# APPENDIX C:
# GEOMORPHOLOGIC INVESTIGATION REPORT

*DRAFT*

# Phase I Geoarchaeological Field Investigations of the DelDOT, Frederica (S.R. 1) Interchange Project, Murderkill Hundred, Kent County, Delaware.

For

A D. Marble & Company
375 Elm Street, Suite 200
Conshohocken, PA 19428

Submitted By

Daniel R. Hayes
Hayes & Monaghan, Geoarchaeologists
125 Bennington Road
Charlottesville, VA 22901
(434) 295-3610
drhayes@ivpc.net

May 6, 2004

*Introduction*

Geoarchaeological field evaluations associated with the proposed DelDOT, Frederica (S.R. 1) Interchange Project were conducted April 21, 2004 in Kent County. The project area included a section of shallow valley dissected by the Murderkill River and tributary Spring Creek. Geomorphological testing within the landform components of the Area of Potential Effect (APE) centered upon the examination of exposed surface sediments and several test excavation units.

A primary goal of this evaluation was to investigate the depositional history of the APE to formulate an initial model of landform history, an evaluation of site context, and an assessment of potential for inclusion of buried archaeological site components. This investigation identified a potential for the preservation of buried archaeological components within eolian sediments. Near-surface archaeological resources were also noted to be in relatively good context.

*Environmental Background*

The project APE occurs within well-drained, sandy-textured, Pleistocene uplands north of the Murderkill River within the Coastal Plain physiographic region of the Delmarva Peninsula. (Figure 1). Surficial deposits are Pleistocene in age, up to 10 m thick and rest on semi-to-poorly consolidated Miocene-age, gray, diatomaceous-to-sandy, fossiliferous bedrock of the Calvert Formation (Pickett and Benson 1983). The upper meter of near-surface deposits exhibit advanced soil formation (pedogenesis).

Upland topography in eastern Kent County forms a relatively flat surface that slopes gently toward Delaware Bay. Near the bay, this upland is at an altitude of 3-5 m above sea level (masl), while further west it rises to 15-18 masl. This plain is mainly Pleistocene in age (Jordan 1964; Pickett and Benson 1983; Groot and Jordan 1999) and has been dissected by a trellised drainage system of east-west to northwest-southeast flowing streams. The upland constitutes the interfluves within this drainage system. The mouths of the dissecting streams at the bay (including the Murderkill) have been drowned, are commonly up to 2 km wide, and today contain extensive, fine-grained, organic-rich tidal marsh deposits (Kraft 1971). These marsh deposits are thickest near the bay, and thinnest near the upstream limits of tidal influence.

*Upland History, Morphology and Soils.*

During the past decade, the nomenclature, age, and stratigraphic relationships of late-Cenozoic surficial deposits comprising the coastal plain of Delaware have undergone revision (Groot and Jordan 1999). Previously, these mainly coarse-grained, sandy deposits were defined as various depositional facies of the Columbia Formation and were believed to generally represent only a single phase of late Pleistocene deposition (see Jordan 1964, 1974, Kraft 1971). More recent researchers, however, have separated the Columbia Formation (Fm.) in Kent County into the Delaware Bay Group, which is confined to within about 10 km of Delaware Bay and made up of the Lynch Heights Fm. and Scotts Corners Fm., and the Columbia Fm., which lies mainly west of Dover (Groot and Jordan 1999). Columbia Formation is reportedly middle Pleistocene in age (>300 thousand years before present; kyBP) while the Delaware Bay Group is late Pleistocene and mainly Sangamon-to-late-Wisconsinan (<100 kyBP; Groot and Jordan 1999). A net result of Pleistocene depositional processes was the concentration of extraordinary gravel resources within the local area, which are mined for aggregate. One sand and gravel quarry is mapped approximately 1.5km NE of the project APE (Figure 1).

The eroded upland terrace comprising the APE consists of a fining-upward sequence of fluvial and near-shore gravels, sands and silty-sands deposited by alluvial processes that occurred during the Pleistocene. However, since initial deposition, eolian processes have resulted in the redistribution of surficial fine-grained sediments within Kent County. These are evident from the identification of extant surface landforms that include blowouts (erosional features) and dunes (constructional features). The existence of intervening sand sheets is less obvious but no less probable.

The possibility that eolian processes have occurred during the Holocene period of human occupation of the Delmarva Peninsula has been addressed from both the standpoint of landform history (Denny and Owens 1979, Stolt and Rabenhorst 1987, Daniels 1995), and archaeological site genesis (Hayes and Monaghan, 2001, Ward and Bachman 1987, Kellog and Custer 1994, 1994, Blume 1995, Custer et al 1996, Petraglia et al 1998). While establishing a definite chronology for eolian activity is somewhat difficult, several distinct periods and preconditions have been suggested. Many upland dune features (Denny et al 1979) and Carolina Bays (Stolt and Rabenhorst 1987) are often attributed to late Pleistocene conditions when strong, dune-building winds originated from the northwest (Denny and Owens 1979). Dunes flanking rivers are thought to differ from upland dunes in both source, and age: the common position of these features on the east and southeast sides of river valleys has led to speculation that they formed during the Holocene, prior to development of adjacent marsh and swamp conditions related to postglacial rise in sea level (Denny and Owens 1979).

In addition, both Kent and Sussex counties have a small percentage of mapped eolian soils, and larger percentage of mapped "possible" eolian soils (USDA-NRCS, 1971, 1974). Eolian landform features such as blowouts and dunes are apparent across the upland areas bordering the Murderkill drainage, and often occur in distinct groups. These are particularly evident on the Frederica USGS 7.5' topographic map, where many of these features exhibit northwest-southeast orientation, with dune features downwind (SE) of blowouts (Figure GEO-1). Blowouts are mapped as round or sub rounded pocket-depressions and are generally less than 2 m deep. Dunes appear arcuate in form and are usually less than 3 m high.

Most local soils in Kent County formed primarily within weathered Pleistocene sediments, or secondarily within windblown (eolian) or stream bottom (alluvial) deposits. Soil maps of the study area delineate the most of the project area as consisting of either Sassafras, or Woodstown Series soils. Both are classified as Ultisols formed in old sandy sediments, and typically display A/E(A2)/Bt soil horizonation: primary differences lie in relative drainage characteristics (which may relate to variations in microtopography associated with eolian processes). A third and very minor soil type mapped near a farm pond consists of "mixed alluvial lands" that consists of mixed and unclassified soil material (USDA-NRCS 1971).

*River Valley Morphology*

Subsequent to initial formation of the Delmarva, drainage networks formed, possibly in conjunction with pre-existing drainage features. Development of the Murderkill drainage network resulted in the long-term exhumation of a relatively shallow valley scored by numerous low-order tributaries, some of which may have been charged by springs (Figure GEO-1). The Murderkill River is a relatively small and low discharge stream. The project APE is situated about x km upstream from the river mouth at South Bowers Beach on the Delaware Bay.

Stream gradient within the Murderkill valley has changed remarkably with sustained increases in sea levels following Late Wisconsinan glaciation. The dramatic fall in sea level associated with extensive continental glaciations, and the subsequent rise in sea level as the ice sheets melted during the late Wisconsinan and early-to- middle Holocene have fostered important environmental consequences (Fairbridge 1992, Fletcher et al 1990). These changes were reflected in general channel morphology, which likely became more of a meandering system as overall stream gradient decreased. Much of the local valley bottom presently consists of a drowned valley (infilled tidal marsh). Principal channels are relatively static and occupy old meanders. Water becomes increasingly brackish downstream, and the biotic community reflects changing environmental conditions. Erosional scarps bordering the marsh represent cut banks that formed during active channel migration. Much of this meandering likely occurred during the middle-late Holocene. Bank erosion likely exposed and exhumed Pleistocene gravels and resorted much of the same in active fluvial channel features, such as bars. Local prehistoric inhabitants likely exploited these bank/bar deposits, as much of this gravel source consists of relatively hard, silica-rich rocks such as quartzite and jasper (Hayes and Monaghan, 2001).

*Methods*

Initial geoarchaeological investigations focused on an assessment of the archaeological potential and content of alluvial landforms within the project corridor. Methods were based in part on systematic reconstruction of the depositional history of project landforms, by evaluation of the morphology and relative age of landform components. This study included assessments of general surface topography and internal stratigraphic characterizations of test exposures, including descriptions of sediment and soil characteristics (including any buried soils). Sedimentological characteristics are most useful in determining conditions of alluvial landform formation, and soil characteristics are most useful in determining conditions of post-depositional changes, both natural and cultural (Waters 1992, Foss et al 1995). Important distinctions exist between sediments and soils: soils are pedogenically-modified sediments; sediments include unweathered and unconsolidated deposits (in this case, alluvium) and are not soils, even when derived from former eroded soils (Hassan 1978; Ferring 1986, 1992). Soils develop in sediments through processes of weathering (transformation, translocation, and removal of both physical and chemical components), and additions of new physical and chemical components (both geo- and biochemical), through infusions of new sediment, organic matter, precipitation, and atmospheric gasses (Birkeland 1984, Holliday 1990).

The relative preservation of sedimentological and pedological characteristics is strongly influenced by the residence time a stratum is subjected to a near-surface environment, and drainage conditions. An actively aggrading landform environment favors preservation of sediment characteristics (including archeological sediments). A relatively stable environment (with little net accumulation of sediment) favors increased pedogenic weathering and an increase in accumulation of anthropogenic debris, sometimes in a midden-like deposit. An actively degrading (or eroding) environment may include truncation of surfaces, selective erosion and displacement of both alluvial and archeological sediments, and a general deflation of the stratigraphic record.

Sediment and soil characteristics within this project area were recorded for several profile exposures. Standard field recording procedures documented details of the sedimentological and pedological environments of formation. These included observations of lithology (texture) of

each distinct stratum as well as bedding, sorting, and the contacts (boundaries) between strata. Elevation differences were measured as depths below ground surface at each individual exposure. Post-depositional weathering and soil formation characteristics were recorded following standard soil descriptive terminology developed by the United States Department of Agriculture, Soil Conservation Service (USDA-SCS 1974). These characteristics include descriptions of texture, color, mottling, structure, consistency, inclusions, intrusions, and transferrals. Soil horizon nomenclature follows Birkeland (1984:7), and the U.S. Department of Agriculture Soil Survey Manual (USDA-SCS 1993). Soil horizon designations represent modern conditions.

*Results*

As stated previously, primary goals of this investigation were to discover and document archeological resources within the project corridor. Secondarily, the project aimed to investigate the depositional history of the project corridor to formulate an initial model of landform genesis, assess its buried-site potential and evaluate the contextual characteristics of any archaeological components, and review any changes in environmental conditions that may have affected any cultural components related to use.

S.R. 1 is a major N-S highway that crosses the E-W trending Murderkill River near the village of Frederica. North of the crossing the road traverses a gently sloping, relatively shallow valley slope that ranges in elevation from ~5ft (1.5m) in elevation along the tidal marsh to 25ft (7.6m) atop the shoulder of the valley slope. The project APE consists of a variably shaped parcel that basically parallels the road corridor and a proposed interchange (Figure ADM-1). The confluence of Spring Creek and the river occurs within the marsh bordering the lowest extent of APE, and a first-order tributary of the creek extends upslope from the marsh and bisects the APE. Uphill of S.R. 1 this tributary was apparently damned and probably deepened to form a pond. With the exception of a historic farmstead most of the APE falls within open fields.

Much of the project area was plowed, gridded, and surface collected. In addition, a series of 1x1m test excavation units were located along a proposed interchange centerline. Geoarchaeological field investigations focused upon the characteristics of the plowed surface in addition to the subsurface exposures provided by the test units.

The plowzone---particularly east of S.R. 1---was noted to contain a fair amount of natural gravels (<40mm) that are likely attributable to original deposition during the Pleistocene. Artifacts were found within pebbly plowzone, especially west of S.R.1 in closer proximity to the drainage: included within this assemblage was firecracked rock formed from cobbles notably larger (>40mm) than those naturally occurring gravels commonly noted. In addition, several discreet areas west of S.R.1 contained few if any pebbles within the plowzone. Several test excavation units were located within, and without, pebble-plowzone areas.

Test Unit N590/E554 was located within an area of pebble-rich plowzone (Figure GEO-2). Its exposure detailed a relatively well-developed soil that has weathered within sediments attributable to the Pleistocene-age of landform construction. The plowzone (Ap) consists of relatively dark (organic-enriched) mixed pebbly sandy loam: most artifacts were derived from this context. Underlying leached (E) and transitional (EB) soil horizons detail minor evidence of bioturbation, common gravels, and few artifacts. The base of the excavation extended into clay- and iron-enriched, pebbly Bt horizon that was generally bereft of archaeological evidence. A sandy anomaly (Feature 1) noted in the SW corner of the unit was of undetermined origin, but

may have well represented a natural soft-sediment deformation feature (related to groundwater, pressure, and disturbance). Altogether this unit appeared typical of weathered Pleistocene sediments, with its archaeological component mostly contained within near-surface context.

Test Unit N660/E584 was located within an area that lacked many pebbles in the plowzone (Figure GEO-3). Notably, the pebble-rich sediment clearly attributable to initial Pleistocene formation first noted ~0.60mbs in a Bt soil horizon typical of other units, including N590/E554. Overlying sediments consisted of relatively pebble-free, well-sorted, very fine sandy loam. Development of soil horizons was similar to other profiles. Weathering process associated with soil formation had masked obvious sedimentary structures that could help distinguish water- from wind-transported sediments, but the lack of pebbles within the matrice and apparent dominance of very fine sand suggest possible eolian deposition. This supposition is supported by the archaeological content of the unit, which included small debitage from 60-70 cmbs, just above the Bt horizon. The locational integrity of this relatively deep context has not been clearly determined.

*Discussion*

In summary, testing determined much of the project APE to consist of relic alluvial deposits associated with Pleistocene formation of the Delmarva Peninsula. These deposits constituted a generally level terrain that has been subsequently incised by evolving and expanding drainage networks. Pleistocene deposits typically consisted of a generally fining upward lithologies of gravels capped with increasingly fine sands and silts. Pedogenic weathering of these sediments indicated long-term soil formation of mostly stable, relic landforms that were capped with disturbed, surficial plowzone (Ap) horizons. Eolian redistribution of surface fines has apparently resulted in the creation of erosional blowout features as well as low dunes across much of the regional landscape: these processes are likely climate-related and may have occurred numerous times during the Pleistocene and Holocene. Examination of the project area noted clear differences in the basic lithologies, or sediment makeup, of surface sediments. Gravel content of the plowzone varied, with Pleistocene gravels commonly noted in most areas, but generally lacking in other places. Test excavation units that provided relatively deep exposures sampled these contrasting locations and confirmed the differences in lithology noted in surface examinations: in some areas gravel-rich Pleistocene deposits extended up to and within the disturbed surface plowzone stratum; in other areas gravel-rich strata were clearly overlain with silty sands that exhibited a relatively high degree of sorting and conspicuous lack of gravel.

While the age and depositional mode responsible for these near-surface fines is not clear, they were noted to occasionally include Holocene-age, prehistoric archaeological materials in subplowzone context, while within gravel-rich portions of the project area most archaeological materials (historic and prehistoric) were recovered from in and near disturbed surface (plowzone) context. Altogether, characteristics of both the archaeological assemblage and surrounding matrices, within a relative subsurface context, in an area where eolian activity apparently occurred, demonstrate an unresolved potential within sections of the project area for the preservation of archaeological site components within a buried and possibly stratified context. Elsewhere within the project area where archaeological components were noted to exist primarily within disturbed, gravel-rich plowzone context the relative distribution of various artifact types

(such as fcr, oyster shell, ceramics….discussed elsewhere) demonstrate good potential for spatial differentiation of site components (both temporal and functional) across the landscape.

REFERENCES


Birkeland, P.W.
1984 *Soils and Geomorphology.* Oxford University Press, New York

Blume C.L.
1995 *Shifting Sands: Practicing Cultural Paleoecology in the James River Watershed.* Unpublished Ph.D. dissertation, The Catholic University of America, Washington, D.C.

Curry D.C. and J.F. Custer
1982 Holocene Climatic Change in the Middle Atlantic Area: Preliminary Observations from Archaeological Sites. *North American Archaeologist*, Vol. 3(4): 275-285.

Custer, J.F., S.C. Watson, B.H. Silber.
1996 *Final Archaeological Investigations at the Carey Farm (7K-D-3) and Island Farm (7K-C-13) Sites, State Route 1 Corridor, Kent County Delaware.* DelDot Project 80-110-01, DelDot Archaeology Series 147 (Draft Copy)

Daniels W.F.
1995 Late Quaternary Geomorphic Setting of Archaeological Site 7K-C-107, Kent County, Delaware. In E.F. Heite and C. L. Blume, eds, *Blueberry Hill Prehistoric Site,* Appendix 1, pp 119-193, Delaware Department of Transportation Archaeological Series, Number 130.

Denny, C.S., J.P. Owens, L.A. Sirkin, and M. Rubin
1979 *The Parsonburg Sand in the Central Delmarva Peninsula, Maryland and Delaware.* Geologic Survey Professional Paper 1067-B, Washington.

Denny C. S. and J.P. Owens
1979 Sand Dunes on the Central Delmarva Peninsula, Maryland and Delaware. Geological Survey Professional Paper 1067-C, Washington.

Fairbridge, R. W.
1992 Holocene Marine Coastal Evolution of the United States. In C.H. Fletcher, III and J.F. Wehmiller, (eds), *Quaternary Coasts of the United States: Marine and Lacustrine Systems.* Society for Sedimentary Geology, Special Publication No. 48. Tulsa.

Fenneman N. M.
1938 Physiography of Eastern United States. McGraw Hill, New York.

Ferring C.R.
1992 Alluvial Pedology and Geoarchaeological Research. In, V.T. Holliday, ed., *Soils in Archaeology.* Smithsonian Institution Press, Washington.

1985 Rates of Fluvial Sedimentation: Implications for Archaeological Variability. *Geoarchaeology*, 1:259-274.

Fletcher, C.H., H.J. Knebel, H.J. and J.C. Kraft
1990 *Holocene evolution of an estuarine coast and tidal wetlands*, Geological Society of America 102, 283-297.

Foss J.E., R.J. Lewis and M.E. Timpson
1995 Soils in Alluvial Sequences: Some Archaeological Implications. *In*, *Pedological Perspectives in Archeological Research.* Soil Science Society of America Special Publication 44, Madison.

Groot J.J. and R. R. Jordan
1999 *The Pliocene and Quaternary Deposits of Delaware: Palynology, ages and Paleoenvironments*: Delaware Geological Survey Report of Investigations No. 58, Newark, Delaware, 32 p.

Hassan F.A.
1978 Sediments in Archaeology: Methods and Implications for Paleoenvironmental and Cultural Analysis. *Journal of Field Archaeology* 5:197-213.

Hayes D.R. and G.W Monaghan
2001 Geoarchaeological Investigation at Hickory Bluff: Site Formation and Preservation within a Changing Holocene Landscape. In *Hickory Bluff: Changing Perceptions of Delmarva Archaeology*, M. Petraglia ed. Delaware Department of Transportation Archaeology Series No. xxxxx.

Holliday V. T.
1990 Pedology in Archaeology. In, N.P. Lasca and J. Donahue, eds., *Archaeological Geology of North America.* Centennial Special Volume Number 4. The Geological Society of America, Boulder.

Jordan R. R.
1964 *Columbia (Pleistocene) sediments of Delaware*: Delaware Geological Survey Bulletin No. 12, 62 p.
1974 Pleistocene deposits of Delaware. in Oaks, R.Q. and J.R. DeBar (eds) *Post-Miocene stratigraphy, central and southern Atlantic Coastal Plain.* Logan, Utah, p. 30-52.

Kellogg, D.C., and J.F. Custer
1994. Integration and Interpretation: Prehistoric Environments of Eastern Delaware. in Douglas Kellogg and Jay Custer (eds), *Paleoenvironmental Studies of the State Route 1 Corridor: Contexts for Prehistoric Settlement, New Castle and Kent Counties, Delaware*. Delaware Department of Transportation Archaeology Series No. 114. pp 48-81

Petraglia, M. et al

1998 *The Prehistory of Lums Pond: The Formation of an Archaeological Site in Delaware.* Parsons Engineering Science Cultural Resources Department. Delaware Department of Transportation Archaeology Series No. 155.

Pickett, T.E. and R.N. Benson
1983 *Geology of the Dover Area, Delaware.* Geological Map Series 6, Delaware Geological Survey. Dover, Delaware, 1 map.

Stolt M.H. and M.C. Rabenhorst
1987 Carolina Bays on the Eastern Shore of Maryland: II. Distribution and Origin. *Soil Science Society of America Journal,* (51) 399-405.

USDA-NRCS (United States Department of Agriculture, Natural Resource Conservation Service)
1971 *Soil Survey of Kent County, Delaware.* United States Department of Agriculture, Natural Resource Conservation Service, U.S. Government Printing Office, Washington.

1974 *Soil Survey of Sussex County, Delaware.* United States Department of Agriculture-Soil Conservation Service.

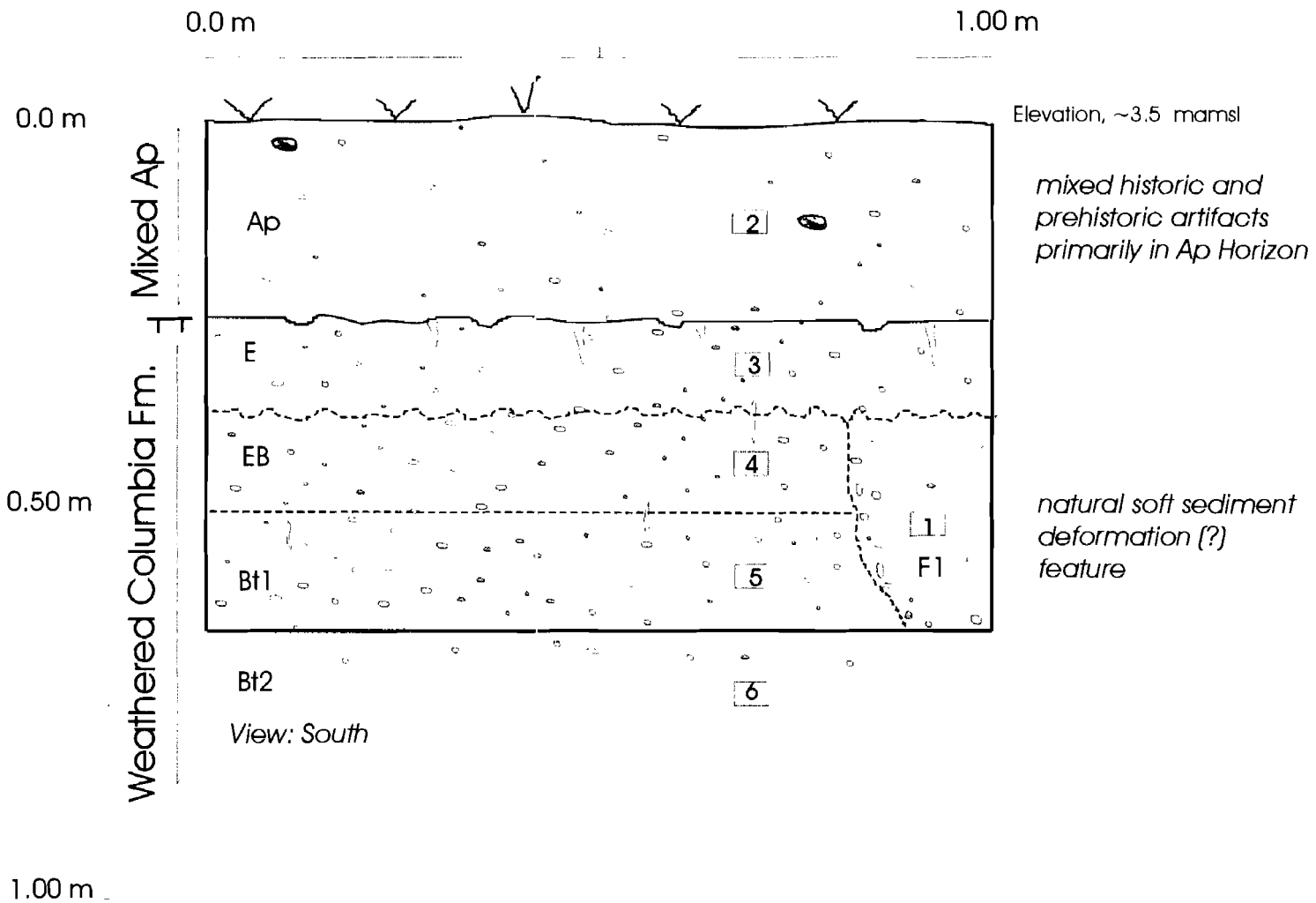
USDA-SCS (United States Department of Agriculture, Soil Conservation Service)
1974 Definitions and Abbreviations for Soil Descriptions. West Technical Service Center, Portland.

USDA-SCS (United States Department of Agriculture, Soil Conservation Service)
1993 *Soil Survey Manual.* USDA Handbook 18, U.S. Government Printing Office, Washington.

USGS (United States Geological Survey)
1993 *Frederica, DE. 7.5' Quadrangle Map*, United States Department of the Interior-Geological Survey, Reston Virginia.

Waters M. R.
1992 *Principles of Geoarchaeology.* University of Arizona Press, Tucson.

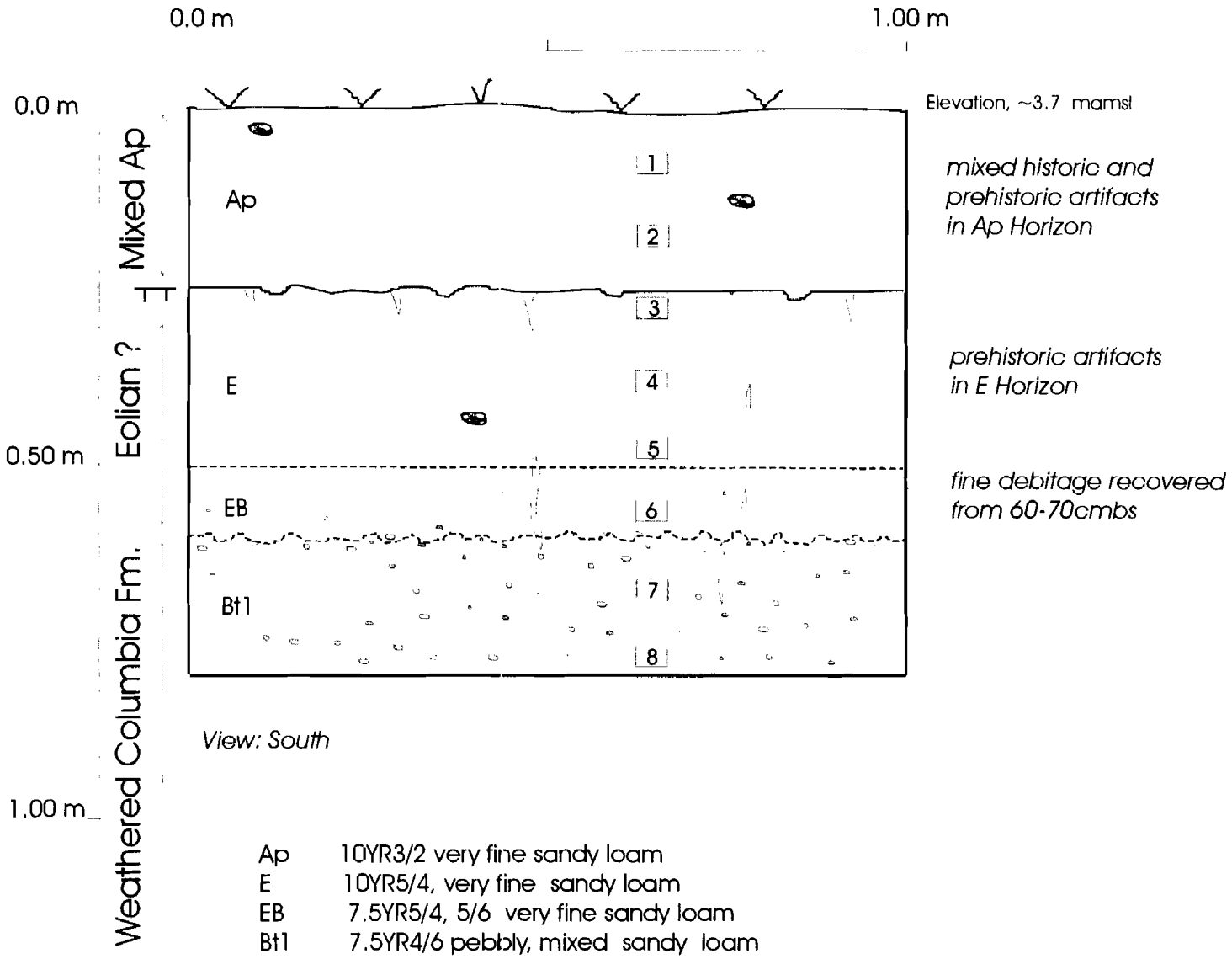
FIG. GEO-1: SR 1, Frederica Interchange
P 730
Test Unit N590/E554: South Wall
*DRAFT*




| | |
|---|---|
| Ap | 10YR3/2 pebbly sandy loam |
| E | 10YR5/4, 6/4pebbly sandy loam |
| EB | 7.5YR5/4 pebbly sandy loam |
| Bt1 | 7.5YR4/4 pebbly sandy loam |
| Bt2 | 7.5YR4/4 pebbly sandy loam |
| F1 | 10YR6/6 mixed clean sand with occasional pebble |

Abrupt Boundary
Clear Boundary
Gradual Boundary
Eroded Contact
Root/Void Cast
Pebble
Fire Cracked Rock
Water Table

FIG. GEO-2: SR 1, Frederica Interchange
P 730
Test Unit N660/E584: South Wall
*DRAFT*




| | |
|---|---|
| Ap | 10YR3/2 very fine sandy loam |
| E | 10YR5/4, very fine sandy loam |
| EB | 7.5YR5/4, 5/6 very fine sandy loam |
| Bt1 | 7.5YR4/6 pebbly, mixed sandy loam |

Abrupt Boundary
Clear Boundary
Gradual Boundary
Eroded Contact
Root/Void Cast
Pebble
Fire Cracked Rock
Sample