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**LABORATORY TEST OF SEDIMENT ERODIBILITY
PART II - ERODIBILITY TESTS ON UNDISTURBED
LAKE ERIE AND LAKE ONTARIO TILLS**

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ABSTRACT

The report provides a full account of 51 laboratory erodibility tests carried out on undisturbed samples of cohesive tills from three sites on the north central shore of Lake Erie and from one site on the south shore of Lake Ontario. The erodibility tests were conducted on 10-cm dia., 10-cm long cylindrical samples using a rotating-cylinder apparatus described in Part One of the report. In each test, the erodibility was characterized by both the critical shear stress, τ_c , and the erosion rate, ϵ . In addition, index-property tests (particle size, natural water content, Atterberg limits and vane shear strength) were carried out. The most consistent results and best correlations with sediment index properties were obtained using only τ_c to characterize sediment erodibility. The analysis of variance confirmed statistically significant difference for two different till formations occurring along the central north shore of Lake Erie, while no significant difference was obtained for two sites within the same formation. Although ϵ values are highly variable for individual samples, averaged values show consistent direct relationship between τ and ϵ . The two Lake Erie tills are more resistant to erosion, both in terms of τ_c and ϵ , than the Halton Till from the Stoney Creek site in Lake Ontario. Surface roughness during the erodibility tests was estimated from comparisons of shear stresses measured with those obtained for five calibration cylinders of known standard-surface roughness. The k_s values for eroding tills were typically found to range from 0.0 to 0.5 mm, except for occasional higher values due to disintegration of samples along existing microfissures.

MANAGEMENT PERSPECTIVE

Cohesive sediments of glacial and glaciolacustrine origin form most of the highly-erodible shores of the lower Great Lakes. The potential for cohesive sediment to erode (its erodibility) is poorly understood. To address problems of shore erosion during periods of high water level, and as related to potential water level fluctuations due to interbasin transfers, the erodibility of soils must be understood. An instrument has been developed to quantify erodibility in terms of critical shear stress and erosion rate and has been used to detect differences for different till formations on the central north shore of Lake Erie, and to show that the till near Stoney Creek in Lake Ontario is more erodible than the Lake Erie formation.

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RÉSUMÉ

Le présent rapport fournit une analyse détaillée de 51 essais d'érodabilité réalisés en laboratoire sur des échantillons non perturbés de tills cohésifs provenant de trois sites de la rive du centre nord du Lac Érié et d'un site de la rive sud du lac Ontario. Les essais d'érodabilité ont été réalisés sur des échantillons cylindriques de 10 cm de diamètre et de 10 cm de longueur à l'aide d'un appareil à cylindre rotatif décrit dans la première partie du rapport. Pour chacun des essais, l'érodabilité a été caractérisée en fonction de la contrainte critique due au cisaillement, T_c et de la vitesse d'érosion, E. De plus, des essais afin de déterminer les propriétés (taille des particules, teneur en eau naturelle, limites d'Atterberg et résistance à l'essai scissométrique) ont été effectués. Les résultats les plus uniformes et les meilleures corrélations avec les propriétés des sédiments ont été obtenus en utilisant seulement T_c pour caractériser l'érodabilité des sédiments. L'analyse de variance a permis de confirmer des différences statistiquement significatives pour deux formations de tills différentes, situées le long de la rive du centre nord du lac Érié, alors qu'aucune différence significative n'a été obtenue pour deux sites provenant de la même formation. Bien que les valeurs de E soient très variables d'un échantillon à l'autre, les valeurs moyennes montrent un rapport direct uniforme entre T et E. Les deux tills du lac Érié sont plus résistants à l'érosion, tant en termes de T_c et de E, que le till Halton provenant du site de Stoney Creek au lac Ontario. On a pu estimer la rugosité en surface dans le cadre des essais d'érodabilité à partir de comparaisons entre les contraintes dues au cisaillement mesurées et les contraintes obtenues pour cinq cylindres de calibration de rugosité de surface standard connue. Les valeurs de k_s pour les tills en cours d'érosion variaient généralement de 0,0 à 0,5 m, sauf en de rares cas où des valeurs plus élevées correspondaient à la désintégration des échantillons le long de microfissures existantes.

PERSPECTIVE-GESTION

Les rives fortement vulnérables à l'érosion des Grands Lacs inférieurs se composent principalement de sédiments cohésifs d'origine glaciaire et glaciolacustre. Le potentiel d'érosion des sédiments cohésifs (érodabilité) est encore peu connu. Afin de résoudre les problèmes d'érosion de la rive durant des périodes où le niveau de l'eau est élevé ou à cause de fluctuations potentielles du niveau d'eau par suite de transferts entre les bassins, il faut bien connaître la question de l'érodabilité des sols. Nous avons mis au point un instrument capable de quantifier l'érodabilité en terme des contraintes critiques dues au cisaillement et de la vitesse d'érosion, lequel a été utilisé pour déterminer les écarts dans des tills différents de la rive du centre nord du lac Érié. Cet instrument a aussi permis de montrer que le till situé près de Stoney Creek dans le lac Ontario est plus érodable que la formation du lac Érié.

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1.0 INTRODUCTION

Quantitative measurements of sediment erodibility should prove useful for interpretation of measured subaerial and subaqueous erosion along cohesive shores, as well as for attempts to model complex processes of bluff recession. On the basis of laboratory and field data, Sunamura (1977) proposed a basic relation for the recession of rock cliffs of the form

$$\frac{dx}{dt} \propto \ln \left(\frac{f_w}{f_r} \right) \quad (1)$$

where dx/dt = the recession rate, f_w = the erosive force of waves and f_r = the resisting force of cliff material. According to Sunamura, f_r is controlled by mechanical properties of the rock cliffs (e.g. compressive strength, tensile strength and wear resistance) and by rock structure (e.g. joints, faults and stratification). Physical reasoning suggests that the same concept, with appropriate modifications, should be applicable to predominantly cohesive shores of the lower Great Lakes.

A previous study (Dick and Zeman, 1983) applied spatially limited data from the Lake Erie north shore and proposed a linear relationship between the work done by the waves, which is strongly dependent on lake-level fluctuations, and measured average toe recession. The erosion resistance of sediments occurring at the toe of bluffs appears therefore of particular interest.

Quantitative measurements of sediment erodibility are also of interest in connection with subaqueous erosion of tills and glaciolacustrine clays that occur in the nearshore zone of the Great Lakes. In comparison with vast amount of information available on the erosion resistance of cohesive sediments in general, the site-specific information on subaqueous erosion in the Great Lakes is relatively scarce.

Field studies of subaqueous erosion at a nearshore site in Lake Ontario near Grimsby, Ontario were carried out by Davidson-Arnott and his co-workers (Davidson-Arnott and Askin, 1980; Davidson-Arnott, 1986). Recent measurements of till surface using a fixed-transducer system at the Stoney Creek site in Lake Ontario are described in Coakley et al. (1986). Philpott (1983) estimated erosion of the nearshore till shelf in the central portion of Lake Erie by comparing 1896 and 1979 bathymetric charts; and his data were later used by Rukavina and Zeman (1985) to estimate contribution of this erosion to the coastal sediment budget.

Considering many intricacies of the shore-recession process, the objective of the present report is deliberately limited to measurements of f_r for undisturbed cohesive sediments that occur at the toe of the bluff and in the nearshore zone. The intent is to express f_r in terms of the critical shear stress, τ_c , and the erosion rate, ϵ , the two most common parameters used in the literature concerned with erodibility of cohesive sediments. Published results for cohesive sediments of comparable consistency as the glacial and glaciolacustrine sediments investigated in the present study are scarce and the values of the critical shear stress obtained from these studies vary widely with different researchers (Kamphuis and Hall, 1983). It appears that this wide discrepancy is due not only to variable geotechnical properties of sediments tested, but also due to differences in testing procedures used, sample-preparation techniques, and due to differences in the definition of the critical shear stress (Zeman, 1983a).

An abbreviated version of this report has appeared previously as a contribution to the Proceedings of the Symposium on Cohesive Shores held in Burlington in 1986 (Zeman, 1986).

2.0 **SAMPLING AND METHODS**
2.1 Field Sampling

The Lake Erie samples used for laboratory tests described in the present report were obtained from three sites located on the north central shore of Lake Erie (Figure 1). All three sites undergo active shore erosion in the general absence of granular beach deposits. Location of the three sampling sites in reference to bluff stratigraphy of the north central shore is shown in Figure 2.

The first site (Site PS) is located in the vicinity of the Elgin County Water Intake Plant. The geology and geotechnical conditions at the site are described in detail in Bou (1975) and a summarized description is contained in Quigley et al. (1977). The site is characterized by 40-m high bluffs, which fail in huge rotational slides as a result of continuous toe erosion. All samples collected from the site were taken from the toe area of the bluffs, which is formed by the Port Stanley Till (Dreimanis, 1967; Zeman, 1980). During sampling care was taken to avoid slumped, fissured and desiccated material. The samples were collected using 15.2-cm (6-in.) dia. heavy-duty plastic tubes, which were slowly hammered into the in-situ bluff stratum. In total, 30 cores, each approximately 15 cm long, were collected at this site. The cores were wrapped in a cheesecloth, waxed immediately after collection, and transported to the laboratory storage room within the week of sampling.

The other two sites (PBA and PBB) are located in the area east of Port Burwell, where a clayey waterlain till occurs at the toe of the bluffs. The extent of this deposit is known from previous studies (Zeman, 1980). Stratigraphically, the deposit is correlated with a prograding deltaic sequence, which occurred possibly during the latter part of the Port Bruce Stadial and the Mackinaw Interstadial (Barnett, 1983). As the toe of the bluffs in this area was found inaccessible, the cores were collected by divers using a hand-held till corer. Site PBA was located 4 m offshore on previously established survey line X 14 of

the NWRI erosion study site (Zeman and Thompson, 1982) and Site PBB was located 6 m offshore at the Elgin/Haldimand - Norfolk County line. The 15.2-cm dia. plastic tubes were pounded approximately 18 cm into the lake bottom using the till corer. The tubes were then dug out using a shovel, and sealed with plastic sheets and waxed cloth to prevent desiccation of the sediment surface. In total, 8 cores were collected from Site PBA and 12 cores from Site PBB.

Six samples from the Stoney Creek site were collected by divers using the hand-held till corer and the location of the sampling stations is shown in Figure 3.

2.2 Sample Preparation

All cores collected were stored in a temperature-controlled humid storage room at 4°C prior to testing. An aluminum cylindrical cutter was used to trim cores to the standard 10-cm dia. sample size. The top and the bottom of a sample were trimmed with a wire saw to the approximate height of 10 cm. Exact caliper measurements of the sample height were recorded as a part of the testing procedure. The sample was then carefully pierced with a thin stainless-steel shaft and metal end pieces were attached tightly to the sample. The sample with both end pieces was then immersed in distilled water for approximately 24 hours and sample weight was measured several times until no gain in sample weight was recorded as a consequence of sample immersion.

2.3 Geotechnical Identification Tests

The natural water content of all samples was determined using the standard ASTM procedure (D 2216) and the results are reported in percent of oven-dry weight. The Atterberg limits were measured in accordance with procedures D423 and D424. The particle size analyses were carried out using a combined pipette-Sedigraph method (Duncan and LaHaie, 1979). Vane shear strength measurements were performed using a Wykeham Farrance 2350 vane apparatus.

2.4 Erodibility Tests

The laboratory erodibility tests were carried out in the rotating-cylinder apparatus described in detail in Part 1 of this report (Zeman, 1984). In accordance with procedure used in previous studies (Sargunam et al., 1973; Arulanandan et al., 1975), erosion rates were determined by the loss in mass of the sample after 60-sec periods of erosion. Measured erosion rates are expressed in kg/m²s in order to account for the slight variation in sample height of individual samples. Both the torque and mass-loss were recorded at 50-rpm increments. Net shear stress, τ_s , was computed from torque measurements following the procedure outlined in Part 1 of the report. A test was terminated when major degradation of the sample occurred or when the rotational speed reached 1800 rpm. All erodibility tests described herein were carried out with distilled water as the eroding fluid. Within the context of the present report, the critical shear stress, τ_c , is defined as the lowest τ value at which erosion is quantitatively detected.

2.5 Determination of Standard Surface Roughness

As discussed in Part 1 of this report, measured torque values during erodibility tests are significantly influenced by the effect of surface roughness. For irregular surfaces, it is convenient to correlate surface roughness with its equivalent standard (Nikuradse's) roughness (Schlichting, 1968). For this reason, five calibration cylinders with closely-packed granular surfaces were used to obtain torque measurements for the surfaces with the following grain size: 0.5 mm (1.0 phi), 1 mm (0.0 phi), 1.41 mm (-0.5 phi), 2.0 mm (-1.0 phi) and 4.0 mm (-2.0 phi). The torque measurements were taken in the range from 50 to 2000 rpm at 50-rpm increments and the measured data were converted to net shear stress values following the procedure described in Part 1 of the present report.

3.0 RESULTS

3.1 Analysis of Variance

In order to evaluate geotechnical and erodibility test results obtained for the four sites, the one-way analysis of variance was applied to test the difference in mean values for each test. First, the differences among the three Lake Erie sites were evaluated. The computed F values (where F is the ratio of independent variances estimating the same population variance) are tabulated in Table 2 for Treatment Groups PS-PBA-PBB, PS-PBA&PBB and PBA-PBB. The values marked with an asterisk indicate significant difference at 1% level between sites PS and PB for the silt and clay contents, the liquid limit, the shear strength and the critical shear stress. There is no significant difference in geotechnical and erodibility tests between sites PBA and PBB. Consequently, the data for these two sites are lumped together and average combined values are given in subsequent tables. Second, the three Lake Erie sites were compared with the Lake Ontario site for the Treatment Groups PS-SC and PBA&PBB-SC, and the computed F values are tabulated in Table 3. The values marked with an asterisk indicate significant differences in the sand and gravel content, the clay content, the natural water content, the liquid limit and the plasticity index. When the PBA&PBB site was compared to the SC site, additional significant differences were obtained for the vane shear strength and the critical shear stress. Other values in Table 3 are not significant, which reflects the relatively high textural heterogeneity of the six SC samples. In general, the SC samples are appreciably coarser and less plastic than the PS and PBA&PBB samples.

3.2 Geotechnical Identification Tests

3.2.1 Particle size

Average values of particle-size analyses are presented in Table 4 and results for individual samples appear in Appendix A.

According to Shepard's classification (Shepard, 1954), samples collected from Site PS (Figures 4 and 5) are all silty clays and the results are in general agreement with previous sampling at this location (Zeman, 1980). Eight samples collected from the waterlain till stratum at Site PBA (Figure 6) are characterized by the absence of sand and gravel, and they are either silty clays or clays. Ten samples collected from site PBB (Figure 7) are texturally very similar to the PBA samples, except for a small percentage of sand. They are also either silty clays or clays, except for Sample PBB 3, which is sandy silty clay. Data presented in Table 4 show that the PS samples are in general coarser than the PBA and PBB samples. The six SC samples (Figure 8) are sandy silty clays and silty clays, which all have relatively high sand content. Samples from the site SC-7 are appreciably finer than samples from the sites SC-5 and SC-6. Sand and gravel contents of the SC samples are, in general, lower than those reported by Davidson-Arnott and Askin (1980) for the study site near Grimsby, which was referred to in Section 1.0 preceding.

3.2.2 Natural water content

Average values of the natural water content are presented in Table 5 and the individual test data appear in Appendix B. Values obtained for the PS samples are closely scattered around 20 %. These values are somewhat higher than the range 16-18 % reported by Bou (1975) for this stratigraphic unit. Measurements for the PBA and PBB samples are, except for a low value obtained for the relatively coarse Sample PBB 3, in the range 26-32 %, being in general agreement with previous determinations carried out for the waterlain-till unit (Zeman, 1983b). Values for the six SC samples range from 15.7 to 19.1 % and are appreciably lower than those obtained for the Lake Erie tills. As expected, the coarser samples from Sites SC-5 and SC-6 have lower water contents than the finer samples from Site SC-7.

3.2.3 Atterberg limits

The results of the Atterberg limits (Table 6) yielded slightly lower values for the PS samples than for the PBA and PBB samples. The difference is more conspicuous for the liquid limit and the liquidity index than for the plastic limit and the plasticity index. The liquid-limit and plasticity-index values of the Lake Erie tills are plotted on the Casagrande plasticity chart (Figure 9), which shows that, except for two anomalous samples, samples from all three sites are clays of low plasticity according to the Unified Soil Classification System (Terzaghi and Peck, 1968). The results for the six SC samples are plotted in Figure 10, which shows all samples to be clays of low plasticity (Groups CL and ML), except for Sample 7B, which falls in the region of Groups ML or OL. In general, five out of six samples from the SC site are less plastic than the Lake Erie tills. On the other hand, the SC samples are slightly more plastic than the values from the study site near Grimsby reported by Davidson-Arnott and Askin (1980). The difference is likely due to different texture, as discussed in Section 3.2.1 preceding.

3.2.4 Vane shear strength

Average values of laboratory vane tests are presented in Table 7 and results for individual samples appear in Appendix D. The s_{uu} values for the PS samples range from about 42 kPa to 83 kPa, thus being of firm to stiff consistency. All values are significantly lower than the single value of 268 kPa (2.8 tsf) reported by Bou (1975) for the till at this location. The s_{uu} values measured on the PBA and PBB samples are, except for one sample (PBB 3), of firm consistency within the range 25-46 kPa. The results are in agreement with previous measurements on six samples from this area (Zeman, 1983b). The values of sensitivity, s_{uu}/s_{ur} , are remarkably uniform for all three sites within the range 2.1-3.2, and the average values are given in Table 7.

The s_{uu} values for the six SC samples range from about 48 kPa to 82 kPa and the values are thus quite similar to those obtained for the PS samples. The s_{ur} values for the SC samples are slightly lower than those obtained for the PS samples and, consequently, the sensitivity values are slightly higher (Table 7). Relatively high scatter in measured shear-strength values reflect the textural heterogeneity of the SC samples discussed in Section 3.2.1 preceding.

3.3 Erodibility Tests

3.3.1 Critical shear stress

All numerical results pertaining to erodibility tests are tabulated in Appendix D.1 for Lake Erie samples and in Appendix D.2 for Lake Ontario samples. Results of a representative test are shown in Figure 11 as a shear stress-rpm plot, and in Figure 12 as an erosion rate-shear stress plot. Critical shear stress values for all 51 samples are presented in Appendix D.3 and plotted against the number of revolutions in Figure 13.

The critical shear stress ranges from 0.68 to 7.05 Pa for Site PS, from 3.06 to 17.66 Pa for Site PBA and from 1.72 to 9.75 Pa for Site PBB; mean and standard deviation values are tabulated in Table 8. The analysis of variance (Table 2) shows statistically significant difference between Site PS and Sites PBA & PBB; no such difference occurs between Sites PBA and PBB. Both Table 8 and Figure 13 indicate that, on the average, τ_c values for the PBA and PBB samples are higher than those obtained for the PS samples. The critical shear stress values for the six SC samples range from 0.53 to 2.28 Pa (Appendix D.3) and the mean and standard deviation values are given in Table 8. The critical shear stress values of the SC samples are somewhat lower than those obtained for the PS samples from Lake Erie but the difference is not statistically significant (Table 3). A significant difference, however, occurs between the SC samples and the PBA & PBB samples (Table 3).

3.3.2 Erosion rate

As shown in Figure 12, measured erosion rates for individual samples vary considerably as a result of changing surface roughness (see Section 3.3.4 following) and disintegration of samples along microfissures at higher shear stresses. Sample erodibility in terms of erosion rates is determined as the slope a_1 of the linear-regression line

$$\dot{\epsilon} = a_0 + a_1 \tau \quad (2)$$

for $\tau > \tau_c$.

Values of the erosion rate gradient, a_1 , and the corresponding coefficient of determination, r^2 , for all 51 samples are tabulated in Appendix D.4. For the Lake Erie samples, mean and standard deviation values (Table 9) indicate somewhat higher a_1 values for PS samples than for the PBA and PBB samples, however, the difference is less conspicuous than in the case of τ_c values, as is also evidenced by relatively low F values for the erosion rate gradient in Table 2.

Another method to present erosion-rate results without experimental scatter associated with individual samples is to compute the average values of τ and $\dot{\epsilon}$ for each pre-set value of rpm. These computations have been carried out for the PS samples within the range from 150 to 1300 rpm, for the PBA and PBB samples from 350 to 1800 rpm, and for the SC samples from 200 to 1750 rpm. The computed average values are tabulated in Appendix D.5. Linear regressions on the averaged data yielded the following relationships

Site PS: $\bar{\epsilon} = 0.857 + 0.211 \bar{\tau}; r^2 = 0.73$

Sites PBA&PBB: $\bar{\epsilon} = -0.371 + 0.097 \bar{\tau}; r^2 = 0.64$

Site SC: $\bar{\epsilon} = 0.120 + 0.386 \bar{\tau}; r^2 = 0.90$

The three empirical relationships are plotted in Figure 14, which shows that the waterlain till is less erodible than the Port Stanley till also in term of erosion rates, and that both these tills are less erodible than the Halton Till. This result is consistent with the values of average τ_c obtained for the three tills (Table 8).

3.3.3 Changes in surface roughness during erodibility tests

The results obtained with five calibration cylinders of known standard-surface roughness are tabulated in Appendix E.0 and the six resulting curves (including the curve obtained for the cylinder with a smooth surface) of rpm vs. τ are plotted in Figure 15. These curves were then superimposed on the rpm-shear stress plots of the erodibility tests for the estimates of k_s of the till samples. The k_s values of eroding till surfaces were found to vary typically between 0.0 and 0.5 mm. Below τ_c , the surface roughnes of most samples was close to $k_s = 0$. Above τ_c , the k_s values varied irregularly within the general range 0.0 to 0.5 mm with no apparent increase with increasing τ . This trend suggests the uniform mode of erosion by the detachment of clay aggregates or flocs. Occasionally, an increase in k_s values beyond 0.5 mm was obtained when a sample started to disintegrate along microfissures in relatively larger chunks of material. This mode of erosion occurred typically at high shear stresses. Apart from the general association of high k_s values with high erosion rates, no obvious differences were noted in the modes of erosion of the three tills tested. Figures 16, 17 and 18 show variations in the surface roughness during the erodibility test on representative samples PS 28, PBB 6 and SC 5A.

4.0 COMPARISON OF GEOTECHNICAL AND ERODIBILITY TESTS

Linear regressions have been performed on results of geotechnical and erodibility tests (Table 10). As shown in individual tables, (Tables 4 to 7) geotechnical properties measured vary within relatively narrow ranges. When data obtained for the PS and PBA & PBB samples were analyzed separately, values of the correlation coefficient, r , were not significant, apart for the regressions $PL-\tau_c$ (Table 10). Upon combining the data for the three sites, significant relations at the 1% level were obtained for $w-\tau_c$, $LL-\tau_c$, $PL-\tau_c$, $LI-\tau_c$ and $s_{uu}-\tau_c$. The first four relations are direct, the remaining one is inverse. The direct relation $cl\%- \tau_c$ and the inverse relation $si\%- \tau_c$ are significant at the 5% level.

Linear regressions for the six SC samples (Table 10) yielded r values significant at the 5% level for $cl\%- \tau_c$, $sa\%- \tau_c$ and $w-\tau_c$. Considering a very narrow range of τ_c values and the small number of samples, these relations are regarded of limited validity.

Combination of all data from the PS, PBA, PBB and SC sites (Table 10) yields, in general, similar relations as those obtained for the three Lake Erie sites. For this combined data set, the relationship $si\%- \tau_c$ is not statistically significant, while the inverse relation $sa\%- \tau_c$ is significant at the 5% level. The combined data set (51 samples) is believed to provide the best insight into the control of the critical shear stress by the geotechnical and grain-size properties. The direct relations between τ_c and plasticity parameters (the liquid limit, the plastic limit and the liquidity index) reflect the control of clay-mineralogical composition and the percentage of clay-sized material present. The relations are in agreement with experimental findings of Smerdon and Beasley (1959). The direct relation $cl\%- \tau_c$ and the inverse relation $sa\%- \tau_c$ are also in agreement with expected trends (Zeman, 1983a). The inverse relations $w-\tau_c$ and s_{uu} should be treated with caution because both geotechnical parameters vary only within relatively narrow ranges (Appendices B.0 and C.0). In summary, the

results indicate that, for the three till formations studied, the critical shear stress is controlled primarily by the sediment mineralogy and texture, while the depositional history (reflected in the values of w and s_{uu}) seems to be of smaller importance.

The comparison of geotechnical test results with the erosion rate gradient, a_1 , yielded no statistically significant values of r .

5.0 DISCUSSION

The tests described in this report have been deliberately conducted on undisturbed samples. Most studies concerned with erosion resistance of cohesive sediments described in the literature have been carried out on artificially-compacted samples, which do not include the effect of the natural structure of the sediment.

Quantitative determination of erodibility with a rotating-cylinder apparatus has both its advantages and limitations. The principal advantage is that the testing procedure is relatively rapid and therefore a large number of samples can be tested within a reasonable length of time. This aspect of the testing method is an important one because of significant differences in erosion resistance encountered during tests on sediments from the same location. This is particularly true for the determination of erosion rates as a function of applied shear stress. Another advantage is that the shear stress applied to the sediment surface can be directly computed from torque measurements and does not have to be derived from measurements of fluid velocity. Furthermore, significantly higher shear stresses can be generated than in flume tests. As to the limitations of the rotating-cylinder test, it is not possible to study the effect of sand abrasion, which is known to be of fundamental importance (Kamphuis, 1983). The testing method does not permit testing of samples that are too soft or that have very low cohesion. Testing of samples under the conditions of oscillatory flow is not possible at present without major modification of the apparatus. In spite of these shortcomings, test results are

considered to be encouraging as they provide answers which are quite conclusive and which would not be probably obtained otherwise.

6.0 CONCLUSIONS

The principal findings of the study can be summarized as follows:

1. Forty-five samples from three sites and two till formations on the Lake Erie north shore were collected. The two tills differ, at statistically significant levels, in several geotechnical properties ($s_i\%$, $c_l\%$, w , LL and s_{uu}) and in values of τ_c . No differences of this type were obtained for samples from the two sites within the same till formation.
2. Six samples from the Stoney Creek site in Lake Ontario are relatively heterogeneous in their geotechnical and grain-size properties, but all samples are characterized by low τ and high ϵ values, most likely as a result of relatively high sand content.
3. The critical shear stress values of the Port Stanley Till are significantly lower than those obtained for the waterlain till. Average erosion rates for the Port Stanley Till are also higher than those measured for the waterlain till. Both Lake Erie tills are less erodible than the Halton Till from Lake Ontario.
4. The critical shear stress values of all 51 samples tested correlate reasonably well with several geotechnical and grain-size properties ($c_l\%$, w , LL, PL, LI, s_{uu} at the 1% level, and $s_a\%$ at the 5% level). Relations between the erosion rate gradient and geotechnical properties are not statistically significant.

5. Surface roughness values, expressed on the scale of standard-surface roughness, k_s , are close to zero below the critical shear stress, and within the range 0 - 0.5 mm when a sample erodes by continuous detachment of sediment flocs. Roughness values in the excess of 0.5 mm are associated with disintegration of samples, typically at high shear stresses, along till microfissures.

ACKNOWLEDGEMENTS

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TABLE 1. LEGEND FOR BLUFF STRATIGRAPHY (FIGURE 2)

No.	Stratigraphic Unit	Tentative Age Correlation
1	Glaciolacustrine Silt and Clay	Port Talbot Interstadial
2	Sand and Gravel	Plum Point Interstadial
3	Catfish Creek Till	Nissouri Stadial
4	Sand	Erie Interstadial
5	Port Stanley Till	Port Bruce Interstadial
6	Glaciolacustrine Silt and Clay	Port Bruce Stadial and Mackinaw Interstadial
7	Glaciolacustrine Silty Sand to Sand	Port Bruce Stadial and Mackinaw Interstadial
8	Waterlain Till	Port Bruce Stadial or Early Mackinaw Interstadial
9	Glaciolacustrine Silt and Sandy Silt	Early Mackinaw Interstadial
10	Wentworth Till	Early Mackinaw Interstadial
11	Sand	Mackinaw Interstadial to Recent
12	Dune Sand	Recent
13	Alluvium	Recent

TABLE 2. ANALYSIS OF VARIANCE (ONE WAY), LAKE ERIE SITES

Test Type	Treatment Groups PS-PBA-PBB F (2/42)	PS-PBA&PBB F (1/43)	PBA-PBB F (1/16)
Gravel&Sand %	3.07	1.73	1.72
Silt %	11.63*	18.88*	2.00
Clay %	6.46*	13.20*	0.01
Natural Water Content	29.52*	57.08*	0.69
Liquid Limit	6.40*	12.75*	0.11
Plasticity Index	3.84	2.90	2.07
Vane Shear	8.89*	17.08*	0.54
Critical Shear Strength	14.26*	23.95*	1.75
Erosion Rate Stress	2.75	5.36	1.40
Gradient			

* significant at 1 % level

TABLE 3. ANALYSIS OF VARIANCE (ONE WAY), LAKE ERIE SITES
AND LAKE ONTARIO SITE

Test Type	Treatment Groups	
	PS-SC F(1/31)	PBA&PBB-SC F(1/22)
Gravel & Sand %	171.83*	24.52*
Silt %	1.48	2.19
Clay %	25.49*	17.50*
Natural Water Content	18.44*	32.75*
Liquid Limit	15.49*	14.70*
Plasticity Index	12.34*	10.68*
Vane Shear Strength	2.39	12.07*
Critical Shear Stress	0.81	9.37*
Erosion Rate Gradient	0.67	0.29

* significant at 1% level

TABLE 4. MEAN (\bar{x}) AND STANDARD DEVIATION (s)
OF PARTICLE-SIZE PERCENTAGES

Site	No. of Samples	Sand and Gravel, %		Silt, %		Clay, %	
		\bar{x}	s	\bar{x}	s	\bar{x}	s
PS	26	5.02	1.58	32.26	4.01	61.50	7.66
PBA	8	0.00	0.00	27.66	9.10	72.34	9.10
PBB	10	5.12	10.87	23.09	4.29	71.81	14.15
PBA & PBB	18	2.84	8.40	25.12	7.02	72.04	11.86
SC	6	21.24	5.80	29.87	6.09	48.89	11.39

TABLE 5. MEAN (\bar{x}) AND STANDARD DEVIATION (s)
OF NATURAL WATER CONTENT

Site	No. of Samples	Nat. Water Content, %	
		\bar{x}	s
PS	27	20.79	1.80
PBA	8	28.84	2.73
PBB	10	27.07	5.31
PBA & PBB	18	27.86	4.34
SC	6	17.44	1.32

TABLE 6. MEAN (\bar{x}) AND STANDARD DEVIATION (s) OF ATTERBERG LIMITS

Site	No. of Samples	Liquid Limit,%		Plastic Limit,%		Plasticity Index,%		Liquidity Index,%	
		\bar{x}	s	\bar{x}	s	\bar{x}	s	\bar{x}	s
PS	27	31.74	1.39	19.13	1.16	12.62	1.32	0.13	0.12
PBA	8	37.07	1.74	23.25	1.57	13.81	1.83	0.41	0.13
PBB	10	34.99	5.83	19.87	2.39	15.12	3.57	0.45	0.22
PBA & PBB	18	35.92	4.51	21.37	2.65	14.54	2.93	0.43	0.18
SC	6	27.63	4.81	17.33	3.93	10.30	2.06	0.00	0.33

TABLE 7. MEAN (\bar{x}) AND STANDARD DEVIATION (s) OF VANE SHEAR STRENGTH

Site	No. of Samples	Undisturbed Shear Strength		Remoulded Shear Strength		Sensitivity	
		s_{uu} ,kPa	s_{ur} ,kPa	s_{uu} ,kPa	s_{ur} ,kPa	s_{uu}/s_{ur}	s_{uu} ,kPa
		\bar{x}	s	\bar{x}	s	\bar{x}	s
PS	27	55.4	10.8	23.2	4.8	2.4	0.1
PBA	8	36.5	5.7	15.1	2.9	2.5	0.2
PBB	10	41.8	19.7	16.7	7.5	2.5	0.2
PBA & PBB	18	39.5	15.0	16.0	5.8	2.5	0.2
SC	6	63.0	12.0	17.0	4.6	3.8	0.6

TABLE 8. MEAN (\bar{x}) AND STANDARD DEVIATION (s)
OF CRITICAL SHEAR STRESS

Site	No. of Samples	Critical Shear Stress, Pa		Number of Revolutions at Onset of Erosion, rpm	
		\bar{x}	s	\bar{x}	s
PS	27	2.00	1.70	361.11	155.25
PBA	8	7.03	4.58	768.75	240.44
PBB	10	4.88	2.16	635.00	158.20
PBA&PBB	18	5.84	3.51	694.44	204.28
SC	6	1.36	0.60	316.67	93.09

TABLE 9. MEAN (\bar{x}) AND STANDARD DEVIATION (s)
OF EROSION RATE GRADIENT

	No. of Samples	Erosion Rate Gradient, $a_1 \times 10^{-3}^*$		Coefficient of Determination, r^2	
		\bar{x}	s	\bar{x}	s
PS	27	0.290	0.281	0.43	0.27
PBA	8	0.100	0.083	0.45	0.22
PBB	10	0.154	0.105	0.35	0.26
PBA&PBB	18	0.130	0.097	0.39	0.24
SC	6	0.180	0.368	0.44	0.32

* determined from linear regression $\varepsilon = a_0 + a_1 \tau$ (for $\tau > \tau_C$)

TABLE 10. SIGNIFICANT VALUES OF CORRELATION COEFFICIENT (r) FOR LINEAR REGRESSIONS BETWEEN GEOTECHNICAL PARAMETERS AND CRITICAL SHEAR STRESS

Site(s)	Regression*	Type of Regression	Significance at 5% Level	Significance at 1% Level
PS	PL - τ_c	d	$r = 0.42$	
PBA&PBB	PL - τ_c	d		$r = 0.61$
PS&PBA&PBB	cl% - τ_c	d	$r = 0.36$	
	si% - τ_c	i	$r = 0.30$	
	w - τ_c	d		$r = 0.59$
	LL - τ_c	d		$r = 0.46$
	PL - τ_c	d		$r = 0.55$
	LI - τ_c	d		$r = 0.54$
	s_{uu} - τ_c	i		$r = 0.41$
SC	cl% - τ_c	i	$r = 0.83$	
	sa% - τ_c	d	$r = 0.85$	
	w - τ_c	i	$r = 0.81$	
PS&PBA&PSB&SC	cl% - τ_c	d		$r = 0.38$
	sa% - τ_c	i	$r = 0.32$	
	w - τ_c	d		$r = 0.61$
	LL - τ_c	d		$r = 0.45$
	PL - τ_c	d		$r = 0.49$
	LI - τ_c	d		$r = 0.52$
	s_{uu} - τ_c	i		$r = 0.43$

* Symbols: cl% = clay content; si% - silt content; sa% - sand content; w = natural water content; LL = liquid limit; PL = plastic limit; LI = liquidity index; s_{uu} = vane shear strength ; τ_c = critical shear stress; d - direct regression; i - inverse regression.

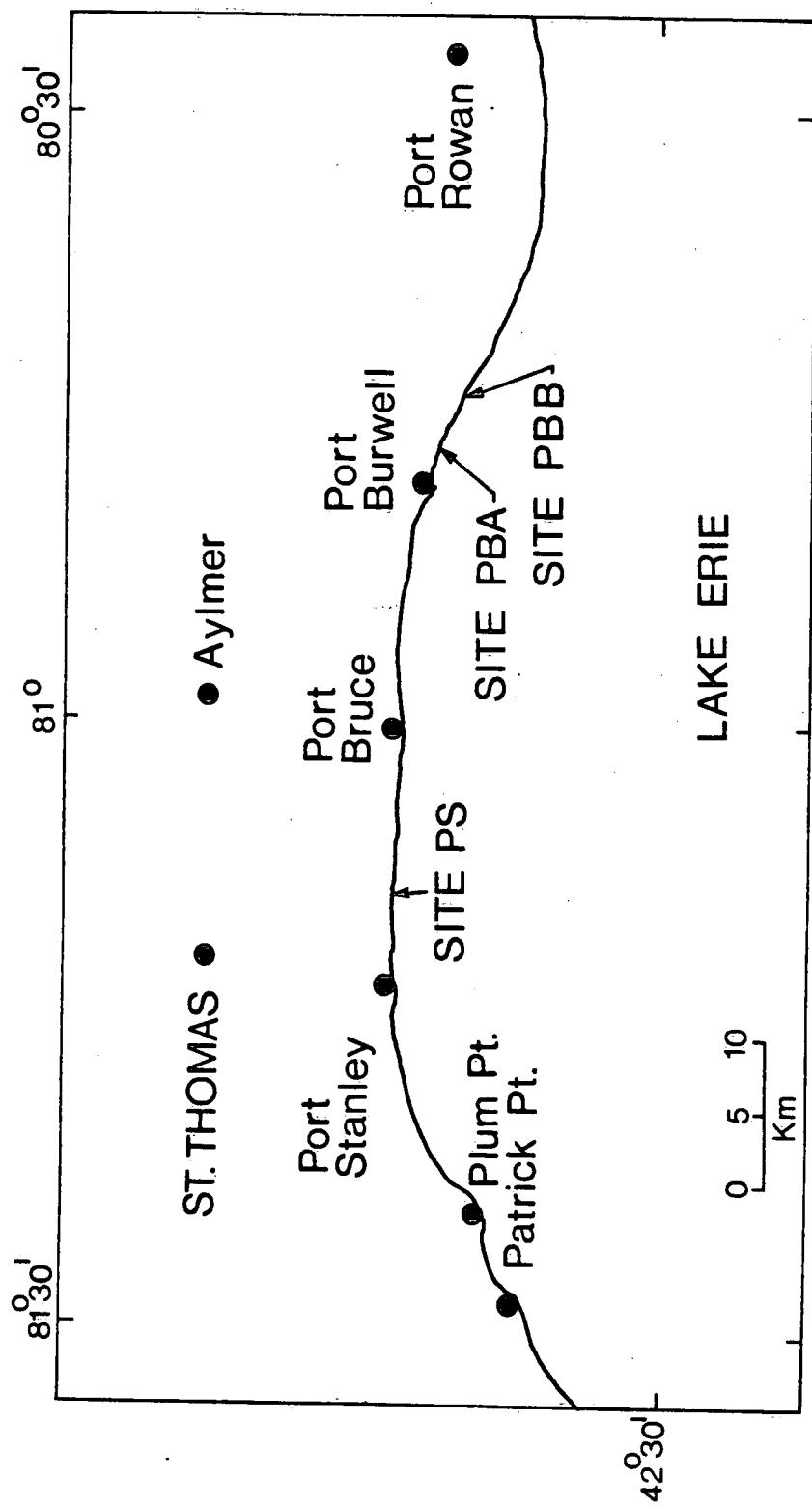
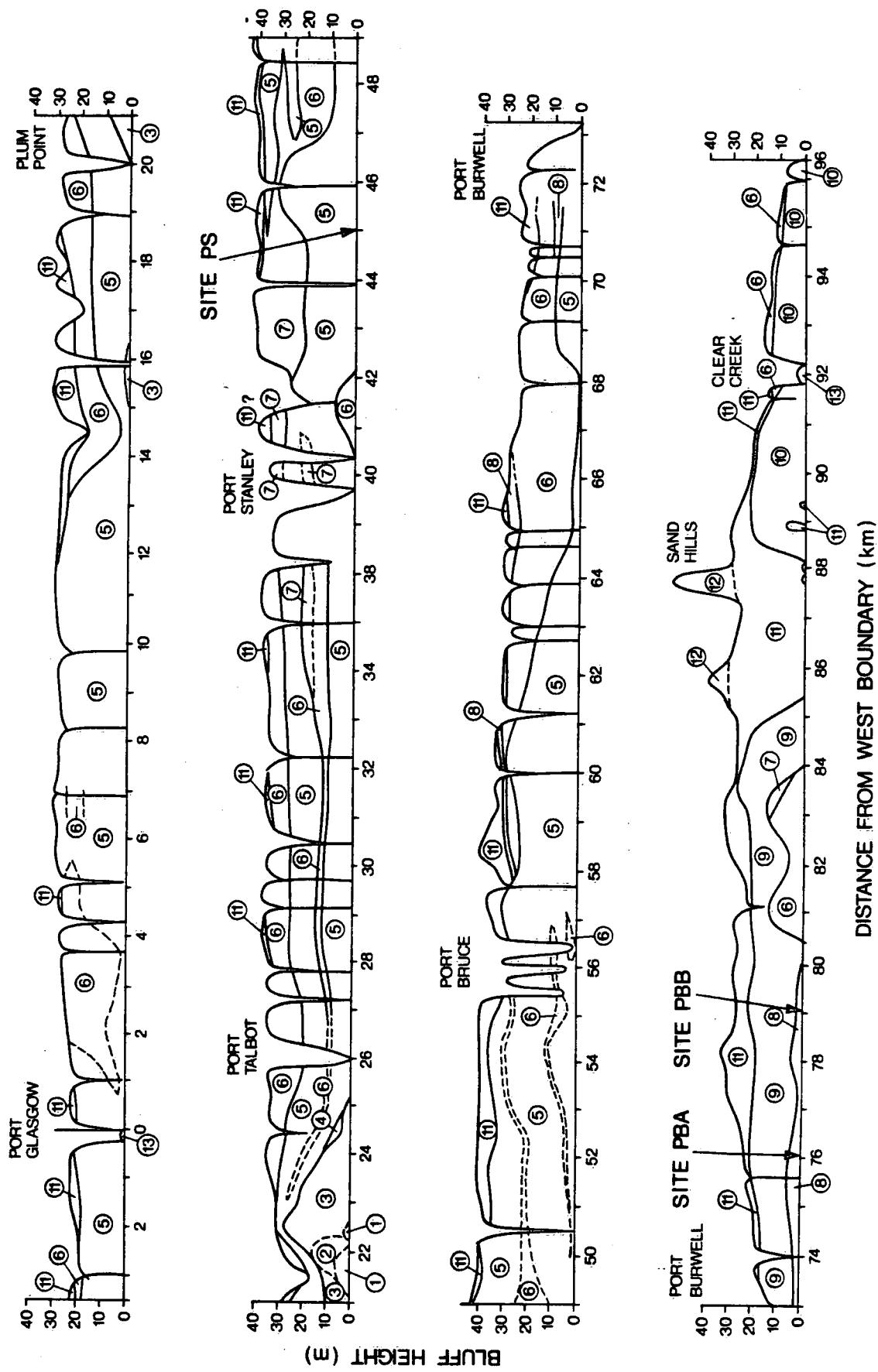
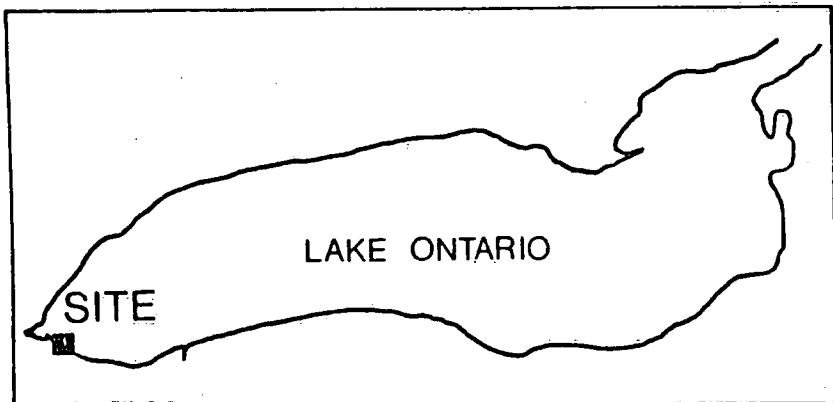


Figure 1. Location of sampling sites, central north shore of Lake Erie.

Figure 2. Lake Erie sampling sites in relation to bluff stratigraphy
 (see Table 1 for legend).





N
↑

○ Transducer
x Sample

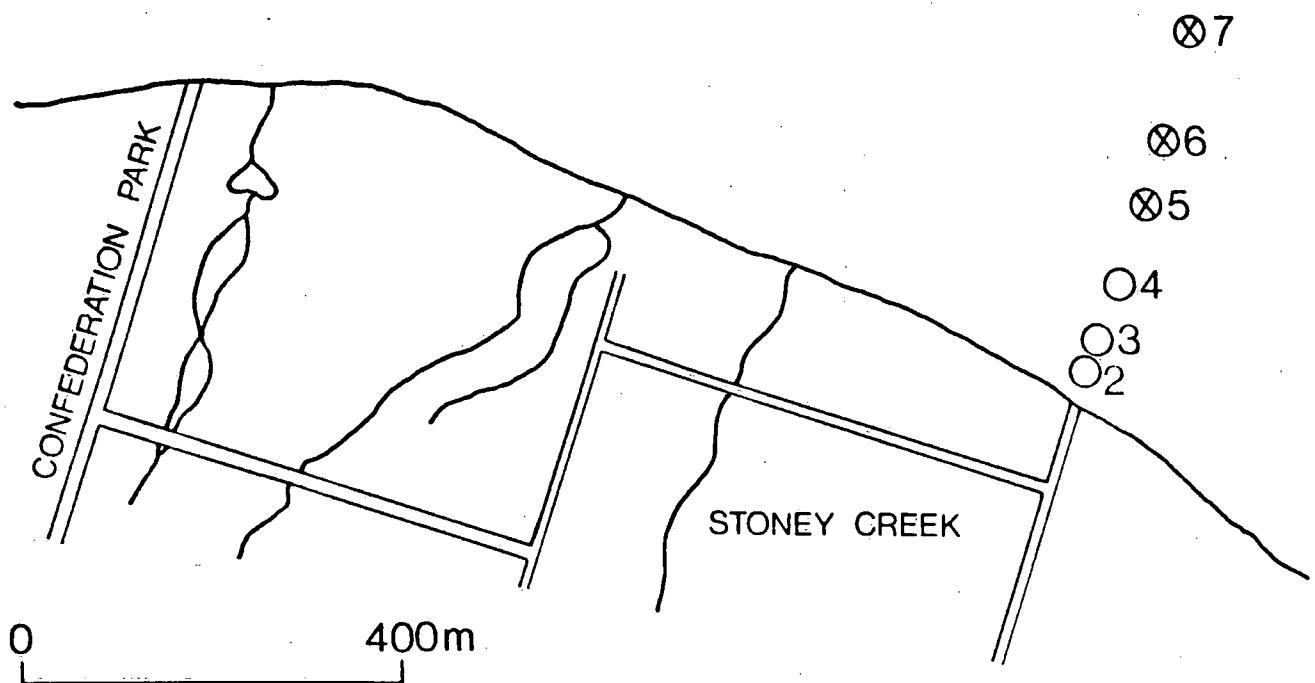


Figure 3. Location of sampling sites, Stoney Creek, Lake Ontario.

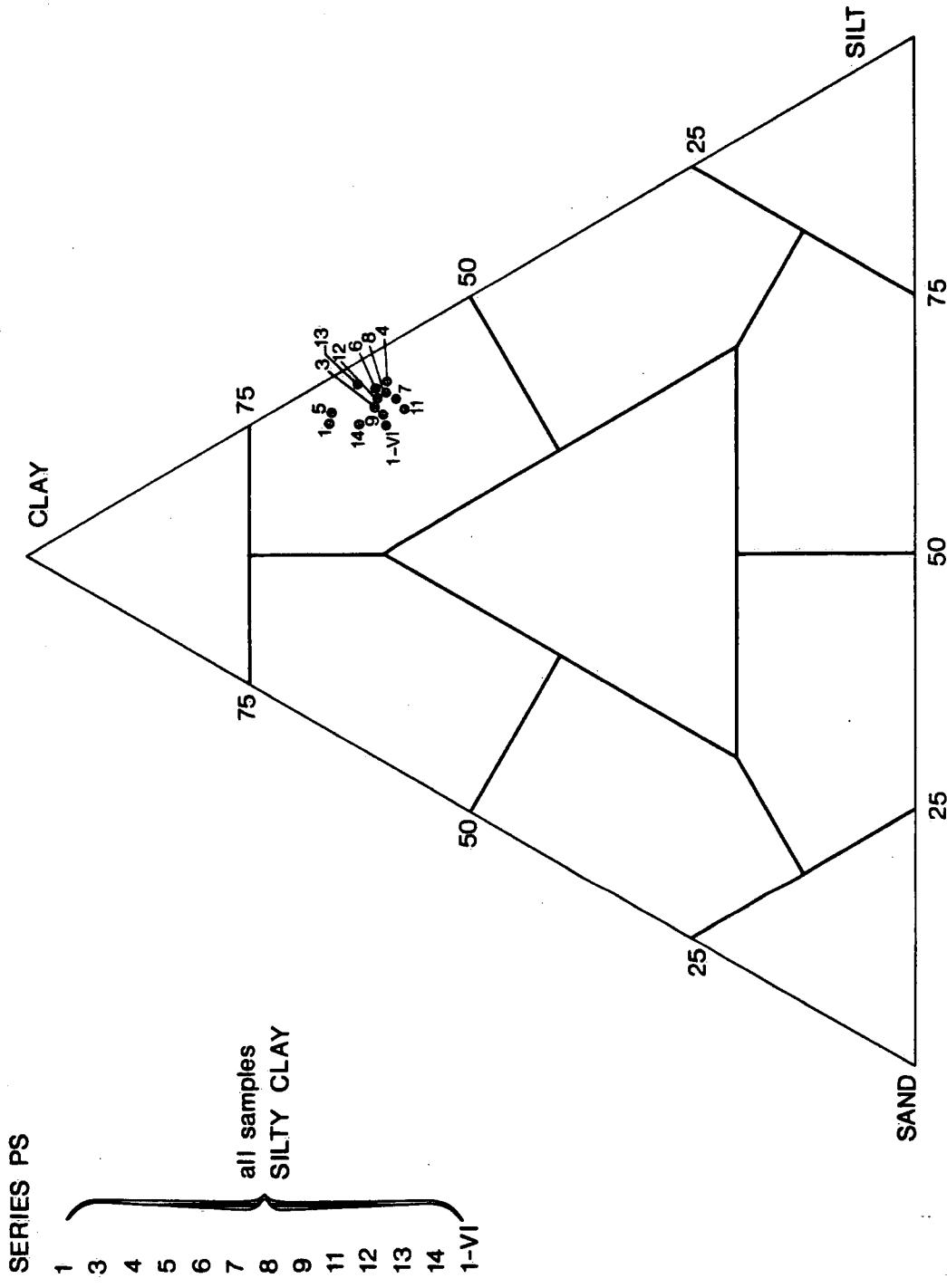


Figure 4. Ternary diagram - samples of Port Stanley Till (PS1-PS 1-VI).

SERIES PS, CONTINUED

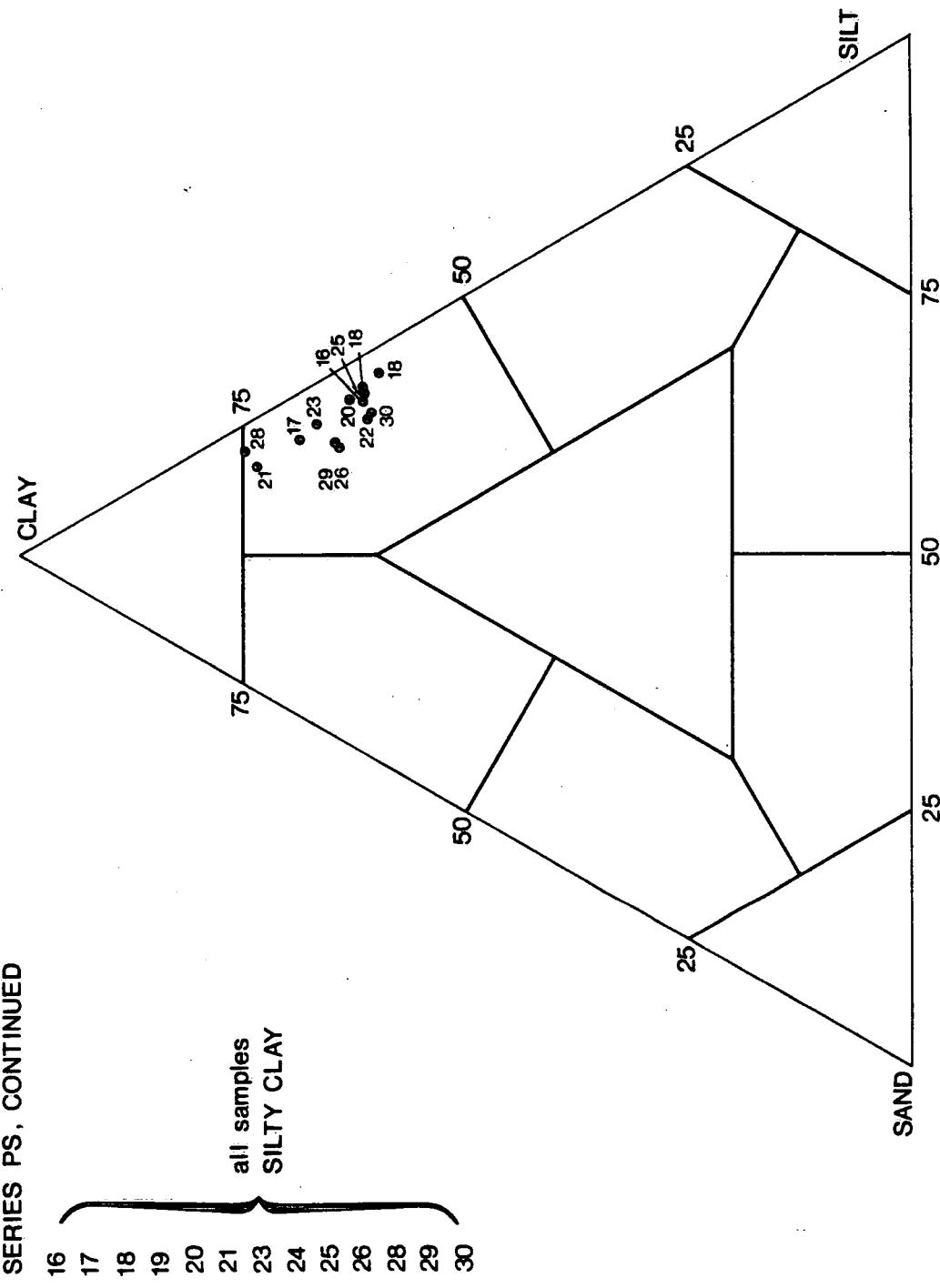


Figure 5. Ternary diagram - samples of Port Stanley Till (PS16-PS30).

SERIES PB-A

- 1 - SILTY CLAY
- 2 - SILTY CLAY
- 3 - SILTY CLAY
- 4 - CLAY
- 5 - CLAY
- 6 - SILTY CLAY
- 7 - SILTY CLAY
- 8 - SILTY CLAY

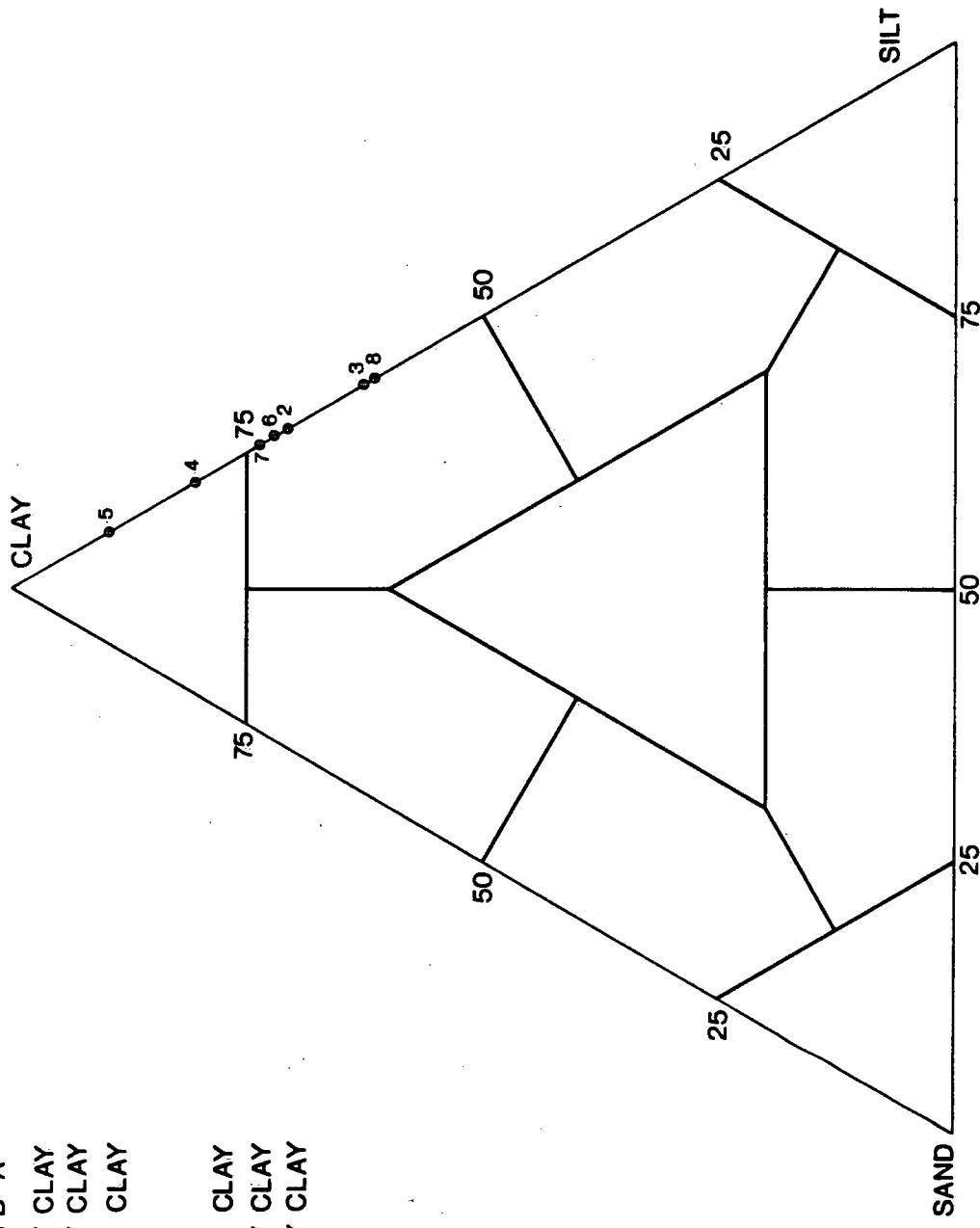


Figure 6. Ternary diagram - samples of waterlain till, Site PBA.

SERIES PB-B
 2 - SILTY CLAY
 3 - SANDY SILTY CLAY
 4 - CLAY
 5 - CLAY
 6 - CLAY
 7 - SILTY CLAY
 8 - SILTY CLAY
 10 - CLAY
 11 - SILTY CLAY
 12 - CLAY

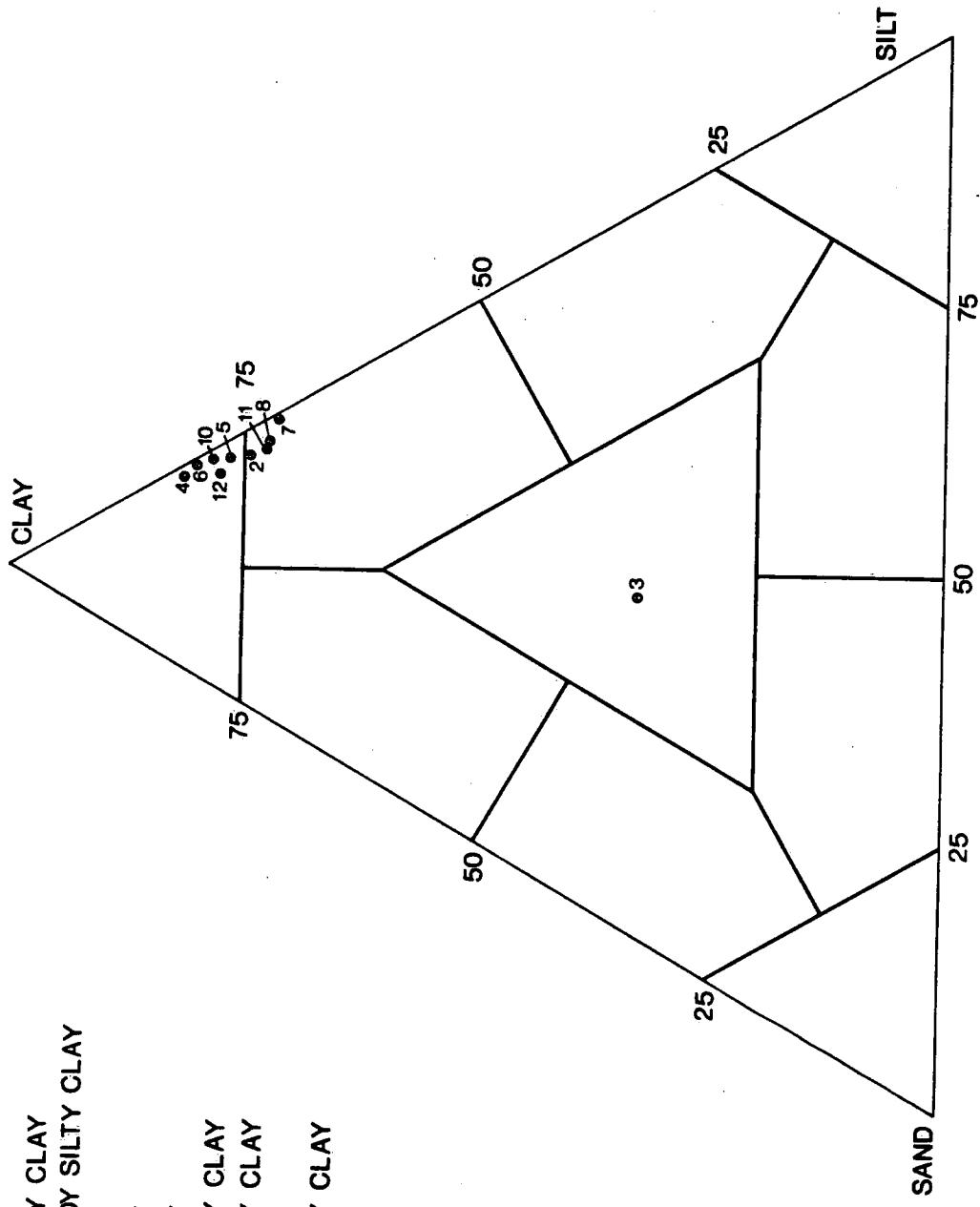


Figure 7. Ternary diagram - samples of waterlain till, Site PBA.

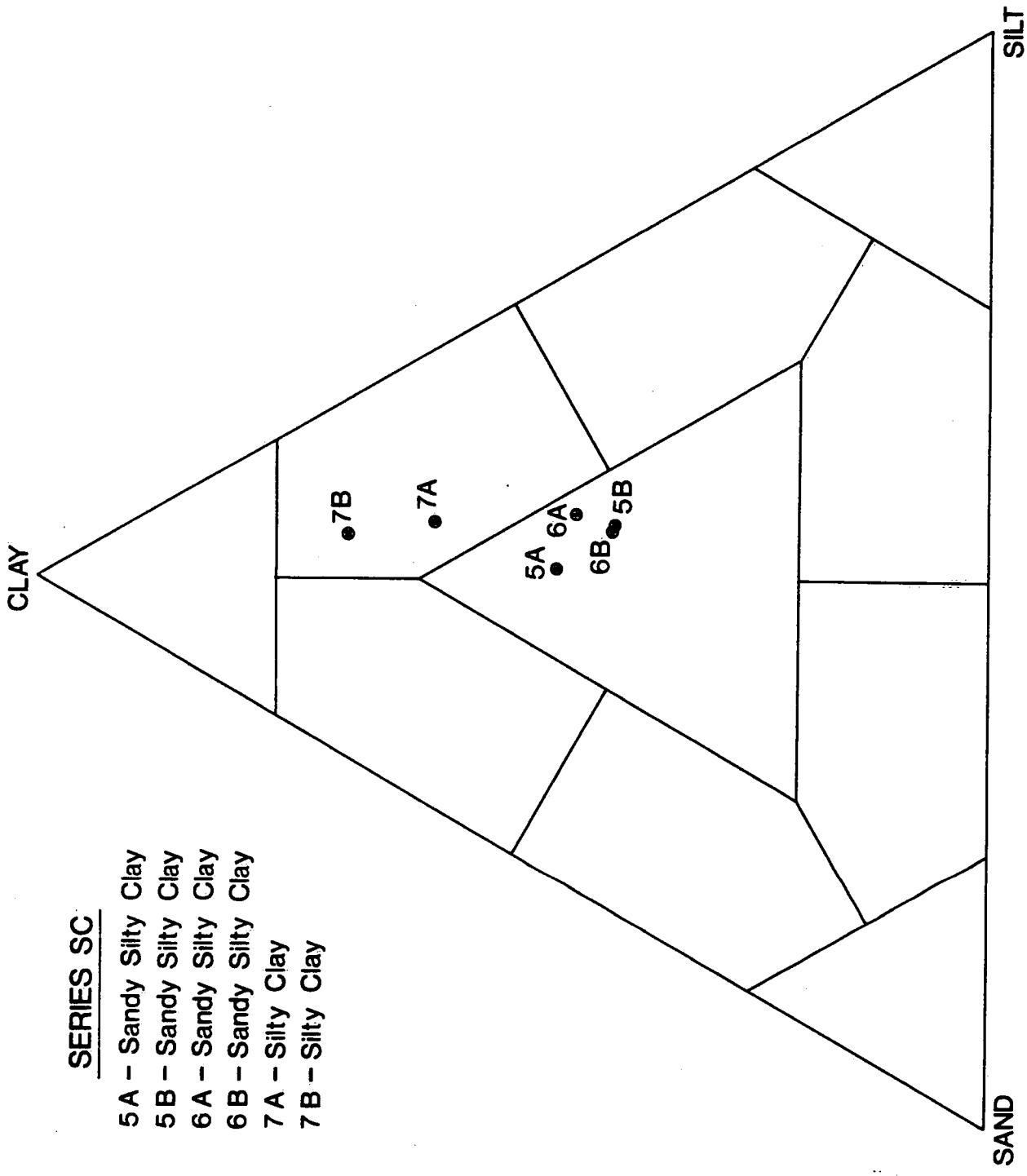


Figure 8. Ternary diagram - samples of Halton Till, Site SC.

Figure 9. Results of plasticity tests
 (Casagrande chart),
 Sites PS and PB.

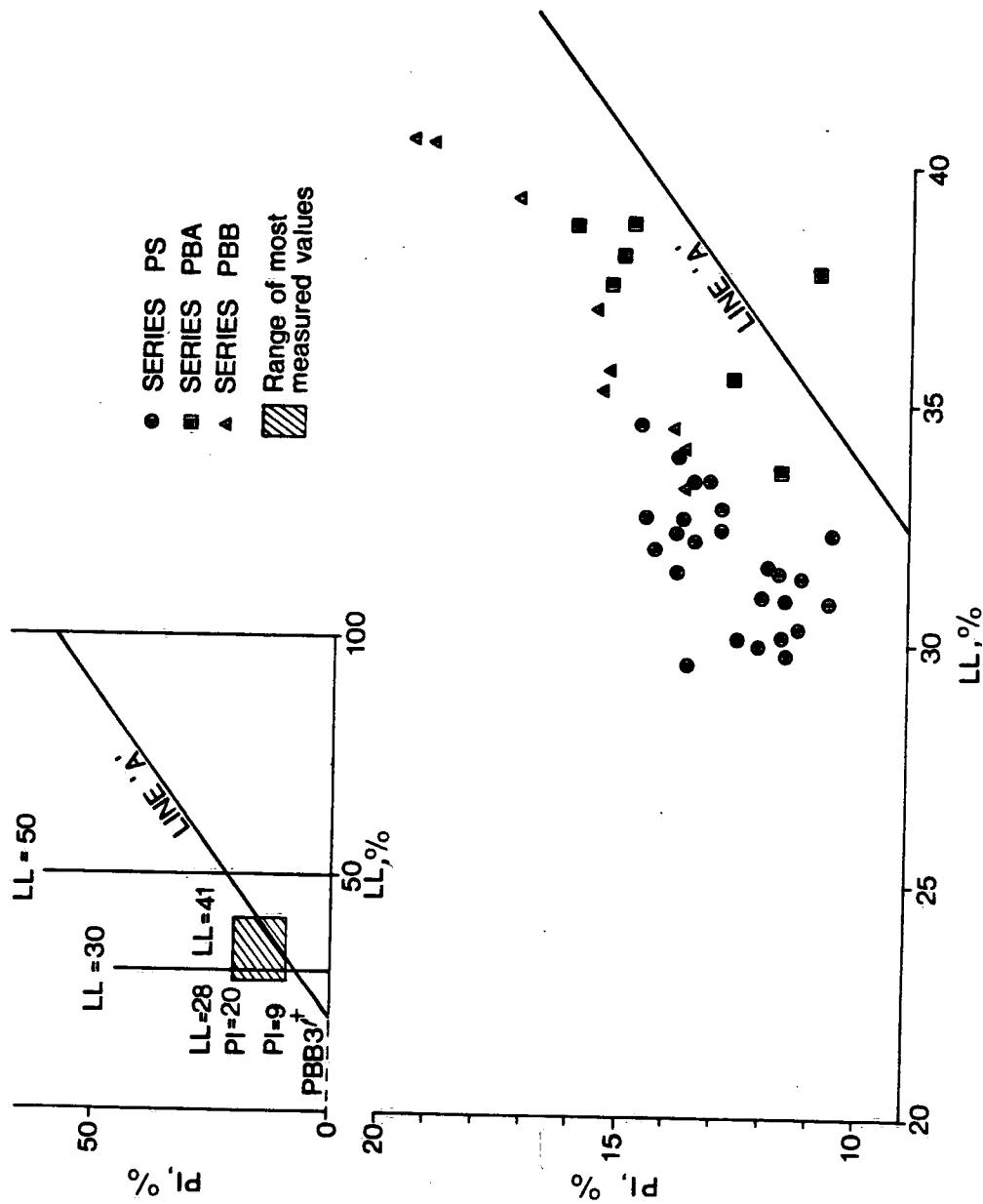
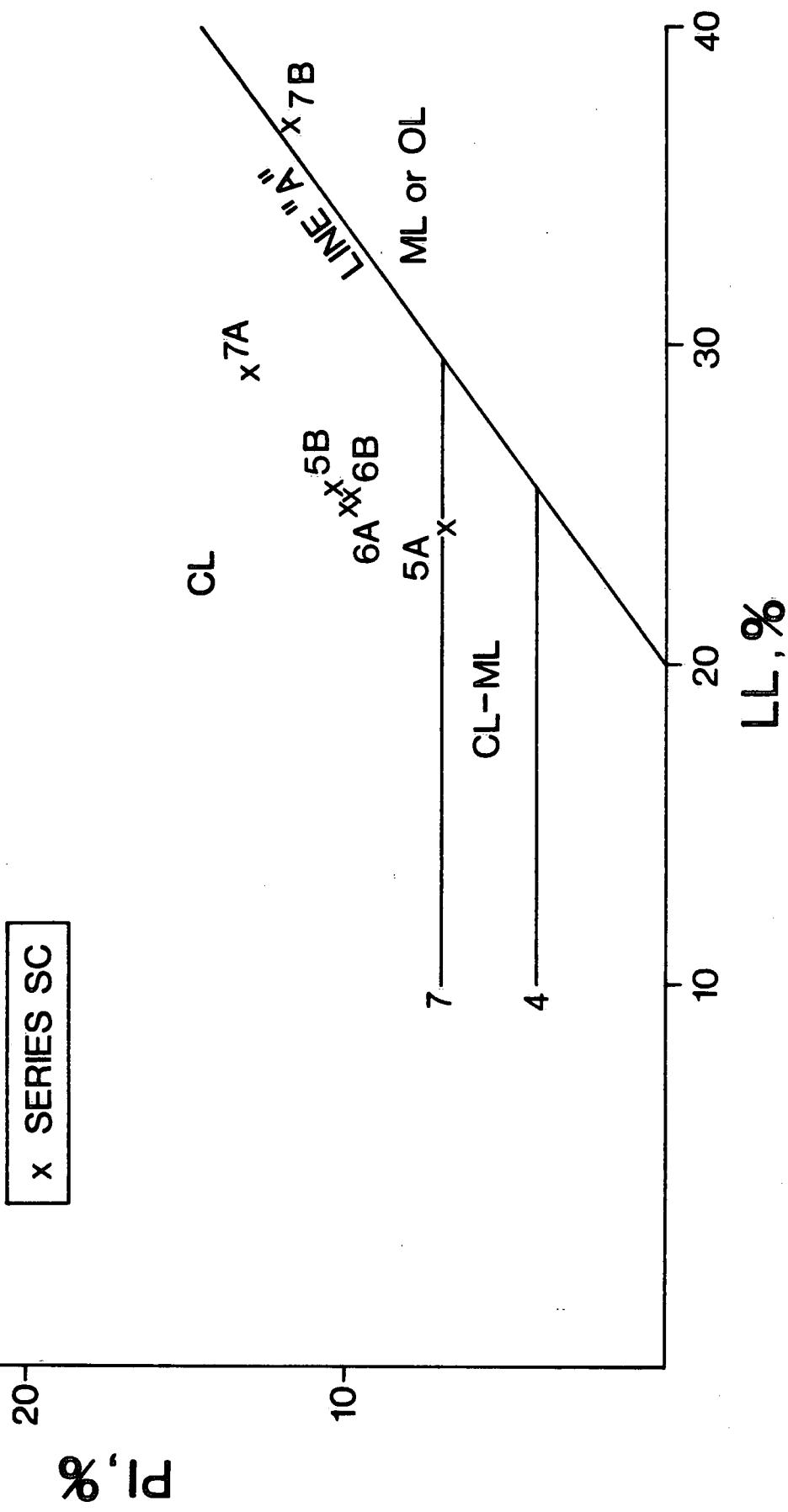


Figure 10. Results of plasticity tests (Casagrade chart), Site SC.

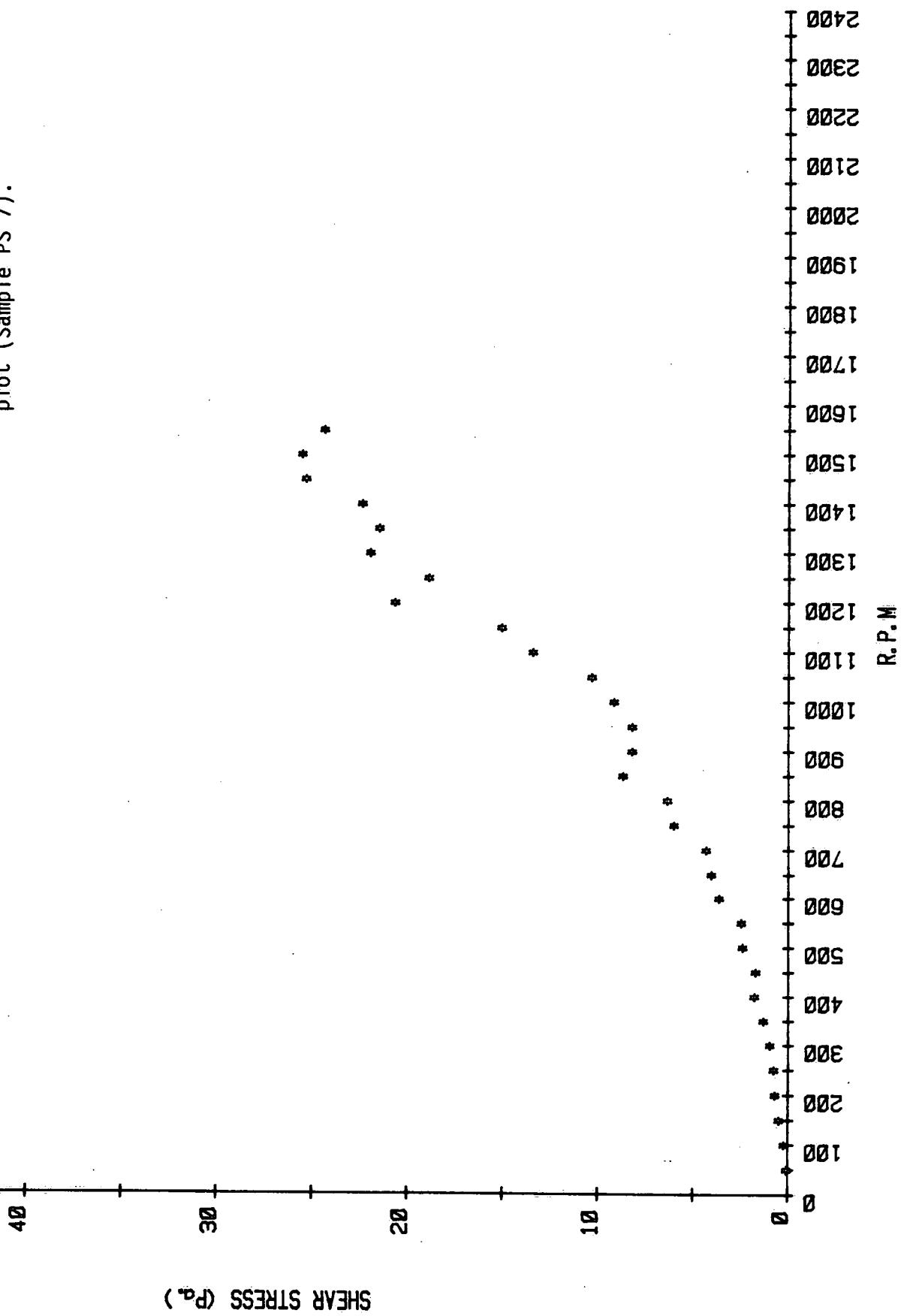
CL, ML, OL
-Groups according to unified soil classification
system (Terzaghi and Peck, 1968)

X SERIES SC



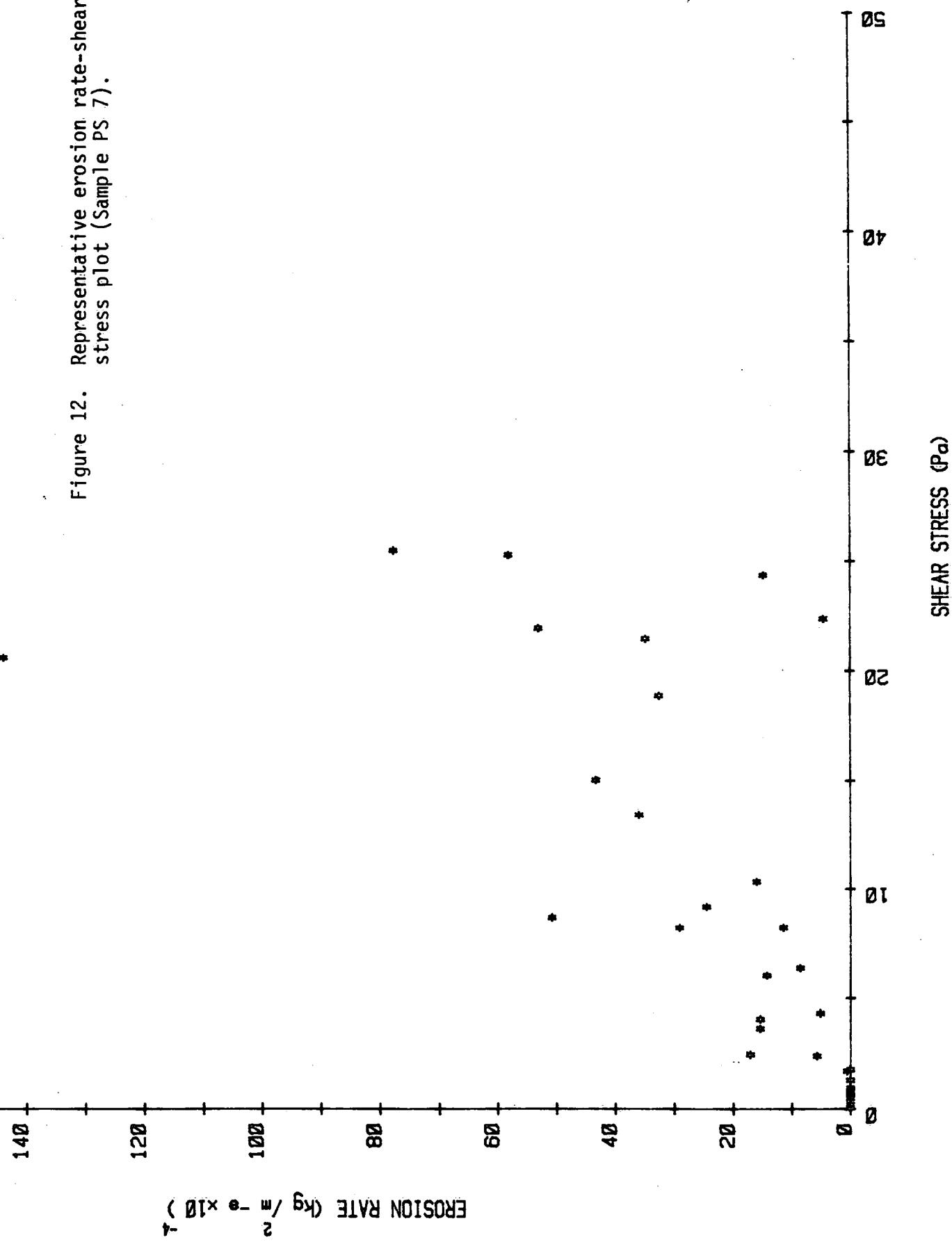
PS# 7

Figure 11. Representative rpm-shear stress plot (Sample PS 7).



PS# 7

Figure 12. Representative erosion rate-shear stress plot (Sample PS 7).



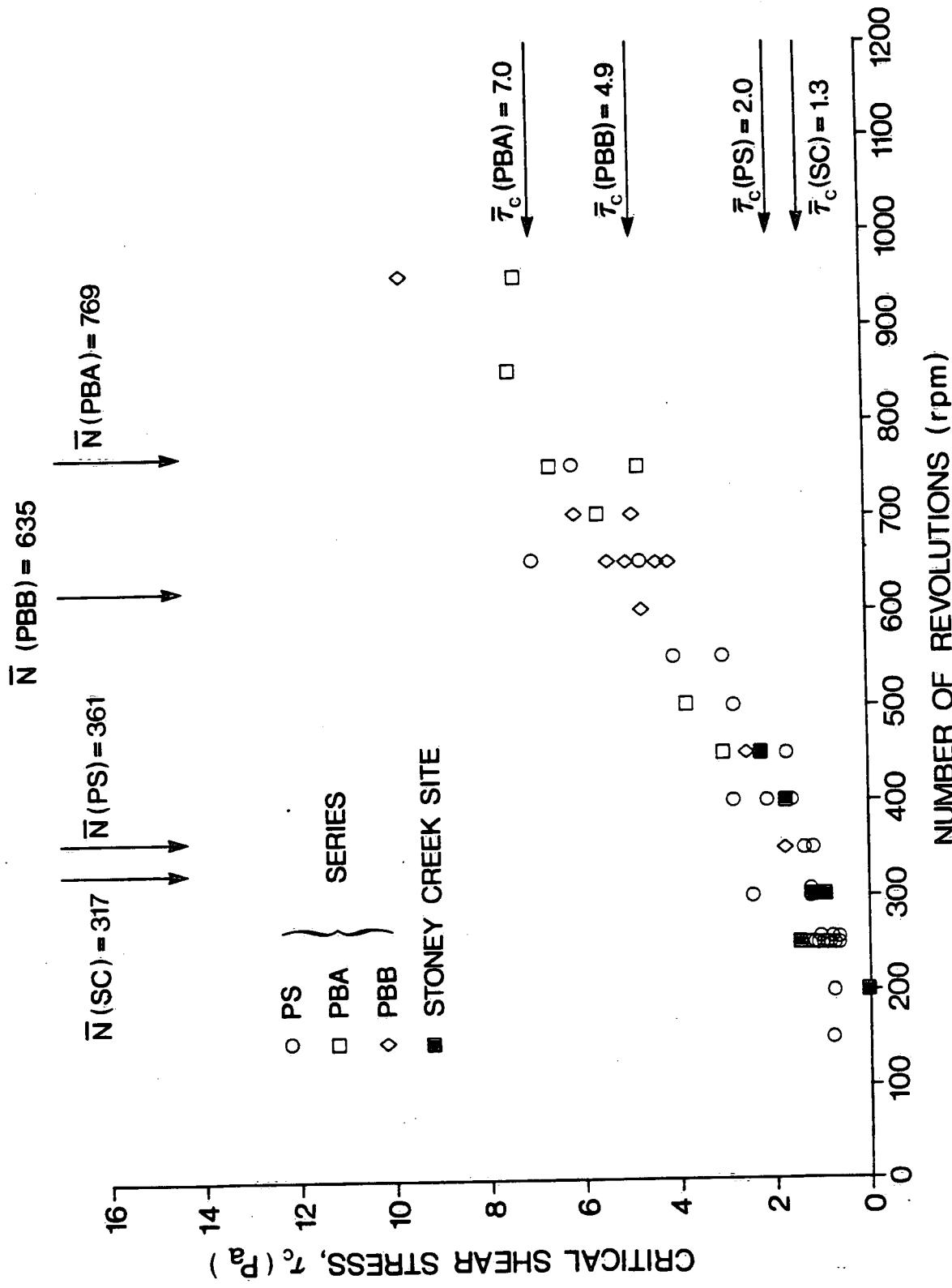


Figure 13. Critical shear stress values for all samples as a function of N (number of revolutions).

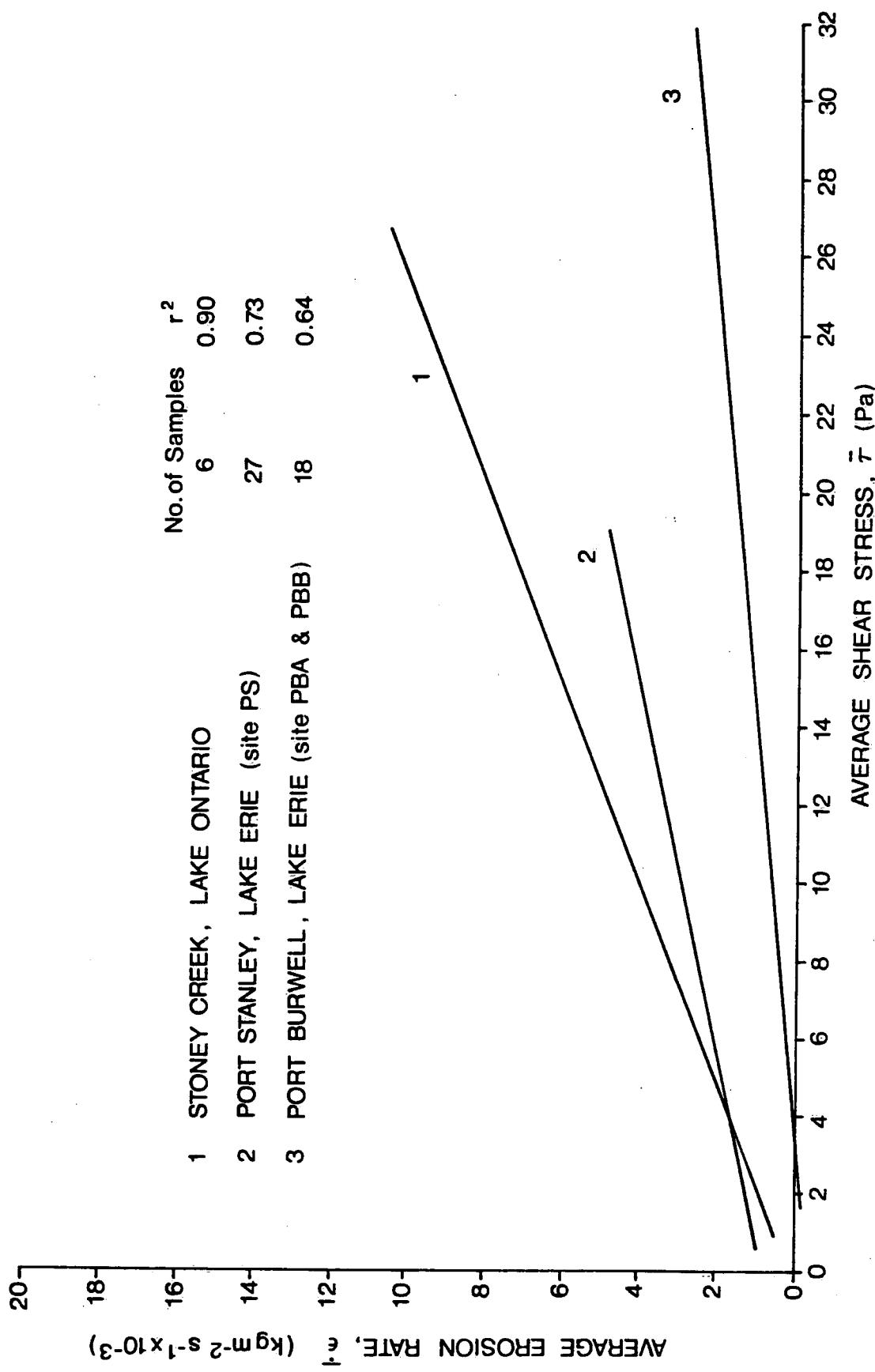


Figure 14. Averaged relationships between $\bar{\tau}$ and \bar{e} for Sites PS, PBA & PBB and SC.

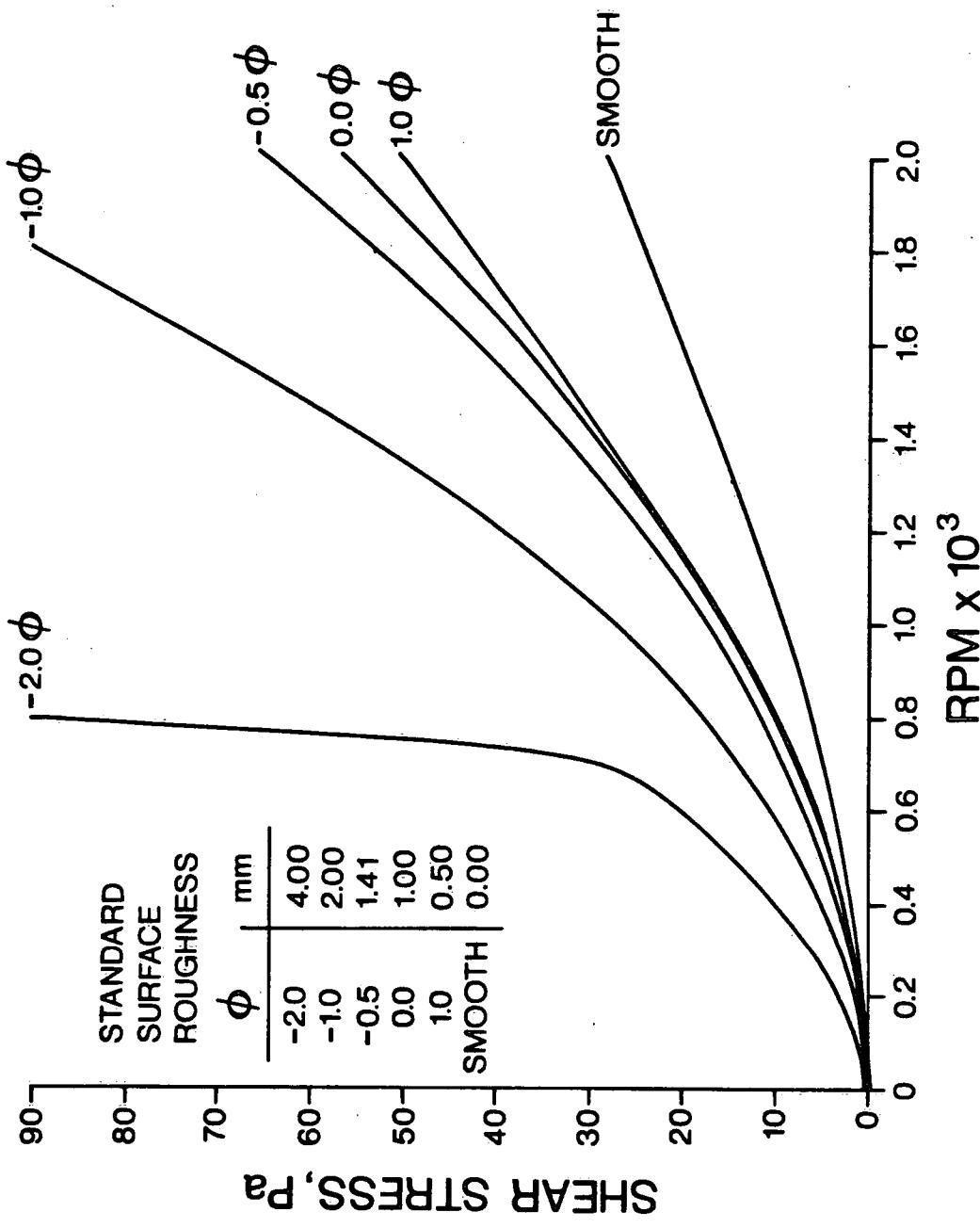


Figure 15. RPM-shear stress plot for calibration cylinders of known standard-surface roughness.

Figure 16. Changes in surface roughness during erodibility test (Sample PS 28).

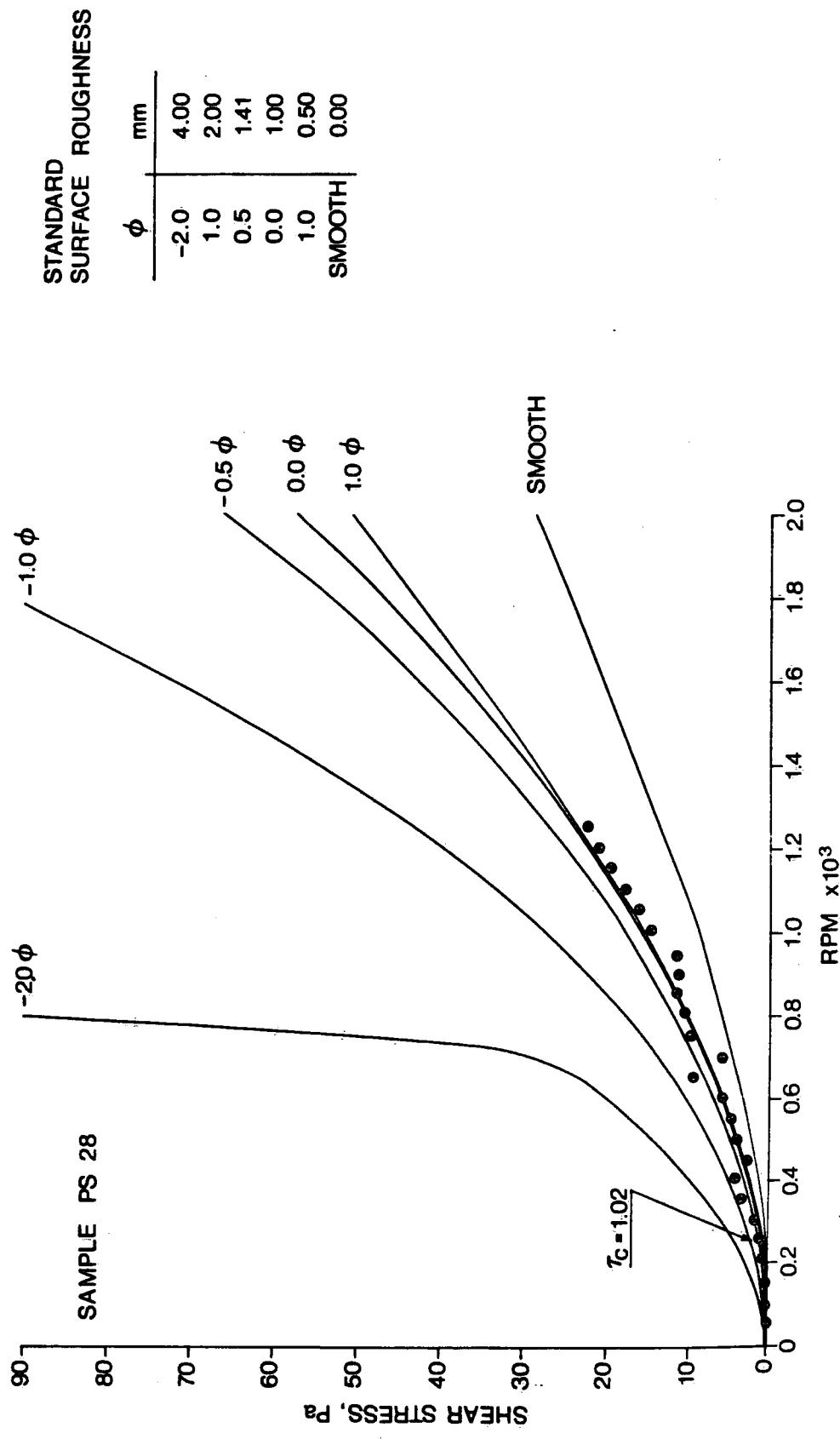
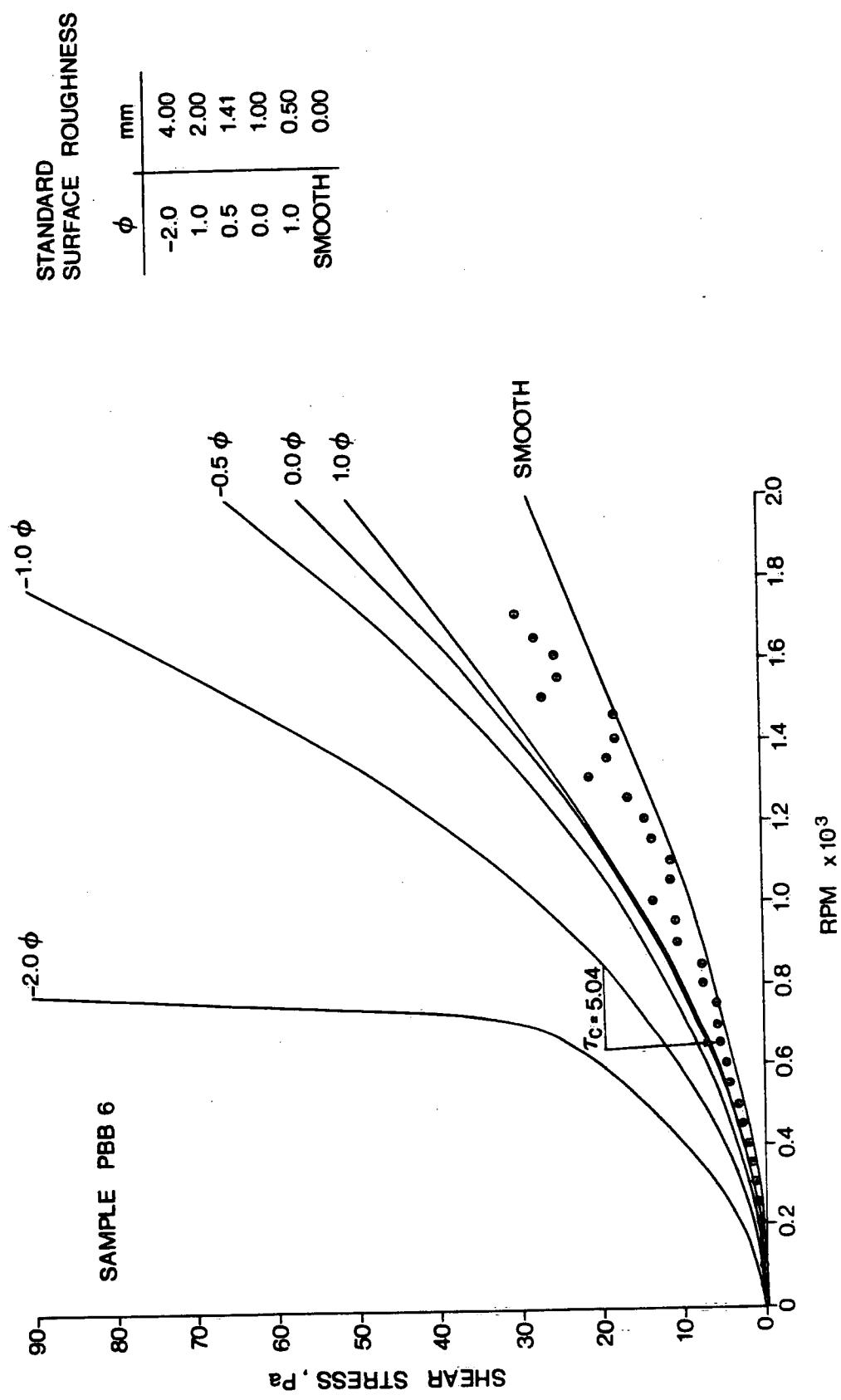


Figure 17. Changes in surface roughness during erodibility test (Sample PBB 6).



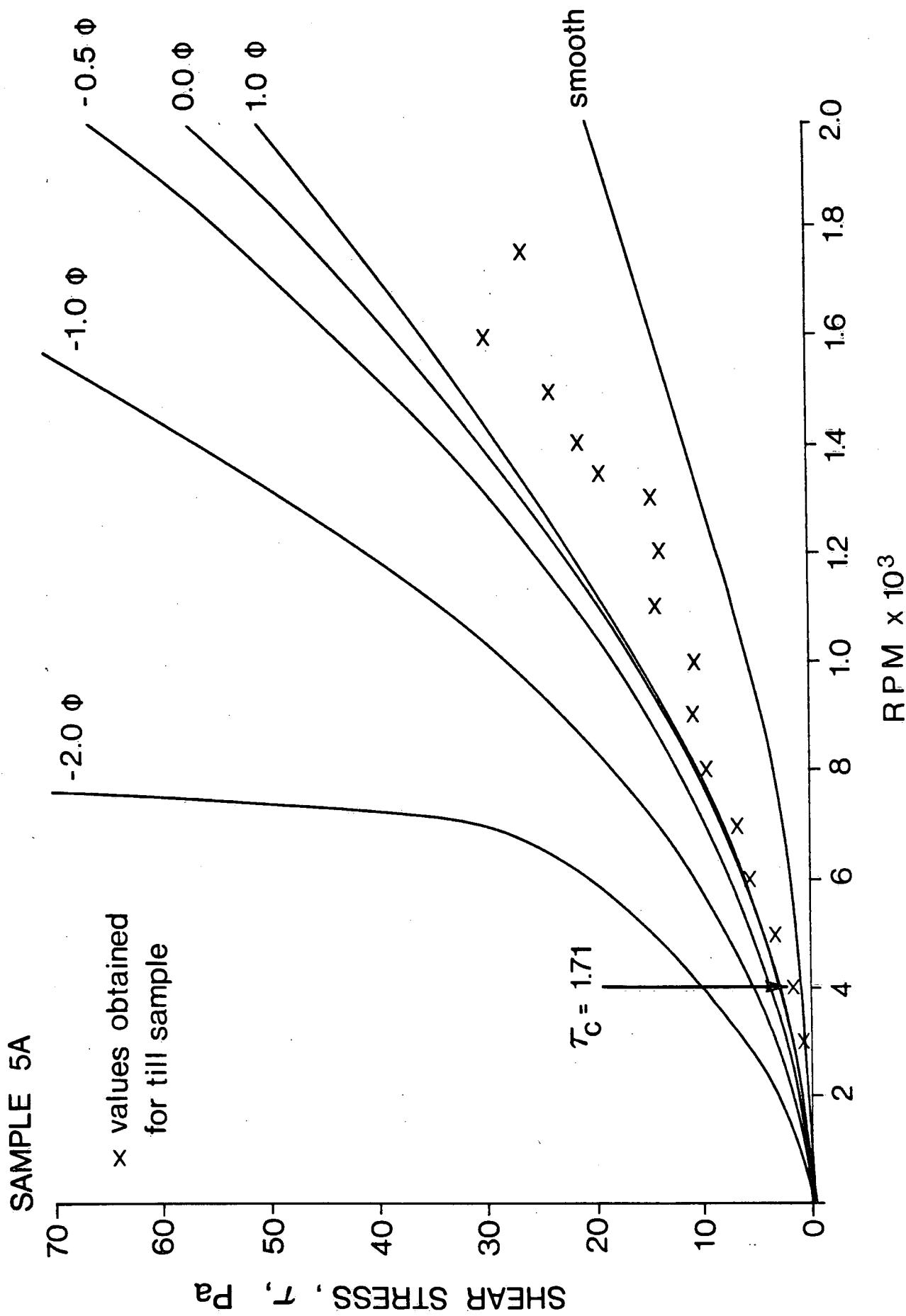


Figure 18. Changes in surface roughness during erodibility test (Sample SC 5A).

APPENDIX A.O

RESULTS OF PARTICLE-SIZE ANALYSIS

A.1 Lake Erie Samples

Series PS

Sample No.	Sand & Gravel, %	Silt, %	Clay, %
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1	4.68	29.55	65.77
3	5.28	34.10	60.62
4	3.90	36.89	59.21
5	3.85	30.75	65.40
6	3.42	35.74	60.85
7	5.82	35.20	58.98
8	4.50	36.29	59.21
9	6.99	33.15	59.86
11	7.17	35.56	57.27
12	4.80	34.62	60.58
I-VI	7.12	33.17	59.71
13	3.06	34.90	62.04
14	6.49	30.86	62.65
16	4.56	34.17	61.27
17	4.83	26.92	68.25
18	2.83	37.90	59.28
19	3.16	35.17	61.67
20	3.22	33.87	62.91
21	4.85	21.88	73.27
23	3.72	29.37	66.92
24	6.23	32.82	60.95
25	3.65	35.35	61.01
26	7.58	28.33	64.09
28	2.98	22.32	74.71
29	7.13	28.79	64.08
30	6.22	33.46	60.32

Series PBA

Sample No.	Sand & Gravel, %	Silt, %	Clay, %
1	0.00	31.31	68.69
2	0.00	29.65	70.35
3	0.00	37.37	62.63
4	0.00	19.70	80.30
5	0.00	10.55	89.45
6	0.00	28.00	72.00
7	0.00	26.50	73.50
8	0.00	38.19	61.81

Series PBB

Sample No.	Sand & Gravel, %	Silt, %	Clay, %
2	2.77	22.48	74.76
3	36.25	31.08	32.67
4	1.21	17.61	81.18
5	1.99	21.56	76.45
6	0.99	18.81	80.20
7	0.44	27.94	71.62
8	2.18	25.79	72.02
10	0.76	20.84	78.40
11	2.35	24.78	72.87
12	2.26	19.84	77.90

A.2 Lake Ontario Samples

Series SC

Sample No.	Sand & Gravel, %	Silt, %	Clay, %
5A	26.27	28.38	45.34
5B	25.12	35.19	39.69
6A	22.49	34.32	43.20
6B	25.40	35.06	39.54
7A	15.93	26.06	58.01
7B	12.25	20.18	67.57

APPENDIX B.O

RESULTS OF NATURAL WATER CONTENT AND ATTERBERG LIMITS TESTS

B.1 Lake Erie Samples

Series PS

Sample No.	Natural Water Content, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Liquidity Index
1	21.94	33.44	20.21	13.23	0.13
3	20.91	34.50	19.92	14.57	0.07
4	22.09	33.44	20.15	13.29	0.15
5	22.29	32.83	19.88	12.95	0.18
6	21.41	33.32	19.76	13.55	0.12
7	20.14	31.42	17.57	13.85	0.19
8	20.49	31.39	20.18	11.21	0.03
9	20.42	32.60	18.07	14.53	0.16
11	20.38	31.93	17.61	14.31	0.19
12	20.56	32.64	18.90	13.74	0.12
I-VI-A	14.93	29.52	15.88	13.64	-0.07
I-VI-B	16.61	29.97	18.23	11.55	-0.14
13	20.52	33.87	20.00	13.88	0.04
14	21.32	30.92	18.85	12.07	0.20
16	20.78	28.76	18.98	9.78	0.18
17	21.58	29.94	17.81	12.13	0.31
18	20.39	30.27	18.97	11.30	0.13
19	21.27	30.98	18.42	12.56	0.23
20	20.12	31.55	19.93	11.62	0.02
21	20.90	31.48	19.78	11.71	0.10
23	22.48	32.35	19.40	12.96	0.24
24	20.42	30.97	19.37	11.60	0.09
25	22.22	32.20	21.66	10.54	0.05
26	20.21	31.59	19.61	11.98	0.05
28	25.10	30.86	20.20	10.66	0.46
29	20.94	32.36	18.48	13.88	0.18
30	20.86	32.17	18.60	13.57	0.17

Series PBA

Sample No.	Natural Water Content, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Liquidity Index
1	28.42	37.46	22.08	15.38	0.41
2	30.53	38.02	22.99	15.03	0.50
3	26.62	38.68	22.67	16.01	0.25
4	31.51	38.76	23.94	14.81	0.51
5	26.57	35.57	22.83	12.75	0.29
6	27.40	36.65	22.81	13.84	0.33
7	33.55	37.76	26.82	10.93	0.62
8	26.09	33.64	21.89	11.76	0.36

Series PBB

Sample No.	Natural Water Content, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Liquidity Index
2	28.38	36.97	21.34	15.63	0.45
3	13.08	20.16	13.49	6.67	-0.06
4	29.37	40.40	21.35	19.04	0.42
5	31.49	39.27	22.00	17.27	0.55
6	31.76	34.05	20.30	13.74	0.83
7	24.89	33.27	19.59	13.68	0.39
8	28.19	35.22	19.75	15.46	0.55
10	28.89	40.49	21.03	19.46	0.40
11	27.41	35.61	20.29	15.32	0.46
12	27.27	34.50	19.53	14.97	0.52

B.2 Lake Ontario Samples

Series SC

Sample No.	Natural Water Content, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Liquidity Index
5A	15.73	24.27	17.34	6.93	-0.23
5B	16.38	25.34	15.00	10.34	0.13
6A	18.01	24.94	14.97	9.97	0.13
6B	16.86	25.36	15.54	9.82	0.30
7A	19.11	29.02	15.98	13.04	0.24
7B	18.52	36.85	25.15	11.70	-0.57

APPENDIX C.O

RESULTS OF VANE SHEAR STRENGTH TESTS

C.1 Lake Erie Samples

Series PS

Sample No.	Undisturbed Shear Strength, S_uu , kPa	Remoulded Shear Strength, S_{ur} , kPa	Sensitivity S_{uu}/S_{ur}
1	53.1	20.9	2.5
3	62.4	27.2	2.3
4	56.8	23.4	2.4
5	81.1	35.7	2.3
6	50.9	21.7	2.3
7	48.0	20.7	2.3
8	62.7	24.9	2.5
9	51.7	21.2	2.4
11	59.6	24.7	2.4
12	53.3	22.3	2.4
I-VI-A	83.2	33.8	2.5
I-VI-B	79.0	34.3	2.3
13	52.2	21.7	2.4
14	49.5	20.9	2.4
16	53.9	21.7	2.5
17	54.0	19.3	2.8
18	42.6	17.9	2.4
19	47.6	19.4	2.5
20	48.1	19.9	2.4
21	58.1	24.4	2.4
23	48.0	21.6	2.2
24	46.9	20.7	2.3
25	43.3	18.0	2.4
26	62.9	27.3	2.3
28	46.0	18.1	2.5
29	51.9	24.9	2.1
30	48.0	20.7	2.3

Series PBA

Sample No.	Undisturbed Shear Strength, S _{uu} , kPa	Remoulded Shear Strength, S _{ur} , kPa	Sensitivity S _{uu} /S _{ur}
1	31.4	11.7	2.7
2	33.1	12.4	2.7
3	38.8	16.3	2.4
4	28.0	11.4	2.5
5	45.5	19.2	2.4
6	36.7	15.5	2.4
7	36.6	16.7	2.2
8	41.8	17.8	2.3

Series PBB

Sample No.	Undisturbed Shear Strength, S _{uu} , kPa	Remoulded Shear Strength, S _{ur} , kPa	Sensitivity S _{uu} /S _{ur}
2	45.8	17.7	2.6
3	94.1	36.0	2.6
4	34.5	13.6	2.5
5	46.2	18.4	2.5
6	24.6	7.8	3.2
7	32.7	13.3	2.5
8	43.3	18.0	2.4
10	29.4	12.2	2.4
11	31.6	15.1	2.1
12	36.0	15.5	2.3

C.2 Lake Ontario Samples

Series SC

Sample No.	Undisturbed Shear Strength, S_uu , kPa	Remoulded Shear Strength, S_{ur} , kPa	Sensitivity S_{uu}/S_{ur}
5A	68.4	16.7	4.1
5B	60.2	20.2	3.0
6A	66.9	14.3	4.7
6B	81.5	24.6	3.3
7A	53.1	13.3	4.0
7B	48.1	12.9	3.7

APPENDIX D.O

RESULTS OF ERODIBILITY TESTS

D.1 Lake Erie Samples (Series PS, PBA and PBB)

PS# 1

TRACK NUMBER= 0

FILE NUMBER = 0

SURFACE AREA OF SAMPLE = 0.0324(m sq.)
 HEIGHT OF SAMPLE = 0.103(m)

RPm	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
150	0.0011	0.0008	0.49	0.0000	0.000000
250	0.0017	0.0012	0.74	0.0000	0.000000
250	0.0020	0.0011	0.68	0.0019	0.000979
300	0.0032	0.0017	1.05	0.0017	0.000876
300	0.0038	0.0017	1.05	0.0014	0.000721
350	0.0046	0.0020	1.24	0.0019	0.000979
350	0.0052	0.0020	1.24	0.0004	0.000206
400	0.0064	0.0025	1.55	0.0000	0.000000
400	0.0071	0.0025	1.55	0.0022	0.001133
450	0.0085	0.0032	1.98	0.0000	0.000000
450	0.0092	0.0031	1.92	0.0008	0.000412
500	0.0106	0.0037	2.29	0.0013	0.000670
500	0.0113	0.0036	2.23	0.0007	0.000361
550	0.0134	0.0047	2.90	0.0005	0.000258
550	0.0145	0.0047	2.90	0.0009	0.000464
600	0.0161	0.0052	3.21	0.0014	0.000721
	0.0173	0.0052	3.21	0.0014	0.000721
50	0.0191	0.0060	3.71	0.0027	0.001391
650	0.0206	0.0060	3.71	0.0013	0.000670
700	0.0236	0.0077	4.76	0.0016	0.000824
700	0.0249	0.0077	4.76	0.0040	0.002060
750	0.0267	0.0081	5.01	0.0020	0.001030
750	0.0281	0.0081	5.01	0.0023	0.001185
800	0.0305	0.0090	5.56	0.0011	0.000567
900	0.0342	0.0112	6.92	0.0030	0.001545
1000	0.0389	0.0143	8.84	0.0030	0.001545
1100	0.0422	0.0160	9.89	0.0080	0.004121
1200	0.0472	0.0193	11.93	0.0052	0.002678
1300	0.0551	0.0254	15.70	0.0057	0.002936
1400	0.0609	0.0295	18.23	0.0067	0.003451

PS# 3

TRACK NUMBER= 0
FILE NUMBER = 1SURFACE AREA OF SAMPLE = 0.0317(m sq.)
HEIGHT OF SAMPLE = 0.101(m)

RPM	UNCORRECTED TORQUE (N-m)	CORRECTED TORQUE (N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.50	0.0000	0.000000
200	0.0020	0.0011	0.69	0.0000	0.000000
250	0.0029	0.0014	0.88	0.0000	0.000000
300	0.0040	0.0019	1.20	0.0009	0.000473
350	0.0050	0.0024	1.51	0.0005	0.000263
400	0.0066	0.0034	2.14	0.0000	0.000000
450	0.0080	0.0041	2.58	0.0001	0.000052
500	0.0081	0.0035	2.21	0.0015	0.000788
550	0.0092	0.0039	2.46	0.0004	0.000210
600	0.0110	0.0049	3.09	0.0011	0.000577
650	0.0138	0.0069	4.35	0.0008	0.000420
700	0.0155	0.0078	4.92	0.0013	0.000683
750	0.0197	0.0110	6.93	0.0009	0.000473
800	0.0214	0.0116	7.31	0.0007	0.000368
850	0.0250	0.0141	8.89	0.0005	0.000263
900	0.0234	0.0113	7.12	0.0013	0.000682
950	0.0285	0.0154	9.71	0.0013	0.000682
1000	0.0306	0.0160	10.09	0.0038	0.001993
1050	0.0348	0.0189	11.91	0.0034	0.001788
1100	0.0388	0.0216	13.61	0.0025	0.001311
1150	0.0448	0.0262	16.51	0.0045	0.002364
1200	0.0479	0.0279	17.59	0.0031	0.001629
1250	0.0517	0.0302	19.04	0.0043	0.002258
1300	0.0538	0.0308	19.41	0.0051	0.002682
1350	0.0616	0.0370	23.32	0.0049	0.002576
1400	0.0686	0.0424	26.73	0.0120	0.006303
1450	0.0681	0.0402	25.34	0.0063	0.003309
1500	0.0729	0.0432	27.23	0.0065	0.003414
1550	0.0728	0.0414	26.10	0.0032	0.001681
1600	0.0793	0.0460	28.99	0.0046	0.002416
1650	0.0808	0.0458	28.87	0.0116	0.006093
1700	0.0825	0.0455	28.68	0.0079	0.004150

PS# 4

TRACK NUMBER= 0
FILE NUMBER = 2SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

RPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0011	0.0006	0.37	0.0000	0.000000
200	0.0018	0.0009	0.56	0.0000	0.000000
250	0.0026	0.0011	0.69	0.0000	0.000000
300	0.0035	0.0014	0.87	0.0000	0.000000
350	0.0046	0.0020	1.25	0.0000	0.000000
400	0.0058	0.0026	1.62	0.0002	0.000104
450	0.0085	0.0046	2.87	0.0000	0.000000
500	0.0103	0.0057	3.56	0.0004	0.000208
550	0.0117	0.0064	3.99	0.0007	0.000364
600	0.0124	0.0063	3.93	0.0010	0.000520
650	0.0135	0.0066	4.12	0.0010	0.000520
700	0.0154	0.0077	4.81	0.0014	0.000728
750	0.0177	0.0090	5.62	0.0017	0.000884
800	0.0187	0.0089	5.55	0.0016	0.000832
850	0.0199	0.0090	5.62	0.0014	0.000728
900	0.0230	0.0109	6.80	0.0019	0.000988
950	0.0248	0.0117	7.30	0.0009	0.000468
1000	0.0295	0.0149	9.30	0.0035	0.001820
1050	0.0327	0.0168	10.49	0.0071	0.003693
1100	0.0372	0.0200	12.48	0.0045	0.002341
1150	0.0404	0.0218	13.61	0.0055	0.002837
1200	0.0421	0.0221	13.79	0.0055	0.002837
1250	0.0435	0.0220	13.73	0.0032	0.001665
1300	0.0477	0.0247	15.42	0.0020	0.001040
1350	0.0567	0.0321	20.03	0.0090	0.004681
1400	0.0582	0.0320	19.97	0.0057	0.002964
1450	0.0787	0.0508	31.71	0.0108	0.005817
1500	0.0852	0.0555	34.64	0.0105	0.005461
1550	0.0905	0.0591	36.89	0.0293	0.015238
1600	0.0774	0.0441	27.52	0.0112	0.005825
1650	0.0769	0.0419	26.15	0.0049	0.002548

PS# 5

TRACK NUMBER= 0
FILE NUMBER = 3SURFACE AREA OF SAMPLE = 0.0336(m sq.)
HEIGHT OF SAMPLE = 0.107(m)

- RPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0001	0.0000	0.00	0.0000	0.000000
100	0.0005	0.0002	0.12	0.0000	0.000000
150	0.0011	0.0006	0.36	0.0000	0.000000
200	0.0018	0.0009	0.54	0.0000	0.000000
250	0.0027	0.0012	0.71	0.0008	0.000396
300	0.0024	0.0003	0.18	0.0011	0.000545
350	0.0045	0.0019	1.13	0.0008	0.000396
400	0.0042	0.0010	0.59	0.0017	0.000843
450	0.0063	0.0024	1.43	0.0058	0.002876
500	0.0075	0.0029	1.73	0.0005	0.000248
550	0.0082	0.0029	1.73	0.0008	0.000396
600	0.0109	0.0048	2.86	0.0019	0.000942
650	0.0108	0.0039	2.32	0.0010	0.000496
700	0.0097	0.0020	1.19	0.0019	0.000942
750	0.0154	0.0067	3.99	0.0059	0.002925
800	0.0161	0.0063	3.75	0.0048	0.002380
850	0.0207	0.0098	5.83	0.0115	0.005702
900	0.0243	0.0122	7.26	0.0044	0.002182
950	0.0264	0.0133	7.91	0.0083	0.004115
1000	0.0293	0.0147	8.75	0.0076	0.003768
1050	0.0285	0.0126	7.50	0.0051	0.002529
1100	0.0299	0.0127	7.56	0.0053	0.002628
1150	0.0355	0.0189	10.06	0.0141	0.006991
1200	0.0379	0.0179	10.65	0.0079	0.003917
1250	0.0405	0.0190	11.30	0.0103	0.005107
1300	0.0449	0.0219	13.03	0.0046	0.002281
1350	0.0471	0.0225	13.39	0.0063	0.003123

PS# 6

TRACK NUMBER= 0
FILE NUMBER = 4SURFACE AREA OF SAMPLE = 0.0333(m sq.)
HEIGHT OF SAMPLE = 0.106(m)

RPm	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./st)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.18	0.0000	0.000000
150	0.0013	0.0008	0.48	0.0000	0.000000
200	0.0021	0.0012	0.72	0.0000	0.000000
250	0.0030	0.0015	0.90	0.0020	0.001001
300	0.0045	0.0024	1.44	0.0005	0.000250
350	0.0068	0.0042	2.52	0.0022	0.001101
400	0.0078	0.0046	2.76	0.0005	0.000250
450	0.0085	0.0046	2.76	0.0003	0.000150
500	0.0106	0.0060	3.60	0.0003	0.000150
550	0.0114	0.0061	3.68	0.0020	0.001001
600	0.0148	0.0087	5.23	0.0027	0.001351
650	0.0183	0.0114	6.85	0.0066	0.003303
700	0.0182	0.0105	6.31	0.0025	0.001251
750	0.0170	0.0083	4.98	0.0097	0.004855
800	0.0250	0.0152	9.13	0.0122	0.006106
850	0.0216	0.0107	6.43	0.0068	0.003403
900	0.0291	0.0170	10.21	0.0054	0.002703
950	0.0326	0.0195	11.71	0.0065	0.003253
1000	0.0692	0.0546	32.79	0.0321	0.016066

PS# 7

TRACK NUMBER= 0
FILE NUMBER = 5SURFACE AREA OF SAMPLE = 0.0292(m sq.)
HEIGHT OF SAMPLE = 0.093(m)

T.P.M.	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.21	0.0000	0.000000
150	0.0012	0.0007	0.48	0.0000	0.000000
200	0.0019	0.0010	0.68	0.0000	0.000000
250	0.0026	0.0011	0.75	0.0000	0.000000
300	0.0035	0.0014	0.96	0.0000	0.000000
350	0.0045	0.0019	1.30	0.0000	0.000000
400	0.0058	0.0026	1.78	0.0000	0.000000
450	0.0064	0.0025	1.71	0.0001	0.000057
500	0.0081	0.0035	2.40	0.0010	0.000570
550	0.0089	0.0036	2.46	0.0030	0.001711
600	0.0114	0.0053	3.63	0.0027	0.001540
650	0.0128	0.0059	4.04	0.0027	0.001540
700	0.0140	0.0063	4.31	0.0009	0.000513
750	0.0175	0.0088	6.02	0.0025	0.001426
800	0.0191	0.0093	6.37	0.0015	0.000856
850	0.0236	0.0127	8.69	0.0089	0.005077
900	0.0241	0.0120	8.21	0.0051	0.002909
950	0.0251	0.0120	8.21	0.0020	0.001141
1000	0.0280	0.0134	9.17	0.0043	0.002453
1050	0.0310	0.0151	10.34	0.0028	0.001597
1100	0.0368	0.0196	13.42	0.0063	0.003594
1150	0.0406	0.0220	15.06	0.0076	0.004335
1200	0.0502	0.0302	20.67	0.0252	0.014375
1250	0.0491	0.0276	18.89	0.0057	0.003252
1300	0.0551	0.0321	21.97	0.0093	0.005305
1350	0.0560	0.0314	21.49	0.0061	0.003480
1400	0.0589	0.0327	22.38	0.0008	0.000456
1450	0.0649	0.0370	25.33	0.0102	0.005810
1500	0.0670	0.0373	25.53	0.0136	0.007758
1550	0.0670	0.0356	24.37	0.0026	0.001483

PS# 8

TRACK NUMBER= 0

FILE NUMBER = 6

SURFACE AREA OF SAMPLE = 0.0339(m sq.)
 HEIGHT OF SAMPLE = 0.108(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0009	0.0006	0.35	0.0000	0.000000
150	0.0018	0.0013	0.77	0.0009	0.000442
200	0.0024	0.0015	0.88	0.0025	0.001228
250	0.0037	0.0022	1.30	0.0010	0.000491
300	0.0031	0.0010	0.59	0.0047	0.002309
350	0.0044	0.0018	1.06	0.0010	0.000491
400	0.0050	0.0018	1.06	0.0027	0.001326
450	0.0071	0.0032	1.89	0.0031	0.001523
500	0.0084	0.0038	2.24	0.0012	0.000590
550	0.0126	0.0073	4.30	0.0358	0.017586
600	0.0173	0.0112	6.60	0.0064	0.003144
650	0.0131	0.0062	3.65	0.0034	0.001670
700	0.0135	0.0058	3.42	0.0046	0.002260
750	0.0167	0.0080	4.72	0.0042	0.002063
800	0.0186	0.0088	5.19	0.0054	0.002653
850	0.0208	0.0099	5.84	0.0039	0.001916
900	0.0224	0.0103	6.07	0.0097	0.004765
950	0.0276	0.0145	8.55	0.0067	0.003291
1000	0.0341	0.0195	11.49	0.0083	0.004077
1050	0.0340	0.0181	10.67	0.0070	0.003439
1100	0.0353	0.0181	10.67	0.0141	0.006926
1150	0.0401	0.0215	12.67	0.0080	0.003930
1200	0.0488	0.0288	16.98	0.0297	0.014589

PS# 9

TRACK NUMBER= 0
FILE NUMBER = 7SURFACE AREA OF SAMPLE = 0.0324(m sq.)
HEIGHT OF SAMPLE = 0.103(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0011	0.0006	0.37	0.0000	0.000000
200	0.0017	0.0008	0.49	0.0000	0.000000
250	0.0026	0.0011	0.68	0.0012	0.000618
300	0.0031	0.0040	2.47	0.0005	0.000257
350	0.0061	0.0035	2.16	0.0016	0.000824
400	0.0055	0.0023	1.42	0.0003	0.000155
450	0.0072	0.0033	2.04	0.0005	0.000257
500	0.0071	0.0025	1.55	0.0017	0.000875
550	0.0112	0.0059	3.65	0.0015	0.000772
600	0.0129	0.0068	4.20	0.0002	0.000103
650	0.0139	0.0070	4.33	0.0020	0.001030
700	0.0160	0.0083	5.13	0.0025	0.001287
750	0.0175	0.0088	5.44	0.0021	0.001082
800	0.0212	0.0114	7.05	0.0021	0.001082
850	0.0219	0.0110	6.80	0.0044	0.002266
900	0.0242	0.0121	7.48	0.0025	0.001287
950	0.0270	0.0139	8.59	0.0027	0.001391
1000	0.0337	0.0191	11.81	0.0051	0.002627
1050	0.0345	0.0186	11.50	0.0037	0.001927
1100	0.0388	0.0216	13.35	0.0035	0.001802
1150	0.0419	0.0233	14.40	0.0017	0.000875
1200	0.0466	0.0266	16.44	0.0052	0.002679
1250	0.0481	0.0266	16.44	0.0058	0.002987
1300	0.0570	0.0340	21.01	0.0057	0.002936
1350	0.0501	0.0255	15.76	0.0073	0.003760
1400	0.0582	0.0300	18.54	0.0042	0.002184
1450	0.0582	0.0303	18.73	0.0039	0.002009
1500	0.0654	0.0357	22.07	0.0102	0.005253
1550	0.0671	0.0357	22.07	0.0072	0.003709
1600	0.0733	0.0400	24.72	0.0055	0.002833

PS# 11

TRACK NUMBER= 0
FILE NUMBER = 8SURFACE AREA OF SAMPLE = 0.0327(m sq.)
HEIGHT OF SAMPLE = 0.104(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0005	0.31	0.0000	0.000000
150	0.0015	0.0010	0.61	0.0000	0.000000
200	0.0024	0.0015	0.92	0.0000	0.000000
250	0.0035	0.0020	1.22	0.0000	0.000000
300	0.0046	0.0025	1.53	0.0000	0.000000
350	0.0059	0.0033	2.02	0.0000	0.000000
400	0.0078	0.0046	2.82	0.0005	0.000255
450	0.0090	0.0051	3.12	0.0007	0.000357
500	0.0108	0.0062	3.80	0.0009	0.000459
550	0.0119	0.0066	4.04	0.0015	0.000765
600	0.0129	0.0068	4.16	0.0006	0.000306
650	0.0159	0.0090	5.51	0.0018	0.000918
700	0.0180	0.0103	6.30	0.0020	0.001020
750	0.0198	0.0111	6.79	0.0015	0.000765
800	0.0245	0.0147	9.00	0.0009	0.000459
850	0.0249	0.0140	8.57	0.0022	0.001122
900	0.0292	0.0171	10.47	0.0018	0.000918
950	0.0324	0.0193	11.81	0.0027	0.001377
1000	0.0346	0.0200	12.24	0.0018	0.000918
1050	0.0375	0.0216	13.22	0.0035	0.001785
1100	0.0366	0.0194	11.88	0.0028	0.001428
1150	0.0499	0.0313	19.16	0.0044	0.002245
1200	0.0525	0.0325	19.89	0.0046	0.002346
1250	0.0527	0.0312	19.10	0.0052	0.002652
1300	0.0575	0.0345	21.12	0.0049	0.002499
1350	0.0680	0.0434	26.57	0.0073	0.003724
1400	0.0660	0.0398	24.36	0.0078	0.003979
1450	0.0715	0.0436	26.69	0.0061	0.003112
1500	0.0765	0.0468	28.65	0.0105	0.005356
1550	0.0797	0.0483	29.57	0.0084	0.004285
1600	0.0792	0.0459	28.10	0.0077	0.003928

PS# 12

TRACK NUMBER= 0
FILE NUMBER = 9SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0003	0.0002	0.12	0.0000	0.000000
100	0.0008	0.0005	0.31	0.0000	0.000000
150	0.0014	0.0009	0.56	0.0000	0.000000
200	0.0022	0.0013	0.81	0.0000	0.000000
250	0.0031	0.0016	1.00	0.0000	0.000000
300	0.0042	0.0021	1.31	0.0000	0.000000
350	0.0054	0.0028	1.75	0.0000	0.000000
400	0.0068	0.0036	2.25	0.0000	0.000000
450	0.0084	0.0045	2.81	0.0000	0.000000
500	0.0091	0.0045	2.81	0.0002	0.000104
550	0.0093	0.0040	2.50	0.0006	0.000312
600	0.0112	0.0051	3.18	0.0005	0.000260
650	0.0150	0.0081	5.06	0.0070	0.003641
700	0.0208	0.0131	8.18	0.0032	0.001665
750	0.0205	0.0118	7.36	0.0019	0.000988
800	0.0259	0.0161	10.05	0.0050	0.002601
850	0.0262	0.0153	9.55	0.0028	0.001456
900	0.0292	0.0171	10.67	0.0054	0.002809
950	0.0311	0.0180	11.23	0.0030	0.001560
1000	0.0323	0.0177	11.05	0.0040	0.002080
1050	0.0342	0.0183	11.42	0.0036	0.001872
1100	0.0360	0.0188	11.73	0.0067	0.003485
1150	0.0390	0.0204	12.73	0.0042	0.002188
1200	0.0444	0.0244	15.23	0.0046	0.002392
1250	0.0501	0.0286	17.85	0.0039	0.002028
1300	0.0530	0.0300	18.72	0.0039	0.002028
1350	0.0535	0.0289	18.04	0.0047	0.002444
1400	0.0567	0.0305	19.04	0.0053	0.002757
1450	0.0612	0.0333	20.78	0.0109	0.005673
1500	0.0612	0.0315	19.66	0.0078	0.004057
1550	0.0729	0.0415	25.90	0.0099	0.005149
1600	0.0689	0.0356	22.22	0.0066	0.003433
1650	0.0899	0.0549	34.27	0.0115	0.005981
1700	0.0814	0.0444	27.71	0.0083	0.004317

I-VI A

TRACK NUMBER = 0
FILE NUMBER = 10SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0003	0.0002	0.12	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.50	0.0000	0.000000
200	0.0021	0.0012	0.75	0.0000	0.000000
250	0.0031	0.0016	1.00	0.0000	0.000000
300	0.0041	0.0020	1.25	0.0000	0.000000
350	0.0052	0.0026	1.62	0.0000	0.000000
400	0.0068	0.0036	2.25	0.0000	0.000000
450	0.0081	0.0042	2.62	0.0000	0.000000
500	0.0096	0.0050	3.12	0.0000	0.000000
550	0.0118	0.0065	4.06	0.0051	0.002653
600	0.0163	0.0102	6.37	0.0009	0.000468
650	0.0128	0.0059	3.68	0.0004	0.000208
700	0.0209	0.0132	8.24	0.0002	0.000109
750	0.0225	0.0138	8.61	0.0066	0.003433
800	0.0320	0.0222	13.86	0.0012	0.000624
850	0.0279	0.0170	10.61	0.0034	0.001769
900	0.0285	0.0164	10.24	0.0017	0.000884
950	0.0301	0.0170	10.61	0.0015	0.000780
1000	0.0365	0.0219	13.67	0.0034	0.001769
1050	0.0337	0.0178	11.11	0.0077	0.004005
1100	0.0465	0.0293	18.29	0.0040	0.002080
1150	0.0488	0.0302	18.85	0.0045	0.002341
1200	0.0515	0.0315	19.66	0.0086	0.004473
1250	0.0556	0.0341	21.28	0.0109	0.005669
1300	0.0509	0.0279	17.41	0.0074	0.003849
1350	0.0578	0.0332	20.72	0.0111	0.005773
1400	0.0649	0.0387	24.15	0.0074	0.003849

I-VI B

TRACK NUMBER= 0
FILE NUMBER = 11SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0005	0.0002	0.12	0.0000	0.000000
150	0.0013	0.0008	0.50	0.0000	0.000000
200	0.0021	0.0012	0.75	0.0000	0.000000
250	0.0031	0.0016	1.00	0.0000	0.000000
300	0.0042	0.0021	1.31	0.0000	0.000000
350	0.0053	0.0027	1.69	0.0000	0.000000
400	0.0066	0.0034	2.12	0.0006	0.000312
450	0.0110	0.0071	4.43	0.0042	0.002185
500	0.0108	0.0062	3.87	0.0018	0.000936
550	0.0098	0.0045	2.81	0.0022	0.001144
600	0.0128	0.0067	4.18	0.0050	0.002600
650	0.0170	0.0101	6.30	0.0036	0.001872
700	0.0204	0.0127	7.93	0.0050	0.002600
750	0.0206	0.0119	7.43	0.0026	0.001352
800	0.0280	0.0182	11.36	0.0134	0.006970
850	0.0265	0.0156	9.74	0.0061	0.003173
900	0.0277	0.0156	9.74	0.0047	0.002445
950	0.0322	0.0191	11.92	0.0036	0.001872
1000	0.0325	0.0179	11.17	0.0036	0.001872
1050	0.0405	0.0246	15.35	0.0086	0.004479
1100	0.0436	0.0264	16.48	0.0045	0.002341
1150	0.0452	0.0266	16.60	0.0033	0.001716
1200	0.0518	0.0318	19.85	0.0058	0.003017
1250	0.0480	0.0265	16.54	0.0047	0.002445
1300	0.0575	0.0345	21.53	0.0040	0.002081
1350	0.0604	0.0358	22.34	0.0052	0.002705
1400	0.0624	0.0362	22.59	0.0055	0.002861

PS# 13

TRACK NUMBER= 0

FILE NUMBER =12

SURFACE AREA OF SAMPLE = 0.0330(m sq.)

HEIGHT OF SAMPLE = 0.105(m)

STPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.24	0.0000	0.000000
150	0.0014	0.0009	0.55	0.0000	0.000000
200	0.0022	0.0013	0.79	0.0000	0.000000
250	0.0035	0.0020	1.21	0.0046	0.002324
300	0.0054	0.0033	2.00	0.0037	0.001869
350	0.0081	0.0035	2.12	0.0030	0.001516
400	0.0086	0.0054	3.27	0.0058	0.002930
450	0.0108	0.0069	4.18	0.0028	0.001415
500	0.0094	0.0048	2.91	0.0000	0.000000
550	0.0156	0.0103	6.24	0.0100	0.005053
600	0.0135	0.0074	4.49	0.0000	0.000000
650	0.0161	0.0092	5.58	0.0009	0.000455
700	0.0163	0.0086	5.21	0.0016	0.000808
750	0.0182	0.0095	5.76	0.0017	0.000859
800	0.0226	0.0128	7.76	0.0000	0.000000
850	0.0258	0.0149	9.03	0.0008	0.000404
900	0.0283	0.0162	9.82	0.0000	0.000000
950	0.0301	0.0170	10.31	0.0002	0.000101
1000	0.0338	0.0192	11.64	0.0038	0.001920
1050	0.0336	0.0177	10.73	0.0002	0.000101
1100	0.0369	0.0197	11.94	0.0021	0.001061
1150	0.0421	0.0235	14.25	0.0010	0.000505
1200	0.0512	0.0312	18.92	0.0031	0.001566
1250	0.0472	0.0257	15.58	0.0002	0.000101
1300	0.0515	0.0285	17.28	0.0001	0.000051
1350	0.0525	0.0280	16.98	0.0025	0.001263
1400	0.0660	0.0398	24.13	0.0038	0.001920
1450	0.0765	0.0486	29.47	0.0014	0.000708
1500	0.0743	0.0446	27.04	0.0000	0.000000
1550	0.0782	0.0468	28.38	0.0016	0.000808
1600	0.0791	0.0458	27.77	0.0015	0.000758
1650	0.0889	0.0539	32.68	0.0026	0.001314
1700	0.0962	0.0592	35.89	0.0033	0.001667

PS# 14

TRACK NUMBER= 0
FILE NUMBER =13SURFACE AREA OF SAMPLE = 0.0330(m sq.)
HEIGHT OF SAMPLE = 0.105(m)

PPM	UNCORRECTED TORQUE (N-m)	CORRECTED TORQUE (N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.24	0.0000	0.000000
150	0.0013	0.0008	0.49	0.0000	0.000000
200	0.0020	0.0011	0.67	0.0000	0.000000
250	0.0029	0.0014	0.85	0.0000	0.000000
300	0.0039	0.0018	1.09	0.0000	0.000000
350	0.0050	0.0024	1.46	0.0000	0.000000
400	0.0062	0.0030	1.82	0.0000	0.000000
450	0.0075	0.0036	2.18	0.0000	0.000000
500	0.0089	0.0043	2.61	0.0000	0.000000
550	0.0104	0.0051	3.09	0.0000	0.000000
600	0.0121	0.0060	3.64	0.0000	0.000000
650	0.0147	0.0078	4.73	0.0010	0.000505
700	0.0153	0.0076	4.61	0.0020	0.001010
750	0.0197	0.0110	6.67	0.0012	0.000607
800	0.0196	0.0098	5.94	0.0005	0.000252
850	0.0253	0.0144	8.73	0.0030	0.001516
900	0.0258	0.0137	8.31	0.0002	0.000101
950	0.0270	0.0139	8.43	0.0005	0.000252
1000	0.0293	0.0147	8.91	0.0032	0.001617
1050	0.0360	0.0201	12.19	0.0009	0.000455
1100	0.0367	0.0195	11.82	0.0001	0.000050
1150	0.0380	0.0194	11.76	0.0022	0.001111
1200	0.0415	0.0215	13.04	0.0006	0.000303
1250	0.0550	0.0335	20.31	0.0072	0.003638
1300	0.0555	0.0325	19.70	0.0012	0.000607
1350	0.0533	0.0287	17.40	0.0029	0.001466
1400	0.0612	0.0350	21.22	0.0008	0.000404
1450	0.0649	0.0370	22.43	0.0007	0.000354
1500	0.0660	0.0363	22.01	0.0014	0.000708
1550	0.0885	0.0571	34.62	0.0057	0.002880
1600	0.0841	0.0508	30.80	0.0013	0.000657

PS# 16

TRACK NUMBER= 0
FILE NUMBER =14SURFACE AREA OF SAMPLE = 0.0324(m sq.)
HEIGHT OF SAMPLE = 0.103(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq. /s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0012	0.0007	0.43	0.0000	0.000000
200	0.0019	0.0010	0.62	0.0000	0.000000
250	0.0028	0.0013	0.80	0.0000	0.000000
300	0.0038	0.0017	1.05	0.0000	0.000000
350	0.0049	0.0023	1.42	0.0000	0.000000
400	0.0061	0.0029	1.79	0.0000	0.000000
450	0.0068	0.0029	1.79	0.0000	0.000000
500	0.0102	0.0056	3.46	0.0000	0.000000
550	0.0102	0.0049	3.03	0.0049	0.002524
600	0.0154	0.0093	5.75	0.0067	0.003451
650	0.0188	0.0119	7.36	0.0056	0.002884
700	0.0180	0.0103	6.37	0.0072	0.003709
750	0.0244	0.0157	9.70	0.0064	0.003296
800	0.0232	0.0134	8.28	0.0057	0.002936
850	0.0234	0.0125	7.73	0.0039	0.002009
900	0.0268	0.0147	9.09	0.0060	0.003090
950	0.0279	0.0148	9.15	0.0095	0.004893
1000	0.0380	0.0234	14.46	0.0216	0.011126
1050	0.0346	0.0187	11.56	0.0051	0.002627
1100	0.0398	0.0226	13.97	0.0048	0.002472
1150	0.0434	0.0248	15.33	0.0094	0.004841
1200	0.0487	0.0287	17.74	0.0148	0.007623
1250	0.0537	0.0322	19.90	0.0031	0.001597
1300	0.0547	0.0317	19.59	0.0073	0.003760

PS# 17

TRACK NUMBER= 0
FILE NUMBER =15SURFACE AREA OF SAMPLE = 0.0327(m sq.)
HEIGHT OF SAMPLE = 0.104(m)

TPM	UNCORRECTED TORQUE (N-m)	CORRECTED TORQUE (N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.18	0.0000	0.000000
150	0.0012	0.0007	0.43	0.0000	0.000000
200	0.0019	0.0010	0.61	0.0000	0.000000
250	0.0028	0.0013	0.80	0.0035	0.001785
300	0.0047	0.0026	1.59	0.0003	0.000153
350	0.0053	0.0027	1.65	0.0017	0.000887
400	0.0064	0.0032	1.96	0.0011	0.000581
450	0.0078	0.0039	2.39	0.0036	0.001837
500	0.0090	0.0044	2.69	0.0018	0.000918
550	0.0125	0.0072	4.41	0.0046	0.002346
600	0.0149	0.0088	5.39	0.0077	0.003928
650	0.0168	0.0099	6.06	0.0048	0.002449
700	0.0197	0.0120	7.35	0.0035	0.001785
750	0.0233	0.0146	8.94	0.0098	0.004999
800	0.0243	0.0145	8.88	0.0050	0.002551
850	0.0239	0.0130	7.96	0.0057	0.002908
900	0.0345	0.0224	13.71	0.0078	0.003979
950	0.0440	0.0309	18.91	0.0192	0.009794
1000	0.0353	0.0207	12.67	0.0037	0.001887
1050	0.0407	0.0248	15.18	0.0108	0.005509
1100	0.0507	0.0335	20.51	0.0088	0.004489
1150	0.0483	0.0297	18.18	0.0126	0.006428
1200	0.0641	0.0441	27.00	0.0109	0.005560
1250	0.0609	0.0394	24.12	0.0092	0.004693
1300	0.0622	0.0392	24.00	0.0063	0.003214

PS# 18

TRACK NUMBER= 0
FILE NUMBER =16SURFACE AREA OF SAMPLE = 0.0324(m sq.)
HEIGHT OF SAMPLE = 0.103(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0012	0.0007	0.43	0.0000	0.000000
200	0.0019	0.0010	0.82	0.0000	0.000000
250	0.0028	0.0013	0.80	0.0031	0.001597
300	0.0037	0.0016	0.99	0.0010	0.000515
350	0.0056	0.0030	1.85	0.0030	0.001545
400	0.0076	0.0044	2.72	0.0024	0.001236
450	0.0095	0.0056	3.46	0.0184	0.009477
500	0.0122	0.0076	4.70	0.0130	0.006696
550	0.0138	0.0085	5.25	0.0195	0.010044
600	0.0165	0.0104	6.43	0.0115	0.005923
650	0.0192	0.0123	7.60	0.0186	0.009602
700	0.0209	0.0132	8.16	0.0220	0.011331
750	0.0228	0.0141	8.71	0.0177	0.009117
800	0.0263	0.0165	10.20	0.0096	0.004945
850	0.0272	0.0163	10.07	0.0106	0.005460
900	0.0332	0.0211	13.04	0.0155	0.007984
950	0.0305	0.0174	10.75	0.0116	0.005975
1000	0.0317	0.0171	10.57	0.0055	0.002833
1050	0.0349	0.0190	11.74	0.0224	0.011538
1100	0.0399	0.0227	14.03	0.0179	0.009219
1150	0.0415	0.0229	14.15	0.0152	0.007829
1200	0.0400	0.0200	12.36	0.0073	0.003760

PS# 19

TRACK NUMBER= 0

FILE NUMBER =17

SURFACE AREA OF SAMPLE = 0.0320(m sq.)
 HEIGHT OF SAMPLE = 0.102(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0012	0.0007	0.44	0.0000	0.000000
200	0.0020	0.0011	0.89	0.0000	0.000000
250	0.0027	0.0012	0.75	0.0000	0.000000
300	0.0037	0.0016	1.00	0.0000	0.000000
350	0.0048	0.0022	1.37	0.0016	0.000832
400	0.0062	0.0030	1.87	0.0029	0.001508
450	0.0086	0.0047	2.93	0.0032	0.001665
500	0.0091	0.0045	2.81	0.0066	0.003433
550	0.0119	0.0066	4.12	0.0044	0.002289
600	0.0139	0.0078	4.87	0.0037	0.001924
650	0.0179	0.0110	6.87	0.0190	0.009882
700	0.0208	0.0131	8.18	0.0068	0.003537
750	0.0199	0.0112	6.99	0.0093	0.004837
800	0.0243	0.0145	9.05	0.0061	0.003173
850	0.0301	0.0192	11.98	0.0147	0.007646
900	0.0290	0.0169	10.55	0.0012	0.000624
950	0.0307	0.0176	10.98	0.0120	0.006241
1000	0.0379	0.0233	14.54	0.0191	0.009934
1050	0.0395	0.0236	14.73	0.0118	0.006137
1100	0.0406	0.0234	14.60	0.0111	0.005773
1150	0.0418	0.0232	14.48	0.0086	0.004473
1200	0.0465	0.0265	16.54	0.0247	0.012847
1250	0.0472	0.0257	16.04	0.0136	0.007074
1300	0.0530	0.0300	18.72	0.0106	0.005513

PS# 20

TRACK NUMBER= 0
FILE NUMBER =18SURFACE AREA OF SAMPLE = 0.0324(m sq.)
HEIGHT OF SAMPLE = 0.103(m)

RPm	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0003	0.19	0.0000	0.000000
150	0.0012	0.0007	0.43	0.0000	0.000000
200	0.0020	0.0011	0.88	0.0000	0.000000
250	0.0030	0.0015	0.93	0.0000	0.000000
300	0.0041	0.0020	1.24	0.0053	0.002730
350	0.0052	0.0026	1.61	0.0026	0.001339
400	0.0067	0.0035	2.16	0.0013	0.000670
450	0.0083	0.0044	2.72	0.0041	0.002112
500	0.0104	0.0058	3.58	0.0230	0.011846
550	0.0154	0.0101	6.24	0.0093	0.004790
600	0.0139	0.0078	4.82	0.0048	0.002472
650	0.0170	0.0101	6.24	0.0052	0.002679
700	0.0186	0.0109	6.74	0.0043	0.002215
750	0.0239	0.0152	9.39	0.0028	0.001432
800	0.0254	0.0156	9.64	0.0132	0.006799
850	0.0309	0.0200	12.36	0.0280	0.014422
900	0.0367	0.0246	15.20	0.0253	0.013031
950	0.0400	0.0269	16.63	0.0155	0.007984
1000	0.0446	0.0300	18.54	0.0226	0.011640
1050	0.0399	0.0240	14.83	0.0144	0.007417
1100	0.0437	0.0265	16.38	0.0059	0.003039
1150	0.0493	0.0307	18.97	0.0131	0.006747
1200	0.0518	0.0318	19.65	0.0149	0.007675
1250	0.0533	0.0318	19.65	0.0223	0.011486
1300	0.0538	0.0308	19.04	0.0078	0.004017

PS# 21

TRACK NUMBER = 0
FILE NUMBER = 19SURFACE AREA OF SAMPLE = 0.0317(m²)
HEIGHT OF SAMPLE = 0.101(m)

TPM	UNCORRECTED TORQUE (N·m)	CORRECTED TORQUE (N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m ² /s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0012	0.0007	0.44	0.0000	0.000000
200	0.0020	0.0011	0.69	0.0000	0.000000
250	0.0031	0.0016	1.01	0.0045	0.002364
300	0.0046	0.0025	1.58	0.0010	0.000525
350	0.0054	0.0028	1.76	0.0030	0.001576
400	0.0062	0.0030	1.89	0.0010	0.000525
450	0.0081	0.0042	2.65	0.0043	0.002259
500	0.0109	0.0063	3.97	0.0047	0.002469
550	0.0132	0.0079	4.98	0.0076	0.003992
600	0.0134	0.0073	4.60	0.0054	0.002837
650	0.0156	0.0087	5.48	0.0044	0.002311
700	0.0196	0.0119	7.50	0.0061	0.003204
750	0.0226	0.0139	8.76	0.0077	0.004045
800	0.0287	0.0189	11.91	0.0315	0.016546
850	0.0302	0.0193	12.17	0.0123	0.006461
900	0.0307	0.0186	11.72	0.0080	0.004202
950	0.0344	0.0213	13.43	0.0091	0.004780
1000	0.0405	0.0259	16.33	0.0127	0.006671
1050	0.0353	0.0194	12.23	0.0112	0.005883
1100	0.0434	0.0262	16.51	0.0072	0.003782
1150	0.0464	0.0278	17.52	0.0078	0.004097
1200	0.0491	0.0291	18.34	0.0075	0.003939
1250	0.0509	0.0294	18.53	0.0113	0.005936
1300	0.0516	0.0286	18.03	0.0013	0.000683

PS# 23

TRACK NUMBER= 0
FILE NUMBER =20SURFACE AREA OF SAMPLE = 0.0314(m sq.)
HEIGHT OF SAMPLE = 0.100(m)

RPm	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.51	0.0000	0.000000
200	0.0021	0.0012	0.76	0.0016	0.000849
250	0.0029	0.0014	0.89	0.0016	0.000849
300	0.0041	0.0020	1.27	0.0033	0.001751
350	0.0048	0.0022	1.40	0.0010	0.000530
400	0.0062	0.0030	1.91	0.0018	0.000954
450	0.0098	0.0059	3.76	0.0092	0.004881
500	0.0116	0.0070	4.46	0.0029	0.001539
550	0.0111	0.0058	3.69	0.0084	0.004456
600	0.0160	0.0099	6.30	0.0103	0.005465
650	0.0188	0.0119	7.58	0.0133	0.007056
700	0.0176	0.0099	6.30	0.0049	0.002600
750	0.0258	0.0171	10.89	0.0163	0.008647
800	0.0255	0.0157	9.99	0.0085	0.005040
850	0.0260	0.0151	9.61	0.0087	0.004616
900	0.0347	0.0226	14.39	0.0161	0.008541
950	0.0351	0.0220	14.01	0.0136	0.007215
1000	0.0338	0.0192	12.22	0.0080	0.004244
1050	0.0390	0.0231	14.71	0.0116	0.006154
1100	0.0468	0.0296	18.84	0.0096	0.005093
1150	0.0618	0.0432	27.50	0.0706	0.037440
1200	0.0472	0.0272	17.32	0.0237	0.012573

PS# 24

TRACK NUMBER= 0
FILE NUMBER =21SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0003	0.19	0.0000	0.000000
150	0.0012	0.0007	0.44	0.0000	0.000000
200	0.0019	0.0010	0.62	0.0000	0.000000
250	0.0027	0.0012	0.75	0.0000	0.000000
300	0.0035	0.0014	0.87	0.0000	0.000000
350	0.0045	0.0019	1.19	0.0003	0.000156
400	0.0074	0.0042	2.62	0.0084	0.004369
450	0.0072	0.0033	2.06	0.0011	0.000557
500	0.0094	0.0048	3.00	0.0021	0.001092
550	0.0103	0.0050	3.12	0.0015	0.000780
600	0.0119	0.0058	3.62	0.0026	0.001352
650	0.0147	0.0078	4.87	0.0037	0.001924
700	0.0170	0.0093	5.80	0.0041	0.002133
750	0.0189	0.0102	6.37	0.0038	0.002028
800	0.0212	0.0114	7.12	0.0070	0.003641
850	0.0251	0.0142	8.86	0.0129	0.006709
900	0.0320	0.0199	12.42	0.0195	0.010350
950	0.0385	0.0254	15.85	0.0219	0.011390
1000	0.0346	0.0200	12.48	0.0231	0.012015
1050	0.0393	0.0234	14.60	0.0124	0.006450
1100	0.0438	0.0266	16.60	0.0154	0.008010
1150	0.0469	0.0283	17.66	0.0192	0.009986
1200	0.0470	0.0270	16.85	0.0124	0.006450
1250	0.0499	0.0284	17.73	0.0129	0.006709
1300	0.0569	0.0339	21.16	0.0102	0.005305

PS# 25

TRACK NUMBER= 0
FILE NUMBER =22SURFACE AREA OF SAMPLE = 0.0324(m sq.)
HEIGHT OF SAMPLE = 0.103(m)

RPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT-LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0005	0.31	0.0000	0.000000
150	0.0013	0.0008	0.49	0.0000	0.000000
200	0.0024	0.0015	0.93	0.0000	0.000000
250	0.0034	0.0019	1.17	0.0127	0.006541
300	0.0050	0.0029	1.79	0.0066	0.003399
350	0.0057	0.0031	1.92	0.0094	0.004841
400	0.0076	0.0044	2.72	0.0094	0.004841
450	0.0092	0.0053	3.28	0.0079	0.004069
500	0.0102	0.0056	3.46	0.0054	0.002781
550	0.0123	0.0070	4.33	0.0091	0.004887
600	0.0156	0.0095	5.87	0.0179	0.009219
650	0.0185	0.0116	7.17	0.0147	0.007572
700	0.0203	0.0126	7.79	0.0099	0.005099
750	0.0214	0.0127	7.85	0.0125	0.006438
800	0.0274	0.0176	10.88	0.0172	0.008859
850	0.0289	0.0180	11.13	0.0101	0.005202
900	0.0296	0.0175	10.82	0.0121	0.006232
950	0.0323	0.0192	11.87	0.0100	0.005151
1000	0.0326	0.0180	11.13	0.0100	0.005151
1050	0.0343	0.0184	11.37	0.0094	0.004841
1100	0.0406	0.0234	14.46	0.0097	0.004996
1150	0.0381	0.0195	12.05	0.0068	0.003502
1200	0.0469	0.0269	16.63	0.0148	0.007623
1250	0.0501	0.0286	17.68	0.0080	0.004121

PS# 26

TRACK NUMBER= 0
FILE NUMBER =23SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT-LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0003	0.0002	0.12	0.0000	0.000000
100	0.0011	0.0008	0.50	0.0000	0.000000
150	0.0021	0.0016	1.00	0.0000	0.000000
200	0.0033	0.0024	1.50	0.0000	0.000000
250	0.0048	0.0033	2.06	0.0000	0.000000
300	0.0060	0.0039	2.43	0.0054	0.002809
350	0.0062	0.0036	2.25	0.0029	0.001508
400	0.0078	0.0046	2.87	0.0026	0.001352
450	0.0089	0.0050	3.12	0.0093	0.004837
500	0.0137	0.0091	5.68	0.0073	0.003797
550	0.0162	0.0109	6.80	0.0088	0.004577
600	0.0178	0.0117	7.30	0.0068	0.003537
650	0.0160	0.0091	5.68	0.0035	0.001820
700	0.0182	0.0105	6.55	0.0008	0.000416
750	0.0208	0.0121	7.55	0.0049	0.002548
800	0.0247	0.0149	9.30	0.0055	0.002861
850	0.0264	0.0155	9.67	0.0056	0.002913
900	0.0288	0.0167	10.42	0.0048	0.002496
950	0.0306	0.0175	10.92	0.0054	0.002809
1000	0.0355	0.0209	13.04	0.0047	0.002444
1050	0.0373	0.0214	13.36	0.0049	0.002548
1100	0.0437	0.0265	16.54	0.0155	0.008062
1150	0.0780	0.0594	37.07	0.0455	0.023665

PS# 28

TRACK NUMBER= 0

FILE NUMBER =24

SURFACE AREA OF SAMPLE = 0.0314(m sq.)
 HEIGHT OF SAMPLE = 0.100(m)

T.P.M.	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.51	0.0000	0.000000
200	0.0021	0.0012	0.76	0.0000	0.000000
250	0.0031	0.0016	1.02	0.0029	0.001539
300	0.0053	0.0032	2.04	0.0103	0.005465
350	0.0085	0.0059	3.76	0.0078	0.004138
400	0.0100	0.0068	4.33	0.0119	0.006313
450	0.0083	0.0044	2.80	0.0020	0.001061
500	0.0113	0.0067	4.27	0.0027	0.001433
550	0.0130	0.0077	4.90	0.0006	0.000318
600	0.0161	0.0100	6.37	0.0064	0.003396
650	0.0222	0.0153	9.74	0.0076	0.004032
700	0.0171	0.0094	5.98	0.0029	0.001539
750	0.0243	0.0156	9.93	0.0032	0.001697
800	0.0260	0.0162	10.31	0.0057	0.003025
850	0.0296	0.0187	11.90	0.0032	0.001697
900	0.0299	0.0178	11.33	0.0016	0.000849
950	0.0312	0.0181	11.52	0.0060	0.003183
1000	0.0378	0.0232	14.77	0.0017	0.000902
1050	0.0416	0.0257	16.36	0.0046	0.002440
1100	0.0451	0.0279	17.76	0.0039	0.002069
1150	0.0496	0.0310	19.74	0.0044	0.002334
1200	0.0527	0.0327	20.82	0.0029	0.001539
1250	0.0568	0.0353	22.47	0.0021	0.001114

PS# 29

TRACK NUMBER= 0
FILE NUMBER =26SURFACE AREA OF SAMPLE = 0.0320(m sq.)
HEIGHT OF SAMPLE = 0.102(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.50	0.0000	0.000000
200	0.0021	0.0012	0.75	0.0000	0.000000
250	0.0029	0.0014	0.87	0.0000	0.000000
300	0.0039	0.0018	1.12	0.0000	0.000000
350	0.0050	0.0024	1.50	0.0000	0.000000
400	0.0063	0.0031	1.93	0.0000	0.000000
450	0.0076	0.0037	2.31	0.0000	0.000000
500	0.0091	0.0045	2.81	0.0000	0.000000
550	0.0108	0.0055	3.43	0.0000	0.000000
600	0.0124	0.0063	3.93	0.0000	0.000000
650	0.0182	0.0113	7.05	0.0051	0.002653
700	0.0186	0.0109	6.80	0.0004	0.000208
750	0.0217	0.0130	8.11	0.0008	0.000416
800	0.0223	0.0125	7.80	0.0001	0.000052
850	0.0228	0.0119	7.43	0.0001	0.000052
900	0.0264	0.0143	8.93	0.0000	0.000000
950	0.0293	0.0162	10.11	0.0014	0.000728
1000	0.0308	0.0162	10.11	0.0002	0.000104
1050	0.0342	0.0183	11.42	0.0002	0.000104
1100	0.0377	0.0205	12.79	0.0001	0.000052
1150	0.0394	0.0208	12.98	0.0001	0.000052
1200	0.0425	0.0225	14.04	0.0012	0.000624
1250	0.0465	0.0250	15.60	0.0006	0.000312
1300	0.0526	0.0296	18.47	0.0018	0.000936
1350	0.0542	0.0296	18.47	0.0011	0.000572
1400	0.0660	0.0398	24.84	0.0755	0.039269

PS# 30

TRACK NUMBER= 0

FILE NUMBER =25

SURFACE AREA OF SAMPLE = 0.0320(m sq.)
 HEIGHT OF SAMPLE = 0.102(m)

RPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0005	0.31	0.0000	0.000000
150	0.0014	0.0009	0.56	0.0000	0.000000
200	0.0022	0.0013	0.81	0.0000	0.000000
250	0.0031	0.0016	1.00	0.0000	0.000000
300	0.0041	0.0020	1.25	0.0000	0.000000
350	0.0052	0.0026	1.62	0.0000	0.000000
400	0.0064	0.0032	2.00	0.0000	0.000000
450	0.0078	0.0039	2.43	0.0000	0.000000
500	0.0093	0.0047	2.93	0.0000	0.000000
550	0.0108	0.0055	3.43	0.0000	0.000000
600	0.0125	0.0064	3.99	0.0000	0.000000
650	0.0146	0.0077	4.81	0.0000	0.000000
700	0.0166	0.0089	5.55	0.0000	0.000000
750	0.0186	0.0099	6.18	0.0002	0.000104
800	0.0193	0.0095	5.93	0.0002	0.000104
850	0.0229	0.0120	7.49	0.0007	0.000364
900	0.0273	0.0152	9.49	0.0001	0.000052
950	0.0260	0.0129	8.05	0.0001	0.000052
1000	0.0308	0.0162	10.11	0.0001	0.000052
1050	0.0301	0.0142	8.86	0.0002	0.000104
1100	0.0325	0.0153	9.55	0.0001	0.000052
1150	0.0399	0.0213	13.29	0.0008	0.000416
1200	0.0389	0.0189	11.80	0.0002	0.000104
1250	0.0508	0.0293	18.29	0.0000	0.000000
1300	0.0466	0.0236	14.73	0.0014	0.000728
1350	0.0561	0.0315	19.66	0.0006	0.000312
1400	0.0523	0.0261	16.29	0.0008	0.000416
1450	0.0635	0.0356	22.22	0.0029	0.001508
1500	0.0636	0.0339	21.16	0.0002	0.000104
1550	0.0724	0.0410	25.59	0.0009	0.000468
1600	0.0742	0.0409	25.53	0.0001	0.000052
1650	0.0720	0.0370	23.09	0.0001	0.000052
1700	0.0761	0.0391	24.40	0.0001	0.000052
1750	0.0780	0.0390	24.34	0.0001	0.000052
1800	0.0951	0.0542	33.83	0.0259	0.013471

PB#1A

TRACK NUMBER = 1
FILE NUMBER = 0SURFACE AREA OF SAMPLE = 0.0330(m sq.)
HEIGHT OF SAMPLE = 0.105(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.18	0.0000	0.000000
150	0.0012	0.0007	0.42	0.0000	0.000000
200	0.0019	0.0010	0.61	0.0000	0.000000
250	0.0027	0.0012	0.73	0.0000	0.000000
300	0.0035	0.0014	0.85	0.0000	0.000000
350	0.0044	0.0018	1.09	0.0000	0.000000
400	0.0057	0.0025	1.52	0.0000	0.000000
450	0.0069	0.0030	1.82	0.0000	0.000000
500	0.0080	0.0034	2.06	0.0000	0.000000
550	0.0098	0.0045	2.73	0.0000	0.000000
600	0.0111	0.0050	3.03	0.0000	0.000000
650	0.0126	0.0057	3.46	0.0000	0.000000
700	0.0144	0.0067	4.06	0.0000	0.000000
750	0.0165	0.0078	4.73	0.0002	0.000101
800	0.0183	0.0085	5.15	0.0003	0.000152
850	0.0212	0.0103	6.24	0.0001	0.000051
900	0.0227	0.0106	6.43	0.0002	0.000101
950	0.0255	0.0124	7.52	0.0008	0.000404
1000	0.0258	0.0112	6.79	0.0001	0.000051
1050	0.0305	0.0146	8.85	0.0001	0.000051
1100	0.0316	0.0144	8.73	0.0001	0.000051
1150	0.0398	0.0212	12.85	0.0001	0.000051
1200	0.0413	0.0213	12.91	0.0027	0.001364
1250	0.0532	0.0317	19.22	0.0024	0.001213
1300	0.0478	0.0248	15.04	0.0015	0.000758
1350	0.0502	0.0256	15.52	0.0004	0.000202
1400	0.0485	0.0223	13.52	0.0001	0.000051
1450	0.0588	0.0309	18.73	0.0006	0.000303
1500	0.0558	0.0261	15.82	0.0004	0.000202
1550	0.0624	0.0310	18.80	0.0009	0.000455
1600	0.0661	0.0328	19.89	0.0002	0.000101
1650	0.0704	0.0354	21.46	0.0003	0.000152
1700	0.0718	0.0348	21.10	0.0002	0.000101
1750	0.0851	0.0461	27.95	0.0027	0.001364
1800	0.0891	0.0482	29.22	0.0068	0.003436

PB#2A

TRACK NUMBER= 1
FILE NUMBER = 1SURFACE AREA OF SAMPLE = 0.0336(m sq.)
HEIGHT OF SAMPLE = 0.107(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0008	0.0005	0.30	0.0000	0.000000
150	0.0015	0.0010	0.59	0.0000	0.000000
200	0.0024	0.0015	0.89	0.0000	0.000000
250	0.0035	0.0020	1.19	0.0000	0.000000
300	0.0047	0.0026	1.55	0.0000	0.000000
350	0.0061	0.0035	2.08	0.0000	0.000000
400	0.0075	0.0043	2.56	0.0000	0.000000
450	0.0092	0.0053	3.15	0.0000	0.000000
500	0.0110	0.0064	3.81	0.0005	0.000248
550	0.0142	0.0089	5.30	0.0003	0.000149
600	0.0182	0.0121	7.20	0.0009	0.000446
650	0.0171	0.0102	6.07	0.0001	0.000050
700	0.0196	0.0119	7.08	0.0001	0.000050
750	0.0261	0.0174	10.35	0.0001	0.000050
800	0.0280	0.0182	10.83	0.0011	0.000545
850	0.0301	0.0192	11.42	0.0007	0.000347
900	0.0341	0.0220	13.09	0.0006	0.000297
950	0.0395	0.0264	15.71	0.0001	0.000050
1000	0.0393	0.0247	14.70	0.0001	0.000050
1050	0.0406	0.0247	14.70	0.0013	0.000645
1100	0.0433	0.0261	15.53	0.0012	0.000595
1150	0.0545	0.0359	21.36	0.0029	0.001438
1200	0.0485	0.0285	16.96	0.0004	0.000198
1250	0.0629	0.0414	24.63	0.0007	0.000347
1300	0.0655	0.0425	25.29	0.0019	0.000942
1350	0.0584	0.0338	20.11	0.0027	0.001339
1400	0.0715	0.0453	26.95	0.0026	0.001289
1450	0.0901	0.0622	37.01	0.0027	0.001339

PB#3A

TRACK NUMBER = 1
FILE NUMBER = 2SURFACE AREA OF SAMPLE = 0.0308(m sq.)
HEIGHT OF SAMPLE = 0.098(m)

RPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.26	0.0000	0.000000
150	0.0013	0.0008	0.52	0.0000	0.000000
200	0.0020	0.0011	0.71	0.0000	0.000000
250	0.0029	0.0014	0.91	0.0000	0.000000
300	0.0039	0.0018	1.17	0.0000	0.000000
350	0.0050	0.0024	1.56	0.0000	0.000000
400	0.0061	0.0029	1.88	0.0000	0.000000
450	0.0076	0.0037	2.40	0.0000	0.000000
500	0.0090	0.0044	2.86	0.0000	0.000000
550	0.0107	0.0054	3.51	0.0000	0.000000
600	0.0124	0.0063	4.09	0.0000	0.000000
650	0.0141	0.0072	4.68	0.0000	0.000000
700	0.0164	0.0087	5.65	0.0000	0.000000
750	0.0186	0.0099	6.43	0.0000	0.000000
800	0.0204	0.0106	6.89	0.0000	0.000000
850	0.0224	0.0115	7.47	0.0009	0.000487
900	0.0266	0.0145	9.42	0.0007	0.000379
950	0.0258	0.0127	8.25	0.0001	0.000054
1000	0.0304	0.0158	10.26	0.0020	0.001083
1050	0.0370	0.0211	13.71	0.0029	0.001570
1100	0.0361	0.0189	12.28	0.0017	0.000920
1150	0.0391	0.0205	13.32	0.0004	0.000217
1200	0.0382	0.0182	11.82	0.0026	0.001407
1250	0.0495	0.0280	18.19	0.0016	0.000866
1300	0.0526	0.0296	19.23	0.0049	0.002653
1350	0.0675	0.0429	27.87	0.0068	0.003699

PB#4A

TRACK NUMBER= 1
FILE NUMBER = 3SURFACE AREA OF SAMPLE = 0.0314(m sq.)
HEIGHT OF SAMPLE = 0.100(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m-sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.51	0.0000	0.000000
200	0.0021	0.0012	0.76	0.0000	0.000000
250	0.0031	0.0016	1.02	0.0000	0.000000
300	0.0041	0.0020	1.27	0.0000	0.000000
350	0.0053	0.0027	1.72	0.0000	0.000000
400	0.0067	0.0035	2.23	0.0000	0.000000
450	0.0079	0.0040	2.55	0.0000	0.000000
500	0.0094	0.0048	3.06	0.0000	0.000000
550	0.0110	0.0057	3.83	0.0000	0.000000
600	0.0129	0.0068	4.33	0.0000	0.000000
650	0.0148	0.0079	5.03	0.0000	0.000000
700	0.0165	0.0088	5.60	0.0003	0.000159
750	0.0164	0.0077	4.90	0.0006	0.000318
800	0.0207	0.0109	6.94	0.0002	0.000106
850	0.0235	0.0126	8.02	0.0003	0.000159
900	0.0264	0.0143	9.10	0.0002	0.000100
950	0.0249	0.0118	7.51	0.0001	0.000053
1000	0.0271	0.0125	7.96	0.0001	0.000053
1050	0.0354	0.0195	12.41	0.0002	0.000106
1100	0.0350	0.0178	11.33	0.0003	0.000159
1150	0.0342	0.0156	9.93	0.0002	0.000106
1200	0.0391	0.0191	12.16	0.0008	0.000424
1250	0.0394	0.0179	11.40	0.0001	0.000053
1300	0.0450	0.0220	14.01	0.0001	0.000053
1350	0.0504	0.0258	16.42	0.0016	0.000849
1400	0.0608	0.0346	22.03	0.0012	0.000637
1450	0.0528	0.0249	15.85	0.0025	0.001326
1500	0.0709	0.0412	26.23	0.0016	0.000849
1550	0.0752	0.0438	27.88	0.0072	0.003820
1600	0.0832	0.0499	31.77	0.0023	0.001220
1650	0.0980	0.0630	40.11	0.0244	0.012945

PB#5A

TRACK NUMBER = 1
FILE NUMBER = 4SURFACE AREA OF SAMPLE = 0.0333(m sq.)
HEIGHT OF SAMPLE = 0.106(m)

-T.P.M	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.24	0.0000	0.000000
150	0.0013	0.0008	0.48	0.0000	0.000000
200	0.0022	0.0013	0.78	0.0000	0.000000
250	0.0033	0.0018	1.08	0.0000	0.000000
300	0.0044	0.0023	1.38	0.0000	0.000000
350	0.0057	0.0031	1.86	0.0000	0.000000
400	0.0072	0.0040	2.40	0.0000	0.000000
450	0.0087	0.0048	2.88	0.0000	0.000000
500	0.0103	0.0057	3.42	0.0000	0.000000
550	0.0119	0.0066	3.96	0.0000	0.000000
600	0.0137	0.0076	4.56	0.0000	0.000000
650	0.0156	0.0087	5.23	0.0000	0.000000
700	0.0178	0.0101	6.07	0.0000	0.000000
750	0.0197	0.0110	6.61	0.0003	0.000150
800	0.0206	0.0108	6.49	0.0001	0.000050
850	0.0219	0.0110	6.81	0.0001	0.000050
900	0.0266	0.0145	8.71	0.0008	0.000400
950	0.0332	0.0201	12.07	0.0002	0.000100
1000	0.0352	0.0206	12.37	0.0002	0.000100
1050	0.0315	0.0156	9.37	0.0002	0.000100
1100	0.0418	0.0246	14.77	0.0004	0.000200
1150	0.0420	0.0234	14.05	0.0001	0.000050
1200	0.0442	0.0242	14.53	0.0002	0.000100
1250	0.0463	0.0248	14.89	0.0019	0.000950
1300	0.0579	0.0349	20.96	0.0001	0.000050
1350	0.0507	0.0261	15.68	0.0004	0.000200
1400	0.0497	0.0235	14.11	0.0008	0.000400
1450	0.0603	0.0324	19.46	0.0004	0.000200
1500	0.0659	0.0362	21.74	0.0029	0.001451
1550	0.0806	0.0492	29.55	0.0036	0.001802
1600	0.0796	0.0463	27.81	0.0017	0.000851
1650	0.0972	0.0622	37.36	0.0076	0.003803
1700	0.0908	0.0538	32.31	0.0093	0.004655
1750	0.1022	0.0632	37.96	0.0228	0.011411

PB#6A

TRACK NUMBER = 1
FILE NUMBER = 5SURFACE AREA OF SAMPLE = 0.0327(m sq.)
HEIGHT OF SAMPLE = 0.104(m)

TRPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.24	0.0000	0.000000
150	0.0014	0.0009	0.55	0.0000	0.000000
200	0.0022	0.0013	0.80	0.0000	0.000000
250	0.0032	0.0017	1.04	0.0000	0.000000
300	0.0047	0.0026	1.59	0.0000	0.000000
350	0.0059	0.0033	2.02	0.0000	0.000000
400	0.0073	0.0041	2.51	0.0000	0.000000
450	0.0089	0.0050	3.06	0.0055	0.002806
500	0.0103	0.0057	3.49	0.0003	0.000153
550	0.0116	0.0063	3.86	0.0004	0.000204
600	0.0125	0.0064	3.92	0.0005	0.000255
650	0.0130	0.0061	3.73	0.0002	0.000102
700	0.0146	0.0069	4.22	0.0001	0.000051
750	0.0172	0.0085	5.20	0.0008	0.000408
800	0.0212	0.0114	6.98	0.0014	0.000714
850	0.0223	0.0114	6.98	0.0008	0.000408
900	0.0287	0.0146	8.94	0.0001	0.000051
950	0.0296	0.0165	10.10	0.0001	0.000051
1000	0.0298	0.0152	9.30	0.0001	0.000051
1050	0.0346	0.0187	11.45	0.0001	0.000051
1100	0.0374	0.0202	12.37	0.0008	0.000408
1150	0.0381	0.0195	11.94	0.0010	0.000510
1200	0.0443	0.0243	14.87	0.0039	0.001989
1250	0.0569	0.0354	21.67	0.0013	0.000663
1300	0.0598	0.0368	22.53	0.0046	0.002347
1350	0.0523	0.0277	16.96	0.0044	0.002244
1400	0.0602	0.0340	20.81	0.0008	0.000408
1450	0.0658	0.0379	23.20	0.0015	0.000765
1500	0.0668	0.0371	22.71	0.0044	0.002244
1550	0.0712	0.0398	24.36	0.0044	0.002244
1600	0.0754	0.0421	25.77	0.0064	0.003265
1650	0.0775	0.0425	26.02	0.0019	0.000969
1700	0.0854	0.0484	29.63	0.0013	0.000663
1750	0.0915	0.0525	32.14	0.0030	0.001530
1800	0.0983	0.0574	35.14	0.0038	0.001938

PB#7A

TRACK NUMBER= 1

FILE NUMBER = 6

SURFACE AREA OF SAMPLE = 0.0320(m sq.)
 HEIGHT OF SAMPLE = 0.102(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.19	0.0000	0.000000
150	0.0013	0.0008	0.50	0.0000	0.000000
200	0.0021	0.0012	0.75	0.0000	0.000000
250	0.0030	0.0015	0.94	0.0000	0.000000
300	0.0039	0.0018	1.12	0.0000	0.000000
350	0.0051	0.0025	1.56	0.0000	0.000000
400	0.0063	0.0031	1.93	0.0000	0.000000
450	0.0076	0.0037	2.31	0.0000	0.000000
500	0.0091	0.0045	2.81	0.0000	0.000000
550	0.0106	0.0053	3.31	0.0000	0.000000
600	0.0123	0.0062	3.87	0.0000	0.000000
650	0.0143	0.0074	4.62	0.0000	0.000000
700	0.0163	0.0086	5.37	0.0000	0.000000
750	0.0183	0.0096	5.99	0.0000	0.000000
800	0.0205	0.0107	6.68	0.0000	0.000000
850	0.0228	0.0119	7.43	0.0000	0.000000
900	0.0253	0.0132	8.24	0.0000	0.000000
950	0.0279	0.0148	9.24	0.0000	0.000000
1000	0.0304	0.0158	9.86	0.0000	0.000000
1050	0.0333	0.0174	10.86	0.0000	0.000000
1100	0.0364	0.0192	11.98	0.0000	0.000000
1150	0.0466	0.0280	17.48	0.0000	0.000000
1200	0.0483	0.0283	17.66	0.0001	0.000052
1250	0.0473	0.0258	16.10	0.0004	0.000208
1300	0.0482	0.0252	15.73	0.0002	0.000104
1350	0.0569	0.0323	20.16	0.0013	0.000676
1400	0.0588	0.0326	20.35	0.0001	0.000052
1450	0.0668	0.0389	24.28	0.0013	0.000676
1500	0.0639	0.0342	21.35	0.0018	0.000936
1550	0.0679	0.0365	22.78	0.0004	0.000208
1600	0.0798	0.0465	29.02	0.0014	0.000728
1650	0.0803	0.0453	28.27	0.0022	0.001144
1700	0.0828	0.0458	28.59	0.0002	0.000104
1750	0.0990	0.0600	37.45	0.0026	0.001352
1800	0.0976	0.0567	35.39	0.0016	0.000832

PB#8A

TRACK NUMBER= 1
FILE NUMBER = 7SURFACE AREA OF SAMPLE = 0.0333(m sq.)
HEIGHT OF SAMPLE = 0.106(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq./s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0006	0.0003	0.18	0.0000	0.000000
150	0.0011	0.0006	0.36	0.0000	0.000000
200	0.0016	0.0007	0.42	0.0000	0.000000
250	0.0025	0.0010	0.60	0.0000	0.000000
300	0.0034	0.0013	0.78	0.0000	0.000000
350	0.0043	0.0017	1.02	0.0000	0.000000
400	0.0055	0.0023	1.38	0.0000	0.000000
450	0.0069	0.0030	1.80	0.0000	0.000000
500	0.0078	0.0032	1.92	0.0000	0.000000
550	0.0095	0.0042	2.52	0.0000	0.000000
600	0.0111	0.0050	3.00	0.0000	0.000000
650	0.0124	0.0055	3.30	0.0000	0.000000
700	0.0143	0.0066	3.96	0.0000	0.000000
750	0.0162	0.0075	4.50	0.0000	0.000000
800	0.0186	0.0088	5.29	0.0000	0.000000
850	0.0211	0.0102	6.13	0.0000	0.000000
900	0.0232	0.0111	6.67	0.0000	0.000000
950	0.0253	0.0122	7.33	0.0014	0.000701
1000	0.0299	0.0153	9.19	0.0003	0.000150
1050	0.0346	0.0187	11.23	0.0010	0.000500
1100	0.0344	0.0172	10.33	0.0002	0.000100
1150	0.0390	0.0204	12.25	0.0001	0.000050
1200	0.0394	0.0194	11.65	0.0002	0.000100
1250	0.0411	0.0196	11.77	0.0000	0.000000
1300	0.0472	0.0242	14.53	0.0001	0.000050
1350	0.0451	0.0205	12.31	0.0005	0.000250
1400	0.0549	0.0287	17.24	0.0003	0.000150
1450	0.0540	0.0261	15.68	0.0001	0.000050
1500	0.0599	0.0302	18.14	0.0012	0.000600
1550	0.0629	0.0315	18.92	0.0011	0.000550
1600	0.0680	0.0347	20.84	0.0001	0.000050
1650	0.0712	0.0362	21.74	0.0013	0.000650
1700	0.0753	0.0383	23.00	0.0011	0.000550
1750	0.0865	0.0475	28.53	0.0006	0.000300
1800	0.0824	0.0415	24.92	0.0006	0.000300

PB#2B

TRACK NUMBER= 0

FILE NUMBER = 1

SURFACE AREA OF SAMPLE = 0.0302(m sq.)
 HEIGHT OF SAMPLE = 0.096(m)

rpm	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0007	0.0004	0.27	0.0000	0.000000
150	0.0014	0.0009	0.60	0.0000	0.000000
200	0.0023	0.0014	0.93	0.0000	0.000000
250	0.0033	0.0018	1.19	0.0000	0.000000
300	0.0043	0.0022	1.46	0.0000	0.000000
350	0.0054	0.0028	1.86	0.0000	0.000000
400	0.0066	0.0034	2.25	0.0000	0.000000
450	0.0080	0.0041	2.72	0.0000	0.000000
500	0.0096	0.0050	3.32	0.0000	0.000000
550	0.0115	0.0062	4.11	0.0000	0.000000
600	0.0132	0.0071	4.71	0.0000	0.000000
650	0.0149	0.0080	5.31	0.0000	0.000000
700	0.0169	0.0092	6.10	0.0001	0.000055
750	0.0165	0.0078	5.17	0.0009	0.000497
800	0.0187	0.0089	5.90	0.0006	0.000332
850	0.0210	0.0101	6.70	0.0031	0.001713
900	0.0267	0.0146	9.68	0.0001	0.000055
950	0.0276	0.0145	9.62	0.0031	0.001713
1000	0.0409	0.0263	17.44	0.0041	0.002266
1050	0.0345	0.0186	12.33	0.0001	0.000055
1100	0.0382	0.0210	13.93	0.0101	0.005581
1150	0.0331	0.0145	9.62	0.0021	0.001161
1200	0.0498	0.0298	19.76	0.0044	0.002432
1250	0.0517	0.0302	20.03	0.0002	0.000111
1300	0.0485	0.0255	16.91	0.0010	0.000553
1350	0.0536	0.0290	19.23	0.0001	0.000055
1400	0.0669	0.0407	26.99	0.0009	0.000497
1450	0.1092	0.0813	53.91	0.0366	0.020226

PB#3B

TRACK NUMBER = 0
FILE NUMBER = 3SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

RPm	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0005	0.0003	0.20	0.0000	0.000000
150	0.0013	0.0008	0.53	0.0000	0.000000
200	0.0021	0.0012	0.80	0.0000	0.000000
250	0.0030	0.0015	0.99	0.0000	0.000000
300	0.0041	0.0020	1.33	0.0000	0.000000
350	0.0052	0.0026	1.72	0.0015	0.000829
400	0.0068	0.0036	2.39	0.0003	0.000166
450	0.0081	0.0042	2.79	0.0013	0.000718
500	0.0087	0.0041	2.72	0.0004	0.000221
550	0.0105	0.0052	3.45	0.0002	0.000111
600	0.0122	0.0061	4.05	0.0004	0.000221
650	0.0144	0.0075	4.97	0.0004	0.000221
700	0.0157	0.0080	5.31	0.0011	0.000608
750	0.0179	0.0092	6.10	0.0107	0.005913
800	0.0219	0.0121	8.02	0.0018	0.000995
850	0.0237	0.0128	8.49	0.0012	0.000663
900	0.0326	0.0205	13.59	0.0016	0.000884
950	0.0347	0.0216	14.32	0.0027	0.001492
1000	0.0349	0.0203	13.46	0.0017	0.000939
1050	0.0408	0.0249	16.51	0.0027	0.001492
1100	0.0461	0.0289	19.16	0.0066	0.003647
1150	0.0409	0.0223	14.79	0.0005	0.000276
1200	0.0472	0.0272	18.04	0.0012	0.000663
1250	0.0540	0.0325	21.55	0.0030	0.001658
1300	0.0545	0.0315	20.89	0.0034	0.001879
1350	0.0629	0.0383	25.40	0.0033	0.001824
1400	0.0662	0.0400	26.53	0.0068	0.003758
1450	0.0789	0.0510	33.82	0.0142	0.007847

PB#4B

TRACK NUMBER = 0
FILE NUMBER = 4SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0008	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0019	0.0010	0.66	0.0000	0.000000
250	0.0026	0.0011	0.73	0.0000	0.000000
300	0.0036	0.0015	0.99	0.0000	0.000000
350	0.0046	0.0020	1.33	0.0000	0.000000
400	0.0059	0.0027	1.79	0.0000	0.000000
450	0.0071	0.0032	2.12	0.0000	0.000000
500	0.0086	0.0040	2.65	0.0000	0.000000
550	0.0099	0.0046	3.05	0.0000	0.000000
600	0.0116	0.0055	3.65	0.0000	0.000000
650	0.0132	0.0063	4.18	0.0002	0.000111
700	0.0157	0.0080	5.31	0.0066	0.003647
750	0.0184	0.0097	6.43	0.0011	0.000608
800	0.0198	0.0100	6.63	0.0009	0.000497
850	0.0210	0.0101	6.70	0.0002	0.000111
900	0.0243	0.0122	8.09	0.0001	0.000055
950	0.0259	0.0128	8.49	0.0001	0.000055
1000	0.0273	0.0127	8.42	0.0002	0.000111
1050	0.0259	0.0100	6.63	0.0001	0.000055
1100	0.0332	0.0160	10.61	0.0008	0.000442
1150	0.0392	0.0206	13.66	0.0007	0.000387
1200	0.0409	0.0209	13.86	0.0002	0.000111
1250	0.0406	0.0191	12.67	0.0004	0.000221
1300	0.0424	0.0194	12.87	0.0007	0.000387
1350	0.0499	0.0253	16.78	0.0005	0.000276
1400	0.0520	0.0258	17.11	0.0019	0.001050
1450	0.0571	0.0292	19.36	0.0001	0.000055
1500	0.0580	0.0283	18.77	0.0004	0.000221
1550	0.0614	0.0300	19.89	0.0006	0.000332
1600	0.0669	0.0336	22.28	0.0010	0.000553
1650	0.0727	0.0377	25.00	0.0011	0.000608
1700	0.0749	0.0379	25.13	0.0003	0.000166
1750	0.0794	0.0404	26.79	0.0010	0.000553
1800	0.1062	0.0653	43.30	0.0134	0.007405

PB#5B

TRACK NUMBER= 0
FILE NUMBER = 5SURFACE AREA OF SAMPLE = 0.0305(m sq.)
HEIGHT OF SAMPLE = 0.097(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m. sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0019	0.0010	0.66	0.0000	0.000000
250	0.0028	0.0013	0.85	0.0000	0.000000
300	0.0037	0.0016	1.05	0.0000	0.000000
350	0.0048	0.0022	1.44	0.0000	0.000000
400	0.0059	0.0027	1.77	0.0000	0.000000
450	0.0073	0.0034	2.23	0.0000	0.000000
500	0.0088	0.0042	2.76	0.0000	0.000000
550	0.0103	0.0050	3.28	0.0000	0.000000
600	0.0118	0.0057	3.74	0.0000	0.000000
650	0.0136	0.0067	4.40	0.0003	0.000164
700	0.0158	0.0081	5.32	0.0005	0.000273
750	0.0188	0.0081	5.32	0.0002	0.000109
800	0.0198	0.0100	6.56	0.0002	0.000109
850	0.0224	0.0115	7.55	0.0002	0.000109
900	0.0219	0.0098	6.43	0.0001	0.000055
950	0.0237	0.0106	6.96	0.0001	0.000055
1000	0.0310	0.0164	10.76	0.0001	0.000055
1050	0.0271	0.0112	7.35	0.0005	0.000273
1100	0.0331	0.0159	10.44	0.0006	0.000328
1150	0.0381	0.0195	12.80	0.0039	0.002133
1200	0.0420	0.0220	14.44	0.0008	0.000438
1250	0.0472	0.0257	16.87	0.0002	0.000109
1300	0.0449	0.0219	14.37	0.0004	0.000219
1350	0.0584	0.0338	22.18	0.0002	0.000109
1400	0.0452	0.0190	12.47	0.0006	0.000328
1450	0.0663	0.0384	25.20	0.0020	0.001094
1500	0.0630	0.0333	21.86	0.0002	0.000109
1550	0.0645	0.0331	21.72	0.0021	0.001149
1600	0.0857	0.0524	34.39	0.0024	0.001313
1650	0.0748	0.0398	26.12	0.0083	0.004539

PB#68

TRACK NUMBER = 0
FILE NUMBER = 6SURFACE AREA OF SAMPLE = 0.0302(m²sq.)
HEIGHT OF SAMPLE = 0.096(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0019	0.0010	0.66	0.0000	0.000000
250	0.0028	0.0013	0.86	0.0000	0.000000
300	0.0038	0.0017	1.13	0.0000	0.000000
350	0.0049	0.0023	1.53	0.0000	0.000000
400	0.0063	0.0031	2.06	0.0000	0.000000
450	0.0077	0.0038	2.52	0.0000	0.000000
500	0.0094	0.0048	3.18	0.0000	0.000000
550	0.0110	0.0057	3.78	0.0000	0.000000
600	0.0127	0.0066	4.38	0.0000	0.000000
650	0.0145	0.0076	5.04	0.0002	0.000111
700	0.0163	0.0086	5.70	0.0003	0.000166
750	0.0176	0.0089	5.90	0.0005	0.000276
800	0.0209	0.0111	7.36	0.0003	0.000166
850	0.0219	0.0110	7.29	0.0002	0.000111
900	0.0276	0.0155	10.28	0.0002	0.000111
950	0.0289	0.0158	10.48	0.0010	0.000553
1000	0.0347	0.0201	13.33	0.0003	0.000166
1050	0.0327	0.0168	11.14	0.0006	0.000332
1100	0.0341	0.0169	11.21	0.0002	0.000111
1150	0.0389	0.0203	13.46	0.0002	0.000111
1200	0.0418	0.0218	14.46	0.0011	0.000608
1250	0.0462	0.0247	16.38	0.0031	0.001713
1300	0.0549	0.0319	21.15	0.0033	0.001824
1350	0.0532	0.0286	18.97	0.0007	0.000387
1400	0.0527	0.0265	17.57	0.0014	0.000774
1450	0.0547	0.0268	17.77	0.0011	0.000608
1500	0.0698	0.0401	26.59	0.0018	0.000995
1550	0.0689	0.0375	24.87	0.0022	0.001216
1600	0.0713	0.0380	25.20	0.0015	0.000829
1650	0.0768	0.0418	27.72	0.0020	0.001105
1700	0.0818	0.0448	29.71	0.0218	0.012047

PB#7B

TRACK NUMBER= 0
FILE NUMBER = 7SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

TPM	UNCORRECTED TORQUE(N-m)	CORRECTED TORQUE(N-m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0018	0.0009	0.60	0.0000	0.000000
250	0.0026	0.0011	0.73	0.0000	0.000000
300	0.0036	0.0015	0.99	0.0000	0.000000
350	0.0046	0.0020	1.33	0.0000	0.000000
400	0.0058	0.0026	1.72	0.0000	0.000000
450	0.0070	0.0031	2.06	0.0000	0.000000
500	0.0084	0.0038	2.52	0.0000	0.000000
550	0.0099	0.0046	3.05	0.0000	0.000000
600	0.0116	0.0055	3.65	0.0000	0.000000
650	0.0133	0.0064	4.24	0.0000	0.000000
700	0.0151	0.0074	4.91	0.0002	0.000111
750	0.0165	0.0078	5.17	0.0009	0.000497
800	0.0226	0.0128	8.49	0.0001	0.000055
850	0.0204	0.0095	6.30	0.0001	0.000055
900	0.0216	0.0095	6.30	0.0002	0.000111
950	0.0284	0.0153	10.15	0.0001	0.000055
1000	0.0303	0.0157	10.41	0.0001	0.000055
1050	0.0289	0.0130	8.62	0.0001	0.000055
1100	0.0294	0.0122	8.09	0.0001	0.000055
1150	0.0359	0.0173	11.47	0.0006	0.000332
1200	0.0339	0.0139	9.22	0.0002	0.000111
1250	0.0425	0.0210	13.93	0.0001	0.000055
1300	0.0449	0.0219	14.52	0.0001	0.000055
1350	0.0453	0.0207	13.73	0.0002	0.000111
1400	0.0464	0.0202	13.40	0.0031	0.001713
1450	0.0593	0.0314	20.82	0.0030	0.001658
1500	0.0579	0.0282	18.70	0.0004	0.000221
1550	0.0665	0.0351	23.28	0.0046	0.002542
1600	0.0780	0.0427	28.32	0.0046	0.002542
1650	0.0760	0.0410	27.19	0.0014	0.000774
1700	0.0765	0.0395	26.19	0.0041	0.002266
1750	0.0819	0.0429	28.45	0.0064	0.003537

PB#8B

TRACK NUMBER= 0
FILE NUMBER = 8SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

T.P.M.	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0007	0.0004	0.27	0.0000	0.000000
150	0.0013	0.0008	0.53	0.0000	0.000000
200	0.0020	0.0011	0.73	0.0000	0.000000
250	0.0029	0.0014	0.93	0.0000	0.000000
300	0.0039	0.0018	1.19	0.0000	0.000000
350	0.0049	0.0023	1.53	0.0000	0.000000
400	0.0062	0.0030	1.99	0.0000	0.000000
450	0.0075	0.0036	2.39	0.0000	0.000000
500	0.0089	0.0043	2.85	0.0000	0.000000
550	0.0106	0.0053	3.51	0.0000	0.000000
600	0.0132	0.0071	4.71	0.0000	0.000000
650	0.0151	0.0082	5.44	0.0015	0.000829
700	0.0146	0.0069	4.58	0.0011	0.000608
750	0.0211	0.0124	8.22	0.0001	0.000055
800	0.0224	0.0126	8.36	0.0001	0.000055
850	0.0227	0.0118	7.83	0.0001	0.000055
900	0.0202	0.0081	5.37	0.0001	0.000055
950	0.0252	0.0121	8.02	0.0001	0.000055
1000	0.0272	0.0126	8.36	0.0002	0.000111
1050	0.0301	0.0142	9.42	0.0001	0.000055
1100	0.0352	0.0180	11.94	0.0001	0.000055
1150	0.0395	0.0209	13.86	0.0001	0.000055
1200	0.0450	0.0250	16.58	0.0005	0.000276
1250	0.0421	0.0206	13.66	0.0001	0.000055
1300	0.0504	0.0274	18.17	0.0004	0.000221
1350	0.0604	0.0358	23.74	0.0010	0.000553
1400	0.0635	0.0373	24.74	0.0001	0.000055
1450	0.0581	0.0302	20.03	0.0021	0.001161
1500	0.0632	0.0335	22.22	0.0012	0.000663
1550	0.0759	0.0445	29.51	0.0023	0.001271
1600	0.0895	0.0562	37.27	0.0022	0.001216
1650	0.0818	0.0468	31.04	0.0026	0.001437
1700	0.0789	0.0419	27.79	0.0007	0.000387
1750	0.0890	0.0500	33.16	0.0445	0.024592

PB#10B

TRACK NUMBER= 0
FILE NUMBER = 9SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

T.P.M	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m.sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0013	0.0008	0.53	0.0000	0.000000
200	0.0021	0.0012	0.80	0.0000	0.000000
250	0.0030	0.0015	0.99	0.0000	0.000000
300	0.0039	0.0018	1.19	0.0000	0.000000
350	0.0051	0.0025	1.66	0.0000	0.000000
400	0.0063	0.0031	2.06	0.0000	0.000000
450	0.0075	0.0036	2.39	0.0000	0.000000
500	0.0090	0.0044	2.92	0.0000	0.000000
550	0.0106	0.0053	3.51	0.0000	0.000000
600	0.0132	0.0071	4.71	0.0015	0.000829
650	0.0130	0.0061	4.05	0.0001	0.000055
700	0.0167	0.0090	5.97	0.0006	0.000332
750	0.0176	0.0089	5.90	0.0005	0.000276
800	0.0184	0.0086	5.70	0.0038	0.002100
850	0.0238	0.0129	8.55	0.0001	0.000055
900	0.0278	0.0157	10.41	0.0005	0.000276
950	0.0260	0.0129	8.55	0.0001	0.000055
1000	0.0299	0.0153	10.15	0.0025	0.001382
1050	0.0331	0.0172	11.41	0.0003	0.000166
1100	0.0357	0.0185	12.27	0.0100	0.005526
1150	0.0468	0.0282	18.70	0.0007	0.000387
1200	0.0445	0.0245	16.25	0.0006	0.000332
1250	0.0455	0.0240	15.92	0.0019	0.001050
1300	0.0451	0.0221	14.66	0.0004	0.000221
1350	0.0539	0.0293	19.43	0.0021	0.001161
1400	0.0549	0.0287	19.03	0.0001	0.000055
1450	0.0551	0.0272	18.04	0.0003	0.000166
1500	0.0633	0.0336	22.28	0.0006	0.000332
1550	0.0664	0.0350	23.21	0.0023	0.001271
1600	0.0766	0.0433	28.71	0.0037	0.002045
1650	0.0863	0.0513	34.02	0.0006	0.000332

PB#11B

TRACK NUMBER= 0
FILE NUMBER =10SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	-0.0006	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0020	0.0011	0.73	0.0000	0.000000
250	0.0028	0.0013	0.86	0.0000	0.000000
300	0.0037	0.0016	1.06	0.0000	0.000000
350	0.0048	0.0022	1.46	0.0000	0.000000
400	0.0059	0.0027	1.79	0.0000	0.000000
450	0.0072	0.0033	2.19	0.0000	0.000000
500	0.0086	0.0040	2.65	0.0000	0.000000
550	0.0101	0.0048	3.18	0.0000	0.000000
600	0.0116	0.0055	3.65	0.0000	0.000000
650	0.0134	0.0065	4.31	0.0000	0.000000
700	0.0157	0.0080	5.31	0.0000	0.000000
750	0.0179	0.0092	6.10	0.0000	0.000000
800	0.0200	0.0102	6.76	0.0000	0.000000
850	0.0221	0.0112	7.43	0.0000	0.000000
900	0.0245	0.0124	8.22	0.0000	0.000000
950	0.0278	0.0147	9.75	0.0030	0.001658
1000	0.0285	0.0139	9.22	0.0031	0.001713
1050	0.0303	0.0144	9.55	0.0001	0.000055
1100	0.0313	0.0141	9.35	0.0001	0.000055
1150	0.0363	0.0177	11.74	0.0005	0.000276
1200	0.0387	0.0187	12.40	0.0001	0.000055
1250	0.0404	0.0189	12.53	0.0012	0.000663
1300	0.0541	0.0311	20.62	0.0062	0.003426
1350	0.0564	0.0318	21.09	0.0050	0.002763
1400	0.0574	0.0312	20.69	0.0046	0.002542
1450	0.0684	0.0405	26.86	0.0132	0.007295

PB#12B

TRACK NUMBER= 0
FILE NUMBER =11SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

RPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m.sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0013	0.0008	0.53	0.0000	0.000000
200	0.0019	0.0010	0.86	0.0000	0.000000
250	0.0027	0.0012	0.80	0.0000	0.000000
300	0.0038	0.0017	1.13	0.0000	0.000000
350	0.0049	0.0023	1.53	0.0000	0.000000
400	0.0062	0.0030	1.99	0.0000	0.000000
450	0.0077	0.0038	2.52	0.0044	0.002432
500	0.0091	0.0045	2.98	0.0007	0.000387
550	0.0095	0.0042	2.79	0.0002	0.000111
600	0.0116	0.0055	3.65	0.0004	0.000221
650	0.0132	0.0063	4.18	0.0027	0.001492
700	0.0168	0.0091	6.03	0.0153	0.008455
750	0.0265	0.0178	11.80	0.0077	0.004255
800	0.0207	0.0109	7.23	0.0006	0.000332
850	0.0229	0.0120	7.96	0.0001	0.000055
900	0.0255	0.0134	8.89	0.0001	0.000055
950	0.0290	0.0159	10.54	0.0002	0.000111
1000	0.0336	0.0190	12.60	0.0037	0.002045
1050	0.0395	0.0236	15.65	0.0053	0.002929
1100	0.0371	0.0199	13.20	0.0007	0.000387
1150	0.0385	0.0199	13.20	0.0030	0.001658
1200	0.0464	0.0264	17.51	0.0080	0.004421

D.2 Lake Ontario Samples (Series SO)

SC-5A

TRACK NUMBER= 0
FILE NUMBER =12SURFACE AREA OF SAMPLE = 0.0305(m sq.)
HEIGHT OF SAMPLE = 0.097(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0005	0.0002	0.13	0.0000	0.000000
150	0.0010	0.0005	0.33	0.0000	0.000000
200	0.0016	0.0007	0.46	0.0000	0.000000
250	0.0025	0.0010	0.66	0.0000	0.000000
300	0.0034	0.0013	0.85	0.0000	0.000000
350	0.0041	0.0015	0.98	0.0000	0.000000
400	0.0058	0.0026	1.71	0.0012	0.000656
450	0.0073	0.0034	2.23	0.0014	0.000766
500	0.0094	0.0048	3.15	0.0011	0.000602
550	0.0114	0.0061	4.00	0.0012	0.000656
600	0.0150	0.0089	5.84	0.0059	0.003227
650	0.0180	0.0111	7.29	0.0071	0.003883
700	0.0178	0.0101	6.63	0.0028	0.001531
750	0.0201	0.0114	7.48	0.0055	0.003008
800	0.0244	0.0146	9.58	0.0084	0.004594
850	0.0275	0.0166	10.89	0.0196	0.010720
900	0.0282	0.0161	10.57	0.0069	0.003774
950	0.0298	0.0167	10.96	0.0070	0.003828
1000	0.0306	0.0160	10.50	0.0111	0.006071
1050	0.0342	0.0183	12.01	0.0094	0.005141
1100	0.0385	0.0213	13.98	0.0107	0.005852
1150	0.0431	0.0245	16.08	0.0098	0.005360
1200	0.0403	0.0203	13.32	0.0116	0.006344
1250	0.0412	0.0197	12.93	0.0066	0.003610
1300	0.0443	0.0213	13.98	0.0077	0.004211
1350	0.0542	0.0296	19.43	0.0128	0.007001
1400	0.0577	0.0315	20.67	0.0261	0.014275
1450	0.0636	0.0357	23.43	0.0176	0.009626
1500	0.0656	0.0359	23.56	0.0221	0.012087
1550	0.0583	0.0269	17.65	0.0175	0.009571
1600	0.0776	0.0443	29.07	0.0196	0.010720
1650	0.0639	0.0289	18.97	0.0210	0.011485
1700	0.0616	0.0246	16.15	0.0112	0.006126
1750	0.0784	0.0394	25.86	0.0194	0.010610

SC-5B

TRACK NUMBER = 0
FILE NUMBER = 13SURFACE AREA OF SAMPLE = 0.0342(m sq.)
HEIGHT OF SAMPLE = 0.109(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq.-s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.23	0.0000	0.000000
150	0.0013	0.0008	0.47	0.0000	0.000000
200	0.0020	0.0011	0.64	0.0000	0.000000
250	0.0029	0.0014	0.82	0.0000	0.000000
300	0.0041	0.0020	1.17	0.0000	0.000000
350	0.0051	0.0025	1.46	0.0000	0.000000
400	0.0064	0.0032	1.87	0.0000	0.000000
450	0.0078	0.0039	2.28	0.0053	0.002580
500	0.0090	0.0044	2.57	0.0040	0.001947
550	0.0097	0.0044	2.57	0.0000	0.000000
600	0.0150	0.0089	5.20	0.0059	0.002872
650	0.0157	0.0088	5.14	0.0093	0.004526
700	0.0208	0.0131	7.65	0.0068	0.003310
750	0.0230	0.0143	8.35	0.0144	0.007009
800	0.0263	0.0165	9.64	0.0141	0.006863
850	0.0279	0.0170	9.93	0.0104	0.005062
900	0.0342	0.0221	12.91	0.0102	0.004964
950	0.0344	0.0213	12.44	0.0077	0.003748
1000	0.0429	0.0283	16.53	0.0186	0.009053
1050	0.0430	0.0271	15.83	0.0059	0.002890
1100	0.0441	0.0269	15.71	0.0103	0.005013
1150	0.0507	0.0321	18.75	0.0168	0.008177
1200	0.0516	0.0316	18.46	0.0000	0.000001
1250	0.0591	0.0376	21.96	0.0227	0.011048
1300	0.0634	0.0404	23.60	0.0172	0.008371
1350	0.0641	0.0395	23.07	0.0000	0.000001
1400	0.0663	0.0401	23.42	0.0125	0.006084
1450	0.0675	0.0396	23.13	0.0164	0.007982
1500	0.0776	0.0479	27.98	0.0292	0.014212

SC-6A

TRACK NUMBER = 0
FILE NUMBER = 15SURFACE AREA OF SAMPLE = 0.0314(m sq.)
HEIGHT OF SAMPLE = 0.100(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.06	0.0000	0.000000
100	0.0007	0.0004	0.25	0.0000	0.000000
150	0.0013	0.0008	0.51	0.0000	0.000000
200	0.0021	0.0012	0.76	0.0000	0.000000
250	0.0030	0.0015	0.95	0.0000	0.000000
300	0.0040	0.0019	1.21	0.0015	0.000796
350	0.0042	0.0016	1.02	0.0002	0.000106
400	0.0059	0.0027	1.72	0.0039	0.002069
450	0.0075	0.0036	2.29	0.0050	0.002653
500	0.0087	0.0041	2.61	0.0012	0.000637
550	0.0108	0.0055	3.50	0.0027	0.001432
600	0.0121	0.0060	3.82	0.0020	0.001061
650	0.0147	0.0078	4.97	0.0015	0.000796
700	0.0155	0.0078	4.97	0.0009	0.000477
750	0.0183	0.0096	6.11	0.0015	0.000796
800	0.0230	0.0132	8.40	0.0016	0.000849
850	0.0264	0.0155	9.87	0.0019	0.001008
900	0.0278	0.0157	9.99	0.0028	0.001485
950	0.0258	0.0127	8.09	0.0013	0.000690
1000	0.0330	0.0184	11.71	0.0005	0.000265
1050	0.0393	0.0234	14.90	0.0008	0.000424
1100	0.0396	0.0224	14.26	0.0065	0.003448
1150	0.0480	0.0274	17.44	0.0006	0.000318
1200	0.0360	0.0160	10.19	0.0010	0.000531
1250	0.0435	0.0220	14.01	0.0014	0.000743
1300	0.0614	0.0384	24.45	0.0028	0.001485
1350	0.0634	0.0388	24.70	0.0090	0.004775

SC-6 B

TRACK NUMBER = 0
FILE NUMBER = 14

SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0001	0.0000	0.00	0.0000	0.000000
100	0.0006	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0020	0.0011	0.73	0.0000	0.000000
250	0.0037	0.0022	1.46	0.0077	0.004255
300	0.0039	0.0018	1.19	0.0006	0.000332
350	0.0046	0.0020	1.33	0.0013	0.000718
400	0.0072	0.0040	2.65	0.0033	0.001824
450	0.0089	0.0050	3.32	0.0000	0.000000

SC-7A

TRACK NUMBER= 0
FILE NUMBER =16SURFACE AREA OF SAMPLE = 0.0302(m sq.)
HEIGHT OF SAMPLE = 0.096(m)

TPM	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (kg)	EROSION RATE (kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0007	0.0004	0.27	0.0000	0.000000
150	0.0011	0.0006	0.40	0.0000	0.000000
200	0.0018	0.0009	0.60	0.0000	0.000000
250	0.0026	0.0011	0.73	0.0000	0.000000
300	0.0036	0.0015	0.99	0.0018	0.000995
350	0.0048	0.0022	1.46	0.0010	0.000553
400	0.0066	0.0034	2.25	0.0021	0.001161
450	0.0078	0.0039	2.59	0.0023	0.001271
500	0.0101	0.0055	3.65	0.0083	0.004587
550	0.0117	0.0064	4.24	0.0056	0.003095
600	0.0121	0.0060	3.98	0.0032	0.001768
650	0.0134	0.0065	4.31	0.0036	0.001989
700	0.0175	0.0098	6.50	0.0053	0.002929
750	0.0184	0.0097	6.43	0.0054	0.002984
800	0.0214	0.0116	7.69	0.0057	0.003150
850	0.0240	0.0131	8.59	0.0047	0.002597
900	0.0242	0.0121	8.02	0.0064	0.003537
950	0.0310	0.0179	11.87	0.0128	0.007074
1000	0.0317	0.0171	11.34	0.0136	0.007516
1050	0.0317	0.0158	10.48	0.0093	0.005139
1100	0.0312	0.0140	9.28	0.0049	0.002708
1150	0.0409	0.0223	14.79	0.0096	0.005305
1200	0.0424	0.0224	14.85	0.0142	0.007847
1250	0.0445	0.0230	15.25	0.0080	0.004421
1300	0.0550	0.0320	21.22	0.0222	0.012268
1350	0.0511	0.0265	17.57	0.0211	0.011660
1400	0.0592	0.0330	21.88	0.0162	0.008952
1450	0.0573	0.0294	19.50	0.0175	0.009671
1500	0.0580	0.0283	18.77	0.0097	0.005360
1550	0.0755	0.0441	29.24	0.0223	0.012323
1600	0.0750	0.0417	27.65	0.0204	0.011273
1650	0.0853	0.0503	33.36	0.0379	0.020944

SURFACE AREA OF SAMPLE = 0.0302(m sq.)

HEIGHT OF SAMPLE = 0.096(m)

REPM.	UNCORRECTED TORQUE(N·m)	CORRECTED TORQUE(N·m)	SHEAR STRESS (Pa)	WEIGHT LOSS (Kg)	EROSION RATE (Kg/m sq.-s)
50	0.0002	0.0001	0.07	0.0000	0.000000
100	0.0008	0.0003	0.20	0.0000	0.000000
150	0.0012	0.0007	0.46	0.0000	0.000000
200	0.0017	0.0008	0.53	0.0006	0.000332
250	0.0028	0.0013	0.86	0.0007	0.000387
300	0.0038	0.0018	1.19	0.0014	0.000774
350	0.0041	0.0015	0.99	0.0034	0.001878
400	0.0069	0.0037	2.45	0.0081	0.004476
450	0.0078	0.0039	2.59	0.0011	0.000608
500	0.0087	0.0041	2.72	0.0012	0.000662
550	0.0108	0.0056	3.71	0.0035	0.001924
600	0.0140	0.0078	5.24	0.0039	0.002135
650	0.0155	0.0063	4.38	0.0036	0.001929
700	0.0159	0.0082	5.44	0.0083	0.004587
750	0.0212	0.0125	8.29	0.0085	0.004697
800	0.0244	0.0146	9.68	0.0106	0.005858
850	0.0260	0.0151	10.01	0.0086	0.004753
900	0.0279	0.0158	10.48	0.0127	0.007018
950	0.0306	0.0175	11.81	0.0079	0.004366
1000	0.0370	0.0224	14.85	0.0106	0.005258
1050	0.0320	0.0171	11.34	0.0095	0.003250
1100	0.0380	0.0208	13.79	0.0091	0.005029
1150	0.0458	0.0272	18.04	0.0118	0.006521
1200	0.0430	0.0260	17.24	0.0085	0.005250
1250	0.0480	0.0243	16.11	0.0155	0.003566
1300	0.0483	0.0233	15.45	0.0086	0.004753
1350	0.0485	0.0239	15.85	0.0114	0.006300
1400	0.0546	0.0284	18.83	0.0115	0.006355
1450	0.0548	0.0269	17.84	0.0072	0.003879
1500	0.0562	0.0265	17.57	0.0080	0.004874
1550	0.0585	0.0255	18.90	0.0113	0.006245
1600	0.0675	0.0342	22.68	0.0180	0.009847
1650	0.0696	0.0346	22.94	0.0148	0.008234
1700	0.0720	0.0350	23.21	0.0127	0.007018
1750	0.0753	0.0383	24.07	0.0183	0.010113
1800	0.0711	0.0362	20.03	0.0054	0.005185
1850	0.0770	0.0341	22.61	0.0100	0.003529
1900	0.0796	0.0344	22.81	0.0170	0.009305
1950	0.0835	0.0361	23.94	0.0117	0.006466
2000	0.0879	0.0382	25.33	0.0149	0.008234
2050	0.0857	0.0337	22.35	0.0077	0.004255
2100	0.0920	0.0377	25.00	0.0157	0.009229
2150	0.0985	0.0318	21.09	0.0088	0.004863
2200	0.0928	0.0337	22.35	0.0109	0.006024
2250	0.0944	0.0328	21.75	0.0130	0.007184
2300	0.1055	0.0413	27.39	0.0410	0.022657

D.3 Values of Critical Shear Stress

Series PS

Sample No.	Critical Shear Stress, Pa	RPM at Onset of Erosion
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1	0.68	250
3	1.20	300
4	1.62	400
5	0.71	250
6	0.90	250
7	1.71	450
8	0.77	150
9	0.68	250
11	2.82	400
12	2.81	500
I-VI-A	4.06	550
I-VI-B	2.12	400
13	1.21	250
14	4.73	650
16	3.03	550
17	0.80	250
18	0.80	250
19	1.37	350
20	1.24	300
21	1.01	250
23	0.76	200
24	1.19	350
25	1.17	250
26	2.43	300
28	1.02	250
29	7.05	650
30	6.18	750

Series PBA

Sample No.	Critical Shear Stress, Pa	RPM at Onset of Erosion
1	4.73	750
2	3.81	500
3	7.47	850
4	5.60	700
5	6.61	750
6	3.06	450
7	17.66	1200
8	7.33	950

Series PBB

2	6.10	700
3	1.72	350
4	4.18	650
5	4.40	650
6	5.04	650
7	4.91	700
8	5.44	650
10	4.71	600
11	9.75	950
12	2.52	450

Series SC

5A	1.71	400
5B	2.28	450
6A	1.21	300
6B	1.46	250
7A	0.99	300
7B	0.53	200

D.4 Values Of Erosion Rate Gradient

Series PS

Sample No.	Erosion Rate Gradient $a_1 \times 10^{-3}$	Coefficient of Determination, r^2
1	0.193	0.70
3	0.143	0.72
4	0.250	0.69
5	0.305	0.49
6	0.490	0.88
7	0.210	0.31
8	0.507	0.29
9	0.141	0.70
11	0.152	0.91
12	0.158	0.66
I-VI-A	0.197	0.45
I-VI-B	0.068	0.11
13	-0.013	0.01
14	0.042	0.15
16	0.140	0.09
17	0.194	0.51
18	0.373	0.22
19	0.390	0.41
20	0.341	0.29
21	0.208	0.15
23	0.880	0.64
24	0.454	0.59
25	0.052	0.02
26	0.571	0.79
28	0.000	0.09
29	1.260	0.44
30	0.185	0.26

Sample No.	Erosion Rate Gradient $a_1 \times 10^{-3}$	Coefficient of Determination, r^2
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Series PBA

1	0.067	0.38
2	0.042	0.53
3	0.160	0.75
4	0.225	0.56
5	0.203	0.57
6	0.051	0.26
7	0.044	0.47
8	0.009	0.04

Series PBB

2	0.343	0.68
3	0.131	0.37
4	0.094	0.29
5	0.067	0.28
6	0.174	0.29
7	0.109	0.64
8	0.206	0.17
10	0.005	0.00
11	0.303	0.76
12	0.107	0.05

Series SC

5A	0.457	0.74
5B	0.254	0.31
6A	0.059	0.13
6B	-0.503	0.08
7A	0.485	0.84
7B	0.327	0.54

D.5 Values of Average Shear Stress and Average Erosion Rate

Series PS

No. of Samples: 27

RPM	Average Shear Stress, Pa	Average Erosion Rate, kg m ⁻² s ⁻¹ × 10 ⁻⁴
150	0.51	0.16
200	0.74	0.80
250	0.95	7.59
300	1.31	8.86
350	1.71	8.48
400	2.16	10.98
450	2.68	15.57
500	3.20	15.41
550	3.91	27.12
600	4.74	20.75
650	5.58	26.98
700	6.09	19.81
750	7.21	26.79
800	8.41	31.96
850	8.95	34.33
900	10.02	31.72
950	11.10	34.80
1000	12.66	42.05
1050	12.30	35.77
1100	14.06	34.72
1150	16.58	57.30
1200	16.95	50.85
1250	18.10	35.64
1300	18.80	26.23
1350	19.55	27.60
1400	21.73	54.46
1450	24.74	31.22
1500	25.31	35.68
1550	28.17	39.67
1600	26.96	24.88
1650	29.01	31.98
1700	29.17	25.47
1750	24.34	0.52
1800	33.83	134.71

Series FBA & FBB

No. of Samples: 18

RPM	Average Shear Stress, Pa	Average Erosion Rate, kg m ⁻² s ⁻¹ × 10 ⁻⁴
350	1.57	0.46
400	2.01	0.09
450	2.44	3.31
500	2.89	0.56
550	3.47	0.32
600	4.16	1.10
650	4.57	1.74
700	5.36	8.06
750	6.38	7.51
800	7.01	3.45
850	7.51	2.46
900	8.77	1.66
950	9.70	4.01
1000	10.81	5.77
1050	11.18	4.72
1100	12.08	10.34
1150	13.69	5.11
1200	14.73	8.38
1250	16.55	5.84
1300	17.73	9.26
1350	19.15	9.82
1400	19.60	8.60
1450	24.38	27.98
1500	21.37	7.35
1550	23.73	14.05
1600	27.61	12.26
1650	28.84	23.72
1700	27.05	23.27
1750	31.55	55.80
1800	33.59	27.82

Series SC

No. of Samples: 6

RPM	Average Shear Stress, Pa	Average Erosion Rate, kg m ⁻² s ⁻¹ × 10 ⁻⁴
200	0.62	0.55
250	0.91	7.74
300	1.10	4.83
350	1.21	5.43
400	2.11	16.98
450	2.55	13.13
500	2.94	16.87
550	3.60	14.23
600	4.82	22.17
650	5.22	26.37
700	6.24	25.67
750	7.33	36.99
800	9.00	42.63
850	9.88	48.28
900	10.39	41.56
950	10.99	39.41
1000	12.99	57.53
1050	12.91	37.69
1100	13.40	44.10
1150	17.02	51.36
1200	14.81	39.95
1250	16.05	56.78
1300	19.74	62.18
1350	20.12	59.47
1400	21.20	89.17
1450	20.98	78.15
1500	21.97	91.58
1550	21.93	93.80
1600	26.47	106.47
1650	25.09	135.71
1700	19.68	65.72
1750	24.97	103.62

APPENDIX E.0 - RESULTS OF STANDARD-SURFACE ROUGHNESS TESTS

CALIBRATION CYLINDER NO. 1

Sand Roughness k_s : 0.50 mm (1.0 phi)

RPM	UNCORRECTED TORQUE (N-m $\times 10^{-3}$)	CORRECTED TORQUE (N-m $\times 10^{-3}$)	SHEAR STRESS (Pa)
50	0.2	0.1	0.06
100	0.7	0.4	0.44
150	1.4	0.9	0.56
200	2.4	1.5	0.94
250	3.6	2.1	1.31
300	4.9	2.8	1.75
350	6.3	3.7	2.31
400	7.8	4.6	2.87
450	9.5	5.6	3.49
500	11.4	6.8	4.24
550	13.4	8.1	5.06
600	15.6	9.5	5.93
650	17.7	10.8	6.74
700	20.3	12.6	7.86
750	23.0	14.3	8.92
800	25.9	16.1	10.05
850	28.9	18.0	11.23
900	32.1	20.0	12.48
950	35.7	22.6	14.10
1000	39.0	24.4	15.23
1050	43.0	27.1	16.91
1100	46.3	29.1	18.16
1150	50.5	31.9	19.91
1200	54.6	34.6	21.59
1250	58.4	36.9	23.03
1300	63.2	40.2	25.09
1350	67.3	42.7	26.65
1400	72.0	45.8	28.58
1450	76.6	48.7	30.39
1500	80.9	51.2	31.95
1550	85.6	54.2	33.82
1600	90.3	57.0	35.57
1650	94.5	59.5	37.13
1700	99.5	62.5	39.00
1750	104.5	65.5	40.88
1800	109.8	68.9	43.00
1850	114.9	72.0	44.93
1900	120.3	75.1	46.87
1950	126.1	78.7	49.11
2000	131.2	81.5	50.86

CALIBRATION CYLINDER NO. 2

Sand Roughness k_s : 1.00 mm (0.0 phi)

RPM	UNCORRECTED TORQUE (N-m $\times 10^{-3}$)	CORRECTED TORQUE (N-m $\times 10^{-3}$)	SHEAR STRESS (Pa)
50	0.2	0.1	0.06
100	0.7	0.4	0.24
150	1.5	1.0	0.61
200	2.5	1.6	0.98
250	3.8	2.3	1.41
300	5.0	2.9	1.77
350	6.6	4.0	2.45
400	8.2	5.0	3.06
450	9.9	6.0	3.67
500	11.7	7.1	4.34
550	13.9	8.6	5.26
600	16.2	10.1	6.18
650	18.6	11.7	7.16
700	21.2	13.5	8.26
750	24.0	15.3	9.36
800	27.2	17.4	10.65
850	30.4	19.5	11.93
900	33.8	21.7	13.28
950	37.4	25.3	15.48
1000	41.0	27.9	17.07
1050	44.6	28.7	17.56
1100	48.2	31.0	18.97
1150	52.1	33.5	20.50
1200	56.7	36.7	22.46
1250	61.2	39.7	24.29
1300	65.6	42.6	26.07
1350	70.1	45.5	27.84
1400	74.9	48.7	29.80
1450	79.2	51.3	31.39
1500	84.9	55.2	33.78
1550	89.8	58.4	35.73
1600	95.1	61.8	37.82
1650	100.4	65.4	40.02
1700	106.1	69.1	42.28
1750	112.4	73.4	44.91
1800	118.3	77.4	47.36
1850	124.9	82.0	50.18
1900	131.0	85.8	52.50
1950	136.6	89.2	54.58
2000	142.9	93.2	57.03

CALIBRATION CYLINDER NO. 3

- Sand Roughness k_s : 1.41 mm (-0.5 phi)

RPM	UNCORRECTED TORQUE (N-m $\times 10^{-3}$)	CORRECTED TORQUE (N-m $\times 10^{-3}$)	SHEAR STRESS (Pa)
50	0.2	0.1	0.06
100	0.7	0.4	0.24
150	1.5	1.0	0.60
200	2.5	1.6	0.96
250	3.7	2.2	1.33
300	5.1	3.0	1.81
350	6.7	4.1	2.47
400	8.3	5.1	3.07
450	10.3	6.4	3.86
500	12.6	8.0	4.82
550	14.8	9.5	5.72
600	17.5	11.4	6.87
650	20.1	13.2	7.95
700	23.0	15.3	9.22
750	26.6	17.9	10.78
800	30.0	20.2	12.17
850	33.1	22.2	13.37
900	36.7	24.6	14.82
950	40.1	27.0	16.27
1000	43.3	28.7	17.29
1050	47.0	31.1	18.74
1100	51.2	34.0	20.48
1150	56.0	37.4	22.53
1200	61.2	41.2	24.82
1250	66.4	44.9	27.05
1300	70.9	47.9	28.86
1350	76.0	51.4	30.96
1400	81.9	55.7	33.55
1450	87.7	59.8	36.02
1500	93.4	63.7	38.37
1550	98.5	67.1	40.42
1600	104.8	71.5	43.07
1650	111.4	76.4	46.02
1700	118.1	81.1	48.86
1750	125.6	86.6	52.17
1800	131.6	90.7	54.64
1850	137.8	94.9	57.17
1900	144.5	99.3	59.82
1950	152.7	105.3	63.43
2000	159.4	109.7	66.08

CALIBRATION CYLINDER NO. 4

Sand Roughness k_s : 2.0 mm (-1.0 phi)

RPM	UNCORRECTED TORQUE (N-m $\times 10^{-3}$)	CORRECTED TORQUE (N-m $\times 10^{-3}$)	SHEAR STRESS (Pa)
50	0.4	0.3	0.18
100	1.1	0.8	0.47
150	2.2	1.7	1.00
200	3.7	2.8	1.65
250	5.5	4.0	2.35
300	7.3	5.2	3.06
350	9.9	7.3	4.30
400	12.2	9.0	5.30
450	15.1	11.2	6.59
500	18.2	13.6	8.00
550	21.7	16.4	9.65
600	25.3	19.2	11.30
650	29.1	22.2	13.07
700	32.6	24.9	14.66
750	37.4	28.7	16.89
800	40.1	30.3	17.83
850	44.5	33.6	19.78
900	48.9	36.8	21.66
950	54.0	40.9	24.07
1000	59.0	44.4	26.13
1050	64.6	48.7	28.66
1100	76.7	59.5	35.02
1150	83.4	64.8	37.72
1200	90.6	70.6	41.55
1250	98.5	77.0	45.32
1300	105.2	82.2	48.38
1350	114.8	90.2	53.09
1400	122.2	96.0	56.50
1450	128.0	100.1	58.92
1500	138.9	109.2	64.27
1550	149.1	117.7	69.28
1600	157.9	124.6	73.34
1650	165.9	130.9	77.05
1700	176.5	139.5	82.11
1750	186.6	147.6	86.88
1800	195.8	154.9	91.17
1850	208.4	165.5	97.41
1900	219.7	174.5	102.71
1950	228.5	181.1	106.59
2000	239.2	189.5	111.54

CALIBRATION CYLINDER NO.5

- Sand Roughness k_s : 4.0 mm (-2.0 phi)

RPM	UNCORRECTED TURQUE (N·m $\times 10^{-3}$)	CORRECTED TURQUE (N·m $\times 10^{-3}$)	SHEAR STRESS (Pa)
50	0.7	0.6	0.33
100	1.7	1.4	0.76
150	3.5	3.0	1.64
200	5.9	5.0	2.73
250	8.9	7.4	4.04
300	12.7	10.6	5.79
350	16.9	14.3	7.80
400	21.9	18.7	10.21
450	24.5	20.6	11.24
500	30.7	26.1	14.25
550	36.7	31.4	17.14
600	43.0	36.9	20.14
650	51.5	44.6	24.34
700	59.7	52.0	28.38
750	114.3	105.6	57.64
800	213.5	203.7	111.18

Maximum torque-sensor load reached at N = 800 rpm