PREDICTIVE MODELS

SUBSISTENCE-SETTLEMENT SYSTEMS IN THE PIEDMONT / COASTAL PLAIN TRANSITION ZONE OF NEW CASTLE COUNTY, DELAWARE

A PREDICTIVE MODEL

The purpose of this section of the Delaware Routes 4, 7 and 273 cultural resources survey report is to develop a predictive subsistence/settlement model for use in locating and identifying prehistoric cultural resources lying within the Piedmont/Coastal Plain transitional zone of New Castle County, Delaware and to provide criteria for the evaluation of significance of those resources located during the survey investigations.

The three highway improvement projects included in this survey lie within a region defined by the Piedmont fall line on the north and the coastal plain tidewater area to the south and east. The region is a part of the Sassafras-Fallsington-Matapeake soil association and is drained entirely by the Christiana River and its tributaries. This transitional zone, while formally a part of the Coastal Plain Physiographic Province, contains environmental resources common to both the Piedmont and the Coastal Plain and as an edge area, is somewhat different than both as a resource base.

In terms of cultural resources, the project region lies within the prehistoric cultural area known as the Middle Atlantic Coast. This area, within which existed similar socioeconomic phenomenon for much of its period of cultural activity, stretches from North Carolina to New York and includes both Piedmont and Coastal Plain peoples (see Figure II-1).

Although it is recognized that cultural resources include those pertaining to the early historic occupation of the project area, and this survey is concerned with those resources, no attempt will be made to develop or apply a historical settlement model in this section. Comments on historic settlement patterns will be provided in the discussion of historic resources found in each survey results section of the report.

The following discussions are aimed at providing background information for the development of, and ultimate testing of, a prehistoric subsistence-settlement model for use in locating, identifying and evaluating the significance of prehistoric cultural resources within the project area.

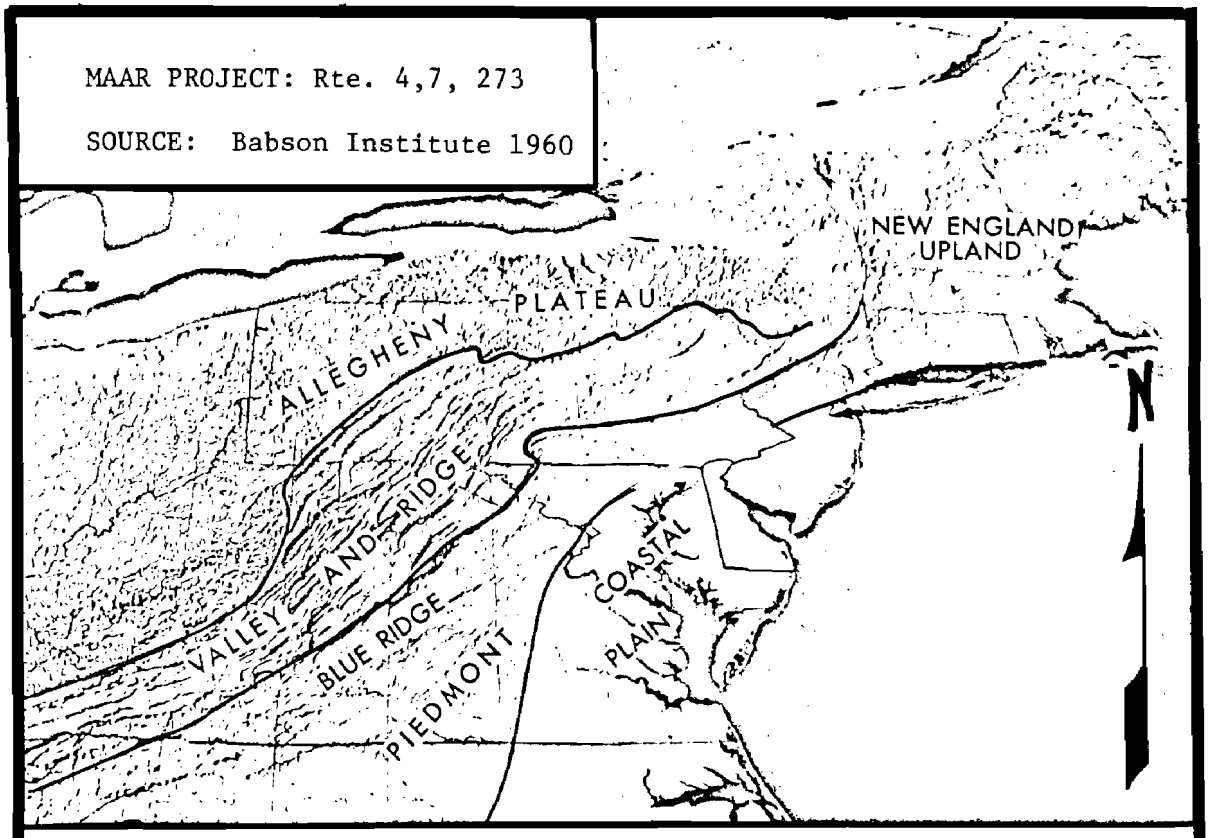

Figure II-1
PHYSIOGRAPHIC PROVINCES of EASTERN NORTH AMERICA

PREHISTORIC OVERVIEW

Man first entered the New World during the later part of the Ice Age or Pleistocene Epoch. During this time, periodic formations of ice sheets grew to continental proportions in the upper northern latitudes of the world. Cooler climates prevailed and in the tropical and temperate regions mountain glaciers increased in size at high elevations. This period of glaciation were often interrupted by longer interglacial periods which were characterized by conditions similar to those existing today.

It is the last glacial period (the Wisconsin Stage - circa 70,000 to 10,000 years ago) and the following post-glacial period that are of primary concern to American archaeologists. During the Wisconsin Stage a land bridge was formed connecting Siberia and Alaska thus allowing the peopling of the New World by hunters and gatherers from eastern Siberia.

The prehistory of the Middle Atlantic Coastal Plain and Piedmont, with which this report is concerned, can be understood by reference to three major cultural traditions defined for the eastern United States; the Paleo-Indian tradition, the Archaic tradition and the Woodland tradition. Each of these is characterized by distinctive adaptations to dynamic or changing environments.

Paleo-Indian Tradition

The earliest recognized prehistoric population on the North American continent was represented by groups of hunter/gatherers known to archaeologists as Paleo-Indians. They ranged over a wide geographic area of this hemisphere and evidence of their presence has been noted from Alaska, eastward to the Atlantic Coast and as far south as the southern extent of the continent.

Their hallmark is a distinctive type of projectile point used on javelins, spears, or knives. They are easily recognized by the presence of single or multiple flake scars which run vertically from the base of the artifact, upwards towards its tip. It is because of this peculiar manufacturing technique that these tools are collectively referred to as fluted points.

Fluted projectile points were first discovered in the mid-1920's on a number of southwestern United States sites in direct association with the bones of extinct Ice Age mammals such as giant bison and mammoth. The majority of these finds were "kill" sites and their subsequent publication led to the traditional conception of these early populations as a "Big Game Hunting Tradition" (Willey 1966:37). Fluted points are fairly well-distributed throughout the northeastern United States. However, to date, none have been found in association with the remains of mastodon or mammoth. Evidence from several excavated northeastern Paleo-Indian sites suggest alternative resource exploitation patterns.

The Holcombe Beach Site in the State of Michigan (Fitting et al 1966) and the Dutchess Quarry Cave Site near Florida, New York (Funk et al 1969) have both yielded the bones of caribou. More recently, the Meadowcroft Rockshelter in southwestern Pennsylvania (Adovasio et al 1977) and the Shawnee-Minisink Site in the upper Delaware River Valley (Dent and Kaufman 1978) have both yielded a surprising number and variety of charred wild plant remains associated with Paleo-Indian horizons. The importance of these food resources is now being understood; earlier estimates of big game importance were grossly overstated.

This is forcefully supported by archaeological investigations being conducted much closer to the project area. Excavations and survey have been underway in the Shenandoah River Valley during the past eight years by Dr. William M. Gardner and associates from Catholic University and the Thunderbird Research Foundation (Gardner 1974). As a result, we now have a well supported "counter-theory" of the subsistence and settlement patterns of the Paleo-Indian peoples of the Middle Atlantic Coast.

Gardner and associates suggest that the Paleo-Indian peoples, rather than emphasizing the hunting of large game animals, maintained a procurement system that was more oriented towards the exploitation of multiple resources including both flora and fauna native to the areas in which their settlements are found. Settlements, as determined by the Shenandoah River Valley investigations, are often determined by the presence of areas in which multiple resources can be simultaneously exploited. Thus, a Paleo-Indian settlement might be expected in an area where lithic raw materials outcrop, which is near a river flood plain or a swampy or marshy area adjacent to or near upland hunting area.

If this theory of multiple resource determinants for Paleo-Indian settlements is accepted, interesting possibilities open up for the discovery of such cultural resources within the fall line zone of New Castle County. In a later section of this report, the environmental parameters and natural resource procurement areas will be discussed. A review of the known Paleo-Indian activity within the area, however, will be appropriate at this time.

Within the Sassafras-Fallsington-Matapeake soil association area of New Castle County is an area containing numerous periglacial hydrological features known locally as sink holes, Carolina Bays, or pingos. These constantly water-laden debressions appear to have served the native fauna as watering holes and to have been exploited by early human occupants of the area. Within the same area in western New Castle County and eastern Cecil County, Maryland are lithic outcrops of two materials; Newark Jasper, a quality brown jasper somewhat similar to the well-known Pennsylvania jasper; and Cecil County Black Flint. Paleo-Indian occupation of this area appears to have been as heavy as in any other area of the Middle Atlantic Coast.

Within the general sink-hole and lithic outcrop area are located three known Paleo-Indian sites from which at least six fluted projectile points and numerous other associated tools have been found. Although limited excavation within the find areas has been undertaken, no subsurface evidence has been found.

As far as can be told, no evidence of Paleo-Indian activity within the exact project areas has been found. Nevertheless, similar environmental areas, and the proximity of the known sites to the project areas, indicates that such activity may have occurred.

Paleo-Indian, by definition, terminates with the end of the Pleistocene and the beginning of a more stable Archaic way of life. Artifacts of the Paleo-Indian tradition in the Middle Atlantic area are no longer found after around 10,000 years ago. Transitional cultures are recognized further to the south of northern Delaware and occasionally isolated finds are picked up in the area. Generally, however, there appears to have been a general depopulation of the immediate project area.

The Archaic Tradition

The end of the Pleistocene was marked by warmer temperatures resulting in glacial melt and a subsequent rise in sea levels. There was also a shift in surface cover from parkland to a Northern or Boreal, Spruce-Pine Forest and, in later times, to a mixed deciduous environment throughout most of the Middle Atlantic area. Many of the cold-adapted animals and plants probably "followed" the retreating glacier northward and, in the case of the mammoth, mastodon and giant ground sloth, among others, into extinction. These creatures were replaced in the local environmental biotic communities by deer, elk, moose, bear and smaller mammals.

During this period there was a change in the style of projectile points and new items such as bola stones and spearthrower weights were later added to the tool kit. The technique of "fluting" points was abandoned and the resulting changes in projectile point form has been used to mark the end of the Paleo-Indian tradition and the beginning of the Early Archaic.

Recently, it has been suggested (Gardner 1974, Bryan 1977) that a change in notched points does not make a new tradition. These students argue that late Paleo-Indian populations and Early Archaic peoples made their living in much the same way - i.e. hunting/gathering and the exploitation of similar resources in similar environmental settings. In other words, they view the Early Archaic as a continuation of the Paleo-Indian tradition. Nevertheless, the Archaic tradition as a whole can be characterized by more specialized forms of technology than had existed at the end of the Paleo-Indian tradition. Of special note are the ground stone woodworking implements. These tools are considered necessary to the successful exploitation of a woodland environment. During the Archaic the tool inventory continued to become more diverse and probably more specialized.

The Archaic tradition developed through a number of stages which can be defined by artifact form. An Early Archaic was succeeded by a more widespread Middle Archaic (characterized in Delaware by bifurcate based projectile points) and then, with a shift in settlement pattern, by a Late Archaic or Terminal Archaic. The recognition of modifications not only in artifact style but also in economic patterns has led some students (Caldwell 1958) to postulate a continuing development of "Forest Efficiency" in the eastern United States.

The population appears to have been much higher than during earlier times and many Archaic Period occupations can be documented on most prehistoric sites identified within the general area. Dating from the very earliest of the Archaic manifestations known in the Middle Atlantic, Kirk/Dalton-like manifestations, these occupations reflect a heavy utilization of the area. One of the largest archaeological sites known in the State of Delaware, the Clyde Farm Site, is located just south of Route 7 along the White Clay Creek. The Clyde Farm covers an area stretching from the confluence of the White Clay Creek with the Christina River up to the proposed new Route 7 ROW. It has been the site of surface collecting activities for over seventy-five years and hundreds and perhaps thousands of projectile points, ground stone tools, and other artifacts have been removed from the site.

Archaeological investigations have been conducted at the Clyde Farm Site since 1966 when the Delaware Archaeological Board of the State of Delaware, whose responsibilities are now vested in the Bureau of Archaeology and Historic Preservation, excavated a portion of the Clyde Farm Site. Subsequent excavations were conducted by the State and by other agencies under the supervision of the State.

The interpretation of the Clyde Farm data suggests that it was a heavily occupied base camp, or series of base camps, for a hunting and gathering people. The attractiveness of the site, which adjoined two large tidal streams and an extensive marsh area, can be suggested as the significant relevant environmental factors leading to its selection by prehistoric peoples. The Clyde Farm natural resources could have supported a large population and were probably exploited by the occupants to the fullest.

Artifacts recovered during the surface collecting activities and during archaeological excavations suggest that the Clyde Farm occupants participated in a wide variety of domestic activities. Evidence of hunting, gathering, food processing, long-distance trade, and ceremonial activities has been found. Occupation appears to have occurred multi-seasonally and lasted from the earliest Archaic periods on through the Late Woodland. Evidence of very early Dutch occupation of the site has also been found.

The Clyde Farm occupation area is located on soils of Sassafras and Matapeake sandy loams, both relatively well-drained soils. The areas of heaviest activity were on high knolls and/or ridges overlooking the two streams and/or the extensive marshlands. A fast flowing fresh water stream bisected the site dividing it into a northern and a southern half. This stream flowed out of upland flats crossed by the Route 7 ROW project area. Elevations at the Clyde Farm ranged from 20 to forty feet above sea level and consisted of prominent knolls with steep slopes of up to 15%.

Upstream from the Clyde Farm Site, and a short distance north of the project area, at the confluence of the White Clay Creek and Pike Creek, is the Green Valley Site. Excavation, under the auspices of the Bureau of Archaeology and Historic Preservation, indicated that this site contained a widely dispersed series of Archaic Period campsites. Although intensive excavations were conducted at the Green Valley Site, no subsurface features were found providing contextual associations for recovered artifacts. Thus, the excavations were unable to provide much data about such site functions as seasonality, subsistence, and other aspects of prehistoric life. However, the occupation appeared to have been intensive and it can be inferred that the presence in the area of natural resources sufficiently extensive to support a resident population was known to the local inhabitants. The Green Valley Site artifacts do not suggest a span of site utilization as long as that of the Clyde Farm, however, and the explanation for this must yet be sought.

The Green Valley Site is located on the southern slope of the Piedmont foothills and the well-drained floodplain of the White Clay Creek. The aspect is south and southwest, thus maximizing the exposure of site occupants to the sun. Soils of the site are Elsinboro silt loam and Delanco silt loam. Both range from moderately well-drained to well-drained and are seldom flooded. Elevation at the site ranges from 20 to 50 feet above sea level. Pike Creek, which flows into the White Clay Creek from the foothills to the north, is a fast-flowing stream carrying a high volume of water from its large drainage area.

Very little is known about any other prehistoric sites in or near the project area. Those that are on record consist of sites reported to the Bureau of Archaeology and Historic Preservation by avocational archaeologists, who have only surface collected selected specimens, or, in a single case, by professional archaeologists involved in contractual surveys. A relatively large site, from which dozens of finished artifacts were recovered, is located in the flood plain of the Christina River about two miles upstream from the Clyde Farm (about the same distance as the Green Valley Site). This site is near Christiana, at an elevation of 10 to 20 feet and only within several hundred feet from the river. The site is located several hundred yards above a slight constriction in the flood plain. It appears to have been occupied during later Archaic periods and perhaps Early/Middle Woodland periods (Sec. V).

Several find spots occur just south of the Route 4 ROW west of New Churchmans Road. These spots were reported by a Delmarva Clearinghouse for Archaeology team (see Alexander 1976). The finds were of single artifacts and were situated on gradual slopes slightly above flat areas of relatively poor drainage. Both finds were in soils of Woodstown and Matapeake sandy loams. Another well-known site just west of the find spots was reported by an avocational archaeologist a number of years ago. This site, known as the "Indian Mound", had been collected for a number of years and produced numerous artifacts of Archaic Period derivation.

The Woodland Tradition

Just as a period of transition occurred at the end of the Pleistocene between traditions defined by the utilization of fluted points and those of more diversified projectile points and specialized tools, so a similar transition separated the Archaic tradition from an intensive sedentary Woodland way of life. For purposes of discussion it is convenient to consider the Woodland as beginning with the introduction of ceramics into an area.

The earliest Woodland manifestations recognized throughout the northeast are those characterized by the presence, on most if not all sites, of an incipient pottery industry referred to as the Marcey Creek type. Marcey Creek is a site located near Washington, D.C. (Manson 1948) that was the type site for the description of this pottery style. The early Woodland people using Marcey Creek pottery apparently led a life much like that of the Archaic peoples who preceeded them. Although it is generally felt that the Woodland traditions enjoyed the knowledge of plant cultivation from the very earliest, there is no evidence to support this contention in the Middle Atlantic area. Also suggested as a characteristic of the Woodland tradition is the existence of settled village life and the elaboration of religious customs. Neither of these can be documented in the very early Woodland of the area.

Later Woodland traditions of the Middle Atlantic area vary considerably in the diversity of economic practices as well as in the recognized styles of their artifacts. This may be due to tool kit diversity or meerly to stylistic differences. During the late part of the Early Woodland and initial periods of the Middle Woodland, the introduction of plant cultivation is probable and the existence of a more settled, village life can be demonstrated in the general Middle Atlantic region (Gardner & McNett 1971:49). At the same time we find evidence of the existence of extensive exchange networks involving the transfer of goods from the continental interior to the Middle Atlantic coast as well as north and south along coastal travel routes (Ford 1959, Thomas 1970).

Middle Woodland traditions appear to be a continuation of traditions that became established during Early Woodland times. While it is possible that shifts in subsistence occur (from a diversified economy depending on both hunted and produced foodstuffs to one with a greater dependence on plant cultivation) we can find little, if any, change in the settlement pattern between Early and Middle Woodland times. However, Gardner and McNett (n.d.:23) have suggested that the Middle Woodland witnessed the first large-scale utilization of shell fish as a food resource. This contention is apparently based on the more frequent occurrence of ceramics, Accokeek Ware and Popes Creek Ware (both newly developed superior pottery types), that may have been used in the processing of shell fish. The existence of large middens of expended shell tends to support this postulated shift in economy.

The Late Woodland tradition was ushered in not only by a different form of ceramics and other artifacts but, more importantly, by a major shift in the subsistence and settlement patterns throughout the Middle Atlantic coast. This shift has been interpreted as due to an acceptance of intensive maize and bean horticulture. Henry Wright's investigations in the Chesapeake tidal regions of the Coastal Plain led him to suggest that "It is possible that the fragmentation into smaller settlements... indicates a period of social readjustment to the introduction of maize horticulture from Piedmont agricultural communities (Wright 1973:26). Wright is referring to his Sullivan Cove phase which he dates at later than 700 A.D. This indicates that earlier "agricultural communties' are thought to have existed in Piedmont areas.

Very little indication of Woodland tradition activity occurs within the fall line zone of New Castle County. Based on the shifts in settlement postulated by Gardner and Wright (see above) this may be explainable. The New Castle County area was never within the range of marine shell fish and if this abundant resource were to be exploited by peoples of the area it would necessitate a permanent or seasonal migration to the south. Likewise, if the earliest of horticulturalists were Piedmont dwellers, and residents of the fall line zone attempted to take up this way of life, a movement, either permanent or seasonal, to the north can be expected. The project area, however, does contain Woodland period artifacts and obviously was utilized during the period.

The Clyde Farm site has produced the earliest ceramics known within the general area. Marcey Creek ceramics were excavated from a feature of unknown function located on a knoll overlooking a large marsh at the confluence of the Christina River and its major tributary, White Clay Creek. This site has also produced other evidence of Woodland tradition artifacts. Few of the other known prehistoric sites within the area, however, contains more than a few small fragments of ceramics, an indicator of base camps and sedentary or semi-sedentary settlement patterns. Woodland lithics do occur, however, and may be interpreted as indicating the seasonal use of the fall line zone during this period of time as a hunting territory by hunters using transient camps. This contention will be further developed later.

Perhaps significantly, similiar settlement shifts appear to occur in the coastal plain of the Delmarva Peninsula. Griffith (personal communication) has conducted research into the settlement locations of various phases of the Late Woodland Period in Delaware and can support a shift not only in settlement location but also in size and site function. These shifts can be seen at the Warrington and Poplar Thicket sites in Sussex County, Delaware. They are reflected by the sizeable and apparently semi-permanent subterranean houses found at these sites (Griffith & Artusy 1975).

CULTURALLY RELEVANT ENVIRONMENTAL PARAMETERS

Prehistoric subsistence and settlement patterns are directly related to those environmental factors that provide the natural resources necessary to substain life. Among these are climate, water resources, flora and fauna, and such non-edible resources as clay, lithic materials for tools, reeds and grasses for basketry, etc.

The environmental parameters of northern New Castle County that are culturally relevant include the geomorphology, the terrain, the temperature and rainfall, the flora and fauna and the soils and rock of the Piedmont outcrops and Coastal Plain sediments. The following discussion generally follows this order. The "fall line zone" of New Castle County is transitional between the Piedmont Plateau and the Atlantic Coastal Plain physiographic provinces. The Piedmont Plateau is mostly hilly with slopes becoming more gradual near the fall line. The hills are cut by numerous streams flowing southeasterly towards the Christina River which itself flows out of the Piedmont of Pennsylvania and Maryland. Elevations in the immediate area range from 100 to 400 feet above sea level. The underlying rock strata of the Piedmont includes micaceous metamorphic rock and igneous rock. Stream floodplains are narrow and drainage is relatively good throughout the area.

The coastal plain consists almost entirely of sediments covering the base rock of the Piedmont. These sediments consist of sands, gravels and clays that are derived from the weathering of Piedmont parent material and which were deposited during both Pleistocene and earlier periods. The coastal plain ranges from level to gently rolling with elevations varying from sea level to about 100 feet. Streams crossing the flood plain run through relatively broad valleys causing meanders and salt marsh areas.

New Castle County has a humid, continental climate which is modified by the nearby presence of the Atlantic Ocean and the two bays; the Chesapeake on the west and the Delaware to the east. The general flow of air is from the west to the east. During the summer months warm air from the south flows through the area. The average monthly temperature is 54.1 degrees with a high of 76 in July and a low of 33.8 in February (Matthews and LaVoie 1970:92). The average rainfall in the county is 44.56 inches annually.

The project area falls within a climax forest of oak and hickory with tulip poplar, gum and yellow pine also important. The native vegetation was probably heavily forested with expanses of marsh vegetation and natural clearings the only break in this dense cover. Fauna occupying such a vegetation zone would include the white-tailed deer, bear, fox, wolf, bob-cat and other large mammals as well as the numerous small mammals, reptiles and amphibians common to such forested areas today. Of major importance as a potential food supply are the numerous wildfowl that frequent the Atlantic Flyway and would have been quite numerous within the marshes and clearings of the area during prehistoric periods.

Of potential significance to aboriginal inhabitants of the area are several lithic sources located throughout the project area. At the western edge of the Sassafras-Fallsington-Matapeake soil association area, at the very edge of the fall line, are outcrops of two silicious materials that are known to have been used by prehistoric peoples. The southwestern slope of Iron Hill and slopes of both Red Hill and Grey Hill in nearby Cecil County, Maryland, contain outcrops of a brown jasper known as Newark Jasper (Wilkins 1976). An associated lithic material, a black flint known as Cecil County Black Flint occurs in the same area and in some cases at the same outcrop. Also found in the project area are gravel beds containing quartzites and quartzes of flakeable quality. These beds are often exposed in stream banks and in floodchute areas.

The terrain is featured by a variety of habitat types ranging from upland, well-drained forests on ridgetops and knolls to upland flats containing poorly-drained soils which support a wetland vegetation (swamps and seasonally wet scrub hardwoods). Floodplains exist along the major stream and along the lower parts of the smaller tributaries. Floodplain vegetation ranges from water-tolerant trees and bushes to grasses of the tidal marshes. Scattered throughout the floodplains are hillocks of treed land surrounded by marshland. Sporatically occurring in the uplands are the sink holes mentioned earlier in this section of the project report.

The major drainage is the Christina River which snakes through the entire fall line zone from its origins in the Piedmont Plateau of Pennsylvania to its entry into the Delaware River near Wilmington. This stream is fed by a series of parallel flowing tributaries running generally south to southeast and separated by only a few miles of upland areas. The specific highway projects transect the Christiana drainage on an east-west orientation and most major tributaries of the Christiana are also crossed.

The Sassafras-Fallsington-Matapeake Association is defined as "Nearly level to steep, well-drained, medium-textured and moderately coarse textured soils on uplands" (Matthews and LaVoie 1970). The soils are described as deep and well drained silt loams with a silty clay loam subsoil. The potential for plant cultivation is listed as good with few limitations.

It is difficult within the context of this report to investigate the paleo-environmental factors that may have differed significantly from current conditions within the general region. Generally rising temperatures and sea levels would have been the rule during the Holocene, however, flucuations in temperature and the amount of available rainfall at various periods in the past may have greatly increased or limited the availability of certain resources and caused a response on the part of the human inhabitants of the project area. This problem must be taken into account in constructing models of subsistence and settlement patterns.

With this brief introduction to the environmental parameters within which prehistoric man conducted his socioeconomic activites, it is now necessary to specify those culturally relevant factors which may have influenced his subsistence and settlement decisions. Before addressing this problem as it applies to the specific fall line zone of New Castle County, Delaware however, it may be advantageous to survey the various predictive models developed for use by other investigator within the Middle Atlantic coast.

PREDICTIVE MODELS

A predictive model is a creation of a researcher involved in a study of the distribution of cultural resources over a landscape and through time. It can be created on the basis of data generated from systematic site surveys in the immediate area or by determining the relevant environmental factors considered significant to the economic or subsistence systems of the prehistoric inhabitants of the area. More appropriately, however, than the exclusive use of either of these approaches is the combination of both inductive and deductive approaches in the development of a testable settlement model.

Predictive models are meant to be tested in the project area for which they were created. Such models, however, should be subjected to preliminary testing or review prior to their being formalized or refined. Such review should take into consideration other models created and tested in environmental/technological situations similar to those of the project area. Unfortunately, no predictive models have been developed for the Piedmont Plateau or transitional Piedmont/Coastal Plain zone within or adjacent to New Castle County. Models of prehistoric subsistence and settlement, however, have been utilized in the Coastal Plain of the lower Delmarva Peninsula (Thomas, Griffith, Wise & Artusy 1975), the Inner Coastal Plain of New Jersey (Cavallo 1977), the Piedmont Plateau of Maryland (McNamara 1977) and the fall line zone of Fairfax County, Virginia (Johnson et al 1978). Also of use in the present investigations are the models discussed by Dr. William M. Gardner in his preliminary report of research conducted in Virginia and Maryland (Gardner 1978) and that of Dr. Jay Custer in Virginia (Custer 1979).

A manuscript made available to the writer by Michael Johnson, Archaeologist for Fairfax County, appears to be of use in creating a model for the New Castle County project area. Although the Johnson model deals with coastal plain and the fall line zone, it also deals with a part of the adjacent Piedmont Plateau. The relevant environmental factors considered by the authors overlap all three areas. The model lists various factors considered as useful in predictions of site locations within Fairfax County, Virginia and does not postulate that these factors will be useful in other areas.

Locations which are considered as "High Probability" zones of aboriginal occupation are: those adjacent to a marsh and either a spring or a stream;

floodplain constrictions that are next to a spring or a stream; peninsulas in a stream area; rock shelters and/or caves; and dry islands in rivers. The latter two do not appear to be useful in the New Castle County project area.

Areas in which sites are "Moderately Probable" include those: near an active or extinct spring; the intersection (confluence) of two streams; river terraces; salt licks; flat ground overlooking a flood plain that is near a spring; areas near lithic sources; fords in major streams; game trail entrapment regions; and high land with a view which is near a spring.

The results of a thorough survey of Seneca Creek State Park (Montgomery County, Maryland) reported by McNamara (1977) are also of use in the creation of a project area site distribution model. The McNamara study can be viewed as an inventory of sites recorded from various sources, none of which were gathered on a systematic basis. Consequently, the model has yet to be tested. McNamara sees the following locations as characteristic of Seneca Creek State Park aboriginal sites; areas of well-drained upland; areas at the confluence of two streams; bluffs or knoll overlooking streams or swampland; heads of streams or springs; well-drained ridges; and areas adjacent to swamps.

A model has been developed to predict the location of prehistoric settlements within the inner coastal plain environments of New Jersey. The model was originally developed as a means of locating sites in Monmouth County, New Jersey, an area of topography somewhat similar to that of New Castle County. The characteristics of Monmouth County topography thought to be of most significance from the standpoint of the selection of favorable site locations are: 1). slope at site - 2 to 5%; 2). slope in contiguous area - same as or greater than site gradient; 3). aspect - 9- to 270 degrees with 120 to 240 degrees preferred; 4). distance from stream - less than 1000 feet with less than 500 feet preferred; 5). water resources beyond immediate stream source - unusual hydraulic features within 5000 feet with less than 3000 feet preferred; 6). stream order - near two or more second order and third order streams; 7). relation of site to stream confluence - within confluence; 8). drainage at site - good preferred, but may be excessive if slope is 0 to 2 degrees; 9). drainage in contiguous areas - should have drainage different than soil on which site is located.

The Gardner paper (1978) provides perhaps the most useful discussion of prehistoric settlement factors for the purposes of the present research. In his discussion of the Coastal Plain of the Potomac River valley, Gardner details aspects of the upland plain that he feels were especially attractive to prehistoric inhabitants and which he feels were determinants in site selection decisions. In his overview section (Gardner 1978:45) he states "The zones of most intense activity are the zones of maximum habitat overlap and/or zones of highest exploitable biomass." These areas he states are the base camp areas; areas situated at the junction of major streams, the mouths of low-order streams, and interior swamps. Gardner goes on to state "In all of these areas, the sites are located where freshwater is available and in the specific locations where the habitats are maximized."

Gardner appears to place the highest significance on the concept of habitat variability, considering the location where the most natural resources could be efficiently harvested as the likely location of settlement. He also points out that proximity to fresh water sources is a significant factor (Gardner 1978:45). Another habitat type considered by Gardner, which may be especially pertinent to the New Castle County study area, is that of upland swamps.

In an extremely interesting and useful comparison of settlement patterning, Custer (1979) discusses the culturally relevant factors which he felt were of significance to the choice of settlement location in two areas of Virginia. Although the environmental settings of the areas are quite unlike those of the present study area, the factors chosen by Custer for close examination may be useful in the attempt to create a predictive model for the fall line zone of northern Delaware. Custer (1979:2) concentrated his interest on three environmental parameters, "..in reality edaphic factors..", which included surface water setting, the geomorphological characteristics of the area, and the soil associations present in the study area. Custer's field investigations seemed to bear out the significance of his selected environmental parameters.

All of the models so far discussed, with the possible exception in part of the Gardner model (1978), seem to have concentrated their interests on determining the most efficient locations for prehistoric settlements. Although they are obviously based on the need to consider natural resource exploitation none really deals with the distribution of resources both over a landscape and through time. The emphasis seems to be on settlement type and location rather than scheduling.

The concept of scheduling deals with the utilization of the seasonality, or season of maximum availability, of certain economically important natural food resources. Seasonality and scheduling are directly related factors in that human groups must schedule their economic activites and their place of settlement to correspond with availability of the resources upon which they depend for a living. The Thomas, Griffith, Wise and Artusy (1975) study is not the only Middle Atlantic area investigation which attempted to predict both the location and function of settlement and also the seasonality of the aboriginal movements. It is, however, the one extensive attempt at determining site function, location and seasonality (a factor, of course, directly related to function) that utilized and tested detailed natural resource data directly applicable to the New Castle County area. The basic principles of that study will be followed here.

THE MODEL

The theory of predictive subsistence-settlement models is based primarily upon the close and direct relationship between man and his environment, and the need for man to economically adapt to the limitations and opportunities of that environment. The principle of "maximization", while not necessarily stated by most users of predictive models, is certainly adhered to (with a few notable exceptions). This principle states that man will attempt to maximize his harvest of natural resources by efficiently scheduling his activities and locating his settlements to take advantage of the opportunities offered in each particular environmental setting.

The primary need, therefore, is to determine the nature of the environmental setting and to identify those natural resources available as potential sources of the necessities of life. It can then be assumed that man will choose to locate his settlements near those resources during the time of the year when they are available. It also can be assumed that he will deploy his human resources (work force) in such a way that all potential food sources will be exploited to the fullest. Unless these assumptions are made it would not be possible to predict site locations based on economic considerations alone.

Although it is realized that the above principles may lead this investigator to make certain assumptions which are not defensible in the minds of less socioeconomically-minded investigators, with the statement that these principles are assumed, it is felt justified to proceed with the creation of the following model. For a further discussion of these potential problems the reader is referred to Thomas, Griffith, Wise and Artusy (1975:55-59).

Fall Line Zone Environmental Resources

The resources considered by prehistoric man as culturally relevent may not be those considered significant to the archaeological investigator. However, it is necessary to list the potential resources in order to develop a predictive model. Whether the actual settlement system matches that of the predictive model can be ascertained through thorough and ongoing archaeological research. The primary resources existing within the fall line zone of New Castle County fall into several major categories; lithic, wild fowl, game animals, fish, seeds and nuts. Other resources that may have been utilized by prehistoric man will not be further considered as economically important.

Lithic resources have already been discussed in an earlier section of this report. In general, the readily available jasper outcrops in the western part of the project area are known to have been used during Paleo-Indian, Archaic and Woodland periods. Occupation, either seasonally or by means of transient camps, in the outcrop areas should be expected. Cobble beds containing lithic materials of flaking quality are scattered throughout the project area. Their exposure to surface exploitation would occur whenever erosional gullies cut through the beds. Potential quarry-workshop areas should be sought in floodchute areas and stream bank cut areas. Lithic resource occupation camps may have been operational throughout the year in association with seasonal exploitation activities related to limited season food resources.

Wildfowl are most numerous in the fall line zone of New Castle County during the late fall and early spring migrations of these birds. The coastal regions would have been occupied by hundreds of thousands of geese and ducks during these periods. Exploitation would have taken place at this time and in areas of open water, ponded regions and large clearings. Seasonal and transient camps of wildfowl hunters can be expected adjacent to ponded marshes and the lower Christina River estuary. Also a possible location for exploiting migratory wildfowl are the sink hole areas of western New Castle County.

The larger wild game animals are available on a year around basis in most of the fall line zone and especially in the margins of the Piedmont area. They are readily and efficiently exploited during the late fall and winter when they congregate in groups within areas protected by heavy forestation and dense underbrush. These types of areas can be found in upland flats, along the margins of open marshes and along stream valleys. The sink hole area of western New Castle County would be another particularly favorable location for exploiting the deer. Beaver may have been hunted in the many small stream valleys leading down into the fall line zone from the Piedmont as well as in Piedmont valleys further to the north.

Fish were certainly a resource exploited by prehistoric man in the study area. Most readily exploited in the spring during their annual spawning runs, these food resources would have provided nourishment for a relatively large population for a short period of time. It is suggested that anadromous fish would occur in the smaller streams of the study area and camps of the fishermen should be located adjacent to constrictions in shallow streams at the foot of the Piedmont white water areas.

Seeds are seasonal food sources that seem to have been heavily exploited by prehistoric man. Sources include those areas at the fringes of marshland where the openness to sun and air support large communities of seed-bearing plants. Also supportive of seed plants are area that are frequently flooded and which can not support trees of any great size. These areas are scattered throughout the study area and should be considered as potential site locations.

The harvesting of nuts may have provided a very large part of the annual nourishment for fall line zone inhabitants. These resources are found in abundance within the zone and in the adjacent Piedmont. They are available in the late fall in upland, well-drained areas and on slopes of stream valleys. Nut harvesting camps should be found in areas adjacent to the resource zones.

Project Area Microenvironments

Within the project area (New Castle County's fall line zone) are four basic microenvironmental zones: 1) Upland Forests, 2) Upland Flats and Wetlands, 3) Stream Valleys, and 4) Water Courses. These four contain in varying amounts the environmental resources noted above. Each was utilized by prehistoric man in the Middle Atlantic Coastal Region and certainly within the project area. The manner in which they were utilized is discussed below.

Upland forests are areas of minor relief but containing well-drained ridges and knolls. Soils are generally of the Sassafras and Fallsington types and support woodland vegetation as well as agricultural land. The fall line zone uplands are generally extensive and are found throughout the county. Resources of significance to subsistence and settlement would include nuts, lithic materials and, in places, seed bearing plants. Upland areas would provide inexhaustable amounts of firewood for settlements and the well-drained areas would be sought for living space.

Upland flats and wetlands include areas of poor drainage located within the uplands. The flats are usually seasonally wet with standing water not uncommon. Wetland vegetation would consist of scrub trees with heavy undergrowth. These areas would be heavily frequented by deer and other game animals and clearings within the wetlands and swamps would be temporarily occupied by migrating wildfowl. Wetland areas would also support various plant foods such as seed-bearing plants, tubers, leafy plants and spring greens, as well as fruit bearing trees. Included in this category are the sink hole areas of western New Castle County.

Stream valleys in the fall line zone are generally broad and shallow with wide flood plains and fringing marshlands. The bottoms would support edible plant life, would be the locations of hunted animals such as beaver and muskrat and would be frequented seasonally by migratory wild fowl. Valley slopes contain nut bearing trees and provide numerous springs and other fresh water sources for human consumption.

Open water, as used here, includes the major stream, the Christiana River, draining the study area and its larger tributaries. These water bodies support fish and in the past had small populations of freshwater shell fish (mussels). The waters were also frequented by the migratory wild fowl that used the Atlantic Flyway in the spring and fall.

The microenvironmental areas of the study area were utilized by man for at least eight thousand years. The general picture of this prehistory, as viewed from a cultural adaptation perspective, was one of a succession of peoples utilizing various areas on a seasonal round system of subsistence. Such a system necessitates seasonal and transient camps, each occupied for the duration of a particular food resource procurement activity.

Predicted Settlement System

Assuming that the prehistoric occupants of the project area depended upon a variety of resources for their existence; that they utilized the natural resources of the entire fall line zone and adjacent Piedmont areas to a maximum, and that during the period in which particular resources were being exploited they lived and worked in semi-permanent, seasonal or transient camps, it is possible to create predictive subsistence-settlement models pertaining to the various prehistoric periods of the area. The following discussion is based upon information presented above and is offered as a model by which the general location of prehistoric settlements can be predicted, the function of those settlements determined and the significance of the potential archaeological information contained within those settlements evaluated.

In the Sassafras-Fallsington-Matapeake Association region, the most important factor in site selection is not necessarily proximity to currently available natural resources. Microenvironments in the study area are compressed and habitat variety exists within a short walk of most points. The site selection decision appears to be influenced by a weighing of various factors the most important of which pertain to the nature of the actual living space itself (see Thomas, Griffith, Wise & Artusy, 1975 for extended discussion).

It is held that semi-permanent base camps are the rule rather than the exception among the permanent inhabitants of the fall line zone. Transient camps would have been used by inhabitants in search of resources within the area that were located away from these base camps and by groups entering the area to exploit those resources that may have attracted them to the area (such as the jasper outcrops of western New Castle County). Fall line zone inhabitants may have left the study area in search of those commodities (resources such as marine shell fish and Piedmont game animals) that were included in their annual exploitive schedule.

If this reasoning is followed, the major factors which influenced the site selection decision must be related to the needs of a semi-permanent base camp in which an entire social group will live and work for the greater part of the year. The factors postulated as critical are those of accessibility to fresh water, availability of sufficient quantities of fire wood, protection from prevailing winter winds, aspect (relating to the number of hours of the day that the encampment is exposed to direct sunlight), transportation accessability, and drainage within the site itself.

In order to predict aboriginal semi-permanent site locations the writer utilized available Soils Maps in conjunction with USGS Topographic Maps. These maps detail the distribution of various soil types and topographical features and allow the pinpointing of possible settlement locations based on drainage, aspect and nearby resource sources. The following figures contain predicted aboriginal site locations within the project highway ROW areas. They also include a sketmatic of the fall line zone with potential semi-permanent base camp location areas (Figures II-2 - II-5).

Transient camp site locations are also included on the accompanying maps of the project area. The assumption is made that these camps are occupied by specialized members of the socioeconomic group and that the selection factors considered differ from those used in selecting semi-permanent camp sites. The major factor for occupation sites of a transient nature is proximity to the resource and drainage. Since resources include hunted game that moves across the landscape congregating in low wetland woods, and since these wooded sites are found throughout the study area, it is likely that the specialized transient camps may be found on almost any well drained area that adjoins a wetland situation.

The above discussion considered site selection factors to the exclusion of an overall subsistence-settlement statement. The following model can be used in the evaluation of significance of resources found within the project area (one of the primary objectives of the study). It is contended that from Archaic Periods through the Late Woodland (with a lessening in intensity of occupation within the study area) occupation of the fall line zone was concentrated in strategically located semi-permanent base camps. These base camps would be occupied during the fall, winter and spring during periods of exploitation of nuts (hickory, walnut and acorn), game animals, spring fish runs, plants, possibly horticultural products and lithic materials. Transient camps would be created to be used by hunters, flint knappers and other specialists for short periods of time. During the summer months excursions to southern coastal zones may have occurred.

Base camps located adjacent to the major streams and near open marshlands or floodplain clearings would be the most strategic location for multiple resource exploitation. Spring fish exploitation, fall nut harvesting, local hunting and gathering activities and the procurement of wild fowl could be conducted at the camp. Transient camps would be occupied in the winter during hunting trips to upland flats, Piedmont forests, jasper outcrops and perhaps southern coastal areas. Semi-permanent base camps should be found on well-drained knolls and ridges in the easternmost part of the study area, along the lower reaches of the Christina River and its major tributaries. Transient camps would be found in other parts of the study area.

In summary, it is proposed that occupancy of well-drained knolls and ridges will occur within the project area when these areas are adjacent to fresh water sources and resource procurement areas. The intensity of occupancy of these areas will increase with the degree of compression of resource areas (habitat variability). Consequently, larger and more permanent sites, sites of more complexity (semi-permanent base camps), will occur, for instance, on well-drained rises located at the point where a fresh water stream or spring enters a large stream and/or marsh area. However, some prehistoric land use can be expected on almost all well-drained sites containing one or more of the listed relevant factors.

Transient camps, of course, are as much a part of the subsistence-settlement system as are base camps and must be subjected to careful study in order to arrive at a total understanding of an economic system. Unfortunately, transient camps are often represented in the archaeological literature by only a brief mention and very little time has been spent on studying their significance (see Figures II-3 thru II-5).

It is suggested that the transient camp sites within the project area may be located on various types of landforms (see Figures II-3 thru II-5). Field survey may find these sites throughout most of the project ROW's. Appropriate concern must be given to the investigation and, if necessary, the preservation of these transient campsite resources.