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Geology, Geohydrology And Soils Of Kennedy Space Center: A Review

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Geology, Geohydrology And Soils Of Kennedy Space Center: A Review

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John F. Kennedy Space Center

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Abstract

Sediments underlying Kennedy Space Center (KSC) have accumulated in alternating periods of deposition and erosion since the Eocene. Surface sediments are of Pleistocene and Recent ages. Fluctuating sea levels with the alternating glacial-interglacial cycles have shaped the formation of the barrier islands. Merritt Island is an older landscape whose formation may have begun as much as 240,000 years ago, although most of the surface sediments are not that old. Cape Canaveral probably dates from <7,000 years B.P. (before present) as does the barrier strip separating Mosquito Lagoon from the Atlantic Ocean. Merritt Island and Cape Canaveral have been shaped by progradational processes but not continuously so, while the Mosquito Lagoon barrier has been migrating landward.

Deep aquifers beneath KSC are recharged inland but are highly mineralized in the coastal region and interact little with surface vegetation. The Surficial aquifer has formed in the Pleistocene and Recent deposits and is recharged by local rainfall. Sand ridges in the center of Merritt Island are important to its recharge. Discharge is from evapotranspiration, seepage to canals and ditches, seepage into interior wetland swales, and seepage into impoundments, lagoons, and the ocean. This aquifer exists in dynamic equilibrium with rainfall and with the fresh-saline water interface. Freshwater wetlands depend on the integrity of this aquifer, and it provides freshwater discharge to the lagoons and impoundments.

Soils of KSC reflect the complexity of soil forming factors (parent material, topography, time, biota) on the landscape. Numerous soil series are represented. Within a given area, soils vary from well to poorly drained. On well drained sites of differing ages, leaching has modified soil properties. Parent material differences (sand, loam, clay, coquina) are also reflected in the soil pattern.

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Acknowledgments

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Introduction

Surficial geology and geologic history form the context under which the biota of a region has developed. The barrier island complex of Merritt Island-Cape Canaveral has a varying history of deposition and erosion with numerous geologic formations represented. In areas of low topographic relief and abundant rainfall such as that occupied by Kennedy Space Center (KSC), the groundwater system interacts dynamically with the surficial geology, vegetation, and soils. Soils form in the surficial geologic deposits. Their properties are influenced by geologic parent material, topographic position, particularly relations to the water table, the prevailing climate, the length of time over which they have formed, and interactions with the biota (Jenny 1941, 1980). In turn, soil properties influence the vegetation growing on a site.

In this report, we review information on the geology, geohydrology, and soils of KSC. Our focus is on those properties of importance to the biota, particularly vegetation, of the area. This is one in a series of reports summarizing information on current environmental conditions on KSC. Other reports will examine quantitative vegetation-soil relationships.

Geology

Merritt Island together with the adjacent Cape Canaveral form a barrier island complex. Topographic relief is slight; elevation ranges from sea level to about 3 m (10 ft) in the inland areas of Merritt Island and to slightly over 6 m (20 ft) on Cape Canaveral and the recent dunes. The topography is marked by a sequence of ridges and swales reflecting relict beach ridges.

Fenneman (1938) mapped the area as part of the East Florida Flatwoods Region of the Coastal Plain Province. Brooks (1981b) mapped the area as the Cape

Canaveral section of the Central Atlantic Coast Strip within the Eastern Flatwoods District.

Florida has a complex geologic history with repeated periods of deposition when the Florida Plateau was submerged and erosion when the seas recessed. The oldest formation known to occur beneath Brevard County, the Avon Park limestone, was deposited in the early (?) Eocene in an open ocean that received little sand or clay (Cooke 1945). This was followed by withdrawal of the sea and a period of erosion. In late Eocene, the seas advanced and limestones of the Ocala group were deposited in an open, fairly shallow sea (Cooke 1945). Following another period of recession of the sea and erosion of the land surface, the Hawthorn formation of calcareous clay, phosphatic limestone, phosphorite, and radiolarian clay was deposited in the late Miocene (Cooke 1945, Brown et al. 1962). Overlying this are unconsolidated beds of fine sand, shells, clay, and calcareous clay of late Miocene or Pliocene age (Brown et al. 1962); these may be equivalent to the Caloosahatchee Marl of Cooke (1945). Surface strata in Brevard County are primarily unconsolidated white to brown quartz sand containing beds of sandy coquina of Pleistocene and Recent (= Holocene) age (Brown et al. 1962). Formations are summarized in Table 1.

Surficial deposits of Merritt Island and Cape Canaveral are of Pleistocene and Recent ages and consist primarily of sand and sandy coquina. Pleistocene deposits on Merritt Island are sometimes mapped as the Anastasia formation of high energy beach and bar shelly sand, some dune sand, loose coquina, and very hard shelly limestone; this formation can have multiple cap rocks (Brooks 1981a). Cooke (1945) restricted the Anastasia formation to coquina cemented by calcium carbonate or iron oxide that ranged from coarse rock of unbroken shells to sandstone where the shells were reduced to "coral sand"; he noted that this formation occurred in Brevard County in a narrow strip of mainland facing the Indian River and at the southern end of Merritt

Table 1. Stratigraphic units of Brevard County, Florida.[1]

Geologic age	Stratigraphic Unit		Approximate thickness (ft) (m)	General Lithologic Character	Water-bearing properties
Recent / Pleistocene	Pleistocene and Recent Deposits		0 - 110 (0 - 33.5)	Fine to medium sand, coquina and sandy shell marl.	Permeability low due to small grain size, yields small quantities of water to shallow wells, principal source of water for domestic uses not supplied by municipal water systems.
Pliocene	Upper Miocene and Pliocene deposits (Caloosahatchee marl)		20 - 90 (6.1 - 27.4)	Gray to greenish gray sandy shell marl, green clay, fine sand, and silty shell.	Permeability very low, acts as confining bed to artesian aquifer, produces small amount of water to wells tapping shell beds.
Miocene	Hawthorn Formation		10 - 300 (3.0 - 91.4)	Light green to greenish gray sandy marl, streaks of greenish clay, phosphatic radiolarian clay, black and brown phosphorite, thin beds of phosphatic sandy limestone.	Permeability generally low, may yield small quantities of fresh water in re-charge areas, generally permeated with water from the artesian zone. Contains relatively impermeable beds, that prevent or retard upward movement of water from the underlying artesian aquifer. Basal permeable beds are considered part of the Floridan aquifer.
Eocene	Ocala Group	Crystal River Formation	0 - 100 (0 - 30.5)	White to cream, friable, porous coquina in a soft, chalky, marine limestone.	Floridan aquifer: Permeability generally very high, yields large quantities of artesian water. Chemical quality of the water varies from one area to another and is the dominant factor controlling utilization. A large percentage of the ground water used in Brevard County is from the artesian aquifer. The Crystal River Formation will produce large quantities of artesian water. The Inglis Formation is expected to yield more than the Williston Formation. Local dense, indurate zones in the lower part of the Avon Park Limestone restrict permeability but in general the formation will yield large quantities of water.
	Ocala Group	Williston Formation	10 - 50 (3.0 - 15.2)	Light cream, soft, granular marine limestone, generally finer grained than the Inglis Formation, highly fossil-iferous.	
	Ocala Group	Inglis Formation	70 + (21.3 +)	Cream to creamy white, coarse granular limestone, contains abundant echinoid fragments.	
	Avon Park Limestone		285+ (86.9+)	White to cream, purple tinted, soft, dense chalky limestone. Localized zones altered to light brown or ashen gray, hard, porous, crystalline dolomite.	

[1] Modified from Brown et al. (1962)

Island. Cape Canaveral and the active barrier beach are mapped as Holocene undifferentiated deposits of sand, shell, clay, marl, or peat (Brooks 1981a). These overlay upper Miocene or Pliocene deposits of unconsolidated beds of fine sand, shells, clay, and calcareous clay (Brown et al. 1962). In the northern section of Merritt Island, the Pliocene Tamiami formation has been identified; it includes a narrow band of shelly conglomerate or medium hard limestone (Edward E. Clark Engineers-Scientists, Inc. 1987c) [hereafter referenced as Clark]. Under these are the Hawthorn formation of Miocene age composed of calcareous clay, sandy phosphatic limestone, phosphorite, and radiolarian clay (Brown et al. 1962). Within KSC, two thin, discontinuous conglomerate limestone/sandstone beds occur within the Hawthorn formation (Clark 1987c). Below these are a series of limestones of Eocene age that include the Ocala group and the Avon Park limestone and also constitute the Floridan aquifer (Brown et al. 1962). Geologic cross sections for Merritt Island are given in Figures 1, 2, and 3; these figures were derived from data from numerous borings conducted in developing the space center (NASA 1986).

In addition to the sequences of sediments of varying age, the surface of Florida is marked by a series of terraces and former shorelines of varying ages. The number and ages of the terraces has been a matter of debate (Fenneman 1938, Cooke 1945, MacNeil 1950, Alt and Brooks 1965, Healy 1975). As summarized by Healy (1975), eight terraces are recognized: Hazelhurst (215-270 ft), Coharie (170-215 ft), Sunderland (100-170 ft), Wicomico (70-100 ft), Penholoway (42-70 ft), Talbot (25-42 ft), Pamlico (5-25 ft), and Silver Bluff (0-10 ft). Cooke (1945) considered these terraces to represent different interglacial periods of high sea level during the Pleistocene. However, Alt and Brooks (1965) concluded that the highest terrace (Hazelhurst, 215-270 ft) was probably of Miocene age, the terrace at 90-100 ft (Wicomico) was probably Pliocene, and the distinct shoreline at 25-30 ft (Pamlico) was definetly Pleistocene and

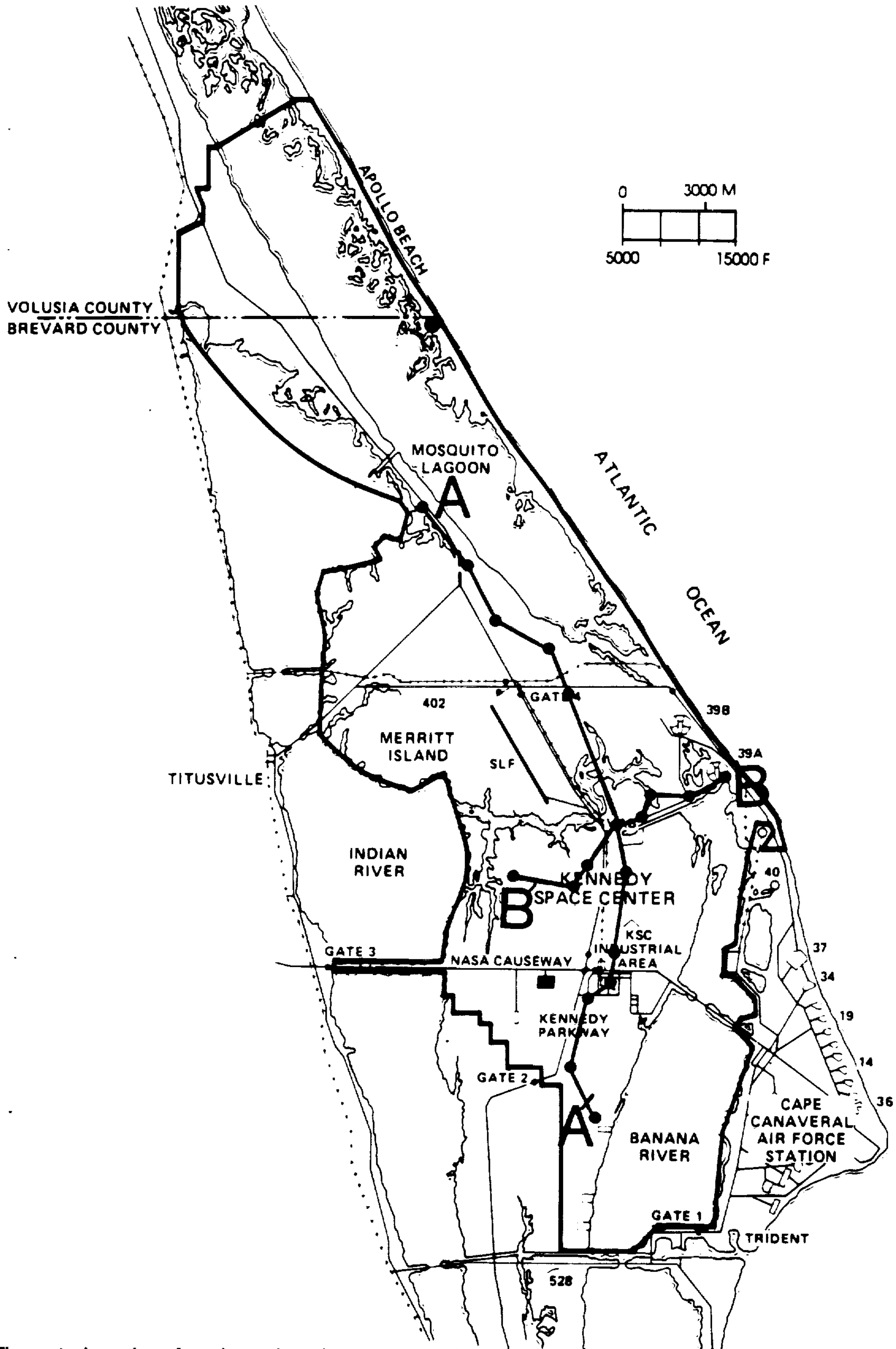

Figure 1. Location of north-south and east-west geologic cross sections on Kennedy Space Center (redrafted from Clark 1987c).

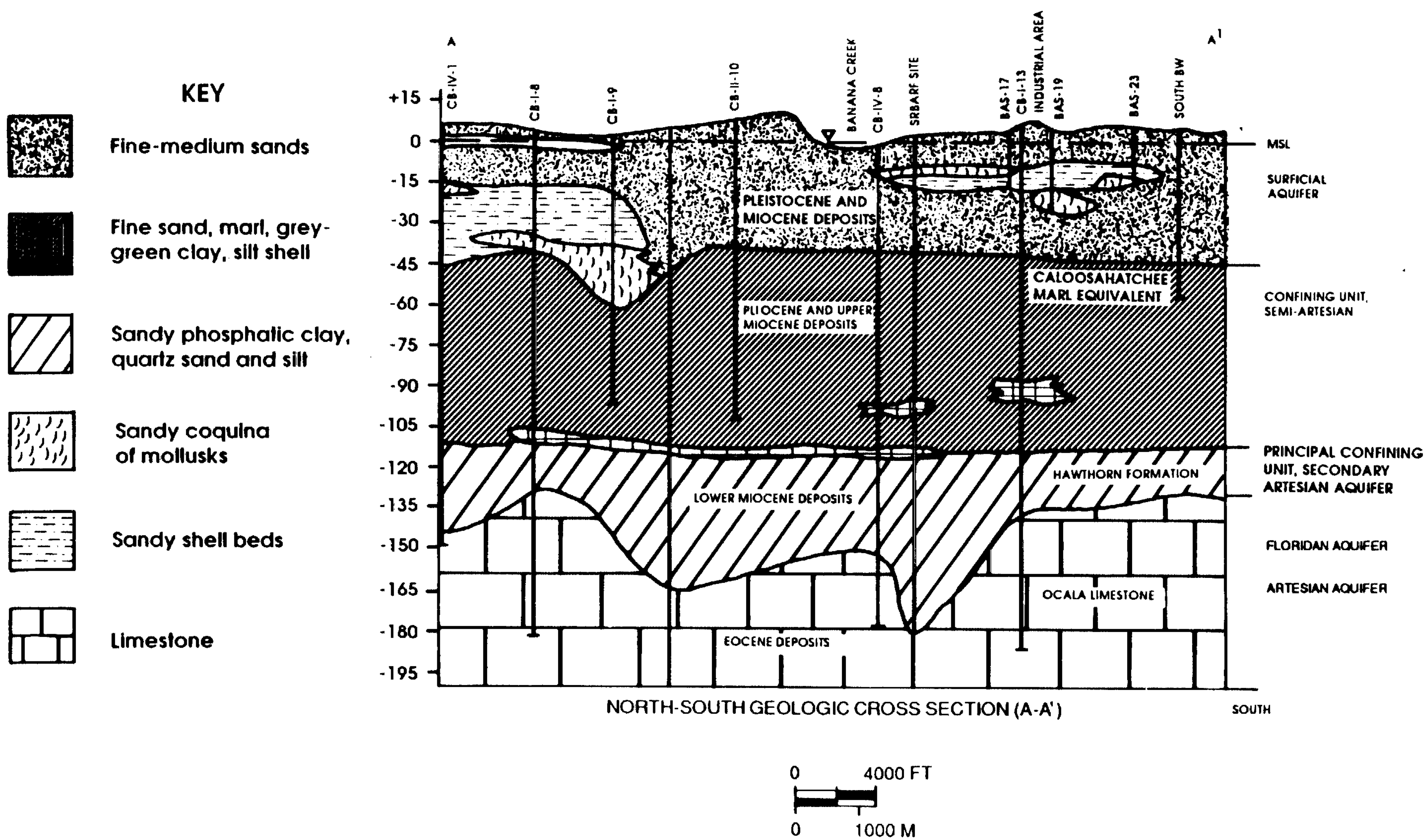

Figure 2. North-south geologic cross section, Kennedy Space Center (redrafted from Clark 1987c). Vertical scale is elevation in feet relative to mean sea level.

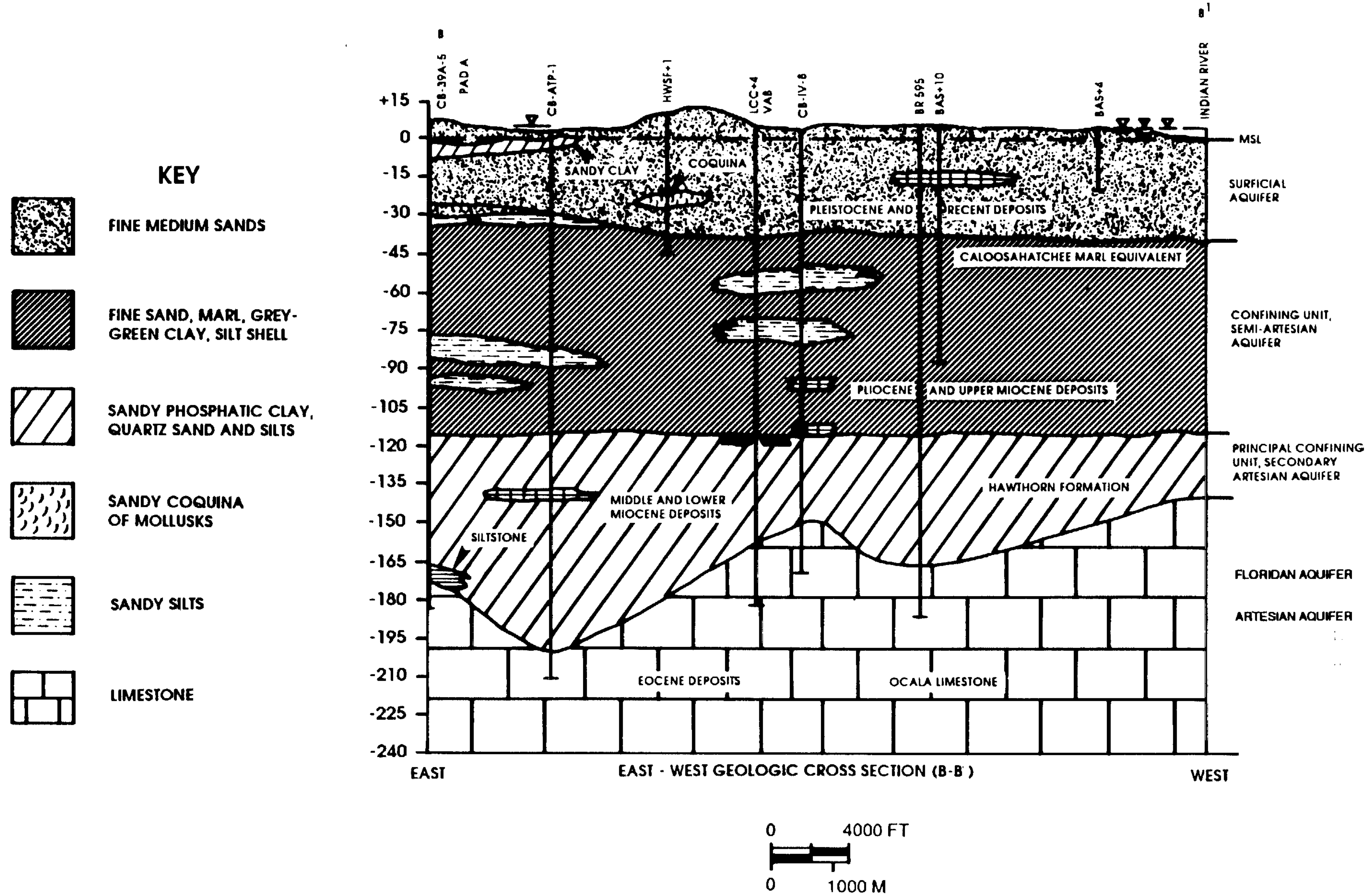

Figure 3. East-west geologic cross section, Kennedy Space Center (redrafted from Clark 1987c). Vertical scale is elevation in feet relative to mean sea level.

may have been occupied repeatedly. Healy (1975) mapped Merritt Island and Cape Canaveral as belonging to the Silver Bluff Terrace, while the Atlantic Coastal Ridge on the adjacent mainland belongs to the Pamlico Terrace.

During the Pleistocene, repeated glaciation of the northern hemisphere produced fluctuations in sea level (see Bowen 1978), while sea level rose with glacial retreat. At the maximum of the Wisconsinan glaciation (ca. 18,000 yr B.P.[before present]) sea levels were on the order of 100 m lower than present and substantial additional areas were exposed along the Atlantic and Gulf Coasts including Florida (Delcourt and Delcourt 1981).

The Cape Canaveral-Merritt Island barrier island complex is unique along the Florida coast; it is not associated with rivers or former deltas as are capes on the coast of the Carolinas (Hoyt and Henry 1970). White (1958, 1970) described this as a prograding barrier island complex. He considered Cape Canaveral to be the result of the southward (longshore) growth of an original cape at the site of the present False Cape. The eastern edge of Merritt Island at its contact with Mosquito Lagoon and the Banana River forms a relict cape coaxial with False Cape. Multiple dune ridges parallel to the present shore inland on Merritt Island apparently represent successive stages in this growth. White (1958, 1970) thought that this succession of cape formations was probably structurally controlled by some bedrock feature that influenced the southward movement of sediments along the coast. Hydrologic factors may also be involved. Brown et al. (1962) showed that the depth to the Eocene limestone formation below the land surface forms a ridge-like structure roughly conforming to the shape of Cape Canaveral, which may be the structure responsible for the cape formation. Chaki (1974) distinguished eleven distinct beach ridge sets on Cape Canaveral and suggested that periods of deposition and erosion have alternated; elevation of older ridges had been reduced by the dissolution of shell material. Brooks (1972) states that the geologic history of the Merritt Island-Cape Canaveral barrier islands is complex, and this is not a simple progradational feature developed during recent times. The older portion of Merritt Island consists of beach deposits > 240,000 years old (Brooks 1972). Previous dating of fossil beach rock, shells, or coquina (Osmond et al. 1970) gave recent ages on the current barrier beach, ca. 30,000 BP on Merritt Island, and ca. 110,000 BP on the adjacent mainland. Changes of sea levels from glacial eustatic ice water volume have occurred, and the Merritt Island-Cape Canaveral complex has grown by successive increments (Brooks 1972). Brooks (1981a) mapped Cape Canaveral as of Holocene age, mostly less than 4,500 BP, but Merritt Island as Pleistocene. He earlier suggested that the formation of the Cape Canaveral peninsula began about 7,000 years ago (Brooks 1972). Successively older landscapes occur westward on Merritt Island. Brooks (1972) related the western part of Merritt Island to the Yarmouth glacial period (ca. 240,000 years ago) and the eastern part to the Sangamon period (110,000 ± 20,000 years ago). Erosion has reduced the western side of Merritt Island to a nearly level plain (Brown et al. 1962) with karst features such as sinkholes not present on the eastern part of the island (Brooks 1972).

Mehta and Brooks (1973) considered the geologic history of Mosquito Lagoon and the barrier beach separating it from the Atlantic Ocean. They state that the seaward barrier initiated at the same time as the Cape Canaveral peninsula about 7,000 years ago. Unlike Cape Canaveral, the history of this barrier beach is marked by erosion, overwash, and landward migration rather than progradation; these processes continue today. They document that there have been five separate inlets between Mosquito Lagoon and the Atlantic Ocean within the last 6,000 to 7,000 years. The most recent one was in the vicinity of Turtle Mound and closed more than 1,500 years ago. Since then, Mosquito Lagoon has been accumulating fine grain sediments.

In the southern Indian River Lagoon, Bader and Parkinson (1990) documented the Holocene flooding of a Pleistocene topographic depression (paleolagoon) at about 5,000 - 6,000 years B.P.

Geohydrology

The geologic structure and composition of the Merritt Island-Cape Canaveral barrier island complex together with climatic conditions form the basis for the hydrology of the system. Groundwater hydrology of KSC has been the subject of recent studies (Edward E. Clark Engineers-Scientists, Inc. 1985, 1987a,b,c) [hereafter referenced as Clark]; the discussion that follows is based primarily on the areawide survey (Clark 1987c).

General characteristics of the groundwater system are given in Figure 4 and Table 2. The principal artesian aquifer beneath KSC is the Floridan aquifer which occurs within the Ocala limestones. Recharge areas for this aquifer are the high ridges of central Florida. This is a large and productive aquifer; however, in the coastal areas, as beneath KSC, the water is highly mineralized. This aquifer is confined by the silts and clays of the Hawthorn formation in most places. Secondary artesian aquifers occur within the Hawthorn formation and the Caloosahatchee Marl Equivalent. The Hawthorn Limestone aquifer is associated with thin, discontinuous beds of limestone, sandstone, and sand within the silts and clays of the Hawthorn formation. It is recharged by upward leakage from the Floridan aquifer. The Shallow Rock aquifer is associated with beds of partially consolidated shelly quartz sand with silt and grey clay and some medium hard limestone of the Tamiami formation or Caloosahatchee Marl Equivalent. Recharge is by upward leakage from the Floridan aquifer. The Semi-artesian Shell and Sand Bed aquifer is associated with minor, discontinuous sand and

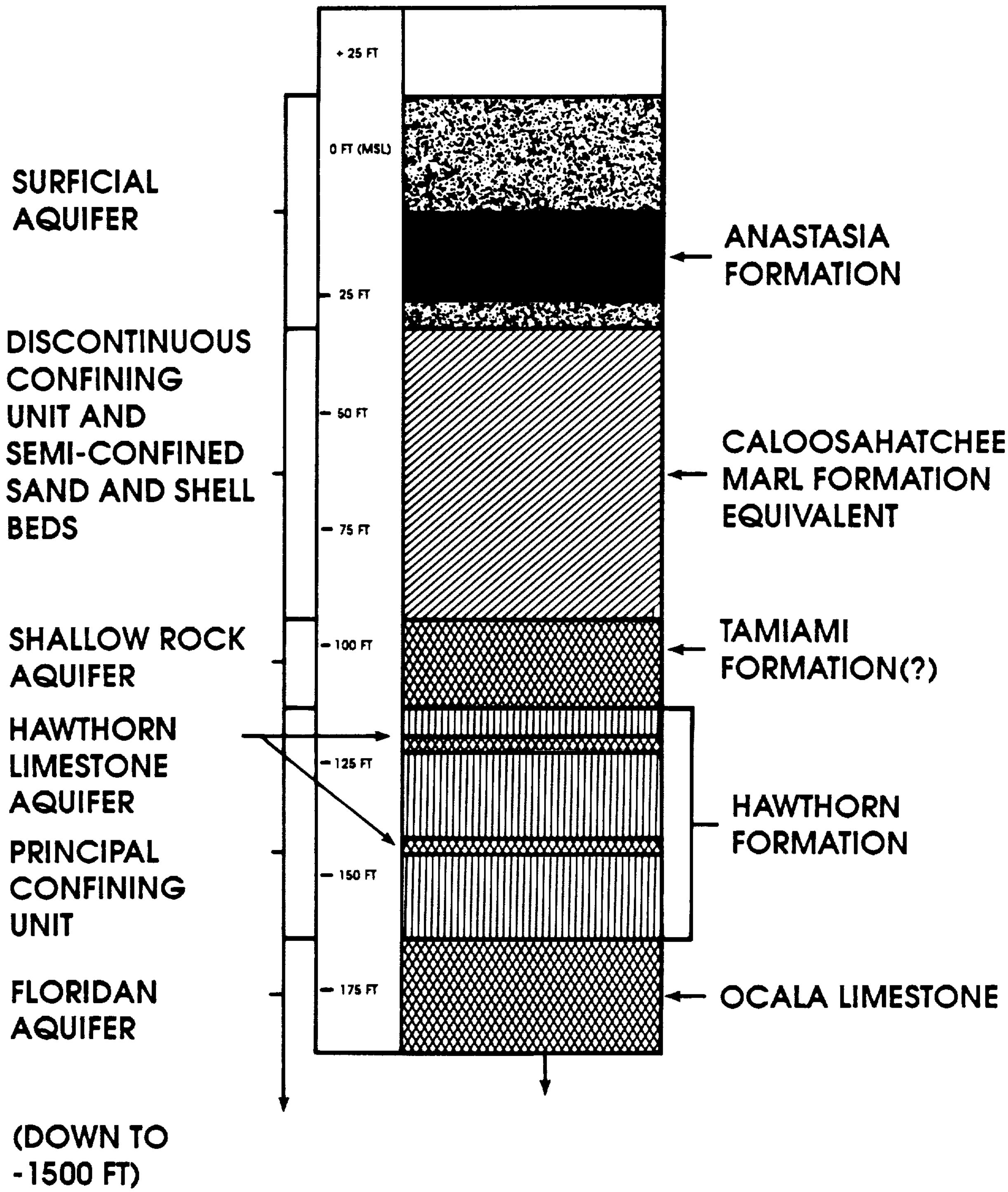

Figure 4. Geohydrologic units on Kennedy Space Center (redrafted from Clark 1987c).

Table 2. General characteristic of the aquifers on Kennedy Space Center.[1]

Aquifer	Geologic Strata	Recharge Areas	Discharge Area	Water Quality
Principal Artesian Aquifer:				
Floridan Aquifer	Eocene limestones-Ocala Group, Avon Park Formation	Central Florida - West Osceola, South Orange, and Polk Counties; Mims - Titusville ridge	Atlantic Ocean via offshore submarine springs, upward leakage where Hawthorn Formation thins	Highly mineralized, primarily chlorides
Secondary Artesian Aquifers:				
Hawthorne Limestone Aquifer	Thin beds of weathered limestone, sandstone, and sand within the Hawthorn Formation	Leakage upward from Floridan aquifer	(?)	Moderately brackish
Shallow Rock Aquifer	Tamiami Formation - shelly, partially consolidated quartz sand and some limestone	Leakage upward from Floridan aquifer	(?)	Brackish
Semi-artesian Shell and Sand Beds	Discontinuous sand and shell beds within Caloosahatchee Marl Equivalent	Little freshwater recharge, may act as conduits for sea-water intrusion	(?)	Moderately brackish, generally poorer than Floridan aquifer
Unconfined Water Table Aquifer:				
Surficial Aquifer	Pleistocene and Recent desposits - sand, shell, coquina, silt, and marl	Rainfall and direct infiltration, particularly that on central sand ridges of island	Drainage canals and ditches (11%), evapotranspiration including loss from swales (87%), seepage to impoundments, lagoons, and ocean (0.5%)	Fresh in center of island, becomes mineralized toward lagoons and ocean

[1] Data from Clark (1987c).

shell beds within the Caloosahatchee Marl Equivalent. There is little freshwater recharge of this aquifer, and it may act as a conduit for seawater intrusion. Both the Shallow Rock and Sand and Shell Bed aquifers are confined by less permeable sediments of the Caloosahatchee Marl Equivalent. The artesian aquifers have little direct influence on surface vegetation; however, artesian wells have been used to irrigate orange groves and previously to maintain water levels in some mosquito impoundments on Merritt Island (Clark 1987c).

The Surficial aquifer occurs in the saturated part of the moderately permeable Pleistocene and Recent deposits of fine to medium sand, shell, coquina, silts, and marl. Its upper boundary is the water table and the lower boundary is the confining unit at the base of the Pleistocene and Recent deposits. Recharge is by direct infiltration of rainfall. The higher sand ridges in the center of the island are particularly important for recharge (Figure 5). These ridges are relatively high, are composed of permeable sands, and infiltration is less restricted by subsurface hardpans than in other areas. Two important areas of sand ridges have been distinguished: the Happy Creek Sand Ridges north of Banana Creek and the Schwartz Road Sand Ridges south of Banana Creek. From these prime recharge areas, groundwater flows east and west toward the lagoon systems and the ocean (Figure 6). Discharge from the surface aquifer is from evapotranspiration, seepage into canals and ditches, seepage into interior wetland swales, and seepage into impoundments, lagoons, and the ocean. Most of the seepage into interior wetland swales is subsequently lost to evapotranspiration. Seasonal fluctations in the water table occur with changes in precipitation and evapotranspiration. The water table is highest late in the wet season (typically September-October) and drops as precipitation declines. In the winter, evapotranspiration is low as temperatures decline and some of the vegetation is dormant. In spring, evapotranspiration increases and the water table may decline

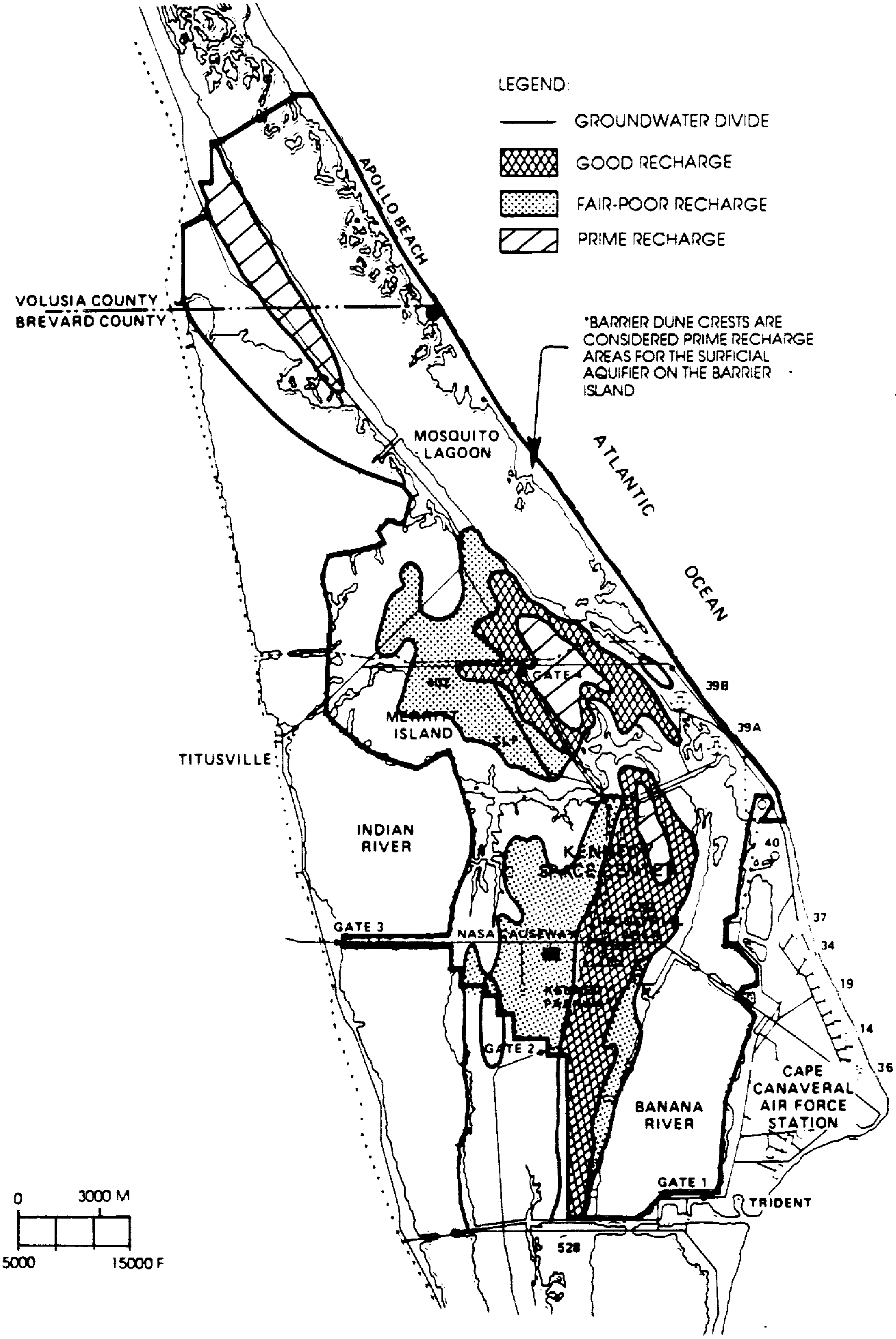

Figure 5. Potential for recharge of the Surficial aquifer (redrafted from Clark 1987c).

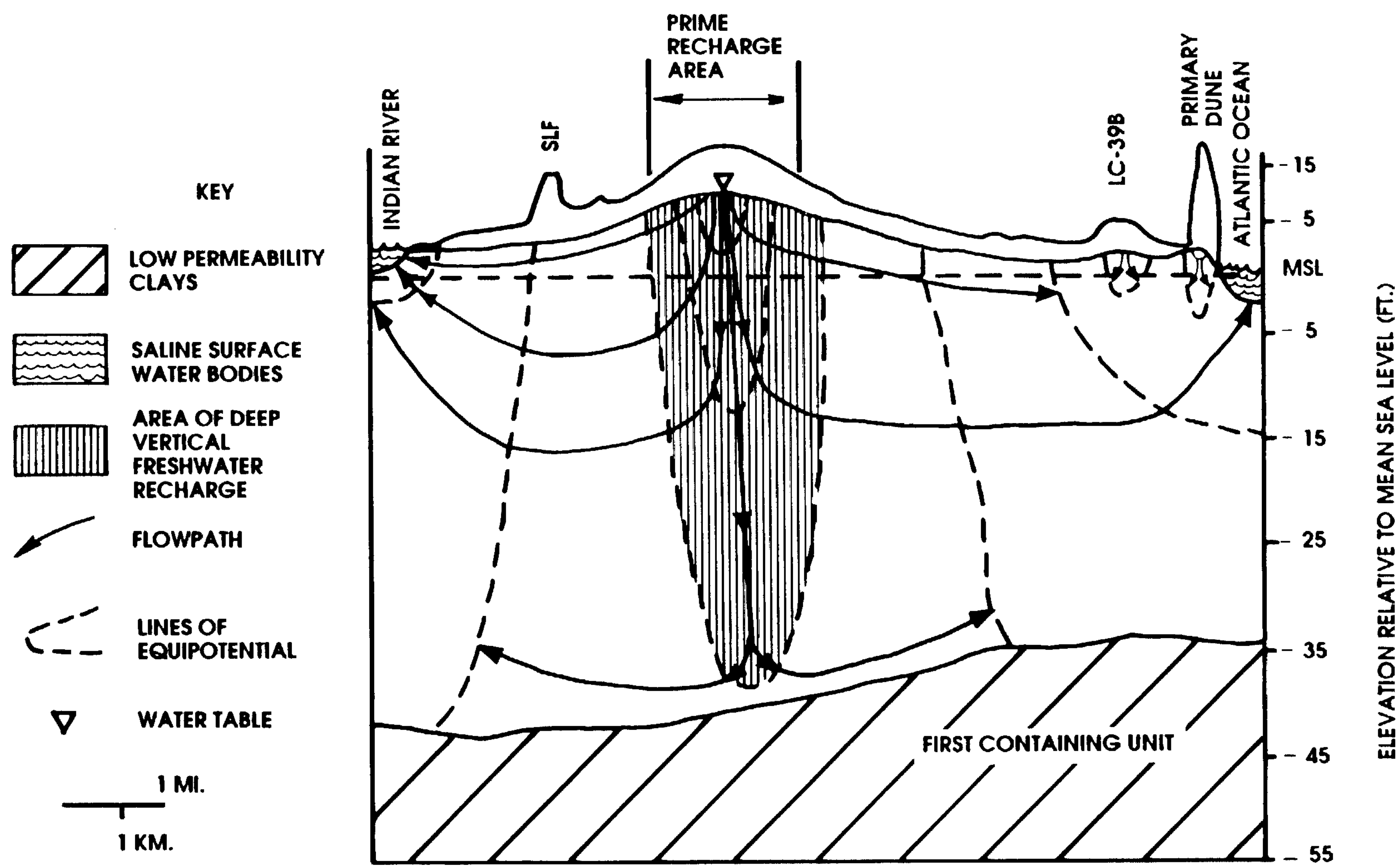

Figure 6. Groundwater circulation in the Surficial aquifer (redrafted from Clark 1987c).

during spring droughts. See Mailander (1990) for further discussion of precipitation and evapotranspiration patterns. The Surficial aquifer is extremely important since it supports the freshwater wetlands and provides fresh groundwater discharge to the surrounding subsaline lagoons (Clark 1987c).

The Surficial aquifer can be divided into several subsystems (Figure 7). The Barrier Island subsystem has a lens of freshwater less than 10 ft (3 m) thick on top of intruded saline water (Figure 8). The primary dune acts as the prime recharge area. Shallow groundwater flows east of the ridge to the Atlantic Ocean and west to Banana River, Mosquito Lagoon, or swales; at depth (> 20 ft [6.1 m]) flow is to the Atlantic Ocean. The Dune-Swale subsystem (Figures 7, 8) includes the high ridges with permeable sand that favor recharge. This is the only area where the freshwater recharge of the deeper layers of the surficial aquifer occurs (Figure 6). During most of the year, shallow groundwater discharges to the swales. At the beginning of the rainy season after the spring drought, swales collect water and remain flooded; lateral and downward seepage from the swales helps to recharge the groundwater. In areas of pine flatwoods and swales, topography is lower and most soils have well developed humic hardpans (spodic horizon, Bh layer) that restrict infiltration. During heavy rains, water perches above the hardpan and infiltrates slowly into the Surficial aquifer. This increases evapotranspiration and reduces recharge relative to the prime recharge areas. In the West Plain and Lowland subsystems (Figure 7, 8), the water table is typically within 3 ft (0.9 m) of the land surface, evapotranspiration losses are high, and the dispersed saline water interface renders water quality variable. In the West Plain south of Banana Creek, a limerock "hardpan" replaces the humic hardpan of the Dune-Swale flatwoods. Along the coastlines, the Surficial aquifer contacts the saline water of the Atlantic Ocean and the brackish lagoons. Seawater intrusion occurs as a wedge at the base of the Surficial aquifer since seawater is denser than fresh. The

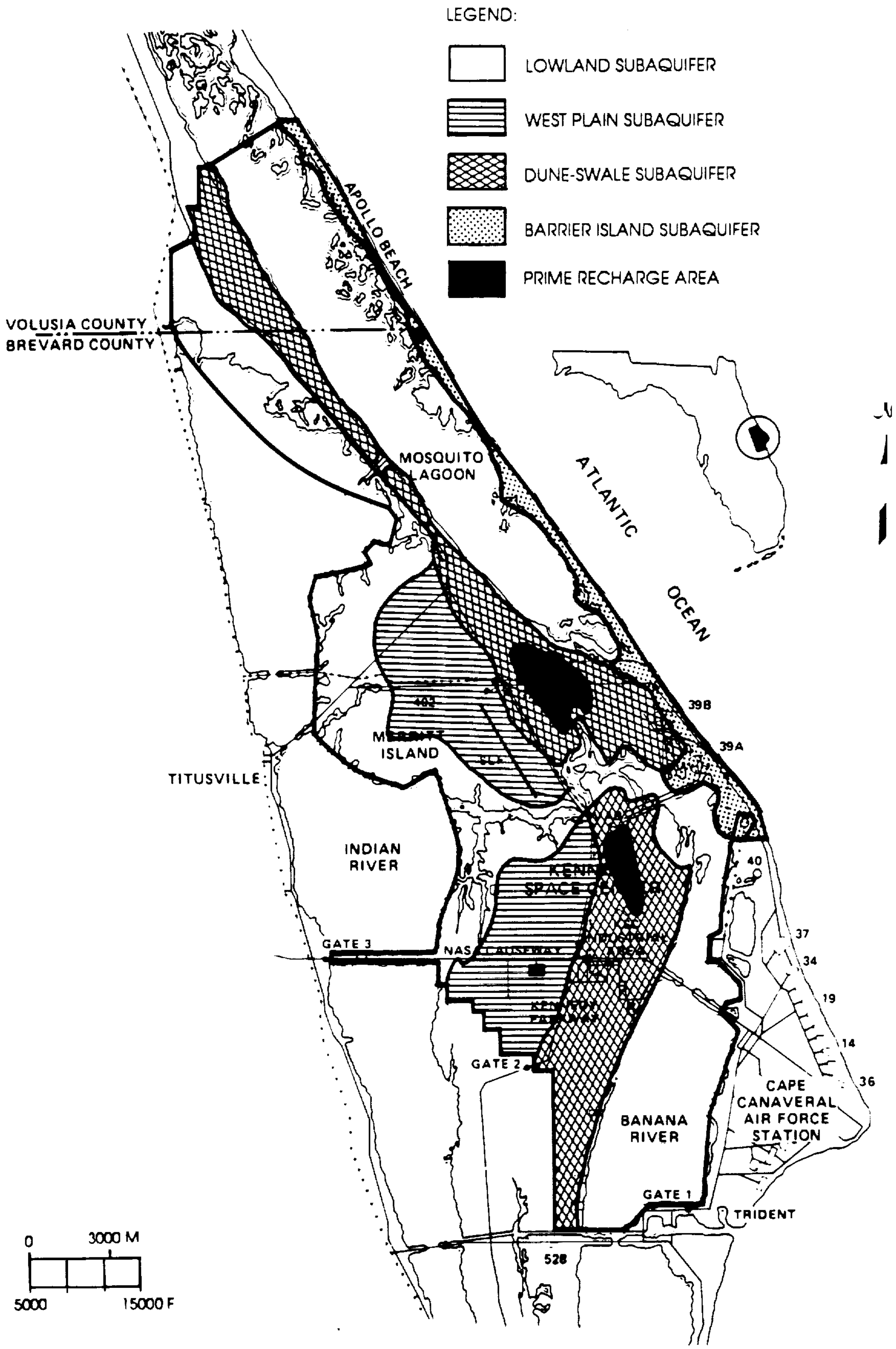

Figure 7. Subsystems of the Surficial aquifer (redrafted from Clark 1987c).

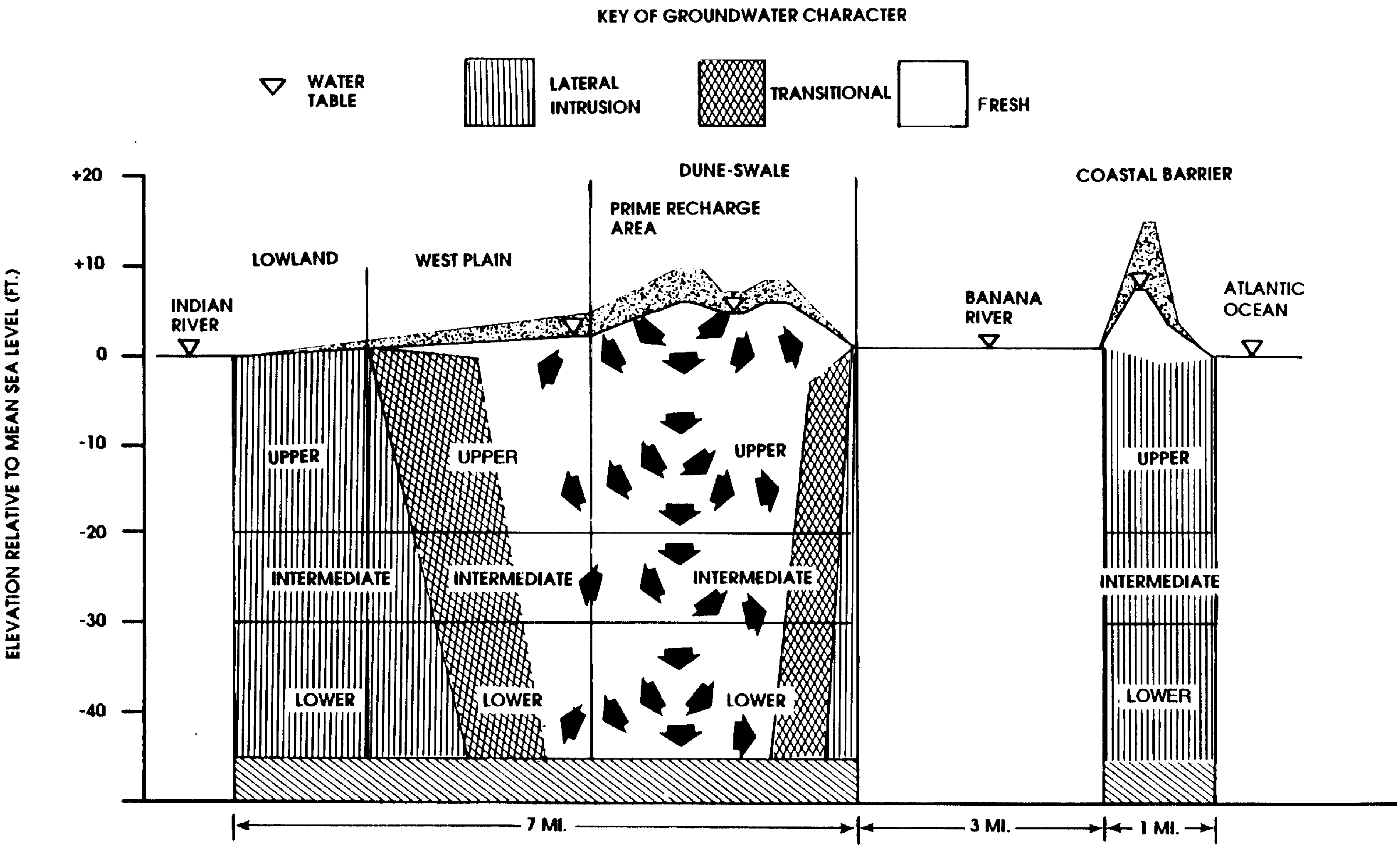

Figure 8. Chemical evolution of groundwater in the Surficial aquifer (redrafted from Clark 1987c).

position of the fresh-saline water interface fluctuates; when water levels are low saline water moves inland, and when they are high saline water is forced out, producing a dynamic system.

Soils

Soils differ through the interaction of several factors: climate, parent material, topography, organisms, and time (Jenny 1941, 1980). The soils of KSC are mapped in the soil surveys for Brevard County (Huckle et al. 1974) and Volusia County (Baldwin et al. 1980), and the resulting soil pattern is complex. Numerous soil series and land types are represented (Table 3), and these include representatives of many of the major soil groups (Table 4). This is interesting since Merritt Island is a relatively young landscape and one formed from coastal plain deposits. Some differences in soil parent material do occur (Table 5). In particular, soils that formed in deposits over limestone, coquina, or other alkaline material differ greatly in properties from those formed in sand. Textural differences in parent material such as that between loam or clay material and sand also influence soil properties.

Not all of the Cape Canaveral-Merritt Island complex is of the same age, as discussed earlier. Soils on Cape Canaveral, False Cape, and the barrier island section on the east side of Mosquito Lagoon are younger than those of Merritt Island and therefore have had less time to weather. Predominant well drained soil series (e.g., Palm Beach, Canaveral) in these areas still retain shell fragments in the upper layers, while those inland on Merritt Island (e.g., Paola, Pomello) do not. The presence of shell fragments influences soil nutrient levels, particularly calcium and magnesium, and pH. The eastern and western sections of Merritt Island differ in age. The eastern section of Merritt Island inland to about State Route 3 has a marked ridge-swale topography presumably retained from its formation as a barrier island, while

Table 3. Soil and land types occurring on Kennedy Space Center.[1]

Soil and Land Types	Area (acres)	Area (hectares)	Percent
Anclote sand	2494.7	1009.6	3.33
Astatula fine sand	592.0	239.6	0.79
Basinger sand	1130.2	457.4	1.51
Beaches	442.1	178.9	0.59
Bradenton fine sand, shallow variant	690.9	279.6	0.92
Bulow sand	58.3	23.6	0.08
Canaveral sand	396.5	160.5	0.53
Canaveral-urban complex	463.6	187.6	0.62
Canova peat	14.0	5.7	0.02
Chobee fine sandy loam	244.4	98.9	0.33
Cocoa sand	845.9	342.3	1.13
Copeland complex	4463.2	1806.2	5.96
Daytona sand	143.2	58.0	0.19
Felda and Winder	4569.6	1849.3	6.10
Felda and Winder, ponded	3949.9	1598.5	5.27
Floridana	95.0	38.4	0.13
Hydraquents	955.6	386.7	1.28
Immokalee sand	12882.9	5213.6	17.19
Myakka sand	4615.5	1867.9	6.16
Myakka sand, ponded	36.6	14.8	0.05
Myakka variant	67.8	27.4	0.09
Orsino fine sand	109.1	44.2	0.15
Palm Beach sand	1346.5	544.9	1.80
Paola fine sand	1221.6	494.4	1.63
Parkwood fine sand	138.7	56.1	0.19
Pineda fine sand	483.4	195.6	0.65
Placid fine sand, depressional	82.5	33.4	0.11
Pomello sand	2068.6	837.2	2.76
Pompano sand	757.7	306.6	1.01
Quartzipsamments	191.9	77.7	0.26
Riviera fine sand	111.4	45.1	0.15
St. Johns fine sand	3004.9	1216.1	4.01
St. Johns fine sand, ponded	1620.2	655.7	2.16
St. Lucie fine sand	6.5	2.6	0.01
Swamp	313.5	126.9	0.42
Submerged marsh	11418.9	4621.2	15.23
Tavares fine sand	40.4	16.3	0.05
Tidal marsh	1383.0	559.7	1.85
Tidal swamp	293.7	118.9	0.39
Turnball muck	554.4	224.4	0.74
Turnball variant sand	104.5	42.3	0.14
Tuscawilla fine sand	291.6	118.0	0.39
Urban land	1426.4	577.3	1.90
Wabasso fine sand	3665.9	1483.6	4.89

Table 3. (continued)

Soil and Land Types	Area (acres)	Area (hectares)	Percent
Winder loamy sand	6.9	2.8	0.01
Gravel pits and quarries	116.5	47.1	0.16
Spoil banks	364.5	147.5	0.49
Dikes	2316.1	937.3	3.09
Made land and other land	21.2	8.5	0.03
Transportation	2333.2	944.2	3.11
Total	74945.6	30330.1	

[1] Data derived from digitized soil map, base maps by Huckle et al. (1974) and Baldwin et al. (1980).

Table 4. Classification of Kennedy Space Center soil series.[1]

Series	Family	Subgroup	Order
Anclote	Sandy, siliceous, hyperthermic	Typic Haplaquoll	Mollisol
Astatula	Hyperthermic, uncoated	Typic Quartzipsamment	Entisol
Basinger	Siliceous, hyperthermic	Spodic Psammaquent	Entisol
Bradenton shallow variant	Fine-loamy, mixed, hyperthermic	Typic Ochraqualf	Alfisol
Bulow	Loamy, siliceous, hyperthermic	Typic Hapludalf	Alfisol
Canaveral	Mixed, hyperthermic	Aquic Udipsamment	Entisol
Canova	Fine-loamy, siliceous, hyperthermic	Typic Glossaqualf	Alfisol
Cassia	Sandy, siliceous, hyperthermic	Typic Haplohumod	Spodosol
Chobee	Fine-loamy, mixed, hyperthermic	Typic Argiaquoll	Mollisol
Cocoa	Sandy, siliceous, hyperthermic	Psammentic Hapludalf	Alfisol
Copeland	Fine-loamy, mixed, hyperthermic	Typic Argiaquoll	Mollisol
Daytona	Sandy, siliceous, hyperthermic	Entic Haplohumod	Spodosol
Felda	Loamy, siliceous, hyperthermic	Arenic Ochraqualf	Alfisol
Floridana	Loamy, siliceous, hyperthermic	Arenic Argiaquoll	Mollisol
Immokalee	Sandy, siliceous, hyperthermic	Arenic Haplaquod	Spodosol
Myakka	Sandy, siliceous, hyperthermic	Aeric Haplaquod	Spodosol
Myakka variant	Sandy, siliceous, hyperthermic	Aeric Haplaquod	Spodosol
Orsino	Hyperthermic, uncoated	Spodic Quartzipsamment	Entisol
Palm Beach	Carbonitic, hyperthermic	Typic Udipsamment	Entisol
Paola	Hyperthermic, uncoated	Spodic Quartzipsamment	Entisol
Parkwood moderately fine subsoil variant	Fine-loamy, mixed, hyperthermic	Mollic Ochraqualf	Alfisol
Pineda	Loamy, siliceous, hyperthermic	Arenic Ochraqualf	Alfisol
Placid	Sandy, siliceous, hyperthermic	Typic Humaquept	Inceptisol
Pomello	Sandy, siliceous, hyperthermic	Arenic Haplohumod	Spodosol
Pompano	Siliceous, hyperthermic	Typic Psammaquent	Entisol

Table 4. (continued)

Series	Family	Subgroup	Order
Riviera	Loamy, siliceous, hyperthermic	Arenic Glossaqualf	Alfisol
St. Johns	Sandy, siliceous, hyperthermic	Typic Haplaquod	Spodosol
St. Lucie	Hyperthermic, uncoated	Typic Quartzipsamment	Entisol
Tavares	Hyperthermic, uncoated	Typic Quartzipsamment	Entisol
Turnbull	Clayey over sandy or sandy-skeletal, montmorillonitic, nonacid, hyperthermic	Typic Hydraquent	Entisol
Turnbull variant	Mixed, hyperthermic	Aquic Udipsamment	Entisol
Tuscawilla	Fine-loamy, mixed, hyperthermic	Typic Ochraqualf	Alfisol
Wabasso	Sandy over loamy, siliceous, hyperthermic	Alfic Haplaquod	Spodosol
Winder	Fine-loamy, siliceous, hyperthermic	Typic Glossaqualf	Alfisol

[1] Classification from Huckle et al. (1974) and Baldwin et al. (1980).

Table 5. Parent material of Kennedy Space Center soil series.[1]

Soil Type	Parent Material
Anclote sand	Sandy marine sediments
Astatula fine sand	Marine or eolian sediments
Basinger sand	Sandy marine sediments
Bradenton fine sand, shallow variant	Sandy and loamy marine sediments over limestone
Canaveral sand	Marine sands and shell fragments
Canova peat	Thin deposits of herbaceous organic material over loamy marine sediments
Chobee fine sandy loam	Loamy marine sediments
Cocoa sand	Sandy marine or eolian sediments over coquina
Copeland complex	Beds of sandy and loamy marine sediments over limestone or coquina
Daytona sand	Beds of marine sand
Felda sand	Stratified marine sands and loamy material
Floridana sand	Sandy and loamy marine sediments
Immokalee sand	Beds of marine sand
Myakka sand	Beds of marine sand
Orsino fine sand	Deep beds of marine or eolian sand
Palm Beach sand	Thick deposits of marine sand and shell fragments
Paola fine sand	Thick beds of eolian sand
Parkwood fine sand	Sandy and loamy marine material over calcareous material
Pineda fine sand	Sandy and loamy marine material
Placid fine sand	Thick beds of sandy marine sediments
Pomello sand	Thick beds of marine sand
Pompano sand	Thick beds of marine sand
Riviera fine sand	Marine sands and clays over alkaline material
St. Lucie fine sand	Thick beds of marine or eolian sand
St. Johns fine sand	Marine sands
Tavares fine sand	Thick beds of sandy marine or eolian deposits
Turnbull muck	Clayey and sandy estuarine deposits
Turnbull variant sand	Deposits of sand and shells over estuarine deposits resulting from dredging
Tuscawilla fine sand	Sandy and loamy marine sediment and shells
Wabasso fine sand	Sandy marine sediments over loamy material
Winder loamy sand	Loamy marine material

[1] Huckle et al. (1974), Baldwin et al. (1980).

west of State Route 3, the island is flatter, without obvious ridges and swales probably due to the greater age of this topography.

Differences in age and parent material account for some soil differences, but on landscapes of Merritt Island with similar age, topography has a dramatic effect on soil formation. Relatively small elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoon systems influences soil salinity.

The major soil series and land types on KSC are discussed in Appendix I based on their general characteristics and occurrence on the KSC landscape. Quantitative soil data will be discussed in following reports.

Summary

1. Sediments underlying KSC have accumulated in alternating periods of deposition and erosion since the Eocene. Surface sediments are of Pleistocene and Recent ages. Fluctuating sea levels with the alternating glacial-interglacial cycles have shaped the formation of the barrier islands. Merritt Island is an older landscape whose formation may have begun as much as 240,000 years ago, although most of the surface sediments are not that old. Cape Canaveral probably dates from <7,000 years B.P. as does the barrier strip separating Mosquito Lagoon from the Atlantic Ocean. Merritt Island and Cape Canaveral have been shaped by progradational processes but not continuously so, while the Mosquito Laggon barrier has been migrating landward.

2. Deep aquifers beneath KSC are recharged inland but are highly mineralized in the coastal region and interact little with surface vegetation. The surficial aquifer has formed in the Pleistocene and Recent deposits and is recharged by local rainfall. Sand

ridges in the center of Merritt Island are important to its recharge. Discharge is from evapotranspiration, seepage to canals and ditches, seepage into interior wetland swales, and seepage into impoundments, lagoons, and the ocean. This aquifer exists in dynamic equilibrium with rainfall and with the fresh-saline water interface. Freshwater wetlands depend on the integrity of this aquifer, and it provides freshwater discharge to the lagoons and impoundments.

3. Soils of KSC reflect the complexity of soil forming factors (parent material, topography, time, biota) on the landscape. Numerous soil series are represented. Within a given area, soils vary from well to poorly drained. On well drained sites of differing ages, leaching has modified soil properties. Parent material differences (sand, loam, clay, coquina) are also reflected in the soil pattern.

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Appendix I

Descriptions of the Soil Series and Land Types on Kennedy Space Center

Descriptions of the Soil Series and Land Types on KSC

Anclote sand is a nearly level, very poorly drained, sandy soil in marshy depressions in flatwoods, broad areas on floodplains, and in poorly defined drainageways. In most years the water table is <10" (25 cm) for >6 months and seldom >40" (102 cm). These soils are occasionally flooded for 2-7 days after heavy rain (Huckle et al. 1974). On KSC, Anclote soils are primarily in swales in flatwoods and scrub and along drainageways.

Astatula fine sand is a nearly level to gently sloping, excessively drained, sandy soil on high undulating ridges. It has low organic matter content and low natural fertility. The water table is typically below 120" (305 cm). This series is better drained than Pomello and lacks the A2 and B horizons of Paola (Huckle et al. 1974). On KSC, this series is found primarily on the higher ridges north of Haulover Canal.

Basinger sand is a nearly level, poorly drained, sandy soil in sloughs of poorly defined drainageways and depressions in flatwoods. In most years, the water table is <10" (25 cm) for 2-6 months, between 10-40" (25-102 cm) for 6 months, and >40" (102 cm) for short periods in the dry season. This series is better drained than Anclote and lacks the weakly cemented Bh horizon of Immokalee (Huckle et al. 1974). On KSC, Basinger sand occurs primarily in swales in flatwoods and scrub.

Beaches are the narrow sandy strips along the Atlantic coast composed of fine to coarse sand mixed with multicolored shells and shell fragments. Sea water regularly overwashes the larger part of these areas at high tide but the higher areas only at equinoctal or storm-driven tides (Huckle et al. 1974).

Bradenton fine sand, shallow variant is a nearly level, poorly drained soil with limestone at a depth of ca. 40" (102 cm). The water table is <10" (25 cm) for 2-6 months, between 10-30" (25-76 cm) for >6 months, and >30" (76 cm) for short periods in the dry season. These soils may be flooded for 2-7 days once in 1-5 years. This series is better drained than Copeland (Huckle et al. 1974). On KSC, this series occurs mainly in the central and western parts of Merritt Island near areas mapped as the Copeland complex.

Bulow sand is a gently sloping, well drained, moderately deep, sandy soil underlain by differentially weathered coquina on narrow sand ridges. The water table is typically below 72" (183 cm) (Baldwin et al. 1980). Bulow sand occurs only to a minor extent on KSC (Table 3) and is found on ridges north of Haulover Canal.

Canaveral sand is a nearly level and gently undulating, moderately well drained, sandy soil mixed with shell fragments. The map unit consists of 60% Canaveral sand and 30% a more poorly drained Canaveral sand in sloughs between ridges with a thicker, darker surface layer and the water table closer to the surface for longer periods. Canaveral sand is not as well drained as Palm Beach but better drained than Anclote (Huckle et al. 1974). On KSC, Canaveral sand is found primarily on the coastal strip inland from Palm Beach sand. It is of modest extent on KSC (Table 3) but occupies most of Cape Canaveral.

Canova peat is a nearly level, very poorly drained soil with a peat surface layer and a loamy subsoil occurring on broad floodplains. The water table is <10" (25 cm) for 9-12 months, continuously flooded for 3-6 months, and >10" (25 cm) for short periods in the dry season. This series is more poorly drained than Felda and Winder soils and has an organic surface layer (Huckle et al. 1974). Canova peat is of minor extent on KSC (Table 3).

Chobee fine sandy loam is a nearly level, very poorly drained, loamy soil with a thick black surface layer that occurs in marshy depressions and floodplains. The water table is <10" (25 cm) for 6-9 months, between 10-40" (25-102 cm) for 3-6 months, >40" (102 cm) for short periods in the dry season, and may be flooded continuously for 1-6 months. This series is more poorly drained than Felda (Huckle et al. 1974). On KSC, a minor acreage (Table 3) of this series occurs on the central and western part of Merritt Island.

Cocoa sand is a nearly level and gently sloping, well drained, sandy soil over coquina. The water table is >72" (183 cm) all year (Huckle et al. 1974). On KSC, this series occurs primarily on low ridges north and south of Haulover Canal.

Copeland is a nearly level, sandy to loamy, very poorly drained soil on low flats underlain by limestone. The Copeland complex map unit consists of several nearly level, very poorly drained soils where the water table is <10" (25 cm) for >6 months, between 10-30" (25-76 cm) in the dry season, and flooded 7-30 days once in 5-20 years. Soils in the complex differ in depth to the limestone layer (Huckle et al. 1974). On KSC, this complex occurs mainly in the central and western part of Merritt Island west of State Route 3.

Daytona sand is a moderately well drained, nearly level to gently sloping soil on undulating sandhills or slightly elevated places in the flatwoods. The water table is between 40-50" (102-127 cm) for 1-4 months per year in the wet season and >72" (183 cm) in the dry season (Baldwin et al. 1980). On KSC, small areas of this series (Table 3) are mapped on ridges north of Haulover Canal in Volusia County.

Felda sand is a nearly level, poorly drained soil on broad low flats, in sloughs, depressions, and poorly defined drainageways. The water table is <10" (25 cm) for 2-6 months and between 10-40" (25-102 cm) for the rest of the year. Water may be above the surface for 2-7 days in 1-3 months per year. Depressions are flooded for >6 months per year (Huckle et al. 1974).

Felda and Winder soils consist of poorly drained soils in low sloughs and slightly higher hammocks. The map unit consists of about 65% sloughs and 35% hammocks. In the sloughs, the soils are 35% Felda, 30% Winder, and <20% Chobee, Floridana, and/or Wabasso. In the hammocks, the soils are 55% a soil similar to Wabasso but over limestone and the remainder a soil similar to Copeland (Huckle et al. 1974). These soils occur in low areas in flatwoods on the east side of Merritt Island and on low flats on the west side of the island.

Felda and Winder soils, ponded are the landward areas of former high tidal marsh impounded for mosquito control and now continuously flooded for >6 months per year. About 50% of the soils are Felda and 25% Winder (Huckle et al. 1974). This soil is also mapped in some of the large interior wetlands on KSC.

Floridana sand is a nearly level, very poorly drained soil in broad areas of floodplains and small to large marshy depressions. The water table is <10" (25 cm) for 6-9 months and between 10-30" (25-76 cm) for the rest of the year. This series is more poorly drained than Felda or Winder (Huckle et al. 1974). Only minor areas of this soil occur on KSC (Table 3).

Hydraquents are variable, silty, clayey, or loamy tidal deposits in mangrove swamps and islands. The outer edges experience tidal overwash daily, while the inner parts are slightly elevated and are inundated only during storms and equinoctal tides. Hydraquents are mapped in Volusia County (Baldwin et al. 1980); in Brevard County, the map unit of Tidal swamp is apparently equivalent (Huckle et al. 1974).

Immokalee sand is a nearly level, poorly drained, sandy soil in broad areas in flatwoods, low ridges between sloughs, and in narrow areas between sand ridges and lakes or ponds. The water table is <10" (25 cm) for 1-2 months, between 10-40" (25-102 cm) for >6 months, and >40" (102 cm) for short dry periods. It may be flooded for 2-7 days once in 1-5 years (Huckle et al. 1974). Immokalee is the one of the major soil series in flatwoods and scrub on KSC (Table 3).

Myakka sand is a nearly level, poorly drained, sandy soil in broad areas in flatwoods, low ridges between sloughs, and in narrow areas between sand ridges and lakes or ponds. The water table is <10" (25 cm) for 1-4 months, between 10-40" (25-102 cm) for >6 months, and >40" (102 cm) for short dry periods. It may be flooded for 2-7 days once in 1-5 years (Huckle et al. 1974). Myakka is an important series in flatwoods and wetter scrub on KSC (Table 3) where it is in lower areas than Immokalee.

Myakka sand, ponded is a nearly level, poorly drained, sandy soil in shallow depressions in flatwoods. It is similar to Myakka but is flooded for 6-12 months per year (Huckle et al. 1974). Only minor areas of this series occur on KSC (Table 3).

Myakka variant fine sand is a nearly level, poorly drained, sandy soil in swells in flatwoods and in slightly higher areas in hardwood hammocks near the coast. The water table is <10" (25 cm) in the rainy season. This series differs form Myakka in the fine sand texture and the presence of a neutral to alkaline IIC horizon with shell fragments (Baldwin et al. 1980). Small areas of this series (Table 3) occur in the northern section of KSC in Volusia County.

Orsino fine sand is a nearly level, moderately well drained, sandy soil on moderately low ridges and between high ridges and poorly drained areas. The water table is between 40-60" (102-152 cm) for >6 months, during dry periods it is >60" (152 cm), and during wet periods between 20-40" (51-102 cm) for 7 days to 1 month (Huckle et al. 1974). Small areas of this soil (Table 3) occur on ridges in the central part of Merritt Island.

Palm Beach sand is a nearly level and gently sloping, excessively drained soil on dune-like ridges that roughly parallel the Atlantic Ocean and consists of mixed sand and shell fragments. The water table is >120" (305 cm). This series is better drained than Canaveral sand (Huckle et al. 1974). On KSC, it occurs on the recent dunes inland from the beaches.

Paola fine sand is a nearly level to strongly sloping, excessively drained, sandy soil of the tops and sides of ridges. This series is better drained than Orsino and much better drained than Immokalee or Myakka (Huckle et al. 1974). On KSC, this series occurs on the higher ridges in the center of Merritt Island and on ridges north of Haulover Canal.

Parkwood fine sand is a nearly level, poorly drained soil with a loamy subsoil occurring in hammocks along streams, poorly defined drainageways, and depressions. The water table is <10" (25 cm) for 2-4 months per year in wet periods, and between 10-30" (25-76 cm) the rest of the year. The soil may be flooded for 7 days to 1 month once in 1-5 years (Huckle et al. 1974). Small areas of this series (Table 3) occur on KSC, generally near the Copeland complex.

Pineda fine sand is a nearly level, poorly drained, sandy soil in broad low flats in the flatwoods, in poorly defined drainageways, and at the edges of sand ponds and swamps. The water table is <10" (25 cm) for 1-6 months; some areas have standing water for 7 days to 6 months in some years (Huckle et al. 1974).

Placid fine sand, depressional is a very poorly drained, nearly level soil in wet depressions. The water table is above the surface for >6 months per year. This series is lower and more poorly drained than Myakka or St. Johns (Baldwin et al. 1980). Minor areas of this series occur on KSC (Table 3).

Pomello sand is a nearly level, moderately well drained, sandy soil on broad low ridges and low knolls in the flatwoods. The water table is between 30-40" (76-102 cm) for 2-4 months per year and between 40-60" (102-152 cm) for >6 months per year. This series is better drained than Immokalee or Myakka but more poorly drained than St. Lucie (Huckle et al. 1974). On KSC, Pomello sand is primarily on the broader ridges of central Merritt Island.

Pompano is a nearly level, poorly drained, sandy soil on broad flats, in shallow depressions, and in sloughs. The water table is <10" (25 cm) for 2-6 months per year, between 10-40" (25-102 cm) for >6 months per year, and >40" (102 cm) in the dry season (Huckle et al. 1974).

Quartipsamments are nearly level to steeply sloping soils reworked by earthmoving equipment. The soil material is derived from a variety of sandy soils (Huckle et al. 1974).

Riviera fine sand is a poorly drained, nearly level soil in broad low flats. The water table is <10" (25 cm) for 2-6 months per year and >40" (102 cm) for ca. 6 months per year (Baldwin et al. 1980). Minor areas of this series (Table 3) occur in the northern part of Merritt Island in Volusia County.

St. Johns sand is a nearly level, poorly drained, sandy soil on broad low ridges in the flatwoods. The water table is <10" (25 cm) for 2-6 months per year and between 10-40" (25-102 cm) the rest of the time. During extended dry periods it may be >40" (102 cm), and the soils may be flooded for 2-7 days following heavy rain (Huckle et al. 1974). This series occurs in low swales in the flatwoods and scrub on the eastern part of Merritt Island and in low flats on the western part of the island.

St. Johns soils, ponded are in sloughs, poorly defined drainageways, and shallow intermittent ponds in the flatwoods. The water table is <10" (25 cm) for 6-12 months per year, and they may be flooded for >6 months per year (Huckle et al. 1974). On KSC, this series is primarily in swales in flatwoods and scrub.

St. Lucie fine sand is a deep, nearly level to strongly sloping, excessively drained, sandy soil on high dune-like ridges and isolated knolls. The water table is below 120" (305 cm) (Huckle et al. 1974). Only minor areas of this soil occur on KSC (Table 3).

Spoil banks are piles of soil material dug from large ditches and canals or dredged from ship channels in the Indian River. On the mainland, spoil banks occur as long, narrow areas adjacent to the ditches and canals from which they were dug. In the Indian River, they occur as scattered islands near the ship channel from which they were dredged. Properties of spoil banks vary depending on the material from which they were taken (Huckle et al. 1974).

Swamp includes nearly level, poorly drained and very poorly drained areas of soils with dense cover of wetland hardwoods, vines, and shrubs in poorly defined drainageways, depressions, and large bay heads. They are flooded with freshwater most of the time. The soil pattern is intricate, varied, and impractical to map separately and includes Anclote, Basinger, Pompano, Terra Ceia, and Tomoka soils (Huckle et al. 1974). On KSC, this series occurs in swales and along drainages.

Submerged marsh is the mapping unit used for areas on the lagoonward side of marshes impounded for mosquito control (Huckle et al. 1974). These are now flooded for much of the year; they may be primarily open water or may still support some marsh vegetation.

Tavares fine sand is a nearly level and gently sloping, well drained, sandy soil on narrow to broad, moderately low ridges. The water table is between 40-60" (102-152 cm) for >6 months per year and >60" (152 cm) in the dry season. This series is better drained than Immokalee or Myakka but less well drained than Astatula, Paola, or St. Lucie (Huckle et al. 1974). Only minor areas of this series occur on KSC (Table 3).

Tidal marsh includes nearly level areas of soils covered with salt or brackish waters at high tide. Soils are highly variable and include shallow mucky sands over marl or limestone, irregularly stratified mixed sand and shell fragments, silty or clayey layers over sand and shells, and deep organic material (Huckle et al. 1974). Tidal marsh is mapped in Brevard County for marsh areas adjacent to the lagoon systems (Indian River, Banana River, Mosquito Lagoon) that are not impounded.

Tidal swamp includes nearly level areas at about mean sea level covered with dense tangled growth of mangrove trees and roots. Soil material ranges from mixed sand and shells to organic material (Huckle et al. 1974). This type is mapped in Brevard County for mangrove islands in Mosquito Lagoon and the Banana River and for other unimpounded areas of mangroves adjacent to the lagoon systems.

Turnbull muck is a very poorly drained soil formed in clayey and sandy estuarine deposits near sea level and periodically flooded by tidal overwash (Baldwin et al. 1980). This series is mapped in marshes bordering the Indian River and Mosquito Lagoon in the Volusia County section of KSC.

Turnbull variant sand consists of mixed sandy and shelly material dredged from the Intracoastal Waterway and placed in narrow strips along it over underlying material of organic deposits and layers of clayey and sandy estuarine deposits (Baldwin et al. 1980). Minor areas (Table 3) of this soil are mapped in the Volusia County section of KSC. It appears to be similar or identical to the Spoil bank type in Brevard County (Huckle et al. 1974).

Tuscawilla fine sand is a nearly level, poorly drained soil in broad hammocks near the coast. The water table is <10" for 2-6 months per year (Baldwin et al. 1980). Areas of this soil are mapped in the northern part of Merritt Island in Volusia County.

Urban land consists of areas that are 60 to >75% covered with streets, buildings, parking lots and similar structures (Huckle et al. 1974).

Wabasso loamy sand is a nearly level, poorly drained, sandy soil on broad areas in the flatwoods and on low ridges in the flatwoods. The water table is <10" (25 cm) for 1-2 months per year and <30" (76 cm) most of the time; during the dry season it may be >30" (76 cm) for short periods. These soils may be flooded for 2-7 days once in

1-5 years (Huckle et al. 1974). On KSC, this series occurs on broad flats on the western side of Merritt Island.

Winder sand is a nearly level, poorly drained, sandy soil in low areas and on low ridges. The water table is <30" (76 cm) most of the time and <10" (25 cm) for 2-6 months per year. During short, dry periods it may be >30" (76 cm); these soils may be flooded occasionally for 2-7 days (Huckle et al. 1974). Only small areas of this soil are mapped separately on KSC (Table 3); others are included in the Felda and Winder class.

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KENNEDY SPACE CENTER

16. Abstract

Sediments underlying KSC have accumulated in alternating periods of deposition and erosion since the Eocene. Surface sediments are of Pleistocene and Recent ages. Fluctuating sea levels with the alternating glacial-interglacial cycles have shaped the formation of the barrier islands. Merritt Island is an older landscape whose formation may have begun as much as 240,000 years ago, although most of the surface sediments are not that old. Cape Canaveral probably dates from ≤7,000 years B.P. (before present) as does the barrier strip separating Mosquito Lagoon from the Atlantic Ocean. Merritt Island and Cape Canaveral have been shaped by progradational processes but not continuously so, while the Mosquito Lagoon barrier has been migrating landward.

Deep aquifers beneath KSC are recharged inland but are highly mineralized in the coastal region and interact little with surface vegetation. The Surficial aquifer has formed in the Pleistocene and Recent deposits and is recharged by local rainfall. Sand ridges in the center of Merritt Island are important to its recharge.

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