GEOLOGIC OBSERVATIONS ON THE ORDINARY HIGH WATER LINE OF LAKE HANCOCK, POLK COUNTY, FLORIDA

FINAL DRAFT REPORT

BY

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INTRODUCTION

Lake Hancock is a large, very shallow lake located in the Central Highlands in the northern portion of the Polk Upland in west central Polk County, Florida. Covering approximately 4,500 acres, most of the lake lies within the northwest quarter of Township 29 South, Range 25 East.

In a general discussion of central Florida lakes, White (1958, 1970) felt that large, shallow, flat bottomed lakes like Lake Hancock were formed in areas where "permeable sands overlie soluble limestone which is sufficiently impermeable to hold the water table up in the sand much of the time" (White, 1958, p. 69), and that the lake bottom was formed by solution in areas where ground water motion was primarily lateral. Once formed, such lakes would accumulate organic muck that would protect their limestone bottoms from further solution.

White pointed out that most of these lakes have both inlets and outlets, indicating that water in these lakes primarily moves laterally. More importantly, he claimed that these outlets assure "a considerable longevity at a fairly uniform surface level". (op cit., p. 72): and that "a lake with surface drainage maintains a rather uniform level of surface which is largely controlled by the level of the spillway over which it drains". (op cit., p. 73) He further states that these lakes are located in areas where the potentiometric surface is above the lake surface, thus preventing downward movement of ground water; this would keep surficial ground water high, and thereby produce more horizontal flow of ground water.

In summary the major points of White's thesis include:

a) The formation of the lakes is due to lateral flow of surficial ground water in permeable sands and associated lateral solution of underlying impervious limestones;

b) This solution process creates a shallow depression which becomes a lake;

c) The subsequent formation of organic muck seals off the bottom of the lake and arrests deepening;

d) The stability of the lake level is assured by the continuous lateral flow of ground water into the lake, and by the level of the lake's discharge outlet which carries off overflow;

e) The continued existence of the lake is assured by the lake level being below the potentiometric surface, thus assuring that downward solution and drainage of either the lake or the surficial aquifer does not take place.

It should also be noted in this regard that any changes affecting the above enumerated elements would threaten either the level or the existence of the lake. Thus, should the organic muck in the bottom of the lake be disturbed, the seal it forms might be breached, allowing further deepening of the lake; should the level of the discharge outlet change, so would the level of the lake and of the aquifer which feeds it; should the level of the surficial aquifer drop either because of natural or artificial factors, the level of Lake Hancock would become dependent primarily on the inflow from that part of Saddle Creek that enters into the North end of the lake and thus fluctuate much more widely than if the level was dependent on outflow from the surficial aquifer. Such fluctuations could be the result of extended droughts or of conditions induced by human activity such as mining.

Changes observed in several lakes located further north along the peninsula led White to postulate that it is the effect of such a combination of events, particularly the breaching of the organic seals by sinkholes which caused the demise of lakes which used to exist in such places as Payne's, Sandez, Kanapaha, and Hogtown Prairies near Gainesville, and that other lakes such as Levy and Newnan's are in the process of disappearing for similar reasons.

Thus, since the time of its formation it appears that water levels in Lake Hancock have been maintained primarily by the elevation of the outlet into lower Saddle Creek, by an adequate outflow from the surficial aquifer into the lake, and perhaps also by recharge from the deeper artesian aquifers.

LOCAL STRATIGRAPHY

Until the 1950's the edges of Lake Hancock supported primarily cattle and timber industries. Since then mining and development of the underlying phosphate resources have crept up on both the South and East shores. Exploration of Lake Hancock by the Three Gee Dee Company (for Coastal Petroleum Company) was carried out by drilling 40 prospect holes in the bottom of Lake Hancock. Their report reveals that the stratigraphy of Lake Hancock conforms to White's general predictions. The lake is shallow, with an average depth of less than 5 feet and a layer of muck along its bottom ranging in depth from 1 to 4 feet. In the eastern portion of the lake the overburden averages nearly 16' in thickness and ranges from 9-17', while the matrix averages a little over 9' in thickness and ranges from 5-14'. Generally, the phosphatic sands, gravels, and clays of the Bone Valley Formation and the "Surficial Sands" comprise a blanket of some 30 feet or more of sediments draped across the Hawthorne limestones. The presence of the Bone Valley Formation underlying the lake and adjacent areas indicate that the lake was formed after the deposition of this formation. Based on paleontological evidence, the sediments of this formation range in age from Miocene to perhaps as late as Middle Pleistocene; therefore, the formation of the lake was probably a Pleistocene event, although nothing precludes its initiation as early as Pliocene.

LAKE TERRACES

The edge of Lake Hancock, as any shoreline, is subjected to the continuous erosional action of waves. Sediments are sorted by the wave action, resulting in the winnowing and carrying out of the finer materials from the beach zone, leaving the coarser materials behind. This combined action of landward erosion and lakeward deposition will in time create a bench or platform that marks the normal shoreward extent of the lake's influence. Often associated with these normal or ordinary wavecut beaches are storm platforms (classically called high-water platforms) formed largely by the splash of storm waves. Because the storm waves attack the shore at higher-than-normal elevation the storm platforms naturally occur at slightly higher elevations than the ordinary wavecut beaches.

Given a minimal recurrence requirement of some years to form platforms in these particular materials, their existence is prima facie evidence for a degree of stability in the water level of the lake. With a widely fluctuating water level there would be insufficient time to form clearly delineated platforms. Where the water level of a lake changes and stabilizes at a different elevation, new beaches are cut. Where the new level is below the original level, the original beach is exposed as a relictual terrace. However, should the rising water levels transgress across older terraces, they will tend to mask or destroy them. Thus, as a general rule any shoreline which shows a succession of stair-step terraces is considered an emergent shoreline and indicates either a drop in water levels or a rise in surrounding land. Since no evidence exists to indicate that surrounding areas have risen, it is safe to assume that these terraces are linked to changes in the lake level.

Despite the fact that Lake Hancock is a small body of water, its shoreline is marked by the presence of several terraces. Although small, they are never-the-less quite distinct and persistent; a plot of elevations along the surveyed botanical transects graphically documents their presence. (see Appendix A) Because these terraces represent the former landward extent of the lake waters' influence, their elevation also represents the elevation at which water had to stand in order to cut these terraces.

Although several different levels are represented on all transects, only two levels assume special significance when the various transects are compared. The most conspicuous group of terrace elevations clusters near 100.6'. Every transect shows a more or less pronounced scarp between 100.4' and 100.8' of elevation. (See Table 1) The second group of terrace elevations clusters near 103.1. Therefore, based on elevation profiles, there are two distinct terrace levels which represent former stable stands of Lake Hancock, the higher at an elevation of 102.5' to 103.3', and the lower at 100.4' to 100.8'. Slight variations in elevation and morphology most likely represent local variations in wave energy and lithology. However, given the continuity of these terraces at similar elevations from transect to transect, it is also evident that these terraces reflect changes in water levels that affected the entire lake rather than merely representing localized conditions.

Based only on morphological evidence there is no absolute way of dating the terraces. However, considering their relative position and the transgressive/regressive criteria mentioned above, the 103'± terrace is clearly older than the 100.5'± terrace. The sequences of terraces, therefore, indicates a two-step drop in the level of Lake Hancock, from an elevation near 103' to an elevation near 100.5', then down to the present elevation of the lake near 98'.

	Present Water Levels	Terrace Elevations					
TR01	97.8		100.1	100.8		102.5	102.8
TR02	97.7		100.2	100.6	101.2 to 101.6	---	102.9 103.4
TR03	97.8		100.7	(Faint)	---	102.2	103.3
TR04	97.6	99.8	---	100.6	---	102.4	103.0
TR06	97.7		100.6	100.8	101.0	102.1	103.1
TR07	97.7	99.2	100.4	(Faint)	101.6	---	103.5
TR11	97.6	99.0	100.5	100.8	101.5	102.6	---

TABLE 1

ELEVATION OF LAKE HANCOCK TERRACES

BASED ON PLOTS OF TRANSECT ELEVATIONS

Such a drop in the lake levels cannot be accounted for by precipitation alone. As indicated in Sutron's Peace River Report, average yearly precipitation records taken over the last ninety years reveal no significant changes in rainfall until 1960. After 1960 there is a decrease of nearly 10% in annual precipitation. Although the cause of recent drops in lake levels may be related to precipitation, such an explanation fails to account for earlier drops documented by the presence of high level terraces. The most probable reasons for such a shift are either a change in elevation in the Saddle Creek outlet or a change in the conditions in the local water table, or both. It should be also noted that structure P-11 was constructed at the outlet of Lake Hancock in 1963, thereby stabilizing the level of the lake. Both of these considerations are treated at length in the various contractor's reports on the Peace River OHWL.

One of the most reproducible indicators of the "presence and action" of water, or the lack thereof, is a change in the composition of soil. As mentioned earlier, the wave action of the lake tends to transport clay and organic materials away from the uplands through the processes of erosion. Generally, this transportation results in a systematic decrease in the average grain size of the soil and a tendency for the particles to become more equal in size (better sorted). A statistically significant difference can often be seen between the physical characteristics of upland soil (parent material) and the eroded soil. At the OHWL a sudden improvement in the sorting characteristics of the soil together with the occurrence of the largest average grain size is usually observed. In addition, there should be detectable differences in leaching and oxidation between upland soils and those subjected to the anaerobic conditions imposed by persistent inundation. The relationship between lake levels and soil features is considered in the following section of this report.

LAKE HANCOCK SOILS

A soil has been defined as "a collection of natural bodies which has been synthesized from a variable mixture of broken and weathered minerals and decaying organic matter which covers the earth in a thin layer and which supplies, when containing the proper amounts of air and water, mechanical support and sustenance for plants." (Brady, 1974) As such, this definition is both pedologic, that is, it considers the origin, history and classification and description of the materials and processes which lead to the existing soil; and edaphic, in that it considers the material and properties of soils in relation to plants. In an effort to arrive at a more refined determination of the HHWL, an examination of the soils along Lake Hancock was undertaken. Primarily pedologic in nature, it was supported by the subsequent chemical analysis of available soil samples. Limited edaphic interpretations have also been included in order to corroborate particular interpretations. More detailed and refined edaphic studies, however, have been carried out by other contractors.

Because of the need for comparisons between transects, a series of trenches was dug parallel to the transects. Owing to a regrettable misunderstanding between the owner and the project sponsors, already communicated to you, our field crew was evicted from the site before being able to complete the trenching, thus severely handicapping the descriptive and comparative aspects of the study. Nonetheless, limited field notes and samples were taken. Based on these observations, materials, and notes some preliminary conclusions were reached.

Upon comparing results from the various transects, it is evident that there are at least two lakeshore sedimentary environments represented: one at TR01 and TR02, and a different one at the other transects.

TR01 and TR02 are located on a small promontory that projects into the lake in an eastward direction and is relatively devoid of vegetation. At both of these transects, there is an outcrop of calcareous sandstone. Test trenches dug to a depth of over two feet pass through an organic-poor, unzoned, sandy and cobbly material obviously derived from the sandstone. Two projectile points crafted between 3000 B.C. to 1000 A.D. were recovered from this trench just above 99.5' of elevation. They were not associated with any particular soil zone, and their presence, as well as their great antiquity, reinforces the assumption that the rubble in which they were contained is a lag concentrate formed by the constant reworking of sediments by wave action focused along the exposed shore.

In contrast to the high energy environment sampled along TR01 and TR02, the remainder of the transects are located along a "cove" in a much more protected sedimentary environment. Their most distinctive, lithologically consistent feature is the presence of a black, highly organic, indurated, sandy layer, up to nearly a foot in thickness at 100' of elevation. (See Fig. 1) When traced to higher elevations, this organic layer rapidly thins near 100.5' and by 101' of elevation it is no longer distinct. As can be seen by the accompanying table (Table 2) there is a decrease in organic content with increased elevation particularly abrupt near 100.5'. This organic-rich layer containing up to 15% organic matter must have been deposited in a quiet reducing environment where the reworking action of waves was relatively weak. In conjunction with this interpretation, it is interesting to note that the transects whose soils contain the highest amount of organic materials show very weak topographical dissection; conversely, TR01 and TR02, which are the most exposed transects, viritually lack organics. In this respect, Lake Hancock is similar to other shallow lakes in Florida.

Elevation & Depth Sample	TR03	TR04	TR06	TR07
100'	12.9 (0-3")	10.1 (0-3")	5.4 (0-2")	15.4 (0-3")
100'	8.2 (3-10")	4.7 (3-7")	3.8 (2-5")	7.8 (3-7")
100.5'	--- ---	--- ---	9.7 (0-2")	5.7 (0-6")
100.5'	--- ---	--- ---	6.1 (2-6")	1.5 (6-9")
100.5'	--- ---	--- ---	--- ---	5.3 (16-18")
101'	5.0 (0-3")	--- ---	--- ---	--- ---
101'	1.5 (3-7")	--- ---	--- ---	--- ---

TABLE 2

Percent Organic Content in Lake Hancock Soils Samples

In a study of present ordinary high water levels of thirty modern Florida lakes, Bishop (1967) indicates that "the landward termination of peat or sandy peat occurs at or very near the same elevation as the landward termination of beach deposits. These materials are deposited along shorelines protected from wave action and are protected from destruction by oxidation by being kept wet with lake water".

Another striking feature of the soils along Lake Hancock is the presence of a brown, variously indurated, organic-rich sand, below the black layer discussed above. In the one sample analyzed (TR07 @ 100.5' of elevation) the organic content of this zone is virtually as high as that of the uppermost soil (5.3% vs. 5.7% for the latter). The amount of organic material present in this brown layer seems to be inversely proportional to the amount of organics in the black upper soil zones. For example, at higher elevations where the surficial soil zones are poor in organic materials, this lower brown layer is extremely conspicuous and indurated. Lakeward, where the percentage of organics increases, the brown layer is less indurated and less prominent.

One plausible explanation for this brown zone might be that it marks the upper zone of a paleosol. It is much more likely, however, that this layer marks a zone of accumulation of leached surface organics.[1] The latter interpretation is reinforced by the fact that all the transects which exhibit this pattern of leaching (i.e., TR03, TR04 and TR07), also have an associated brown organic zone. The transect (TR06) which does not show this leaching pattern and where, in fact, organics increase with higher elevation (5.4% @ 100' vx 7.7% @ 100.5'), also lacks this organic zone. Were this brown layer

[1] No destinction is made here between leaching and eluviation and/or cheluviation. For these purposes, "leaching" is used collectively to include downward removal of both soluble and particulate material.

at the upper zone of a paleosol, one would expect to find this relictual soil represented in all the transects rather than only in those where leaching is prominent.

Where measured, the organic zone occurs between 98' and 99' of elevation. This elevation corresponds approximately to the present elevation of the lake water. Thus, the formation of such a soil would have had to occur at an elevation close to the present elevation close to the present elevation of the lake. Yet, the terraces indicate that lake levels have been decreasing rather than widely oscillating. Also, one would expect that such a paleosol would be increasingly prominent lakeward rather than to be increasingly attentuated as is the case with the peaty sand at 100.5'.

In sum, the limited pedological sampling carried out indicates the following:

1. TR01 and 02 differ from the other transects and provide little comparable pedological information because of differences in environment and lithology.
2. TR03, TR04, TR06 and TR07 feature a black, organic rich soil, which disappears (and probably was not deposited) between 100' and 101' of elevation. This layer is interpreted to represent a relictual swamp or marsh deposit.
3. Because the black organic layer requires standing water and reducing conditions for its formation and because it disappears beyond 100.5' of elevation, the formation of this soil layer is interpreted to indicate a former lake stand near 100.5' of elevation.

4. TR03, TR04, and TR07 show a brown organic rich zone associated with the upper higher elevation soil zones. This layer is interpreted to represent a secondary depositional zone associated with the leaching of organics from soils exposed to leaching beyond what was then the OHWL.

Soil Analyses

Spectroscopic analyses of the limited number of samples available were performed using both water and double-acid extraction methods. The results of these analyses are given in Tables 3 and 4.

Because Ordinary High Water represents such a significant change in environmental conditions, the soils that it influences should reflect and record this change. The soils above the OHWL are exposed to the leaching action of downward moving water and generally exhibit greater leaching in their upper zones and less leaching and even accumulation in their lower zones. As leaching is considerably reduced below the OHWL, the soils exhibit a generally greater concentration of certain inundation-controlled constituents than above this line and there is little difference between topsoil and subsoil. Because the HHWL is a relictual OHWL, and because of the greater effect of time, leaching will be more intense above the HHWL than above the OHWL.

Analysis of the spectroscpoic data from TR07 and TR03 indicates that a major change in elemental concentration takes place between 100' and 101'. The marked decrease in concentration of virtually all elements indicates increased leaching. There is also a consistently greater difference between the lower and upper soil samples at or above 100.5' when compared to the same zones at 100'. It is noteworthy that on TR07 the zones of concentration of various constituents, notably Al, Ca, Fe, Mg, P, and Ai, (Table 3) correspond to zones of increased organics, supporting the statement made earlier in this report that the "brown zone", found in all transects other than TR01, TR02, and TR06, is a zone of accumulation rather than a paleosol. In this lake side profile, the same mechanisms which control organic concentration control the accumulation of other elements as well. Given the restrictions imposed by the limited number of samples we were able to take, the elemental analysis is remarkably consistent with the other evidence presented and indicates that the major change in the soils occurs between 100' and 101'.

Edaphic/Botanical Observations

As mentioned earlier, soil conditions to a large extent control plant distribution; thus changes in the substrate will normally also be reflected in vegetation. Along the Lake Hancock transects there is very clear evidence of two vegetational zones. On the highest terrace (above 103') large live oaks (Quercus virginianus) and thick stands of sawtooth palmettos (Serenoa repens) are abundant. Both these species extend down to approximately 100.5' of elevation, although they become less common lakeward. Because these species are intolerant of sustained inundation, their rather abrupt shoreward exclusion near 100.5' suggests that this elevation marks the approximate extent of the former high water line.

Conversely, mature bald cypresses (Taxodium distichum) occur consistently up to 100.5' of elevation where they form a distinct line that parallels established contour lines marking that elevation. Since this species is generally accepted as occurring at or below the OHWL, the consistent and abrupt appearance of mature specimens reflects the landward extent of the former OHWL. In his previously mentioned study of modern lake shorelines in Florida, Bishop (1967) also found that the line between Taxodium distichum, on the one hand, and Serenoa repens and Quercus virginianus on the other, marked the approximate landward extent of stratified beach deposits and therefore marked the actual high water line of these Florida lakes. Extension of his analysis to Lake Hancock confirms our conclusion that the 100.5' elevation marks the pre-mining OHWL of this lake.

CONCLUSIONS

1. Based solely on geomorphic (terrace) evidence, the pre-mining or HHWL, could be located either slightly over 100.5' above MSL (100.6-100.8') or at slightly above 103' (103.0-103.3').

2. Based on soil profiles, particularly on the presence of the black organic-rich sands just below 100.5' and their absence above that elevation, we conclude that, although the 103' terrace represents a former high stand of Lake Hancock, eluviation of clay and organic matter and leaching from its surficial layers indicate it was formed too remotely to reflect processes acting within the last forty years. However, distinct organic accumulations have not yet been eluviated from the 100.5' terrace; therefore this terrace is regarded as more accurately representing the HHWL.

3. Botanical evidence supports the geomorphic and pedologic conclusions: Mesic plant species are profusely distributed beyond the 103' elevation contour; they extend, although much more sparsely, down to 100.5'. Mature specimens of water tolerant species extend no further inland than to the same 100.5' elevation; thus the abrupt contact between upland and lowland species indicates that lake water consistently stood at 100.5' in recent times. Dendrochronological techniques should readily yield a date after which water tolerant species were no longer able to become established at 100.5' because of the lowering of the lake. Therefore, based on the three separate lines of evidence, it is our opinion that the Historical Water Line on Lake Hancock was located at or near 100.5' of elevation prior to phosphate mining.

SELECTED REFERENCES

Bishop, E.W., 1967. Florida Lakes Part I. A Study of the High Water Lines of Some Florida Lakes. Fla. Bd. of Conserv. Dir. of Water Resources, Tallahassee, Florida.

Brady, 1974. The Nature and Properties of Soils, 8th Ed. MacMillan Pub. Co., Inc., New York.

White, W.A., 1958. Some Geomorphic Features of Central Peninsular Florida. Fla. Geol. Survey Bulletin 41, Tallahassee, Florida.

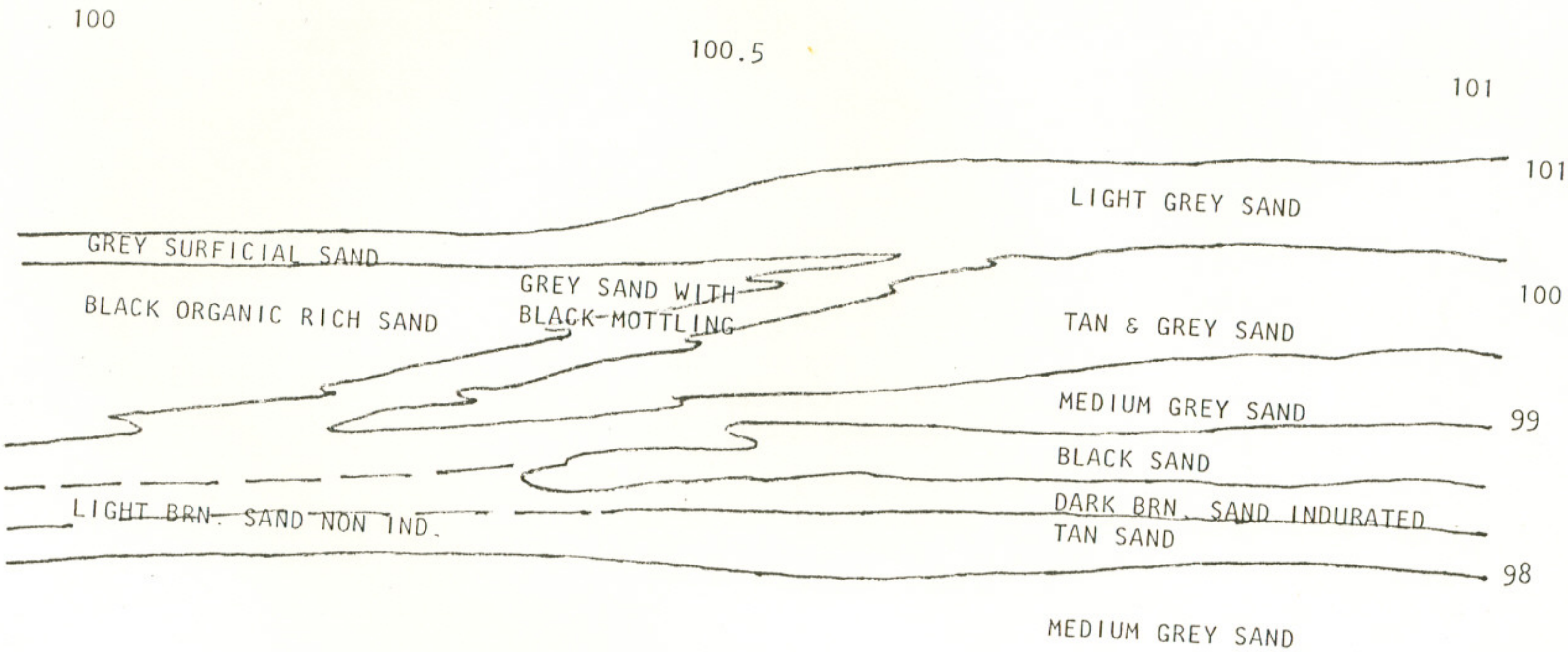
White, W.A., 1970. The Geomorphology of the Florida Peninsula. Geol. Bulletin #51. State of Florida Department of Natural Resources. Bur. of Geol., Tallahassee, Florida.

APPENDIX A

PLOT OF LAKE SHORE

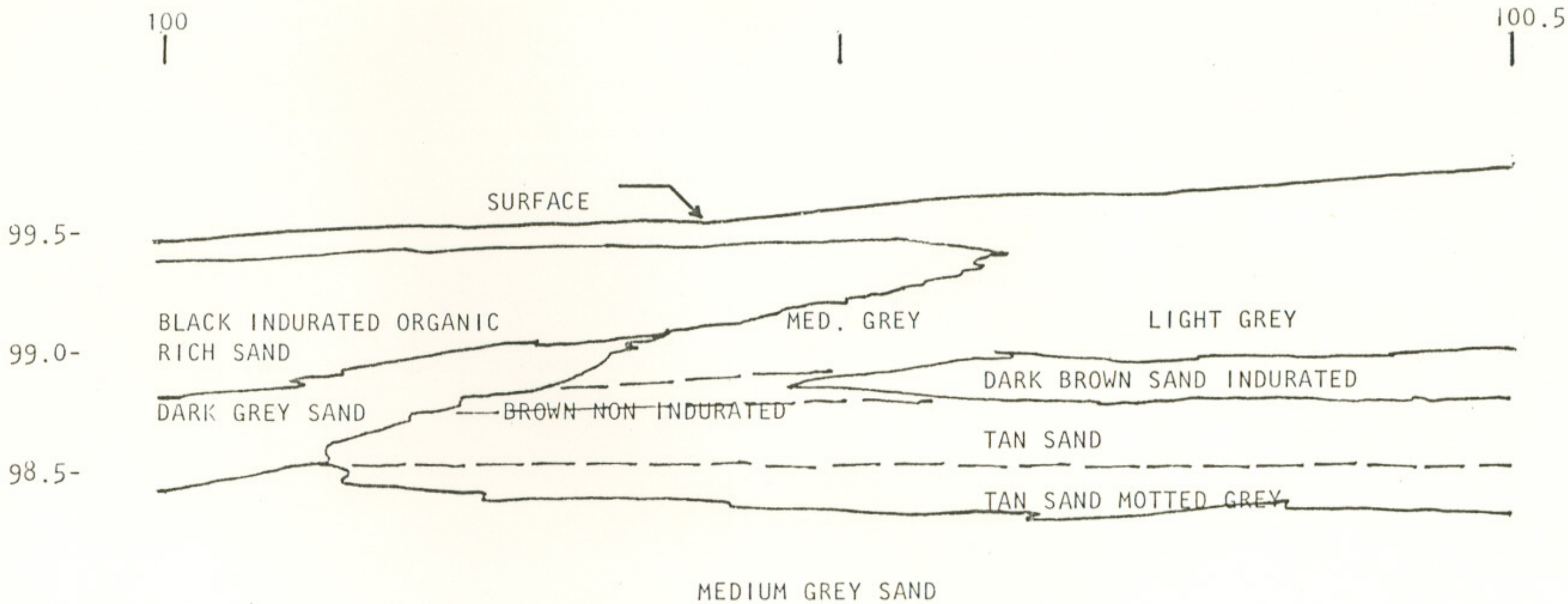
PROFILES ALONG BOTANICAL TRANSECTS

FIG. 1 CROSS SECTION OF SOIL PROFILES AT TR05



HOR. DISTANCE APPROX. 15 FT.

FIG. 2 GENERALIZED CROSS SECTION OF SOIL AT TR07



Sample	Item (T107H)	Depth	Color	% O.M.	Texture	Al	B	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Si	Zn	Mo	Sr	Ba
						DOUBLE ACID, ppm																			
20	T0tH 100	0-3	grey	15.4	sand	82.54	.1748	247.7	.0189	.0445	.0331	.0279	8.313	7.583	25.82	.4451	3.921	.1267	30.79	.4049	9.417	.4516	.3142	1.159	.3579
19	" "	3-7	grey	28	sand	82.54	.1467	101.8	.0170	.0540	.0427	.0276	10.97	3.114	9.122	.1407	2.746	.1148	47.66	.4564	7.620	.2790	.4921	.5320	.3398
16	" 100.5	0-6	white	5.7	sand	27.97	.1224	187.5	.0129	.0202	.0233	.0174	2.592	4.871	17.44	.3619	2.196	.0765	4.294	.2373	3.459	.4050	.2997	.9365	.4955
37	" "	6-9		1.5		6.356	.0449	36.43	.0125	.0175	.0201	.0198	1.818	1.088	2.770	.0323	1.046	.0897	1.962	.2790	5.613	.1824	.2278	.2473	.2469
40	" "	9-13 A		0.4		2.521	.0620	18.11	.0059	.0214	.0119	.0217	1.856	.8170	1.776	.0224	.9520	.0713	1.473	.3443	3.518	.1623	.2238	.1255	.1471
39	" "	13-16		1.0		16.50	.0439	27.85	.0152	.0229	.0169	.0218	2.024	1.088	2.706	.0327	1.195	.1052	4.755	.3829	2.171	.1915	.3341	.2039	.2919
45	" "	16-18		5.3		82.54	.0659	51.58	.0170	.0526	.0945	.0237	9.642	1.676	5.117	.1468	1.563	.0813	129.9	.8895	4.429	.1925	.9951	.2591	.3274
41	" "	18-20		1.4		82.54	.0664	13.83	.0160	.0459	.1023	.0227	10.04	1.475	1.365	.0655	1.246	.0502	132.5	.7773	8.722	.1526	.7581	.1855	.2873
38	" "	20-23		0.5		82.47	.0774	16.47	.0129	.0281	.0497	.0249	3.957	1.115	2.413	.0420	1.848	.0546	54.13	.4717	6.289	.4200	.3900	.1439	.2071
30	" "	24-28	yellow	1.0		12.88	.0848	104.1	.0165	.0752	.0464	.0265	19.55	2.185	16.51	.0476	1.326	.0806	14.59	.2865	15.57	.1448	.2310	.7753	.2674
T3H																									
33	100	0-3	white	12.9	sand	56.05	.0970	199.6	.0156	.0328	.0246	.0303	4.224	5.850	26.99	.2215	4.042	.1143	5.429	.3770	5.603	.4668	.3135	.8345	.3763
21	"	3-10 A	grey	8.2	sand	76.14	.0714	78.03	.0135	.0362	.0259	[illegible]	4.993	2.351	11.93	.0869	2.718	.1047	5.890	.3103	7.949	.2591	.2803	.5968	.2987
26	101	0-3	wh-grey	5.0	sand	10.52	.0681	110.2	.0083	.0119	.0144	.0026	1.892	2.038	9.292	.2233	.7714	.0378	2.626	.2618	1.917	.2952	.1872	.4057	.4813
15	"	3-7	white	1.5	sand	14.47	.0327	70.63	.0025	.0094	.0128	.0269	1.868	.9981	5.131	.0926	1.053	.0598	4.109	.2199	2.433	.2044	.1313	.3252	.4103
T6H																									
36	100	0-2	wh-yellow	5.4	sand	19.60	.0598	98.61	.0163	.0337	.0224	.0206	4.078	3.546	12.22	.2001	1.999	.0813	5.032	.3715	6.845	.3991	.2702	.3993	.4429
18	"	2-5	white	3.8	sand	75.01	.1017	68.57	.0212	.0335	.0166	.0304	5.941	3.036	7.857	.0926	2.458	.1143	9.363	.3042	10.78	.3752	.2371	.4062	.5071
29	100.5	0-2	white	7.7	sand	20.82	.2309	271.3	.0169	.0755	.0306	.0366	21.83	7.762	32.98	1.421	2.776	.1279	6.417	.3139	2.811	1.075	.1197	.9105	.3607
28	"	2-6	sgh-yellow	6.1	sand	28.56	.1038	118.5	.0254	.0411	.0224	.0074	8.013	2.637	12.58	.3666	1.177	.0909	5.909	.3662	6.275	.6828	.2195	.4796	.6386

TABLE 3 Lake Hancock Soil Sample Analyses

ample	Item	Color	O.M.	Texture	Al	B	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Si	Zn	Mo	Sr	Ba
					Water, ppm																			
20	Both (100) 0-3	grey	15.4	sand	1.325	.0933	7.283	-.0016	.0045	.0008	.0986	.2352	2.723	1.673	.0258	2.506	.0179	2.814	-.0974	1.816	.0352	.0863	.0234	.0057
19	" 3-7	grey	7.9	sand	1.212	.0877	4.201	.0030	.0050	.0023	.0988	.1474	.7228	.8433	.0002	1.470	.0186	1.808	.1400	1.000	.0111	.0599	.0175	.0043
16	" (100.5) 0-6	white	5.7	sand	.4808	.0837	4.300	.0045	.0051	.0217	.0982	.1757	1.892	1.036	.0257	1.098	.0190	2.719	.1820	.6786	.0029	.0508	.0175	.0040
37	" " 6-9		1.5		.0869	.0322	.9430	.0058	.0050	.0047	.0969	.0782	.1291	.1627	.0024	.3135	.0107	1.334	.2333	.3803	.0268	.0083	.0244	.0008
40	" " 9-13		0.4		.0716	.0466	.5954	.0067	.0050	.0035	.0989	.0687	.0491	.0900	-.0007	.1887	.0279	1.049	.0566	.3412	.0263	.1023	.0063	.0016
39	" " 13-16		1.0		.2700	.0260	1.057	.0002	.0050	.0009	.0975	.0644	.1973	.0083	.0014	.3637	.0105	2.096	.0085	.1671	.0261	.1414	.0063	.0030
45	" " 16-18		5.3		.4349	.0494	3.084	.0051	.0050	.0003	.0994	.0169	.2916	.7630	.0041	.7530	.0140	4.347	.1388	.7697	.0007	.1414	.0083	.0040
41	" " 17-20		1.4		.5876	.0418	1.325	.0067	.0064	.0034	.1015	.0004	.3657	.1824	.0002	.4008	.0256	2.881	.1191	.2842	.0212	.0827	.0083	.0130
38	" " 20-23		0.5		.4768	.0662	1.880	-.0051	-.0050	-.0015	-.0994	.0013	.3725	.5330	.0020	1.026	.0198	2.593	.1351	.1536	.0234	.0404	.0122	.0133
30	" " 24-28	yellow	1.0		11.9[illegible]	.0514	4.533	-.0020	.0081	.0150	-.0958	4.280	.6285	1.030	.0241	1.283	.0140	2.777	.0750	17 23	.0202	.0567	.2592	.0826
	T3H																							
33	(100) 0-3	white	12.9	sand	.9425	.0514	4.284	-.0034	-.0050	.0005	.0965	.2476	2.070	1.451	.0002	2.569	.0186	2.934	.0823	.8861	.0254	.1349	.0136	.0044
21	" 3-10	grey	8.2	sand	.7704	.0324	2.289	-.0005	.0076	.0003	.0973	.2783	.7798	.8255	.0010	2.105	.0134	1.724	-.0903	.8599	.0173	.1327	.0102	.0051
26	(101) 0-3	wh-grey	5.0	sand	.1691	.0427	2.241	-.0052	.0078	.0036	.0978	.0756	.9115	.4586	-.0007	.6278	.0233	2.358	-.1939	.2666	.0224	.0762	.0088	.0022
15	" 3-7	white	1.5	sand	.1465	.0203	2.621	-.0041	.0009	.0004	.0961	.0446	.2655	.4477	-.0001	.2966	-.0138	3.382	-.1937	.3019	.0224	.1097	.0078	.0030
	T6H																							
36	(100) 0-2	wh-yellow	5.4	sand	.3732	.0316	3.620	.0026	.0022	.0012	-.0960	.3052	1.219	1.114	.0057	.9580	.0097	3.033	-.1000	1.136	.0288	.1200	.0117	.0040
18	" 2-5	white	3.8	sand	1.094	.0629	2.963	.0019	.0049	.0013	.0765	.3939	.6092	.7560	-.0001	1.216	.0103	3.434	-.0662	1.122	.0165	.0706	.0122	.0057
29	(100.5) 0-2	white	7.7	sand	.4402	.1155	6.493	.0036	.0049	.0059	-.0959	.2340	3.042	1.506	.0202	1.669	.0184	3.617	-.2379	1.603	.0207	.0787	.0141	.0045
28	100.5 2-6	wh-yellow	6.1	sand	.5922	.0579	3.426	.0079	.0051	.0062	.0975	.2724	1.044	.8096	.0002	1.086	.0260	2.928	-.1355	.5049	.0189	.1037	.0088	.0033

TABLE 4: Lake Hancock Soil Sample analyses.