 1943. Unpublished.
5. W. D. Lowry, and R. S. Mason: Eugene Sand Foundry Tests. Oregon Dept. of Geol. and Min. Ind. (Oct. 1943).
6. W. D. Lowry: Memorandum on Steel Foundry Sand at Eugene, Oregon. Oregon Dept. of Geol. and Min. Ind. (1944).
7. Silica Sand Deposits in the Eugene Area, Lane County, Oregon, U. S. Bur. Mines *War Minerals Report* 199 (1944).
8. Memorandum Prepared by the Bureau of Ships, Navy Dept., for the Oregon Dept. of Geol. and Min. Industries.
9. W. D. Lowry: Eugene Silica Sand Casting Results Obtained by the Oregon Steel Foundry, Portland, Oregon, May 1945.

EUGENE SILICA SAND CASTING RESULTS

OBTAINED BY OREGON STEEL FOUNDRY, PORTLAND, OREGON*

Silica foundry sand is being produced from a deposit near Eugene, Oregon, by Silica Products, Oreg., Ltd., Portland. The Oregon Department of Geology and Mineral Industries has previously made several reports** on this sand and the object of the present report is to describe present casting results, using Eugene silica sand, which are being obtained by the Oregon Steel Foundry, Portland, Oregon.

Plate 1 shows a 13,000-pound steel gear blank with gates and shrink heads made with Eugene heap sand after the molding sand has been knocked off. About 40 pounds of silica flour had to be added to about 1,000 pounds of Eugene heap sand (which had been in the circuit for about 8 weeks) to bring the permeability down to the desired point.

Plate 2 shows the bottom side of another gear blank of the same type and size (made with Eugene heap sand after cleaning). With shrink heads and gates removed, this casting weighs approximately 6,000 pounds. According to Mr. Al Usinger, cleaning supervisor, cleaning time on these castings made with Eugene sand was "about 2 hours" as compared with "at least 10 hours for Ottawa."

Plate 3 shows a collection of miscellaneous steel castings made with Eugene heap sand. Mr. Usinger states, "Roughly speaking, taking both large and small castings of all types, those made with Eugene sand save from 30 - 40 percent in cleaning time compared to castings made with Ottawa sand." In addition to the cleaning time saved, Mr. Usinger declares, "The Eugene sand comes off so much easier and cleaner that you can see any flaws in the casting, whereas burned-in sand obscures these flaws so that they cannot be seen." This according to Mr. Usinger is one of the most important advantages of Eugene sand. He states also, "A rough casting (made with Eugene sand) that has not been sand-blasted appears about the same as a cast-iron one."

---

* Memorandum Report by Wallace D. Lowry, Oregon Department of Geology and Mineral Industries, May 3, 1945.

** 1. Treasher, Ray C., Preliminary report on a possible molding or glass sand, Oregon Department of Geology and Mineral Industries, 1943, unpublished.

2. Lowry, W. D., and Mason, R. S., Eugene sand foundry tests, Oregon Department of Geology and Mineral Industries, 1943.

3. Memorandum on steel foundry sand at Eugene, Oregon, Oregon Department of Geology and Mineral Industries, 1944.

4. The Eugene Silica Foundry Sand, THE ORE.-BIN, vol. 7, no. 2., February 1945.

The Oregon Steel Foundry has had a 50-ton carload of Eugene silica sand in its circuit since March 1. The sand makes one complete circuit each day. The only new sand added to the circuit has been a small amount needed to replenish that lost mechanically. Mr. Roy Simpson, foundry superintendent, reports, "We have had to add less new Eugene sand after continued use than we had to add to Ottawa sand." He states, "The permeability of the Eugene sand dropped after 3 or 4 days' use from 200 to between 190 and 180 and continued to drop very rapidly to a low of about 170 within the first week. Since then it's built up to between 170 and 180 where it has remained. We find that's not too low for heap backing sand and it works out very well. We haven't had the least bit of trouble with Eugene sand since we started using it."

Eugene sand is being used for making both cores and molds. Only Eugene heap sand is now used for molding. Simpson says that rarely is any new sand added to the facing. As already pointed out the castings shown in the photographs were made with heap sand.

In regard to molding properties of Eugene sand, Mr. H. M. Schiewe, head molder, says that he likes it better than any other sand he has seen for steel molding. Schiewe says, "It is more rubbery and feels like there is more binder in it." He also reports, "Eugene sand has greater strength and requires fewer nails than Ottawa and that the Eugene sand does not burn-in nearly as bad." Schiewe declared, "The Eugene sand can stand more heat in drying and more abuse than any sand I have ever used." He reports that they no longer use bottom boards when rolling molds, even for molds measuring 5 feet in diameter or 6 feet long by 2 feet wide.

Mr. Simpson states, "I did not tell the molders about the new (Eugene sand) for three weeks, fearing that they would be skeptical and would not give it a fair trial." Then when he asked one of the molders how he liked it, the molder replied, "I was wondering what the matter was - thought I was getting to be a better molder."

The properties of the Eugene sand mix used by the Oregon Steel Foundry for casting large gear blanks such as those shown in the accompanying photographs are about as follows:

Permeability	100
Moisture	5 - 5.2 %
Green compression strength	11 - 12
Mold hardness	80 - 85

For a green sand mix for making light castings the properties are about:

Permeability	120 - 130
Moisture	3.5 %
Green compression strength	5.5 - 6.5
Mold hardness	70

Water is first added to the heap sand and then bond and silica flour are added until the desired properties are obtained. A previous article on the Eugene sand* included a report by Mr. Simpson on tests which his foundry conducted. In that report he gave the Eugene sand mixture which they used in pouring a 10,000-pound gear blank. In regard to pouring temperatures, Mr. Simpson reports, "The refractory qualities of the Eugene sand are so good that most castings can be poured far hotter than usual - it is thermally more stable and has great hot strength."

It is pointed out by Mr. Simpson that an additional saving is made in using Eugene sand, as a ton of this sand has about one-fifth greater volume than the steel foundry sand formerly used and thus more molds may be made with the Eugene sand. This greater volume points to the greater permeability of the Eugene sand which was described by one of the molders, who said that the men doing the pouring liked the Eugene sand better because it is "more open."

The Oregon Department of Geology and Mineral Industries wishes to express thanks and appreciation to Mr. Roy Simpson, superintendent, and all other employees of the Oregon Steel Foundry who have so willingly contributed the information contained in this memorandum, and also for the opportunity of being present at the pouring of one of the 13,000-pound gear blanks.

---

* Op. Cit. (THE ORE.-BIN)

EUGENE SAND FOUNDRY TESTS

W. D. Lowry and R. S. Mason

Introduction:

The sand used in this series of tests was washed from the north bank of the old Eugene Fire Clay Products Company pit located in Lane County in the NE$\frac{1}{4}$ sec. 34, T. 17 S., R. 4 W., approximately three miles west of Eugene. This deposit is described in R. C. Treasher's "Preliminary Report on a Possible Molding or Glass Sand," Oregon Department of Geology and Mineral Industries, 1943, unpublished. In this report, he states that the bank material at this pit contains approximately 35% clay and 65% quartz sand with a minor amount of mica, and was used in the manufacture of no. 2 refractory brick. Sand for this test was washed from bank material by hand and was not screened.

The following data were compiled from the foundry tests made at Crawford & Doherty Foundry, Portland, Oregon, from October 7 to 11, 1943. Crawford & Doherty's plant is a semi-steel foundry; their product is known as "Meehanite."

The purpose of these tests was to determine the durability of this sand. To accomplish this, the sand was subjected to a series of pourings of a semi-steel (55% steel rail) casting made at a temperature of 2700° ∠ F. Samples of the sand were taken before and after each pouring. The sample selected after each pouring was taken from that part of the facing sand which was thought to have been subjected to the greatest heat and stress. The A.F.A. clay was removed from each sample and the material then screened. The accompanying record sheets show the various mixes used, their properties, the screen analyses and accompanying graphs of the sand before and after each pouring made. Miscellaneous information is also included. The tests were discontinued when someone on the foundry night shift unknowingly mixed the sand being tested with the regular foundry heap sand.

Properties of the sand:

Chemical analyses:

(1) R. G. Bassett (from Treasher's report)

SiO_2	95.8 %
Ignition loss.	2.3 %
	98.1 %

(2) L. L. Hoagland (Assayer, Oregon Department of Geology)

A.F.A. clay and plus 30 mesh fraction removed before analyzing - Sample No. P-1767.

SiO_2	96.39 %
H_2O	1.3 %
	97.69 %

Spectrographic analysis (by H. C. Harrison, Oregon Department of Geology):

Sample No. P-1829; Spectrographic Laboratory No. 773.
(A.F.A. clay and plus 20 mesh fraction removed.)

QUALITATIVE SPECTROGRAPHIC ANALYSIS
(Quantities estimated to nearest power of ten)

Elements present in concentrations over 10%.
Silicon

Elements present in concentrations 1% - 0.1%
Iron, Aluminum, Titanium

Elements present in concentrations 0.1% - .01%
Zirconium, Calcium, Magnesium

Petrographic analysis (by W. D. Lowry, Oregon Department of Geology):

The various sieve fractions of this sand were examined petrographically. The following paragraph summarizes its character:

The sand is made up predominantly (about 96%) of subangular to angular grains of quartz whose surfaces are somewhat frosted. The plus 40 mesh (U.S. Bur. Standards) fractions (1.5 ∠ %) are dominantly aggregate grains composed almost entirely of subangular grains of quartz approximately 0.4 mm in diameter, cemented together with clay. The grains of the smaller sieve fractions (minus 100 mesh) tend to be angular. Of the quartz grains, from 3 to 7% (probably about 6%) are either strained, cracked, or aggregate. Some of the surfaces of the quartz grains are partially coated with a thin film of clay. About 4% of the sand is chalcedonic aggregates; the minus 70 mesh (U.S. Bur. Standards) sieve fractions have a higher percentage of chalcedonic grains. Mica flakes constitute less than 1% of the total.

Screen analysis:

Approximately 1500 lbs. of Eugene sand was sampled. Fifty grams was dried, the A.F.A. clay removed, and the sand redried before screening.

Size (U.S. Bur. Standards)	Weight	Percent	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	0.00 g.	0.00 %	0.00 %	0.00 %
" " 30 "	0.10	0.20	0.21	0.21
" " 40 "	0.83	1.66	1.79	2.00
" " 50 "	8.66	17.32	18.71	20.71
" " 70 "	23.73	47.46	51.23	71.94
" " 100 "	8.82	17.64	19.09	91.03
" " 140 "	2.33	4.66	5.04	96.07
" " 200 "	0.83	1.66	1.79	97.86
Pan	0.99	1.98	2.14	100.00
	46.29 g.	92.58 %	100.00 %	
A.F.A. clay	1.75	3.50		
Loss (drying & screening)	1.96	3.92		
	50.00 g.	100.00 %		

EUGENE SAND FOUNDRY TEST

Pour No. 1 October 8, 1943

Type of casting:

96 lb. armature-spider cast by Crawford & Doherty for Marine Electric Co. The casting is 55% steel (steel rail) poured at about 2700°F.

Number of casting:

1 and 2

Mix used*:

Eugene sand.	600 lbs.
Water.	24 lbs.
Bentonite.	30 lbs.

*This mixture has too much "body," due to excess bentonite.

Properties of mix:

Moisture*.	6.2%
Green permeability	165
Green compression strength**	8.6

*Sand as furnished contained approximately 2% moisture.
**No green shear or tensile values were measured as their ratio to the green compression strength for practical purposes is said by H. Ries to remain fairly constant.

Molding characteristics:

The pattern used was made of 3 pieces. These fitted together very poorly and the surface of the pattern was in several places quite rough as some poorly fitting cardboard lagging had been used. The molder said the above mix was "easy to work and required no nails." The molder rammed this mix the same way he was accustomed to ramming the sand commonly used by the foundry - a sand of much lower permeability. The character of the casting later proved that the sand had not been rammed hard enough.

Pouring characteristics:

Poured quietly.

Remarks:

The casting was poor, very rough. The breakaway of the sand from the casting was poor. Lack of ramming permitted metal to run into the facing sand.

EUGENE SAND FOUNDRY TEST

Pour No. 1 (cont.)

Screen analyses*:

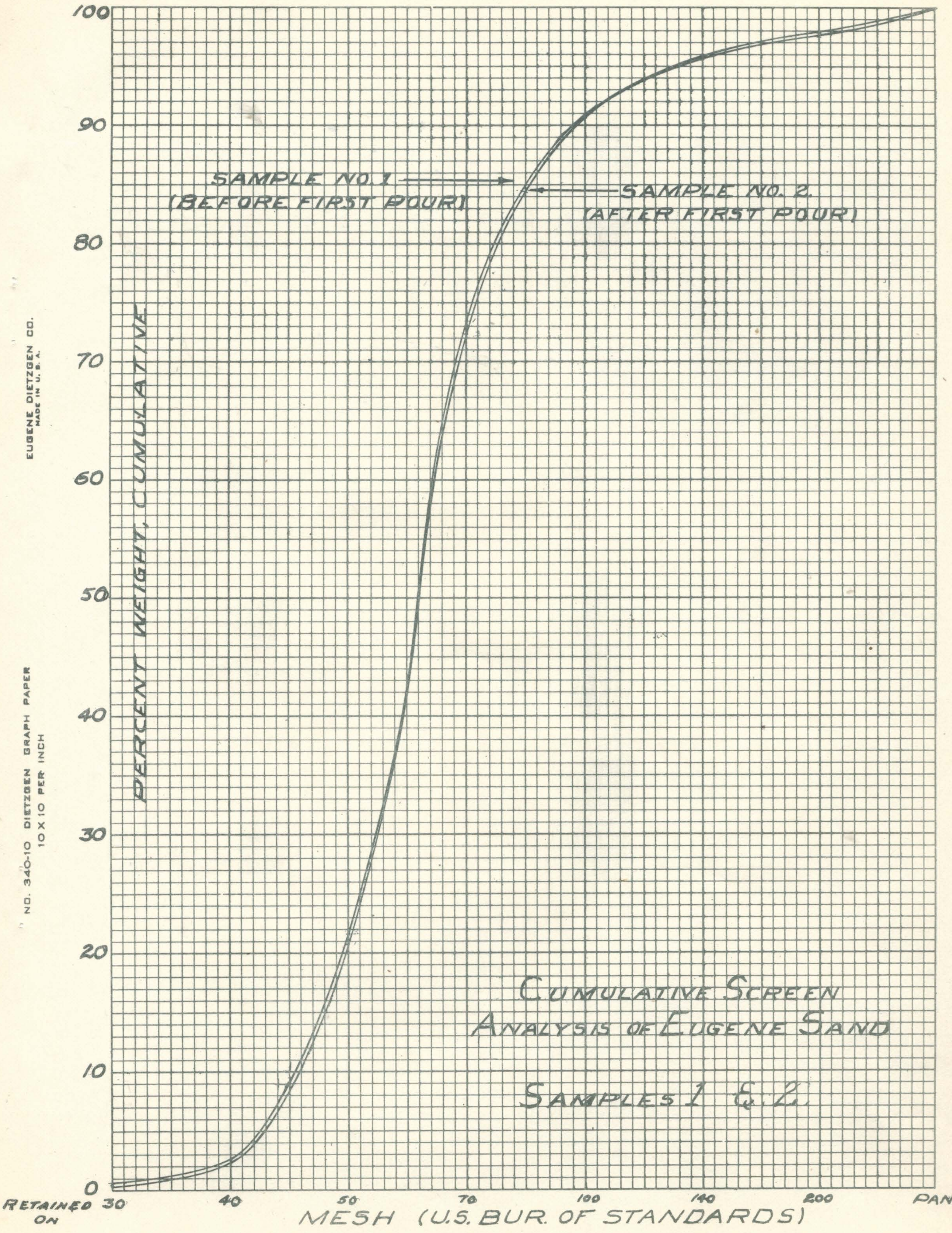
Sample No. 1
(Original mix)
A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.285 g.	.64 %	.64 %
" " 40 "	.715	1.61	2.25
" " 50 "	8.270	18.62	20.87
" " 70 "	23.400	52.61	73.48
" " 100 "	7.780	17.49	90.97
" " 140 "	2.120	4.64	95.61
" " 200 "	.835	1.87	97.48
Pan	1.120	2.52	100.00
	44.525 g.	100.00 %	
A.F.A clay (10.550%)	5.275		
	49.800 g.		

Sample No. 2
(Sand from facing of casting no. 1, first pour)
A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.324 %	.324 %
" " 30 "	.170	.366	.690
" " 40 "	.865	1.864	2.554
" " 50 "	9.190	19.140	21.694
" " 70 "	23.325	50.670	72.364
" " 100 "	8.460	18.390	90.754
" " 140 "	2.425	5.230	95.984
" " 200 "	.900	1.920	97.904
Pan	.975	2.096	100.000
	46.460 g.	100.000 %	
A.F.A. clay (5.840%)	2.920		
	49.380 g.		

* For comparative curves of these screen analyses see plate following page 4.



100
90
80
70
60
50
40
30
20
10
0
PERCENT WEIGHT, CUMULATIVE
SAMPLE NO. 1
(BEFORE FIRST POUR)
SAMPLE NO. 2
(AFTER FIRST POUR)
CUMULATIVE SCREEN
ANALYSIS OF EUGENE SAND
SAMPLES 1 & 2
RETAINED ON
30
40
50
70
100
140
200
PAN
MESH (U.S. BUR. OF STANDARDS)

EUGENE SAND FOUNDRY TEST

Pour No. 2 October 9, 1943

Type of casting:

96 lb. armature-spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

3

Mix used:

Sand recovered from first pour. No new bond added. Water added which brought moisture up to 9%.

Properties of mix:

Moisture 9%
Green permeability 85
Green compression strength . 10.1

Molding characteristics:

Sand was rammed much harder. Molder says, "too wet." Mold, after pattern was removed, looked rough in places due to inadequate ramming.

Pouring characteristics:

Poured quietly.

Remarks:

Character of casting no. 3 fair, much improved over nos. 1 and 2. After removal from rattler mill, casting was quite smooth. The sand broke away from the casting better than from casting nos. 1 and 2.

EUGENE SAND FOUNDRY TEST

Pour No. 2 (cont.)

Screen analyses*:

Sample No. 3

(Sand used for casting no. 3 - previously used once - before pouring)
A.F.A. clay removed from 50 g. dried sample before screening.

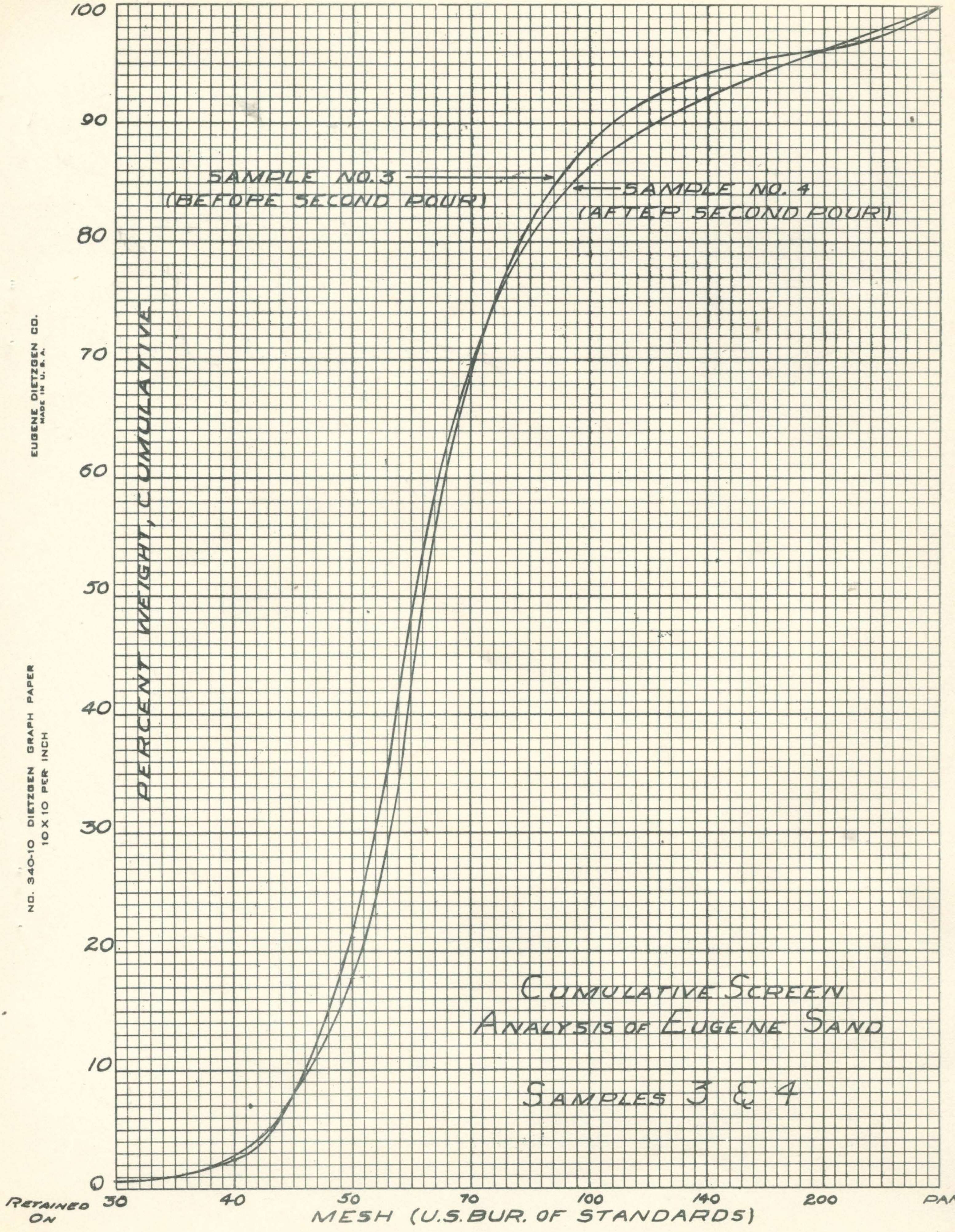
Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.205 g.	.460 %	.460 %
" " 30 "	.185	.420	.880
" " 40 "	.605	1.372	2.252
" " 50 "	6.875	15.610	17.862
" " 70 "	22.435	50.894	68.756
" " 100 "	8.650	19.635	88.391
" " 140 "	2.520	5.720	94.111
" " 200 "	.935	2.121	96.232
Pan	1.660	3.768	100.000
	44.070 g.	100.000 %	
A.F.A. clay (10.520%)	5.260		
	49.330 g.		

Sample No. 4

(Sand used for casting no. 3 - previously used twice - after pouring, taken from face of casting)
A.F.A. clay removed before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.328 %	.328 %
" " 30 "	.180	.394	.722
" " 40 "	.795	1.706	2.428
" " 50 "	8.525	18.600	21.028
" " 70 "	22.325	48.600	69.628
" " 100 "	7.910	16.640	86.268
" " 140 "	2.755	5.840	92.108
" " 200 "	1.195	4.092	96.200
Pan	1.730	3.800	100.000
	45.565	100.000 %	
A.F.A. clay (8.50%)	4.250		
	49.815 g.		

* For comparative curves of these screen analyses see plate following page 6.



100
90
80
70
60
50
40
30
20
10
0
PERCENT WEIGHT, CUMULATIVE
SAMPLE NO. 3
(BEFORE SECOND POUR)
SAMPLE NO. 4
(AFTER SECOND POUR)
CUMULATIVE SCREEN
ANALYSIS OF EUGENE SAND
SAMPLES 3 & 4
RETAINED ON
30
40
50
70
100
140
200
PAN
MESH (U.S. BUR. OF STANDARDS)

EUGENE SAND FOUNDRY TEST

Pour No. 3 October 11, 1943

Type of casting:

96 lb. armature-spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

4

Mix used:

150 lbs. sand from second pouring
150 lbs. sand from first pouring
(left over as only one casting poured second day)
15 lbs. sea coal
Water added which brought moisture up to 6.8%

Properties of mix:

Moisture	6.8%
Green permeability	112
Green compression strength .	8.6

Molding characteristics:

Too hard to ram well as result of excessive bentonite at above moisture content.

Pouring characteristics:

Poured quietly.

Remarks:

Character of casting no. 4 improved over no. 3 but still rough in places. Sand broke away from the casting a little too hard. Foundryman said casting no. 4 "somewhat improved."

EUGENE SAND FOUNDRY TEST

Pour No. 3 (cont.)

Screen analyses*:

Sample No. 5

(Sand used for casting no. 4, before pouring - half of this sand previously used once; half, twice)
A.F.A. clay removed from 50 g. dried sample before screening.

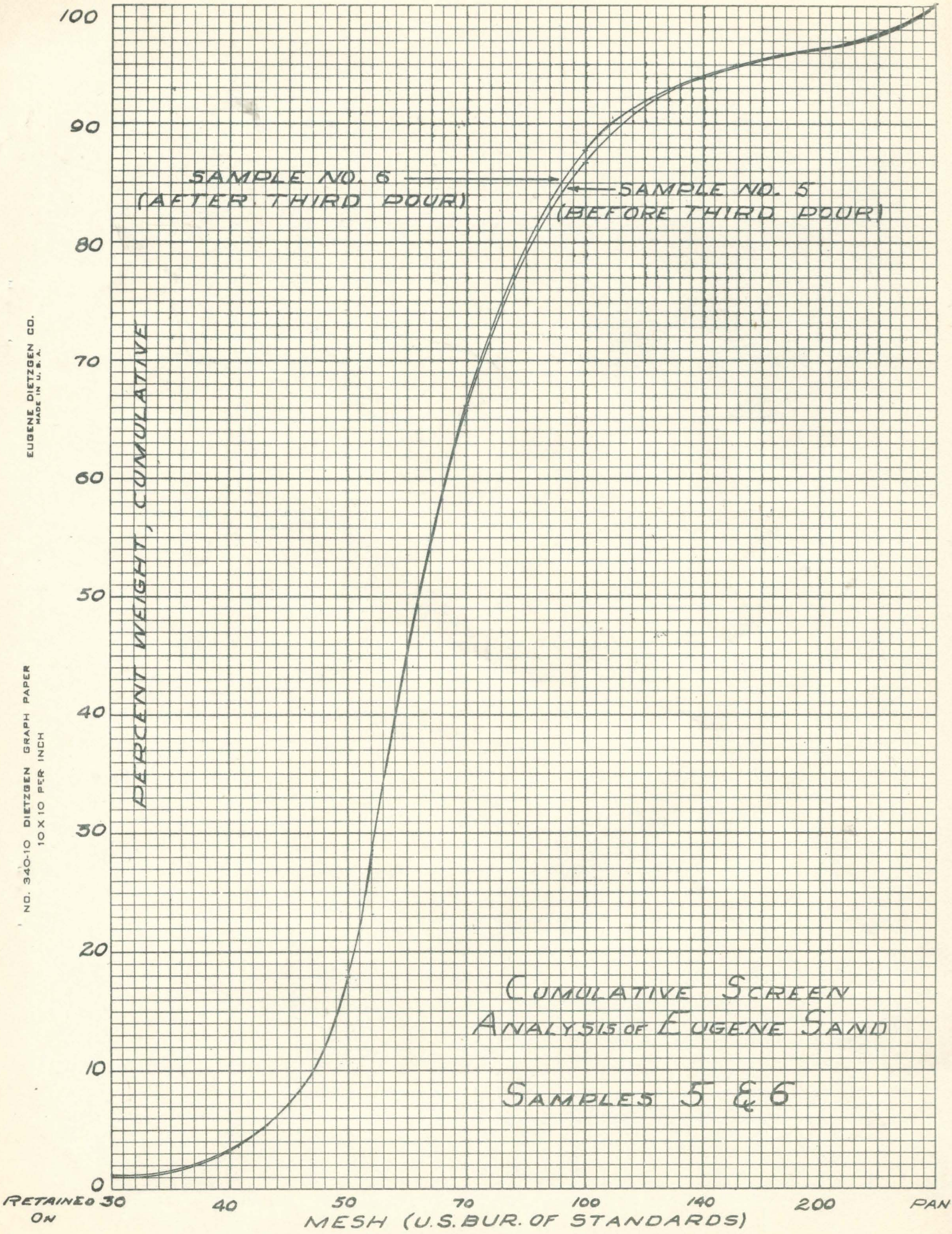
Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.215 g.	.488 %	.488 %
" " 30 "	.300	.684	1.172
" " 40 "	.805	1.832	3.004
" " 50 "	6.790	15.450	18.454
" " 70 "	21.410	48.776	67.230
" " 100 "	9.055	20.630	87.860
" " 140 "	2.675	6.080	93.940
" " 200 "	1.025	2.280	96.220
Pan	1.660	3.780	100.000
	43.935 g.	100.000 %	
A.F.A. clay (12.10%)	6.050		
	49.985 g.		

Sample No. 6

(Sand used for casting no. 4, after pouring, taken from face of casting - half of this sand previously used twice; half, used 3 times)
A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.185 g.	.420 %	.420 %
" " 30 "	.375	.852	1.272
" " 40 "	.860	1.956	3.228
" " 50 "	6.495	14.750	17.978
" " 70 "	21.485	48.864	66.842
" " 100 "	9.245	21.010	87.852
" " 140 "	2.685	6.104	93.956
" " 200 "	.960	2.182	96.138
Pan	1.700	3.862	100.000
	43.990 g.	100.000 %	
A.F.A. clay (11.850%)	5.925		
	49.915 g.		

* For comparative curves of these screen analyses see plate following page 8.


100
90
80
70
60
50
40
30
20
10
0
PERCENT WEIGHT, CUMULATIVE
SAMPLE NO. 6
(AFTER THIRD POUR)
SAMPLE NO. 5
(BEFORE THIRD POUR)
CUMULATIVE SCREEN
ANALYSIS OF EUGENE SAND
SAMPLES 5 & 6
RETAINED ON
30
40
50
70
100
140
200
PAN
MESH (U.S. BUR. OF STANDARDS)
EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix A) October 12, 1943

Type of casting:

96 lb. armature-spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

5

Mix used:

200 lbs. new sand
100 lbs. from second pouring (used 2 times)
30 lbs. sea coal
10 lbs. water
7 lbs. bentonite

Properties of mix:

Moisture 4.6%
Green permeability 158
Green compression strength . 6.7

Molding characteristics:

Molder says rammed much better but sand stuck to pattern upon removal due to heat generated by excessive mulling*.

Pouring characteristics:

Poured quietly.

Remarks:

Casting no. 5 was good with exception of lower portion where sand stuck to pattern during molding. Sand broke away easily from casting. Superintendent said casting no. 5 was good.

* This mix had to be mulled twice. First batch too dry and too low in bond and required remulling.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix A

Screen analyses*:

Sample No. 7A

(Sand used for casting no. 5, before pouring)
A.F.A. clay removed from 50 g. dried sample before screening.

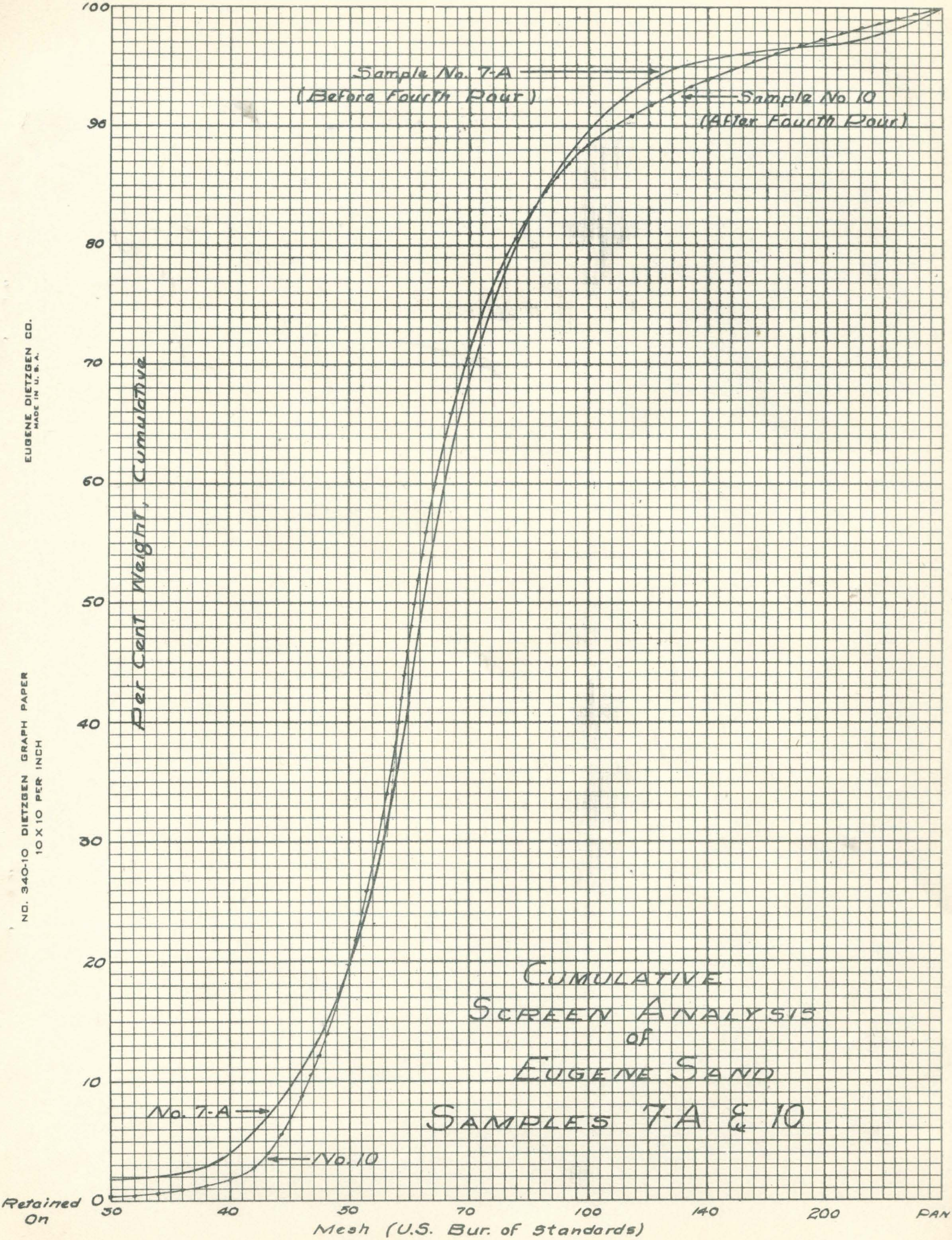
Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.275 g.	.604 %	.604 %
" " 30 "	.485	1.068	1.672
" " 40 "	.960	2.106	3.778
" " 50 "	7.050	15.496	19.274
" " 70 "	22.410	49.238	68.512
" " 100 "	9.715	21.360	89.872
" " 140 "	2.440	5.360	95.232
" " 200 "	0.725	1.592	96.824
Pan	1.445	3.176	100.000
	45.505 g.	100.000 %	
A.F.A. clay (8.80%)	4.400		
	49.905 g.		

Sample No. 10

(Sand used for casting no. 5, after pouring,
taken from face of casting)
A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.160 g.	.324 %	.324 %
" " 40 "	.700	1.418	1.742
" " 50 "	8.980	18.220	19.962
" " 70 "	24.930	50.482	70.444
" " 100 "	8.900	18.000	88.444
" " 140 "	2.750	5.536	93.980
" " 200 "	1.500	3.040	97.020
Pan	1.470	2.980	100.000
	49.390 g.	100.000 %	
A.F.A. clay (1.15%)	0.575		
	49.965 g.		

* For comparative curves of these screen analyses see plate following page 10.


Cumulative Screen Analysis of Eugene Sand
Samples 7-A & 10
Sample No. 7-A (Before Fourth Pour)
Sample No 10 (After Fourth Pour)
No. 7-A
No. 10
Per Cent Weight, Cumulative
Retained On
Mesh (U.S. Bur. of Standards)
0
10
20
30
40
50
60
70
80
90
100
30
40
50
70
100
140
200
PAN
EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix B) October 12, 1943

Type of casting:

96 lb. armature-spider cast by Crawford & Doherty for Marine Electric Co. Casting of 55% steel (steel rail) poured at about 2700° F.

Number of casting:

6

Mix used:

300 lbs. sand from third pouring
(half of this sand previously used twice; half, 3 times)
15 lbs. sea coal
7 lbs. water

Properties of mix:

Moisture 4.6%
Green permeability 138
Green compression strength . 10.2

Molding characteristics:

Rammed well. Possibly a little too dry but poor pattern was largely to blame for slight damage to mold when the pattern was removed.

Pouring characteristics:

Poured quietly.

Remarks:

Character of casting no. 6 not quite as good as no. 5 due to slight flaring out at bottom of casting. This may have been caused by lack of ramming near base of mold. Sand broke away readily from casting.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix B

Screen analyses*:

Sample No. 8A

(Sand used for casting No. 6, before pouring - half previously used twice; half, 3 times)

A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.425 g.	.968 %	.968 %
" " 30 "	.525	1.194	2.162
" " 40 "	1.150	2.604	4.766
" " 50 "	6.600	15.030	19.796
" " 70 "	20.050	45.650	65.446
" " 100 "	9.410	21.440	86.886
" " 140 "	2.725	6.210	93.096
" " 200 "	1.025	2.334	95.430
Pan	2.030	4.570	100.000
	43.940 g.	100.000 %	
A.F.A. clay (11.86%)	5.930		
	49.870 g.		

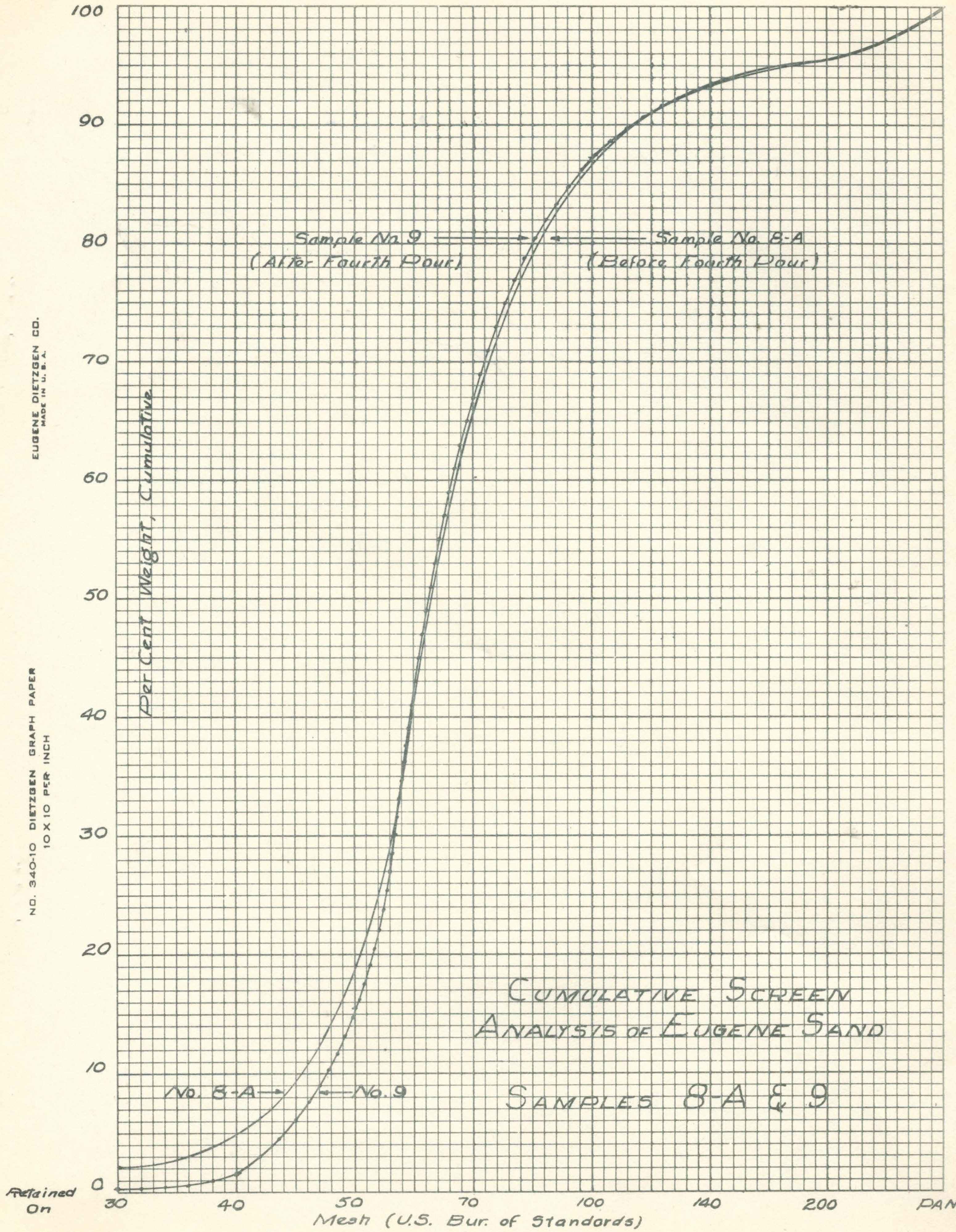
Sample No. 9

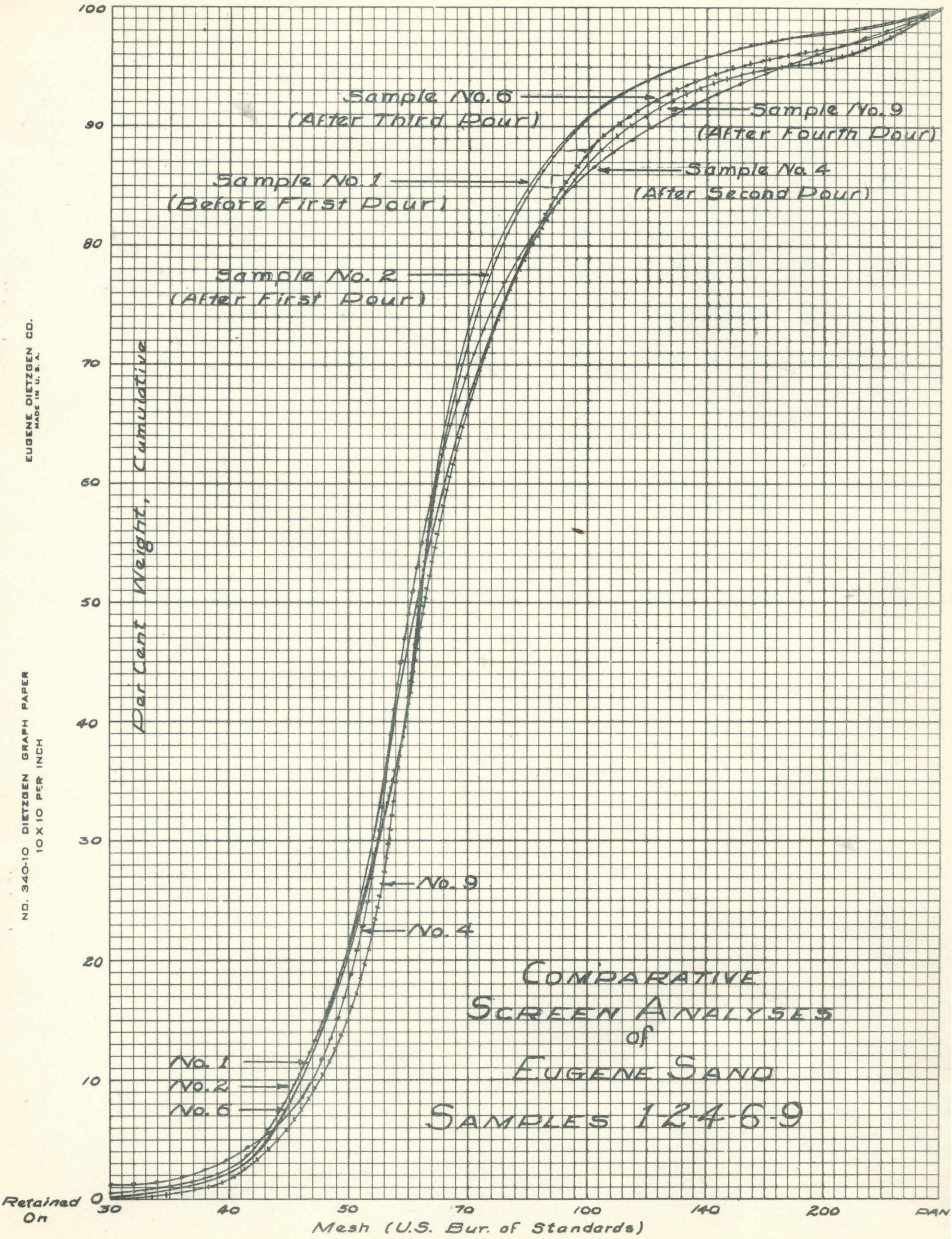
(Sand used for casting no. 6, after pouring. Half of sand has now been subjected to 3 pourings; half to 4 pourings)

A.F.A. clay removed from 50 g. dried sample before screening.

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.035 g.	.072 %	.072 %
" " 30 "	.125	.260	.332
" " 40 "	.530	1.104	1.436
" " 50 "	6.740	14.040	15.476
" " 70 "	24.565	51.092	66.568
" " 100 "	9.900	20.600	87.168
" " 140 "	2.870	5.960	93.128
" " 200 "	1.150	2.392	95.520
Pan	2.150	4.480	100.000
	48.065	100.000 %	
A.F.A. clay (3.87%)	1.935		
	50.000 g.		

* For comparative curves of these screen analyses see plate following page 12.


Cumulative Screen Analysis of Eugene Sand
Samples 8-A & 9
Sample No. 9 (After Fourth Pour)
Sample No. 8-A (Before Fourth Pour)
No. 8-A
No. 9
Per Cent Weight, Cumulative
Mesh (U.S. Bur. of Standards)
Retained On
30
40
50
70
100
140
200
PAN
0
10
20
30
40
50
60
70
80
90
100


Sample No. 6
(After Third Pour)
Sample No. 9
(After Fourth Pour)
Sample No. 1
(Before First Pour)
Sample No. 4
(After Second Pour)
Sample No. 2
(After First Pour)
Per Cent Weight, Cumulative
No. 9
No. 4
No. 1
No. 2
No. 6
Comparative
Screen Analyses
of
Eugene Sand
Samples 1-2-4-6-9
100
90
80
70
60
50
40
30
20
10
Retained On
0
30
40
50
70
100
140
200
PAN
Mesh (U.S. Bur. of Standards)

MEMORANDUM

The following are notes on the foundry test made by the Electric Steel Foundry, Portland, Oregon, on the Eugene (Fire Clay Products Co.) sand in parallel with Ottawa (Federal 17). This test was made for K. E. Hamblen, 2825 S.W. Montgomery Drive, Portland, Oregon, on August 10, 1943. The same mix was used on both sands.

The properties of the sand mixes, as determined by the Electric Steel Foundry laboratory, before the casting test, were:

	Ottawa	Eugene
Moisture	4.1%	5.8%
Green Permeability	110	105
Green Shear	2.6	3.1
Green Compression	8.9	10.8
Green Tensile	10.5	17.5
Dry Permeability	155	130
Dry Shear	23.5	55

Screen Analyses*
(By W. D. Lowry, Ore. Dept. of Geology)

Size (U.S. Bureau of Standards):

Retained	Ottawa Fed. 17 (unused) Percent of sand total	Cumulative percent of sand total	Ottawa Fed. 17** (used, from facing of casting)*** Percent of total sample	Percent of sand total	Cumulative percent of sand total
On 20 mesh	0.0 %	0.00%	0.24%	0.24%	0.24%
" 30 "	0.16	0.16	2.32	2.34	2.58
" 40 "	20.14	20.28	27.56	27.77	30.35
" 50 "	48.60	68.84	31.94	32.24	62.59
" 70 "	20.60	89.42	23.18	23.40	85.99
" 100 "	9.28	98.69	7.60	7.67	93.66
" 140 "	1.26	99.95	4.56	4.60	98.26
" 200 "	0.04	99.99	0.86	0.87	99.13
Pan	0.01	100.00	0.86	0.87	100.00
	100.09 %		99.12	100.00%	
		A.F.A. clay	0.60		
			99.72 %		

*A.F.A. clay removed before screening. See comparative curves shown on plate following page 14.

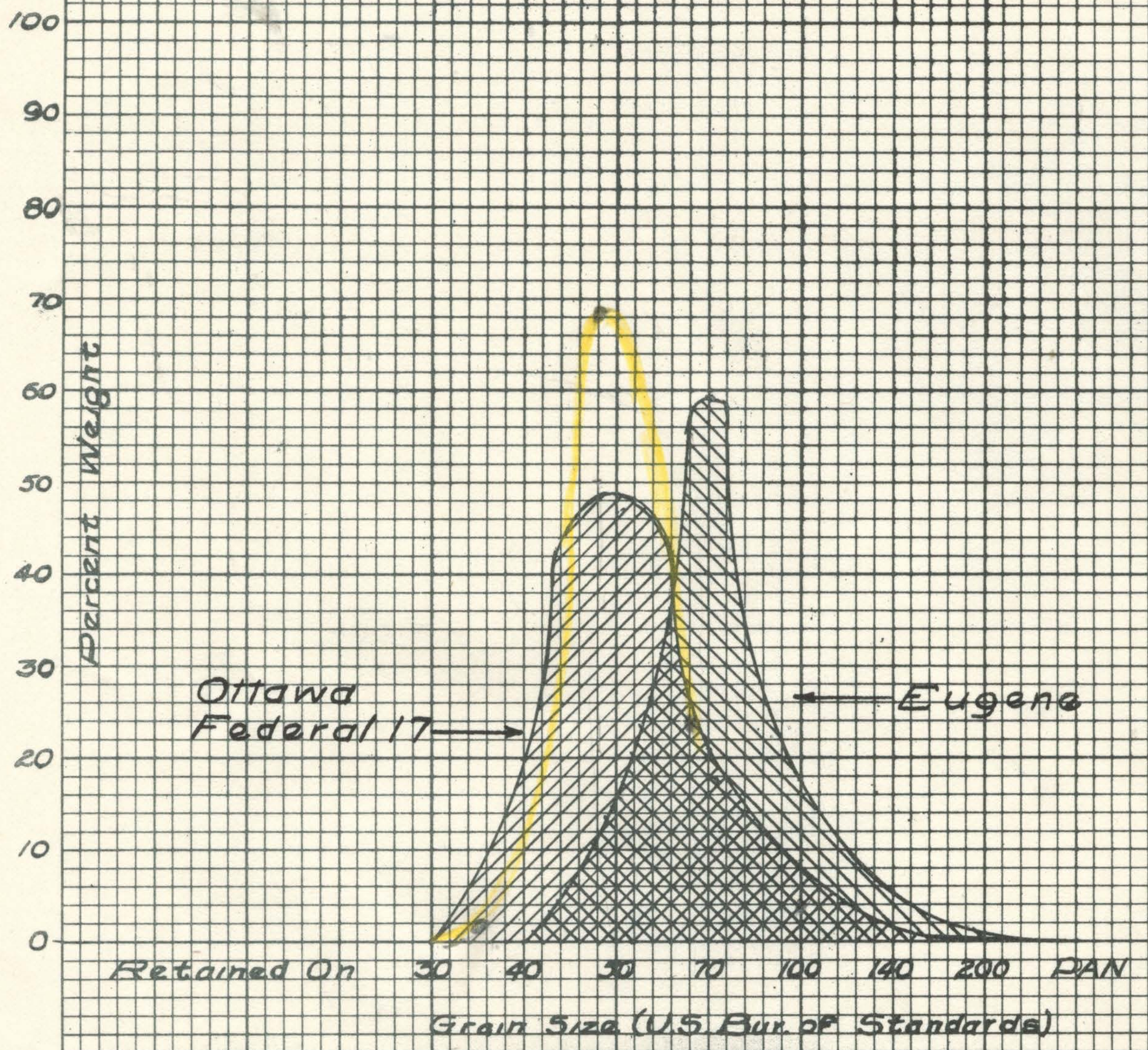
**Believed to be all Ottawa Fed. 17. Electric Steel Foundry uses Ottawa Banding also.

***There was some cementation or welding of grains and some of these were not separated by the leaching action of the standard sodium hydroxide solution recommended by the American Foundrymen's Association to remove A.F.A. clay.

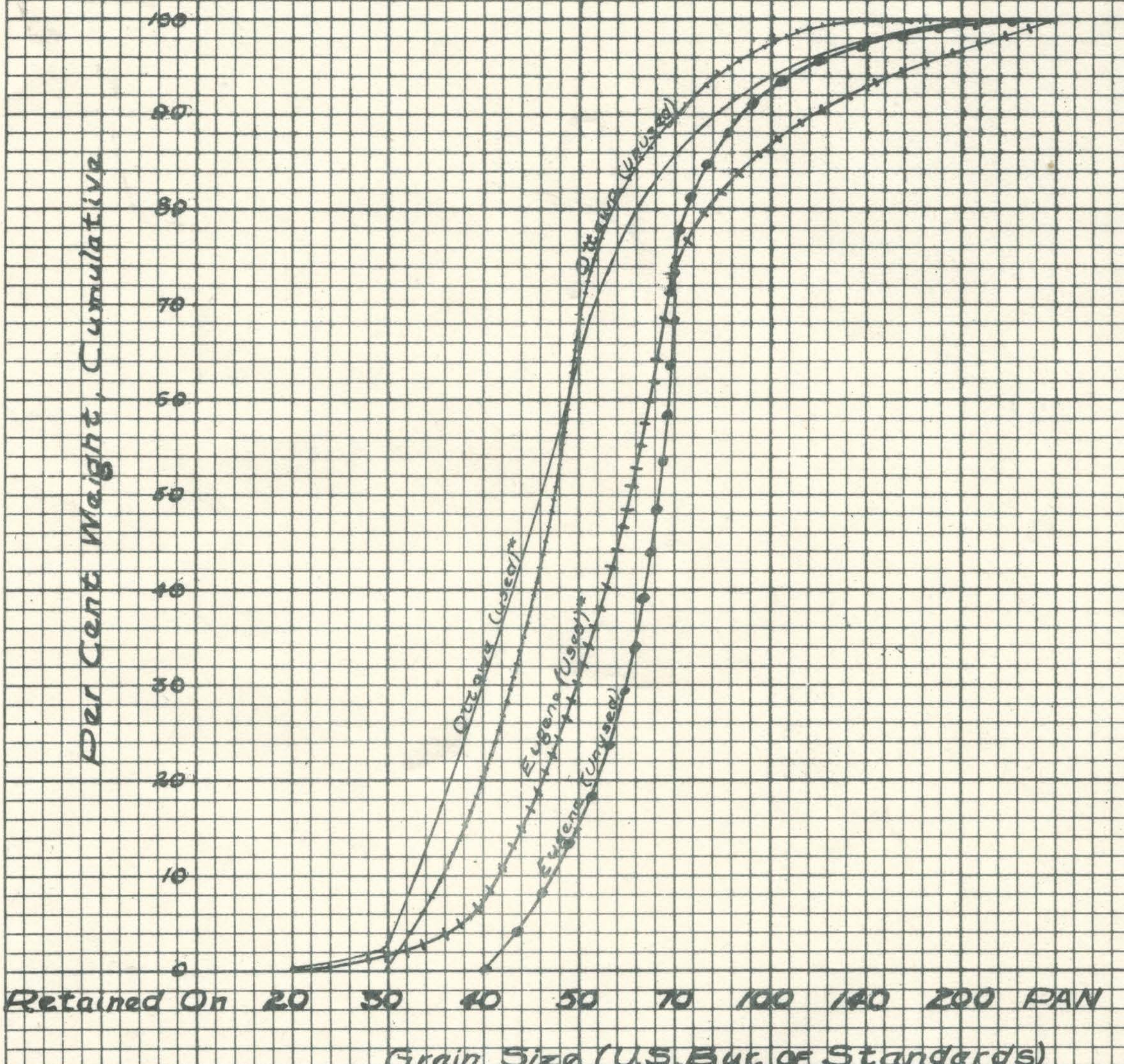
Size (U.S. Bur. of Standards):

	Eugene (unused)			Eugene (used, from facing of casting)*		
Retained	Percent of total sample	Percent of sand total	Cumulative percent of sand total	Percent of total sample	Percent of sand total	Cumulative percent of sand total
On 20 mesh	0.0 %	0.00%	0.00%	0.32%	0.33%	0.33%
" 30 "	0.0	0.00	0.00	1.14	1.16	1.49
" 40 "	0.26	0.27	0.27	5.82	5.94	7.43
" 50 "	14.68	15.02	15.29	23.76	24.22	31.65
" 70 "	58.00	59.46	74.75	41.50	42.41	74.06
" 100 "	17.20	17.62	92.37	11.82	12.07	86.13
" 140 "	5.28	5.42	97.79	6.84	6.98	93.11
" 200 "	1.28	1.31	99.10	3.06	3.12	96.23
Pan	0.88	0.90	100.00	3.68	3.77	100.00
	97.58%	100.00%		97.94%	100.00%	
A.F.A. clay	2.44		A.F.A. clay	1.78		
	100.02%			99.72%		

* There was some cementation or welding of grains and some of these were not separated by the leaching action of the standard sodium hydroxide solution recommended by the American Foundrymen's Association to remove A.F.A. clay.



GRAIN SIZE DISTRIBUTION
of
OTTAWA FED. 17 & EUGENE SANDS

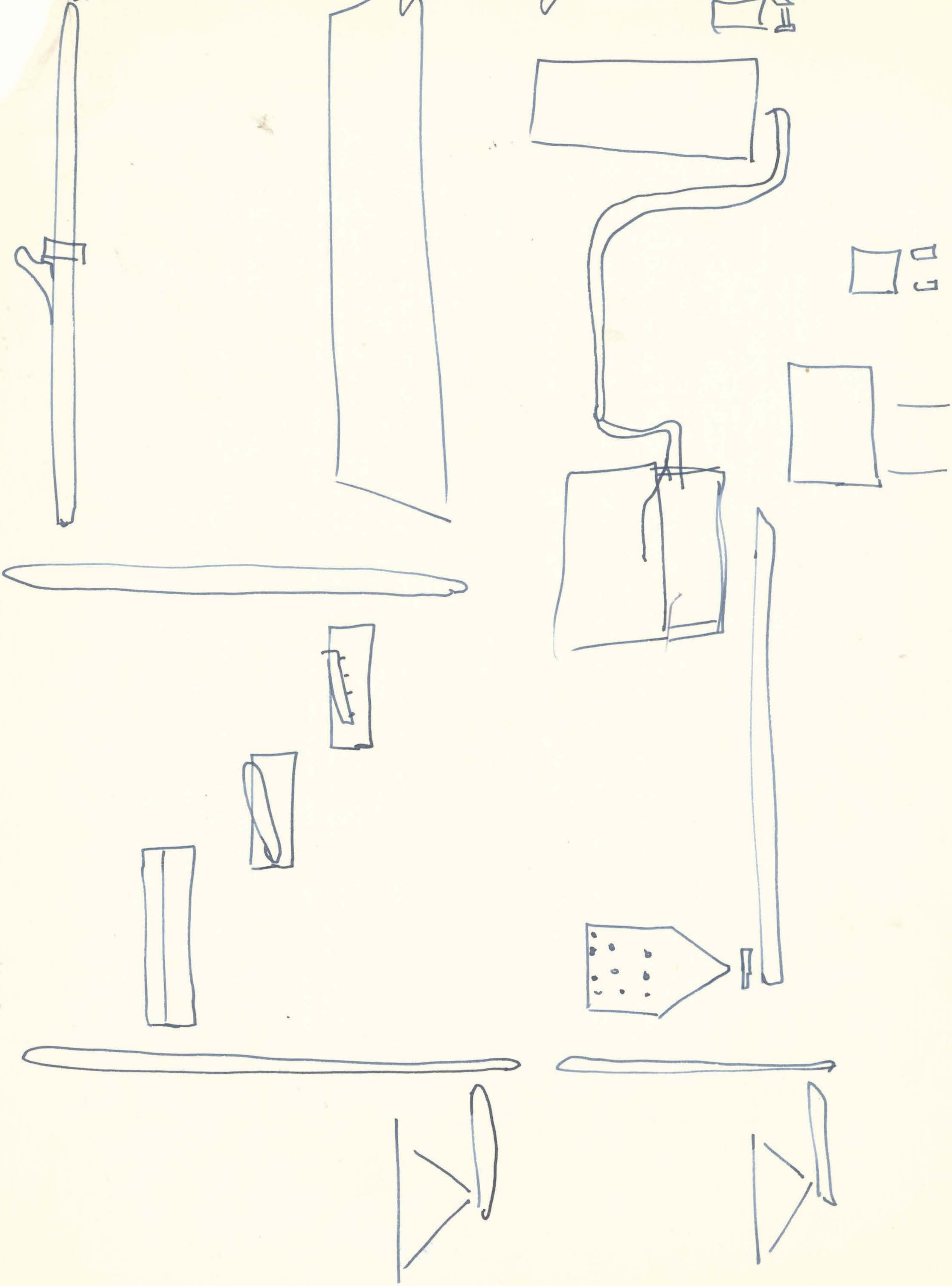


*Some of Larger Grains Are Aggregates Due To Either Cementation Or Welding.

Cumulative Screen Analysis of Ottawa Fed. 17 & Eugene Sands

Before & After Pouring

Silica Sand Co. - Eugene, Oregon



State Department of Geology and Mineral Industries

702 Woodlark Building
Portland, Oregon

EUGENE SAND FOUNDRY TESTS

W.D. Lowry and R.S. Mason

Introduction:

The sand used in this series of tests was washed from the north bank of the old Eugene Fire Clay Products Company pit located in Lane County in the NW¼ sec. 36, T. 17 S., R. 4 W., approximately three miles west of Eugene. This deposit is described in R. C. Treasher's "Preliminary Report on a Possible Molding or Glass Sand", Oregon Department of Geology and Mineral Industries, 1943, unpublished. In this report, he states that the bank material at this pit contains approximately 35% clay and 65% quartz sand with a minor amount of mica, and was used in the manufacture of no. 2 refractory brick. Sand for this test was washed from bank material by hand and was not screened.

The following data were compiled from the foundry tests made at Crawford & Doherty Foundry, Portland, Oregon, from October 7-11, 1943. Crawford & Doherty's plant is a semi-steel foundry; their product is known as "Meehanite".

The purpose of these tests was to determine the durability of this sand. To accomplish this, the sand was subjected to a series of pourings of a semi-steel (55% steel rail) casting made at a temperature of 2700° ± F. Samples of the sand were taken before and after each pouring. The sample selected after each pouring was taken from that part of the facing sand which was thought to have been subjected to the greatest heat and stress. The A.F.A. clay was removed from each sample and the material then screened. The accompanying record sheets show the various mixes used, their properties, the screen analyses and accompanying graphs of the sand before and after each pouring made. Miscellaneous information is also included. The tests were discontinued when someone on the foundry night shift unknowingly mixed the sand being tested with the regular foundry heap sand.

Properties of the sand:

Chemical analyses:

(1) R. G. Bassett (from Treasher's report)

SiO_2	95.8 %
Ignition loss	2.3
	98.1 %

(2) L.L. Hoagland (Assayer, Oregon Department of Geology)

A.F.A. clay and plus 30 mesh fraction removed before analyzing - Sample No. P-1767.

SiO_2	96.39 %
H_2O	1.3
	97.69 %

Spectrographic analysis (by H.C. Harrison, Oregon Department of Geology):

Sample No. P-1829; Spectrographic Laboratory No. 773.
(A.F.A. clay and plus 20 mesh fraction removed.)

QUALITATIVE SPECTROGRAPHIC ANALYSIS
(Quantities estimated to nearest power of ten)

Elements present in concentrations over 10%.
Silicon

Elements present in concentrations 1% - 0.1%.
Iron, Aluminum, Titanium

Elements present in concentrations 0.1% - .01%.
Zirconium, Calcium, Magnesium.

Petrographic analysis (by W.D. Lowry, Oregon Department of Geology):

The various sieve fractions of this sand were examined petrographically. The following paragraph summarizes its character:

The sand is made up predominantly (about 96%) of subangular to angular grains of quartz whose surfaces are somewhat frosted. The plus 40 mesh (U.S. Bur. Standards) fractions (1.5 ± %) are dominantly aggregate grains composed almost entirely of subangular grains of quartz approximately 0.4 mm in diameter, cemented together with clay. The grains of the smaller sieve fractions (minus 100 mesh) tend to be angular. Of the quartz grains, from 3-7% (probably about 6%) are either strained, cracked, or aggregate. Some of the surfaces of the quartz grains are partially coated with a thin film of clay. About 4% of the sand are chalcedonic aggregates; the minus 70 mesh (U.S. Bur. Standards) sieve fractions have a higher percentage of chalcedonic grains. Mica flakes constitute less than 1% of the total.

Screen analysis:

Approximately 1500 lbs. of Eugene sand was sampled. Fifty grams were dried, the A.F.A. clay removed, and the sand redried before screening.

Size (U.S. Bur. Standards)	Weight	Percent	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	0.00 g.	0.00 %	0.00 %	0.00 %
" " 30 "	0.10	0.20	0.21	0.21
" " 40 "	0.83	1.66	1.79	2.00
" " 50 "	8.66	17.32	18.71	20.71
" " 70 "	23.73	47.46	51.23	71.94
" " 100 "	8.82	17.64	19.09	91.03
" " 140 "	2.33	4.66	5.04	96.07
" " 200 "	0.83	1.66	1.79	97.86
Pan	0.99	1.98	2.14	100.00
	46.29 g.	92.58 %	100.00 %	
A.F.A. clay	1.75	3.50		
Loss (drying & screening)	1.96	3.92		
	50.00 g.	100.00 %		

EUGENE SAND FOUNDRY TEST

No. 1 Pour Oct. 8, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. The casting is 55% steel (steel rail) poured at about 2700° F.

Number of casting:

1 and 2

Mix used:*

Eugene sand	600 lbs.
Water	24 lbs.
Bentonite	30 lbs.

*This mixture has too much "body", due to excess bentonite.

Properties of mix:

Moisture*.	6.2%
Green permeability	165
Green compression strength**	8.6

* Sand as furnished contained approximately 2% moisture

** No green shear or tensile values were measured as their ratio to the green compression strength for practical purposes are said by H. Ries to remain fairly constant.

Molding characteristics:

The pattern used was made of 3 pieces. These fitted together very poorly and the surface of the pattern was in several places quite rough as some poorly fitting cardboard lagging had been used. The molder said the above mix was "easy to work and required no nails". The molder rammed this mix the same way he was accustomed to ramming the sand commonly used by the foundry - a sand of much lower permeability. The character of the casting later proved that the sand had not been rammed hard enough.

Pouring characteristics:

Poured quietly

Remarks:

The casting was poor, very rough. The breakaway of the sand from the casting was poor. Lack of ramming permitted metal to run into the facing sand.

EUGENE SAND FOUNDRY TEST

Pour No. 1 (cont.)

Screen analyses*:

Sample No. 1
(Original mix)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.285 g.	.64 %	.64 %
" " 40 "	.715	1.61	2.25
" " 50 "	8.270	18.62	20.87
" " 70 "	23.400	52.61	73.48
" " 100 "	7.780	17.49	90.97
" " 140 "	2.120	4.64	95.61
" " 200 "	.835	1.87	97.48
Pan	1.120	2.52	100.00
	44.525 g.	100.00 %	
A.F.A. clay (10.550%)	5.275		
	49.800 g.		

Sample No. 2
(Sand from facing of casting no. 1, first pour)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.324 %	.324 %
" " 30 "	.170	.366	.690
" " 40 "	.865	1.864	2.554
" " 50 "	9.190	19.140	21.694
" " 70 "	23.325	50.670	72.364
" " 100 "	8.460	18.390	90.754
" " 140 "	2.425	5.230	95.984
" " 200 "	.900	1.920	97.904
Pan	.975	2.096	100.000
	46.460 g.	100.000 %	
A.F.A. clay (5.840%)	2.920		
	49.380 g.		

* For comparative curves of these screen analyses see page 5a.

page 5

EUGENE SAND FOUNDRY TEST

Pour No. 2 Oct. 9, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

3

Mix used:

Sand recovered from first pour. No new bond added. Water added which brought moisture up to 9%.

Properties of mix:

Moisture	9%
Green permeability	85
Green compression strength	10.1

Molding characteristics:

Sand was rammed much harder. Molder says, "too wet". Mold, after pattern was removed, looked rough in places due to inadequate ramming.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 3 fair, much improved over nos. 1 and 2. After removal from rattler mill, casting was quite smooth. The sand broke away from the casting better than from casting nos. 1 and 2.

page 6

EUGENE SAND FOUNDRY TEST

Pour No. 2 (cont.)

Screen analyses*:

Sample No. 3
(Sand used for casting no. 3, previously used once, before pouring)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.205 g.	.460 %	.460 %
" " 30 "	.185	.420	.880
" " 40 "	.605	1.372	2.252
" " 50 "	6.875	15.610	17.862
" " 70 "	22.435	50.894	68.756
" " 100 "	8.650	19.635	88.391
" " 140 "	2.520	5.720	94.111
" " 200 "	.935	2.121	96.232
Pan	1.660	3.768	100.000
	44.070 g.	100.000 %	
A.F.A. clay (10.520%)	5.260		
	49.330 g.		

Sample No. 4
(Sand used for casting No. 3, previously used twice, after pouring, taken from face of casting)
A.F.A. clay removed before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.150 g.	.328 %	.328 %
" " 30 "	.180	.394	.722
" " 40 "	.795	1.706	2.428
" " 50 "	8.525	18.600	21.028
" " 70 "	22.325	48.600	69.628
" " 100 "	7.910	16.640	86.268
" " 140 "	2.755	5.840	92.108
" " 200 "	1.195	4.092	96.200
Pan	1.730	3.800	100.000
	45.565 g.	100.000 %	
A.F.A. clay (8.50%)	4.250		
	49.815 g.		

* For comparative curves of these screen analyses see page 7a.

page 7

EUGENE SAND FOUNDRY TEST

Pour No. 3 Oct. 11, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

4

Mix used:

150 lbs. sand from second pouring
150 lbs. sand from first pouring
(left over as only one casting poured second day)
15 lbs. sea coal
Water added which brought moisture up to 6.8%

Properties of mix:

Moisture	6.8%
Green permeability	112
Green compression strength	8.6

Molding characteristics:

Too hard to ram well as result of excessive bentonite at above moisture content.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 4 improved over no. 3 but still rough in places. Sand broke away from the casting a little too hard. Foundryman said casting no. 4 "somewhat improved".

EUGENE SAND FOUNDRY TEST

Pour No. 3 (cont.)

Screen analyses*:

Sample No. 5
(Sand used for casting no. 4, before pouring -
Half of this sand previously used once; half, twice)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.215 g.	.488 %	.488 %
" " 30 "	.300	.684	1.172
" " 40 "	.805	1.832	3.004
" " 50 "	6.790	15.450	18.454
" " 70 "	21.410	48.776	67.230
" " 100 "	9.055	20.630	87.860
" " 140 "	2.675	6.080	93.940
" " 200 "	1.025	2.280	96.220
Pan	1.660	3.780	100.000
	43.935 g.	100.000 %	
A.F.A. clay (12.10%)	6.050		
	49.985 g.		

Sample No. 6
(Sand used for casting no. 4, after pouring, taken from face of casting -
Half of this sand previously used 2 times; half, used 3 times)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.185 g.	.420 %	.420 %
" " 30 "	.375	.852	1.272
" " 40 "	.860	1.956	3.228
" " 50 "	6.495	14.750	17.978
" " 70 "	21.485	48.864	66.842
" " 100 "	9.245	21.010	87.852
" " 140 "	2.685	6.104	93.956
" " 200 "	.960	2.182	96.138
Pan	1.700	3.862	100.000
	43.990 g.	100.000 %	
A.F.A. clay (11.850%)	5.925		
	49.915 g.		

* For comparative curves of these screen analyses see page 9a.

page 9

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix A) Oct. 12, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting 55% steel (steel rail) poured at about 2700° F.

Number of casting:

5

Mix used:

200 lbs. new sand
100 lbs. from second pouring (used 2 times)
30 lbs. sea coal
10 lbs. water
7 lbs. bentonite

Properties of mix:

Moisture	4.6%
Green permeability	158
Green compression strength . . .	6.7

Molding characteristics:

Molder says rammed much better but sand stuck to pattern upon removal due to heat generated by excessive mulling.*

Pouring characteristics:

Poured quietly

Remarks:

Casting no. 5 was good with exception of lower portion where sand stuck to pattern during molding. Sand broke away easily from casting. Superintendent said casting no. 5 was good.

* This mix had to be mulled twice. First batch too dry and too low in bond and required remulling.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix A

Screen analyses*:

Sample No. 7A
(Sand used for casting no. 5, before pouring)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.275 g.	.604 %	.604 %
" " 30 "	.485	1.068	1.672
" " 40 "	.960	2.106	3.778
" " 50 "	7.050	15.496	19.274
" " 70 "	22.410	49.238	68.512
" " 100 "	9.715	21.360	89.872
" " 140 "	2.440	5.360	95.232
" " 200 "	0.725	1.592	96.824
Pan	1.445	3.176	100.000
	45.505 g.	100.000 %	
A.F.A. clay (8.80%)	4.400		
	49.905 g.		

Sample No. 10
(Sand used for casting no. 5, after pouring,
taken from face of casting)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 30 mesh	.160 g.	.324 %	.324 %
" " 40 "	.700	1.418	1.742
" " 50 "	8.980	18.220	19.962
" " 70 "	24.930	50.482	70.444
" " 100 "	8.900	18.000	88.444
" " 140 "	2.750	5.536	93.980
" " 200 "	1.500	3.040	97.020
Pan	1.470	2.980	100.000
	49.390 g.	100.000 %	
A.F.A. clay (1.15%)	0.575		
	49.965 g.		

* For comparative curves of these screen analyses see page 11a.

page 11

EUGENE SAND FOUNDRY TEST

Pour No. 4 (Mix B) Oct. 12, 1943

Type of casting:

96 lb. armature spider cast by Crawford & Doherty for Marine Electric Co. Casting of 55% steel (steel rail) poured at about 2700° F.

Number of casting:

6

Mix used:

300 lbs. sand from third pouring
(half of this sand previously used twice; half, 3 times)
15 lbs. sea coal
7 lbs. water

Properties of mix:

Moisture	4.6%
Green permeability	138
Green compression strength	10.17

Molding characteristics:

Rammed well. Possibly a little too dry but poor pattern was largely to blame for slight damage to mold when the pattern was removed.

Pouring characteristics:

Poured quietly

Remarks:

Character of casting no. 6 not quite as good as no. 5 due to slight flaring out at bottom of casting. This may have been caused by lack of ramming near base of mold. Sand broke away readily from casting.

EUGENE SAND FOUNDRY TEST

Pour No. 4 (cont.)

Mix B

Screen analyses*:

Sample No. 8A
(Sand used for casting no. 6, before pouring -
Half previously used twice; half 3 times)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.425 g.	.968 %	.968 %
" " 30 "	.525	1.194	2.162
" " 40 "	1.150	2.604	4.766
" " 50 "	6.600	15.030	19.796
" " 70 "	20.050	45.650	65.446
" " 100 "	9.410	21.440	86.886
" " 140 "	2.725	6.210	93.096
" " 200 "	1.025	2.334	95.430
Pan	2.030	4.570	100.000
	43.940 g.	100.000 %	
A.F.A. clay (11.86%)	5.930		
	49.870 g.		

Sample No. 9
(Sand used for casting no. 6, after pouring -
Half of sand has now been subjected to 3 pourings; half to 4 pourings)
A.F.A. clay removed from 50 g. dried sample before screening

Size (U.S. Bur. Standards)	Weight	Percent of sand total	Cumulative percent of sand total
Retained on 20 mesh	.035 g.	.072 %	.072 %
" " 30 "	.125	.260	.332
" " 40 "	.530	1.104	1.436
" " 50 "	6.740	14.040	15.476
" " 70 "	24.565	51.092	66.568
" " 100 "	9.900	20.600	87.168
" " 140 "	2.870	5.960	93.128
" " 200 "	1.150	2.392	95.520
Pan	2.150	4.480	100.000
	48.065 g.	100.000 %	
A.F.A. clay (3.87%)	1.935		
	50.000 g.		

* For comparative curves of these screen analyses see page 13a.

State Department of Geology and Mineral Industries

702 Woodlark Building
Portland, Oregon

MEMORANDUM ON THE EUGENE SILICA SAND *

Eugene, Oregon

Location:

The deposit is about 2 miles west of Eugene which is approximately 120 miles south of Portland, Oregon. It makes up most of Wallace Butte, a low elongate hill in secs. 34 and 35, T. 17 S., R. 4 W.W.M., and can be reached via 11th Street. The Silica Products, Oreg., Ltd. plant, which washes and dries the sand, is located about 1 mile north of the deposit on the Coos Bay branch of the Southern Pacific Railroad.

Ownership:

The southwestern part of Wallace Butte, which includes the pit area from which sand is being mined, is owned by the Silica Products, Oreg., Ltd., 808 Couch Building, Portland, Oregon. Their holdings comprise 38 acres plus a smaller acreage to the east. The remaining part of the hill is held by several home owners.

Composition of the sand:

The pit material from which the sand is recovered is about two-thirds quartz sand and one-third fire clay with a minor amount of mica.

Chemical analyses of the washed sand made by the Oregon Department of Geology and Mineral Industries show it contains about 98% SiO_2.

---

* Prepared by the Oregon Department of Geology and Mineral Industries, June 15, 1946.

The main impurity is alumina which occurs largely as a clay film on the grains. A spectrographic analysis of the sand made by the Oregon Department is given below:

<u>Qualitative Spectrographic Analysis</u>
(Quantities estimated to nearest power of ten)

1. Elements present in concentrations over 10%	Silicon
2. Elements present in concentrations 0.1 - 1%	Aluminum Iron Titanium
3. Elements present in concentrations 0.01 - 0.1%	Calcium Magnesium Zirconium

Chemical analysis of a sample of the sand scoured in a small ball mill showed it contained 0.095% Fe_2O_3. Determinations of the silica and alumina content of the sample have not yet been completed.

Petrographic analysis of the sand shows it is made up predominantly (about 96%) of subangular to angular grains of quartz. Chalcedonic quartz grains constitute about 4% of the sand and mica flakes less than 1%. The grain size of the sand is remarkably uniform and accounts for its high permeability. The 70 mesh (U.S. Bur. Standards) fraction makes up more than half of the sand and together with the 50 and 100 mesh fractions constitutes more than 90%.

A screen analysis of a hand-washed sample of the Eugene sand is given on the following page.

Screen Analysis of Eugene Sand

Size (U.S. Bur. Standards)	Percent	Cumulative Percent
Retained on 12 mesh	0.00	0.00
" " 20 "	0.10	0.10
" " 30 "	0.50	0.60
" " 40 "	2.92	3.52
" " 50 "	24.22	27.74
" " 70 "	54.30	82.04
" " 100 "	14.30	96.34
" " 140 "	2.60	98.94
" " 200 "	0.62	99.56
" " 270 "	0.22	99.78
Pan	0.26	100.04

The average of the screen analyses of samples from 30 cars of washed sand shipped by the Silica Products company is given below. As some of the finer sand grains are removed in the washing process, the analysis differs slightly from that given above.

Screen Analysis of Eugene Sand
Marketed by Silica Products, Oreg., Ltd.

Size (U.S. Bur. Standards)	Percent	Cumulative Percent
Retained on 40 mesh	4.00	4.00
" " 50 "	23.46	27.46
" " 70 "	55.27	82.73
" " 100 "	14.61	97.34
" " 140 "	1.62	98.96
" " 200 "	0.65	99.61
" " 270 "	0.13	99.74
Pan	0.20	99.94

Size of the deposit:

An auger drilling project carried out by the U. S. Bureau of Mines in 1943 (War Minerals Report 199) failed to delimit the deposit both as to depth and areal extent. As the alluvial overburden is thicker on the flanks of the hill, the sand was not encountered in the shallow auger holes put down on some of the lower slopes. However the drilling did show that the sand deposit is surprisingly uniform in character. The U. S. Bureau of Mines estimated on the basis of their drilling results that 93,500 tons of measured sand, free from clay, and an additional 307,500 tons of indicated sand are available. An old well on the Silica Products tract is reported to have encountered 75 feet of sand, whereas the deepest auger hole which the Bureau of Mines was able to put down was less than 25 feet. The sand is also known to be present across the road south of Wallace Butte. A similar but slightly lower grade sand deposit, known as the Hawkins locality, lies about 1 mile to the southeast and suggests that the areal extent of the Wallace Butte deposit is much greater than indicated by the auger drilling.

A chemical analysis made by the Oregon Department of a hand-washed sample of the Hawkins sand is given below:

<u>Hawkins Sand</u>

Silica (SiO_2)	92.46 %
Iron oxide (Fe_2O_3)	0.81
Alumina (Al_2O_3)	5.7

Another sample of this sand with the minus 100 mesh fraction removed was found to contain 94.38% SiO_2. The Hawkins deposit was auger drilled in 1945 by the U. S. Bureau of Mines and it is reported that a substantial tonnage is indicated.

<u>Economic aspects of the deposit:</u>

The washed and dried sand is now being marketed in Portland at $8.75 a short ton. In Seattle it sells for $9.00 and in San Francisco for $9.25. Its main user has been the foundry trade.

The clay removed in the washing process is being collected in settling ponds. The clay is a kaolin with a P.C.E. value above cone 31. The pit material was formerly used for making fire brick. Test work on the clay suggests its suitability for a number of uses. As yet none of the clay has been marketed. A chemical analysis of the clay made by the Oregon Department is given below:

<u>Eugene Clay</u>

Alumina (Al_2O_3)	35.0 %
Silica (SiO_2)	51.4
Iron oxide (Fe_2O_3)	1.6
Ignition loss	Not determined