RI 9549

REPORT OF INVESTIGATIONS/1995

Characterization of Dredged River Sediments in 10 Upland Disposal Sites of Alabama

UNITED STATES DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES

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By C. W. Smith

UNITED STATES DEPARTMENT OF THE INTERIOR
Bruce Babbitt, Secretary

BUREAU OF MINES
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This report is based upon work done under an agreement between the University of Alabama and the U.S. Bureau of Mines.

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	pct	percent
g	gram	ppm	part per million
h	hour	s	second
in	inch	wt pct	weight percent
L	liter	yd	yard
min	minute	yd^3	cubic yard
mL	milliliter	°C	degree Celsius

CHARACTERIZATION OF DREDGED RIVER SEDIMENTS IN 10 UPLAND DISPOSAL SITES OF ALABAMA

By C. W. Smith[1]

ABSTRACT

The U.S. Bureau of Mines, Tuscaloosa Research Center, in cooperation with the U.S. Army Corps of Engineers under interagency Agreement No. 14-09-0078-1510, conducted a comprehensive sampling program of 10 upland disposal sites along the Alabama, Black Warrior, and Tombigbee River systems in Alabama. Samples from each site were characterized according to particle size, chemical analysis, mineralogical content, and potential end use. Additionally, samples were subjected to the Toxic Characteristic Leachate Procedure to determine the presence of potentially harmful heavy metals. Based on the results of these studies, each sample was determined to have properties amenable for use as aggregate in general-purpose portland cement concretes and certain asphalt concrete applications.

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INTRODUCTION

The U.S. Bureau of Mines (USBM), as a part of its mission to develop marketable products from waste materials, conducted a comprehensive sampling program of 10 upland disposal sites along the Alabama, Black Warrior, and Tombigbee River systems in Alabama. The U.S. Army Corps of Engineers (Corps), as a part of its mission, is charged with the channel maintenance of navigable waterways. Dredging is often required to maintain the proper depth of these channels. Each year over 300 million yd^3 [2] of material are dredged from river channels and stored in upland disposal areas. These upland disposal areas typically consist of an impoundment with an overflow weir. The dredged material is pumped to the impoundment where the solids settle out and the clear water is decanted through the weir and returned to the waterway.

The Tuscaloosa Area Office of the Corps is currently responsible for 17 upland disposal areas in Alabama with additional areas being constructed as needed. The land for these disposal areas is typically leased from individual landowners. When disposal areas are filled, the Corps must lease new land and construct a new disposal area. The USBM, Tuscaloosa Research Center, in cooperation with the Tuscaloosa Area Office of the Corps, under interagency Agreement No. 14-09-0078-1510, conducted a comprehensive sampling program of upland disposal sites along the Alabama, Black Warrior, and Tombigbee River systems in Alabama. A total of 10 upland disposal areas were sampled in this study in an effort to determine an end use for the material; thus, providing two potential benefits. First, the usable life of the area would be extended, eliminating the cost of constructing new areas. Second, the material represents a potentially usable product, which could provide a source of income for the landowner. Two sites sampled in this study were located on the Alabama River, five were located on the Tombigbee River, and the remaining three were located on the Black Warrior River. Figure 1 gives the approximate location of each site.

PROCEDURES AND STUDIES

SAMPLING PROCEDURES

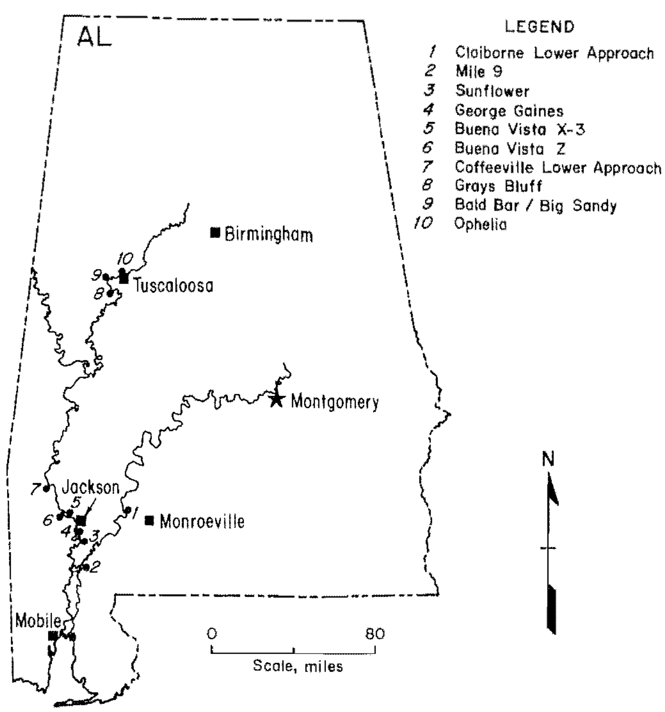
A total of 10 holes for sampling the disposal area were drilled at each site. The location of the holes were based on the positions that would yield the most representative sample of the material. Using a track mounted auger drilling rig, samples were collected at 5-ft intervals to determine segregation of the material with depth. No segregation was noted; therefore, the samples from each hole were combined prior to analysis.

AGGREGATE STUDIES

Visual examination of the samples suggested a potential use of the materials as aggregate in portland cement concrete and asphalt concrete. High-quality natural sand and gravel requires several steps to produce aggregate. First, the material must be excavated, which often requires the removal of useless overburden. Next, the material must be washed and sized to remove the clays and other fine materials. Then the material must be transported to the end-use site by truck, rail, or, in the case of large tonnages, barge.

The materials contained in the upland disposal areas in this study exhibit several characteristics that make them an obvious choice for use as an aggregate. First, in all cases the material is a clean quartz sand and gravel with few

Figure 1



Locations of upland disposal sites.

[2]Although the U.S. Bureau of Mines uses metric units, the measurements in this report were made using U.S. customary units. Foot equals 0.30 meter, inch equals 2.54 centimeters, mile equals 1.60 kilometers, yard equals 0.91 meter, and cubic yard equals 0.76 cubic meter.

impurities. Second, very little of the material is fine undersize (minus 200 mesh); thus, eliminating the need for washing and sizing. Third, the materials are located adjacent to navigable waterways making barge transportation an economical option.

Aggregates are an important constituent in portland cement concretes and asphalt concrete mixtures. Aggregates represent 70 to 85 wt pct of portland cement concretes and 90 to 95 wt pct of asphalt concrete mixtures (*1*).[3] The workability, strength, durability, moisture susceptibility, and performance of these construction materials are greatly influenced by the physical properties of the aggregate. Among the more important properties of aggregates are size and grading, hardness, porosity, particle shape and texture, volume stability, specific gravity, and chemical stability. Appendix A lists the standard tests used to determine aggregate properties.

Portland cement concretes typically use a particle size gradation obtained by blending coarse and fine aggregates. Coarse aggregate is classified as material coarser than 4 mesh while fine aggregate is typically minus 4 plus 200 mesh. Table 1 gives the gradation for coarse and fine aggregate as specified by the American Society for Testing and Materials (ASTM) Standard Specification C 33 (*2*). Generally, cement efficiency increases as coarser aggregate is used while workability is increased by the addition of fine aggregate. Acceptable gradations for asphalt concrete mixtures vary over a wide size range, depending on the end use of the mixture.

Table 1.—Size gradation for coarse and fine aggregate

Sieve size	*Passing, pct*
Coarse aggregate (gradation number 56):	
1-1/2 in	100
1 in	90-100
3/4 in	40- 85
1/2 in	10- 40
3/8 in	5- 15
No. 4	0- 5
Fine aggregate:	
3/8 in	100
No. 4	95-100
No. 8	80-100
No. 16	50- 85
No. 30	25- 60
No. 50	10- 30
No. 100	2- 10
No. 200	0- 2

The particle shape of an aggregate influences the properties of portland cement concrete. Use of a rough textured, angular aggregate requires the addition of more water to achieve a workable mixture. The loss of compressive strength due to the additional water is somewhat offset by an increase in the bond between the cement paste and aggregate (*3*). The use of angular aggregate in asphalt concrete mixtures is preferred due to an interlocking between particles that increases the strength and stability of these mixtures (*4*). The presence of flat and elongated particles in portland cement concrete and asphalt concretes results in reduced strength and stability.

Certain deleterious materials can have a profound effect on the strength and durability of portland cement concretes. Chert is one of the more common impurities that may lead to failure. Shale and argillaceous limestone may also cause considerable damage in concretes exposed to severe weathering. Certain reactive aggregates, such as opal and chalcedony, can also cause failure due to chemical expansion. Small amounts of deleterious or reactive aggregate may be present without serious damage taking place. The presence of less than 5 pct of these substances generally cause no problem, but the presence of minor amounts of organic impurities can lead to failure of portland cement concretes.

HEAVY MINERAL STUDIES

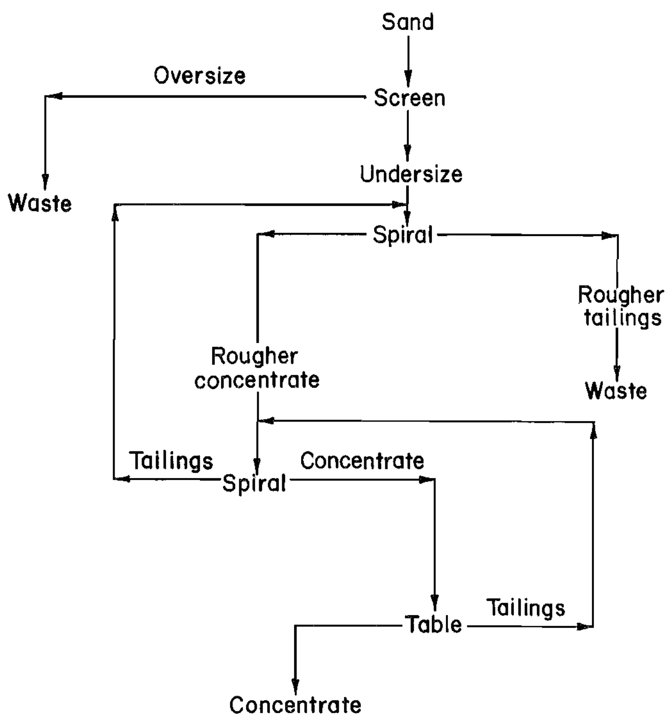
A second potential use for these materials is as a source of strategic heavy minerals such as rutile, zircon, ilmenite, kyanite, and monazite. Production of heavy minerals requires sizing to remove oversize and undersize particles followed by gravity concentration. Gravity concentration is typically achieved using a series of tables and spirals to concentrate the heavy minerals while rejecting the lighter minerals such as quartz. A general flowsheet of the process used to concentrate heavy minerals is shown in figure 2. The total heavy mineral content of samples in this study was determined by sink-float separation in heavy liquid at a specific gravity of 2.94. The heavy minerals present were identified through petrographic examination and X-ray diffraction analysis. Since the cost of production would exceed the value of the product, none of the samples in this study represented an economical source of heavy minerals due to the minor quantities present. However, economical amounts of heavy minerals were expected to be found in samples taken further up the Alabama River due to the geology of the rocks in the surrounding area.

TOXICITY STUDIES

A solid waste is defined as a hazardous waste by the U.S. Environmental Protection Agency (EPA) if it exhibits

[3]Italic numbers in parentheses refer to items in the list of references preceding the appendixes.

Figure 2



Flowsheet for concentration of heavy minerals.

the characteristics of ignitability, corrosivity, reactivity, or toxicity. Toxicity is determined using the Toxic Characteristic Leachate Procedure (TCLP) in which a representative sample of the waste is agitated in a mildly acidic solution for 18 h. The solution is then filtered from the solids and analyzed for metals using atomic absorption methods as suggested by the EPA. Table 2 shows the metals and the maximum allowable concentrations used in determining that the material is not a hazardous waste. Appendix B gives the standard EPA TCLP (*5*). Composite samples from each of the sites were checked for toxicity using the TCLP.

Table 2.—Maximum concentration of contaminants for TCLP

Contaminant	*Max conc, ppm*	*Contaminant*	*Max conc, ppm*
Ag	5.0	Cr	5.0
As	100.0	Hg	0.2
Ba	1.0	Pb	5.0
Cd	5.0	Se	1.0

TESTING PROCEDURES

Size and sink-float analyses were performed on each of the samples using the following procedures. A representative sample was split from the bulk sample and screen sized at 20 mesh. The plus 20-mesh material was further screened to produce mineral size fractions. The minus 20-mesh material was split into two fractions. One fraction was screened to determine size distribution while the remaining fraction was wet scrubbed to clean the particle surfaces and wet screened at 200 mesh to yield a minus 20- plus 200-mesh sample for sink-float separation. The sample was separated in heavy liquid with a specific gravity of 2.94 to liberate the heavy minerals. Figure 3 presents a flowsheet showing the procedures used for size analysis and sink-float separation of the samples.

SITE DESCRIPTIONS

GENERAL CHARACTERISTICS

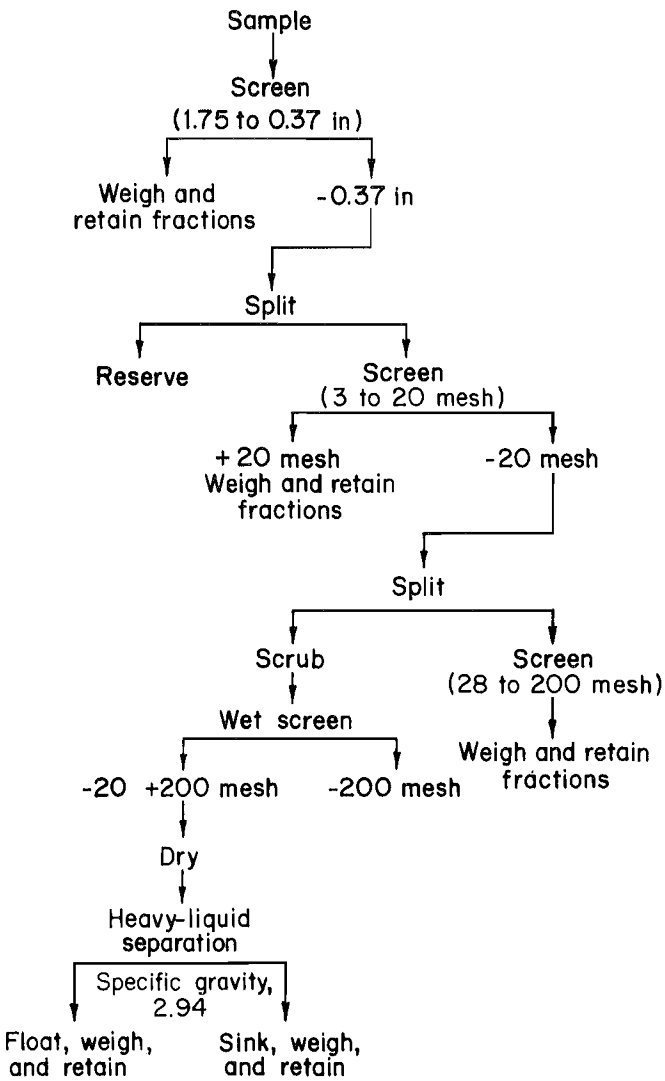
Samples from each site had several general characteristics in common. In all cases the material was a clean quartz sand and gravel with few impurities. The sand grains were all subangular to subrounded in shape. Minor amounts of heavy minerals were present in all samples. No chert, reactive aggregate, or deleterious organic materials were found. Results of the TCLP showed no sample to be a hazardous waste. Table 3 gives a summary description of the material contained in each disposal site. Material contained in other disposal areas, which were not sampled, are expected to exhibit general characteristics similar to the material in the sampled areas due to similar geology from which the materials are derived.

Table 3.—Summary of data for sites investigated

Site	Volume, yd^3	Material, wt pct			
		Coarse	Fine	Minus 200	Heavy minerals
Claiborne	134,476	4.88	94.59	0.53	0.62
Mile 9	654,296	0.38	98.35	1.27	0.42
Sunflower	835,610	4.37	94.66	0.97	0.45
George Gaines ..	351,708	7.53	91.53	0.94	0.37
Buena Vista X-3	1,084,726	10.02	88.91	1.07	0.52
Buena Vista Z ..	1,500,000	10.66	88.36	0.98	0.49
Coffeeville	536,450	0.73	97.57	1.70	0.44
Grays Bluff	216,261	4.96	94.13	0.91	0.36
Bald Bar/ Big Sandy	1,390,481	2.34	95.19	2.47	0.43
Ophelia (east) ..	62,616	7.59	91.19	1.22	0.24
Ophelia (west) ..	127,131	21.71	77.02	0.27	0.30

Samples of material from each of the sites have properties that appear suitable for use in most general-purpose portland cement concretes. Examples of such general-purpose use for the cement are in mortar mixes, curbs and drains, sidewalks, driveways, guard rail supports, and culverts. Due to the subrounded shape of the grains, use in high-strength applications such as bridges and load-bearing walls may not be recommended. Likewise, the material appears suitable for use in most general-purpose asphalt applications while use in high-strength applications is discouraged.

Figure 3

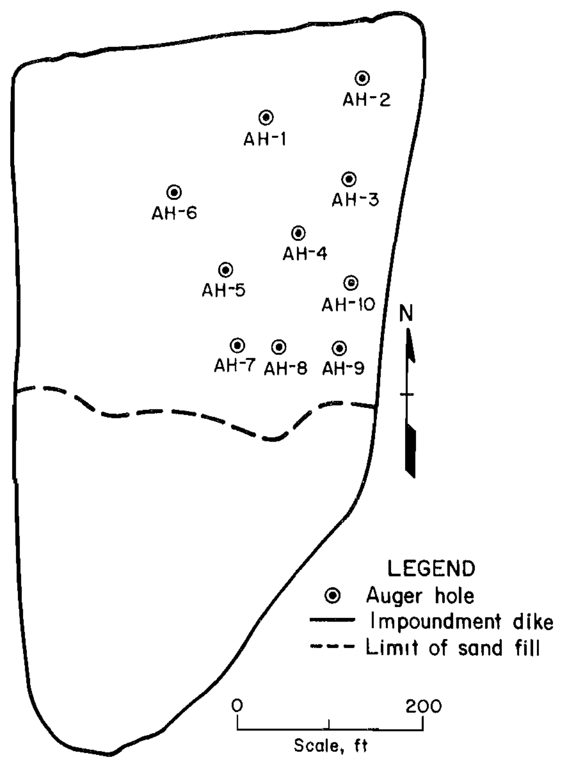


Sizing and sink-float separation of samples.

CLAIBORNE LOWER APPROACH

The Claiborne Lower Approach site is located adjacent to the Claiborne Lock and Dam at mile 72.5 on the Alabama River in sec. 35, T. 8N., R. 5E., Monroe County, AL. The site lies approximately 150 ft from the edge of the river and covers approximately 6 acres. The site presently contains approximately 134,476 yd^3 of material. It is estimated that an additional 68,000 yd^3 of material will be placed in the disposal area each year. Heavy minerals identified at the site in order of decreasing occurrence are ilmenite, rutile, zircon, kyanite, hematite, tourmaline, garnet, and pseudobrookite. Figure 4 shows the approximate location and depth of each of the sample holes. The material consists of 4.88 pct coarse aggregate, 94.59 pct fine aggregate, 0.53 pct undersize (minus 200 mesh), and

Figure 4



Sample locations in Claiborne Lower Approach test site.

contains 0.62 pct heavy minerals. Table 4 gives the size distribution of each sample. Table 5 gives the chemical analysis for the minor impurities present in each sample. Table 6 gives the results of the TCLP for a composite sample from the site.

Table 4.—Screen analysis of Claiborne Lower Approach samples

Size	Hole 1	Hole 2	Hole 3	Hole 4		Hole 5	Hole 6	Hole 7	Hole 8	Hole 9	Hole 10
				0-5 ft	5-10 ft						
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	0.85	0.35	0.62	0.21	0.22	0.15	0.39	0.40	0.30	0.18	0.20
Minus 0.75 plus 0.50 in	0.38	1.09	1.02	0.43	0.42	0.71	1.34	1.01	1.14	0.69	0.44
Minus 0.50 plus 0.37 in	1.03	1.91	1.96	1.29	1.20	1.02	1.38	2.58	1.85	1.12	1.25
Minus 0.37 in plus 3 mesh	2.54	2.09	2.27	1.14	0.89	0.92	1.65	2.20	2.15	0.82	1.18
Minus 3 plus 4 mesh	2.24	1.56	2.58	1.47	1.27	1.14	2.15	3.00	1.66	1.24	1.40
Minus 4 plus 6 mesh	3.02	1.82	2.58	1.84	1.50	1.60	2.67	3.34	1.72	1.50	1.91
Minus 6 plus 8 mesh	3.32	2.11	2.38	2.12	1.83	1.76	2.24	2.93	2.01	1.79	2.08
Minus 8 plus 10 mesh	2.96	2.03	2.30	2.14	1.61	2.02	2.44	2.46	2.13	1.99	2.18
Minus 10 plus 14 mesh	2.43	1.91	9.19	10.16	1.60	9.98	11.34	11.03	2.01	10.04	10.22
Minus 14 plus 20 mesh	10.83	8.63	9.90	10.74	8.36	11.04	13.07	11.15	8.53	10.98	10.68
Minus 20 plus 28 mesh	11.20	9.09	9.62	10.26	9.12	11.30	12.09	26.02	9.24	11.15	10.28
Minus 28 plus 35 mesh	26.06	9.62	27.63	24.82	10.62	29.98	25.28	10.92	9.47	30.13	24.80
Minus 35 plus 48 mesh	10.18	29.81	18.42	23.00	32.39	20.07	17.34	16.41	28.96	20.02	22.92
Minus 48 plus 65 mesh	16.21	18.32	6.34	7.89	18.35	6.21	4.54	4.77	19.23	6.27	7.97
Minus 65 plus 100 mesh	4.97	6.65	1.57	1.40	6.68	1.23	0.93	1.11	6.62	1.21	1.36
Minus 100 plus 150 mesh	1.01	1.58	0.88	0.61	1.97	0.51	0.60	0.33	1.61	0.53	0.67
Minus 150 plus 200 mesh	0.43	0.76	0.74	0.48	1.10	0.36	0.55	0.34	0.72	0.34	0.46
Minus 200 mesh	0.34	0.67	0	0	0.87	0	0	0	0.71	0	0
Composite	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 5.—Chemical analysis of minor elements in Claiborne Lower Approach samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-15	2,950	719	3,640	2,330	67	24	440	374
2	0-14	2,520	180	3,800	2,050	66	22	355	559
3	0-13	3,160	241	3,690	2,530	51	46	453	328
4	0- 5	3,580	284	4,470	2,830	67	61	513	604
4	5-10	3,090	273	3,940	2,730	59	43	502	474
5	0- 8	3,640	516	4,540	2,710	82	52	469	878
6	0- 5	3,120	364	5,660	2,310	132	106	379	1,960
7	0- 8	3,020	295	4,220	2,580	86	89	508	828
8	0- 8	3,340	320	4,460	2,730	66	56	485	488
9	0- 9	2,990	273	3,830	2,720	74	62	385	623
10	0-11	3,220	380	4,170	2,440	68	51	495	385

[1] <0.02 ppm Hg for all holes.

Table 6.—TCLP results for Claiborne Lower Approach test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	0.014	Cr	<0.037
As	0.734	Hg	<0.001
Ba	0.354	Pb	0.254
Cd	0.012	Se	<0.300

MILE 9

The Mile 9 site is located at mile 9 on the Alabama River in sec. 28, T. 3N., R. 2E., Baldwin County, AL. The site lies approximately 250 ft from the edge of the river and covers approximately 5 acres. The site presently contains approximately 324,777 yd^3 of material. It is estimated that an additional 53,000 yd³ of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are ilmenite, rutile, kyanite, hematite, tourmaline, garnet, and pseudobrookite. Figure 5 shows the approximate location and depth of each sample hole. The material consists of 0.38 pct coarse aggregate, 98.35 pct fine aggregate, 1.27 pct undersize, and contains 0.42 pct heavy minerals. Table 7 gives the screen analysis of each sample. Table 8 gives the chemical analysis for the minor impurities present in the sample. Table 9 gives the results of the TCLP for a composite sample from the site.

Table 7.—Screen analysis of Mile 9 samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5				Hole 6	Hole 7	Hole 8	Hole 9
					0.5-ft	5-10 ft	10-15 ft	15-20 ft				
Minus 1.0 in . . .	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	0.07	0.06	0.11	0.10	0.23	0.11	0.04	0.12	0.02	0.08	0.08	0.06
Minus 0.75 plus 0.50 in . .	0.04	0.06	0.10	0.23	0.31	0.06	0.10	0.13	0.03	0.11	0.12	0.08
Minus 0.50 plus 0.37 in . .	0.04	0.06	0.06	0.15	0.23	0.14	0.14	0.22	0.08	0.37	0.12	0.08
Minus 0.37 in plus 3 mesh	0.06	0.06	0.12	0.23	0.34	0.25	0.15	0.24	0.10	0.30	0.20	0.10
Minus 3 plus 4 mesh . .	0.14	0.14	0.06	0.28	0.30	0.33	0.18	0.39	0.13	0.41	0.22	0.14
Minus 4 plus 6 mesh	0.18	0.16	0.12	0.42	0.38	0.48	0.24	0.58	0.18	0.57	0.28	0.16
Minus 6 plus 8 mesh	0.24	0.26	0.14	0.16	0.45	4.03	2.45	0.61	0.25	0.71	2.10	0.35
Minus 8 plus 10 mesh	2.93	2.20	0.19	3.13	3.76	9.66	6.73	1.01	0.32	0.97	5.95	2.54
Minus 10 plus 14 mesh	8.15	6.18	0.26	8.15	10.62	11.85	10.41	6.10	3.19	5.78	9.82	6.18
Minus 14 plus 20 mesh	14.03	9.25	2.94	13.06	13.57	33.28	32.11	10.65	8.38	11.50	38.84	12.35
Minus 20 plus 28 mesh	36.27	34.69	8.19	29.09	32.48	26.67	32.56	11.08	11.72	15.24	32.25	39.73
Minus 28 plus 35 mesh	27.70	32.16	12.35	32.20	27.75	8.28	9.78	33.89	38.32	34.69	6.65	25.65
Minus 35 plus 48 mesh	7.53	10.42	37.98	8.47	6.71	1.96	1.97	23.36	25.51	20.36	1.32	8.50
Minus 48 plus 65 mesh	1.31	2.18	26.75	1.75	1.23	1.16	1.26	7.39	7.61	5.60	0.95	1.65
Minus 65 plus 100 mesh . . .	0.62	1.06	7.53	1.16	0.68	1.74	1.88	1.68	1.70	1.27	1.10	1.08
Minus 100 plus 150 mesh . . .	0.69	1.06	1.32	1.42	0.96	0	0	1.09	1.04	0.84	0	1.35
Minus 150 plus 200 mesh . . .	0	0	0.86	0	0	0	0	1.46	1.42	1.20	0	0
Minus 200 mesh	0	0	0.92	0	0	0	0	0	0	0	0	0
Composite . .	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 8.—Chemical analysis of minor elements in Mile 9 samples.

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-15	3,240	123	4,160	2,380	83	27	356	246
2	0-21	3,520	234	3,900	2,430	73	33	363	190
3	0-11	2,740	131	4,010	2,420	66	23	449	349
4	0-20	3,310	176	4,050	2,530	76	46	495	387
5	0- 5	2,620	98	3,990	2,110	72	23	314	589
5	5-10	2,630	101	4,010	1,940	74	<22	323	575
5	10-15	3,320	158	3,870	2,240	73	<22	406	240
5	15-20	3,570	146	4,780	2,750	114	<22	435	277
6	0- 8	2,620	132	4,060	2,400	77	58	390	403
7	0- 9	2,660	147	3,880	2,190	70	23	344	407
8	0-11	3,035	126	4,160	2,260	83	23	370	433
9	0- 9	2,840	134	3,980	2,150	80	31	320	395

[1]<0.02 ppm Hg for all holes.

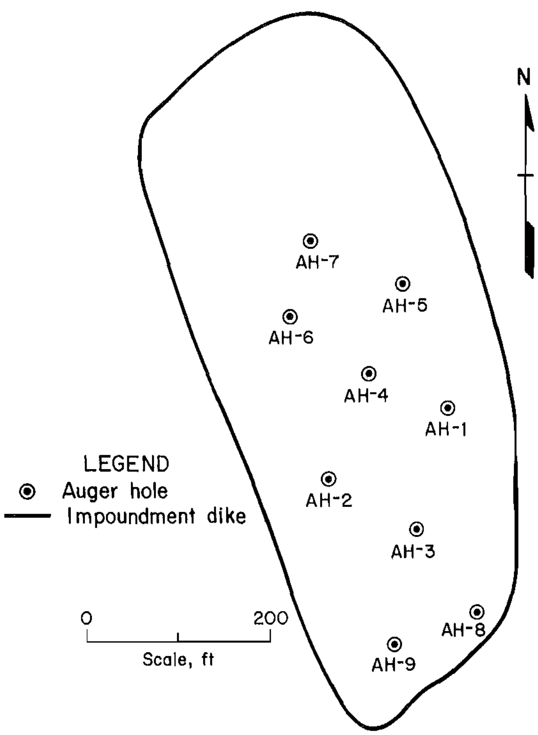
Table 9.—TCLP results for Mile 9 test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.036
As	0.831	Hg	<0.001
Ba	2.370	Pb	0.292
Cd	<0.005	Se	<0.300

SUNFLOWER

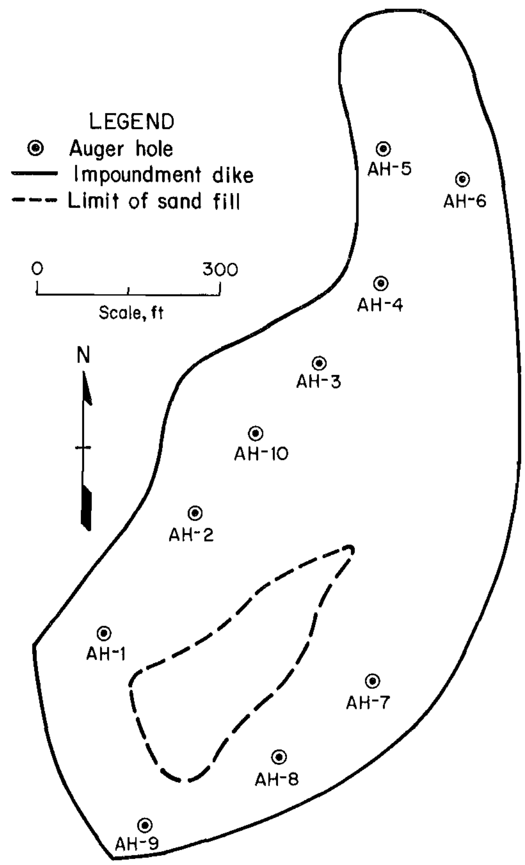
The Sunflower site is located at mile 78 on the Tombigbee River in sec. 20, T. 5N., R. 2E., Clarke County, AL. The site lies approximately 400 ft from the edge of the river and covers approximately 80 acres. The site presently contains approximately 835,610 yd^3 of material and it is estimated that an additional 85,000 yd^3 will be added to the disposal area each year. Heavy minerals identified, in decreasing order of occurrence, include zircon, ilmenite, rutile, kyanite, hematite, tourmaline, and garnet. Figure 6 shows the approximate location and depth of each sample hole. The material consists of 4.37 pct coarse aggregate, 94.66 pct fine aggregate, 0.97 pct undersize, and contains 0.45 pct heavy minerals. Table 10 gives the screen analysis of each sample. Table 11 gives the chemical analysis for the minor impurities present in the sample. Table 12 gives the results of the TCLP for a composite sample from the site.

Figure 5



Sample locations in Mile 9 test site.

Figure 6



Sample locations in Sunflower test site.

Table 10.—Screen analysis of Sunflower samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5				Hole 6	Hole 7	Hole 8	Hole 9	Hole 10
					0-5 ft	5-10 ft	10-15 ft	15-20 ft					
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0.62	0	0
Minus 1.0 plus 0.75 in	0	0.22	0.61	0	0	0	0	0	0	0	0.31	0.12	0.32
Minus 0.75 plus 0.50 in	0.81	0.50	1.78	0.04	0.49	0.54	0.26	0	0.15	0.88	0.64	1.52	1.28
Minus 0.50 plus 0.37 in	1.34	0.64	2.34	0.38	0.82	0.90	0.84	0.56	0.32	1.74	0.59	1.33	1.54
Minus 0.37 in plus 3 mesh ..	1.62	0.82	2.35	0.58	0.70	0.87	1.63	1.15	0.60	2.43	0.84	1.80	1.61
Minus 3 plus 4 mesh	1.42	0.66	1.63	0.55	0.97	0.74	1.51	0.89	0.74	2.61	0.66	1.62	1.35
Minus 4 plus 6 mesh	1.36	0.76	1.41	0.61	1.06	0.50	1.82	1.12	0.76	2.49	0.64	1.60	1.19
Minus 6 plus 8 mesh	1.13	0.60	1.18	0.62	0.75	0.47	1.92	1.08	0.57	2.15	0.55	1.22	1.11
Minus 8 plus 10 mesh	0.85	0.43	0.94	0.46	0.40	0.25	1.60	0.89	0.47	1.49	0.44	0.74	0.89
Minus 10 plus 14 mesh	0.76	0.45	0.94	0.52	0.28	0.19	1.52	1.00	0.41	1.31	0.48	0.77	0.93
Minus 14 plus 20 mesh	4.41	3.32	4.02	3.04	1.73	1.74	8.80	6.21	2.18	5.80	2.63	3.08	3.88
Minus 20 plus 28 mesh	6.52	5.17	4.35	4.59	2.60	2.80	14.94	12.12	4.00	6.72	4.97	5.43	7.29
Minus 28 plus 35 mesh	10.24	12.52	9.27	9.65	4.81	4.23	14.29	21.77	7.48	7.11	11.22	10.47	10.28
Minus 35 plus 48 mesh	23.84	32.59	35.38	26.19	28.74	25.19	24.17	16.35	28.55	34.26	45.10	39.72	38.18
Minus 48 plus 65 mesh	25.03	27.53	21.70	33.07	38.50	40.86	16.33	22.88	33.15	18.78	18.61	17.98	17.36
Minus 65 plus 100 mesh ...	14.93	10.44	8.48	14.10	13.07	14.71	6.95	10.59	14.64	8.15	8.18	8.38	8.70
Minus 100 plus 150 mesh ...	3.29	2.18	1.98	3.24	2.86	3.69	1.64	2.03	3.35	2.00	1.82	2.14	2.10
Minus 150 plus 200 mesh ...	1.26	0.69	0.79	1.21	1.24	1.25	0.84	0.68	1.38	1.08	0.79	1.04	0.94
Minus 200 mesh	1.19	0.48	0.85	1.15	0.98	1.07	0.94	0.68	1.25	1.00	0.91	1.04	1.05
Composite ..	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 11.—Chemical analysis of minor elements in Sunflower samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-24	1,550	<35	3,540	1,250	55	<22	216	611
2	0-23	1,350	<34	3,100	877	54	<22	127	484
3	0-21	1,340	<34	3,160	721	51	<22	171	469
4	0-23	1,900	<44	3,570	1,270	62	<22	207	733
5	0- 5	1,910	41	3,750	1,200	67	<22	314	776
5	5-10	2,190	66	3,930	1,620	60	<22	301	771
5	10-15	1,490	<35	3,380	879	59	<22	203	479
5	15-20	1,290	<34	3,180	989	48	<22	202	464
6	0-19	1,950	<34	3,370	1,310	49	<22	167	505
7	0-22	1,720	<34	3,220	811	48	<22	65	499
8	0-21	1,360	<35	3,230	844	53	<22	69	534
9	0-22	1,970	59	3,430	1,120	59	25	187	503
10	0-22	1,760	<35	3,290	1,060	50	<22	132	507

[1]<0.02 ppm Hg for all holes.

Table 12.—TCLP results for Sunflower test site

Contaminant	Conc, ppm	Contaminant	Conc, ppm
Ag	<0.014	Cr	<0.037
As	0.556	Hg	<0.001
Ba	0.262	Pb	0.332
Cd	<0.005	Se	<0.300

GEORGE GAINES

The George Gaines test site is located at mile 82 on the Tombigbee River in sec. 37, T. 5N., R. 2E., Clarke County, AL. The site presently lies at the edge of the river and covers approximately 35 acres. The site contains approximately 654,296 yd^3 of material. Heavy minerals identified in order of decreasing occurrence are zircon, ilmenite, rutile, kyanite, hematite, tourmaline, and garnet. Figure 7 shows the approximate location and depth of each sample hole. The material consists of 7.53 pct coarse aggregate, 91.53 pct fine aggregate, 0.94 pct undersize, and contains 0.37 pct heavy minerals. Table 13 gives the screen analysis of each sample. Table 14 gives the chemical analysis for the minor impurities in the sample. Table 15 gives the results of the TCLP for a composite sample from the site.

Table 13.—Screen analysis of George Gaines samples

Size	Hole 1	Hole 2					Hole 3	Hole 4	Hole 5	Hole 6	Hole 7	Hole 8	Hole 9	Hole 10
		0-5 ft	5-10 ft	10-15 ft	15-20 ft	20-25 ft								
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in ...	0	0.39	0	0	0.27	0.41	0	0	0	0	0.77	0.66	0.10	0.13
Minus 0.75 plus 0.50 in ...	1.29	0.24	0.21	0.08	0.12	2.13	0.66	0.60	0.99	1.06	3.70	2.06	0.99	0.72
Minus 0.50 plus 0.37 in ...	1.76	0.69	0.52	0.54	1.06	3.66	1.43	1.52	1.98	2.01	5.46	3.03	1.82	1.77
Minus 0.37 in plus 3 mesh ...	2.27	1.00	0.59	1.07	2.04	3.57	1.90	1.75	2.59	2.76	6.21	2.85	2.09	1.93
Minus 3 plus 4 mesh	1.80	1.15	0.94	0.88	1.48	3.00	1.91	1.61	2.54	2.99	3.78	2.65	1.63	1.57
Minus 4 plus 6 mesh	1.87	1.36	1.07	1.09	1.64	2.92	2.20	1.54	2.45	3.42	3.47	2.40	1.79	1.70
Minus 6 plus 8 mesh	1.81	1.41	1.16	1.23	1.72	1.44	2.18	1.52	2.18	2.72	2.66	2.23	1.54	1.60
Minus 8 plus 10 mesh	1.50	1.31	1.11	1.09	1.40	1.85	1.71	1.30	1.68	2.19	2.03	1.73	1.13	1.25
Minus 10 plus 14 mesh	1.61	1.22	1.12	1.28	1.26	2.69	1.63	1.33	1.65	1.93	1.93	1.48	1.04	1.22
Minus 14 plus 20 mesh	7.69	8.13	9.08	8.34	7.91	7.83	10.18	9.53	10.64	11.32	10.89	10.31	5.97	6.71
Minus 20 plus 28 mesh	12.33	20.99	14.48	14.49	12.28	11.42	16.01	13.97	13.98	14.22	14.21	12.78	11.25	9.48
Minus 28 plus 35 mesh	16.94	22.49	22.36	20.66	20.25	17.93	21.23	19.05	18.58	17.18	16.17	17.06	18.03	18.09
Minus 35 plus 48 mesh	26.45	24.48	26.87	26.34	26.88	21.78	22.58	23.81	22.21	21.62	16.13	20.80	27.91	30.24
Minus 48 plus 65 mesh	12.61	8.85	11.96	11.72	11.88	10.56	9.60	12.13	10.23	8.85	7.06	10.31	13.84	13.07
Minus 65 plus 100 mesh	6.12	4.31	5.29	5.83	5.60	4.94	4.07	6.48	5.20	4.64	3.81	5.82	6.73	6.41
Minus 100 mesh plus 150 mesh	1.72	1.11	1.44	1.81	1.83	1.57	1.25	1.96	1.66	1.44	1.04	1.98	2.12	2.21
Minus 150 plus 200 mesh	0.99	0.48	0.84	1.08	0.99	0.99	0.63	0.95	0.72	0.92	0.36	0.97	1.03	1.03
Minus 200 mesh	1.22	0.39	0.96	1.47	1.39	1.30	0.83	0.95	0.72	0.76	0.36	0.88	0.99	0.87
Composite ...	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 14.—Chemical analysis of minor elements in George Gaines samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-24	1,140	218	2,910	1,110	46	110	263	357
2	0- 5	1,110	86	2,600	745	36	55	121	200
2	5-10	1,070	<54	2,590	452	50	<32	102	324
2	10-15	1,350	149	2,930	718	54	104	144	373
2	15-20	1,310	150	2,990	830	52	91	212	406
2	20-24	1,280	127	3,060	917	50	87	209	340
3	0-25	1,320	146	3,070	825	54	112	226	370
4	0-21	1,430	118	2,970	696	54	74	137	274
5	0-17	1,030	79	2,860	907	62	<32	135	343
6	0-17	1,050	<54	2,890	579	51	<32	60	343
7	0- 3	1,070	69	3,100	960	64	<32	114	131
8	0-14	1,890	179	3,370	1,220	69	97	229	180
9	0-15	1,320	105	3,120	758	49	69	200	507
10	0-12	1,120	66	2,770	966	39	<32	146	354

[1]<0.02 ppm Hg for all holes.

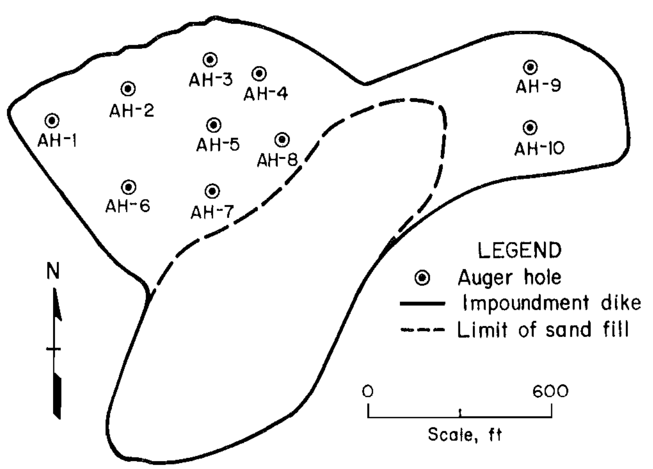
Table 15.—TCLP results for George Gaines test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.037
As	0.599	Hg	<0.001
Ba	0.326	Pb	0.120
Cd	<0.005	Se	<0.300

BUENA VISTA X-3

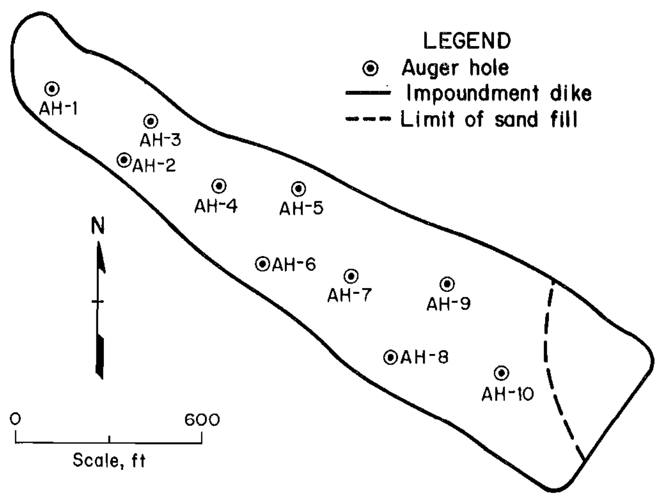
The Buena Vista X-3 site is located at mile 108 on the Tombigbee River in the Mitchell Reserve, T. 8N., R. 1W., Clarke County, AL. The site lies approximately 500 ft from the edge of the river and covers approximately 30 acres. The site presently contains approximately 1,084,726 yd³ of material. It is estimated that an additional 150,000 yd³ of material will be added to the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, rutile, kyanite, ilmenite, tourmaline, and hematite. Figure 8 shows the approximate location and depth of each sample hole. The material consists of 10.02 pct coarse aggregate, 88.91 pct fine aggregate, 1.07 pct undersize, and contains 0.52 pct heavy minerals. Table 16 gives the screen analysis for each sample. Table 17 gives the chemical analysis for the minor impurities present in the samples. Table 18 gives the results of the TCLP for a composite sample from the site.

Figure 7



Sample locations in George Gaines test site.

Figure 8



Sample locations in Buena Vista X-3 test site.

Table 16.—Screen analysis of Buena Vista X-3 samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5					Hole 6	Hole 7	Hole 8	Hole 9	Hole 10
					0-5 ft	5-10 ft	10-15 ft	15-20 ft	20-25 ft					
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	0.76	0.19	0	0.93	0.26	0.20	0	0.24	0.19	0.09	0.30	0	0.10	0.52
Minus 0.75 plus 0.50 in ..	1.45	0.83	1.05	2.58	1.19	1.67	1.32	1.96	0.83	1.88	0.66	0.40	0.31	1.61
Minus 0.50 plus 0.37 in ..	4.53	1.76	1.41	5.03	2.34	2.91	3.10	2.76	1.69	4.24	2.86	1.12	0.59	3.17
Minus 0.37 in plus 3 mesh ..	2.66	2.57	1.84	6.16	2.91	3.31	3.87	2.66	1.67	4.82	3.56	1.68	1.11	4.79
Minus 3 plus 4 mesh	3.62	2.34	1.91	4.66	2.86	2.66	3.34	2.46	1.57	3.21	2.85	0.95	1.08	4.13
Minus 4 plus 6 mesh	3.24	2.01	1.75	3.83	2.52	2.38	2.79	1.70	1.19	2.57	2.21	0.79	0.95	3.42
Minus 6 plus 8 mesh	2.45	1.43	1.46	2.69	1.67	1.67	2.10	1.26	0.91	1.72	1.49	0.49	0.56	2.26
Minus 8 plus 10 mesh	1.65	0.87	0.93	1.66	1.19	1.21	1.37	0.78	0.66	0.98	0.87	0.35	0.35	1.33
Minus 10 plus 14 mesh	1.26	0.58	0.66	1.14	0.89	0.90	0.91	0.65	0.53	0.68	0.52	0.27	0.25	0.86
Minus 14 plus 20 mesh	6.38	2.92	3.19	5.22	4.67	4.79	4.70	3.53	2.86	2.81	2.08	1.45	1.10	3.11
Minus 20 plus 28 mesh	7.70	3.68	4.30	5.69	7.65	7.29	6.85	5.78	6.18	4.06	2.82	2.73	2.17	4.91
Minus 28 plus 35 mesh	10.43	6.17	6.84	7.89	11.92	11.94	10.81	9.10	7.93	5.28	3.96	5.25	3.11	6.86
Minus 35 plus 48 mesh	14.70	14.07	14.38	14.08	20.40	20.55	20.48	19.84	21.71	12.99	14.57	17.56	13.75	17.05
Minus 48 plus 65 mesh	23.73	34.42	33.45	22.84	25.76	25.15	25.02	30.30	33.13	30.69	40.20	43.16	48.11	30.36
Minus 65 plus 100 mesh ...	11.06	19.12	20.06	11.13	10.20	9.64	9.30	12.43	13.88	17.05	15.91	17.82	20.16	12.08
Minus 100 mesh plus 150 mesh	2.49	4.09	4.02	2.38	1.85	1.75	1.88	2.31	2.70	4.34	3.03	3.56	3.79	2.00
Minus 150 plus 200 mesh ...	0.98	1.54	1.43	1.08	0.83	0.88	0.99	1.12	1.22	1.54	1.18	1.34	1.48	0.77
Minus 200 mesh	0.91	1.41	1.32	1.01	0.89	1.10	1.17	1.12	1.15	1.05	0.93	1.08	1.03	0.77
Composite ..	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 17.—Chemical analysis of minor elements in Buena Vista X-3 samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-30	1,940	60	4,340	1,090	94	39	174	668
2	0-20	2,900	117	4,720	1670	99	92	282	998
3	0-26	2,860	86	4,300	1,450	93	73	247	787
4	0-25	2,120	<34	4,510	1,270	96	23	132	924
5	0- 5	1,280	<34	3,550	973	73	<22	74	505
5	5-10	1,400	<34	3,490	802	65	<22	115	417
5	10-15	1,640	<34	3,800	1,010	76	<22	116	507
5	15-20	2,560	129	4,440	1,350	92	69	286	522
5	20-28	2,880	128	4,520	1,680	87	81	298	286
6	0-23	3,090	109	4,760	1,720	102	34	332	1,010
7	0-28	1,800	35	4,170	1,330	90	<22	173	863
8	0-28	2,680	104	4,140	1,510	83	67	220	829
9	0-16	2,880	128	4,350	1,860	95	79	327	944
10	0- 9	2,020	98	4,490	1,240	86	37	211	635

[1]<0.02 ppm Hg for all holes.

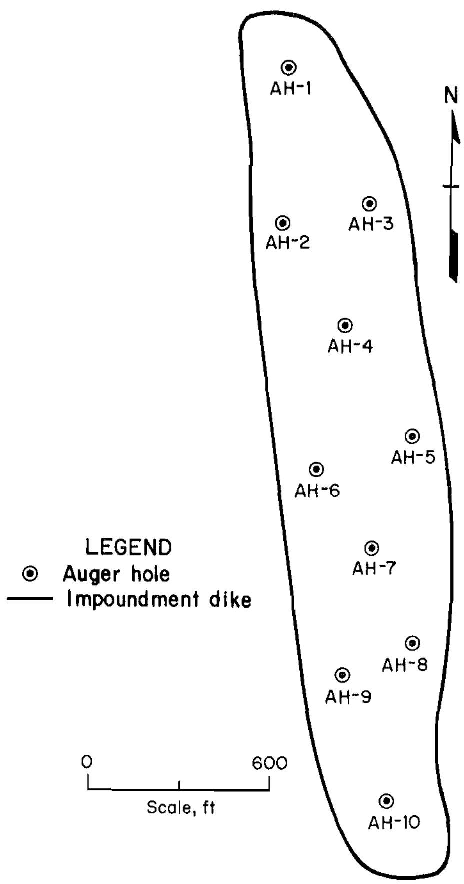
Table 18.—TCLP results for Buena Vista X-3 test site

Contaminant	Conc, ppm	Contaminant	Conc, ppm
Ag	<0.014	Cr	<0.037
As	0.623	Hg	<0.001
Ba	0.239	Pb	0.303
Cd	<0.005	Se	<0.300

BUENA VISTA Z

The Buena Vista Z test site is located at mile 109 on the Tombigbee River in sec. 37, T. 8N., R. 1W., Washington County, AL. The site lies approximately 300 ft from the edge of the river and covers approximately 35 acres. The site contains approximately 1,500,000 yd³ of material. It is estimated that an additional 150,000 yd³ of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, rutile, kyanite, ilmenite, tourmaline, hematite, and garnet. Figure 9 shows the approximate location and depth of each sample hole. The material consists of 10.66 pct coarse aggregate, 88.36 pct fine aggregate, 0.98 pct undersize, and contains 0.49 pct heavy minerals. Table 19 gives the screen analysis of each sample. Table 20 gives the chemical analysis for the minor impurities present in the sample. Table 21 gives the results of the TCLP for a composite sample from the site.

Figure 9

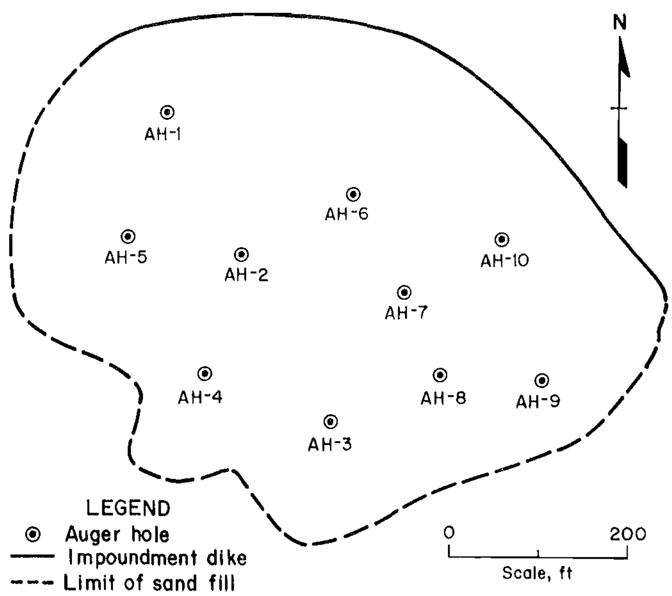


Sample locations in Buena Vista Z test site.

COFFEEVILLE LOWER APPROACH

The Coffeeville Lower Approach site is located adjacent to the Coffeeville Lock and Dam at mile 116 on the Tombigbee River in sec. 7, T. 9N., R. 1W., Choctaw County, AL. The site lies approximately 100 ft from the edge of the river, covers approximately 100 acres, and presently contains approximately 536,450 yd³ of material. It is estimated that an additional 80,000 yd³ of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, rutile, ilmenite, kyanite, tourmaline, hematite, and garnet. Figure 10 shows the approximate location and depth of each sample hole. The material consists of 0.73 pct coarse aggregate, 97.57 pct fine aggregate, 1.70 pct undersize, and contains 0.44 pct heavy minerals. Table 22 gives the screen analysis and heavy mineral content of each sample. Table 23 gives the chemical analysis for the minor impurities present in each sample. Table 24 gives the results of the TCLP for a composite sample from the site.

Figure 10



Sample locations in Coffeeville Lower Approach test site.

Table 19.—Screen analysis of Buena Vista Z samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5	Hole 6					Hole 7	Hole 8	Hole 9	Hole 10
						0-5 ft	5-10 ft	10-15 ft	15-20 ft	20-25 ft				
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	1.81	0.32	0.74	1.68	0.28	1.23	0.43	0.18	0.17	2.83	0.18	0.59	0.73	0.24
Minus 0.75 plus 0.50 in	3.38	3.00	4.33	2.77	1.53	0.62	0.82	1.07	1.55	4.39	0.41	2.91	1.23	0.77
Minus 0.50 plus 0.37 in	4.72	6.10	7.05	5.02	2.75	0.53	0.84	1.29	3.56	5.43	0.56	3.73	1.28	0.78
Minus 0.37 in plus 3 mesh ..	3.54	7.19	8.89	4.43	3.42	0.45	0.69	0.87	3.16	3.58	0.80	4.07	1.17	1.62
Minus 3 plus 4 mesh	2.99	5.06	6.54	4.08	2.63	0.29	0.56	0.68	2.35	2.71	0.77	2.69	0.81	1.53
Minus 4 plus 6 mesh	2.12	4.41	5.21	2.76	2.03	0.22	0.39	0.62	2.06	1.90	0.65	1.54	0.52	1.33
Minus 6 plus 8 mesh	1.33	2.86	3.16	1.77	1.42	0.18	0.24	0.46	1.43	1.18	0.49	0.91	0.35	0.95
Minus 8 plus 10 mesh	0.93	1.85	1.81	1.19	0.90	0.16	0.19	0.39	1.07	0.87	0.34	0.54	0.30	0.62
Minus 10 plus 14 mesh	4.58	1.34	1.24	5.60	0.63	0.82	0.84	1.84	0.83	3.91	0.29	0.46	1.51	0.51
Minus 14 plus 20 mesh	8.48	6.37	5.13	9.52	2.91	2.46	2.64	3.07	4.12	8.03	1.61	2.56	2.76	2.35
Minus 20 plus 28 mesh	8.85	11.52	8.05	9.71	5.50	3.42	3.30	4.40	7.61	7.83	4.04	4.09	5.31	3.23
Minus 28 plus 35 mesh	16.90	10.43	7.73	20.79	6.40	26.47	32.57	28.39	8.10	24.63	4.52	7.39	23.36	5.47
Minus 35 plus 48 mesh	25.76	15.02	12.45	20.82	18.91	39.06	36.40	36.77	25.54	23.03	36.58	28.11	37.32	16.16
Minus 48 plus 65 mesh	10.68	15.19	15.66	6.57	32.96	18.27	15.11	14.73	26.89	6.48	29.17	28.66	16.93	45.15
Minus 65 plus 100 mesh ...	2.06	6.09	8.85	1.59	13.28	3.56	2.64	2.70	7.95	0.88	14.29	8.73	3.34	14.75
Minus 100 mesh plus 150 mesh	0.89	1.61	1.80	0.85	2.43	1.30	1.20	1.27	1.78	1.52	2.70	1.62	1.59	2.40
Minus 150 plus 200 mesh ...	0.98	0.80	0.72	0.85	1.13	0.96	1.14	1.27	0.87	0.80	1.35	0.78	1.49	1.10
Minus 200 mesh	0	0.84	0.64	0	0.89	0	0	0	0.96	0	1.25	0.62	0	1.04
Composite ..	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 20.—Chemical analysis of minor elements in the Buena Vista Z samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-17	2,780	175	4,500	1,510	78	94	239	482
2	0-21	2,050	156	4,280	1,120	119	31	159	403
3	0-17	1,960	83	4,450	1,030	113	30	177	946
4	0-27	2,180	99	4,910	1,110	114	51	187	884
5	0-17	2,760	120	4,340	1,610	92	93	257	581
6	0- 5	3,180	185	4,980	1,840	106	127	333	1,180
6	5-10	2,600	159	4,410	1,460	88	99	446	780
6	10-15	2,320	62	4,020	1,310	92	51	191	732
6	15-20	2,070	47	4,060	944	92	31	129	514
6	20-27	2,370	84	4,360	1,200	110	70	197	631
7	0-23	2,670	134	4,520	1,420	98	87	217	1,190
8	0- 8	2,580	134	3,920	1,530	95	101	265	310
9	0-17	2,340	149	3,940	1,610	86	73	320	441
10	0-14	2,360	71	4,310	1,440	93	74	205	1,040

[1]<0.02 ppm Hg for all holes.

Table 21.—TCLP results for Buena Vista Z test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.037
As	0.866	Hg	<0.001
Ba	0.362	Pb	0.222
Cd	<0.005	Se	<0.300

Table 22.—Screen analysis of Coffeeville Lower Approach samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5				Hole 6	Hole 7	Hole 8	Hole 9	Hole 10
					0-5 ft	5-10 ft	10-15 ft	15-20 ft					
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 0.75 plus 0.50 in	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 0.50 plus 0.37 in	0.26	0.43	0.11	0.02	0.05	0.04	0	0.02	0.04	0.41	0.29	0.51	0.27
Minus 0.37 in plus 3 mesh	0.35	0.37	0.09	0.07	0.39	0.20	0.07	0.10	0.07	0.51	0.23	0.47	0.22
Minus 3 plus 4 mesh	0.33	0.37	0.09	0.05	0.28	0.29	0.12	0.11	0.04	0.58	0.26	0.43	0.22
Minus 4 plus 6 mesh	0.31	0.36	0.09	0.10	0.33	0.27	0.17	0.11	0.08	0.61	0.21	0.47	0.22
Minus 6 plus 8 mesh	0.25	0.31	0.07	0.08	0.33	0.27	0.20	0.11	0.10	0.59	0.19	0.44	0.19
Minus 8 plus 10 mesh	0.25	0.28	0.09	0.10	0.36	0.27	0.14	0.10	0.08	0.45	0.34	0.23	0.14
Minus 10 plus 14 mesh	0.23	0.26	0.07	0.11	0.33	0.27	0.14	0.11	0.13	0.53	0.16	0.22	0.13
Minus 14 plus 20 mesh	1.83	1.47	0.59	0.77	2.43	1.69	0.96	0.94	0.70	2.42	0.87	1.07	0.79
Minus 20 plus 28 mesh	5.88	3.31	2.03	1.95	3.70	3.53	2.75	2.41	2.04	4.72	2.53	2.10	2.19
Minus 28 plus 35 mesh	12.59	8.29	5.87	5.20	7.71	6.94	5.88	6.67	5.54	7.98	5.28	5.37	5.20
Minus 35 plus 48 mesh	40.40	30.64	30.66	31.53	35.09	33.13	32.04	37.50	26.25	29.74	30.16	26.63	31.22
Minus 48 plus 65 mesh	23.41	36.08	39.29	40.98	33.88	40.37	43.44	39.29	38.41	31.17	36.81	31.23	34.75
Minus 65 plus 100 mesh	7.54	10.34	11.33	10.49	8.40	7.25	8.39	7.02	13.18	9.36	10.73	13.20	11.04
Minus 100 mesh plus 150 mesh	3.39	4.35	5.77	4.85	3.92	2.38	2.57	2.48	8.01	6.20	6.79	10.52	8.16
Minus 150 plus 200 mesh	1.48	1.67	2.29	2.00	1.55	1.28	1.31	1.31	3.34	2.90	3.02	4.64	3.39
Minus 200 mesh	1.31	1.42	1.56	1.70	1.25	1.64	1.82	1.72	1.83	1.83	2.08	2.41	1.55
Composite	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 23.—Chemical analysis of minor elements in Coffeeville Lower Approach samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-22	1,830	277	3,890	862	96	44	179	379
2	0-22	2,800	252	4,440	1,530	102	72	250	867
3	0-18	2,830	133	4,100	1,340	104	77	186	464
4	0-17	2,880	204	4,200	1,480	111	86	317	646
5	0- 5	2,560	142	4,010	1,180	103	72	244	588
5	5-10	1,980	105	3,660	1,080	95	37	129	432
5	10-15	1,930	156	3,460	939	88	<23	130	404
5	15-20	1,600	117	3,350	732	94	<22	92	439
6	0-18	3,190	176	4,580	1,770	107	98	302	901
7	0-18	3,270	248	4,830	1690	111	115	279	828
8	0-18	2,770	140	4,400	1,040	105	87	300	557
9	0-13	4,150	319	5,360	2,620	113	179	598	777
10	0-11	3,380	219	4,520	1,940	88	130	445	523

[1]<0.02 ppm Hg for all holes.

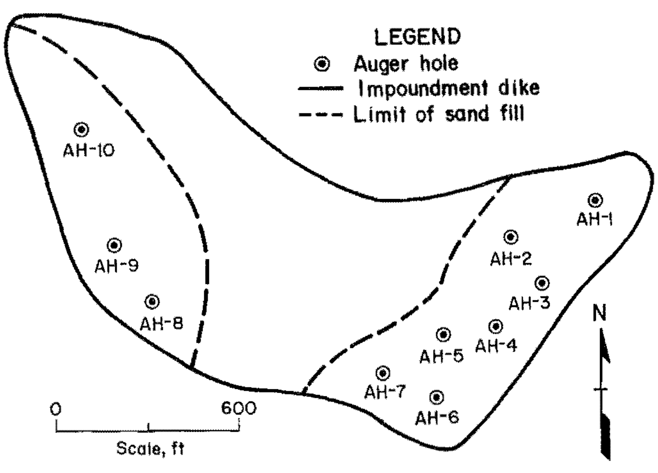
Table 24.—TCLP results for Coffeeville Lower Approach test site

Contaminant	Conc, ppm	Contaminant	Conc, ppm
Ag	<0.014	Cr	<0.037
As	0.505	Hg	<0.001
Ba	0.402	Pb	0.125
Cd	<0.005	Se	<0.300

GRAYS BLUFF

The Grays Bluff site is located at mile 297 on the Black Warrior River in sec. 33, T. 24N., R. 4E., Tuscaloosa County, AL. The site lies approximately 100 ft from the edge of the river and covers approximately 40 acres. The site presently contains approximately 216,261 yd^3 of material. It is estimated that an additional 70,000 yd^3 of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, rutile, kyanite, ilmenite, tourmaline, and garnet. Figure 11 shows the approximate location and depth of each sample hole. The material consists of 4.96 pct coarse aggregate, 94.13 pct fine aggregate, 0.91 pct undersize, and contains 0.36 pct heavy minerals. Table 25 gives the screen analysis of each sample. Table 26 gives the chemical analysis of the minor impurities present in each sample. Table 27 gives the results of the TCLP for a composite sample from the site.

Figure 11

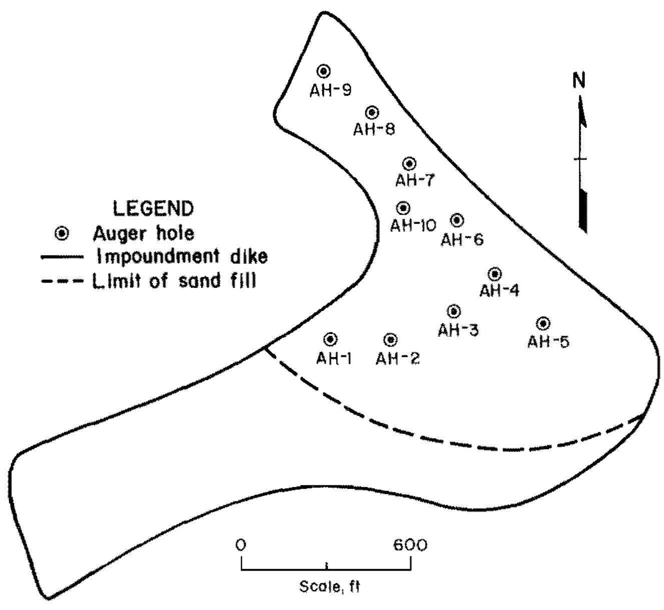


Sample locations in Grays Bluff test site.

BALD BAR/BIG SANDY

The Bald Bar/Big Sandy site is located at mile 307 on the Black Warrior River in sec. 13, T. 24N., R. 4E., Tuscaloosa County, AL. The site lies approximately 100 ft from the edge of the river and covers approximately 80 acres. The site presently contains approximately 1,390,481 yd^3 of material. It is estimated that an additional 150,000 yd^3 of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, rutile, ilmenite, kyanite, garnet, and tourmaline. Figure 12 shows the approximate location and depth of each sample hole. The material consists of 2.34 pct coarse aggregate, 95.19 pct fine aggregate, 2.47 pct undersize, and contains 0.43 pct heavy minerals. Table 28 gives the screen analysis of each sample. Table 29 gives the chemical analysis for the minor impurities present in each sample. Table 30 gives the TCLP results for a composite sample from the site.

Figure 12



Sample locations in Bald Bar/Big Sandy test site.

Table 25.—Screen analysis of Grays Bluff samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5	Hole 6				Hole 7	Hole 8	Hole 9	Hole 10
						0-5 ft	5-10 ft	10-15 ft	15-20 ft				
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	0	0	0	0	0	0.69	0.47	0	0	0.42	0	0	0
Minus 0.75 plus 0.50 in	1.19	0	0.22	0.24	0	3.32	0.78	0.84	0.55	3.13	0.94	0	0.26
Minus 0.50 plus 0.37 in	1.66	0.49	1.11	0.38	0.31	4.62	1.90	1.00	1.98	3.95	1.53	0.97	0.16
Minus 0.37 in plus 3 mesh	1.87	0.56	0.96	0.66	0.33	4.74	2.11	0.96	1.18	4.11	1.71	1.43	0.31
Minus 3 plus 4 mesh	1.42	0.47	0.83	0.44	0.21	3.17	1.57	0.76	1.22	3.08	1.04	1.06	0.14
Minus 4 plus 6 mesh	1.06	0.54	0.50	0.35	0.13	2.48	1.27	0.76	0.94	2.47	0.88	1.03	0.23
Minus 6 plus 8 mesh	0.97	0.39	0.37	0.31	0.15	1.64	0.73	0.72	0.83	1.41	0.66	0.79	0.24
Minus 8 plus 10 mesh	1.06	0.43	0.37	0.26	0.15	1.31	1.14	0.61	0.67	0.84	0.54	0.61	0.23
Minus 10 plus 14 mesh	0.47	0.24	0.19	0.13	0.08	0.64	0.43	0.37	0.39	0.40	0.42	0.45	0.23
Minus 14 plus 20 mesh	3.30	2.08	1.96	0.93	0.44	2.79	2.01	1.57	1.34	1.20	2.19	2.45	1.29
Minus 20 plus 28 mesh	7.27	6.88	6.34	3.06	1.18	4.80	4.25	3.06	2.40	1.95	6.22	6.41	3.52
Minus 28 plus 35 mesh	18.13	16.47	15.12	8.14	4.20	9.58	8.61	7.22	6.63	5.19	16.42	17.10	6.97
Minus 35 plus 48 mesh	36.93	40.33	37.14	33.27	30.33	32.36	32.14	32.47	32.49	25.00	37.64	37.77	27.07
Minus 48 plus 65 mesh	17.54	23.08	24.43	37.41	45.25	21.77	31.75	37.73	37.51	33.76	21.03	20.91	41.22
Minus 65 plus 100 mesh	3.58	5.12	6.07	8.81	10.80	4.20	7.27	7.40	7.50	8.44	5.07	4.96	12.32
Minus 100 mesh plus 150 mesh	1.61	1.87	2.44	3.27	3.93	1.20	2.07	2.32	2.19	2.71	1.92	1.87	3.96
Minus 150 plus 200 mesh	0.78	0.61	0.99	1.11	1.30	0.33	0.73	0.92	0.87	0.92	0.83	0.91	1.10
Minus 200 mesh	1.15	0.44	0.96	1.22	1.22	0.36	0.78	1.28	1.31	1.03	0.96	1.27	0.73
Composite	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 26.—Chemical analysis of minor elements in Grays Bluff samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-22	1,660	<54	4,630	867	104	<32	72	513
2	0-22	2,010	75	3,980	1,120	94	57	61	233
3	0-15	1,860	<53	3,940	856	100	<32	<54	250
4	0-17	520	119	4,230	1,190	95	89	187	524
5	0-18	2,470	159	4,240	1,390	85	96	236	689
6	0- 5	2,440	159	4,200	948	92	122	169	538
6	5-10	2,280	142	4,150	1,090	88	98	176	623
6	10-15	2,560	131	4,230	990	94	87	154	556
6	15-23	2,450	156	4,210	1,030	93	68	144	728
7	0-16	2,440	100	4,180	1,310	83	85	169	637
8	0-16	1,920	133	3,810	918	57	97	177	1,275
9	0-25	1,730	65	3,710	883	64	45	88	385
10	0-16	1,750	<54	4,130	1,220	93	40	149	827

[1] <0.02 ppm Hg for all holes.

Table 27.—TCLP results for Grays Bluff test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.037
As	0.759	Hg	<0.001
Ba	0.353	Pb	0.506
Cd	<0.005	Se	<0.300

Table 28.—Screen analysis of Bald Bar/Big Sandy samples

Size	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5	Hole 6					Hole 7	Hole 8	Hole 9	Hole 10
						0-5 ft	5-10 ft	10-15 ft	15-20 ft	20-25 ft				
Plus 1.0 in	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	0	0	0	0.23	0	0	0	0	0	0	0	0	0.98	0.50
Minus 0.75 plus 0.50 in	0	0.33	0.89	0.30	0.37	0.76	0	0.09	0	0.41	0.13	0.19	2.20	0.75
Minus 0.50 plus 0.37 in	0.11	0.71	0.69	0.08	0.48	0.56	0.12	0.21	0.30	0.22	0.45	0.91	2.28	0.99
Minus 0.37 in plus 3 mesh	0.13	0.53	0.63	0.23	0.45	0.58	0.24	0.18	0.16	0.15	0.39	1.34	3.11	0.89
Minus 3 plus 4 mesh	0.26	0.43	0.54	0.14	0.34	0.62	0.24	0.12	0.13	0.26	0.27	1.16	2.25	0.67
Minus 4 plus 6 mesh	0.14	0.28	0.49	0.11	0.36	0.71	0.22	0.12	0.09	0.15	0.30	0.99	1.73	0.58
Minus 6 plus 8 mesh	0.11	0.17	0.39	0.12	0.36	0.70	0.20	0.13	0.12	0.19	0.24	0.73	1.27	0.43
Minus 8 plus 10 mesh	0.06	0.12	0.33	0.13	0.30	0.59	0.16	0.11	0.11	0.17	0.20	0.49	0.88	0.32
Minus 10 plus 14 mesh	0.06	0.10	0.24	0.13	0.24	0.50	0.15	0.11	0.12	0.14	0.15	0.34	0.63	0.23
Minus 14 plus 20 mesh	0.10	0.43	1.10	0.73	1.10	2.28	0.77	0.63	0.57	0.81	0.77	1.25	2.27	1.14
Minus 20 plus 28 mesh	0.43	1.19	3.19	2.55	2.91	7.10	2.91	2.08	1.87	3.02	2.21	2.85	4.66	2.65
Minus 28 plus 35 mesh	1.08	2.90	7.21	6.09	6.69	14.55	6.59	4.29	4.78	7.18	5.97	5.82	10.18	5.85
Minus 35 plus 48 mesh	2.90	11.35	16.89	14.55	15.82	26.21	15.09	13.19	19.62	18.20	18.45	18.91	25.11	15.41
Minus 48 plus 65 mesh	10.60	34.33	30.44	29.15	23.67	24.99	30.01	33.59	36.13	33.14	35.71	37.87	23.53	32.87
Minus 65 plus 100 mesh	30.87	26.32	19.06	23.96	22.42	10.85	21.96	23.78	20.44	21.18	20.90	17.74	11.02	20.71
Minus 100 mesh plus 150 mesh	28.44	14.65	12.40	14.59	16.69	5.60	13.41	13.64	9.48	9.96	8.92	6.20	4.66	10.46
Minus 150 plus 200 mesh	16.85	4.09	3.58	4.36	5.23	1.90	4.30	4.03	2.92	2.68	2.49	1.73	1.49	3.12
Minus 200 mesh	5.22	2.07	1.93	2.55	2.57	1.50	3.63	3.70	3.16	2.14	2.45	2.08	1.75	2.43
Composite	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 29.—Chemical analysis of minor elements in Bald Bar/Big Sandy samples

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-17	4,860	145	5,280	3,060	110	103	496	957
2	0-17	5,270	204	5,050	2,600	127	231	429	849
3	0-18	4,880	156	4,750	2,600	115	226	348	694
4	0-18	4,280	121	4,760	2,450	105	147	372	730
5	0-10	5,830	115	5,150	2,870	119	220	389	712
6	0- 5	2,260	<54	4,150	1,290	103	<32	176	581
6	5-10	4,980	175	5,110	2,790	138	186	372	791
6	10-15	4,820	221	5,290	2,810	132	170	475	860
6	15-20	3,920	169	4,680	2,140	135	188	344	654
6	20-24	3,560	113	4,620	2,430	110	106	355	753
7	0-23	2,630	<54	4,220	1,760	114	<32	172	659
8	0-26	3,420	98	4,360	1,830	140	117	206	699
9	0-23	3,460	194	4,550	1,530	132	156	257	577
10	0-31	5,090	192	4,990	2,540	141	207	410	728

[1]<0.02 ppm Hg for all holes.

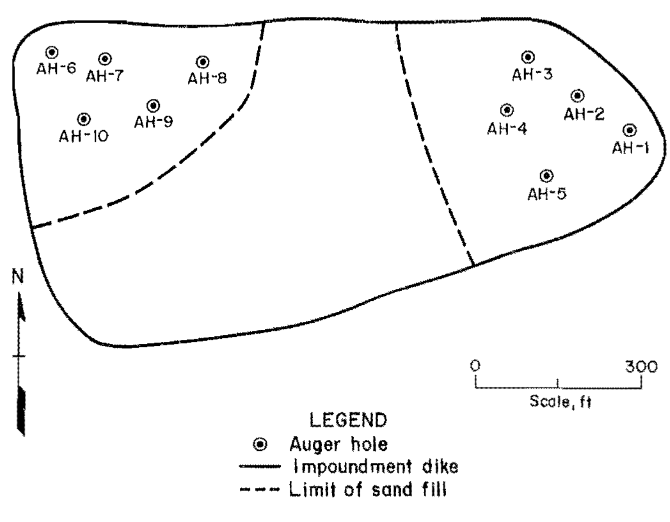
Table 30.—TCLP results for Bald Bar/Big Sandy test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.037
As	0.760	Hg	<0.001
Ba	0.180	Pb	0.094
Cd	<0.005	Se	<0.300

OPHELIA

The Ophelia site is located at mile 329 on the Black Warrior River in sec. 34, T. 21S., R. 11W., Tuscaloosa County, AL. The site lies approximately 200 ft from the edge of the river and covers approximately 52 acres. The site presently contains approximately 189,747 yd³ of material. It is estimated that an additional 26,000 yd³ of material will be placed in the disposal area each year. Heavy minerals identified in order of decreasing occurrence are zircon, ilmenite, rutile, hematite, kyanite, tourmaline, garnet, and monazite. Figure 13 shows the approximate location and depth of each sample hole. The dredged material was placed in two separate areas within the impoundment. The areas varied considerably in the proportion of coarse and fine aggregate, thus separate consideration was given to each area. The material in the eastern area consists of 7.59 pct coarse aggregate, 91.19 pct fine aggregate, 1.22 pct undersize, and contains 0.24 pct heavy minerals. Table 31 gives the screen analysis of each sample from this area. Table 32 gives the chemical analysis of the minor impurities present in each sample. The material in the western area consists of 21.71 pct coarse aggregate, 77.02 pct fine aggregate, 1.27 pct undersize, and contains 0.30 pct heavy minerals. Table 33 gives the screen analysis of each sample from this area. Table 34 gives the chemical analysis of the minor impurities present in each sample. Table 35 gives the results of the TCLP for a composite sample from the site.

Figure 13



Sample locations in Ophelia test site.

Table 31.—Screen analysis of Ophelia samples (eastern area)

Size	Hole 1	Hole 2			Hole 3	Hole 4	Hole 5
		0-5 ft	5-10 ft	10-15 ft			
Plus 1.0 in	0	0	0	0	0	0	0
Minus 1.0 plus 0.75 in	1.18	0	0.37	0	1.31	1.28	0.55
Minus 0.75 plus 0.50 in	2.80	1.50	0.54	1.03	3.57	2.37	1.55
Minus 0.50 plus 0.37 in	1.89	1.68	0.19	1.37	3.14	2.61	1.99
Minus 0.37 in plus 3 mesh	2.23	1.66	0.49	1.87	2.65	2.07	2.30
Minus 3 plus 4 mesh	1.66	0.97	0.28	1.19	1.71	1.44	1.76
Minus 4 plus 6 mesh	1.37	0.93	0.24	1.02	1.16	0.97	1.42
Minus 6 plus 8 mesh	1.07	0.70	0.21	0.72	0.87	0.74	1.05
Minus 8 plus 10 mesh	0.75	0.58	0.19	0.53	0.61	0.60	0.65
Minus 10 plus 14 mesh	0.49	0.43	0.16	0.37	0.37	0.40	0.36
Minus 14 plus 20 mesh	1.76	1.65	0.33	1.31	1.52	1.52	0.92
Minus 20 plus 28 mesh	2.93	3.37	2.11	2.93	3.08	3.29	1.56
Minus 28 plus 35 mesh	7.92	9.81	7.62	7.89	7.50	8.42	4.64
Minus 35 plus 48 mesh	32.39	37.16	38.29	32.88	31.33	31.97	24.20
Minus 48 plus 65 mesh	31.14	29.95	37.09	34.74	29.76	29.23	39.58
Minus 65 plus 100 mesh	6.75	6.40	7.30	7.22	6.89	7.55	10.80
Minus 100 mesh plus 150 mesh	2.11	2.01	2.26	2.30	2.42	3.06	3.84
Minus 150 plus 200 mesh	0.70	0.59	0.88	0.99	0.91	1.19	1.42
Minus 200 mesh	0.86	0.61	1.45	1.65	1.20	1.29	1.45
Composite	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 32.—Chemical analysis of minor elements in Ophelia samples (eastern area)

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
1	0-12	3,320	159	4,360	1,320	100	174	286	401
2	0- 5	2,650	72	3,930	1,220	74	125	180	436
2	5-10	2,810	105	3,660	1,150	118	118	180	388
2	10-17	2,030	<53	3,530	903	97	<32	109	342
3	0-18	1,960	113	3,930	938	71	54	243	411
4	0-12	2,370	89	4,240	1,330	105	48	240	324
5	0-11	3,290	206	3,970	1,660	106	147	438	475

[1] <0.02 ppm Hg for all holes.

Table 33.—Screen analysis of Ophelia samples (western area)

Size	Hole 6	Hole 7		Hole 8	Hole 9	Hole 10
		0-5 ft	5-10 ft			
Plus 1.0 in	0.48	0	0	0.52	0	0.81
Minus 1.0 plus 0.75 in	2.04	1.98	1.47	0.56	0.69	2.41
Minus 0.75 plus 0.50 in	9.32	8.02	2.98	4.03	5.10	4.33
Minus 0.50 plus 0.37 in	9.46	8.36	3.49	5.30	4.17	4.35
Minus 0.37 in plus 3 mesh	8.86	7.02	2.27	4.61	4.26	4.09
Minus 3 plus 4 mesh	5.27	4.80	1.49	2.80	2.37	2.55
Minus 4 plus 6 mesh	3.95	3.34	1.06	2.41	1.73	1.87
Minus 6 plus 8 mesh	2.60	2.22	0.76	1.62	1.14	1.18
Minus 8 plus 10 mesh	1.57	1.54	0.48	1.07	0.77	0.87
Minus 10 plus 14 mesh	0.96	0.94	0.33	0.70	0.51	0.52
Minus 14 plus 20 mesh	2.30	2.78	0.97	1.87	1.47	1.62
Minus 20 plus 28 mesh	3.59	4.21	1.55	2.69	2.75	2.78
Minus 28 plus 35 mesh	5.59	7.63	3.75	5.05	5.83	6.64
Minus 35 plus 48 mesh	19.62	20.23	18.95	17.92	22.38	25.29
Minus 48 plus 65 mesh	17.28	18.33	41.08	30.82	29.83	27.88
Minus 65 plus 100 mesh	4.02	5.20	12.44	11.26	9.41	7.73
Minus 100 mesh plus 150 mesh	1.46	1.97	4.03	3.97	4.30	2.91
Minus 150 plus 200 mesh	0.66	0.70	1.26	1.23	1.72	1.05
Minus 200 mesh	0.97	0.73	1.64	1.57	1.57	1.12
Composite	100.00	100.00	100.00	100.00	100.00	100.00

Table 34.—Chemical analysis of minor elements in Ophelia samples (western area)

Hole	Depth, ft	Chemical analysis,[1] ppm							
		Al	Ca	Fe	K	Mn	Mg	Na	Ti
6	0-16	3,900	114	6,020	1,600	76	178	249	540
7	0- 5	2,190	99	4,400	1,140	57	106	210	422
7	5-13	2,950	62	3,960	1,300	102	78	150	470
8	0-16	3,300	<54	4,830	1,470	51	115	263	578
9	0- 5	3,750	99	4,470	1,820	91	104	381	440
10	0-12	3,430	107	4,480	1,800	92	143	314	529

[1]<0.02 ppm Hg for all holes.

Table 35.—TCLP results for Ophelia test site

Contaminant	*Conc, ppm*	*Contaminant*	*Conc, ppm*
Ag	<0.014	Cr	<0.037
As	0.393	Hg	<0.001
Ba	0.162	Pb	0.158
Cd	<0.005	Se	<0.300

CONCLUSIONS

Samples from each of the upland disposal sites were determined to have the properties necessary for use as aggregate in general-purpose portland cement concretes. In all cases the material in the disposal sites was clean quartz sand and gravel containing few impurities and no reactive or deleterious constituents. Due to the semi-rounded shape of the particles, use in high-strength applications is not recommended. Although a more angular shaped material is generally preferred in asphalt concrete mixtures, the samples meet all the other criteria necessary for these mixtures and may be suitable for use in certain applications. Sink-float analyses revealed no economical heavy mineral values in any of the samples. Results of the TCLP showed no sample to be a hazardous waste.

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APPENDIX A.—STANDARD ASTM TESTS FOR AGGREGATE USED IN PORTLAND CEMENT CONCRETE

Aggregate characteristic	*ASTM test method*
Sampling	D 75
Gradation:	
Coarse and fine	C 136
Mineral filler	C 117
Fineness modulus	C 136
Unit weight	C 29
Particle shape	D 2248
Los Angeles abrasion:	
Coarse	C 535
Fine	C 131
Deleterious materials:	
Clay and friable particles	C 142
Chert	C 123
Minus 200-mesh	C 117
Organic impurities	C 40
Reactive aggregate	C 33

APPENDIX B.—TOXIC CHARACTERISTIC LEACHATE PROCEDURE (TCLP, METHOD 1311)

Extraction solution #1
11.4 mL glacial acetic acid
Approximately 128.6 ml of 1.0 N NaOH
Dilute to 2 L with distilled water
Adjust pH to 4.93 +/-0.05 with 1.0 N NaOH

Extraction solution #2
11.4 mL glacial acetic acid
Dilute to 2 L with distilled water
Adjust pH to 2.88 +/-0.05 with 1.0 N NaOH

Crush sample to minus 3/8 in

Place a 5 g sample into 150 mL etched beaker
Add 96.5 mL distilled water
Cover and stir 5 min

Measure pH
If pH </=5.0 use solution 1

If pH >5.0 add 3.5 mL 1 N HCl
Stir 30 s
Heat to 50° C for 10 min

Cool to room temperature
Measure pH
If pH </=5.0 use solution 1

If pH >5.0 use solution 2

Add 100 g of sample to 2 L of extraction solution
Tumble for 18 h
Vacuum filter
Analyze filtrate as per EPA approved procedures

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