REPORT

DEMONSTRATION OF PAPER PULP WASTE FOR ALTERNATIVE DAILY COVER CINDER LAKE LANDFILL FLAGSTAFF, ARIZONA

Prepared for
City of Flagstaff
211 West Aspen Avenue
Flagstaff, AZ 86001

and

Arizona Department of Environmental Quality
3003 North Central Avenue
Phoenix, AZ 85012-2905

Woodward-Clyde Project No. 96A199-1101

May 30, 1997

Woodward-Clyde

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Woodward-Clyde
Engineering & sciences applied to the earth & its environment

May 30, 1997

Mr. Larry K. Lampert, P.E.
Environmental Engineer
Arizona Department of Environmental Quality
3003 North Central Avenue
Phoenix, AZ 85012-2905

Subject: Demonstration of Paper Pulp Waste for Alternative Daily Cover
Cinder Lake Landfill
Flagstaff, Arizona
ADEQ File No. 100852
Woodward-Clyde Project No. 96A199-1101

Dear Mr. Lampert:

On behalf of the City of Flagstaff, Woodward-Clyde International-Americas (Woodward-Clyde) is pleased to submit this demonstration for the use of paper pulp waste as an alternative daily cover at the Cinder Lake Landfill in Flagstaff, Arizona. This report addresses the requirements of Title 40, Code of Federal Regulations (CFR), §258.21(b) which indicates that the Director of an approved State may approve an alternative cover material, provided that the owner or operator demonstrates that the alternative cover material will control disease vectors, fire, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

This report presents the results of tests we performed to evaluate the physical characteristics of paper pulp waste from the Wisconsin Tissue plant in Flagstaff. It also provides a discussion of other landfill sites that have utilized the paper pulp waste as a cover material.

Based on the results of our tests and review of other experience, it is our opinion that the tested paper pulp waste will be suitable for use as an alternative daily cover and satisfies the requirements in 40 CFR 258.21(b). Should ADEQ approve this demonstration, the approval will be placed in the Operating Record for the Cinder Lake Landfill, and it will be considered as an amendment to the Daily Cover Section (Section 10.9) of the current facility operations plan dated March 1, 1994.

Woodward-Clyde Consultants
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If you have any questions regarding this report, please call me at 619-683-6112.

Very truly yours,

WOODWARD-CLYDE INTERNATIONAL-AMERICAS

David E. Marx
Project Manager

DEM:/hal

cc: Mr. Ben Fisk, City of Flagstaff

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This report provides the results of Woodward-Clyde International-Americas' (Woodward-Clyde) evaluation of paper pulp waste from the Wisconsin Tissue (formerly known as Orchid Paper) plant in Flagstaff, Arizona, proposed to be used as an alternative daily cover at the Cinder Lake Landfill in Flagstaff, Arizona. The paper pulp waste has characteristics similar to clay soils and has created an interest in using the waste as a substitute for soils as the daily cover material.

The purpose of our services was to determine the physical characteristics of paper pulp waste from the Wisconsin Tissue plant in Flagstaff and evaluate its use as an alternative daily cover material. As specified in Title 40 CFR §258.21(b) and reiterated in Arizona Department of Environmental Quality's letter dated October 13, 1995, our evaluation addresses the paper pulp waste's ability to provide sufficient cover to control vectors, fires, odors, litter and scavenging without presenting a threat to human health or the environment. The scope of our evaluation was outlined in our proposal dated March 10, 1997 and consisted of a literature review, laboratory testing of the waste, evaluations of the waste for use as daily cover, and preparation of this report.

The Wisconsin Tissue facility recycles high-grade office paper and other papers by recovering the fiber component. The paper pulp waste that results from this process is often referred to as paper sludge and is also called deinking sludge. Industry-wide, this waste typically consists of 50-65% ash comprised of clay, calcium carbonate, trace amounts of titanium and other paper mill fillers and additives (NCASI, 1991). A Material Safety Data Sheet obtained from Champion International, indicates a typical composition of their paper sludge to be 40% clay, 30% fiber, 20% calcium carbonate, 4% casein, 2% titanium dioxide, and 4% dye, latex and defoamer.

At the Wisconsin Tissue facility, the paper pulp waste is processed through a filter press to remove "free liquid" as defined by EPA Method 9095 (Paint Filter Liquids Test) in order to comply with the liquids restriction criteria specified in 40 CFR §258.28. The resulting dewatered paper pulp waste has the appearance and texture of soft clay granules with embedded fibers.

A literature review was performed to evaluate the past use of paper pulp waste as a landfill cover material. In addition, a number of operating landfills that are currently using paper pulp waste as a daily cover were contacted to solicit information on its use.

2.1 LITERATURE REVIEW

The National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) has conducted research on the use of paper pulp waste for use both as daily and final cover for municipal solid waste landfills (NCASI, 1989). In 1989, NCASI identified 14 landfills where paper pulp waste or fly ash had been used as cover materials. Eight sites used the paper pulp waste as an intermediate or daily cover material. Hydraulic conductivity was measured in the laboratory on the various paper pulp wastes being utilized and ranged from 10^{-4} to 10^{-8} centimeters per second (cm/sec).

An evaluation was recently performed for the use of paper pulp waste at three landfills in the northeastern United States (Floess, 1995). The paper pulp waste utilized at these three landfills was characterized as a "fiber-clay" as it was typically composed of wood fibers, grit and clay obtained as a by product of the paper production. Although the fiber clay had a moisture content often exceeding 200% (by dry weight) it was workable by standard landfilling equipment and did not require moisture conditioning for placement or compaction. For paper pulp waste containing more than 40 to 50% clay, hydraulic conductivities of 10^{-7}cm/sec were measured in the laboratory.

Another evaluation was recently performed of paper pulp waste from seven different paper plants (Moo-Young and Zimmie, 1996). This study found that the paper pulp waste has a high degree of compressibility and behaves like a highly organic soil. Lab permeability tests on in-situ specimens indicated that they met the regulatory requirements for the barrier layer of a final cover system (10^{-7}cm/sec or less) or were very close. They found that consolidation and dewatering of the waste over time decreased the hydraulic conductivity by an order of magnitude.

NCASI also conducted a study related to the chemical characteristics of paper pulp waste (NCASI, 1991). Paper pulp waste from six mills were analyzed for toxic characteristic constituents (heavy metals and TCLP organics). The measured concentrations were less than 5% of the corresponding hazardous waste thresholds.

Chemical analysis was conducted on paper pulp waste from the Wisconsin Tissue facility in 1993, 1994 and 1995. The results of these analyses indicate that the paper pulp waste from the Flagstaff facility categorizes as a non-hazardous waste when compared to the regulatory criteria found in 40 CFR Part 261.

2.2 LANDFILLS CONTACTED

Five currently operating landfills were also contacted to solicit information on their use of paper pulp waste as a cover material. Mallard Lake Landfill in Illinois began using short paper fiber waste when a two-year experimental permit was granted by Illinois EPA allowing the use on two

working faces with a maximum exposure of 6 days (Griesbach, 1997). The permit requires a minimum of six inches to be used as cover; they typically use six to twelve inches. After 2 years an official permit was granted. The only change was that the final permit allowed the paper pulp waste to be exposed for up to twelve days. The landfill operators have found that the waste has worked very well for vector and litter control. Although the waste has a musty odor when it arrives, that odor is not strong or offensive and goes away when it dries slightly.

The Chain of Rocks Landfill in Illinois is using a paper mill sludge for daily cover (Rainer, 1997). This sludge was too wet to utilize at first but then the supplying mill passed the sludge through a press to dewater it before shipping it to the landfill. They can easily spread the dewatered sludge with bulldozers. The sludge is placed 7 to 8 inches thick and is typically covered by the landfilling operations within a week. The sludge is not odorous and is effective in controlling vectors. The sludge does not get dusty even after drying for a week.

The Milam Landfill in Illinois also uses paper pulp sludge as a daily cover (Dennison, 1997). The Illinois EPA has allowed up to 5,000 square feet to be exposed at any one time and it may be exposed for up to two weeks.

Rodman Landfill in Rodman, New York had a Beneficial Use Determination issued from the New York EPA in 1994 to use paper pulp waste as a daily cover (Condino, 1997). They receive paper sludge from 6 different mills and they apply the waste in a 6- to 12-inch layer with a bulldozer. During daily operations, they do not have odor or vector problems with the sludge. However, they did try to stockpile a few months supply of the sludge for future use and did have an odor problem at the stockpile.

Fulton County Landfill in New York has been using the paper pulp waste for two to three years as daily cover and have had no problems with it (Bevington, 1997). They are permitted to have it exposed for up to 29 days yet typically it is covered within one week. They are able to use it year round and in all weather conditions.

We have characterized the physical properties of samples of the paper pulp waste proposed for use as an alternative daily cover for the Cinder Lake Landfill. The sample evaluated was obtained in three sealed five-gallon containers from the Wisconsin Tissue plant in Flagstaff which currently disposes the waste in the Cinder Lake Landfill. The results of the tests performed on the paper pulp waste are presented in Table 1.

3.1 MOISTURE CONTENT AND DENSITY

The moisture content of the as-received sample of the paper pulp waste was determined in accordance with ASTM D2216. The moisture content was found to range from 196% to 200% (of dry weight). The density of the paper pulp waste, as-received in the sample containers, was also determined. The wet density of the paper pulp waste was 70 to 71 pounds per cubic foot (pcf) which, with the above moisture contents, would give a dry density of 23 to 25 pcf.

3.2 INDEX TESTS

The specific gravity of the paper pulp waste was determined in accordance with ASTM D854 and found to be 2.00. The liquid and plastic limits (Atterberg limits) were determined in accordance with ASTM D4318. However the fibrous content of the samples did not allow for repeatable results. The results obtained on one of the specimens is presented in Table 1.

3.3 GRADATION

The fiber content in the paper pulp waste also created difficulties with testing the gradation of the waste. The size of the fiber that would pass through the sieves was dependent on the amount of agitation that was used during the sieving process. The fibers and clays also flocculated to such an extent during a hydrometer analysis that this test could not be completed.

Using the Atterberg limits and the Unified Soil Classification System, the fine fraction of the paper pulp waste would be classified as a highly plastic silt (USCS classification MH).

3.4 COMPACTION

A compaction test was performed to evaluate the moisture content-density relationship using ASTM D698. The as-received moisture content of the waste was much higher than the optimum moisture content and the samples required considerable drying to obtain the maximum density. A maximum density of 40 pcf at an optimum moisture content of 65% (of dry weight) was obtained. The results of the lab compaction tests are shown in Figure 1.

3.5 STRENGTH

The strength of the paper pulp waste was evaluated using the direct shear apparatus in accordance with ASTM D3080. The test was performed on a specimen compacted at the as-received moisture content and using the standard energy applied in ASTM D698. The results of the strength test are presented in Figure 2.

3.6 HYDRAULIC CONDUCTIVITY

The hydraulic conductivity was determined in accordance with ASTM D5084. The test was performed on a specimen compacted at the as-received moisture content and using the standard energy applied in ASTM D698. The results of these tests indicate a hydraulic conductivity of 1.2 to 2.6×10^{-7} cm/sec.

Our tests results and a review of information on other paper pulp waste that has been used as landfill cover material indicates that the Wisconsin Tissue paper pulp waste will be suitable for use as an alternative daily cover. The test results indicate that the material is similar in characteristics to paper pulp waste that have been utilized elsewhere for landfill cover material; Table 1 includes a comparison of our test data with published data on other paper pulp waste that has been used as landfill cover material. The published reports and discussions with current landfill operators utilizing the paper pulp waste as alternative daily cover indicates that this can be a beneficial use for the waste. The following paragraphs discuss the beneficial aspects of the paper pulp waste as an alternative daily cover.

4.1 40 CFR §258.21(b) REQUIREMENTS

4.1.1 Disease Vector and Scavenging Control

A review of the published literature and discussions with current operators indicate that the paper pulp waste is applied to the landfill in a manner very similar, if not identical to, a soil cover and controls vectors from the landfill waste and prevents scavenging. A minimum thickness of 6 inches was typically used for the cover. Discussions with the landfill operators, mill operators and NCASI research staff indicated that the waste does not attract flies, rodents, birds, mosquitoes or other animals.

4.1.2 Fire Prevention

The as-received moisture content of the paper pulp waste is very high and the material provides a good fire retardant by covering the working face in a manner similar to a soil cover with a non-ignitable material. Similar to a soil cover, it limits the access of atmospheric oxygen to the landfill waste. The flashpoint of the paper pulp waste is greater than 350°F based on chemical analysis conducted by the Flagstaff facility in 1994. Although the paper pulp waste can itself be combustible if oven dried, the reviewed literature and discussion with current operators indicate that for exposures of up to four weeks it does not become dry enough to combust.

4.1.3 Odor Control

The test results indicate a hydraulic conductivity of the paper pulp waste was on the order of 10^{-7} cm/sec. Material with this low of a hydraulic conductivity will provide suitable control of landfill odors. Our discussion with landfill operators confirm that using paper pulp waste as cover has not resulted in odor problems at these landfills. Additionally, based on discussions with the landfill operators at the Cinder Lake Landfill, no odor problems have been associated with the paper pulp waste that has been disposed at the landfill for over ten years.

4.1.4 Blowing Litter and Dust Control

The paper pulp waste in the moist condition as received at the landfill is of sufficient weight to prevent litter blowing from the landfill waste. The wet unit weight of the waste is only slightly lower a loose soil. Cinder Lake Landfill operations personnel have indicated that during high-

wind conditions paper pulp waste delivered to the site for disposal is often placed on the working face at intervals throughout the day in order to reduce wind-blown litter prior to the application of daily cover. It has also been reported by operators currently using similar wastes that the paper pulp waste does not dry with normal exposures to create a dust problem.

4.2 OTHER ISSUES

4.2.1 Moisture Barrier

As discussed above, the hydraulic conductivity of the paper pulp waste was tested to be on the order of 10^{-7} cm/sec. This is sufficiently low that the paper pulp waste will provide a suitable barrier to minimize infiltration and leachate generation. In the future, it is possible that the paper pulp waste could be used as part of a composite liner and/or cap system for new Subtitle D cells to be constructed at the site. If this is proposed in the future, the design plans for the new cells to be submitted to and approved by ADEQ will contain the appropriate engineering and stability analysis related to the use of this material in the liner and/or cap system.

4.2.2 Placement

The as-received moisture content of the paper pulp waste is quite high. However, researchers (Moo-Young and Zimmie, 1996) found that a high water content is desirable for the construction of a landfill capping layer using paper pulp waste. They found that the minimum permeability for paper pulp waste occurs at a water content that is at least 50% to 100% wet of the optimum water content. Most operators have found that the material is workable with standard landfilling equipment. Small ground pressure dozers provided the best method for placement and compaction. This equipment successfully eliminated large voids from the sludge material and kneaded the material homogeneously.

Based on experience at other landfills using paper pulp waste as an alternative daily cover, the paper pulp waste cover should be placed at least 6 inches thick and should not remain exposed for more than 30 days.

4.3 CONCLUSIONS

Considerable research has been conducted on paper pulp waste related to the use of this material for landfill cover. Numerous landfills are currently using paper pulp waste as an alternative daily cover material under review by state regulatory agencies and in some cases the US EPA. Several states have approved and permitted the use of paper pulp as alternative cover material on a permanent basis.

The physical properties of the paper pulp sample analyzed indicates that the paper pulp from the Wisconsin Tissue facility is similar to paper pulp waste that has been researched and utilized for daily cover material at other existing facilities. Chemical analysis of the Wisconsin Tissue paper pulp provided by the facility indicates that, similar to published research on other paper pulp wastes, hazardous constituents in their paper pulp waste are well below hazardous waste regulatory thresholds. This information, combined with experience from other landfills that have

successfully used the paper pulp waste for alternative daily cover, and observations related to the Wisconsin Tissue paper pulp waste both at the mill and at the Cinder Lake Landfill, provides the demonstration that the Wisconsin Tissue paper pulp waste used as an alternative cover material will control disease vectors, fire, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

Bevington, George. 1997. Personal Communication, Telephone: 518-762-0501.

Condino, John. 1997. Personal Communication, Telephone: 315-232-3236.

Dennison, Denny. 1997. Personal Communication, Telephone: 618-271-6788, ext. 122.

Floess, Carsten H., Raymond F.J. Smith and Robert H. Hitchcock. 1995. "Capping With Fiber Clay." Civil Engineering Magazine, August, 1995, pp. 62-63.

Griesbach, Brian. 1997. Personal Communication, Telephone: 630-894-9000.

Maltby, Van. 1997. NCASI, Personal Communication, Telephone: 616-387-5128.

Moo-Young, Horace K. and Thomas F. Zimmie, 1996. "Geotechnical Properties of Paper Mill Sludges for Use in Landfill Covers" ASCE Journal of Geotechnical Engineering, Vol. 122, No. 9, September, 1996, pp. 768-775.

National Council of the Paper Industry for Air and Stream Improvement, Inc. 1991. "Characterization of Wastes and Emissions from Mills Using Recycled Fiber," NCASI Technical Bulletin No. 613, September 1991.

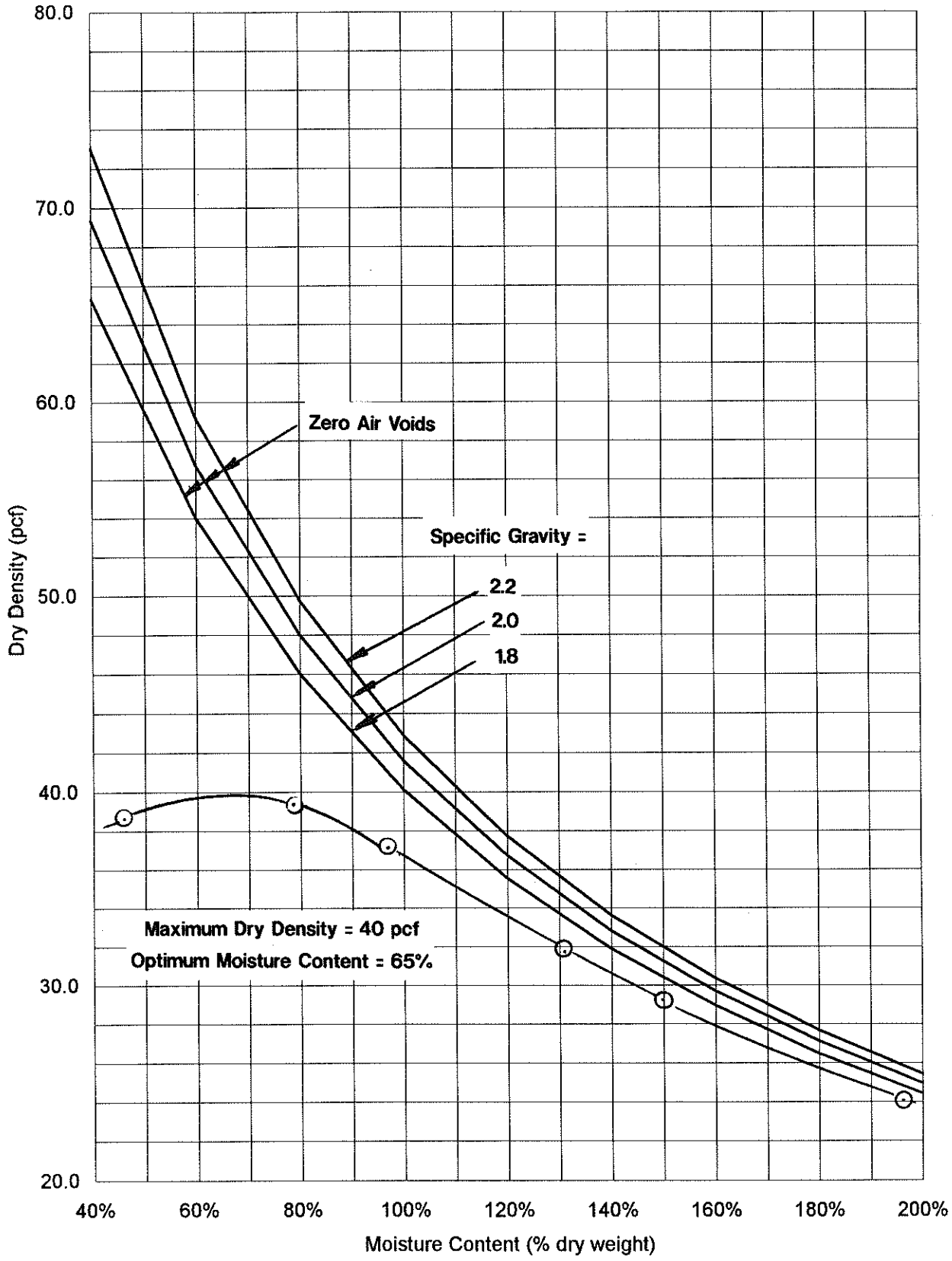
National Council of the Paper Industry for Air and Stream Improvement, Inc. 1989. "Experience With and Laboratory Studies of the Use of Pulp and Paper Mill Solid Waste in Landfill Cover Systems," NCASI Technical Bulletin No. 559, January 1989.

Rainer, Bill. 1997. Personal Communication., Telephone: 618-797-0405.

Table 1
SUMMARY OF LABORATORY TEST RESULTS FOR PAPER PULP WASTE CINDER LAKE LANDFILL AND OTHERS

Property	ASTM Test Method Used for this Study	Test Results			
		This Study	Moo-Young & Zimmie, 1996	Floess, et al., 1995	NCASI, 1989
As Received Moisture Content (% of dry weight)	D2216	197 to 204	150 to 268	150 to 233	121 to 409
As Received Total Density (pcf)	Note 1	70 to 71	—	—	19 to 37 (3)
As Received Dry Density (pcf)	Note 1	23 to 24	—	—	—
Specific Gravity	D854	2.00	1.80 to 2.08	—	1.56 to 2.39
Liquid Limit (% of dry weight)	D4318	183	218 to 297	—	—
Plastic Limit (% of dry weight)	D4318	86	94 to 147	—	—
Plasticity Index (% of dry weight)	D4318	97	77 to 191	—	—
Friction Angle (degrees)	D3080 (2)	40	25 to 40	—	—
Cohesion (psf)	D3080 (2)	60	58 to 188	—	—
Hydraulic Conductivity (cm/sec)	D5084 (2)	1.2 to 2.6 x 10^{-7}	0.4 to 4 x 10^{-7}	0.4 to 3 x 10^{-7}	4 x 10^{-4} to 5 x 10^{-8}
Maximum Dry Density	D698	40	35 to 51	—	—
Optimum Moisture Content (% of dry weight)	D698	65	50 to 100	—	—

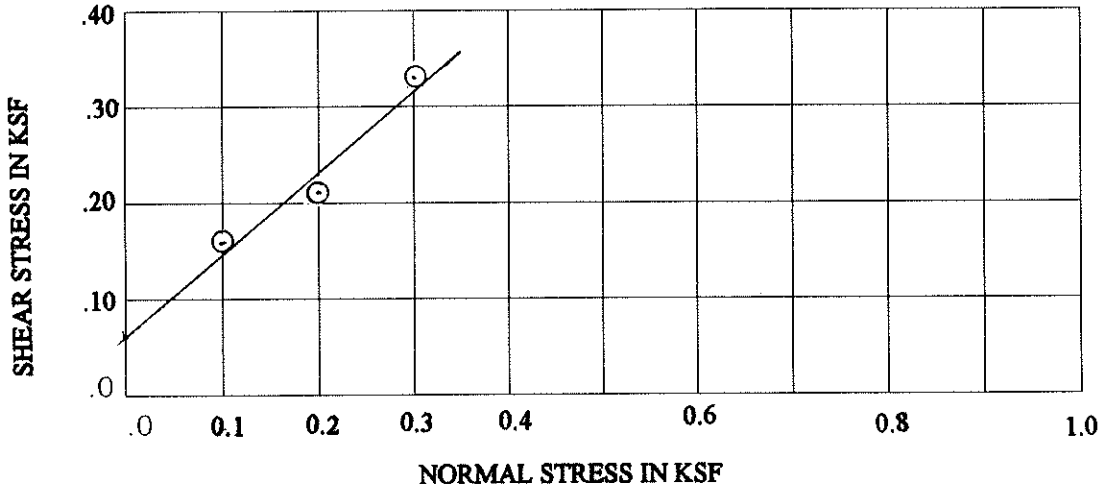
Notes:
(1) Density determined for as-received condition in containers.
(2) Specimen compacted at as-received moisture content and using energy of ASTM D698.
(3) NCASI, 1991

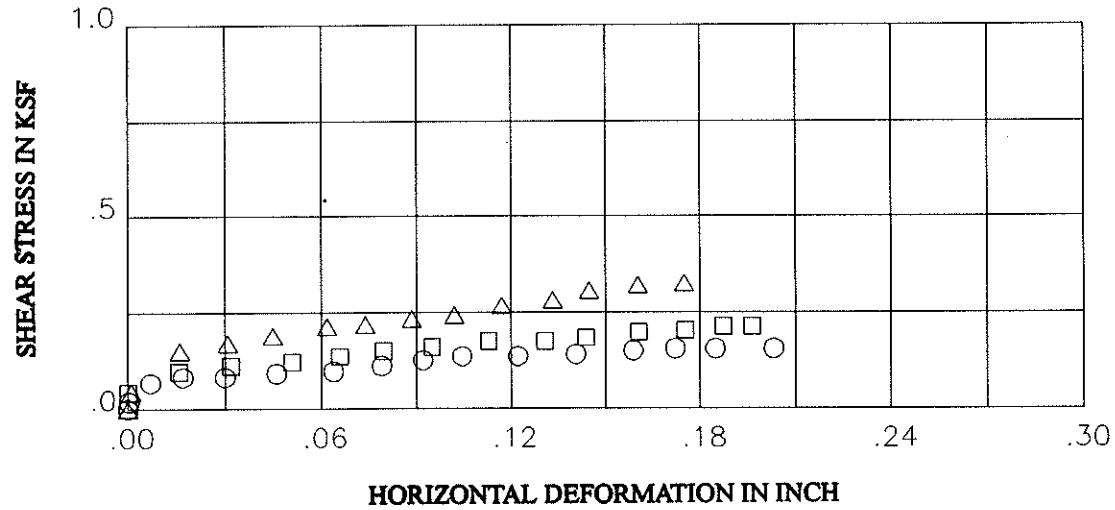


COMPACTION TEST DATA (ASTM D698)
PAPER PULP WASTE
CINDER LAKE LANDFILL

DRAWN BY: cb	CHECKED BY:	PROJECT NO: 96A199-1101	DATE: 5-27-97	FIGURE NO: 1

Woodward-Clyde





BORING/SAMPLE: Pulp
DESCRIPTION: Paper pulp waste
STRENGTH INTERCEPT (C): 0.62 KSF (PEAK STRENGTH)
FRICTION ANGLE (PHI): 40.4 DEG

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	NORMAL STRENGTH (ksf)	PEAK SHEAR (ksf)	RESIDUAL SHEAR (ksf)
○	193.2	20.0	5.242	.10	.16	.16
□	191.5	21.2	4.880	.20	.21	.21
△	192.2	23.2	4.384	.30	.33	.33

96A199-1101	CINDER LAKE LANDFILL
WOODWARD-CLYDE CONSULTANTS SAN DIEGO	DIRECT SHEAR TEST — Figure No. 2