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PROPOSED FULTON STREET TRANSIT CENTER

FULTON, DEY, CHURCH, JOHN, CORTLANDT & WILLIAM STREETS, MAIDEN LANE AND BROADWAY
BLOCK 63, LOT 13
BLOCK 79, LOTS 15, 16, 18, 19 AND 21
BLOCK 93, LOT 1
NEW YORK, NEW YORK

PHASE IA ARCHAEOLOGICAL ASSESSMENT

FTA - 106 M

∅ Fulton St

Prepared for:

New York City Transit
New York, New York

MTA New York City Transit

Prepared by:

The Louis Berger Group, Inc.
New York, New York

July 2004

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I. INTRODUCTION

I. INTRODUCTION

New York City Transit (NYCT) is planning to construct the Fulton Street Transit Center (FSTC) in the vicinity of Fulton Street and Broadway, covering portions of Fulton, Dey, Church, and William streets and Broadway, with direct impacts to Block 63, Lot 13; Block 79, Lots 15, 16, 18, 19, and 21; Block 80, Lot 1; Block 93, Lot 1, New York, New York (Figures 1 and 2). The proposed project includes:

1. Construction of a new Transit Center Building at Block 79, Lots 15, 16, 18, 19 and 21, designed to connect subway passengers with other elements of the FSTC;
2. Construction of a pedestrian tunnel underneath Dey Street from the Transit Center Building at Broadway and to the redeveloped World Trade Center site and R/W service at the Cortland Street stop at Church and Dey streets, with an entrance at 189 Broadway;
3. Improvements to the Fulton Street A/C underground mezzanines and J/M/Z entrances and mezzanines, by widening the existing facilities;
4. Installation of stairways and elevators at various locations throughout the project area, including the southwest and southeast corners of the intersection of Maiden Lane and Broadway, the southwest corner of Dey Street and Broadway, 150 William Street, 195 Broadway, and the northeast corner of Church and Dey streets;
5. Rehabilitation of the existing 2/3 and 4/5 stations at Fulton Street;
6. Creation of a new, paid R/W to E and an unpaid E to the FSTC connections along Church Street at the Chambers Street at WTC/Cortland Street stations.

The FSTC project will affect six existing subway stations: the Fulton Street 2/3, Fulton Street 4/5, Broadway-Nassau Street A/C, Fulton Street J/M/Z, Cortlandt Street R/W, and the Chambers Street-WTC E. The project is designed to improve access to and connections between 12 existing subway lines. These lines provide service for hundreds of thousands of daily commuters, Lower Manhattan residents, and visitors to the downtown area. The project will also link NYCT facilities with PATH service and the World Trade Center site.

The area to be impacted by this project encompasses an irregularly shaped corridor beginning on the west side of Church Street at its intersection with Dey Street and extending to the east side of William Street along Fulton Street. The archaeological area of potential effect (APE) covers all portions of the project where ground disturbance will occur, either through construction, utility relocation or demolition of existing buildings. The archaeological APE is confined mainly to Church Street between Dey and Fulton streets, Dey Street between Church Street and Broadway, Broadway between Cortlandt Street/Maiden Lane and Fulton Street, Fulton Street between Broadway and William Street, and William Street between Ann and John streets (Figure 2). The remaining impacts will occur within Block 79, Lots 15, 16, 18, 19, and 21 (bounded by Broadway, John Street and Fulton Street), Block 63, Lot 13 (189 Broadway at the southwest corner of Broadway and Dey Street), two small areas for staircases located on the southwest and southeast corners of the intersection of Cortlandt Street/Maiden Lane and Broadway, a new street entrance to the Fulton Street 2/3 station at 150 William Street (Block 93, Lot 1), new staircases and escalators to the southbound Fulton Street 4/5 station platform at 195 Broadway (east side of Block 80, Lot 1), and a new staircase and elevator to the Cortlandt Street R/W at the northeast corner of Church and Dey streets (southwest corner of Block 80, Lot 4).

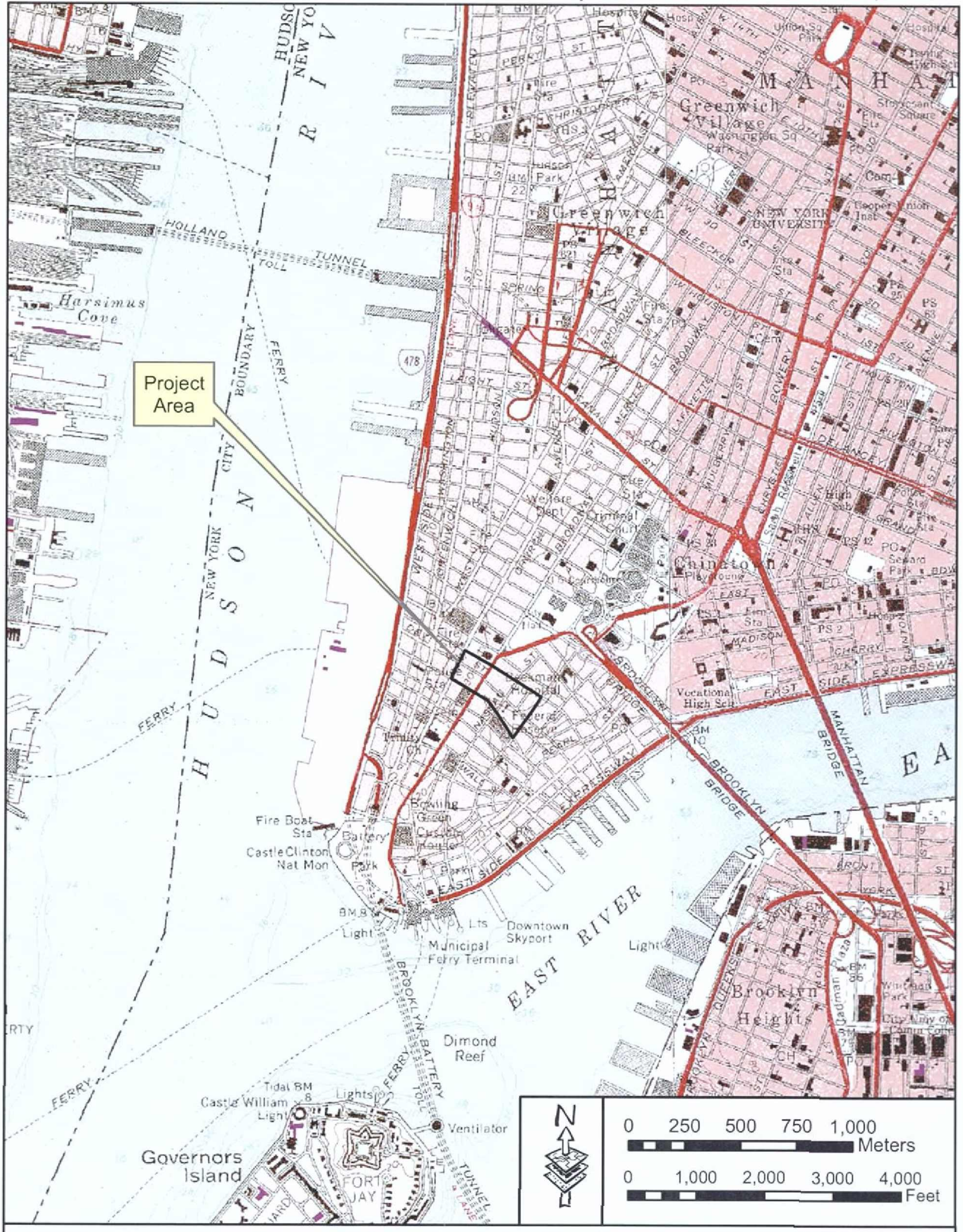

FIGURE 1: Overview of the Proposed Fulton Street Transit Center Project Location

SOURCE: USGS Jersey City, NJ-NY, 1981 & Brooklyn, NY 1979, 7.5' Series

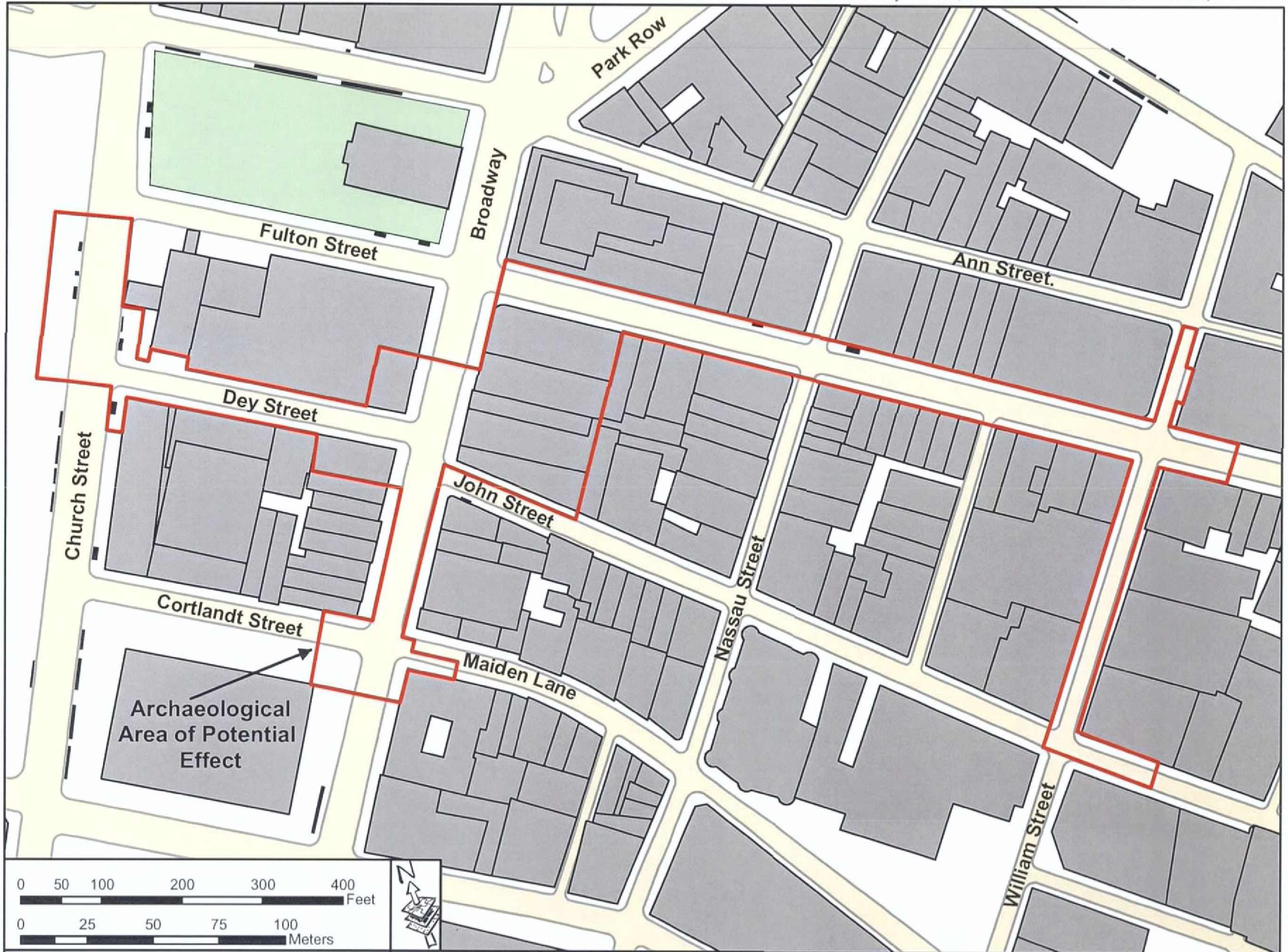

FIGURE 2: Archaeological Area of Potential Effect for the Proposed Fulton Street Transit Center

Source: NYCEMap GIS

Under Section 106 of the National Historic Preservation Act (NHPA) and the regulations established by the Protection of Historic Properties (36 CFR 800), the local agency, NYCT, must take into account the effects of its undertaking on historic properties either listed in or eligible for listing in the National Register of Historic Places. To comply with the Section 106 process, NYCT contracted with The Louis Berger Group, Inc. (Berger), to complete a Phase IA Archaeological Assessment of the proposed FSTC complex, in order to evaluate the archaeological potential of the area to be excavated for the proposed project.

This investigation was conducted in compliance with the National Historic Preservation Act of 1966 (36 CFR 800). Work conformed to the *Cultural Resource Standards Handbook* prepared by the New York Archaeological Council Standards Committee and the *Guidelines for Archaeological Work in New York City* prepared by The City of New York Landmarks Preservation Commission (LPC). The investigation consisted of background research on the natural environment, prehistory, and historical development of the project area. Background research was conducted between March 12 and May 15, 2003, and included examination of historical maps and texts, secondary histories, and relevant cultural resource studies. Historical resources were consulted at the following institutions: New York Public Library's Map Room, The City of New York Landmarks Preservation Commission, the Map Room of the Manhattan Borough President's Office and the Elmer Holmes Bobst Library at New York University. Archaeological site files were reviewed at the New York State Museum and the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP), both in Albany. Background research for the report was performed by Mr. Gerard Scharfenberger and Mr. Zachary Davis, both RPA-certified archaeologists. The report was authored by Mr. Davis and Mr. Scharfenberger. The graphics were prepared by Mr. Davis and the report was edited by C. Carol Halitsky.

II. PROJECT SETTING

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A. PROJECT LOCATION

The proposed FSTC project is located in downtown Manhattan, north of Wall Street and east of the World Trade Center site. The project area is bounded by Church Street to the east, Maiden Lane to the south, Fulton Street to the north, and William Street to the east. The project is set in a densely commercial and developing residential area with the full range of architectural styles reflecting the area's nearly 250 years of occupation.

The Fulton Street station complex is the busiest subway station in Lower Manhattan, with over 275,000 passenger entries, exits, and transfers each day. Many of these trips are made by commuters traveling to or from homes in the NYC area, or to commuter rail hubs at Penn Station, Grand Central Terminal, Atlantic Terminal in Brooklyn, and Jamaica. The current subway complex is made up of six separate subway stations, built at different times by different companies or agencies between 1905 and 1932. Because the subway lines competed with each other during this period, there was little incentive to make it easy to transfer from one line to another. Consequently, these stations suffer from a number of impediments to efficient use. Many subway entrances are obscured and poorly identified, and entrances are frequently dark, narrow, and confusing. Station egress is hampered by narrow sidewalks and heavy street traffic. Transfers between the subway lines are complicated, requiring the use of multiple stairways, ramps, and narrow passageways. Lastly, the Lexington Avenue line ❹/❺ platforms are crowded by transferring passengers, creating delays in train boarding and overall subway service.

B. ARCHAEOLOGICAL AREA OF POTENTIAL EFFECT

The area to be impacted by this project encompasses an irregularly shaped corridor beginning on the west side of Church Street at its intersection with Dey Street and extending to the east side of William Street along Fulton Street. The archaeological area of potential effect (APE) covers all portions of the project where ground disturbance will occur, either through construction, utility relocation or demolition of existing buildings. The archaeological APE is defined as: the west side of Church Street (width of 40 feet from the street curb) between Dey and Fulton streets, the Church Street streetbed between Dey and Fulton streets, the east side of Church Street (width of 30 feet to the east) north of Dey Street, the east side of Church Street (width of 20 feet to the east) south of Dey Street, the width of Dey Street (from building façade to building façade) including both north and south sidewalks, the building at 189 Broadway (Block 63, Lot 13), the southeast corner of 195 Broadway (Block 80, Lot 1), the Broadway streetbed from Dey Street/John Street south to its intersection with Cortlandt Street/Maiden Lane, the northern sidewalk of John Street along the south side of 192 Broadway (the Corbin Building, Block 79, Lot 15), the entirety of Block 79, Lots 15, 16, 18, 19 and 21, the Fulton Street streebed including the northern and southern sidewalks from Broadway to a point 90 feet east of William Street, the William Street streetbed from Fulton to Ann street, the William Street streetbed from Fulton Street to John Street including the western sidewalk, and the John Street streetbed from William Street east for 110 feet including the northern sidewalk.

C. EXISTING UTILITIES/SUBSURFACE INFRASTRUCTURE

Previous utility installation has disturbed significant portions of the proposed FSTC project area. Mapping of the underground utilities in the project area was provided by New York City Transit and has been reproduced in Figure 3. The presence of numerous utilities throughout the archaeological APE suggests that

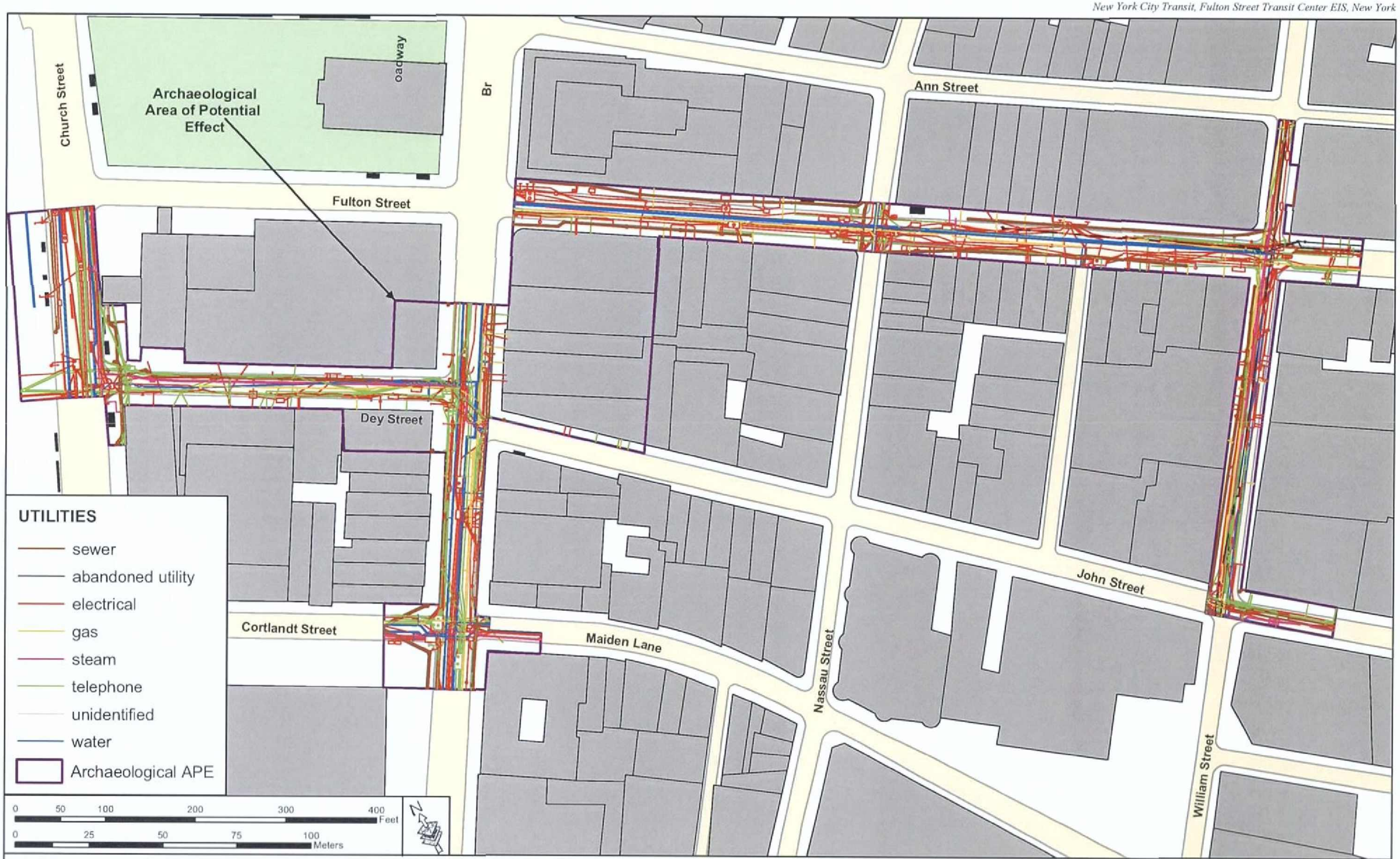

FIGURE 3: Existing Utilities within the Fulton Street Transit Center Archaeological APE

Source: NYCEMap GIS

the project area has been extensively by previous excavation for utilities over the past 200 years. It is unknown to what depth the archaeological APE has been disturbed by all utilities, but the depth of the sewer line is known to vary from 10 to 12 feet below the surface within the archaeological APE. Sewer lines are typically the deepest utilities; therefore, the remainder of the utilities are assumed to extend to much more shallow depths.

Test pits excavated by NYCT for the FSTC project have confirmed the shallow nature of utilities in the archaeological APE. Information is available on three test pits excavated in 2004: TP-10, TP-11 and TP-12, located on the west side of Broadway at Cortlandt Street (Figure 4). These three test pits encountered extensive utilities along the west side of Broadway. Utilities present included water (at a depth of 4'7" b.g.s.), several telephone lines (at depths of 2'1", 2'6" and 2'10" b.g.s.), several electrical lines (at depths of 1'1", 1'7", 1"9" and 6' b.g.s.) and gas (at a depth of 2'4" b.g.s.). These test pits indicate that the installation for water lines extended down approximately 5 feet, electrical lines extended down to 6 feet in some places (though they are more commonly encountered at depths between 1-2 feet), and gas and telephone lines are located between 2-3 feet. Based upon the information from these test pits and previous research on utilities in Lower Manhattan (Geismar 2003), it is assumed that where utilities are present, the first three feet in depth b.g.s. has been disturbed by previous utility installations. Underneath the first three feet in depth, sewer lines have disturbed the archaeological APE to a depth of approximately 10-12 feet b.g.s.

Outside of these disturbed areas, it is possible to encounter archaeological resources if such archaeological resources would be expected there. One potential archaeological resource within the streetbed that may have survived twentieth century utility installation is late eighteenth and early nineteenth century subterranean infrastructure, including bored-out wooden logs used by the Manhattan Water Company to deliver water to Lower Manhattan at the turn of the eighteenth century (Gesimar 2003). Research on the historic installation of water, gas and steam lines in the archaeological APE has been conducted to document the potential archaeological resources that may be encountered in areas that have escaped twentieth century disturbance (Appendix A).

Additional disturbances to the project area have occurred with the excavation and construction of the various subway lines located within the archaeological APE. Figure 5 details the extent of the subway lines, station, vents, stairs, elevators and other facilities located below ground that have disturbed significant portions of the archaeological APE. One section of the archaeological APE that has not been disturbed by the existing subway construction is Dey Street, which has subway entrances at the Broadway and Church Street intersections only. The main streetbed of Dey Street was purported to have contained an underground passageway connecting the H&M Tubes (the forerunner to the modern day PATH system) to the ❹/❺ subway line at Dey Street and Broadway (ARUP 2004a), but this connection appears to have never advanced beyond the conceptual/design stages. For the most part, it appears that the Dey Street streetbed is less disturbed than the remainder of the archaeological APE.

Other disturbances to the archaeological APE are represented by the footprints/vaults of the various buildings occupying portions of the archaeological APE (ARUP 2004b). Along Dey and Fulton streets and Broadway, existing vaults protrude into the archaeological APE, therefore creating further disturbances to the archaeological APE. Additionally, the footprints of the buildings located within the archaeological APE create further disturbances to the archaeological APE. Figure 6 provides information on the portions of the archaeological APE that lie within existing building's footprints or vaults. Along Dey Street, portions of both the northern and southern sidewalks have vaults that extend underneath the sidewalks. Similarly, the eastern side of Broadway has vaults extending into the archaeological APE, as do portions of both the northern and southern sidewalks along Fulton Street. It is assumed that the three portions of the archaeological APE within

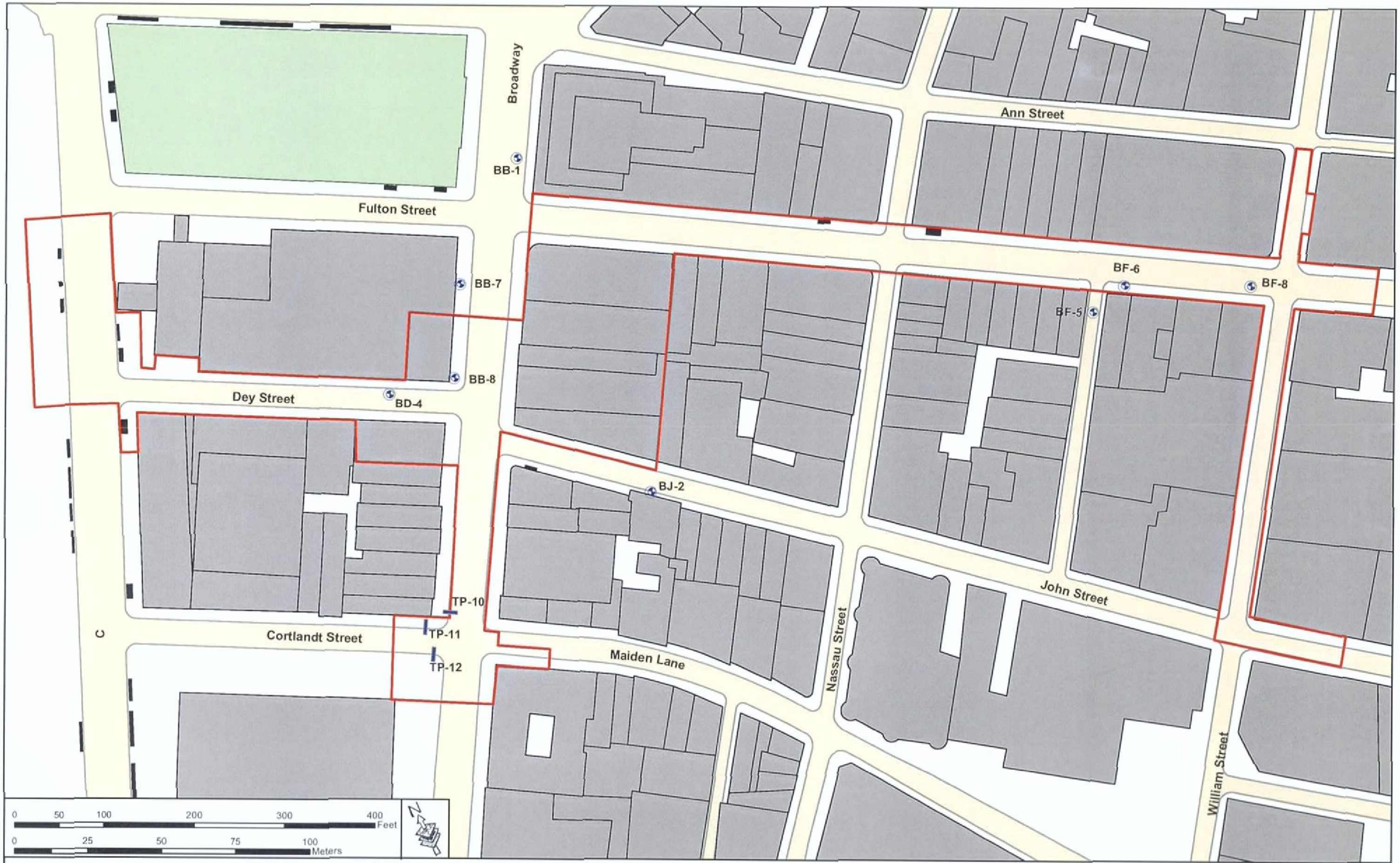

FIGURE 4: Soil Borings and Test Pits Excavated for the Fulton Street Transit Center Project

Source: NYCEMap GIS

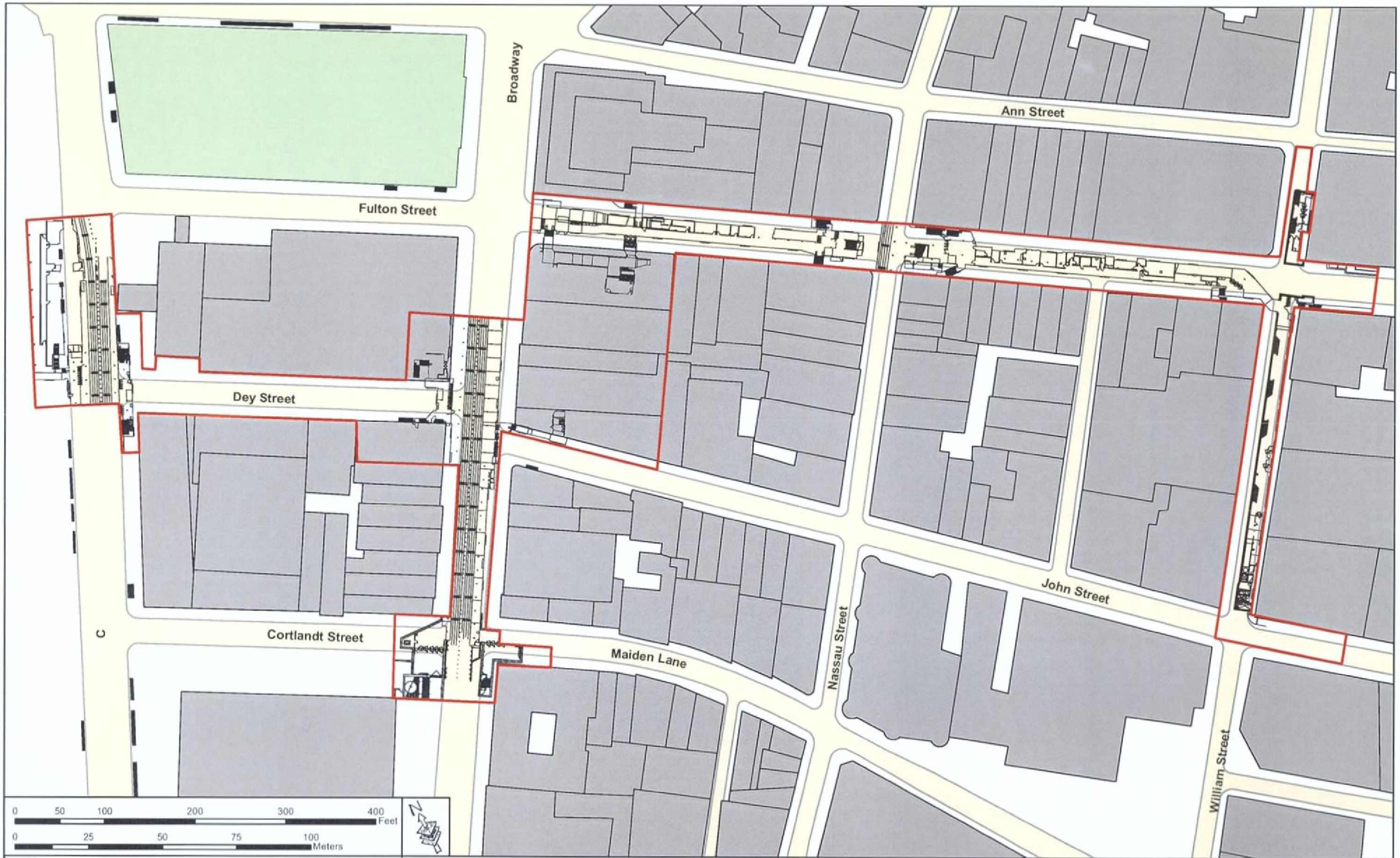

FIGURE 5: Location of NYCT Subway Elements within the Fulton Street Transit Center Archaeological APE

Source: NYCEMap GIS

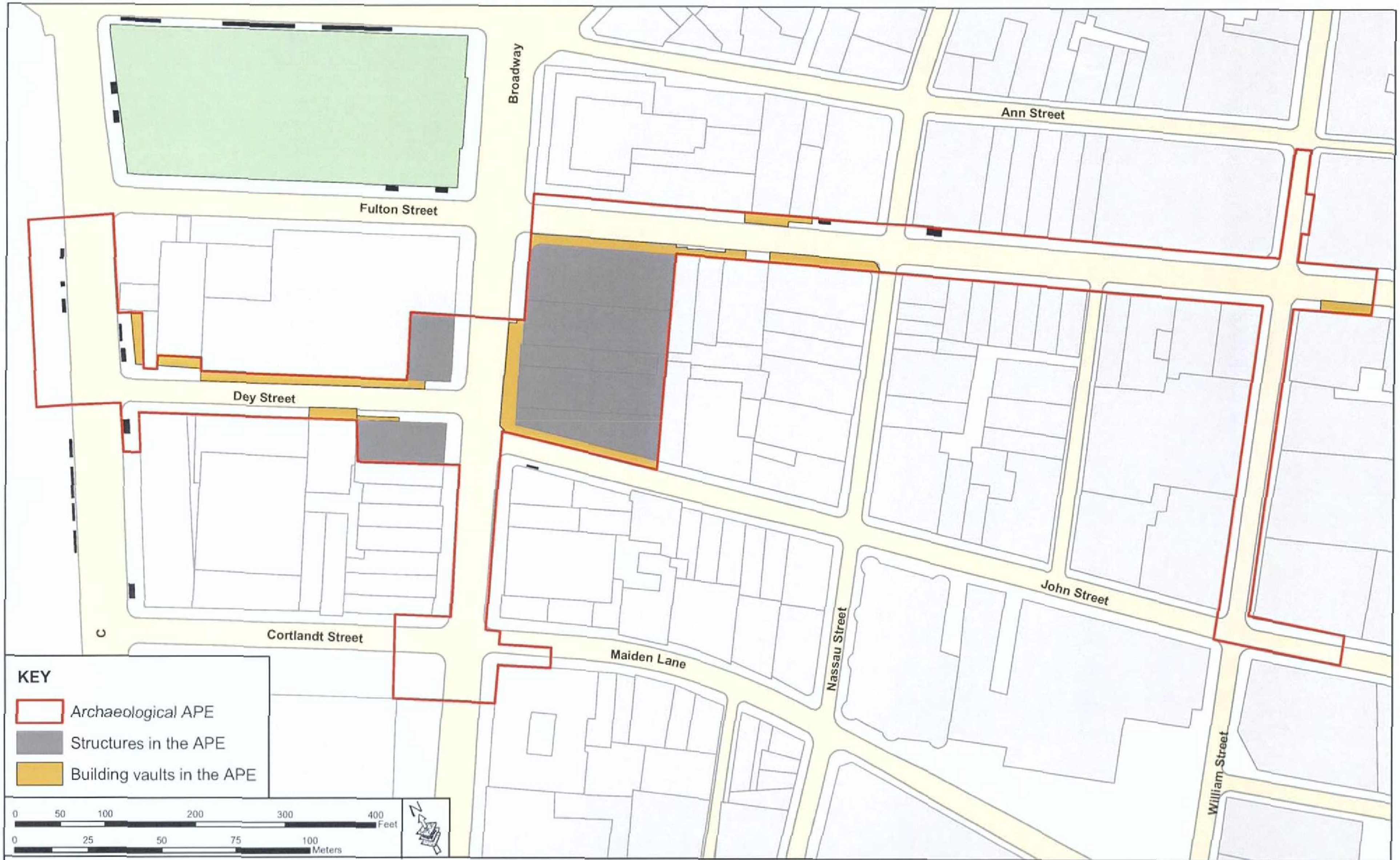

FIGURE 6: Building Footprints and Vaults within the Fulton Street Transit Center Archaeological APE

Source: NYCEMap GIS

these existing buildings have been disturbed during the construction of these buildings as all possess deep basements within their existing footprints.

Combined together, the utility, subway, building and vault information provides an understanding of the extent of disturbance to the archaeological APE. Given that the sewer lines are deepest across the project area, it was assumed that wherever the sewers are located has been disturbed and lacks archaeological potential. Similarly, it is assumed that the presence of the subway lines and associated facilities has disturbed portions of the archaeological APE. Lastly, the presence of building footprints and vaults has disturbed additional areas of the archaeological APE. Taken together, small portions of the archaeological APE do exist that have not been disturbed by these historic construction/excavation activities (Figure 7). These undisturbed portions of the archaeological APE may possess archaeological resources if it can be demonstrated that past human activities occurred in these areas. It is possible that historic infrastructure, such as the Manhattan Water Company's bored-out wooden logs, may be located within these undistrurbed portions of the archaeological APE.

D. GEOLOGY AND GEOGRAPHY

Manhattan is situated at the extreme southern terminus of the Manhattan Prong, part of the New England Upland physiographic province. The Manhattan Prong is a northeast-trending, deeply eroded sequence of metamorphic rocks. Manhattan consists of three prominent geologic formations: Manhattan Schist, Fordham Gneiss, and Inwood Marble, all of which are highly folded, faulted, and metamorphosed rocks.

Manhattan Schist occurs throughout Manhattan and is the most prevalent bedrock formation. The Manhattan Schist consists of foliated pelitic schists that may be of Middle Ordovician age (460 to 470 millions years ago). Sillimanite, garnet, muscovite, biotite, plagioclase, quartz, and kyanite comprise the schist. Layers of gneiss composed of similar materials are also present in this formation. The project area is located over bedrock composed of Manhattan schist.

Fordham Gneiss is a coarsely banded hornblende-biotite-quartz plagioclase formation primarily from the Upper Precambrian age (1.2 billion to 544 million years ago). It exists primarily in the northeastern portions of Manhattan north of Central Park.

Inwood Marble is commonly associated with valleys and lower-lying areas and is primarily a white to gray, medium- to-coarse-grained rock that ranges in composition from calcite to nearly pure dolomite. Inwood Marble can be of either Lower Ordovician or Upper Cambrian ages (470 to 510 million years ago). Inwood Marble is found primarily along the shores of the East River in lower Manhattan and in some areas near the Harlem River.

The topography of Manhattan has been shaped by glaciation that began nearly 300,000 years ago. Glacial reformation of topography smoothed out the ground surface and often deepened valleys that were oriented in the direction of glacial advance. Glacial till, deposited as ground moraine directly from the bottom of glacial ice, is the dominant overburden material in Manhattan (Schuberth 1968).

Although the project area has seen extensive commercial development throughout the twentieth century, the original topography of the project area is known from Viele's (1865) cartographic research conducted in the late-nineteenth century (Figure 8). The project area as plotted on Viele's map of Manhattan's original topography and water courses within downtown Manhattan reveals the original shoreline of Manhattan and the seventeenth century canal that once ran along Broad Street, known as the *Heere Gracht* (Berger 2003).

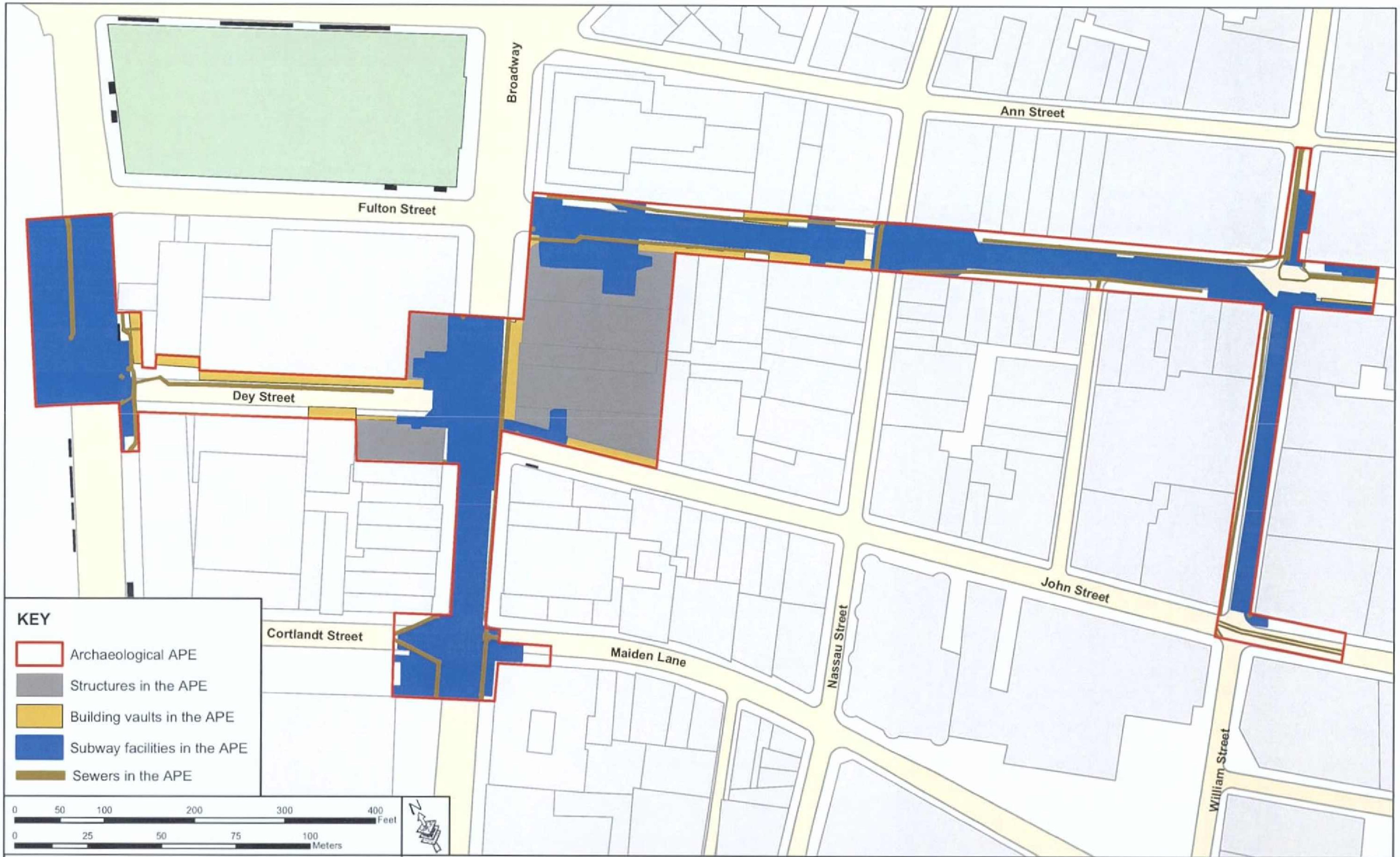

FIGURE 7: Extent of Historic Subsurface Disturbance to the Fulton Street Transit Center Archaeological APE

Source: NYCEMap GIS

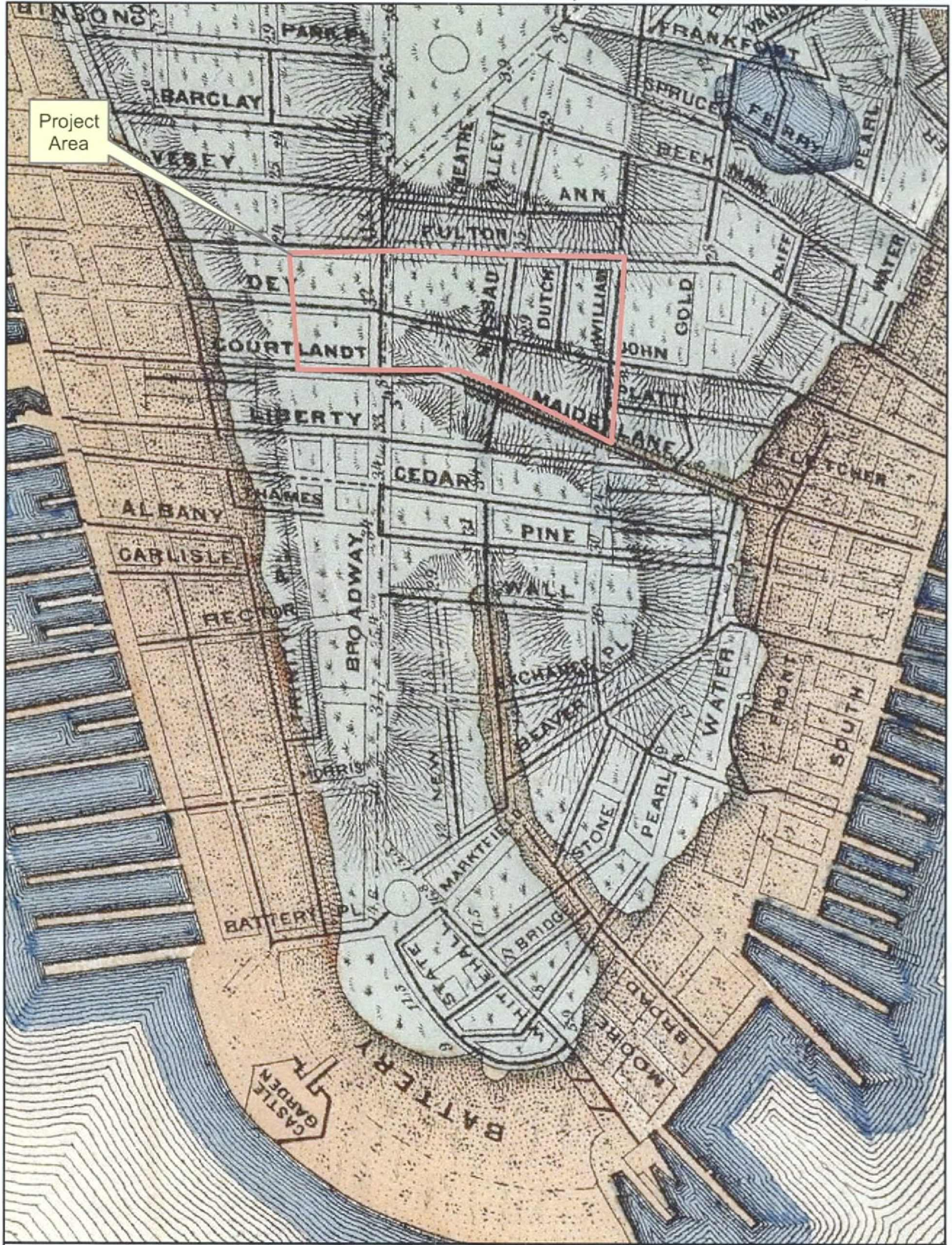

FIGURE 3: Map of Lower Manhattan in 1865

SOURCE: Viele 1865

Soil borings excavated by NYCT for the FSTC (see Figure 4) reveal that the project area is situated in an area with some deposits of modern fill, ranging in depth from 12-15 feet b.g.s., with fine to medium sands overlying glacial till (Appendix B). Three of the borings, BB-1, BF-5 and BF-6, recovered brick and/or cinders remains within the fill layer. From these borings, it can be assumed that the original surface of the project area was approximately 12-15 feet below the modern surface, due to development of the project area since the area was first occupied in the 1600s.

E. PLANT AND ANIMAL RESOURCES

Prior to European contact, the Native Americans in the vicinity of the project area subsisted by hunting small game, fishing, collecting shellfish, and gathering local plants (Gilder 1936:3). Cultivation of corn, local wild grasses, and tubers may have occurred prior to European contact, but this point is currently under debate. The first European explorers, Henry Hudson and Giovanni Verrazano, among others, noted in some detail the surrounding environment; they remarked on the great quantities of fish, small game, oysters, and waterfowl (Kieran 1971). The early European settlers of the seventeenth century imported many of the initial foodstuffs they needed, including domestic animals (sheep, cattle, horses, swine, and fowl), seeds, grains, and root plants. The new agricultural species had very few problems adapting to local soils; however, along with these importations came an unwanted invasion of foreign insects and fungi that later proved detrimental to native species (Barlow 1971; Kieran 1971).

F. PALEOENVIRONMENT

Reconstructing environmental and landscape changes through time is essential to identifying an area's archaeological sensitivity, as certain environmental conditions produced preferred locations for prehistoric settlement. The climatic, hydrologic, and vegetational conditions in the project area have changed over the course of human occupation. For example, the earliest evidence of human activity in what is now New York occurred during the Late Pleistocene, when the climate was considerably colder (Imbrie and Imbrie 1979). Changes in the climatic system in the vicinity of the project area since the end of the Pleistocene have affected the evolution of waterways in the area and the types of plant and animal resources upon which human populations depended. Paleoenvironmental reconstructions of the area provide a model for predicting settlement history and potential archaeological site locations.

Based on data from fossil pollen remains and associated radiocarbon dates, the local environment during the earliest human habitation of the area can be generally characterized as periglacial. The remnants of the Wisconsin glacial advance stretched in a northwesterly direction in an irregular belt almost one mile wide from Perth Amboy at the mouth of Raritan Bay in New Jersey across New York State. Between 12,000 and 13,000 years before present (BP), sea level may have been 300 feet lower than at present, and the shoreline would have extended out approximately 120 miles from its present position (Cantwell and diZerega Wall 2001). Consequently, river and stream systems and their plant and animal communities exhibited different configurations (Edwards and Merrill 1977). Peat borings from the continental shelf indicate that the fairly level plain supported an open spruce parkland or spruce woodland environment, including pine, fir, and other vegetation (Sirkin 1976, 1977). The geomorphology of the area, in combination with the effects of glaciation and subsequent sea level rise, indicates that marine environments were probably not stable at that early date and could not have served as a primary focus of human subsistence activities (Edwards and Merrill 1977; Newman 1977).

The glaciers began to retreat between 17,000 and 15,000 BP. Glacial scarring created a variety of developing habitats, including estuaries, salt and freshwater marshes, bogs, and upland and midslope communities. Glacial soils contained a wide diversity of particle size, which allowed good drainage and adequate water supplies for the developing plant and animal communities.

After the retreat of the glaciers the coastal region of New York was favored by a set of ecological factors that probably contributed to its attractiveness to early human populations. These factors included a relatively long frost-free period, a greater annual reception of sunlight, and the tempering effects of a coastal environment. Brennan (1977) suggests that during postglacial recovery, deciduous forests penetrated the coastal regions of New York and New England more rapidly than in the cooler and higher inland regions. Many of the cold-adapted animals probably followed the retreating glaciers northward and, in the case of mammoth and mastodon, became extinct. These creatures were replaced by deer, elk, moose, bear, and smaller mammals.

By circa 15,000 BP the Wisconsin Ice Margin had receded north of New Jersey (Schuberth 1968). It is estimated that at that time sea level was approximately 300 feet lower than the current level. This would have exposed a large area of the continental shelf, possibly as far as 120 miles east of the present coastline. As a result, many of the islands in New York Harbor would have been connected to the mainland.

During the period of the glacial retreat the regional vegetation changed from open spruce forest to mixed hardwood vegetation in the uplands, and grasses and wetlands forest in the lowlands (Sirkin 1976,1977). Changes in faunal communities accompanied the shifts in climate and vegetation. Large cold-adapted species, such as mammoths, mastodons, and caribou, were replaced by more temperate species, such as white-tailed deer. With the rise in sea levels, the vicinity of the project area changed from an inland setting to a coastal one. These changes would have had an enormous effect on potential for population movements and resource exploitation. Upland terrain would have supported mixed hardwood forests, and lowlands would have supported a variety of wetland and lowland forest vegetation. Expanding wetlands and waterways in the project area would have provided environments for numerous migratory birds, waterfowl, fish, and mollusks.

Pollen data show that the regional environment continued to change after glaciation. By 2000 BP environmental and meteorological conditions had approached those of the present, but southern tree species continued to migrate into the area (Barlow 1971).

III. PREHISTORIC CONTEXT

III. PREHISTORIC CONTEXT

Three major periods are commonly used to describe the prehistoric cultures of New York: Paleoindian, Archaic, and Woodland. The Paleoindian period dates from approximately 11,000 to 10,000 BP (Curran 1996; Fiedel 1999). The earliest known occupation of New York City comes from the southwestern shore of Staten Island, where stone tools dating to about 10,000 BP were found in disturbed soils associated with the Port Mobil oil tanks. Along Charleston Beach, located just south of Port Mobil, local avocational archaeologists collected stone tools that were similar to those found at Port Mobil (Boesch 1994). The common stone tool recovered from these two sites is a lanceolate-shaped spear point with a long, thin channel removed longitudinally from both faces of the point. This technique is known as "fluting" and is a hallmark of the Paleoindian period (Callahan 1979). In addition to these fluted points, other stone tools included unfluted points, scrapers, knives, borers, and gravers (Eisenberg 1978; Kraft 1977). This small collection of stone tools has been interpreted as prehistoric refuse from a small resource-procurement encampment (Funk 1977). Although the Port Mobil Site presently overlooks the Arthur Kill, sea levels were lower during the Paleoindian period and the waterway did not exist when the site was occupied (Edwards and Merrill 1977). The occupation represented at the Port Mobil Site probably represents a reconnaissance or hunting camp, rather than a marine-oriented gathering station.

The Paleoindian economy may have centered on the hunting of game. Although other economic activities, such as the gathering of plant foods or maritime resources, may have been equally important (Jones, et al. 2002; Roosevelt, et al. 1996; Sandweiss, et al. 1998), they have left little or no trace in the archaeological record. Lithic technological considerations may have also contributed to Paleoindian landscape settlement patterns. Goodyear (1989) suggests that high-quality cryptocrystalline materials (i.e., chert, jasper, and chalcedony) were the materials most commonly used to manufacture fluted lanceolate projectile points. He suggests that Paleoindians used high-quality lithic materials when producing fluted points because of the predictable manner in which these materials fractured, thereby decreasing the possibility of catastrophic fractures occurring as a result of internal (and hidden) flaws that are typically present in low-quality lithic materials. This predominance of high-quality lithic materials suggests that Paleoindians sought out high-quality materials, a hypothesis that is supported by the presence of high-quality lithic materials derived from great distances (up to 300 kilometers) at Paleoindian sites. However, recent geoarchaeological surveys have challenged this assumption by identifying local sources for Paleoindian lithic material (LaPorta 1994; Moeller 1999). These recent studies suggest that Paleoindians were occasionally manufacturing fluted projectile points on local and poorer quality lithic materials (Bamforth 2002).

The southwestern shore of Staten Island remains the only location in New York City where Paleoindian artifacts have been uncovered. There are several explanations for the limited evidence of Paleoindian occupation in coastal New York. One is the distance from high-quality lithic sources that were apparently critical to Paleoindian procurement and settlement strategies (Custer, et al. 1983; Goodyear 1989). Another is that many habitation sites from the Paleoindian era may have been destroyed by coastal geomorphologic changes that occurred after the sites were abandoned (Marshall 1982). Given the scarcity of known Paleoindian remains in the area, the potential for recovering Paleoindian remains or cultural resources from the project area is rather low.

The Archaic period (10,000 to 3000 BP, or 8000 to 1000 BC) is divided into Early, Middle, and Late subperiods, distinguished by differences in tool assemblages, projectile point types, and preferred lithic materials. Of the several Early-Archaic sites (8000 to 6000 BC) identified in New York City, most are located in Staten Island, including the Old Place Site, the Ward's Point Site, the H.F. Hollowell Site, and the Richmond Hill Site. All of these sites produced Kirk components, which produced radiocarbon dates from 5310 BC to

6300 BC. A radiocarbon date of 7410 BC from the Richmond Hill Site has also been identified, in relation to a Palmer (an Early Archaic variant) occupation (Ritchie and Funk 1971; Ritchie and Funk 1973:38-39).

Middle Archaic (6000 to 4000 BC) remains are extremely rare in New York City, although extensive Middle Archaic shell midden sites are known from further up the Hudson River (Brennan 1974; Claassen 1995). Middle Archaic artifacts, such as Kanawha or LeCroy projectile points, have been uncovered in southern Staten Island in the Rossville area (Historical Perspectives, Inc. 1996). Unfortunately, so little is known about the Middle Archaic occupation of the metropolitan region that it is often linked with either the Early or Late Archaic in discussions of prehistory (Kraft and Mounier 1982).

Late Archaic sites (4000 to 1000 BC), on the other hand, are better documented for New York City owing to the high quantity of diagnonstically dateable projectile points from this period that have been recovered. Two sites in northern Manhattan provide traces of information on Late-Archaic settlement in the metropolitan region. These two sites, Tubby Hook and Inwood (Skinner 1920), are multicomponent sites, indicating these locations were preferred habitation sites for several millennia. Late-Archaic sites in the metropolitan area characteristically are situated on tidal inlets, coves, and bays. Site location and contents suggest that Late Archaic hunter-gatherer groups exploited various marine resources, including shellfish and fish. The sites are typically small and multicomponent because of reoccupation as preferred locations for resource procurement. Changes that occur in the Late-Archaic aboriginal/indigenous toolkits reflect an expansion in the variety of utilized resources. Some of these changes include the manufacturing of fishing gear, such as netsinkers (weights), fishhooks, and an increase in the use of groundstone (Ritchie 1994). The increased utilization of marine and estuarine resources in this period may be associated with the eventual stabilization of coastal environments (Edwards and Merrill 1977), although sea levels were rising throughout the Archaic period (Bradley 1999; Salwen 1962).

Late Archaic remains found in New York City are mainly represented by narrow projectile points, including Poplar Island and Bare Island types (Silver 1984), other stone tools (endscrapers, bifacial knives, side scrapers), and special items such as bannerstones, steatite bowls, grooved axes, cylindrical pestles, and hammerstones (Ritchie 1994). Groundstone implements are also known from the Late Archaic (Historical Perspectives Inc. 1996), though these most likely would have been used to grind acorns into a meal (Ritchie 1980). Many points that are characteristic of the Late Archaic occupations of Staten Island and the rest of Late Archaic sites in New York City are made of argillite, which is not found locally. The nearest source of this material is within the Lockatong Formation of central New Jersey (Didier 1975; Venuto 1967). The increased variety of stone implements implies an increasingly complex development in the economic subsistence base exploited by the prehistoric population of New York City. The population would have been able to subsist on maritime, terrestrial, and even arboreal resources with their increasingly sophisticated technological repertoire, possibly moving from coastal to inland sites on a seasonal basis, as is suggested by ethnographic accounts worldwide (Mazel and Parkington 1981; Thompson 1939)

The Transitional or Terminal Archaic period (circa 1000 to 700 BC) is represented by the introduction of soapstone vessels and distinctive fishtail types of diagnostic points. A complex mortuary tradition associated with Terminal Archaic sites has been found on Long Island (Latham 1953; Ritchie 1965); however, such traditions have not been identified to date in New York City. Terminal Archaic sites in New York City have been identified in the Bronx (Skinner 1919), on Staten Island (Silver 1984), and Manhattan (Skinner 1919). The appearance of shell middens, which is characteristic of subsistence practices in the coastal areas of New York, continues through the Woodland period.

The Woodland-period occupation (circa 700 BC to AD 1500) in New York City is characterized by the introduction of ceramic technology. The earliest ceramics recognized in coastal New York are grit-tempered wares similar to a Vinette I-style series that is U-shaped with a rounded conical point when seen from top edge to bottom. Changes in pottery temper, vessel form, and surface treatments are useful chronological indicators. Middle Woodland ceramics include shell-tempered wares with cord and net impressions; Late Woodland ceramics include various collared vessels with incised as well as dentate and cordmarked decoration (Ritchie 1994).

While Early Woodland occupants appear to have followed hunting and gathering lifeways, plant cultivation became increasingly important during the Late Woodland period. Changes in subsistence practices and population growth led to increased settlement that resulted in the appearance of villages. Previous research has addressed the effects of an increasingly sedentary lifestyle on settlement patterns in coastal New York during the late Prehistoric and Contact periods (Ceci 1979; Silver 1984; Smith 1950).

Several Woodland sites have been identified in the City of New York, but only a few sites on Manhattan have yielded Woodland period material. The largest sample of Woodland sites come from Staten Island, although sites in the Bronx have yielded spectacular information regarding exchange networks in the metropolitan region (Kaeser 1963). The largest prehistoric burial site in the New York metropolitan area was found at the southwestern corner of Staten Island at Wards Point. First noticed by Skinner, this site, known as Burial Ridge, provides a good example of the range of occupations that can occur within a single archaeological site. Collections from Burial Ridge include a large variety of projectile point types, dating from the Early Archaic through the Late Woodland. The assortment of ceramic wares that has been recovered is diagnostic of all phases of Woodland occupation. At least 127 pits, burials, hearths, and some 4,000 artifacts have been associated with the Burial Ridge/Wards Point complex. Such findings suggest intensive Native American occupation from the Archaic through the Woodland periods (Jacobson 1980). Frequencies of types indicate that the most intensive prehistoric occupations of this area of Staten Island occurred during the Late Archaic and Middle through Late Woodland periods.

The end of the Woodland Period is marked by the encounter between the indigenous Native American population occupying the metropolitan region and European explorers looking for the elusive route to the spice-laden lands of southeast Asia. Around 1524, Giovanni Verrazzano sailed into New York Harbor and commented on the general pleasantness of the Native Americans riding along in canoes as they came close to his ship (Burrows and Wallace 1999). During this period, no longer the Late Woodland and not yet the time when permanent European settlements were established, the indigenous population began trading and interacting with the Dutch and English travelers exploring New York Harbor and eventually settling on Manhattan. Evidence of this interaction between the native population and the European explorers has been documented archaeologically in Staten Island (Skinner 1909), the Bronx (Skinner 1919), and Manhattan (Skinner 1920).

The people inhabiting Lower Manhattan at the time of the European explorers were probably the Marechkawieck group of the Canarsee, who controlled all of the nearby islands in the East River and Brooklyn (Bolton 1975:14-15; Grumet 1981:26-28; Jaffe 1979). The Canarsee were related to Delaware or Munsee-speaking groups who occupied the west side of the Hudson and the area around New York Bay (Goddard 1978:214-215). Manhattan itself is derived from the Delaware mannahata, meaning "hilly island" (Ruttenber 1906:14) or Manahachtanienk, meaning "the island where we all became intoxicated" (Heckewelder 1876:262).

The Marechkawieck were dispersed throughout lower Manhattan and lower Brooklyn, including Governor's Island, then called Pagganck (meaning nut or walnut) by the Canarsee (Grumet 1981:41). The Marechkawieck are most likely the individuals responsible for selling Manhattan Island to the Dutch in 1626 as they are listed on a 1637 document for the sale of Hell Gate to the Dutch (Grumet 1981:27). The Marechkawieck had a settlement in lower Manhattan just north of New Amsterdam in proximity to the Collect and Little Collect, spring-fed freshwater ponds located in what is now Foley Square (Geismar 1993; Harris, et al. 1993). The area of City Hall Park would have been a desirable location for Native American settlement as it was comparatively level and close to the freshwater ponds, swampland, and the East River. Valentine (1856:426) noted that the location of City Hall marked the former site of "a large Indian village." Bolton's map and index of Indian sites in New York City and its environs lists one site in the general project vicinity, Warpoes or Werpoes, described as shellheaps in an area above Collect Pond (Bolton 1934:133, 1975:78-79). The location of this village is variously given as west or south of Collect Pond (Geismar 1993:56). A Native American foot path was located in this section of Lower Manhattan, running north from the Battery to the northern end of Manhattan Island. This path, called the Wickquasgeck Road, was the main pathway for north-south movements along the length of Manhattan Island at the time of European occupation. This path followed the route of Broadway in Lower Manhattan (Grumet 1981:59).

By the time of permanent Dutch settlement on lower Manhattan in 1623, the Canarsee way of life had been forever changed by the introduction of European items, including guns, metal, alcohol, and glass. The most significant European contribution to the demise of the indigenous population was the spread of diseases, such as smallpox. Snow (1980) calculated mortality rates from imported diseases on New England's indigenous population at 55-98 percent. The young and old were disproportionally affected. The loss of young people had a devastating effect on the size of subsequent generations. Maintaining traditional cultural integrity was likely substantially affected by the loss of elders. The remaining Canarsee eventually sold their land to the Dutch and moved to Massachusetts or were killed by the Dutch or Mohawk during the mid-seventeenth century (Jaffe 1979:55). By the 1800s the population that had once occupied Lower Manhattan and Brooklyn had been completely removed from the metropolitan landscape.

IV. HISTORIC CONTEXT

IV. HISTORIC CONTEXT

Europeans probably first set foot on Manhattan during Henry Hudson's 1609 voyage up the river that now bears his name (Burrows and Wallace 1999:15). Following Hudson's travels in the New York City area, Adriaen Block, sailing for the New Netherland Company, made four trips to Manhattan. On the fourth trip in 1613-14, his ship, the *Tyjger*, burned where it rested on the western shore of Manhattan. A resourceful man, Block constructed a new ship, the *Onrust*, and sailed back to Holland in the spring of 1614. In 1916 during construction of the IRT subway at the intersection of Dey and Greenwich streets, the charred keelson of an early Dutch ship was uncovered, most likely the remains of Block's *Tyjger*. Although the remainder of the ship's hull was left in place, no further remains of the ship were uncovered in the 1960s during construction of the World Trade Center (Solecki 1974). Block's forced winter stay, during which the Dutch sailors relied on the local Canarsee for food, represents the first European settlement on Manhattan. The remains of this early Dutch ship represent the earliest archaeologically documented European activity on Manhattan.

In May of 1623 the *New Netherland* sailed into New York Harbor with thirty Dutch families, mostly French-speaking Walloons, representing around 120 people (Gilder 1936). These settlers were sent by the Dutch West India Company to create a permanent settlement to be called New Amsterdam. The *New Netherland* landed at the southern shore of Manhattan about where Greenwich Street and Battery Place now intersect, (Gilder 1936:4) as Greenwich Street runs along what was then the western shore of Manhattan. These colonists immediately began constructing a fort for their protection from the elements and the local Canarsee population.

The thirty families that arrived on the *New Netherland* settled at various locations in the metropolitan area, including parts of Staten Island, Brooklyn, and Jersey City. This dispersed pattern was designed to strengthen the Company's territorial claims to the New York City area. When Peter Minuit assumed control of New Netherland in 1626, he recognized the hazards of a dispersed population pattern and concentrated the colonists on Manhattan after his famous purchase of the island from the Native American inhabitants. The settlement on Manhattan grew slowly throughout the middle years of the seventeenth century.

The inhabitants of New Amsterdam/New York engaged in trade and maritime industries for the most part; the community included individuals following other occupations common to town dwellers (bakers, brewers, tavern keepers, government officials, etc.). The settlement on Manhattan continued to be concentrated at the southern tip of the island for most of the eighteenth century, although farms and villages were located farther north. The location of the proposed FSTC was part of a farm called the "King's Farm," property owned by the English crown. This farm had originally been called the "Company's Farm" by the Dutch, which they had set aside for use by the Dutch West India Company only. When the English took over the Dutch territories in the New World the Company's Farm was handed over to the Duke of York. When he ascended to the English throne the land became known as the King's Farm, and when Queen Anne came to power in 1702 it was known as the "Great Queen's Farm." Governor Lord Cornbury granted the entire estate to the English Church of Manhattan Island in 1705 (Janvier 1894). Eventually this land came to be owned by a Thenius Dey, a Dutch gardener and miller in the eighteenth century (Feirstein 2001:26). The modern Dey Street, which had also been known as "Batteau Street," is named for this Dutch gardener (Stokes 1915:997).

The earliest historical map depicting the approximate location of the project area is Maerschalk's (1755) map of Manhattan (Figure 9). When this map is geo-referenced to the NYCMap coordinate system, the project area is easily located within the mapped grid that conforms closely to the present-day configuration. Fulton Street is labeled Partition Street west of Broadway, while east of Broadway, Fulton Street is known as Fair Street; Dey Street is called Dyes Street. Church Street is absent from the western side of the archaeological APE, as Church Street was not extended through the project area until the late nineteenth century. In several locations,

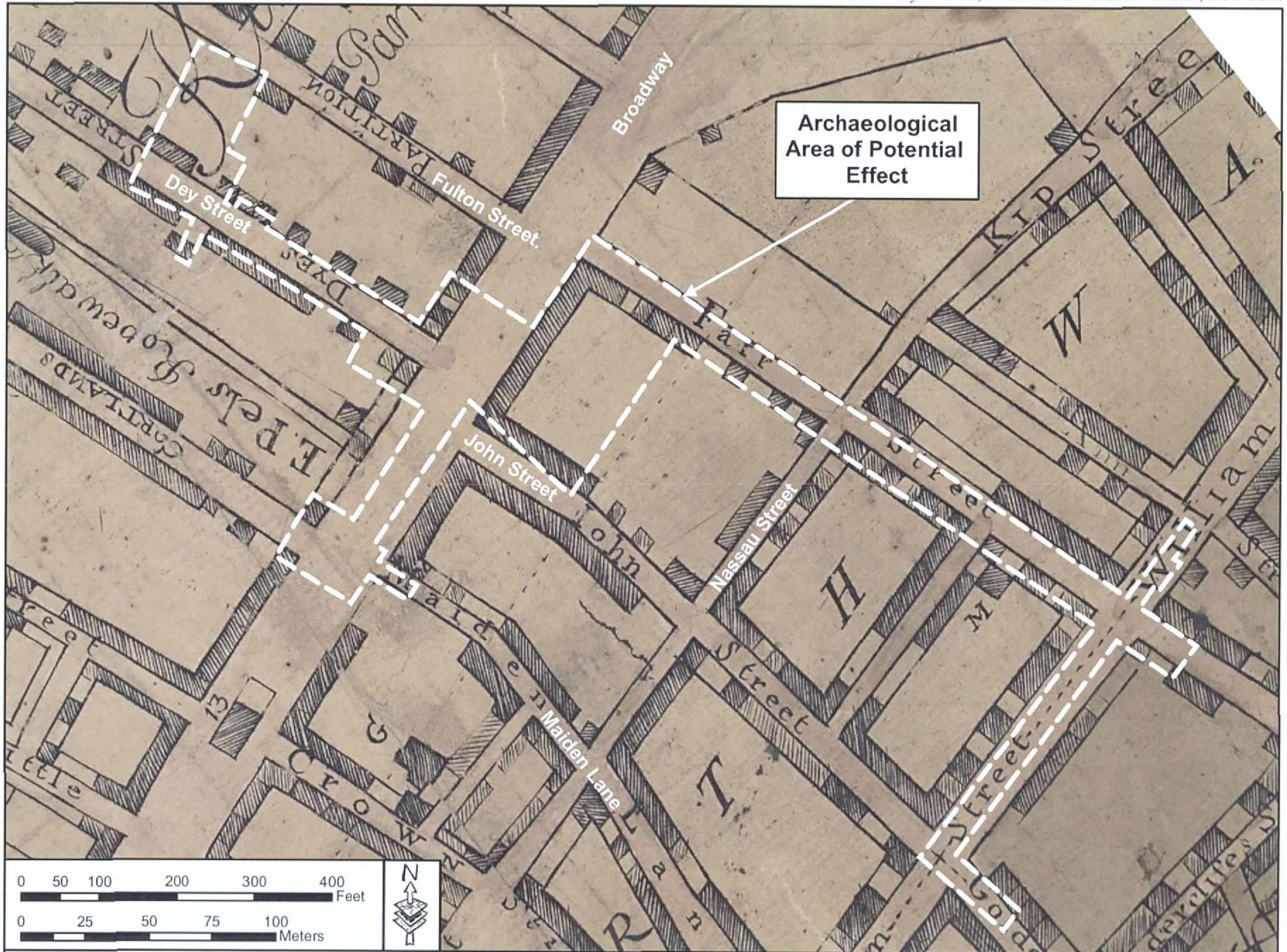

FIGURE 9: Fulton Street Transit Center Project Area in 1755

Source: Maerschalck 1755

the archaeological APE appears to overlap with historic structures. Along the western edge of the archaeological APE, the present day location of Church Street is occupied by several structures and backyards along Fulton and Dey streets. Additionally, when the archaeological APE is overlaid across Fulton Street between Broadway and William Street, it appears that the southern half of modern Fulton Street is located within the limits of the historic structures on the south side of Fair Street. This is most likely the result of inaccuracies between the historic mapping of Fulton Street and the more accurate modern mapping of the project area. Despite this apparent cartographic illusion, it is possible that portions of the structures located along the south side of Fair Street (modern Fulton Street) could be located within the southern sidewalk of Fulton Street between Broadway and William Street. Outside of Fulton Street, the archaeological APE is constrained to the historic streetbed of William Street and may therefore contain remnants of eighteenth century infrastructure within the historic William Street streetbed. The intersection of Broadway and John Street appears to have been configured differently from the present configuration, where the present day location of the Corbin building at the northeast corner is situated slightly further to the north, allowing for a more fluid intersection between John and Dey streets crossing Broadway. The archaeological APE at this intersection appears to intersect with several structures that would eventually be replaced by the Corbin building in 1888. At the western side of Broadway along Dey Street, there are several buildings located at the northern and southern corners and within the archaeological APE. Lastly, at Broadway's intersection with Cortlandt Street, the proposed locations for the street-level stairs to the ❹/❺ line do contain structures at this point in time. The archaeological APE at Broadway's intersection with Maiden Lane does not appear to contain structures. At all portions of the archaeological APE within the streetbed, potential historic infrastructure may be present. South of (and outside) the archaeological APE on Broadway at Crown Street (modern Liberty Street) is a market (number 13 in Figure 9), known as the Oswego Market.

The Ratzen (1767) map of lower Manhattan illustrates the historic development of the project area (Figure 10). The archaeological APE is surrounded by developed streets and several prominent structures are indicated in the vicinity. A building marked "Theatre" is depicted adjacent east of the proposed location for the Fulton Street Transit Center's main facility at modern-day Block 79 on the western half of the block bounded by Fulton Street, Nassau Street, John Street, and Broadway. A small portion of a second structure appears to lie within the APE in the area fronted by Fulton Street and bounded to the east by William Street and to the west by Dutch Lane. This structure, the Moravian's Meeting House, is located on the south side of Fulton Street. When the Ratzen map was reprojected to fit in the NYCMap GIS data, slight inaccuracies on the Ratzen map were amplified, making it appear that the structure was actually located in the street. When reprojecting historic maps onto modern GIS data it is not uncommon to encounter misleading differences; although the Moravian's Meeting House appears upon comparison of the Ratzen map with modern data to have been located in Fulton Street, Fulton Street has never been located north of its current position, and therefore the meeting house was not located in the current course of the street. It is possible that the front steps or similar architectural features of the Moravian Meeting House may be located within the portion of the archaeological APE covered by the south sidewalk along Fulton Street. The remainder of the archaeological APE contains historic structures at the following locations: along modern-day Church Street between Fulton and Dey streets; at the northwest and southwest corners of Broadway and Dey Street; along the eastern side of William Street between Anne and Fulton streets; at the southwestern corner of Broadway and Cortlandt Streets. South of the APE on Broadway, the Oswego Market (number 31 in Figure 10) remains located at Crown Street. In 1771, the Oswego Market would move to Maiden Lane, just east of Broadway and within the archaeological APE (see Appendix A:Figure 5 and discussion of the market's history in Appendix A:Section 6).

After the Revolutionary War, various factors (in particular rapid population growth, increasing industrialization, the domestic revolution with its consequent separation of the home and the workplace, and construction of roads) led to the expansion of Manhattan. Streets beyond what had previously been established

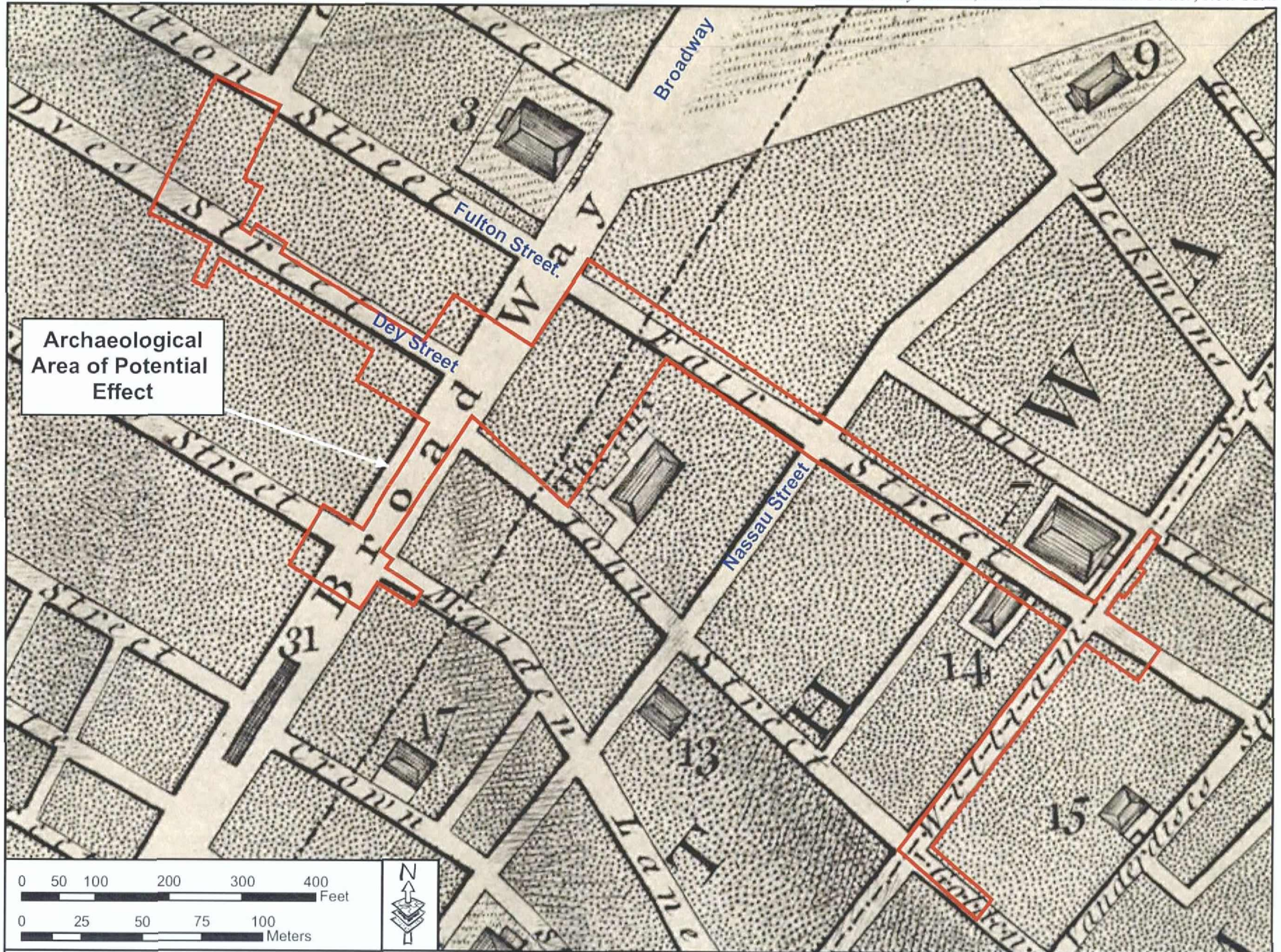

FIGURE 10: Fulton Street Transit Center Project Area in 1767

Source: Ratzen 1767

were further expanded as the Queen's Farm was divided up and sold off by the English crown. Modern Fulton Street continued to be called Partition Street, and Church Street did not continue northward past Liberty Street until 1867 (Greenhouse Consultants Inc. 1985:16). Early nineteenth century maps of the project area indicate structures were located throughout the archaeological APE, but it is not until the mid-nineteenth century that maps with sufficient details are produced to ascertain the types of structures within the archaeological APE. The Burr (1836) map of Manhattan shows project area has been extensively developed (Figure 11). One obvious error in the 1836 map occurs at the intersection of William and John streets, where the historic map places John Street much further north than it is located today.

The Dripps 1851 (Figure 12) and Perris 1855 (Figure 13) maps of the project area indicate that the all portions of the archaeological APE within the footprints of modern buildings (the proposed locations for the Transit Center Building, access to the Dey Street concourse at 189 Broadway and the new stairs to the 4/5 line at 195 Broadway) were occupied by structures in the mid-nineteenth century. The building located today at 195 Broadway was occupied by a structure know as the Franklin House at its southeast corner. It is most probable that the construction of these structures has disturbed their locations, thereby destroying any potential archaeological resources within these three portions of the archaeological APE.

The depiction of lot lines on the mid-nineteenth century maps allows for greater accuracy in assessing the potential to encounter archaeological resources in the archaeological APE. The area surrounding the archaeological APE contained a number of hotels located to the south, and Barnum's Museum is depicted on Ann Street between Broadway and Nassau Street just north of the project area. The Perris (1855) map of Manhattan shows a number of smaller structures, probably dwellings, stores, and associated outbuildings, located along Dey and Fulton streets, and Broadway.

Projecting the archaeological APE on the Dripps map, one can reconstruct the probable location of Church Street through the archaeological APE, although it was not present in the 1850s. Present day Church Street crosses Dey Street at the 10th lot west from the Franklin House (northwest corner of Dey Street and Broadway). The small portions of the archaeological APE extending out from Dey Street at the corner of Dey and Church streets would have extended into the residences on both sides of Dey Street. Given that the construction of the R/W subway line along Church Street has extensively destroyed the streetbed of Church Street (see Figure 7), it is not expected that the Church Street streetbed would yield potential archaeological resources. However, the northeast and southeast corners at Church and Dey streets may hold potential archaeological resources. On the north side of Dey Street, the portion of the archaeological APE with potential archaeological resources would be located within the foundations for 20, 22, 24 and 26 Dey Street, while 27 Dey Street on the south side of Dey Street may contain potential archaeological resources.

The Dripps (Figure 12) and Perris (Figure 13) maps also provide information regarding the widening of Dey Street in 1850. Historic documentation stored at the Manhattan Borough President's Office indicated that Dey Street was widened 10 feet to the south on September 28, 1850. Prior to this widening, Dey Street was 40 feet wide. When Dey Street expanded 10 feet to the south, the street bed encompassed the northen portion of several structures along the south side of Dey Street. Figure 12 demonstrates this narrow 10 foot wide strip of land at the northern edge of the southern sidewalk of Dey Street. By the time of the Perris map in 1855, Dey Street had been widened 10 feet to the south and the northern section these structures had been cut-back, replaced by the sidewalk of Dey Street. It is most likely that the original foundations and/or underground vaults would be located underneath the southern sidewalk of Dey Street, unless they had been demolished by later development in the late nineteenth or twentieth centuries. The proposed Dey Street underground concourse will be positioned within the middle of modern Dey Street and just north of the historic location of the structures along the south side of Dey Street prior to its widening. The proposed excavation for the Dey Street

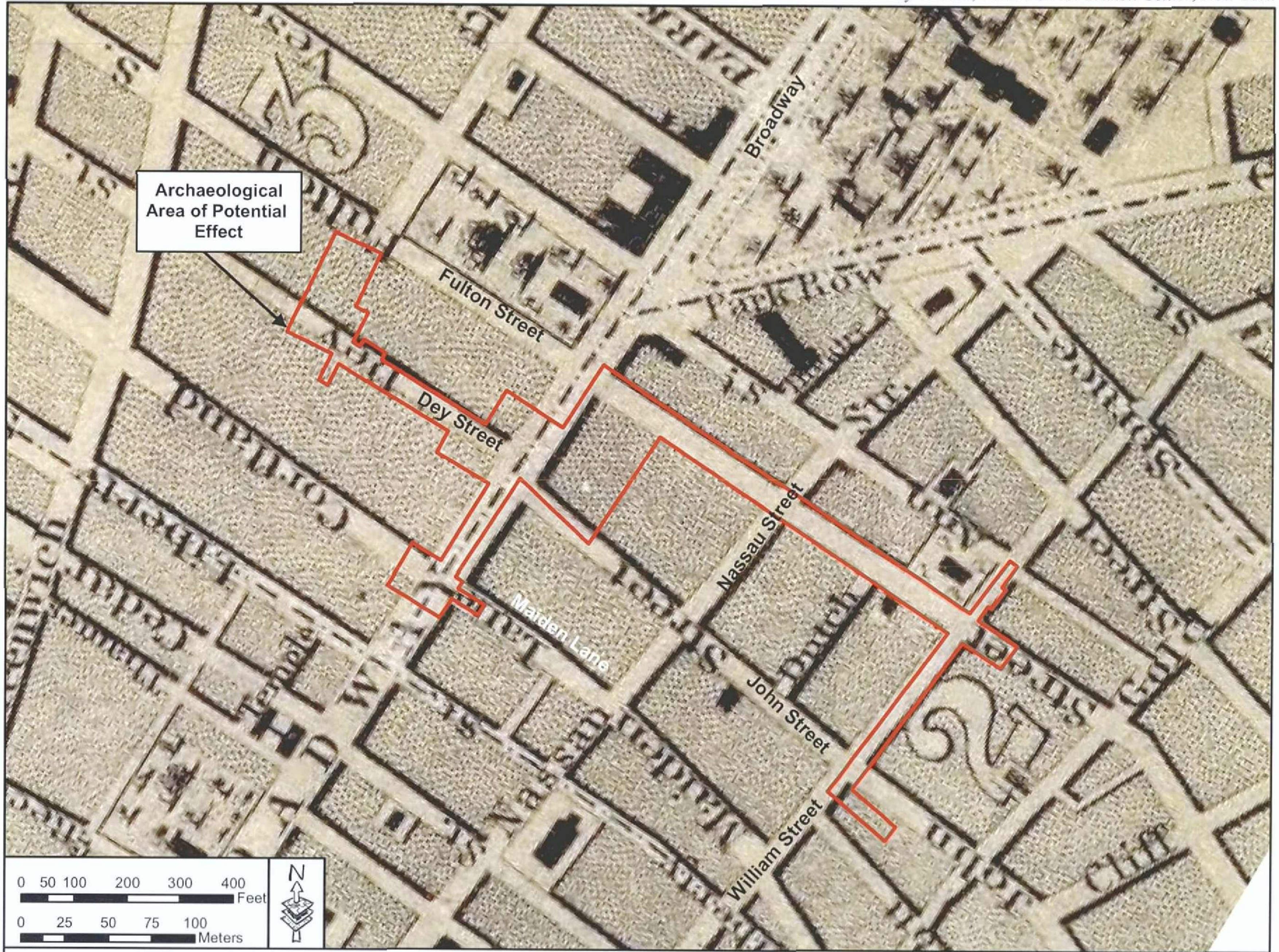

FIGURE 11: Fulton Street Transit Center Project Area in 1836

Source: Burr 1836

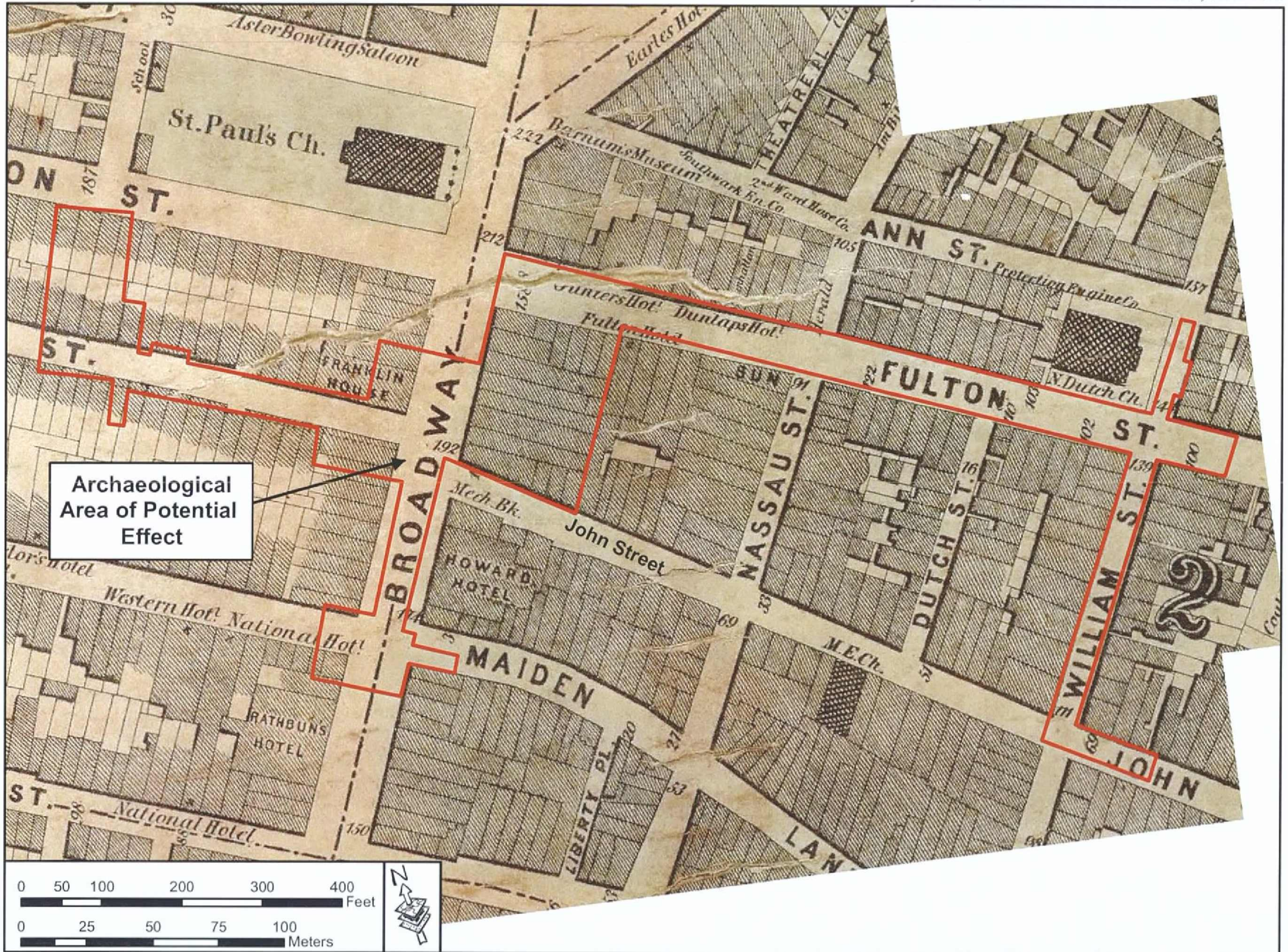

FIGURE 12: Fulton Street Transit Center Project Area in 1851

Source: Dripps 1851

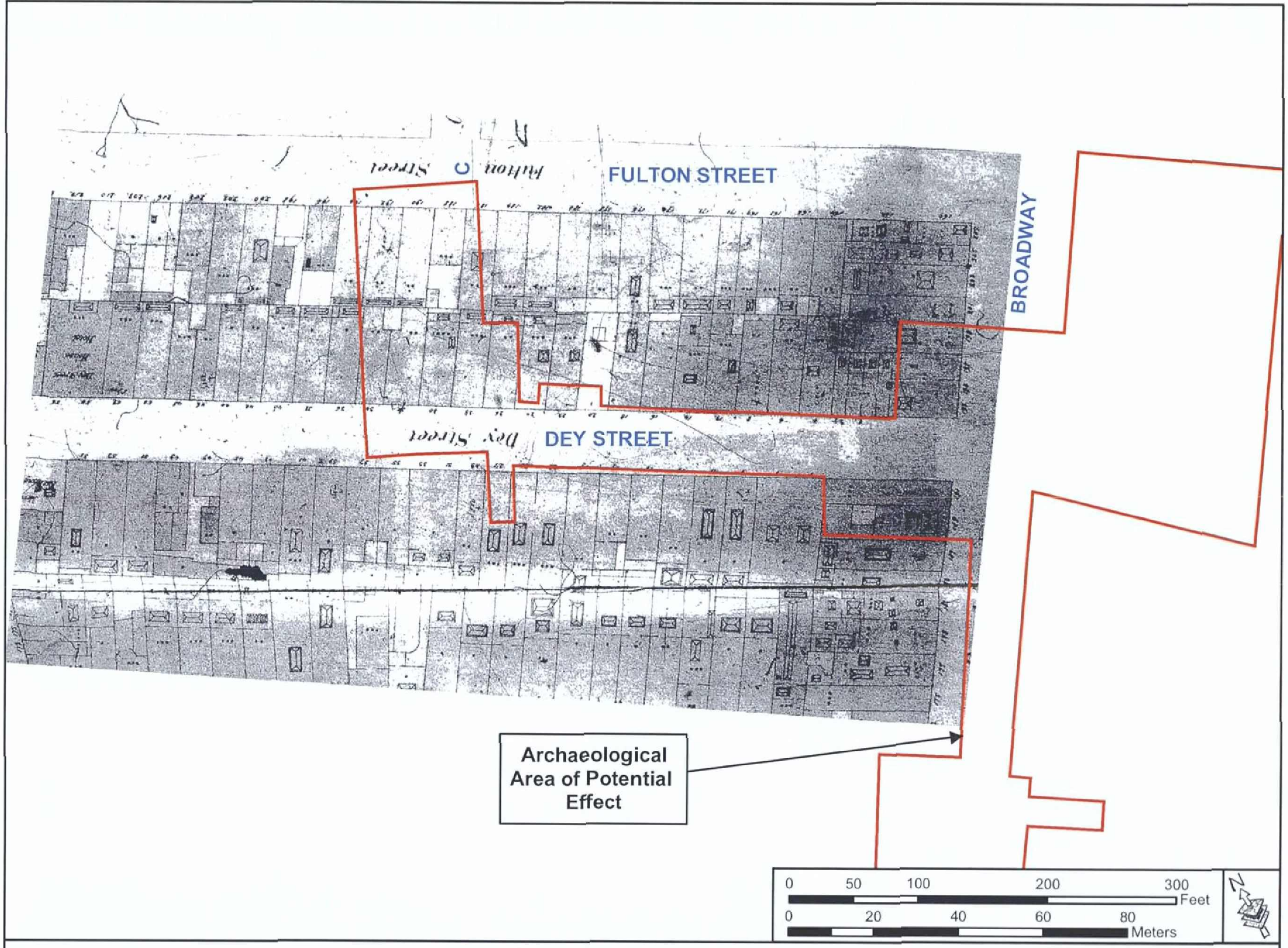

FIGURE 13: Western Portion of the Fulton Street Transit Center Project Area in 1855

Source: Perris 1855

underground concourse (28 feet in width) will not impact the location of the structures along the southern side of Dey Street. However, the relocation of utilities along Dey Street and the installation of a secant pile wall in portions of Dey Street may impact potential archaeological resources within the southern sidewalk of Dey Street.

The 1865 Viele map details the topography of the project area and verifies its location within the original shoreline of Manhattan (Figure 14). The map depicts the area just prior to the extension of Church Street through the blocks bounded by Liberty, Cortland, Dey, and Fulton streets.

Additional historic maps consulted from the late nineteenth and early twentieth centuries confirm the observations made from the Dripps map. The extension of Church Street through Cortland, Dey, and Fulton streets is the next significant change to the project area, occurring in 1867 (Figure 15). When this occurred, a large swath of structures were destroyed along the path of the proposed R/W line to E line Connection (see Figure 7).

Sanborn insurance maps provide greater detail of the development that occurred within the archaeological APE during the second half of the nineteenth century. Late nineteenth-century Sanborn insurance maps indicate a decided shift to commercial uses within the project area. The 1894 Sanborn Insurance Map depicts the appearance of the Western Union Telegraph Company and New York Mail and Express commercial complexes adjacent north of the Dey Street portion of the project area within the block bounded by Dey Street, Broadway, Fulton Street, and Church Street (Figure 16). A number of smaller structures depicted on the 1855 Perris map were demolished to make way for these complexes, a trend that would continue throughout the twentieth century. In addition, the extension of Church Street south necessitated the removal of a number of structures between Dey Street and Cortlandt Street. At the northeast corner of Dey and Church streets, the archaeological APE is shown to extend through a portion of the buildings at 20, 22 and 24 Dey Street, all five-story residences. Presumably, prior to the extension of Church Street, 26 Dey Street would have been located to the west of 24 Dey Street, as shown in Figure 13.

The 1923 Sanborn Insurance Map shows a continuation of the trend toward commercialization, with offices and stores replacing dwellings in the vicinity of the project area (Figure 17). This map also provides some indication of the effect that municipal utility systems had on the project area. Waterlines are depicted at the intersections of Fulton Street and Broadway, Dey Street and Broadway, Church Street and Fulton Street, and Church Street and Dey Street, with lines extending under the roadbed of each respective street. The northeast corner of Dey and Church streets remains occupied by the residences at 20, 22 and 24 Dey Street.

The 1923 Sanborn Insurance Map revised in 1951 illustrates the impact of underground transportation systems on the project area, with subway entrances located at various points along Dey Street, Fulton Street, and Church Street (Figure 18). In addition, the Corporation of Trinity Church Vestry Offices and School structures that appeared on earlier maps fronted by Church Street between Fulton Street and Vesey Street are now gone. These were demolished sometime between 1913 and 1931 during the construction of the BMT R/W line, which ran from Broad Street to Chambers Street. The western portion of the archaeological APE has also seen a change in the structures located along the east side of Church Street between Fulton and Dey streets. Where this portion of the archaeological APE was occupied by residential structures, a large bank (the New York Bank for Savings, constructed in 1946) building is now located, covering the footprints of the residences previously located here. The construction of the bank building would have destroyed any potential archaeological resources within the footprint of the building between Fulton and Dey streets, including those potential archaeological resources at 20, 22, 24, and 26 Dey Street.

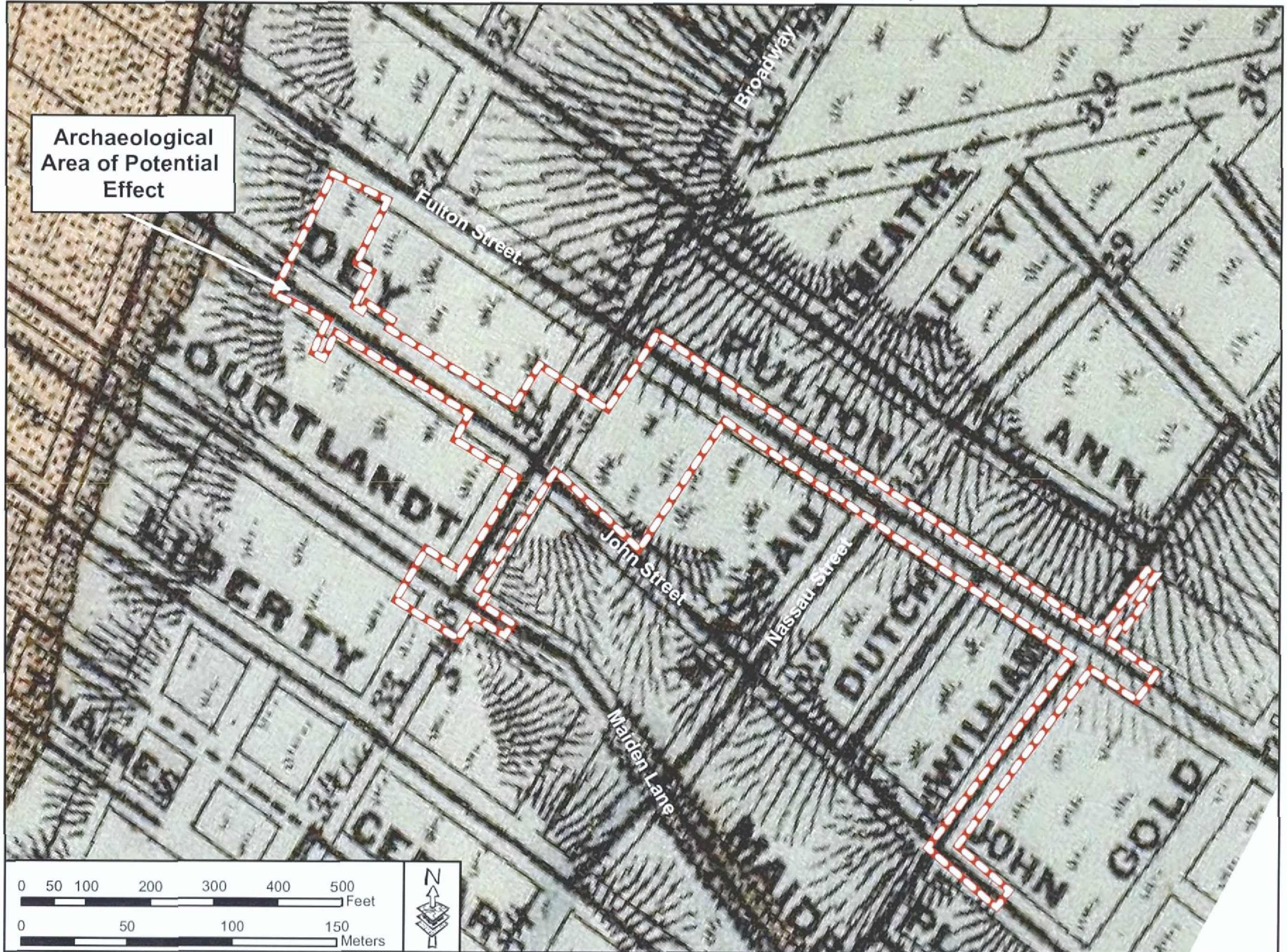

FIGURE 14: Fulton Street Transit Center Project Area in 1865

Source: Viele 1865

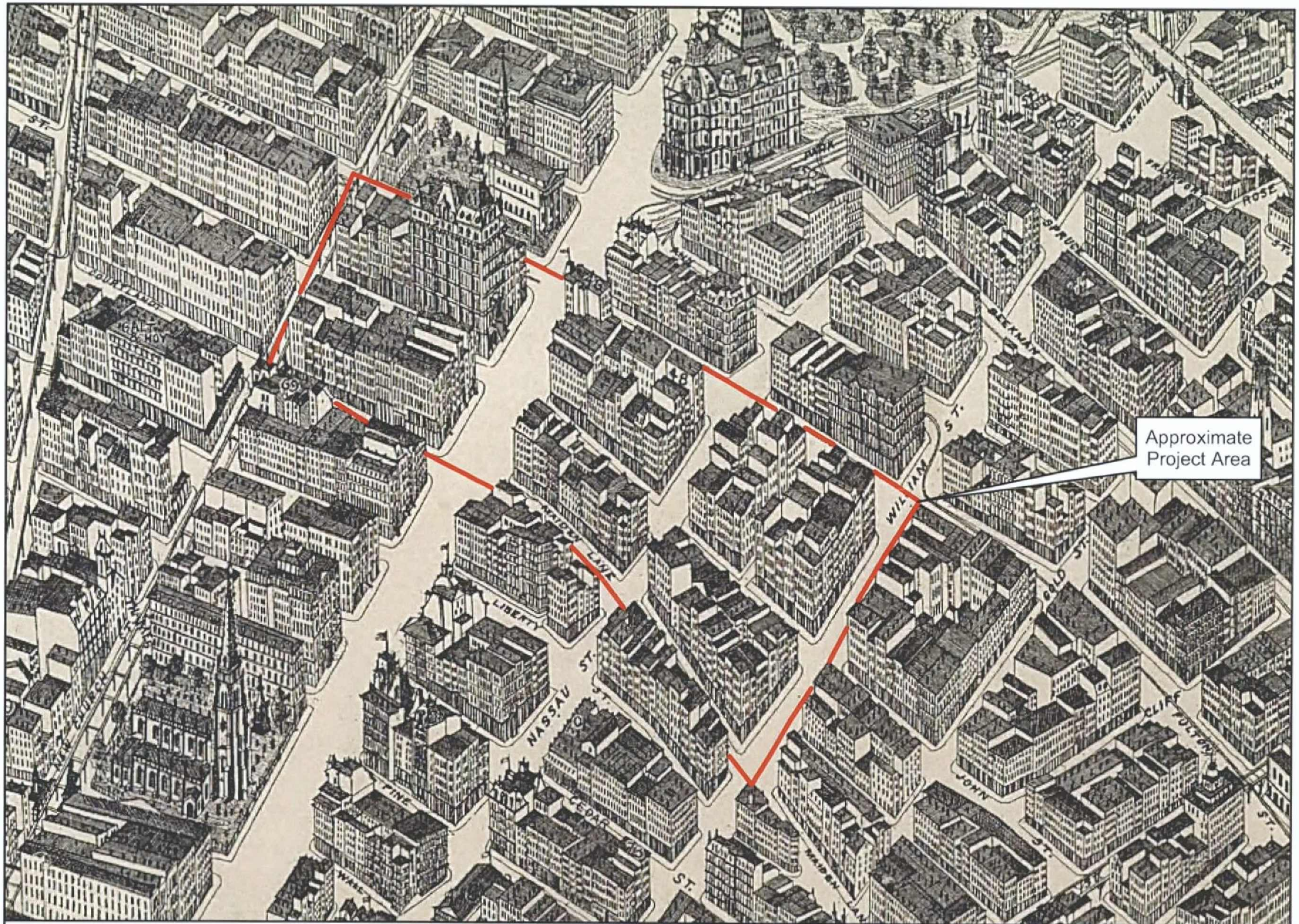

FIGURE 15: Bird's-Eye View of the Project Area in 1879

Source: Galt & Hoy 1879

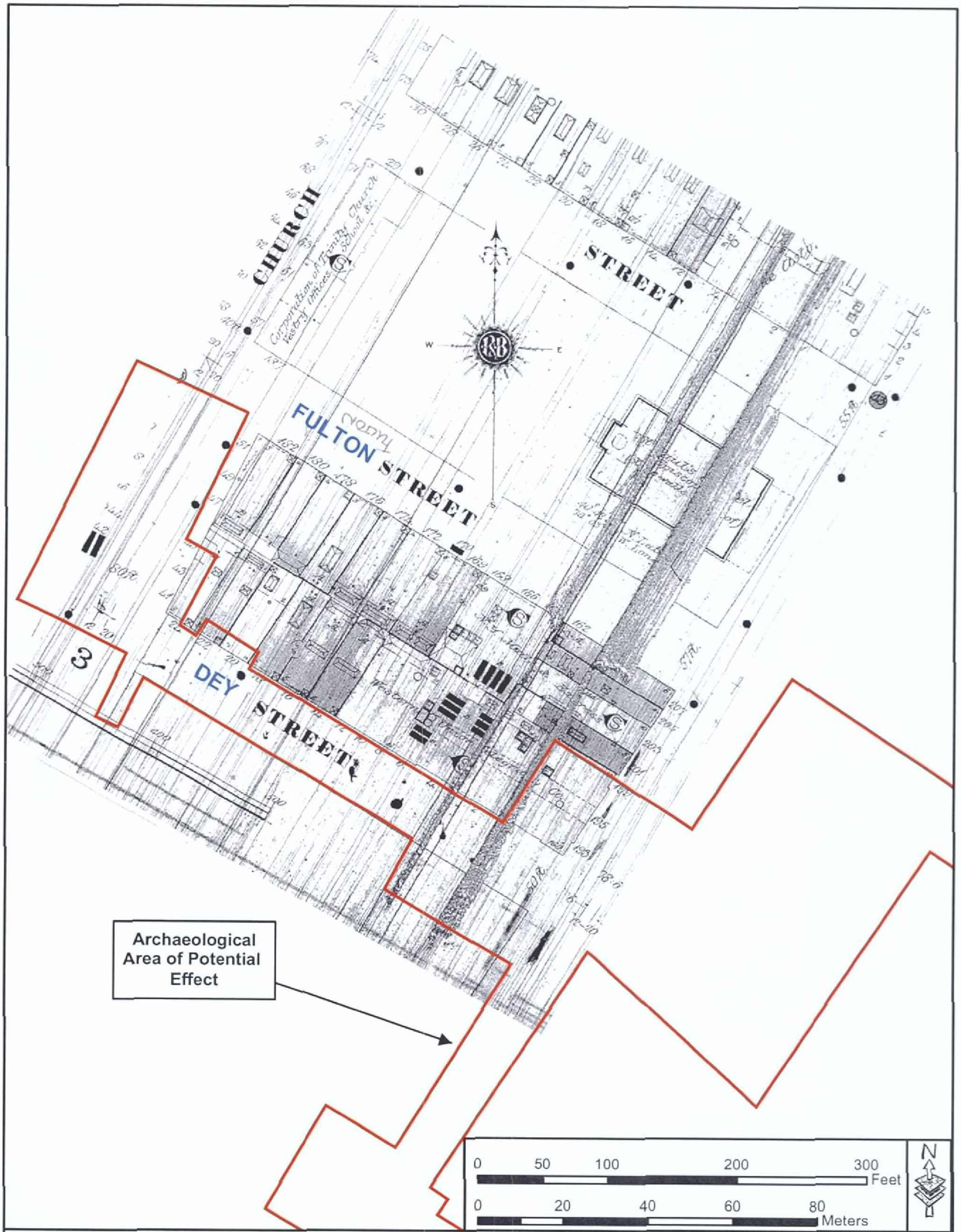

FIGURE 16: Western Portion of the Fulton Street Transit Center Project Area in 1894 *Source: Sanborn 1894*

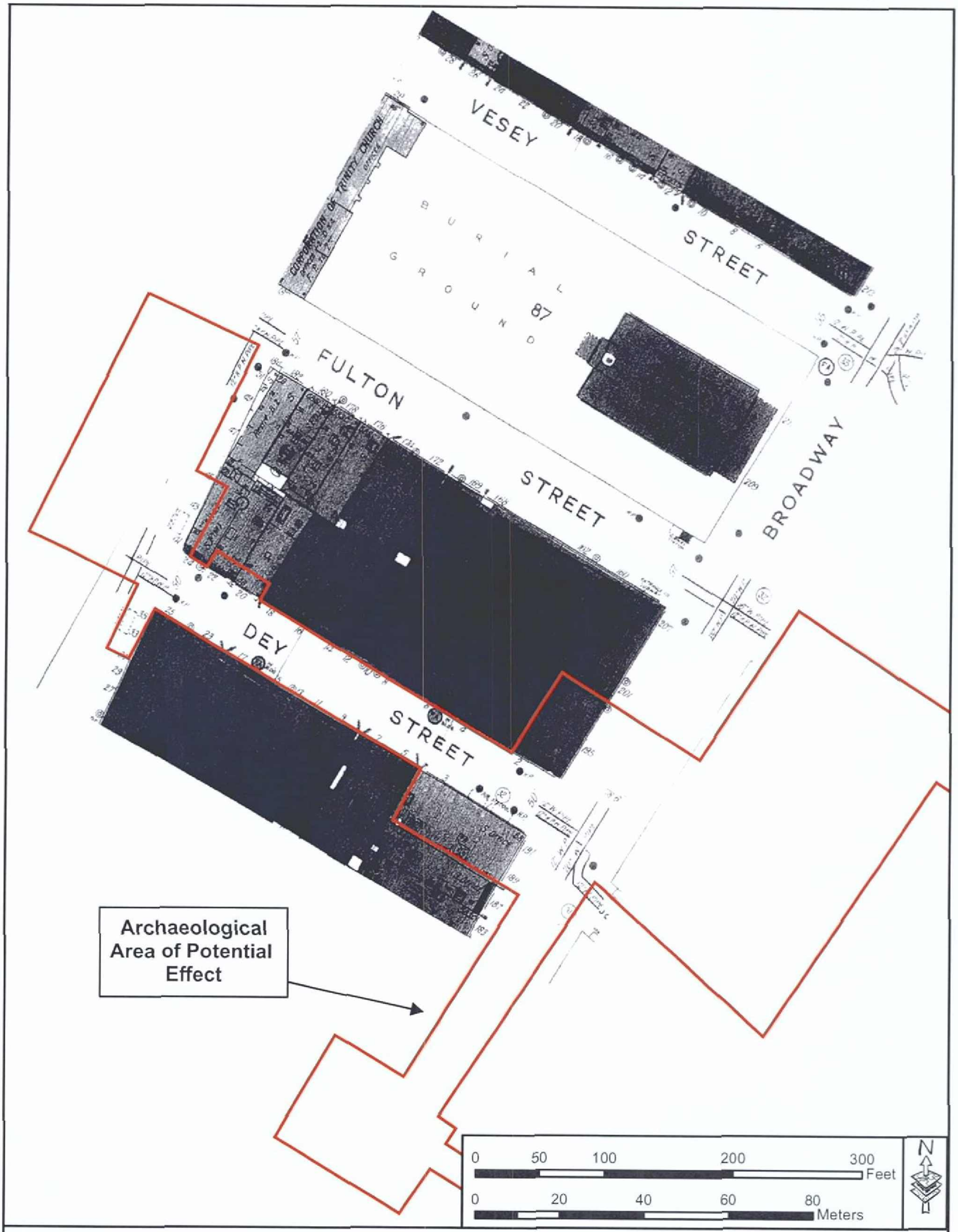

FIGURE 17: Western Portion of the Fulton Street Transit Center Project Area in 1923 *Source: Sanborn 1923*

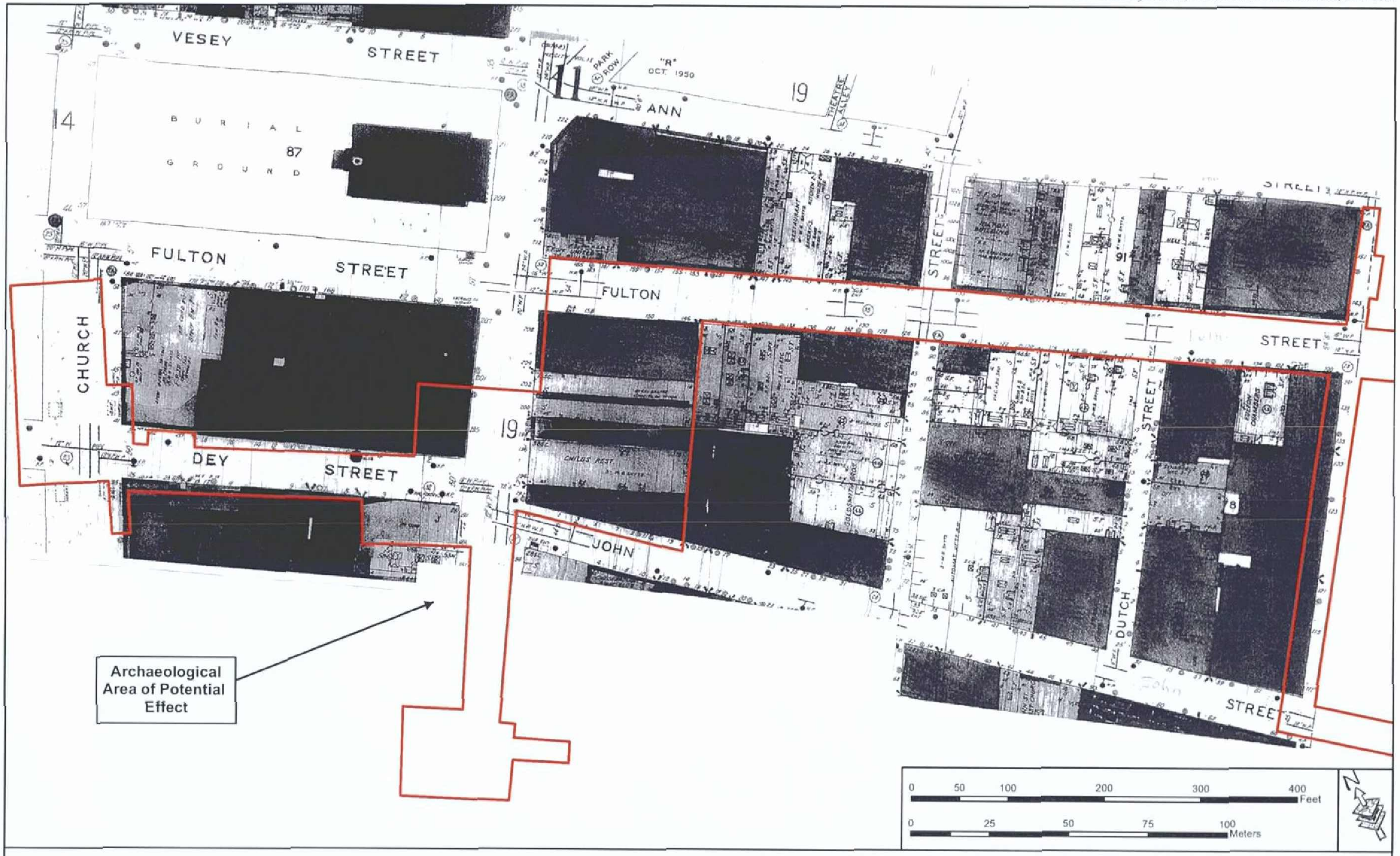

FIGURE 18: Fulton Street Transit Center Project Area in 1951

Source: Sanborn 1951

A further revision of the 1923 Sanborn Insurance Map in 1977 shows the complete transformation of the project area into a commercial district (Figure 19). The former Western Union Telegraph Company and New York Mail and Express commercial complexes were demolished prior to 1915 and 1921 respectively, and replaced by the American Telephone and Telegraph Company building. This building encompasses approximately 75 percent of the block bounded by Dey Street, Fulton Street, Church Street, and Broadway, with the remainder occupied by the New York Bank for Savings building, presently the Hilton Millennium Hotel. The modern configuration of the Hilton Millennium Hotel leaves an open plaza area where 24 and 26 Fulton Street were located. However, the previous bank building would have destroyed a large portion of the footprints from 24 and 26 Fulton Street during its construction.

Construction of the subway lines through the project area in the early twentieth century created further impacts to the project area and destroyed significant amounts of potential archaeological resources within several portions of the archaeological APE. Specifically, the construction of the R/W line has impacted the portion of the archaeological APE corresponding to the proposed R/W line to E line Connection along Church Street. Additionally, the construction of the 4/5 line has impacted the location for the proposed stairway, escalator, and ADA elevator at the southwest corner of Dey Street and Broadway and the two proposed staircases at the southwest and southeast corners of Broadway and Maiden Lane (see Figures 6 and 7).

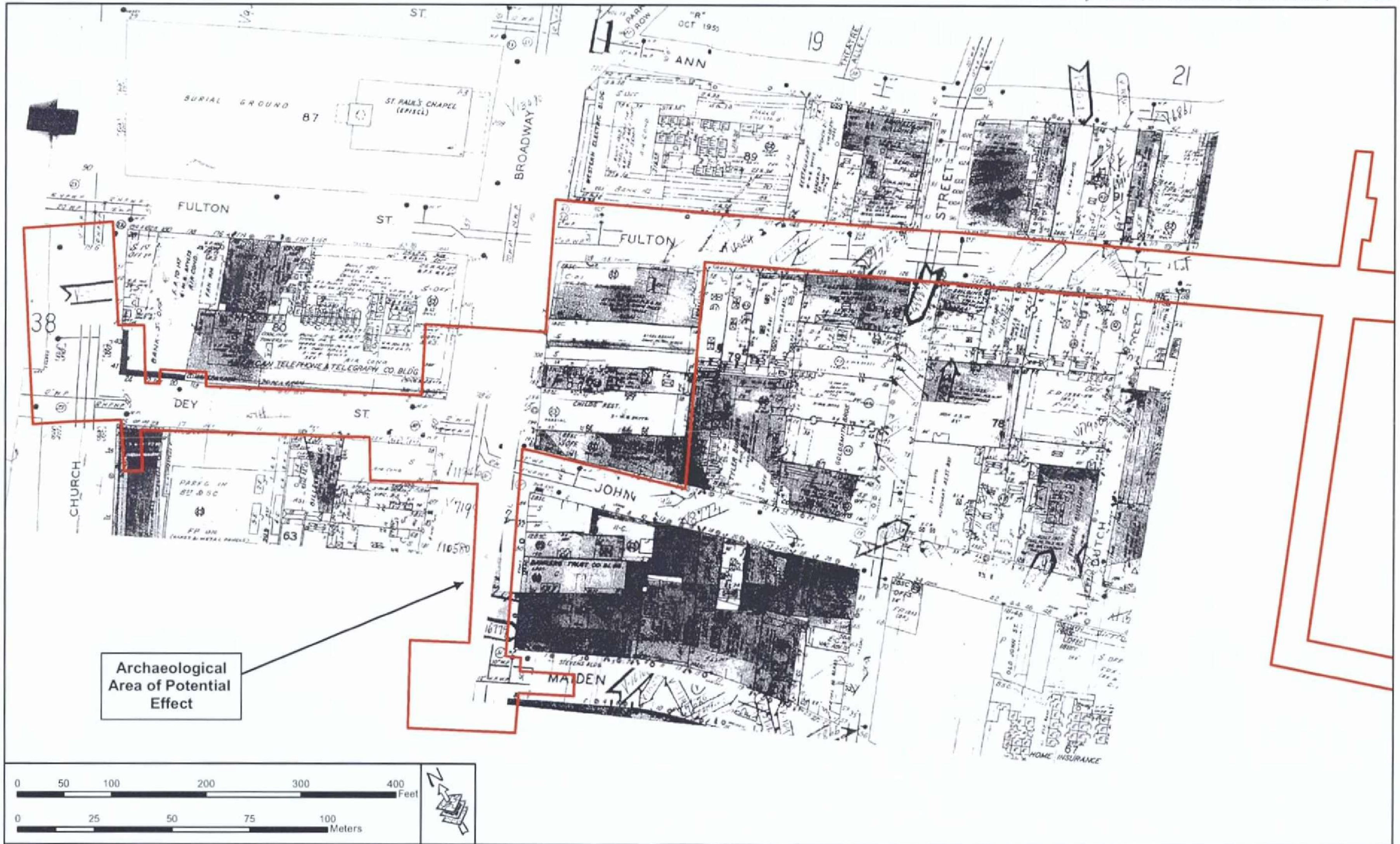

FIGURE 19: Fulton Street Transit Center Project Area in 1977

Source: Sanborn 1977

V. ARCHAEOLOGICAL RESOURCE POTENTIAL

V. ARCHAEOLOGICAL RESOURCE POTENTIAL

A. PREVIOUSLY CONDUCTED ARCHAEOLOGICAL STUDIES IN THE PROJECT AREA AND VICINITY

Several archaeological studies have been conducted within close proximity to the project area, though not within the areas of proposed construction (Figure 20). These studies were consulted for contextual and historical information on the project area. The following archaeological assessments or surveys were reviewed at the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP) and the New York City Landmarks Preservation Commission (LCP) as part of the archaeological assessment for the proposed FSTC.

1. *Cultural Resource Sensitivity Study and Impact Analysis of the Western Half of the AT&T Block, Block 80 – Lots 4-12* (Greenhouse Consultants, Inc. 1985)

2. *John Street Methodist Church, An Archaeological Investigation* (New York City Landmarks Preservation Commission 1991)

3. *Phase IA Archaeological Documentary Study, Gold Street Hotel Site* (Historical Perspectives, Inc. 1992)

4. *Stage 1A Archaeological Assessment, 18 Platt Street, Manhattan, New York* (Historical Perspectives, Inc. 1999)

5. *7 World Trade Center Reconstruction Project: SEQRA Environmental Assessment Form and Supporting Analyses* (Allee King Rosen & Fleming, Inc. 2002)

6. *Second Avenue Subway - Phase IA Archaeological Assessment* (Historical Perspectives, Inc. 2002)

Additionally, archaeological site files at the NYSOPRHP and the New York State Museum were reviewed for the project area. Based on a thorough review of these files, it was determined that no previously identified archaeological sites exist within the project area.

B. PROJECT AREA ARCHAEOLOGICAL POTENTIAL

1. Areas of Archaeological Resource Potential

The archaeological APE has seen development since the 1700s, as indicated from the earliest maps consulted, but it is not until the mid-nineteenth century that maps with sufficient detail are produced to ascertain the types of structures within the archaeological APE. The Dripps 1851 map of the project area indicates that the location of the proposed Transit Center Building is entirely occupied by structures, demonstrating that the entire footprint of the proposed Transit Center Building has been disturbed by these historic structures. The location for the proposed Dey Street Concourse is located entirely within Dey Street, an area that lacks any indication of historic period structures, but may contain archaeological resources in the form of historic infrastructure, including historic water mains dating to the turn of the eighteenth century (see Appendix A).

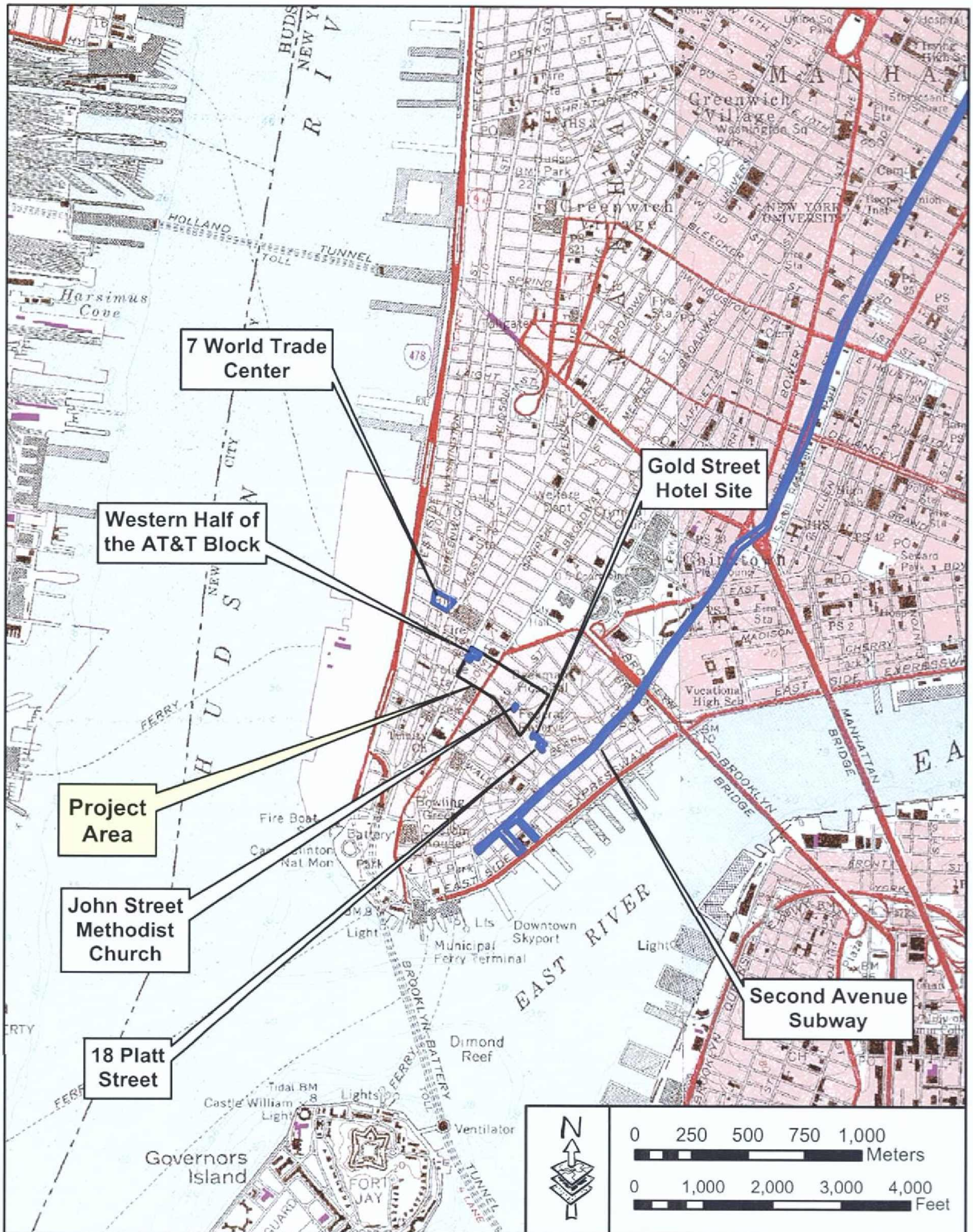

FIGURE 20: Previously Conducted Archaeological Assessments in the Vicinity of the Proposed Fulton Street Transit Center Project Area

SOURCE: USGS Jersey City, NJ-NY, 1981 & Brooklyn, NY 1979, 7.5' Series

Additionally, areas along the northern and southern sidewalks of Dey Street may contain evidence of historic structures dating to the mid-nineteenth century. Specifically, the southern sidewalk of Dey Street may contain the foundations for structures built here prior to the 10 foot widening of Dey Street in 1850. Also, the northeast corner of Dey and Church streets may contain archaeological resources associated with the residences at 20, 22, 24 and 26 Dey Street while the southeast corner of Dey and Church streets may contain archaeological resources associated with the residence at 27 Dey Street. These areas of potential archaeological resources were disturbed during the construction of the R/W line along Church Street. However, when all of the disturbances from the subway line construction, excavation for utility trenches (specifically the deep excavations for the sewer lines) and existing vaults/buildings, a few small portions of the archaeological APE appear to be undisturbed by twentieth century development (see Figure 7). Some areas of archaeological potential have been further diminished by excavation for twentieth century buildings that are no longer extant, such as the New York Bank for Savings.

Combining all of these lines of evidence indicates that there are some portions of the archaeological APE that are undisturbed from twentieth century development and possess the potential to encounter archaeological resources (Figure 21). Most of these locations possess the potential to encounter archaeological resources in the form of historic infrastructure, such as the early utility lines of lower Manhattan (Geismar 2004; Appendix A), within the streetbeds of Dey, Cortlandt, Fulton, William and John Streets and Maiden Lane. The intersection of Church and Dey streets possess the potential to encounter historic structures dating to the mid-nineteenth century prior to the construction of Church Street through Dey Street.

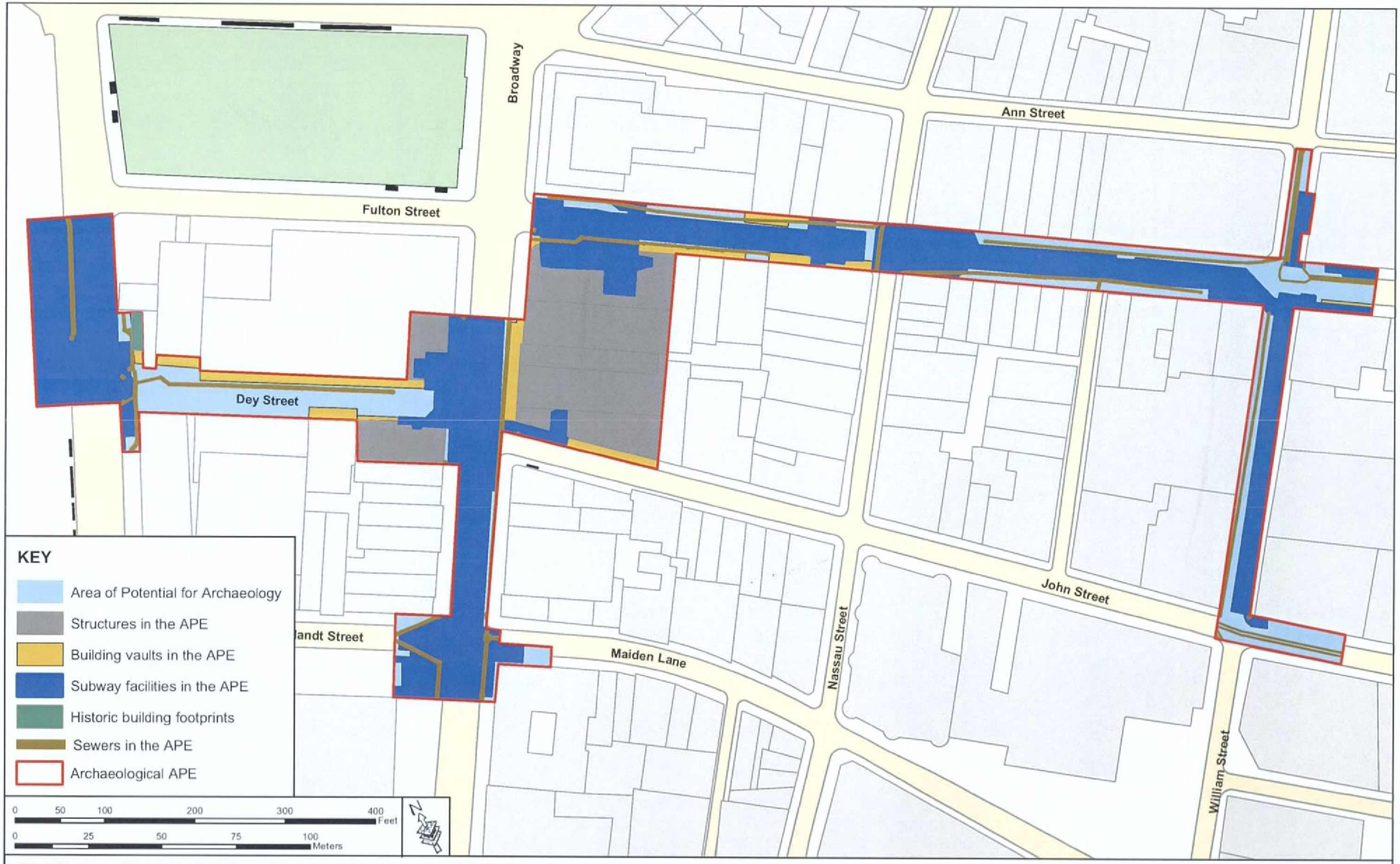

FIGURE 21: Areas with the Potential to Encounter Archaeological Resources within the Fulton Street Transit Center Archaeological APE

Source: NYCEMap GIS

VI. RECOMMENDATIONS

VI. RECOMMENDATIONS

The Louis Berger Group, Inc., has completed a Phase IA Archaeological Assessment for the proposed FSTC located within an area bounded by Church Street, Fulton Street, William Street, and Maiden Lane, Manhattan, New York. The purpose of the archaeological investigation was to assess the project area's potential to contain previously undisturbed archaeological deposits. After consulting historical cartographic sources and the present-day mapping of the subway lines and utilities, it was determined that the majority of the proposed project area was never located within the limits of any historical structures. However, there are two locations within the archaeological APE with the potential to contain mid-nineteenth century historic archaeological resources that may have escaped destruction from the nearby subway lines, building construction and utility installation that has typified the archaeological APE. These locations are the northeast and southeast corners of the intersection of Church and Dey streets. Additionally, the streetbeds running through the archaeological APE also possess the potential to contain historic archaeological resources in the form of historic infrastructure dating to the turn of the eighteenth century. Although significant portions of the archaeological APE have been extensively disturbed over the past one hundred years, it is possible, though unlikely, that small portions of the archaeological APE may contain archaeological resources with information relevant to the history of the project area. As there are several locations with the potential to contain historic period archaeological resources, Berger recommends that a professional archaeologist be present during construction activities in all portions of the archaeological APE designated with archaeological potential to monitor the construction activities for the presence of such archaeological resources. Unanticipated discoveries of archaeological resources, including human remains, encountered in the absence of an archaeologist will be addressed by the protocol established in the Memorandum of Agreement among the Federal Transit Administration, the Metropolitan Transportation Authority, New York City Transit, MTA Capital Construction Company and the New York State Historic Preservation Office regarding the Fulton Street Transit Center Project. If archaeological resources are discovered in the presence of an archaeologist, such resources would be addressed by the protocol established in the Archaeological Resource Management Plan for the Fulton Street Transit Center Project.

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VII. REFERENCES CITED

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APPENDIX A: RESEARCH CONDUCTED ON HISTORIC INFRASTRUCTURE IN THE ARCHAEOLOGICAL APE

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CM-1252 - Fulton Street Transit Center

Archaeological Report

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Archaeological Report

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CONTENTS

1. ABSTRACT

This archaeological report, prepared by Joan H. Geismar, Ph.D., LLC, for the New York City Transit Authority through the FSTC Design Team, documents the features that might be encountered in an archaeological context during the construction phase of the Fulton Street Transit Center (FSTC). This assessment is made recognizing that the project's Area of Potential Effects (APE) has been subjected to intensive disturbance as documented in the project's 1A archaeological report (Louis Berger 2004). Research undertaken for the archaeological study presented here considered early development in the APE that included urban infrastructure. It also considered the proven tenacity of archaeological deposits, even in highly disturbed contexts. This research indicated that among the features that might be encountered are remnants of early-19th-century log water mains, wells, pumps, cisterns, vaults, drains, and hydrants. Perhaps the most likely example of early infrastructure to remain is the deeply buried, round brick sewers introduced into the project APE in the mid-19th century. This is in addition to the foundations of 18th and early 19th-century structures possibly under streets that were widened over time, and a public market, its exact structure unknown, that stood in one street in the APE for almost 40 years. To address these potential archaeological issues without causing construction delays, it is recommended that a project archaeologist, as well as a faunal expert, be on call, and that an established protocol be in effect during construction to address unanticipated discoveries.

2. INTRODUCTION

This archaeological report, prepared by Joan H. Geismar, Ph.D., LLC, for the New York City Transit Authority through the FSTC Design Team, documents the features that might be encountered in an archaeological context during the construction phase of the Fulton Street Transit Center (FSTC) in Lower Manhattan (Figure 1). The report was researched and written by Joan H. Geismar, Ph.D., assisted by Shelly Spritzer.

Urbanization has shifted Lower Manhattan from a mixed residential-commercial district to one that, until recently, has been mainly commercial. This process has undoubtedly adversely affected archaeological resources that might have been found in this historic area. However, the tenacity of archaeological features and deposits has been proven time and again. It is possible that it may yet again be witnessed within the FSTC Area of Potential Effects (APE). In this case, the APE is where construction will occur throughout the project area (Figure 2). It is the goal of this report to identify what form this evidence could take and to determine the likelihood of finding it intact and with integrity.

Early to mid-18th-century maps document development in the APE (e.g., Bradford/Lyne 1730; Figure 3 in this report; Maerschalck 1755 in Louis Berger 2004 Figure 8).[1] Street records, which note the destruction of houses on Cortlandt Street in the 1776 fire that decimated much of Lower Manhattan (Cortlandt Street File Card, n.d.), indicate that development had indeed occurred in the APE prior to the Revolutionary War (see below); early development is also confirmed by water records that document service to commercial and residential establishments in the APE by the first decade of the 19th century (Water Works Journals 1820-1824). With this development would have come the need for infrastructure to support the growing residential and commercial population as well as the street features discussed below. The infrastructure would have included street pumps, wells and cisterns to provide water, drains to take it away, and, as time went on and development intensified, sewers and hydrants. This early infrastructure and other street features are the focus of archaeological concern in this report that should be considered an adjunct to the project's 1A archaeological assessment (Louis Berger 2004).

3. METHOD

Typically, archaeological assessments consider the likelihood of impacting prehistoric resources. Moreover, in a historic-era urban context, the focus is often on the backyard privy pit and cistern. The privy pit—the underground component of an outdoor toilet facility—and the in-ground cistern, also located in backyards and used to collect and store water, are the usual archaeological features encountered in an urban situation. But in the FSTC Archaeological APE, the main concern is neither prehistoric deposits nor the house privies and cisterns found in 18th and 19th-century urban backyards. Instead, since the areas of new

[1] The cited maps indicate that almost all the blocks adjoining the APE were developed by 1728; the exceptions were Dey Street and Church Street, initially part of a large government farm and then a church farm tract, where development is not cartographically documented until 1754 (see Maerschalck 1755 depicting conditions in 1754 in Berger 2004: (Figure 8).

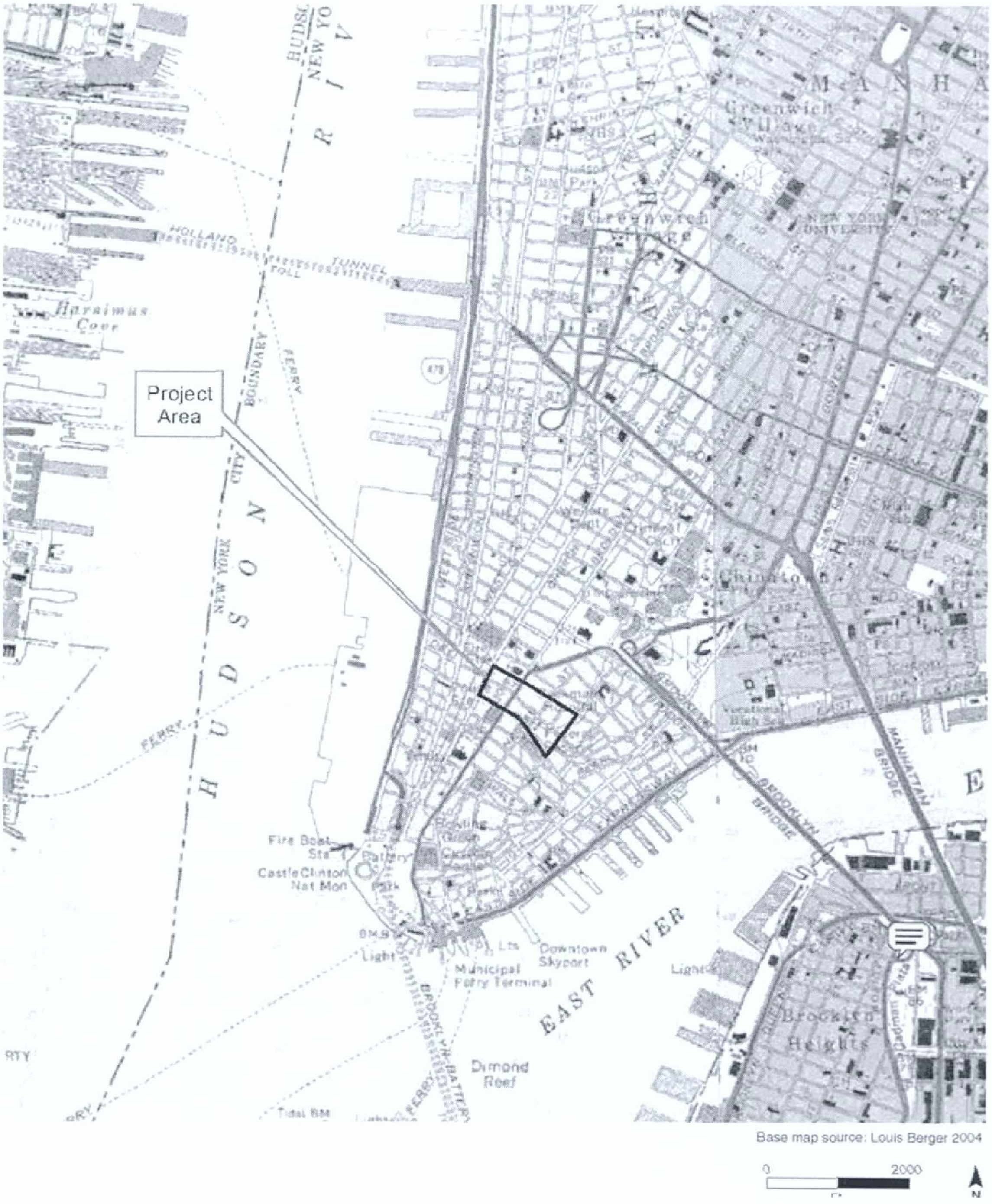


Figure 1 - Project Location

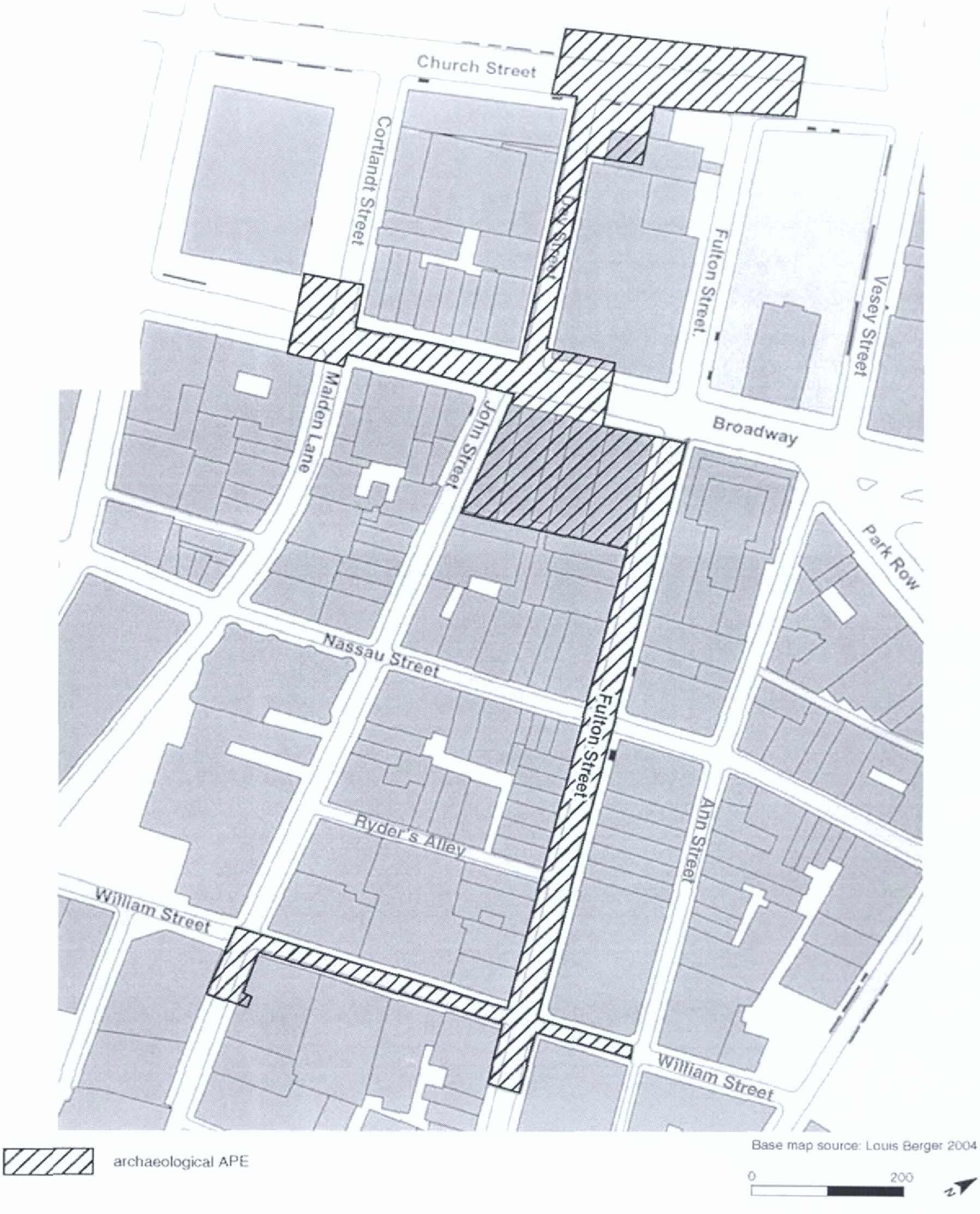


Figure 2 – Archaeological Area of Potential Effects (APE), approx.

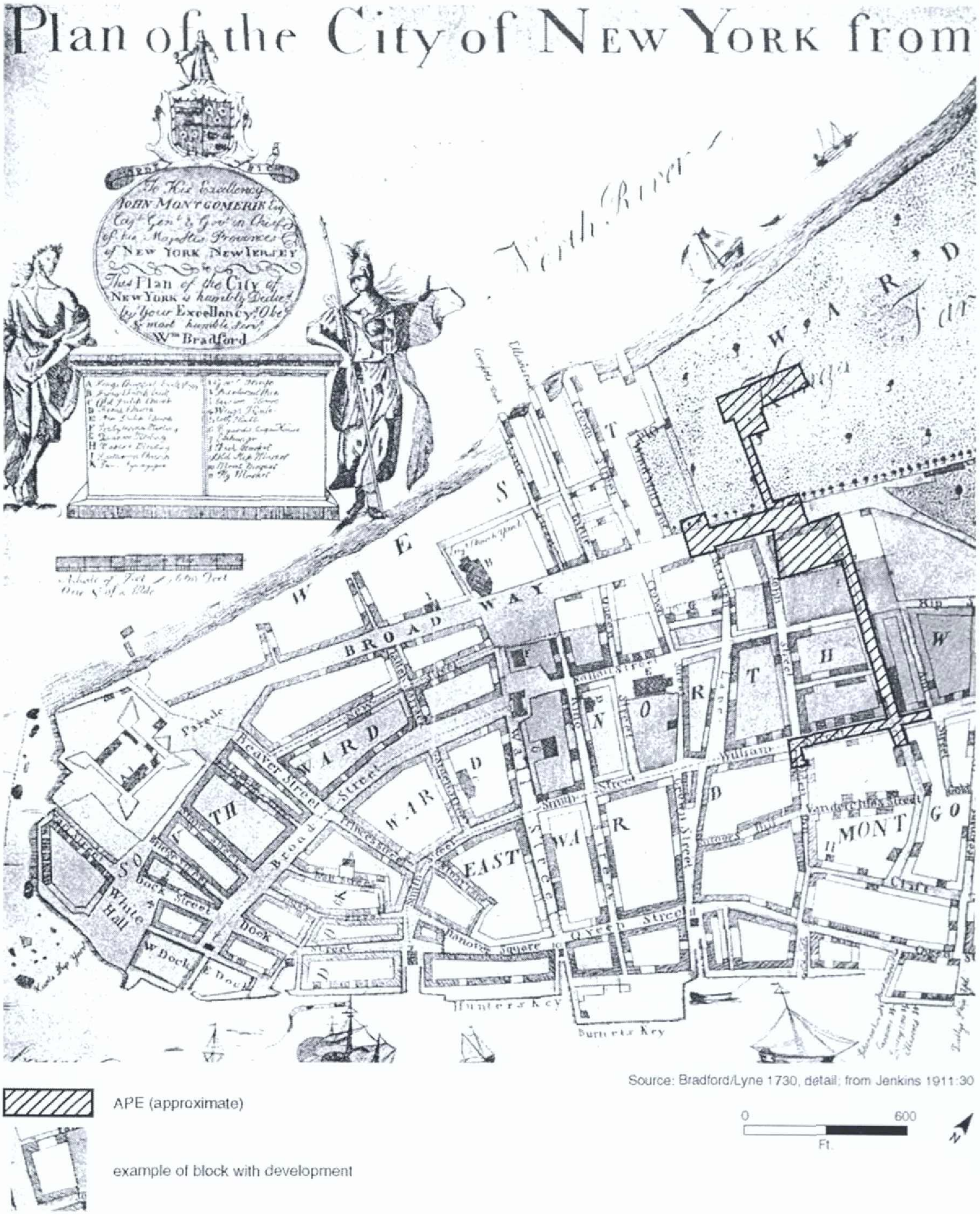


Figure 3 – Project APE 1728

impact are mainly confined to streets, sidewalks, and to former block fronts obliterated during street widening, the potential issue is mostly limited to private and public utilities. That is, the early infrastructure that supported increasing urbanization.[2]

Documentary compilations—mainly the Minutes of the Common Council (MCC) and I. N. P. Stokes's *The Iconography of Manhattan Island*—were the major resources consulted to address research issues. This was in addition to New York City directories and tax assessment records, deeds, and maps consulted to locate street references found in city documents. Research was conducted at the Municipal Archives, the Municipal Reference Library, Manhattan Tapping (sewer information), the Topographical Bureau of the Manhattan Borough President's Office, and the Subsurface Exploration Division of the Department of Design and Construction (NYCDDC). Also consulted were the New York Public Library, the New York Society Library, the Fire Department Library, the Chase Archives at the JP Morgan Chase Bank, and the New-York Historical Society Library. Published and unpublished histories and reports were also reviewed and researched. In addition, selected construction-related soil borings were monitored, as are selected test pits under excavation, at this writing, for utility identification and to obtain subsurface information. The goal of monitoring is not only to determine subsurface conditions for construction purposes, but also to ensure that the proposed undertaking will not impact any historical infrastructure or other unidentified archaeological features.

The following sections also include street opening information in the FSTC Archaeological APE and identify documented street alterations. In addition, they offer information about water supply and the historic infrastructure and street features that may be encountered during construction.

4. ARCHAEOLOGICAL POTENTIAL

Streets in the project area, or APE, were first laid out between 1677 and 1750 (Street Opening n.d.). While not the city's earliest—this honor belongs to the landmarked 17th-century colonial road network that extends south of Wall Street (e.g., Geismar 2003)—these streets are likely to contain the potentially archaeologically sensitive street infrastructure and features noted above. More specifically, they could include wells, pumps, cisterns, drains, street and sidewalk vaults (not to be confused with the utility vaults documented in the APE in the 1A report), fireplugs and early hydrants, and round, oval, and elliptical brick sewers at depths greater than 8 feet (*Annual Report of the Croton Aqueduct Department* 1857; Church 1987; Dempsey 1849; Dunshee 1952; Goodrich 1828; Holland 1797; Manhattan Tapping; MCC [various]; see Table 1). For example, petitions for street wells are documented in 1748 in Cortlandt Street, John Street, Dey Street, and at the intersection of Ann and Broadway (MCC V 1905:234 and 223).

Bored-out log water mains introduced into these streets by the Manhattan Company at the turn of the 19th century are another concern (e.g., Koeppel 2000). Records of this company, which was the forerunner of what later became the Chase Manhattan Bank, now the JP Morgan Chase Bank, Inc., indicate it had supplied water, albeit of questionable quality, to all the streets in the project APE by 1807 or 1809 (e.g., Water Works Journals 1820 to 1824). Since these mains were tapped for water to fight fires, they could not be more than 2 to 3 feet below original grade. Street excavations conducted over the years have revealed evidence of this extensive water supply system (for example, see Figure 4). The most recent known discovery in Lower Manhattan occurred near the Battery in 1962 (Chase Manhattan

[2] This was also the identified issue in a recent archaeological assessment of the New York Stock Exchange Street Improvements Project, another Lower Manhattan project (Geismar 2003).

1962:3), and experts feel strongly that similar isolated finds are possible throughout Lower Manhattan (Greeley 2003:personal communication). Photos and sections of these log mains found in relatively 20th - century contexts are available in private archives. This includes a section of log main with a stop-cock, an apparatus associated with obtaining water for fire fighting, still in place (Figure 5). In addition to this early infrastructure, the 19th-century Minutes of the Common Council (MCC) document late-18th and early 19th-century street and sidewalk vaults, another potential archaeological resource (see Table 1).

Utility maps compiled by the WPA in 1938 (WPA 1939) were consulted regarding street infrastructure within the APE. These show the expected range of utilities (e.g., water, gas, and electric lines, sewers, and hydrants). They also indicate that sewers in streets without subways in 1938 were often those originally constructed in the mid-19th century (WPA 1939: Sheets 18, 19, 20, 28). Mid-19th-century records and maps document sewers within the APE as follows: Broadway between Fulton Street and Maiden Lane (1848); Church Street (after 1867); Cortlandt Street between Broadway and the Hudson River (1848); Dey Street (after 1857 but before 1864); Fulton Street (Broadway to Church Street (1851); Broadway to Nassau Street (1849); Nassau Street to the East River (1847); John Street (1847); Maiden Lane between Broadway and William Street (1847); and William Street between Ann Street and Maiden Lane (1849) (*Annual Report of the Croton Aqueduct Department 1857*:110). The 5-foot diameter circular sewer installed on Maiden Lane, presumably of brick and contracted for in March 1847, is the earliest sewer documented in the project APE. While it is almost inconceivable that this conduit is still in use, it is entirely possible.

5. WATER IN THE APE: THE MANHATTAN WATER COMPANY[3]

The Manhattan Company, or Manhattan Water Works, was a private company incorporated in 1799 to supply water to residents, trades, and industries under a charter that included banking and other privileges (Stokes V 1926:1364-1365). Aaron Burr was a major organizer. The water company and the Manhattan Bank, forerunner of the Chase Manhattan Bank, now the JP Morgan Chase Bank, Inc., were established at the same time. The methods and policies of the Manhattan Company, which included distributing water from wells adjacent to the recognizably polluted Collect Pond,[4] support the assertion that it "provided only enough water service to maintain the franchise, for its founders had used the charter primarily as an entry into the banking business" (Duffy 1968:201). The company's offices were established at what is now 40 Wall Street, later the location of the Manhattan Bank building (Stokes V 1926:1369; see Stokes V 1926:1364-1369 for details of the water company's beginnings, and Duffy 1968:202-211 for a synthesis of its goals and operation; also Church 1987:B-9 to B-12 and Koeppel 2002:70-101).

[3] Excerpted and adapted from Geismar 2003.
[4] By 1799, filling began to eliminate the pond polluted by the noxious industries that had developed around it; by 1810, the filling process was complete (Geismar 1993:9).

Figure 4 – Section of log water main being removed from intersection of New Street and Exchange Place in 1965. (Courtesy of Chase Archives)

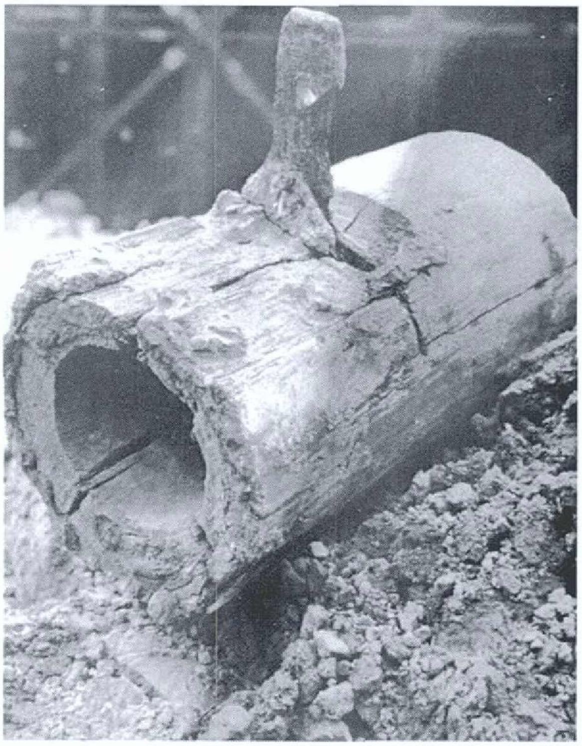


Figure 5 – Section of log water main with stop-cock in place. (Courtesy of Chase Archives)

Whatever the ulterior motive for its inception, and for better or worse, the Manhattan Company became the main supplier of water to New York City's residents in the early years of the 19th century (e.g., Koeppel 2002). It also supplied water free of charge to fight the fires that made a comprehensive water supply system a necessity in the growing city. Hand-written journals indicate that company water was available to residences and businesses on all the streets in the project study area during the first decade of the 19th century (indeed, many had cancelled the service during that same decade). Charges for the water were initially based on the number of fireplaces in a building, and commercial establishments paid more than private residences. Extant company records, and a series of questions and answers issued in 1823 (Lozier, 1823), suggest that cheating the company was often the goal of householders and businesses alike: the former shared water among neighbors and the latter used free water as a come-on to attract business.

For almost three decades, water was distributed in mains created from hollowed-out logs, mainly of yellow pine. Fire fighting entailed exposing the main and tapping into it with a "cock." While no records were located that document the depth of the mains, their fire-fighting function suggests they were relatively shallow to allow tapping on demand (this is in contrast to an undated newspaper account that reports the discovery of a wooden main at Front and Water streets at a depth of 10 feet (Anon. n.d.)). A log section, now in the possession of the Chase Archive, was recovered at the intersection of New Street and Exchange Place in 1955 (see Figure 4), and other random discoveries have been made over the years (Elliot 2003:personal communication; Greeley 2003:personal communication). By 1827, the wooden mains were being replaced with cast-iron pipes, and street hydrants were either planned or installed throughout the city (e.g., Goodrich 1828; see Figures 8 and 11 for examples of 19th-century hydrants and cast-iron mains). Despite repeated efforts to relinquish its water supply operation to the city, and despite the recognized inferiority of the water it offered, the Manhattan Company persisted until the introduction of Croton water in 1842.

6. STREET OPENINGS, FEATURES, AND ALTERATIONS

Information concerning streets in the FSTC APE comes from *The Iconography of Manhattan Island* (Stokes 1914 to 1926), the Minutes of the Common Council (1905 and 1917), Street Files and the Street Opening Book (n.d.) at the Topographical Bureau of the Manhattan Borough President's Office, and a Street Opening Map (SOM n.d.) in the author's collection. The distinction between a street being "Laid Out," which is equivalent to being run, and being "Opened," which is when the city takes title, (Marks 2003:personal communication), should be noted. As time went on, these two dates were often the same, but in early times, there could be many years, if not decades, between them. It should be noted that the various sources providing street opening information often do not agree. The dates given below come mainly from the street opening book in the Topographical Bureau of the Manhattan Borough President's Office. Other sources were consulted as cited. Tables 1 and 2 offer information about street features and alterations in the APE.

- Ann Street (from Nassau to William; includes intersection with William just north of the APE): opened 1708; laid out at 22 feet wide (SOM n.d.)
- Broadway (Liberty to Ann): opened 1677
- Church Street (Liberty to Fulton): opened after 1842; (Extended from Fulton south to Morris): contracted in 1867; opened 1869; (Fulton to Vesey): opened 1750
- Dey Street (Broadway to Greenwich): laid out 1740; regulated 1750

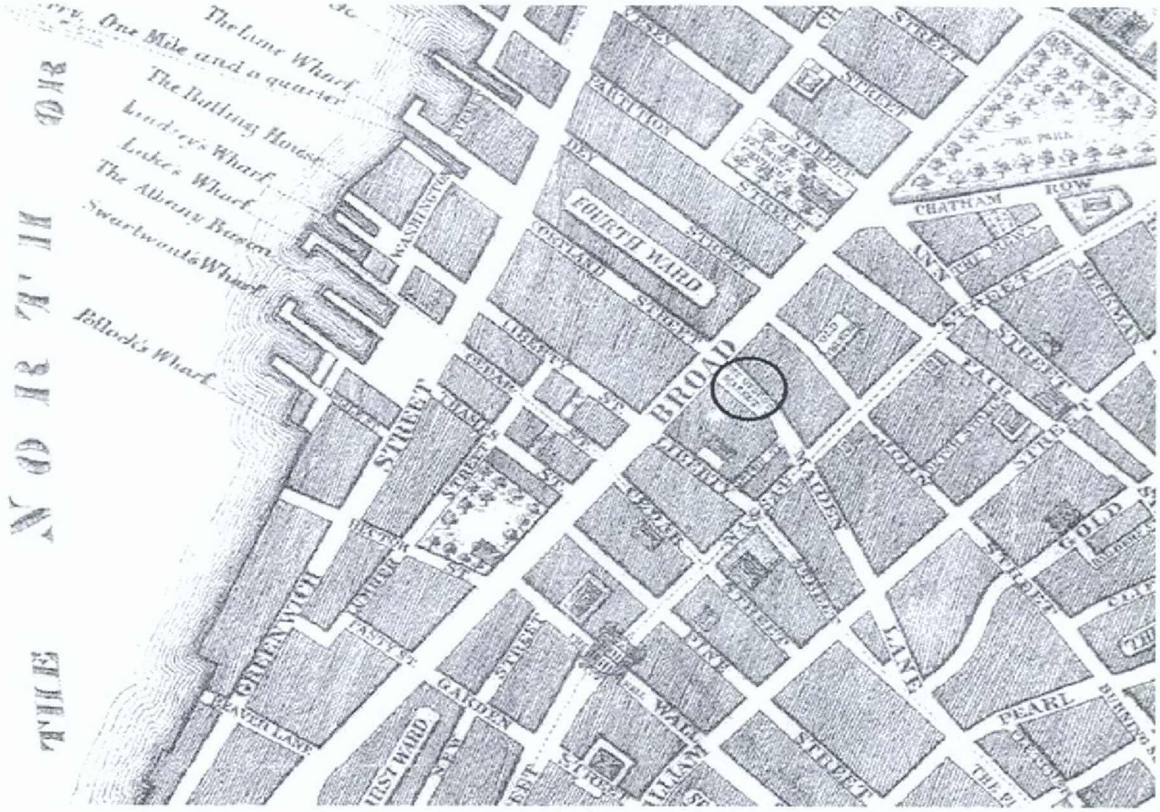
- Cortlandt Street (Broadway to Church; includes APE intersection): opened 1734
- Fulton Street (Laid out as Fair Street in the APE [called Partition Street west of Broadway]; combined and renamed for Robert Fulton in 1834): originally opened 1690
- John Street (intersection with William and east to Pearl): opened 1690
- Maiden Lane (Broadway to Liberty Place): opened 1691
- William Street (Maiden Lane to Ann): opened 1690

As noted above, street features include sidewalk vaults—the most ubiquitous of the features—public and private cisterns, wells and pumps, water pipes, and sewers. Cast iron gas pipes to provide street lighting were laid throughout most of the streets in the APE by the 1830s (see below), and a market, the second Oswego Market, was established on the south side of Maiden Lane in 1772. According to Thomas De Voe, who described it as a "market-house," its covered roof extended into the street just off Broadway (1862:330-340). However, a 1797 map suggests it covered the greater part of the street in the vicinity of Broadway (Taylor-Roberts 1797; see Figure 6). Occupied mainly by butchers, this market stood on Maiden Lane between Broadway and Nassau Street for almost forty years.

7. IDENTIFIED STREET ISSUES AND POTENTIAL STREET FEATURES

7.1 Issues

As previously discussed or implied, many factors are involved in the potential archaeological sensitivity of the streets in the FSTC Archaeological APE. A number have been widened, extending streets dating from the late colonial period and early republic onto former building lots; all have been subject to the introduction of utilities and therefore, to disturbance and repaving. The Minutes of the Common Council (MCC) and the records of the aforementioned Manhattan Company document complaints about street disturbance and attempts to identify responsibility for repaving. There are also the water mains, first of wood and then cast iron, and sewers—then and now the deepest of the utilities, originally mainly brick and then iron. Installing sewers undoubtedly caused great disturbance to reach required depths and grades. There were also the wells, pumps, and street cisterns that supplied water for private and commercial consumption. They also provided water for fire fighting in a city with buildings of wood, with heat provided by fireplaces, and light by candles and oil lamps. Previously mentioned sidewalk and street vaults were also urban features. All these street features could be found in an archaeological context. Many are documented in archival records. As noted above, Figure 7 offers a schematic showing the approximate locations of several of these resources identified in the APE through research. Details about what might be encountered are described below. A total of 23 street features, which should be considered only a minimum number, were identified in, or possibly in, the APE. Of these, fourteen with their locations identified, or possibly identified, are indicated in Figure 7.



Source: Taylor-Roberts 1797

Oswego Market

no scale

N

Figure 6 – Oswego Market (1772-1811) in 1797

Table 1 - FSTC ARCHAEOLOGICAL REPORT Street Features and Probable Locations*

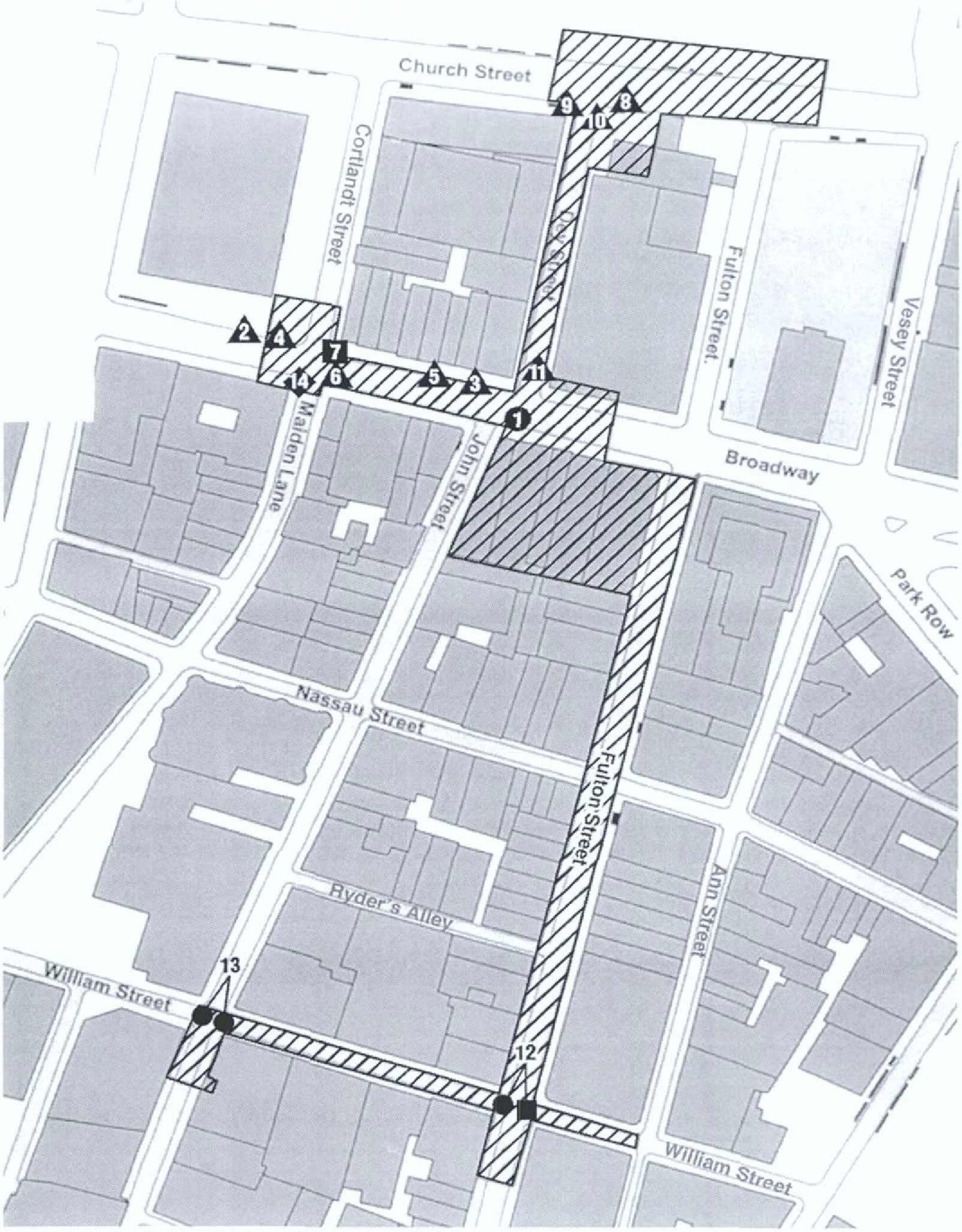
Street	Date/MCC 1917 Citation	Street Feature	Location and Petitioner (s) from MCC & NY Directories	Modern Location/ Remarks/# on Figure 7
Broadway*	1766	Well	In Broadway opposite Battow (sic) [Batteau] Street	Batteau Street now Dey; named "Batteau" because of "an early Dutch boat buried in the mud at what is now Greenwich and Dey Street" (SF) #1
	1798 (II:456)	Vault	165 Broadway/Alex McDonald	W side of Broadway, just south of Cortlandt-Broadway intersection #2
	1803 (III:303)	Coal Vault	187 Broadway/Garrett Gilbert	W side of Broadway between Dey and John #3
	1807 (IV:413, 467)	Pump†	On Broadway between Cortlandt and Liberty Streets	Possibly in APE? In this year pumps were to be removed from the streets to the sidewalks (MCC IV 1917:413, 467)
	1808 (V:100)	Vault	166 (James Anderson?) and 168 Broadway/Hector Craig	W side of Broadway, just south of the Cortlandt Street intersection (2 vaults in street) #4
	1810 (VI:187)	Vault	179 Broadway/Theophilus Prince	W side of Broadway #5
	1812 (VII:276)	Vault	172 Broadway/Catherine Ritter	NE corner of Broadway and Maiden Lane #6
Cortlandt*	1748	Wells†	Ordered wells sunk in Cortlandt, no location	Possibly in APE (MCC V 1905:243)
	1749	Well†	Ordered £8 towards digging, sinking of well, in Cortlandt no location	Possibly in APE (V 1905:266); possibly same as above
	1771	Pump†	Ordered work to pump, in Cortlandt, no location	Possibly in APE (VII 1905:313)
	1810 (VI:217)	Pump	E side of Cortlandt, junction of Cortlandt and Broadway	Based on cardinal directions of the time, near NW corner of intersection of Broadway and Cortlandt; possibly removed to street #7
Dey	1748	Well†	Well to be sunk in Dey, no location	Possibly in APE (MCC V 1905:243)
	1805 (IV:13)	Vault	26 Dey/William W. Gilbert	N side of Dey-Church intersection #8
	1810 (VI:282)	Vault	21 Dey/Mrs. Renwick	S side of Dey-Church intersection #9
	1814 (VIII:69)	Vault	24 Dey/Dr. William Hardy	Within APE #10
	1817 (IX:154)	Vault	4 Dey/D. L. Haight	Within APE #11
Fulton*	1813 (VII:539)	Well & Pump	"To be placed in Fair Street near William"	Fulton near William; possibly in APE although it could have been on the east side of the Fulton - William intersection #12
	1813 (VII:506)	Pump†	Fair Street, no location	E of Broadway on Fulton possibly in APE
John	1748	Well†	Well sunk in "neighborhood John Street," no location	Possibly in APE? (MCC V 1905:240)
	1788 (I:394)	Wells	John and William	Fill one well, sink another at intersection of John and William, possibly in APE #13
	1810 (VI:343)	Request to remove Pump †	John Street, no address	Request rejected; pump possibly in APE
Maiden Lane*	1771-1811	Market	Oswego Market, 2nd site, S side of Maiden Lane just E of Broadway	Located in street for almost 40 years (De Voe 1861:330-340; Stokes III 1922:959) #14
William*	1805 (IV:114)	Pump†	William, no address	Removed pump possibly in APE

*As noted in the text, gas lights were introduced into Broadway, Cortlandt Street, Fulton Street, Maiden Lane, and William Street in the 1830s. While there is no direct information about John Street, it seems likely that it, too, had been supplied with gas lights by this time.
† Location too vague to locate on Figure 7
MCC=Minutes of the Common Council; SF=Street File

Table 2 - FSTC ARCHAEOLOGICAL REPORT Identified Street Alterations

Street	Action	Details	Date/Reference	Remarks
Cortlandt	Grading	Descent to be made 8 inches every 12½ feet	8/28/1756 (MCC VI 1905:63)	From upper to lower Cortlandt, location not established
	Regulation	Descent 2 inches on 14 feet for 400 feet and 5 ½ inches every 10 feet	10/4/1759 (MCC VI 1905:185	Broadway from middle of street to end of Dey and end of Cortlandt; for kennel in Broadway
	Grading	Street to be highest in middle	7/28/1784 (MCC I 1917:62)	Kennels or gutters for drainage on either side near front of lots
	Grading	Corner Cortlandt opposite the Oswego Market, Maiden Lane near Broadway	5/21/1784 (MCC I 1917:37)	Descent of street for drainage from Broadway to the North (Hudson) River
	Widening	Street to be widened 10 ft	6/9/1784 (MCC I 1917:45); (SF)	Opened at 40 feet; widening took 5 feet on either side, making it 50 feet wide
	Widening	Loss of 5 feet from corner lot, Broadway and Cortlandt	3/16/1795 (MCC II 1917:132)	Petition of Menassah Salter for compensation; granted 6/8/1795 MCC II:152
	Street lighting	Gas lighting	9/20/1830 (MCC XIX 1917:254)	Pipes laid from Broadway to West Street
Dey Street	Widened	10 feet on S side Between Broadway and Greenwich	1850 (SF); 1851 (Post 1882:70)	Widened between 1850 and 1851
Fulton (from intersection with William west to Broadway)	Grading (includes intersection)	Fair [Fulton] from Gold to William ascending 1 18/100 inches every 10 feet to William then 2 15/100 inches to Nassau, then ascending 1½ inches for 80 feet then descending 1 ½ inches every 19 feet to the east side of Broadway	7/23/1790 (MCC I 1917:567)	
	Widened	Fulton to be 55 feet wide; widened on S side	6/6/1835 (SF; SOW)	Widened from Broadway to Ryders Alley (east of Gold Street)
	Regulated from Gold to William	Ascending 1 & 18/100 inches on every 10 feet	7/23/1730 (MCC IV 1905:567)	
	Street lighting	Lighted with gas	9/20/1830 (MCC XIX 1917:254)	
John (from intersection with William west)	Widened and straightened	Broadway to Pearl widened to 45 feet	12/19/1831 (SF); (9/3/1839 SOW n.d.)	Laid out at 40 feet; Post (1882: 71) says widened between Broadway and Pearl Street 2/16/1836
Maiden Lane	Widened from Broadway to Nassau	Crookedness noted (1804) (SF); widened to 50 feet in APE	5/6/1811 (VI:580; 725; SF)	Widened to 50 feet in APE after 1811 removal of the Oswego Market
William (between Ann and Maiden Lane)	Widened	Maiden Lane to Ann widened uniformly to 50 feet in segments	5/10/1836 (SF)	Widening actually occurred November 1836; opened and widened legally from Maiden Lane to Chatham 5/14/1847 (SF)
	Widened	Maiden Lane to Chatham Square	5/28/1847 (SOW n.d.)	Post (1882:76) says 1847

Key: MCC=Minutes of the Common Council; SF=Street Files; SOW=Street Openings and Widenings



Note: locations approximate and not to scale. Numbers identify entries in Table 1

Base map source: Louis Berger 2004

archaeological APE ▲ vault ■ pump ● well ◆ market

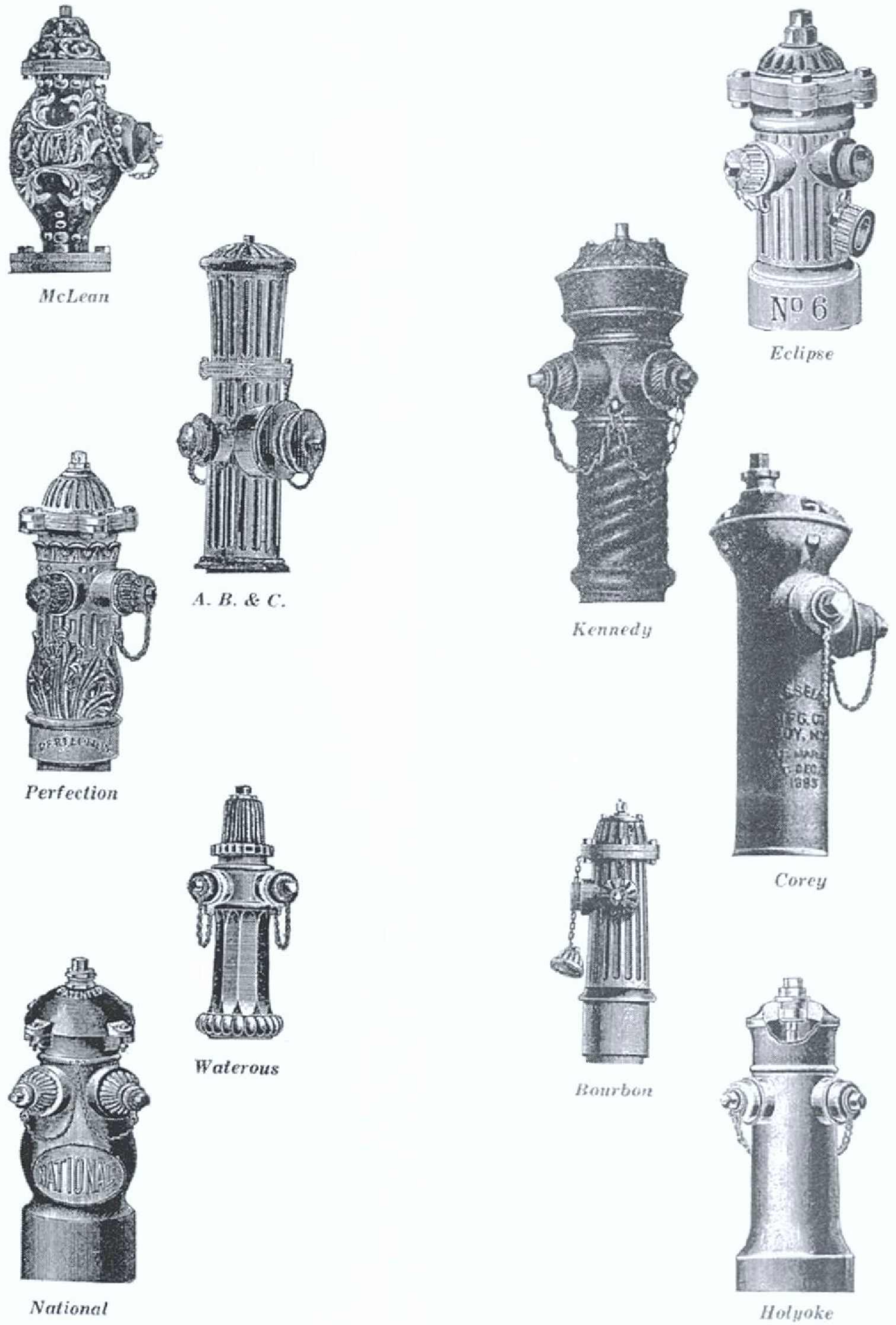
0 200

Figure 7 – Possible Historic Street Feature Locations

7.1.1 Pumps and Wells

Six public wells are documented south of the project area in 1696, all of them located in the middle of the street south of Wall Street (Miller 1696; not illustrated). Sometime before the end of the 18th century, these wells were abandoned and new ones constructed on sidewalks throughout the city. However, the quality of the water in these wells, which was mainly brackish, was far from acceptable (an exception was the Tea Water Well or Pump located near Park Row and Baxter Street, near the Collect Pond. This would place it just above Worth Street, a few blocks north of the APE. This spring provided pure water until the nearby pond became polluted by the industries that grew up around it [Church 1987:B-41]). Public wells with hand pumps were common after the first half of the 18th century (e.g., Holland 1797; Figure 9), and there were said to be 249 public wells in New York City by 1809 (Blake 1956 cited in Church 1987:B-4l), long after development had occurred in the project APE.

Wells and pumps in the APE are mentioned in the Minutes of the Common Council (see Table 1) and undoubtedly others were also present. Those documented in the project area, which should be considered only a minimum number, include a well on Broadway at its intersection with Dey Street, a pump between Cortlandt and Liberty Streets, possibly in the APE, two or more wells and two pumps on Cortlandt Street, a well on Dey Street, a well and two pumps on Fulton Street, and two consecutively constructed wells and a pump on John Street near William Street. Unfortunately, the exact locations of these features are not well-defined in the Minutes of the Common Council. In an archaeological context, they undoubtedly would be deep, circular or sometimes square or rectangular features of brick or stone that could be mistaken for manholes.



Source: Carey 1945:28-29

Figure 8 – 19th and Early 20th Century Hydrants

7.1.2 Sewers

Brick sewers constructed by the city and documented throughout the project APE include the following: Ann Street between Park Row and William Street: circular, 4-foot diameter, May 1849; Cortlandt Street between Broadway and the Hudson River: circular, 4-foot diameter, June 1848; Fulton Street: Nassau to the East River, circular, 4-foot diameter, May 1847; John Street: Broadway to Pearl Street, circular, 4-foot diameter, May 1847; Maiden Lane between Broadway and the East River, circular, 5-foot diameter, March 1847; William Street between Beekman and Fulton, circular 4-foot diameter, December 1848; Fulton and John circular, 4-foot diameter, May 1849; John and Maiden Lane, circular, 4-foot diameter, August 1847 (*Annual Report of the Croton Aqueduct Department* 1857:110ff). The 5-foot diameter circular sewer installed on Maiden Lane, presumably of brick and under contract in March 1847, is the earliest documented in the project APE. While it is almost inconceivable that this conduit is still in operation, or that any of it survived the 1928 construction of the subway in William Street, remnants might yet exist.

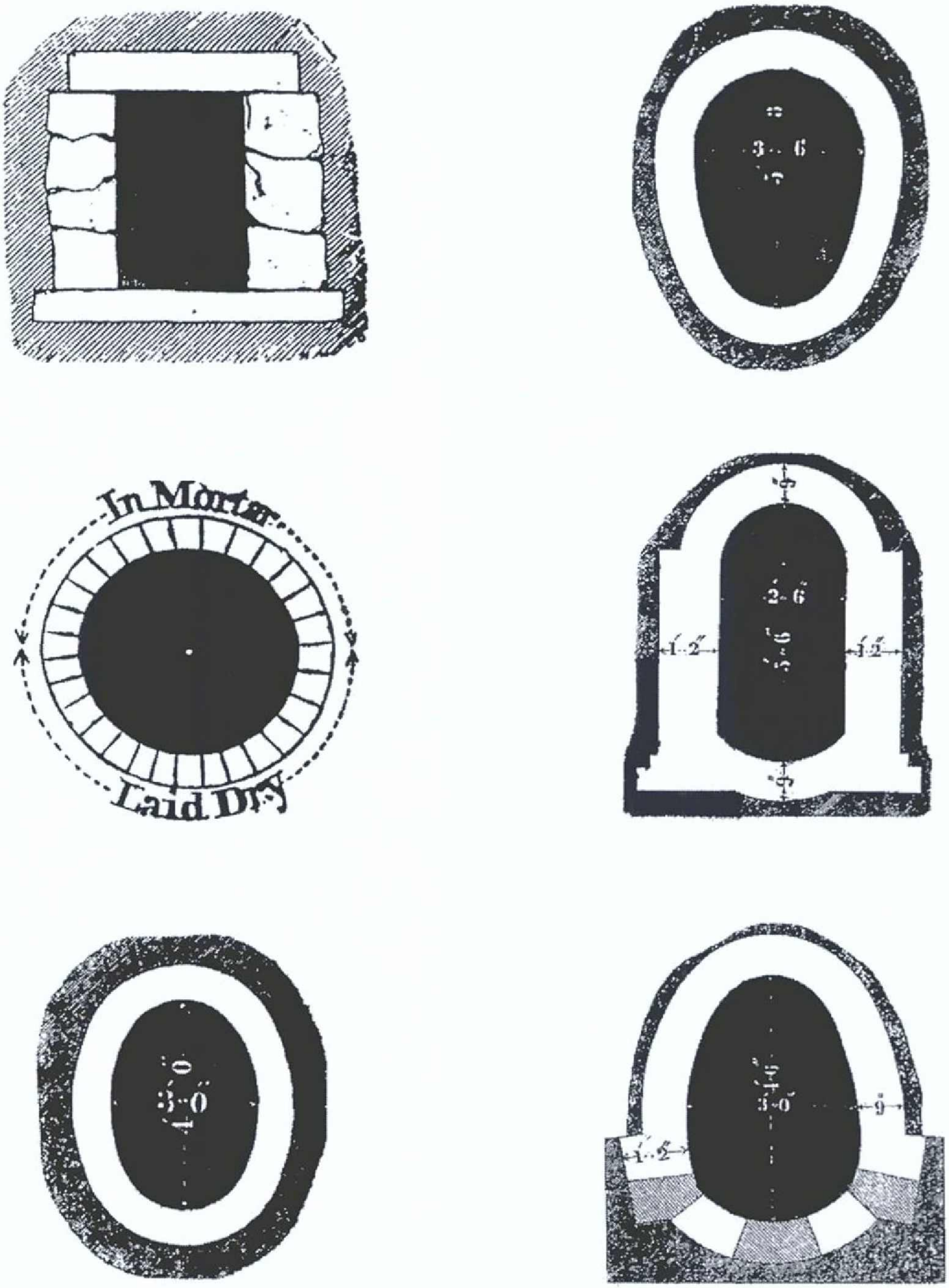
George Dempsey, a mid-19th-century engineer, described and illustrated the variety of sewers in use in 1849. These included stone conduits that were not very practical. More typically, they were of brick and were round, oval, or elliptical (Dempsey 1849; Figure 10). In the project APE, the earliest documented sewers were circular, and between 4 and 5 feet in diameter.

In mid-19th-century New York City, water and waste management was undertaken as the need arose. Unlike the city's water supply system designed and constructed by John Jervis and activated in 1842, New York's sewer system was an afterthought and, initially, a rather *ad hoc* affair (Spann 1981:132). As such, its remnants are an example of what can only be described as a somewhat piecemeal municipal solution to an entirely new situation. It entailed construction of brick sewers that were initially circular but, over time, shifted to a more efficient elliptical or egg-shape. It should be noted that the first sewers documented in the APE were all circular, ranging from 4 to 5 feet in diameter (see above). As such, they are examples of the earliest municipal attempts at water and waste management in New York City, all but two of them constructed before the state created the Croton Aqueduct Department (Spann 1981:641n). On April 11, 1849, this municipal entity was made responsible for the "construction, repairs, and cleaning of all sewers and underground drains" (Duffy 1968:413).

7.1.3 Street or Sidewalk Vaults

These 18th and 19th-century vaults may still be found in their original locations where little or no disturbance has occurred. A case in point may be a brick feature uncovered during recent test pit excavations on the northwest corner of the Cortlandt StreetBroadway intersection, although it seems more likely that this feature is related to a high-pressure hydrant also uncovered in the pit. Research is currently underway to determine its association. These vaults may be found under streets that have been widened, with former sidewalks now beneath expanded roadways.

Figure 9 – Broad Street from Exchange Place looking North to Wall Street and Federal Hall in 1797. Note hand pumps (arrows) on either side of the Street. A hitching post is on the left side of Broad to the right of the pump. (Holland 1797)



Source: Dempsey 1849

Figure 10 – Mid-19th Century Sewers

The earliest vault documented in the APE was constructed on Broadway in 1798 (165 Broadway; see Table 1) and was probably intended for storage. Whatever their original purpose, during the 19th century it is more than likely these vaults were intended to receive and store coal. A vault, identified as a coal vault, is documented on Broadway in the APE in 1803 (see Table 1), and they are still found throughout areas of nearby Jersey City. Not far from the project area, a restaurant on Duane Street in Lower Manhattan has converted a sidewalk vault into a private dining room-wine cellar. If the few vaults seen to date are any example, they would be made of brick, have vaulted ceilings, and be located directly under the sidewalk. Within the APE, five are documented on Broadway and four on Dey Street (see Table 1 and Figure 7). Once again, the nine documented or implied vaults should be considered only a minimum number.

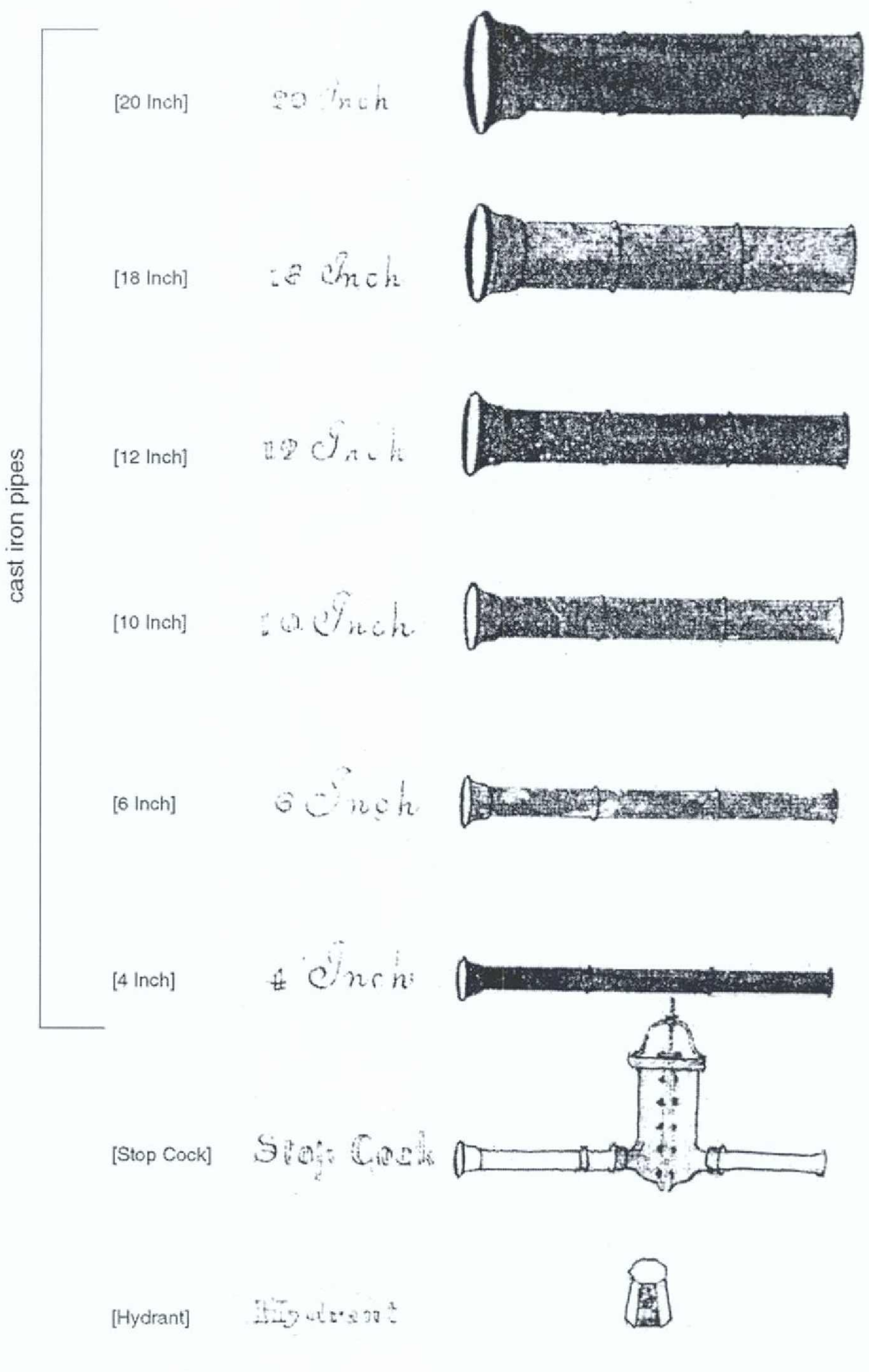
7.1.4 Water Mains

As mentioned earlier, bored-out logs were used to conduct Manhattan Company water to the early-19th-century homes and businesses that subscribed to the service. The water came from wells mainly located near Manhattan's Fresh Water Pond (an apparent euphemism as its waters became polluted over time), or Collect Pond, as it was also known. This pond was situated just north of Worth Street with a dip south into what is now Hamill Park south of Worth Street and east of Centre Street (Geismar 1993:10-11). Manhattan Company water was distributed from a large cistern on Reade Street that stood west of Centre Street until 1913 (American Scenic and Historic 1915 in Geismar 1993:40) and was stored in a Classic-style reservoir on the north side of Chamber Street almost directly across from what is now the Tweed Courthouse (Wegmann 1896:Plate 4). By 1828, the Manhattan Company was in the process of replacing these log mains with cast iron-pipes of various sizes (e.g., Goodrich 1828; Figure 11).

Records in the Chase Manhattan Archives indicate that water was available to all those living or working in the APE before 1807, the year many subscribers "stopped" service (Water Works Journals 1820-1825). This suggests that early-19th century log water mains were introduced to all the streets in the FSTC APE.

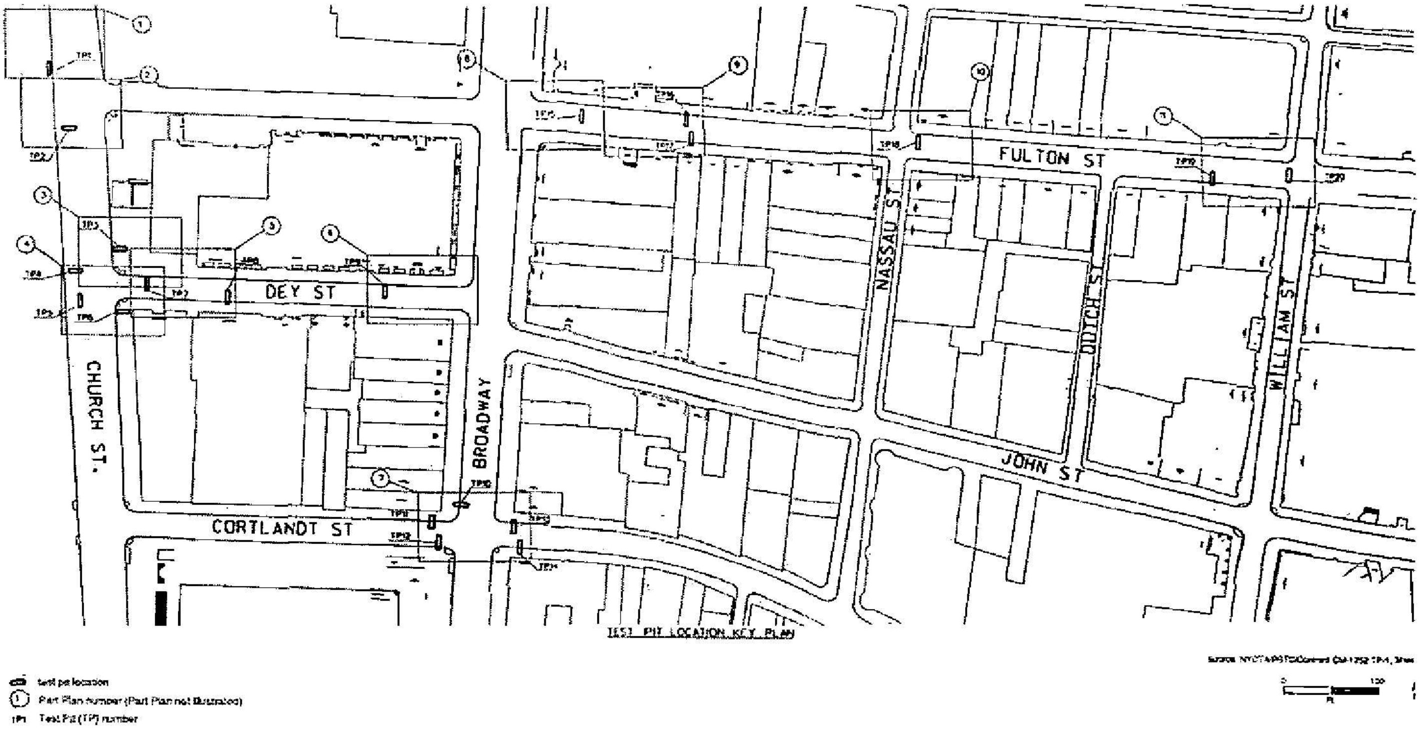
8. FIELD INVESTIGATIONS (TEST PITS)

At this writing, test pits (TP), or trenches, are being excavated by hand to determine subsurface conditions at nineteen street locations throughout the APE: these are designated TP1 to TP19 on Figure 12. At this writing, excavation of six test pits in streets have documented a dense utility network throughout. However, as noted earlier, despite the disturbance, brick construction, possibly associated with the remnants of a pressure hydrant, was located on the north side of Cortlandt Street just west of Broadway in TP11. In addition, a brick sewer was documented 12 feet Below the Ground Surface (BGS) in TP 8 on Dey Street just east of Church. Deep excavations, extending to 15 feet BGS, are planned at two other locations. To date, no testing has occurred under sidewalks; three sidewalk areas with no utilities documented are expected to be tested in the future (TP3, TP6, and TP13). Monitoring is planned at these locations.



Source: Goodrich 1828

Figure 11 – Cast Iron Pipes, Stop-Cocks, and Hydrants in Use 1827



ure 12 – Test Pit Location Plan

9. CONCLUSIONS AND RECOMMENDATIONS

Historical research suggests that despite extensive disturbance that includes street widening, the introduction of utilities, and the cut-and-cover construction of subways, remnants of early infrastructure and street features could be a concern in the project APE. A test pit excavated and monitored within the FSTC APE documented a mid-19th-century brick sewer, and another revealed what may be the remnants of an obsolete high-pressure hydrant. The sewer was exposed at 12 feet BGS on Dey Street between Broadway and Church Street (TP7), the hydrant and what appears to be an associated brick chamber, on Cortlandt Street just west of Broadway (TP11). None of these test pits has revealed any evidence of the wells, pumps, drains, cisterns, bored-out log water mains, or street or sidewalk vaults that could potentially be found in the project APE. However, at this writing, no testing has occurred on sidewalks where less disturbance is documented.

While these features, if found, do not warrant interference with project schedules or goals, they do warrant documentation as surviving manifestations of New York's early infrastructure and examples of its urbanizing process. It is suggested that a protocol be established prior to construction to carry out this documentation if needed during construction without causing undue delays and interference. In this regard, a project archaeologist should be on call to assess, photograph, and measure any historic utilities or features encountered during construction. This includes brick sewers, street or sidewalk vaults, street cisterns and wells, early hydrants, pumps, and log water mains. If remnants of log water mains are found, Douglas Greeley, Deputy Commissioner, New York City Department of Environmental Protection, Bureau of Water and Sewers Operations, should be contacted to remove and store the specimen. In this way, these "unanticipated discoveries" can be handled to everyone's satisfaction without detriment to the project, its schedules, or the resource.

Although research does not suggest that human remains will be an issue, it is nonetheless prudent to have a protocol in place to address unanticipated discoveries. If human remains are encountered and it is suspected they are less than 50 years old, both the project archaeologist and the coroner's office should be notified. Should the remains obviously be archaeological in nature, the New York City Landmarks Preservation Commission archaeologists should be notified in addition to the project archaeologist. A faunal expert, also on call, should identify the remains. The protocol established by applicable statutes in regard to human remains would then be implemented. Depending on the circumstance, it is anticipated the remains would be identified and either be protected in place or removed to an appropriate burying place. Guidelines should be established per relevant Federal Statutes prior to construction for an appropriate protocol should the remains prove to be of Native American origin.

Fulton Street Transit Center

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APPENDIX B: SOIL BORING LOG SHEETS

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BB-1

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 132.62	NORTH: 198316
DATUM NYCT	EAST: 981791
FINAL BORING DEPTH (FT) 105.4	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: P. Lynch
CASING SIZE: 4 inch.	ENGINEER: J. Au
CASING HAMMER: 140 lb automatic	DATE START: 10/18/03 DATE END: 10/19/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/26/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
10/19/03	9:00	34.3	70.0	16 Hours
10/25/03	12:15	33.3	OW	6 Days
11/6/03	10:45	33.1	OW	18 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Asphalt pavement (0.5 ft.)		FILL	Boring advanced by hand to a depth of 6 ft.
		H1	2-6						0	Reddish - brown, fine to coarse SAND, little asphalt and brick fragments, trace Silt (SP/11-65)			Sample H1 obtained from hand auger cuttings.
5													
		S1	6-8	1-2 4-2	6	24/7			0	Loose, dark brown, fine to coarse SAND, little brick and asphalt fragments, trace Silt (SP/11-65)			Boring advanced by rotary methods from 6 ft. to completion.
		S2	8-10	3-4 4-4	8	24/6			0	Loose, dark brown, fine to coarse SAND, little brick and asphalt fragments, trace Silt (SP/11-65)			
10		S3	10-12	4-4 5-6	9	24/8			0	Loose, dark brown, fine to coarse SAND, little brick fragments, trace Gravel, trace asphalt fragments, trace Silt (SP/11-65)			Sample S3 collected for environmental testing.
15		S4	15-16.5	5-6	11	24/12			0	Medium dense, dark brown, fine to coarse SAND, trace fine Gravel, trace Silt, micaceous (SP/11-65)			
		S4A	16.5-17	5-7						Dark brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)		F-M SAND	
20		S5	20-22	12-13 14-12	27	24/12			0	Medium dense, reddish - brown, fine to medium SAND, some Silt, trace Gravel, micaceous (SM/8-65)			
25		S6	25-27	7-10 7-11	17	24/12			0	Medium dense, reddish - brown, fine to medium SAND, some Silt, micaceous (SM/8-65)			
30												SILTY FINE SAND	

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BB-1

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 132.62	NORTH: 198316
DATUM NYCT	EAST: 981791
FINAL BORING DEPTH (FT) 105.4	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: P. Lynch
CASING SIZE: 4 inch.	ENGINEER: J. Au
CASING HAMMER: 140 lb automatic	DATE START: 10/18/03 DATE END: 10/19/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/26/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
10/19/03	9:00	34.3	70.0	16 Hours
10/25/03	12:15	33.3	OW	6 Days
11/6/03	10:45	33.1	OW	18 Days

DEPTH (FT)	CASING (BPF) CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	10-11 8-9	19	24/12			0	Medium dense, reddish - brown, fine to medium SAND, some Silt, trace Gravel, micaceous (SM/8-65)		SILTY FINE SAND	
35		S8	35-37	6-10 16-17	26	24/15			0	Medium dense, reddish - brown, fine SAND, some Silt, micaceous (SM/8-65)			
												F-M SAND	Falling head permeability test performed at 40.0 ft.
40		S9	40-41	9-6	12	24/18			0	Reddish - brown, fine to medium SAND, little Gravel, trace Silt, micaceous (SM/6-65)		STRATIFIED SILT AND SILTY FINE SAND	
		S9A	41-42	6-9						Reddish - brown, SILT and fine Sand (ML/10-65)			
45		S10	45-46	2-2	8	24/24			0	Reddish - brown, fine SAND, little Silt with varves of Clayey Silt (SM/8-65)			WC = 28.3%, LL = NP, PI = NP
		S10A	46-47	6-11						Brown, SILT, little fine Sand, micaceous (ML/10-65)			
50		S11	50-52	4-8 11-14	19	24/24			0	Medium dense, reddish - brown, fine SAND, some Silt, micaceous (SM/8-65)			Falling head permeability test performed at 50.0 ft.
												F-M SAND	
55		S12	55-57	6-7 11-13	18	24/24			0	Medium dense, brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)			
60													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated: fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
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4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BB-1

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 132.62	NORTH: 198316
DATUM NYCT	EAST: 981791
FINAL BORING DEPTH (FT) 105.4	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: P. Lynch
CASING SIZE: 4 inch.	ENGINEER: J. Au
CASING HAMMER: 140 lb automatic	DATE START: 10/18/03 DATE END: 10/19/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/26/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
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10/25/03	12:15	33.3	OW	6 Days
11/6/03	10:45	33.1	OW	18 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-62	5-8 8-18	16	24/24			0	Medium dense, reddish - brown, SILT and fine Sand, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	Falling head permeability test performed at 60.0 ft.
65		S14	65-67	3-4 10-12	14	24/24			0	Medium dense, reddish - brown, fine SAND, trace Silt with varves of Clayey Silt, micaceous (SP/7-65)			
70		S15	70-72	4-6 7-12	13	24/20			0	Medium dense, reddish - brown, SILT, some fine Sand, micaceous (ML/10-65)			Falling head permeability test performed at 70.0 ft.
75		S16	75-77	5-7 14-17	21	24/21			0	Medium dense, grayish brown, SILT and fine Sand, micaceous (ML/10-65)			
80		S17	80-82	2-4 6-9	10	24/21			0	Medium dense, brown, SILT, trace fine Sand, micaceous (ML/10-65)			SG = 2.77, WC = 30.8%, LL = NP, PI = NP
												GLACIAL TILL	
85		S18	85-86.4	34-59 100\5	159/11	17/12			0	Very dense, gray, fine to medium SAND, some Silt, little Gravel, micaceous (SM/6-65)			
												DECOMP. SCHIST	
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
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4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BB-1

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 132.62	NORTH: 198316
DATUM NYCT	EAST: 981791
FINAL BORING DEPTH (FT) 105.4	

SAMPLER: 2 inch. Split Spoon
SAMPLER HAMMER: 140 lb Safety Hammer
CASING SIZE: 4 inch.
CASING HAMMER: 140 lb automatic
ROCK CORE: NX

BORING CO: Jersey Boring & Drilling Company., Inc.
FOREMAN: P. Lynch
ENGINEER: J. Au
DATE START: 10/18/03 DATE END: 10/19/03
REVIEWED BY: P. Mahon DATE: 10/26/03

GROUND WATER READINGS

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DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN/REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S19	90-91.4	65-96 100/5	196/11	17/10			0	Very dense, gray, fine to coarse SAND, little Gravel, little Silt, micaceous (SM/4-65)		DECOMP. SCHIST	
												SCHIST	Difficult borehole advancement between 94.0 and 95.0 ft.
95	3, 4, 4, 4, 4	C1	95-100.2			5.2/5.2	100	100		Hard, fresh to slightly weathered, fine to coarse grained, gray, quartz - mica - garnet SCHIST, with very thin, convoluted, crenulated, sub-horizontal to vertical foliation, no apparent joints/fractures (1-65)			Unconfined Compressive Strength = 6.96 ksi (Sample collected between 99.3 and 100.2 ft.)
100	3, 4, 4, 4, 4	C2	100.2-105.4			5.2/5.2	100	100		Hard, fresh to slightly weathered, fine to coarse grained, gray, quartz - mica - garnet SCHIST, with very thin, convoluted, crenulated, sub-horizontal to vertical foliation, no apparent joints/fractures (1-65)			
105										Bottom of borehole at 105.4 ft.			Observation well installed to a depth of 45.5 ft.
110													
115													
120													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

Sheet: 1 of 3

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BB-7

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
SURF EL. 115.1	NORTH: 198225
DATUM NYCT	EAST: 981669
FINAL BORING DEPTH (FT) 81.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: P. Lynch / A. Feliciano
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/03 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.6	25'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Concrete Slab (1.0 ft.)			Boring advanced by rotary methods to completion.
		S1	1-3	3-2 2-2		24/6			0	Reddish - brown, fine to medium SAND, some Silt, trace Gravel, micaceous (SM/8-65)		F-M SAND	WC = 11.9% See general note 4 regarding N-values.
5		S2	5-7	23-8 6-8		24/4			0	Reddish - brown, fine to medium SAND, little Silt, trace Gravel, micaceous (SM/8-65)			WC = 19.3%
												SILTY FINE SAND	
10		S3	10-12	11-10 12-12		24/8			0	Reddish - brown, fine SAND, some Silt, trace Gravel, micaceous (SM/8-65)			Portion of sample S3 collected for environmental testing. WC = 24.6%
15		S4	15-17	8-11 12-13		24/10			0	Reddish - brown, fine SAND and Silt, trace Gravel, micaceous (SM/8-65)			WC = 29.2%
20		S5	20-22	10-12 12-11		24/10			0	Reddish - brown, fine SAND, some Silt, micaceous (SM/8-65)			WC = 24.5%
												STRATIFIED SILT AND SILTY FINE SAND	
25		S6	25-27	32-28 22-18		24/8			0	Reddish - brown, SILT, little fine SAND, micaceous (ML/10-65)			WC = 24.6%, LL = NP, PI = NP
30													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 15 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-Values cannot be reported.

BORING LOG

BORING NO. BB-7

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
SURF EL. 115.1	NORTH: 198225
DATUM NYCT	EAST: 981669
FINAL BORING DEPTH (FT) 81.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: P. Lynch / A. Feliciano
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/03 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.6	25'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	10-18 16-20		24/12			0	Reddish - brown, CLAYEY SILT, little fine SAND, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	WC = 30.1%, LL = 23, PI = 1
35		S8	35-37	15-17 20-23		24/12			0	Reddish - brown, fine SAND, some Silt, micaceous (SM/8-65)			SG = 2.73, WC = 22.8%, LL = NP, PI = NP
40		S9	40-42	10-11 15-21		24/16			0	Reddish - brown, SILT, some fine Sand, micaceous (ML/10-65)			WC = 30.7%
45		S10	45-47	14-14 17-33		24/14			0	Reddish - brown, fine to medium SAND, some Silt, micaceous (SM/8-65)			
50		S11	50-52	10-15 19-29		24/14			0	Reddish - brown, fine SAND, little Silt, micaceous (SM/8-65)			
55		S12	55-57	15-23 19-20		24/12			0	Reddish - brown, fine SAND, little Silt, micaceous (SM/8-65)			
60													

GRANULAR SOILS BPF	DENSITY	COHESIVE SOILS BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 16 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-Values cannot be reported.

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BB-7

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
SURF EL. 115.1	NORTH: 198225
DATUM NYCT	EAST: 981669
FINAL BORING DEPTH (FT) 81.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: P. Lynch / A. Feliciano
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/03 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.6	25'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN /REC (IN/IN) ROCK PEN/REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-62	10-27 31-37		24/12			0	Grayish - brown, SILTY CLAY, trace fine Sand with varves of fine to medium Sand (CL/9-65)		STRATIFIED SILT AND SILTY FINE SAND	
		S14	65-65	100/0		0/0						GLACIAL TILL	
65	2, 2, 2, 2, 2	C1	65-70			5/0.3	6			Gray Boulder/cobbles			Difficult borehole advancement. Gauge indicates 160 psi down pressure at the start of C1. Cobble blocked core barrel during advancement.
70		S15	70-70.4	100/5		5/3			0	Black, fine to coarse GRAVEL, trace fine to coarse Sand, trace Silt (GP/6-65)			
75	3, 2, 3, 2	C2	74-78			4/0.5	13			Boulder/cobbles			Cobble blocked core barrel during advancement.
80	3, 2, 3	C3	78-81			3/0.5	17			Boulder/cobbles			Cobble blocked core barrel during advancement.
										Bottom of borehole at 81.0 ft.			
85													
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 16 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-Values cannot be reported.

BORING NO. BB-8

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
SURF EL. 114.9	NORTH: 198137
DATUM NYCT	EAST: 981614
FINAL BORING DEPTH (FT) 81.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: S. Laurenza / T. Martin
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/02 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.0	20'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Concrete Slab (1.5 ft.)			
		S1	1.5-3.5	18-4 5-4		24/3			0	Reddish - brown, fine to medium SAND, trace Gravel, trace Silt, micaceous (SP/7-65)		F-M SAND	Boring advanced by rotary methods to completion. See general note 4 regarding N-Values.
5		S2	5-7	6-4 5-4		24/3			0	Reddish - brown, fine to medium SAND, some Gravel, trace Silt, micaceous (SP-SM/6-65)			WC = 32.3%
10		S3	10-12	5-6 7-7		24/10			0	Reddish - brown, fine SAND, some Silt, micacous (SM/8-65)		SILTY FINE SAND	WC = 14.8%
15		S4	15-17	5-6 8-11		24/12			0	Reddish - brown, SILT, some fine Sand, micaceous (ML/10-65)			WC = 15.7%
20		S5	20-22	7-5 8-10		24/24			0	Reddish - brown, SILT, little fine Sand, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	WC = 33.6%, LL = 23, PI = 0
25		S6	25-27	5-6 13-15		24/24			0	Reddish - brown, SILT & CLAY, little fine Sand, micaceous (CL/9-65)			GS = 2.79, WC = 30.5%, LL = 26, PI =8
30													

GRANULAR SOILS BPF	DENSITY	COHESIVE SOILS BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
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3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 28 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-Values cannot be reported.

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BB-8

BORING STATION:		OFFSET:	
PROJECT NO. CM - 1252		COORDINATES:	
SURF EL. 114.9		NORTH: 198137	
DATUM NYCT		EAST: 981614	
FINAL BORING DEPTH (FT) 81.0			

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: S. Laurenza / T. Martin
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/02 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.0	20'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN /REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	18-21 33-26		24/18			0	Reddish - brown, SILT, little fine Sand, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	WC = 23.6%, LL = NP, PI = NP
35		S8	35-37	11-16 18-22		24/14			0	Reddish - brown, SILT and fine Sand, micaceous (ML/10-65)			WC = 26.3%
40		S9	40-42	14-17 17-18		24/22			0	Reddish - brown, fine SAND and Silt, micaceous (SM/8-65)			WC = 23.9%
45		S10	45-47	12-9 14-27		24/24			0	Reddish - brown, fine SAND, some Silt, micaceous (SM/8-65)			
50		S11	50-52	9-11 13-18		24/24			0	Reddish - brown, fine SAND, some Clayey Silt, micaceous (SM/8-65)			
55		S12	55-57	5-5 7-9		24/24			0	Reddish - brown, fine SAND and Silt, micaceous (SM/8-65)			
60													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated, fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in *instrument units calibrated* to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a *drop height of 28 inches was used to drive* split spoons. Because of the different energy, blows/6 inch may be misleading and N-values cannot be reported.

BORING LOG

BORING NO. BB-8

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
SURF EL. 114.9	NORTH: 198137
DATUM NYCT	EAST: 981614
FINAL BORING DEPTH (FT) 81.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: S. Laurenza / T. Martin
CASING SIZE: 4 inch.	ENGINEER: J. Au / V. Raghavan
CASING HAMMER: 140 lb Donut	DATE START: 11/1/02 DATE END: 11/2/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/18/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/2/03	6:00	9.0	20'	0.5 Hours

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-60.3	100\3		4/4			0	Grayish - brown, SILTY CLAY, little Gravel, trace fine to coarse Sand (CL/9-65)			
	15											GLACIAL TILL	
	15												
	10	C1	61-66			5/2.3	46			Gray - reddish brown Boulder/Cobbles, little Gravel			
	12												
65	10												
70													
	15	S14	71-71.4	100\5		5/3			0	Brown - black - red, fine to coarse SAND and Gravel, trace Silt (SP/6-65)			
	18												
	20	C2	71.5-76			4.5/0.4	9			Gray Boulder/Cobbles			Cobble blocked core barrel during advancement.
	16												
75	12												
	10												
	12												
	10	C3	76-81			5/1.8	36			Gray - green - reddish brown Boulder/Cobbles			Cobble blocked core barrel during advancement.
	8												
80	10												
										Bottom of borehole at 81.0 ft.			
85													
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 28 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-values cannot be reported.

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BD-4

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 129.77	NORTH: 198156
DATUM NYCT	EAST: 981542
FINAL BORING DEPTH (FT) 80.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: E. Feliciano
CASING SIZE: 4 inch.	ENGINEER: V. Raghavan
CASING HAMMER: Not Used	DATE START: 10/5/03 DATE END: 10/5/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/23/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Asphalt (0.5 ft) Concrete and stone blocks		FILL	Boring advanced by hand to a depth of 6 feet.
		H1	2-4							Brown, fine to medium SAND, some Gravel, little Silt. (SW-SM/11-65)			Samples H1 and H2 obtained from hand auger cuttings.
5		H2	4-6							Brown, fine to medium SAND, little Gravel, little Silt (SM/11-65)			
		S1	6-8	11-6 5-4	11	24/7			0	Medium dense, brown, fine to medium SAND, little Gravel, little Silt (SM/11-65)			Boring advanced by rotary methods from 6.0 ft. to completion.
		S2	8-10	15-15 18-17	33	24/20			0	Dense, brown, fine to medium SAND and concrete fragments, little Silt, trace Gravel (SM/11-65)			Gravel in spoon tip.
10		S3	10-12	11-17 20-25	37	24/0			0	Dense, brown, fine to medium SAND, some concrete fragments, little Silt (SM/11-65)			No recovery; Sampler readvanced to 14.0 ft. to collect sample S3. Portion of sample S3 collected for environmental testing.
15												F-M SAND	
		S4	15-17	7-9 10-11	19	24/13			0	Medium dense, reddish - brown, fine to medium SAND, little Silt, micaceous (SP-SM/7-65)			
20		S5	20-22	10-12 12-14	24	24/0			0	Medium dense, reddish - brown, fine to medium SAND, trace Gravel, trace Silt, micaceous (SP/7-65)			No recovery; Sampler readvanced to 24.0 ft to collect sample S5.
25		S6	25-26.5	4-5	14	24/10			0	S6: Medium dense, reddish - brown, fine to medium SAND, trace Silt, micaceous (SP-SM/7-65)			
		S6A	26.5-27	9-10						S6A: Reddish - brown, Clayey SILT, some fine Sand with varves of Silt, micaceous (ML/10-65)		SILTY FINE SAND	
30													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
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4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING NO. BD-4

BORING LOG | Sheet: 2 of 3

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BD-4

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 129.77	NORTH: 198156
DATUM NYCT	EAST: 981542
FINAL BORING DEPTH (FT) 80.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: E. Feliciano
CASING SIZE: 4 inch.	ENGINEER: V. Raghavan
CASING HAMMER: Not Used	DATE START: 10/5/03 DATE END: 10/5/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/23/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME

DEPTH (FT)	CASING (BPF) CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN/REC (IN/IN) ROCK PEN/REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	2-4 7-11	11	24/0			0	Medium dense, reddish - brown, fine SAND and Silt with lenses of clay, micaceous (SM/8-65)		SILTY FINE SAND	No recovery; Sampler readvanced to 34 ft. to collect sample S7.
												F-M SAND	
35		S8	35-37	3-4 7-4	11	24/17			0	Medium dense, brown, fine to medium SAND, trace Silt, micaceous (SP-SM/7-65)			Falling head permeability test performed at 35.0 ft.
												STRATIFIED SILT AND SILTY FINE SAND	
40		S9	40-42	5-12 17-4	29	24/18			0	Very stiff, brown CLAYEY SILT, little fine Sand, micaceous (ML/10-65)			SG = 2.77, WC = 22.7%, LL = 22, PI = 2
45		S10	45-47	5-7 13-12	20	24/20			0	Medium dense, reddish - brown, CLAYEY SILT with varves of fine Sand (ML/10-65)			
50		S11	50-52	6-15 18-14	33	24/12			0	Dense, reddish - brown, fine to medium SAND, some Silt, micaceous (SM/8-65)			Falling head permeability test performed at 50.0 ft.
55		S12	55-57	4-9 12-14	21	24/14			0	Dense, reddish - brown, CLAYEY SILT, some fine Sand with lens of Clay from 56.5-56.8 ft., micaceous (Ml/10-65)			
60													

GRANULAR SOILS BPF	DENSITY	COHESIVE SOILS BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
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BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BD-4

BORING STATION:		OFFSET:	
PROJECT NO. CM - 1252		COORDINATES:	
G. SURF EL. 129.77		NORTH: 198156	
DATUM NYCT		EAST: 981542	
FINAL BORING DEPTH (FT) 80.0			

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.		
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: E. Feliciano		
CASING SIZE: 4 inch.	ENGINEER: V. Raghavan		
CASING HAMMER: Not Used	DATE START: 10/5/03	DATE END: 10/5/03	
ROCK CORE: NX	REVIEWED BY: P. Mahon	DATE: 10/23/03	

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-62	6-10 9-14	19	24/16			0	Medium dense, reddish - brown, CLAYEY SILT, some fine Sand, seam of gray Silt & Clay, trace fine Sand, between 61.0 and 61.3 ft (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	Gray Silt & Clay collected between 61.0 and 61.3 ft. is labelled as S13A. WC = 31.9%, LL = 28, PI = 9 (Testing on seam of Silt & Clay) Falling head permeability test performed at 65.0 ft.
65		S14	65-67	2-9 11-18	20	24/20			0	Medium dense, reddish - brown to dark gray, CLAYEY SILT, some fine Sand (ML/10-65)			
70		S15	70-72	6-10 12-11	22	24/20			0	Medium dense, reddish - brown to dark gray, CLAYEY SILT, trace fine Sand (ML/10-65)			
75												GLACIAL TILL	Intermittent vigorous rapping of drill rods between 76.0 and 80.0 ft.
80		S16	80-80	50/0	50/0	0/0				Bottom of borehole at 80.0 feet.			
85													
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
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4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING NO. BD-4

BORING LOG	Sheet: 1 of 4

BORING NO. BF-5

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.33	NORTH: 197861
DATUM NYCT	EAST: 982268
FINAL BORING DEPTH (FT) 108.0	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi
CASING SIZE: 4 inch.	ENGINEER: D. Bastos
CASING HAMMER: Not Used	DATE START: 10/7/03 DATE END: 10/10/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/21/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/23/03	13:30	29.3	OW	32 Days
11/26/03	9:45	29.2	OW	35 Days
12/10/03	15:05	28.4	OW	62 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Asphalt (0.3 ft) Concrete (0.6 ft)		FILL	Boring advanced by hand to a depth of 6 ft.
5		H1	4-6							Brown, fine to medium SAND, some Gravel, trace Silt, trace brick fragments (SP/11-65)			Sample H1 obtained from hand auger cuttings.
		S1	6-8	1-2 2-2	4	24/6			0	Loose, brown, fine to medium SAND, little Silt, trace Gravel, (SM/11-65)			Boring advanced by 4.25 inch. augers from 6.0 ft to a depth of 35.0 ft.
		S2	8-10	2-2 3-3	5	24/6			0	Loose, brown, fine to medium SAND, little Silt, trace Gravel (SM/11-65)			
10		S3	10-12	12-7 5-6	12	24/4			0	Medium dense, brown, fine to medium SAND and brick fragments, trace Silt (SP/11-65)			Brick fragment in spoon tip.
												F-M SAND	
15		S4	15-17	6-7 8-9	15	24/12			0	Medium dense, reddish - brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)			Portion of sample S4 collected for environmental testing.
20		S5	20-22	7-7 8-8	15	24/12			0	Medium dense, reddish - brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)			
												SILTY FINE SAND	
25		S6	25-27	7-6 10-6	16	24/14			0	Medium dense, reddish - brown, fine SAND, little Silt, micaceous (SM/8-65)			
30													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG	Sheet: 2 of 4

		BORING NO. BF-5	
Fulton Street Transit Center	FULTON STREET TRANSIT CENTER	BORING STATION:	OFFSET:
		PROJECT NO. CM - 1252	COORDINATES:
		G. SURF EL. 131.33	NORTH: 197861
		DATUM NYCT	EAST: 982268
		FINAL BORING DEPTH (FT) 108.0	

		GROUND WATER READINGS				
SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company, Inc.					
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi	DATE	TIME	DEPTH	CASING	STAB. TIME
CASING SIZE: 4 inch.	ENGINEER: D. Bastos	11/23/03	13:30	29.3	OW	32 Days
CASING HAMMER: Not Used	DATE START: 10/7/03 DATE END: 10/10/03	11/26/03	9:45	29.2	OW	35 Days
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 10/21/03	12/10/03	15:05	28.4	OW	62 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	5-7 6-6	13	24/22			0	*Medium dense, reddish* - brown, fine SAND and Silt, seams of Clayey Silt, micaceous (SM/8-65)		SILTY FINE SAND	Groundwater encountered at a depth of 30.0 ft.
35		S8	35-37	WOR	0	24/22			0	Very loose, brown, fine SAND and Silt, micaceous (SM/8-65)			Boring advanced by mud rotary after S8 to completion
												STRATIFIED FINE SAND AND SILT	
40		S9	40-42	13-11 11-10	22	24/18			0.2	Medium dense, brown, CLAYEY SILT, some fine Sand, seams of Silty Clay, micaceous (ML/10-65)			Falling head permeability test performed at 40.0 ft. WC = 24.8%, LL = 22, PI =2
45		S10	45-47	7-10 17-18	27	24/23			0.2	Medium dense, brown, CLAYEY SILT, little fine Sand, micaceous (ML/10-65)			WC = 24.0%, LL = 22, PI = 3
50		S11	50-52	5-8 9-12	17	24/10			0.2	Medium dense, brown, fine to medium SAND, little Silt, micaceous (SM/8-65)			Falling head permeability test performed at 50.0 ft.
55		S12	55-57	5-7 7-11	14	24/12			0	Medium dense, reddish - brown, fine SAND, little Silt, micaceous (SM/8-65)			
60													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV *lamp. Results are presented* in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BF-5

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.33	NORTH: 197861
DATUM NYCT	EAST: 982268
FINAL BORING DEPTH (FT) 108.0	

SAMPLER: 2 inch. Split Spoon
SAMPLER HAMMER: 140 lb Safety Hammer
CASING SIZE: 4 inch.
CASING HAMMER: Not Used
ROCK CORE: NX

BORING CO: Jersey Boring & Drilling Company., Inc.
FOREMAN: J. Zambardi
ENGINEER: D. Bastos
DATE START: 10/7/03 DATE END: 10/10/03
REVIEWED BY: P. Mahon DATE: 10/21/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/23/03	13:30	29.3	OW	32 Days
11/26/03	9:45	29.2	OW	35 Days
12/10/03	15:05	28.4	OW	62 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-62	5-7 11-16	18	24/22			0	Medium dense, reddish - brown, SILT and fine Sand, micaceous (ML/10-65)		STRATIFIED FINE SAND AND SILT	Falling head permeability test performed at 60.0 ft. WC = 20.5%, LL = NP, PI = NP
													WC = 31.0 %, LL = 26, PI = 1
65		S14	65-67	5-6 8-17	14	24/24			0	Stiff, brown, CLAYEY SILT, trace fine Sand, micaceous (ML/10-65)			
70		S15	70-72	5-12 15-12	27	24/22			0	Very stiff, brown, CLAYEY SILT, trace fine Sand, micaceous (ML/10-65)			
													WC = 26.0 %, LL = 26, PI =3
75		S16	75-77	8-10 12-12	22	24/23			0	Very stiff, brown, CLAYEY SILT, trace fine Sand (ML/10-65)			
												GLACIAL TILL	
80		S17	80-82	26-28 21-21	49	24/20			0	Dense, brown, fine to medium SAND, some Silt, little Gravel (SM/6-65)			
85		S18	85-86.4	35-41 100/5	141/11	17/10			0	Very dense, brown, fine SAND, some Clayey Silt (SM/8-65)			Difficult borehole advancement
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BF-5

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.33	NORTH: 197861
DATUM NYCT	EAST: 982268
FINAL BORING DEPTH (FT) 108.0	

SAMPLER: 2 inch. Split Spoon
SAMPLER HAMMER: 140 lb Safety Hammer
CASING SIZE: 4 inch.
CASING HAMMER: Not Used
ROCK CORE: NX

BORING CO.: Jersey Boring & Drilling Company., Inc.
FOREMAN: J. Zambardi
ENGINEER: D. Bastos
DATE START: 10/7/03 DATE END: 10/10/03
REVIEWED BY: P. Mahon DATE: 10/21/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
11/23/03	13:30	29.3	OW	32 Days
11/26/03	9:45	29.2	OW	35 Days
12/10/03	15:05	28.4	OW	62 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S19	90-90.1	100\1	100/1	1/0			0	(No Recovery)		GLACIAL TILL	
95	2, 2, 2, 2, 1	C1	91-96			5/0		N/A		(No Recovery)			Cobble blocked core barrel during advancement.
		S20	96-96.4	100\5	100/5	5/2			0	Very dense, brown, fine to coarse SAND, some Gravel, little Silt (SM/6-65)			
100		S21	100-100.3	100\4	100/4	4/2		N/A	0	Very dense, brown, fine to coarse SAND, little Gravel, little Silt (SM/6-65)			
105		S22	105-105.1	100\1	100\1	1/0		N/A	0	(No Recovery)		D.SCH	Schist fragments observed in drilling fluid between 107.0 to 108.0 ft.
110										Bottom of borehole at 108.0 ft.			Observation well installed to a depth of 43.0 ft.
115													
120													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BF-6

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 130.87	NORTH: 197870
DATUM NYCT	EAST: 982312
FINAL BORING DEPTH (FT) 12.5	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: E. Feliciano
CASING SIZE: 4 inch.	ENGINEER: V. Raghavan
CASING HAMMER: 140 lb Automatic	DATE START: 10/18/03 DATE END: 10/18/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/17/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Concrete (0.9 ft.) Concrete blocks and debris (3 ft.)			Boring advanced by hand to a depth of 6 ft.
5		H1	4-6						0	Reddish - brown, fine to coarse SAND, some Gravel, trace Silt (SP/11-65)		FILL	Sample H1 obtained from hand auger cuttings.
		S1	6-8	5-4 4-4	8	24/7			0	Loose, reddish - brown, fine to coarse SAND, some Gravel, trace Silt (SP/11-65)			Boring advanced by rotary methods from 6.0 ft. to completion.
		S2	8-10	4-7 5-4	12	24/14			0	Medium dense, reddish - brown, fine to medium SAND, trace Gravel, trace Silt, trace cinder fragments (SP/11-65)			
10		S3	10-12	7-5 3-3	8	24/10			0	Loose, reddish - brown, fine to coarse SAND, trace Gravel, trace Silt (SP/11-65)			Portion of sample S3 collected for environmental testing.
		S4	12-12.5	35\6		6/2			0	Metallic material, possibly slag (11-65)			
										Bottom of borehole at 12.5 ft.			Boring terminated at 12.5 ft. due to difficult split spoon advancement and potential suspected utility conflicts.
15													
20													
25													
30													

GRANULAR SOILS BPF	DENSITY	COHESIVE SOILS BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG	Sheet: 1 of 1

Fulton Street Transit Center	FULTON STREET TRANSIT CENTER	BORING NO. BF-8
		BORING STATION: / OFFSET:
		PROJECT NO. CM - 1252 / COORDINATES:
		SURF EL 113.80 / NORTH: 197803
		DATUM NYCT / EAST: 982434
		FINAL BORING DEPTH (FT) 21.5

SAMPLER: 2 inch, Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.	GROUND WATER READINGS
SAMPLER HAMMER: 140 lb Donut Hammer	FOREMAN: P. Lynch/A. Feliciano	DATE / TIME / DEPTH / CASING / STAB. TIME
CASING SIZE: 4 inch.	ENGINEER: C. Ramsburg/J. Au/D. Bastos	
CASING HAMMER: 140 lb Donut	DATE START: 1/10/04 DATE END: 1/10/04	
ROCK CORE: NA	REVIEWED BY: P. Mahon DATE: 1/26/04	

DEPTH (FT)	CASING (BPF) CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Concrete Slab (1.6 ft.) Void (0.4 ft.)			
		S1	2-4	4-3 3-3		24/14			0	Brown, fine to medium SAND, trace Silt, micaceous (SM/7-65)		F-M SAND	Boring advanced by wash rotary to completion See general note 4 regarding N-vales
5		S2	5-7	5-4 6-5		24/2			0	Brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)			
10		S3	10-10.3	8-6		24/19			0.1	Brown, fine to medium SAND, little Silt, micaceous (SM/7-65)			
		S3A	10.3-12	4-6						Brown, fine to medium SAND, trace Silt, micaceous (SP/7-65)			
15		S4	15-17	16-10 12-12		24/11			0	Brown, fine to medium SAND, little Silt, micaceous (SM/7-65)			
20		S5	19.5-21.5	4-12 13-16		24/11			0	Brown, fine to medium SAND, little Silt, micaceous (SM/7-65)			
										Bottom of borehole at 21.5 ft.			Boring temporarily abandoned by contractor at a depth of 21.5 ft. due to equipment malfunction.
25													
30													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Due to restrictions of the equipment used to perform this boring, a donut hammer with a drop height of 18 inches was used to drive split spoons. Because of the different energy, blows/6 inch may be misleading and N-Values cannot be reported.

BORING LOG

Sheet: 1 of 4

BORING NO. BJ-2

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.75	NORTH: 197922
DATUM NYCT	EAST: 981745
FINAL BORING DEPTH (FT) 119.3	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi
CASING SIZE: 4 inch.	ENGINEER: C. Ramsburg / J. Au
CASING HAMMER: 140 lb Automatic	DATE START: 11/15/03 DATE END: 11/16/03
ROCK CORE: NX NW	REVIEWED BY: P. Mahon DATE: 11/25/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
2/2/04	14:15	27.8	OW	2 Day
2/4/04	13:20	27.8	OW	4 Days
2/5/04	14:55	27.7	OW	5 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC.(IN/IN) ROCK PEN./REC.(FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
										Asphalt (1.0 ft.)		FILL	Boring advanced by a hand to a depth of 6 ft. Void observed beneath asphalt to a depth of 4 ft.
5		H1	4-6						0	Brown, fine to coarse SAND, trace Gravel, trace Silt, trace brick fragments and glass fragments, (SP/11-65)			Sample H1 obtained from hand auger cuttings.
		S1	6-8	1-2 3-1	5	24/4			0	Loose, dark brown, fine to coarse SAND, some Gravel, trace Silt (SP/11-65)			Boring advanced by mud rotary from 6.0 ft. to completion.
		S2	8-10	1-1 1-1	2	24/4			0	Very loose, dark brown, fine to coarse SAND, little Gravel, little Silt, trace brick fragments, (SM/11-65)			
10		S3	10-12	4-5 5-7	N/A	24/12			0	Reddish - brown, fine to coarse SAND, little Gravel, trace Silt, trace brick fragments (SP/11-65)			Sample S3 obtained by driving a 3 - inch. split spoon; N-value not reported. Sample S3 collected for environmental testing.
												F-M SAND	
15		S4	15-17	4-4 4-4	8	24/12			0	Loose, brown, fine to medium SAND, little Silt; trace Gravel, micaceous (SM/7-65)			WC = 12.2% Sample S5 & S5A obtained by driving a 3 - inch. split spoon; N-value not reported.
20		S5	20-21	17-20	N/A	24/24			0	Reddish - brown, medium to coarse SAND, trace Gravel, trace Silt, micaceous (SP/7-65)			WC = 17.6%
		S5A	21-22	25-22						Brown - gray - red; medium to coarse SAND, little Gravel, trace Silt (SW/6-65)			WC = 10.8% Portion of sample S5 & S5A collected for environmental testing.
25		S6	25-27	12-14 19-15	33	24/22			0	Dense, reddish - brown, fine to coarse SAND, trace Silt, trace Gravel, micaceous (SP/7-65)			WC = 23.6%
30													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

BORING NO. BJ-2

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.75	NORTH: 197922
DATUM NYCT	EAST: 981745
FINAL BORING DEPTH (FT) 119.3	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi
CASING SIZE: 4 inch.	ENGINEER: C. Ramsburg / J. Au
CASING HAMMER: 140 lb Automatic	DATE START: 11/15/03 DATE END: 11/16/03
ROCK CORE: NXWV	REVIEWED BY: P. Mahon DATE: 11/25/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
2/2/04	14:15	27.8	OW	2 Day
2/4/04	13:20	27.8	OW	4 Days
2/5/04	14:55	27.7	OW	5 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S7	30-32	8-7 6-6	13	24/10			0	Medium dense, reddish - brown, fine to coarse SAND, trace Silt, micaceous (SP/7-65)		F-M SAND	WC = 17.5%
35		S8	35-37	4-5 7-8	12	24/16			0	Medium dense, reddish - brown, SILT, some fine Sand, micaceous (ML/10-65)		SILTY FINE SAND	WC = 29.0%
40		S9	40-42	5-5 10-10	15	24/24			0	Stiff, reddish - brown, CLAYEY SILT, some fine Sand, lenses of fine Sand, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	SG = 2.75, WC = 28.2%, LL = 23, PI = 2
45		S10	45-47	5-6 7-12	13	24/20			0	Medium dense, reddish - brown, SILT, trace fine Sand, with varves of fine Sand, micaceous (ML/10-65)			WC = 24.0%, LL = NP, PI = NP
50		S11	50-52	5-7 9-14	16	24/20			0	Medium dense, reddish - brown, SILT, trace fine Sand with seams of brown Silty Clay, micaceous (ML/10-65)			WC = 27.0%, LL = NP, PI = NP
55		S12	55-57	6-12 12-15	24	24/14			0	Medium dense, reddish - brown, SILT and fine Sand, with seams of brown Silty Clay, micaceous (ML/10-65)			WC = 24.2%, LL = NP, PI = NP
60													

GRANULAR SOILS BPF	DENSITY	COHESIVE SOILS BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING LOG

Sheet: 3 of 4

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BJ-2

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.75	NORTH: 197922
DATUM NYCT	EAST: 981745
FINAL BORING DEPTH (FT) 119.3	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi
CASING SIZE: 4 inch.	ENGINEER: C. Ramsburg / J. Au
CASING HAMMER: 140 lb Automatic	DATE START: 11/15/03 DATE END: 11/16/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/25/03

GROUND WATER READINGS

DATE	TIME	DEPTH	CASING	STAB. TIME
2/2/04	14:15	27.8	OW	2 Day
2/4/04	13:20	27.8	OW	4 Days
2/5/04	14:55	27.7	OW	5 Days

DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
		S13	60-62	9-9 13-13	22	24/16			0	Medium dense, reddish - brown, SILT and fine Sand, micaceous (ML/10-65)		STRATIFIED SILT AND SILTY FINE SAND	WC = 23.9%
65		S14	65-67	8-10 9-14	19	24/14			0	Medium dense, reddish - brown, SILT, little fine Sand, micaceous (ML/10-65)			WC = 31.9%, LL = NP, PI = NP
70		S15	70-72	7-10 10-13	20	24/12			0	Medium dense, grayish - brown, SILT, little fine Sand, micaceous (ML/10-65)			WC = 30.8%
75		S16	75-77	6-8 10-14	18	24/10			0	Medium dense, reddish - brown SILT, trace fine Sand, lenses of gray Silty Clay (ML/10-65)			WC = 29.6%, LL = NP, PI = NP
												GLACIAL TILL	Vigorous rapping of drill rods between 79 and 80 ft.
80		S17	80-81.4	14-33 100\5	133/11	17/17			0	Very dense, brown and gray, fine to medium SAND, little Silt, trace Gravel (SM/7-65)			WC = 11.9% Drilling mud level observed at depth of 15 ft. with casing advanced to 16 ft. (15 minute stabilization)
85		S18	85-87	40-32 61-60	93	24/14			0	Very dense, brown and gray, fine to medium SAND, some Silt, trace Gravel. (SM/7-65)			WC = 9.3%
												D.SCHIST	
90													

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:

1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
2) Stratification lines represent approximate boundaries between soil and rock types, transition may be gradual.
3) The field screening was performed, in the head space of sealed jars using an organic vapor meter equipped with a photoionization detector (PID) and a 10.6 eV lamp. Results are presented in instrument units calibrated to a 100 parts per million by volume (PPM) isobutylene standard.
4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

BORING NO. BJ-2

BORING LOG

Fulton Street Transit Center

FULTON STREET TRANSIT CENTER

BORING NO. BJ-2

BORING STATION:	OFFSET:
PROJECT NO. CM - 1252	COORDINATES:
G. SURF EL. 131.75	NORTH: 197922
DATUM NYCT	EAST: 981745
FINAL BORING DEPTH (FT) 119.3	

SAMPLER: 2 inch. Split Spoon	BORING CO: Jersey Boring & Drilling Company., Inc.
SAMPLER HAMMER: 140 lb Safety Hammer	FOREMAN: J. Zambardi
CASING SIZE: 4 inch.	ENGINEER: C. Ramsburg / J. Au
CASING HAMMER: 140 lb Automatic	DATE START: 11/15/03 DATE END: 11/16/03
ROCK CORE: NX	REVIEWED BY: P. Mahon DATE: 11/25/03

GROUND WATER READINGS

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DEPTH (FT)	CASING (BPF)/ CORING (MIN/FT)	SAMPLE / CORE NO.	SAMPLE DEPTH (FT)	BLOWS / 6 INCH	N VALUE	SOIL PEN./REC (IN/IN) ROCK PEN./REC (FT/FT)	TOTAL CORE REC (%)	RQD (%)	PID READING	BURMISTER DESCRIPTION (USCS/NYCBC CLASSIFICATIONS)	STRATA SYMBOL	STRATIGRAPHY	NOTES
	5, 3, 4, 5, 5	C1	90-95			5/3.1	62	28		Hard, slightly to completely Weathered, fine to coarse grained, gray, quartz-mica-garnet SCHIST, with very thin, convoluted, subhorizontal to subvertical foliation, very closely to moderately closely spaced, slightly to completely weathered, horizontal to moderately dipping foliation and cross-foliation joints/fractures (4-65)		DECOMP. SCHIST	
95	5, 5, 10, 10	C2	95-99			4/1.8	45	0		Hard, slightly to completely weathered, fine to coarse grained, gray, quartz-mica- garnet SCHIST, with very thin, convoluted, crenulated, subvertical to moderately dipping foliation, very closely to closely spaced, slightly to completely weathered, horizontal to vertical foliation and cross-foliation joints/fractures (4-65)			
100	5, 5, 5, 5, 5	C3	99-104			5/4.8	96	88		Hard, fresh to slightly weathered, fine to coarse grained, gray, quartz-mica-garnet SCHIST, with very thin, horizontal to vertical foliation, very closely to moderately closely spaced, slightly to completely weathered, horizontal to moderately dipping foliation and cross-foliation joints/fractures (1-65)		SCHIST	Core barrel blocked at approximately 99 ft. Advanced roller bit to 99.0 ft. prior to C3. Unconfined Compressive Strength = 8.02 ksi (Sample collected between 102.6 and 103.7 ft.)
105	5, 5, 5, 5, 5	C4	104-109.2			5.2/5.2	100	100		Hard, fresh, fine to coarse grained, gray, quartz-mica-garnet SCHIST, with very thin, convoluted,moderately dipping to subvertical foliation, no apparent joints/fractures (1-65)			
110	5, 5, 7, 10, 10	C5	109.2-114.2			5/5	100	100		Hard, fresh, fine to coarse grained, gray, quartz-mica-garnet SCHIST, with very thin, convoluted, crenulated vertical to moderately dipping foliation, widely spaced subhorizontal foliation joint/fracture (1-65)			Increased coring times likely due to worn coring bit.
115	10, 10, 10, 10, 10	C6	114.2-119.3			5.1/5.1	100	100		Hard, fresh, fine to coarse grained, gray, quartz-mica-garnet SCHIST, with very thin, convoluted, crenulated, vertical to moderately dipping foliation, no apparent joints/fracture (1-65)			Observation well installed to a depth of 45.0 ft.
120										Bottom of borehole at 119.3 ft.			

GRANULAR SOILS		COHESIVE SOILS	
BPF	DENSITY	BPF	CONSISTENCY
0-4	Very Loose	<2	Very Soft
4-10	Loose	2-4	Soft
10-30	Medium Dense	4-8	Med Stiff
30-50	Dense	8-15	Stiff
>50	Very Dense	15-30	Very Stiff
		>30	Hard

GENERAL NOTES:
1) Water level readings have been made at times and under conditions stated; fluctuations of water levels may occur due to other factors than those present at the time measurements were made.
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4) Soil density or consistency is based on N - value which is the sum of the middle two blows/6 inch.

APPENDIX C: KEY PERSONNEL

ZACHARY J. DAVIS
The Louis Berger Group, Inc.
Senior Archaeologist

EDUCATION

- Interdepartmental Doctoral Program in Anthropological Science, State University of New York at Stony Brook
- M.A., Anthropology, State University of New York at Stony Brook, 2000
- M.A., Archaeology, Institute of Archaeology, University of London, 1994
- B.A., Archaeological Studies, Boston University, 1993

PROFESSIONAL REGISTRATIONS

- Register of Professional Archaeologists (RPA)

TECHNICAL TRAINING

- 40-Hour H&S for Hazardous Waste Operations and Emergency Response meeting the training requirements of 29 CFR 1910.120. Emilcott Associates, Inc., March 15, 2004.
- Trenching and Excavation Safety—OSHA Construction Industry Standards, Subpart P (29 CFR 1926.650-652). Emilcott Associates, Inc., February 19, 2004.
- Introduction to Section 106 Review (Ralston Cox, instructor), February 20-21, 2002
- Introduction to GPS using the Trimble Pro XR Training Class (Mike Popoloski, instructor), March 19, 2001.

PROFESSIONAL AFFILIATIONS

- Society for American Archaeology
- Geological Society of America
- Paleoanthropology Society of America
- Society for Archaeological Sciences
- Archaeological Society of New Jersey

PROFESSIONAL EXPERIENCE

Mr. Davis's background includes archaeological investigations at prehistoric sites dating from the Paleoindian through the Late Woodland period and historic sites dating from the seventeenth century through the early twentieth century. As Principal Investigator, he is responsible for the implementation and execution of archaeological research projects involving historic and prehistoric resources in the Northeast. His responsibilities include coordinating and supervising interdisciplinary multitask studies, planning and conducting surveys and excavations of historic and prehistoric sites and their resources, interfacing with clients and subconsultants, maintaining project schedules, and preparing research proposals and technical reports. In addition, Mr. Davis has extensive experience with lithic material analysis and Geographic Information Systems database development and analysis for cultural resources. Since joining Berger, Mr. Davis's major projects include:

- **Phase IA Archaeological Assessment, Proposed Vent Plant Installation, West 21st Street and Sixth Avenue, New York, New York.** Principal Investigator for an archaeological resource assessment of a proposed vent plant installation, located in Chelsea. Employed GIS technology to georeference historic maps to trace potential historic archaeological resources within the project area. For New York City Transit.

- **Phase IA Archaeological Assessment, Hudson Yards/Number 7 Subway Line Extension, New York, New York.** Assisted with the analysis of archaeological resource potential for 39 lots on the Westside of Manhattan. For New York City Department of City Planning and New York City Transit.

- **Phase IB Archaeological Survey, Proposed Vent Plant Installation, Chrystie and Stanton Streets, New York, New York.** Principal Investigator for an archaeological survey consisting of a back-hoe trench excavated to assess the presence or absence of late nineteenth- and early twentieth-century front yard archaeological resources. For New York City Transit.

- **Phase IA Archaeological Assessment, Proposed Fan Plant Rehabilitation, 52nd Street and Sixth Avenue, New York, New York.** Principal Investigator for an archaeological resource assessment of a proposed fan plant rehabilitation, located in midtown Manhattan. Employed GIS technology to georeference historic maps to trace potential historic archaeological resources within the project area. For New York City Transit.

- **Phase IA Archaeological Assessment, Proposed Fulton Street Transit Center, Fulton Street and Broadway, New York, New York.** Principal Investigator for an archaeological resource assessment of the proposed downtown transit facility, located at Fulton Street and Broadway. Reviewed historic maps and documents and summarized past disturbances to the project area to calculate the project area's potential for archaeological resources. For New York City Transit.

- **Phase IA Archaeological Assessment, New South Ferry Terminal, New York, New York.** Responsible for the archaeological resource assessment of a proposed subway terminal project in Battery Park. Required extensive cartographic research documenting the historic evolution of the Lower Manhattan shoreline. Employed GIS technology to georeference numerous historic maps in order to trace potential historic archaeological resources within the project area. Coordinated review with New York City Landmarks Commission and New York State Office of Parks, Recreation and Historic Preservation. Prepared the Archaeological Resource Management Plan, a required component of the Programmatic Agreement between SHPO, LPC, FTA and NYCT. For New York City Transit.

- **Phase IA Archaeological Assessment, Proposed Fan Plant Rehabilitation, Lafayette and Flatbush Avenues, Brooklyn, New York.** Principal Investigator for an archaeological resource assessment of a proposed fan plant rehabilitation, located in Fort Green, Brooklyn. Employed GIS technology to georeference historic maps to trace potential historic archaeological resources within the project area. For New York City Transit.

- **Phase IA Archaeological Assessment, Proposed Vent Plant Installation, Chrystie and Stanton Streets, New York, New York.** Principal Investigator for an archaeological resource assessment of a proposed vent plant installation, located in Manhattan's Lower East Side. Employed GIS technology to georeference historic maps to trace potential historic archaeological resources within the project area. For New York City Transit.

- **Phase IA Archaeological Assessment, Niagara Mohawk/Hudson (Water Street) Site, City of Hudson, New York.** Principal Investigator for the Phase IA archaeological assessment of a late nineteenth-/early twentieth-century coal-to-gas generating facility located on the banks of the Hudson River. Study involves the research and analysis of past disturbances and potential for historic archaeological resources associated with the industrial use of the project area. For Blasland, Bouck and Lee, Inc.

- **Phase I Archaeological Investigation, Sweet Brook Drainage Area, Carlton Boulevard, Annadale, Staten Island, New York.** Principal Investigator for a Phase I archaeological survey for sewage installation project along the Sweet Brook in southern Staten Island. For JRC Construction Corporation at the request of NYC DEP.

- **Phase I Archaeological Survey, Luzerne County Road No. 9, Jackson, Lehman, and Dallas Townships, Luzerne County, Pennsylvania.** Documented the results of a previously conducted road-way survey, located along Luzerne County Road 9, designed to assess the project's potential impact on late historic period archaeological deposits. For Pennsylvania Department of Transportation Engineering District 4-0.

- **Cultural Resource Constraints Assessment, Route 9 and Garden State Parkway, Cape May County, New Jersey.** Conducted background research on archaeological and historic architectural resources within the project corridor. Prepared GIS files for cultural resources and summary cultural resource assessment of the project corridor. For the South Jersey Transportation Planning Organization.

- **Stage IA Archaeological Assessment, Cross Harbor Freight Improvement Project, Greenville Yards, Jersey City, New Jersey.** Co-Principal Investigator for the Phase IA archaeological assessment of the Greenville Yard. Study involved the research and analysis of past disturbances and potential for prehistoric and historic period resources. For Allee King Rosen & Fleming, Inc. in association with New York City Economic Development Corporation (NYCEDC).

- **Cultural Resource Constraints Assessment, Route 17, Bergen County, New Jersey.** Conducted background research on archaeological and historic architectural resources within the project corridor. Prepared GIS files for cultural resources and summary cultural resource assessment of the project corridor. For the North Jersey Transportation Planning Organization.

- **Cultural Resource Constraints Assessment, Route 22, Essex and Union Counties, New Jersey.** Conducted background research on archaeological and historic architectural resources within the project corridor. Prepared GIS files for cultural resources and summary cultural resource assessment of the project corridor. For the North Jersey Transportation Planning Organization.

- **Cultural Resource Constraints Assessment, Route 57 , Warren County, New Jersey.** Conducted background research on archaeological and historic architectural resources within the project corridor. Prepared GIS files for cultural resources and summary cultural resource assessment of the project corridor. For the North Jersey Transportation Planning Organization.

- **Phase IA Archaeological Assessment, East 126th Street Bus Garage, New York, New York.** Responsible for the archaeological and architectural site file review at New York City Landmarks Commission (LPC), background research, and archaeological assessment for the half block project area. For New York City Transit.

- **Cultural Resource Eligibility/Effects Documentation for Final Scope Development of Routes 1 and 9 at North Avenue, City of Elizabeth, New Jersey.** Principal Investigator for the identification and evaluation of archaeological resources (Phase I/II) and historic architectural properties (eligibility/effect) within the proposed project area for roadway improvements. Also conducted all background research and prepared archaeological report. For the New Jersey Department of Transportation.

- **Hudson Energy Project, Hudson River Bulkhead at Pier 92, Manhattan, New York**. Responsible for the archaeological and architectural site file review at New York City Landmarks Commission (LPC), background research, and field inspection of the study area from the bulkhead at Pier 92 to the ConEd substation at West 94th Street in Manhattan. For Genpower Hudson Energy.

- **New Jersey Cellular Telecommunications.** Principal Investigator for several Phase IA Archaeological Assessments and Historic Architectural Resource assessments for proposed Nextel cell tower installation in Essex, Berger, Morris, Sussex, Warren, Hunterdon, Somerset, Middlesex and Monmouth counties. For IVI Environmental, Inc.

- **La Tourette Park, Staten Island, New York.** Principal Investigator for a Historic Architectural Resource assessment of a proposed Omnipoint cell tower installation in Richmond County, New York. For Goodkind and O'Dea, Inc.

- **Bradley Beach, New Jersey.** Principal Investigator for a Historic Architectural Resource assessment of a proposed Verizon cell tower installation in Monmouth County, New Jersey. For Innovative Engineering, Inc.

- **Southern New Jersey Cellular Telecommunications.** Principal Investigator for several Phase IB archaeological assessment of proposed AT&T cell tower installations in Salem and Gloucester counties, New Jersey. For Rescom Environmental Corporation.

- **P.S. 234-Q, Long Island City, Queens, New York.** Principal Investigator for a Phase IB archaeological assessment for a proposed New York City public school in Astoria, Queens. For Parsons Brinckerhoff, Inc and the New York City School Construction Authority (SCA).

- **Arthur Kill Road Bus Maintenance Facility, Staten Island, New York.** Principal Investigator for a Phase IB archaeological survey for prehistoric and historic resources. For New York City Transit.

- **Arbutus Avenue Sewer Project, Staten Island, New York.** Principal Investigator for a Phase I archaeological survey for sewage installation project along the Arbutus Creek. For JRC Construction Corporation.

- **Two Bridges Road Bridge, Lincoln Park, Wayne and Fairfield, New Jersey.** Principal Investigator for cultural resource screening of archaeological and historic architectural properties, including five known prehistoric Native American sites, several historic residences pre-dating 1950, and the 1887 National Register-eligible steel truss bridge. Project involved assessing archaeological sensitivity for the area surrounding the confluence of the Passaic and Pompton rivers. For the County of Passaic.

- **Interchange 142 (Garden State Parkway and I-78), Hillside, Irvington, and Union, New Jersey.** Principal Investigator for a Phase IB archaeological survey along the Garden State Parkway at Exit 142, straddling the Union/Essex County line. For the New Jersey Highway Authority.
- **Interchange 142 (Garden State Parkway and I-78), Hillside, Irvington, and Union, New Jersey.** Contributed to the Historic Architectural Evaluation with background research on and evaluation of the Elizabeth River Park, a National Register-eligible park in Union County. For the New Jersey Highway Authority.

PREVIOUS PROFESSIONAL EXPERIENCE

- **Calverton Naval Weapons Industrial Reserve, Calverton, New York.** Geographic Information Systems analyst. Integrated GIS analysis with lithic analysis to interpret prehistoric activity patterns.

- **PS 56R Site, Staten Island, New York.** Lab Director. Analysis, curation, and data entry for cultural material derived from the mitigation of a primarily Late Archaic prehistoric site.

- **Calverton Naval Weapons Industrial Reserve, Calverton, New York.** Field Supervisor. Cultural resource survey of 6,000-acre parcel with several early mid-twentieth-century buildings and several Late Archaic and Late Woodland prehistoric sites.

- **Russian Mission, The Bronx, New York.** Lithic Analyst. Cultural resource survey of a Late Archaic/Woodland quartz quarry site.

- **Long Island College Hospital, Brooklyn, New York.** Excavator. Monitoring heavy machine excavation of eighteenth-, nineteenth-, and twentieth-century historical archaeological deposits for the construction of a parking garage along Atlantic Avenue.

- **Robin's Island, Southold, New York.** Field Supervisor and Lithic Analyst. Survey of 450-acre island located in the Peconic Bay, revealing several prehistoric and historic sites.

- **Hudson Valley Rod & Gun Club, Pawling, New York.** Excavator. Mitigation of a Middle and Late Archaic prehistoric site.

- **Umm el Tlel, Syria.** Excavator. Long-term excavations of an open-air site containing cultural material spanning from the terminal Lower Palaeolithic, through the Middle, Upper, and Epi-Palaeolithic, to the Neolithic.

- **Abri Castanet, Sergeac (Perigord), France.** Excavator. Long-term excavations of an early Upper Palaeolithic rockshelter in the southwest of France.

- **Le col de Jiboui, Haut-Diois (Drôme), France.** Excavator. Salvage excavations of an open-air Middle Palaeolithic site in the French Alps.

- **Fouilles Préhistoriques à Cagny, Cagny (Nord), France.** Excavator. Excavation of two open-air Lower Palaeolithic sites located in northern France.

- **Spencer-Pierce-Little Farm, Newbury, Massachusetts.** Excavator. Boston University archaeological field school at a late seventeenth-century homestead.

ACADEMIC POSITIONS

Graduate Teaching Associate, Department of Anthropology, SUNY at Stony Brook. Primary Instructor: Anthropology 402, Problems in Archaeology - Landscape exploitation strategies in the Eurasian Palaeolithic.

Graduate Teaching Assistant, Department of Anthropology, SUNY at Stony Brook. Primary Teaching Assistant for Anthropology 102, Introduction to Cultural Anthropology; Primary Teaching Assistant for Anthropology 356, Urban Anthropology; Primary Teaching Assistant for Anthropology 104, Introduction to Archaeology; Primary Teaching Assistant for Anthropology 290, Ancient Science and Technology.

Graduate Teaching Assistant, Department of Anthropology, SUNY at Stony Brook. Lab Instructor for Anthropology 418, Lithic Technology; Lab Instructor for Anthropology 420, Geographic Information Systems in Environmental Analysis.

HONORS/AWARDS

- Graduate Council commendation for excellence in teaching by a graduate student, SUNY at Stony Brook.
- General grant for thesis research, L.S.B. Leakey Foundation.
- Grant for thesis research, Geological Society of America.
- Grant for thesis related research, IDPAS, SUNY at Stony Brook.
- Travel grant to the Annual Meeting of the Paleoanthropology Society, Columbus.
- Travel grant to the 63rd Annual Meeting of the Society for American Archaeology, Seattle.
- Travel grant for summer fieldwork, Sigma Xi Research Foundation.
- General research grant, IDPAS, SUNY at Stony Brook.
- Travel grant to the 62nd Annual Meeting of the Society for American Archaeology, Nashville.

PUBLICATIONS

- Experimental Test of Middle Palaeolithic Spear Points Using a Calibrated Crossbow. By J.J. Shea, Z.J. Davis, and K.S. Brown. *Journal of Archaeological Science* 28:807-816. 2001.

- Quantifying Lithic Curation: An Experimental Test of Dibble and Pelcin's Original Flake-Tool Mass Predictor. By Z.J. Davis and J.J. Shea. *Journal of Archaeological Science* 25:603-610. 1998.

PAPERS PRESENTED

- Costs and Benefits of Levallois Flake Production: An Economic Perspective on the Variability in Middle Palaeolithic Stone Tool Assemblages. Paper presented at the 65th Annual Meeting of the Society for American Archaeology, Philadelphia. 2000.
- Levantine Mousterian Mobility Patterns: The View from Mt. Carmel, Israel. Paper presented at the 1999 Paleoanthropology Society Meetings, Columbus. 1999.
- Experimental Test of Middle Paleolithic Hunting Weapons: Preliminary Results. Paper presented at the 64th Annual Meeting of the Society for American Archaeology, Chicago. 1999 (with J.J. Shea and K.S. Brown).
- The Analytical Potential of Refitting Studies: History and Synthesis of Applications. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle. 1998.
- The PS 56R Site: A Vosburg Habitation on Staten Island, New York. Paper presented at the 62nd Annual Meeting of the Society for American Archaeology, Nashville. 1997 (with A.M. Pappalardo).

CONFERENCE SYMPOSIA ORGANIZED

- Refitting Studies in New and Old World Lithic Analyses. Symposium organized for the 63rd Annual Meeting of the Society for American Archaeology, Seattle. 1998.

GERARD PAUL SCHARFENBERGER
The Louis Berger Group, Inc.
Archaeologist

EDUCATION

- Doctoral Program, City University of New York
- M.A., Anthropology, Hunter College, New York
- B.F.A., Anthropology, Rutgers University, New Jersey
- Queens College, New York
- Pace University, New York

TECHNICAL TRAINING

- Trenching and Excavation Safety—OSHA Construction Industry Standards, Subpart P (29 CFR 1926.650-652). Emilcott Associates, Inc., 2004.
- Health and Safety Training for Hazardous Waste Operations and Emergency Responses to meet the requirements of OSHA (29 CFR 1910.120)

PROFESSIONAL AFFILIATIONS

- Monmouth County Historical Association
- Society for Historical Archaeology
- Society for Industrial Archaeology
- Archaeological Society of New Jersey
- Council for Northeast Historical Archaeology
- Society of American Archaeology

PROFESSIONAL EXPERIENCE

Mr. Scharfenberger's background includes archaeological investigations at numerous rural and urban industrial, domestic, and military sites dating from the late seventeenth century through the twentieth century. He is responsible for the implementation and execution of archaeological research projects involving historic and prehistoric resources in the Northeast and Middle Atlantic. His responsibilities include coordinating and supervising interdisciplinary, multitask studies, planning and conducting surveys and excavations of historic and prehistoric sites and their resources, interfacing with clients and subconsultants, maintaining project schedules, and preparing research proposals and technical reports. As Material Specialist, he is responsible for overseeing all aspects of the laboratory process, including cataloging, analysis, and curation of archaeological collections. Additional duties undertaken include the analysis of small finds/architectural artifacts, ceramics, and clay pipes, and material conservation and curation for selected projects. Since joining Berger in 1995, some of his projects have included:

- **Phase I and Phase II Archaeological Investigations, Pennrose Affordable Housing Site, Fort Lee, New Jersey.** Project archaeologist for the background research, subsurface investigations, and artifact analysis to determine whether proposed construction would impact remains of the Revolutionary War-era Fort Lee complex or other historic period resources. For Bergen County Community Development.

- **Phase IA Archaeological Assessment, Ridgewood Station, New Jersey.** Archaeologist for the assessment of archaeological resources associated with the proposed improvements to the circa-1916 railroad station, which is listed in the State and National Registers of Historic Places. For New Jersey Transit.

- **Archaeological Services for Proposed Wireless Telecommunication Facilities in New Jersey.** Project Archaeologist responsible for the assessment of project plans and impacts, background and site file research, development of prehistoric and historic site sensitivity assessments, Phase IB and Phase II archaeological fieldwork, and coordination with prime and SHPO.

- **Monitoring and Rehabilitation of the Colt Gun Mill Site, City of Paterson, New Jersey.** Project Archaeologist for the monitoring of debris-removal activities, mapping, and salvage of materials at the 1836 Colt Gun Mill site. For the City of Paterson in conjunction with the National Park Service and New Jersey Historic Trust.

- **Cultural Resource Constraints Study for New Brunswick Waterfront Development, New Jersey.** Assessed the potential for buried foundations and deposits within a multi-acre site along Route 18 historically associated with the commercial and transportation hub of New Brunswick since the mid-seventeenth century. For the New Brunswick Development Corporation.

- **Phase I and II Archaeological Investigations, Route 47 Improvements, Glassboro, New Jersey.** Project archaeologist for the archaeological survey and evaluation of the Stanger Glassworks vicinity, which was historically significant both in the development of the glass industry in New Jersey and the growth of the town of Glassboro. For the New Jersey Department of Transportation.

- **Raritan River Crossings Historic Context.** Preparation of the revised report in response to comments for the historical documentation of Raritan River crossings between Raritan Bay and New Brunswick. For the New Jersey Department of Transportation.

- **Wyckoff's Mills Wetland Mitigation Bank, Middlesex County, New Jersey.** Project Archaeologist. Phase IA and Phase IB archaeological survey of proposed 50-acre wetland mitigation site situated adjacent to the Millstone River.

- **Gateway National Recreation Area (GNRA), Sandy Hook Unit, Fort Hancock, New Jersey.** Archaeological testing and monitoring of historic munitions proving grounds and industrial crematorium, in response to proposed developments at GNRA, of unexploded ordnance sweeps. For the National Park Service, Denver Service Center.

- **Gateway National Recreation Area (GNRA), Miller Field, Staten Island, New York.** Subsurface testing, archaeological monitoring, and analysis of circa World War I military airfield and related military objects. For the National Park Service, Denver Service Center.

- **New Jersey Route 31, Rowland's Mills, Readington Township, Hunterdon County, New Jersey.** Field Assistant. Phase II archaeological data recovered during investigations of a nineteenth-century mill village in central New Jersey. For the New Jersey Department of Transportation.

- **Route 18 Bridge Replacement, East Brunswick, New Jersey.** Archaeological monitoring and mapping of nineteenth-century Morgan-Van Wickle stoneware pottery site and industrial operation. For the New Jersey Department of Transportation.

- **New Jersey Route 21, City of Newark, Essex County, New Jersey.** Phase II archaeological evaluation of the nineteenth-century Ballantine Brewery industrial complex and analysis of features associated with manufacturing and recovered brewery artifacts. For the New Jersey Department of Transportation.

- **Bloomfield Avenue Bridge, Verona, New Jersey.** Field Supervisor. Phase IB cultural resource survey for proposed bridge replacement. For Essex County.

- **Route 206, Hillsborough and Montgomery Townships, Somerset County, New Jersey.** Field Assistant. Phase I archaeological survey, Route U.S. 206, Hillsborough Bypass. For the New Jersey Department of Transportation.

- **Passaic River Bridge Replacement, Chatham, New Jersey.** Field Assistant. Phase IB cultural resource survey for proposed bridge replacement. For Essex County.

- **Garden State Parkway, Route 78 Interchange.** Field Assistant. Phase IB testing for proposed redesigning of existing traffic circle. For the New Jersey Department of Transportation.

- **New Jersey Turnpike/Route 1 Interchange.** Field Assistant. Phase I testing for proposed wetlands replacement project. For the New Jersey Department of Transportation.

- **U.S. Route 9, Edison Bridge Rehabilitation and Widening, South Amboy and Woodbridge, Middlesex County, New Jersey.** Field Assistant. Phase I cultural resource survey. For the New Jersey Department of Transportation.

- **5.46-Mile E-Loop, New Jersey Mainline, Woodbridge to Linden, New Jersey.** Field Assistant. Phase I cultural resource survey of a proposed 42-inch gas pipeline alignment. For Transcontinental Gas Pipe Line Corporation.

- **Driscoll Bridge Rehabilitation and Improvements, South Amboy and Woodbridge, Middlesex County, New Jersey.** Field Assistant. Phase I cultural resource survey. For the New Jersey Department of Transportation.

PAST PROFESSIONAL EXPERIENCE

- **Twin Lights Historical Site, Atlantic Highlands, New Jersey.** Field Supervisor. Cultural resource survey of early nineteenth-century lighthouses and foundation of eighteenth-century structure.

- **Luyster House, Holmdel, New Jersey.** Principal Investigator. Archaeological survey of early eighteenth-century farmhouse.

- **Merchants and Drovers Tavern, Rahway, New Jersey.** Field Supervisor. Cultural resource survey of late eighteenth-century tavern.
- **Feltville Village Site, Watchung, New Jersey.** Graduate Field School sponsored by Montclair State University, Montclair, New Jersey. Circa 1840 paper mill site.

- **Old Tennent Church Parsonage Site, Freehold, New Jersey.** Field Supervisor. Mitigation of stone-lined feature from site of early eighteenth-century structure.

- **Old Presbyterian Burying Ground, Middletown, New Jersey.** Survey and testing of early eighteenth-century cemetery as part of the Old First Church project.

- **Parker House, Little Silver, New Jersey.** Field Supervisor. Data recovery of late seventeenth-century farmhouse.

- **Trinity Church, Princeton, New Jersey.** Field Supervisor. Mitigation of early nineteenth-century church during renovation and building expansion.

- **Saratoga Square Development, Bedford Stuyvesant, New York.** Excavator. Phase III mitigation of early nineteenth-century residences, inclusive of privies and cisterns.

- **Princeton Battlefield, Princeton, New Jersey.** Field Supervisor. Surface collection and subsurface analysis of Revolutionary War battleground. Project is ongoing and will be expanded to include extant period dwelling.

- **Pemberton Farm, Pemberton, New Jersey.** Field Supervisor. Surface reconnaissance of Native American site and subsequent colonial dwellings.

- **Moore's Tavern, Hightstown, New Jersey.** Field Supervisor. Final mitigation of artifacts from late eighteenth-century tavern before renovation of building and grounds.

- **Dutch Reformed Cemetery, Holmdel, New Jersey.** Principal Investigator. Preliminary exploration of cemetery uncovered mid-nineteenth-century domestic bottle dump. Project is ongoing.

- **Holmdel Community Church, Holmdel, New Jersey.** Principal Investigator. Total mitigation of artifacts and recording of related features prior to basement repairs. Artifacts range from the eighteenth to early twentieth century. Project is ongoing.

- **Monmouth Battlefield Site, Freehold, New Jersey.** Excavator/Supervisor. First in a series of projects involving the restoration of the site to its battle-period landscape. The purpose of this phase is to gather, identify, and catalog any military or possible Native American artifacts before restoration work commences.

- **Camp Vreedenburgh, Freehold, New Jersey.** Excavator. Project sought to locate and excavate a Union Army Civil War training camp. Duties included general surveying, field conservation of artifacts, and recording soil profiles.

- **Old First Church, Middletown, New Jersey.** Excavator. Site is an early nineteenth-century church believed to be built directly over the original seventeenth-century church location.

- **Thomas Paine Park Site, New York City.** Excavator. Project sought to locate an early nineteenth-century shot tower and any related structures.

PAPERS PRESENTED

- The Activities of the Philadelphia Quakers As Seen Through the Small Finds They Left Behind. Vol. I. With Christy L. Roper. Paper presented at the Society for Historical and Underwater Archaeology Annual Conference, Corpus Christi, Texas. 1996.

- The Activities of the Philadelphia Quakers As Seen Through the Small Finds They Left Behind. Vol. II. With Christy L. Roper. Paper presented at the Mid-Atlantic Archaeological Annual Conference, Ocean City, Maryland. 1997.

- The Small Finds of the Apoquinimink North Site. With Christy L. Roper. Paper presented at the Council for Northeast Historical Archaeology Annual Conference, Altoona, Pennsylvania. 1997.

- The McKean/Cochran Farm. Paper presented at the Society for Historical and Underwater Archaeology Annual Conference, Atlanta, Georgia. 1998.

- Consumer Revolution and the Early Eighteenth-Century Farmer. Vol. I. Paper presented at the Society for Historical and Underwater Archaeology Annual Conference, Montreal, Canada. 1998.

- The Consumer Revolution and the Early Eighteenth-Century Farmer. Vol. II. Paper presented at the Society for Historical and Underwater Archaeology Annual Conference, Salt Lake City, Utah. 1999.

- The Johannes Luyster House: An Early Eighteenth-Century Dutch Farmhouse. With Dr. Richard Veit. Paper presented at the Archaeological Society of New Jersey Quarterly Meeting, Monmouth University, Long Branch, New Jersey. 1999.

- A Day at the Beach: The Unexploded Ordnance Sweeps at Sandy Hook. Paper presented at the Council for Northeast Historical Archaeology Conference, St. Mary's City, Maryland. 1999.

- The Johannes Luyster House: An Early Eighteenth-Century Dutch Farmhouse. Vol. II. With Dr. Richard Veit. Paper presented at the Society for Historical and Underwater Archaeology Annual Conference, Quebec City. 2000.

- Recent Archaeology in New Jersey. With John J. Killeen. Paper presented at the New Jersey Historical Society, Newark, New Jersey, 2000.

- People Who Live in Glass Houses: The Eighteenth-Century Stanger Glass Works. Paper presented at the Archaeological Society of New Jersey Quarterly Meeting, Ringwood State Park, Ringwood, New Jersey, 2000 and the Society For American Archaeology Annual Meeting, New Orleans, Louisiana, 2001.

- Logging All the Way to the Bank: Landmarking in Colonial New York. Paper presented at the Society for Historical Archaeology Annual Conference, Long Beach, California, 2001.

- A Day at the Beach: The Unexploded Ordnance Sweeps at Sandy Hook, New Jersey. Presented at the Archaeological Society of New Jersey Quarterly Meeting, Monmouth University, Long Branch, New Jersey.

- Recent Evidence for Broad Window in Seventeenth and Eighteenth Century America. Presented at the Council on Northeast Historical Archaeology Annual Conference, Niagara Falls, Ontario, 2001.