CHAPTER 21. CONSTRUCTION

21.1 INTRODUCTION

21.1.1 CONTEXT

The World Trade Center (WTC) was conceived in the 1960s to represent and enhance the commercial vitality of New York City and the nation as a whole. Between 1957 and 1974, Lower Manhattan experienced a real estate boom that resulted in 46 million square feet of new prime office space. The WTC was the largest of all new developments in Lower Manhattan, and the WTC became the center of international trade and the home of the Port Authority of New York and New Jersey (Port Authority).

The construction of 12 million square feet of office, retail and hotel space at the WTC, the superblock bounded by West, Vesey, Church, and Liberty Streets surrounding a three acre plaza, required thousands of pieces of construction equipment and large numbers of workers just to move the enormous amounts of earth that had rarely been equaled in the City's history. In order to create the WTC, five streets were closed off and 164 buildings were demolished. Construction required the excavation of more than 1.2 million cubic yards of earth, which was then used to create land for Battery Park City, an area that has since been developed into homes for thousands of residents, office and retail space for thousands of workers, and open spaces for residents, workers, and visitors alike.

As one of the largest and longest construction projects in New York City's history, the WTC required over the six-year period from 1966-1972, 3,500 construction workers at its peak (and a total of 10,000 people), 200,000 tons of steel and 425,000 cubic yards (CY) of concrete, 43,600 windows, and 12,000 miles of electric cables.

The design of the Twin Towers and the WTC complex also required a number of innovative design and construction techniques. Perhaps the best known is the use of a slurry wall to create the bathtub, a central symbol in the planning for and rebuilding of the WTC Site.

With the completion of Towers One and Two in December 1970 and January 1972, respectively, and their dedication in April 1973, the buildings were the tallest buildings in the world and represented the centerpiece of a complex containing five other buildings, including a major hotel and the largest shopping center in Lower Manhattan. When completed, the WTC, with approximately 50,000 daily workers and many visitors played a pivotal role in Lower Manhattan's financial district, the third largest business district in the country.

The attacks on the Twin Towers on September 11, 2001 resulted in the collapse of the towers on the WTC Site and surrounding areas and near total destruction of other buildings that were part of the WTC complex. All mass transit lines and stations, including the WTC PATH station, within the WTC Site were destroyed. All infrastructure elements on site were severed or inoperable. The eastern and southern slurry walls forming part of the bathtub of the WTC Site were damaged but did not collapse as reinforcements known as tiebacks and other measures were taken to allow them to continue the task of holding back the Hudson River to prevent flooding and to prevent the intrusion of groundwater at the WTC Site. Adjacent to the WTC Site, several buildings were destroyed (7 WTC, St. Nicholas Church), or heavily damaged (90 West Street, 130 West Street and 130 Liberty Street).

Rescue and recovery operations began immediately after the attacks under the direction of the Federal Emergency Management Agency (FEMA) and the New York City Department of Design and Construction (DDC). Work continued 24 hours a day, seven days a week. Initial efforts were tremendous and focused on human rescue operations. As weeks passed, the magnitude of the material diminished likelihood of successful rescue and recovery of human remains became the primary challenge.

As material was removed from areas near the WTC complex, verified workers and residents were generally allowed to return to the area. However, some buildings to both the south and the north of the WTC Site remain unoccupied. Most are being repaired or reconstructed.

The City of New York (City) maintained primary responsibility for the recovery efforts until June 30, 2002 and coordinated its efforts with other private and governmental entities. Approximately 1.8 million tons of damaged structures and materials were removed through the fall, winter, and spring of 2001-2002. In order to preserve the WTC Site as well as the health and safety of workers, necessary infrastructure repairs were undertaken concurrently with the recovery efforts, including the temporary stabilization of the slurry wall and flood-proofing of the WTC Site. The portion of the WTC complex on which 7 WTC was located was returned to Port Authority control on May 7, 2002 and reconstruction of the building began shortly thereafter. Recovery efforts concluded as of June 30, 2002 when the WTC Site was returned to Port Authority control. Metropolitan Transportation Agency/New York City Transit (MTA/NYCT) completed reconstruction of the No. 1/9 IRT subway tunnel in September 2002 and service resumed on that subway line to Lower Manhattan.

In order to restore service to a major regional transit hub, construction of a temporary WTC PATH station by the Port Authority began in July 2002 on conclusion of the recovery operations. The station opened for service in November 2003, symbolizing the first step towards reuse of the site as existed pre-September 11. The temporary WTC PATH station was constructed in substantially the same configuration that existed prior to September 11.

On the Southern Site, 130 Liberty Street remains vacant and shrouded in black netting. Its plaza and the supporting structure for the plaza were removed, leaving a deep hole in the ground. To the west, the block formerly occupied by the church and the parking lot was repaved and has been used for construction staging. In BPC, two large tents were erected on Site 26 to serve recovery workers, but the site again functions as a surface parking lot.

Following the initial rescue efforts, LMDC was established to coordinate the rebuilding efforts of Lower Manhattan. For the World Trade Center Memorial and Redevelopment Plan (Proposed Action) to succeed in rebuilding the WTC as the iconic center of the financial district and to honor those who died there on September 11, 2001 and on February 26, 1993, the city, state, and nation seek to capitalize on the initial steps taken on the WTC Site to date and embark on an ambitious program of construction comparable to the efforts conducted for the original WTC complex.

The Proposed Action would provide for the construction on the Project Site of a World Trade Center Memorial and memorial-related improvements, up to 10 million square feet of commercial office space, up to 1 million square feet of retail space, a hotel with up to 800 rooms and up to 150,000 square feet of conference facilities, new open space areas, museum and cultural facilities and certain infrastructure improvements, including below-grade parking for automobiles and buses, and security facilities. The extension of Greenwich and Fulton Streets through the WTC Site and the reconfiguring of Cedar and Washington Streets through the Southern Site are also included in the Proposed Action.

For the purposes of this analysis, it is assumed that the construction of the Proposed Action would take place over approximately twelve years, from 2004 to 2015. It is expected that the Memorial and memorial-related components, Freedom Tower, retail spaces, and open spaces and street extensions would be completed by 2009. The remainder of the development *is expected to be completed by 2015.*

It is acknowledged that market demand and other factors would play a role in the actual completion date for all program elements. The most intense period of activity is anticipated to occur between the Third Quarter of Year 2004 and Fourth Quarter of 2008 with a peak period occurring in 2006. This construction period would include the following activities:

- Demolition of remaining below grade elements from 4, 5, and 6 WTC;
- Construction of Memorial and *Memorial Center;*
- Construction of the Freedom Tower;
- Construction of up to one million square feet of above and below grade retail *and retail bases of Towers 2, 3, and 4;*
- Construction of all below-grade elements including bus parking, security check zones, and linkages to the PATH pedestrian connections
- Construction of Fulton and Greenwich Streets, Washington and Cedar Streets;
- Construction of open spaces including Wedge of Light *Plaza, PATH Plaza*, September 11 Place, and Liberty Park;
- Construction of cultural buildings *and* a performing arts center; *and*
- *Testing, cleaning and deconstruction of 130 Liberty Street building*.

While not a part of the Proposed Action, several other major projects are also anticipated to occur in or around the Project Site during the 2004-2015 period. Three of the other major projects are transportation recovery construction projects: permanent WTC PATH Terminal on the WTC Site, Route 9A *Reconstruction Project*, and the Fulton Street Transit Center (FSTC), all of which are anticipated to begin in 2004 and be completed by 2008/2009. A fourth transportation recovery project, the reconstruction of the South Ferry subway station, is anticipated to occur during the same time period but is located approximately one-half mile to the south of the WTC Site. These construction activities and other projects such as street reconstruction and private residential and commercial development are anticipated to occur during the 2004-2015 period.

Taken together temporally and spatially, the construction activities of this major project would affect everyday activities for residents, workers, and visitors to the Project Site and Lower Manhattan, particularly during the peak construction period in 2006. This chapter details the construction activities required to complete the Proposed Action elements as described in Chapter 1, "Project Description" and the four major Lower Manhattan transportation projects. In doing so, this Construction chapter provides inputs for analysis of potential impacts from construction activities, particularly during the peak period of construction year 2006.

The cumulative construction period analysis is conducted for the peak year (2006) of the combined construction activities of the major Lower Manhattan construction projects. This analysis also recognizes other commercial office and residential construction projects that may occur during the same time period, particularly during the peak year (2006). The potential effects of other major projects are included where applicable and appropriate to the specific resource. The conditions in 2006 would be projected based on the Current Conditions (2003) Scenario.

The potential cumulative effects from the five major projects occurring in and around the Project Site are analyzed from several perspectives. The purpose of this analysis is to assess the combined impacts of similar activities occurring at the same time within the several projects, particularly during the 2006 peak period of construction in Lower Manhattan. Specific resource areas identified for such analysis include:

- Access and Circulation;
- Air Quality;
- Noise and Vibration;
- Economic Effects; and
- Cultural Resources.

For impact analysis purposes, 2006 conditions with background growth and the construction of the four major Lower Manhattan transportation recovery projects except the Proposed Action are compared against the same condition but including the Proposed Action. The increment between these two conditions represents the cumulative construction effects of the Proposed Action when added to background growth and construction activity of the other major Lower Manhattan projects.

It is conservatively assumed that the Proposed Action would be the last of the major Lower Manhattan transportation recovery projects implemented, so that its effects are added to those of the other projects, rather than assuming that the effects of the Proposed Action would occur prior to those of the other projects. This is a conservative approach, as it assumes that environmental conditions in Lower Manhattan would have already been affected by the other projects even before effects of the Proposed Action are added to these conditions.

21.1.2 CONCLUSIONS

ACCESS AND CIRCULATION

The 2006 Future Without the Proposed Action (consisting of the four major Lower Manhattan transportation recovery projects plus background growth) traffic analysis results were compared with the 2006 Future With the Proposed Action (the four transportation recovery projects and the Proposed Action) to determine the relative change in level of service between the two scenarios for the AM, midday, and PM peak hours.

The 2006 Future Without the Proposed Action was compared with the 2006 Future With the Proposed Action to determine the impact of the Proposed Action’s generated construction traffic on the study area for the AM, midday, and PM peak hours. A total of six intersections were identified with impacts as a result of construction vehicles attributable to the Proposed Action. These intersections include: Vesey Street/Route 9A during the AM peak hour; Chambers Street/Church Street during the AM and PM peak hours; Barclay Street/Church Street during the AM peak hour; Cortlandt Street/Church Street during the midday peak hour; Canal

Street/Broadway during the PM peak hour; and Worth Street/Broadway during the AM, midday, and PM peak hours. Mitigation measures for these construction impacts are discussed in Chapter 22, "Mitigation."

AIR QUALITY

No significant adverse impacts on particulate matter were predicted along the Proposed Action's construction access routes, and no significant adverse impacts were predicted on overall respirable particulate matter (PM_{10}) concentrations in the vicinity of the construction sites. However, *absent mitigation*, the predicted maximum increases in fine respirable particulate matter ($PM_{2.5}$) concentrations, due to the Proposed Action alone and the cumulative impact of the Proposed Action and the other major Lower Manhattan recovery projects were substantially higher than the interim guidance threshold values for both annual and 24-hour average. Under the worst-case conditions, it was predicted that, *absent mitigation*, the cumulative impact of the Proposed Action and the other major reconstruction projects would substantially exceed 24-hour average $PM_{2.5}$ National Ambient Air Quality Standard. *While NO_2 levels would not exceed the NAAQS, a significant adverse impact on NO_2 concentrations was predicted, absent mitigation, immediately adjacent to the construction site*. Possible mitigation for *these* impacts is discussed in Chapter 22, "Mitigation," *which identifies measures that would significantly reduce these concentrations and the extent of any such impacts*.

Regional inventories of PM_{10}, NO_x, and VOC direct and indirect emissions from the construction of the Proposed Action are presented.

NOISE

Both the 2006 Future Without the Proposed Action scenario (consisting of the four major Lower Manhattan transportation recovery projects) and the 2006 Future With the Proposed Action scenario (consisting of the four major Lower Manhattan transportation recovery projects and the Proposed Action) were compared against each other for potential noise level increases. The evaluation was conducted based on New York City Environmental Quality Review (CEQR), New York State Department of Environmental Conservation (NYSDEC), and Federal Transit Administration (FTA) guidelines and criteria to determine the relative change in noise levels.

Under the 2006 Future Without the Proposed Action, traffic volumes would not change substantially from 2003 existing and pre-September 11 conditions, except for Sites 16 and 17 on Barclay Street, which would carry construction related vehicles and trucks associated with other major construction activities in 2006. As a result, noise level increases associated with mobile (vehicular) sources are not expected to increase substantially (defined as 3 dBA or greater) at most receptor sites, except for sites 16 and 17 on Barclay Street.

Under the 2006 Future Without the Proposed Action, noise levels attributed to construction activities other than mobile sources (e.g. trucks and cars to and from the Project Site) would exceed the CEQR construction noise impact thresholds at *12* sites, as the result of construction activities associated with all other major construction projects in the area. In addition, peak 8-hour noise levels would exceed FTA criteria at sites *4, 11, 13, 14, and 21*. Peak 30-day noise levels would also exceed FTA criteria at site *14*.

Under the 2006 Future With the Proposed Action, noise levels during the peak construction 2006 took into account increased noise from any traffic (i.e. truck hauling, driving to work site, detouring and diversion related) associated with the major transportation recovery projects and the Proposed Action. Noise impacts are anticipated to occur from mobile sources at site 11 on Liberty Street, sites 16 and 17 on Barclay Street for the Future With the Proposed Action scenario.

Noise levels attributed to construction activities other than mobile sources (e.g. trucks, cars to and from the Project Site) would exceed CEQR criteria at all receptor locations evaluated, expect for sites 1, 12, and 18 to 20. In addition, peak 8-hour noise levels would exceed FTA criteria at sites 4, 7 through 11, 13 through 15, and 21. Peak 30-day noise levels would also exceed FTA criteria at sites 4, 7, 9 through 11, and 14 for this Future With the Proposed Action Scenario.

VIBRATION

The vibration impacts associated with the permanent WTC PATH Terminal, Route 9A Reconstruction and FSTC were evaluated. No significant vibration impacts are anticipated at the receptor sites evaluated. Peak vibration levels attributed to the construction of the Proposed Action would not exceed 0.12 inches per second (ips) at any sensitive receptors evaluated during the peak construction period of 2006. Therefore, significant vibration impacts during the construction of the Proposed Action are not expected to occur.

ECONOMIC EFFECTS

The major construction projects that would be occurring in 2006 would all generate major economic benefits. In particular the Proposed Action is estimated to generate about 4,136 person-years of construction employment and about 6,373 person-years of employment in the city and about 7,853 person-years of employment in the state; construction activity equal to about $1.33 billion in the state, of which $1.02 would occur in the city; and tax revenues, exclusive of property-related payment, equal to $53.09 million.

Planning for construction of all the major projects has taken into account access to businesses and other uses in the area. New York State Department of Transportation (NYSDOT) and the Port Authority have completed temporary access across Vesey Street between Church Street and Battery Park City that includes a temporary pedestrian bridge and a protected pedestrian walkway at-grade.

LMDC and the Port Authority are working together to minimize disruptions to businesses during construction of the Proposed Action. Many of the buildings and businesses to the north and south of the Project Site (the areas closest to the proposed construction) were damaged and closed due to the terrorist attacks on September 11. However, some businesses south of the Project Site that have reopened or are expected to open, may be adversely affected by construction noise and air quality. On the other hand, the businesses would also likely benefit from the large number of construction workers. Church Street would remain open throughout the construction period, although the western lane may be closed for much of the time, as well as portions of Church Street between Vesey and Dey Streets. It is not expected that access to retail uses or other businesses on the east side of Church Street in this area would be restricted so much that the businesses would be adversely impacted.

CULTURAL RESOURCES

The pedestrian connection to the World Financial Center would be constructed through the Hudson River Bulkhead as part of the permanent WTC PATH Terminal project. Alteration of the bulkhead would require mitigation based on a Programmatic Agreement (previously established for Hudson River Park). Some limited areas of the eastern side of the WTC Site and of the Southern Site would require testing and monitoring, respectively to avoid adverse impacts to archaeological resources. Analysis as part of the environmental review for the permanent WTC PATH Terminal would insure the avoidance of any potential impacts to archaeological resources in the location of the potential below grade pedestrian connection under Church Street from the permanent WTC PATH Terminal to Liberty Plaza. Taken cumulatively, no significant adverse impacts to archaeological resources would be anticipated from the Proposed Action and the other major construction projects.

Construction of the Proposed Action has the potential to cause damage to nearby historic resources from ground-borne vibrations, dewatering (for the bathtub on the east side of the site and for the expansion of the existing bathtub to the south), and other activities. To avoid any adverse impacts to standing structures throughout the construction period, construction protection plans would be developed in consultation with the New York State Historic Preservation Officer. Taken cumulatively, it is not expected that there would be any adverse impacts to historic resources adjacent to the Project Site.

Construction activities on the WTC Site have the potential to adversely affect some of the remaining remnants from the former WTC Complex. To minimize or mitigate any such effects from the Proposed Action, LMDC has incorporated into the proposed Programmatic Agreement, referred to in Chapter 5, "Historic Resources," a series of commitments with respect to the future treatment of such remnants and procedures for consulting with the New York State Historic Preservation Officer (SHPO) and identified consulting parties concerning such treatment. It is expected that the sponsors of other Lower Manhattan Recovery Projects that might have the potential for similar effects on such remnants would enter into similar arrangements or take comparable actions to avoid or mitigate such impacts as well.

21.2 LMDC'S ENVIRONMENTAL PRINCIPLES

Since its creation in November 2001, LMDC has conducted continuous coordinated outreach with a broad range of individuals and groups affected by the WTC disaster and who have a collective voice in the reconstruction of the Project Site and Lower Manhattan. The formation of Advisory Councils to provide forums for public input and participation was essential in defining LMDC's initial mission and principles for action, "Principles and Preliminary Blueprint (Blueprint)." Guided by the Blueprint, LMDC sponsored interactive town hall meetings to discuss preliminary design concepts. The meetings were attended by over 4,500 people representing a diverse demographic and geographic population (another 800 participated in the dialogue on-line). The meetings resulted in over 10,000 public comments. In response to the comments, LMDC initiated the Innovative Design Study that produced nine final designs from over 400 submissions. The final designs exhibition drew over 100,000 people in December 2002 and over 13,000 public comments.

LMDC recognized the need to work closely with other agencies in the reconstruction and redevelopment of Lower Manhattan in the aftermath of September 11. The draft environmental principles were the product of LMDC's early coordination efforts with other federal and state agencies. The principles identified actions such as the development of a construction management plan, ongoing communication, and public outreach that could be taken to avoid and minimize potential environmental impacts in specific areas of concern.

LMDC is committed to continuing outreach efforts and communication and coordination efforts with agencies throughout the environmental process.

21.2.1 ENVIRONMENTAL PERFORMANCE COMMITMENTS (EPCs)

LMDC and the transportation recovery project sponsors (Port Authority, MTA NYCT, and NYSDOT) agreed to a common set of Environmental Performance Commitments (EPCs). The EPCs represent the mutual stewardship of the agencies, and are the product of extensive discussion and coordination among the agencies, and agencies that have participated in the process have co-signed the EPCs, thereby agreeing to implement the measures where practicable and applicable. As a result, the EPCs are considered to be policies enumerated by the LMDC as part of its overall environmental principles and its guiding principles.

EPCs address construction techniques, design elements, and operating procedures that would be implemented to lessen the potential for adverse environmental impacts from construction activities in areas of special concern including: air quality; noise and vibration; cultural and historic resources; access and circulation; economic effects; and environmental design (see Table 21-1 below). This proactive approach is anticipated to diminish the likelihood of adverse cumulative effects by incorporating them up front into the Proposed Action. In addition, each agency would undertake additional EPCs appropriate to its project based on the project's particular nature, timing, and scope.

Consistent with the environmental performance commitments made by the agencies funding and sponsoring major projects in Lower Manhattan, LMDC will participate in the ongoing coordination efforts that are expected to continue throughout construction. As part of this effort, LMDC *will continue to explore additional commitments that address specific project-related and cumulative adverse impacts identified in this FGEIS.*

21.2.2 SUSTAINABLE DESIGN GUIDELINES

The EPCs represent only a portion of the commitment to green construction, green design, and sustainability principles. In addition to the EPCs, the LMDC, Port Authority, and Silverstein Properties, as the net lessee, are developing *Sustainable Design Guidelines* as discussed earlier in Chapter 1, “Project Description.” (The current draft is included as Appendix A.) consistent with New York State Executive Order (EO) 111 and the New York State LEED Green Building Rating System, the *Sustainable Design Guidelines* include measures to avoid and minimize construction impacts for not only the Project Site, but the overall urban environment encompassing Lower Manhattan and the region beyond. The *Sustainable Design Guidelines* incorporate a Comprehensive Resource Management Plan (SEQ-1), which takes into consideration the environment with various agreed upon plans for managing the site, the water and energy usage, materials management, indoor air quality and integrated pest operations. The *Sustainable Design Guidelines* also contain the following plans: Construction Environment Plan (SEQ-5); Construction IAQ Management Plan (IEQ-5), Construction Storm Water Pollution Prevention Plan (SEQ-6), Construction Waste Management Plan (MEQ-2) and Use Existing Site Structures (SEQ-7).

The implementation of the Construction Environment Plan (SEQ-5) to reduce pollution, noise and vibration from construction activities is part of the design to reduce impacts on adjoining neighborhoods. In addition, development of a staging and laydown plan prior to commencement of construction for rebuilding helps to reduce pollution. Other elements of the Construction Environment Plan include: site erosion control, collection and utilization of stormwater, reduction of impacts on air and water, and use of ultra low sulfur fuels, as appropriate.

Table 21-1
Environmental Performance Commitments

Air Quality
Use ultra-low sulfur diesel fuel in off-road construction equipment with engine horsepower (HP) rating of 60 HP and above.
Where practicable, use diesel engine retrofit technology in off-road equipment to further reduce emissions. Such technology may include Diesel Oxidation Catalyst /Diesel Particulate Filters, engine upgrades, engine replacements, or combinations of these strategies.
Limit unnecessary idling times to 3 minutes.
Locate diesel powered engines away from fresh air intakes.
Control dust related to construction site through a Soil Erosion and Sediment Control Plan the following measures that includes, among other things: a. spraying of a suppressing agent on dust pile (non-hazardous, biodegradable); b. containment of fugitive dust; and, c. adjustment for meteorological conditions as appropriate.
Noise and Vibration
Where practicable, schedule individual project construction activities to avoid or minimize adverse impacts.
Coordinate construction activities with projects under construction in adjacent and nearby locations to avoid or minimize impacts.
Consider condition of surrounding buildings, structures, infrastructure, and utilities, where appropriate.
Prepare contingency measures in the event established limits are exceeded.
Cultural and Historic Resources
Establish coordination between projects to avoid or minimize interruption in access to cultural and historic sites.
Initiate public information and involvement outreach with sensitivity to local cultural resources.
Identify existing information sources that would be providing current information about access during construction.
Consult with the New York State Office of Historic Preservation and the New York City Landmarks Preservation Commission regarding potentially impacted, culturally significant sites. Monitor noise and vibration during construction at such sites as appropriate.
Access and Circulation
Establish a project-specific pedestrian and vehicular maintenance and protection plan.
Promote public awareness through mechanisms such as: a. signage; b. telephone hotline; and, c. web site updates.
Ensure sufficient alternate street, building, and station access during construction period.
Regular communication with New York City Department of Transportation and participation in its construction coordination efforts.
Economic Effects
Coordinate with LMDC and Downtown Alliance and other entities to minimize residential and retail impacts as required through: a. relocation assistance, as applicable, to persons or businesses physically displaced by the project; and, b. focus on essential businesses and amenities to remain in Lower Manhattan.
Add appropriate signage and way finding for affected businesses and amenities.
Environmental Design (Operational)
Use Energy Efficiency/Renewable Energy appliances and equipment.
Employ Enhanced Indoor Environmental Quality (IEQ) guidelines, where possible.
Conserve, reuse and recycle Materials and Resources.
Use Green Design/Design for Environment principles for Operations & Maintenance items.
Employ Water Conservation and Site Management techniques.
Implement sound Waste Management and Recycling policies (during construction).

The Construction IAQ Management Plan (IEQ-5) is to be implemented as per EO 111. This plan is to ensure filtration of air during and after construction of the commercial and retail space.

The Construction Storm Water Pollution Prevention Plan (SEQ-6) is designed to address site erosion and control water and air pollution from dust and particulate matter during construction phases. This plan is in conjunction with the Construction Environment Plan.

The Construction Waste Management Plan (MEQ-2) is designed to reduce the amount of debris from construction and demolition (C&D) waste which would otherwise enter landfills or incinerators. Recycling and recovery are two of the options with a minimum diversion of 50% of waste from C&D operations.

The Use Existing Site Structures (SEQ-7) supports conservation of resources via the reuse of existing structures on the WTC Site. That is, the incorporation of the slurry wall, excavation of the bathtub, and sharing elements of the permanent WTC PATH Terminal (e.g. utilities), as appropriate.

The Use of Undeveloped Parcels (SEQ-12) would utilize inactive and undeveloped site parcels to provide a positive contribution to site environmental qualities. Inactive and undeveloped site parcels could also be utilized for activities such as stormwater detention, wheel washing or staging and laydown areas.

21.2.3 LOWER MANHATTAN CONSTRUCTION COORDINATION

In conjunction with other Lower Manhattan Recovery project sponsors (including the Port Authority, NYSDOT, and MTA NYCT) and private entities such as Silverstein Properties, LMDC is participating in a Lower Manhattan Construction Coordination Group (LMCCG). The LMCCG will create an entity or strategy to ensure that Lower Manhattan Recovery projects move forward expeditiously while minimizing the impact to residents, businesses, workers, commuters, pedestrians, and vehicles.

Government agencies sponsoring and private construction firms managing recovery projects in Lower Manhattan are expected to dedicate one full time person each to participate in construction coordination activities.

The LMCCG represents a natural extension of LMDC's environmental principles, which include close coordination and communication with stakeholders in Lower Manhattan, including other agencies, residents, businesses and visitors. It is anticipated that the entity or strategy created by LMCCG will be responsible for the following:

- *Coordinating the work of the participants in the rebuilding process seen to on a daily basis and throughout the planning process. Mediating conflicts in schedules and street and site access among construction projects, agencies, and the Lower Manhattan community;*
- *Instituting construction coordination protocols and requirements for all government agencies, developers, construction managers, general contractors, and contractors to follow for all Lower Manhattan Recovery projects;*
- *Planning the Lower Manhattan Recovery construction projects to minimize inconvenience for residents, workers, businesses, pedestrians, vehicles, and commuters;*

- *Ensuring that the Lower Manhattan area maintains the highest degree of order throughout construction; and*
- *Utilizing technology to facilitate coordination of Lower Manhattan Recovery projects.*

The ability to disseminate and receive information, concerns and complaints from the Lower Manhattan community and relay feedback to the agencies will be another key function of the entity or strategy developed by the LMCCG. In addition, the LMCCG may also have a role in the implementation and enforcement of construction-related EPCs, including:

- *Establishing communications protocols that include Informing residents, businesses, and visitors of scheduled work and progress;*
- *Maintaining and providing information on timing and location of construction activities;*
- *Maintaining an internet site for up to date construction schedules and other data;*
- *Implementing signage to maintain businesses visibility and provide wayfinding*
- *Facilitating communications with construction coordinators or managers;*
- *Providing grievance and rapid response mechanisms for community complaints;*
- *Coordinating and enforcing Maintenance and Protection of Traffic plans;*
- *Establishing construction protocols (e.g., hours of work, fencing around construction sights, security, and signage;)*
- *Establishing materials procurement specifications and centralizing contracts; and*
- *Evaluating and implementing best practices methods and appropriate technology to reduce pollution, noise and vibration to adjoining neighborhoods including use of "smart alarm" systems that limit back-up noise on construction vehicles to only necessary noise levels but maintain safety.*

21.2.4 CUMULATIVE EFFECTS ANALYSIS APPROACH

LMDC committed to a common analytical approach to the cumulative effects analysis for the Proposed Action and the Lower Manhattan recovery projects. In adopting this coordinated cumulative effects approach, LMDC endeavors to deliver its best effort to avoid to the maximum extent practicable the adverse cumulative effects of the relevant projects. The methodology to achieve the goals of the cumulative effects analysis would be inclusive, yet it would focus on those cumulative effects that are potentially significant. A more detailed discussion of the cumulative effects approach is provided in the following section.

21.2.5 METHODOLOGY

As discussed earlier, this chapter assesses the cumulative effects of construction activities from the Proposed Action and other major Lower Manhattan projects during the peak period of 2006 upon the following resources areas: air quality; noise and vibration; pedestrian and vehicular traffic; economic conditions; cultural resources; waste disposal; water quality; and neighborhood character. Direct and indirect effects from the Proposed Action's construction activities upon other technical resources are discussed within their respective chapters. For example, the

Chapter 20, "Environmental Justice" discusses potential indirect impacts of the construction truck traffic farther away from the Project Site.

This section serves as an overview of available guidance and documents for the assessment of direct cumulative effects from construction activities. While guidance from various federal and local agencies is available for cumulative effects and, to a lesser degree, construction impacts, there is no guidance on specifically cumulative construction effects upon technical resources.

21.2.6 CUMULATIVE EFFECTS METHODOLOGY

In addition to the construction on the Project Site, a number of major transportation infrastructure recovery projects in Lower Manhattan may be under construction, including the Route 9A Promenade south of Albany Street to Battery Park, permanent WTC PATH Terminal on the Project Site, the FSTC a block east of the Project Site, the new South Ferry subway station near the southern tip of Manhattan, and the Route 9A Reconstruction Project immediately adjacent to the Project Site on the west.

As Lower Manhattan would be subject to several construction and rebuilding efforts over the next decade, several of which would be occurring over the same periods and in close proximity, the potential for cumulative construction effects warrants particular consideration. Such cumulative effects can result from the incremental effect of a given action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes such actions. The objective of a cumulative effects analysis is to identify and consider the combined effects of multiple actions that potentially would not be identified if each action and its associated effects were evaluated in isolation.

This analysis of the potential cumulative effects of the Proposed Action and the above projects focuses on five areas of potential concern during the construction period that have been identified by and agreed to by LMDC and the various involved agencies:

- Access and circulation;
- Air quality;
- Noise and vibration;
- Cultural resources; and
- Economic effects.

The cumulative construction period analysis includes the effects of those actions that overlap with the Proposed Action in time and space, that affect the same resource as those that may be affected by the Proposed Action, and that represent a change from conditions existing prior to September 11, 2001.

The cumulative construction period analysis is conducted for the peak year (2006) of the combined construction activities of the major Lower Manhattan construction projects. This analysis also recognizes other commercial office and residential construction projects that may occur during the same time period, particularly during the peak year (2006). The potential effects of other major projects are included where applicable and appropriate to the specific resource.

For impact analysis purposes, 2006 conditions with background growth and the construction of the major Lower Manhattan projects except the Proposed Action (see above) are compared against the same condition but including the Proposed Action. The increment between these two conditions represents the cumulative construction effects of the Proposed Action when added to background growth and construction activity of the other major Lower Manhattan projects.

The analysis that follows presents both (1) the individual construction-period environmental impacts of the Proposed Action in 2006; and (2) the environmental conditions resulting from the combined impacts in 2006 of the Proposed Action and the other major Lower Manhattan projects discussed above. The analysis also presents existing environmental conditions in 2003 for traffic, air quality, noise and other areas of environmental concern during the construction period. The difference between 2003 existing conditions and 2006 conditions with the Proposed Action and other major Lower Manhattan projects represents the cumulative impacts of all such Lower Manhattan projects, including the Proposed Action, in 2006. This is a highly conservative portrayal of such impacts because it not only assumes simultaneous construction activities on all five projects during the analysis periods, but also does not take credit for any background growth in the area between 2003 and 2006.

Note that this chapter discusses the cumulative effects from the construction of the Proposed Action. Other potential effects from the Proposed Action during the construction period are also discussed in Section 21.8 of this chapter.

It is conservatively assumed that the Proposed Action would be the last of the major Lower Manhattan construction projects implemented, so that its effects are added to those of the other projects, rather than assuming that the effects of the Proposed Action would occur prior to those of the other projects. This is a conservative approach, as it assumes that environmental conditions in the Lower Manhattan environment would be affected by the other projects even before effects of the Proposed Action are added to those conditions.

Section 21.8 of this chapter discusses the potential effects from the Proposed Action construction activities upon other resource areas within the project area of the Proposed Action.

21.2.7 CONSTRUCTION ANALYSIS METHODOLOGY

The construction methodology described has been developed as a tool for the estimation of the type and amount of construction equipment employed on the site; and for the quantification of construction-related vehicle traffic that would be added to the local road network. Such project-specific details are required for the accurate assessment of potential impacts from the Proposed Action during its construction period. In order to derive this information from the conceptual construction plan, and to maintain flexibility to incorporate on-going schedule modifications, a procedure for quantifying equipment and vehicle impacts was developed. This procedure is described below.

CONSTRUCTION PLAN

The conceptual construction plan has been broken down into a series of discrete sub-tasks for which typical equipment usage and construction vehicle numbers can be assigned. In general, major tasks were disaggregated into repeatedly smaller tasks until such point as it can be assumed that daily equipment usage, and daily truck generation, is approximately uniform throughout the duration of the sub-task. For example, a major activity such as “Construct East Bathtub” has been disaggregated into its constituent tasks; “Construct Site Retention”, “Excavate to Design Elevation”, and “Demolish Existing Structures”. The sub-tasks occur at different periods within the overall duration of the major activity. Sub-tasks are then displayed graphically on a construction schedule for agency and peer review.

PROJECT SCHEDULE

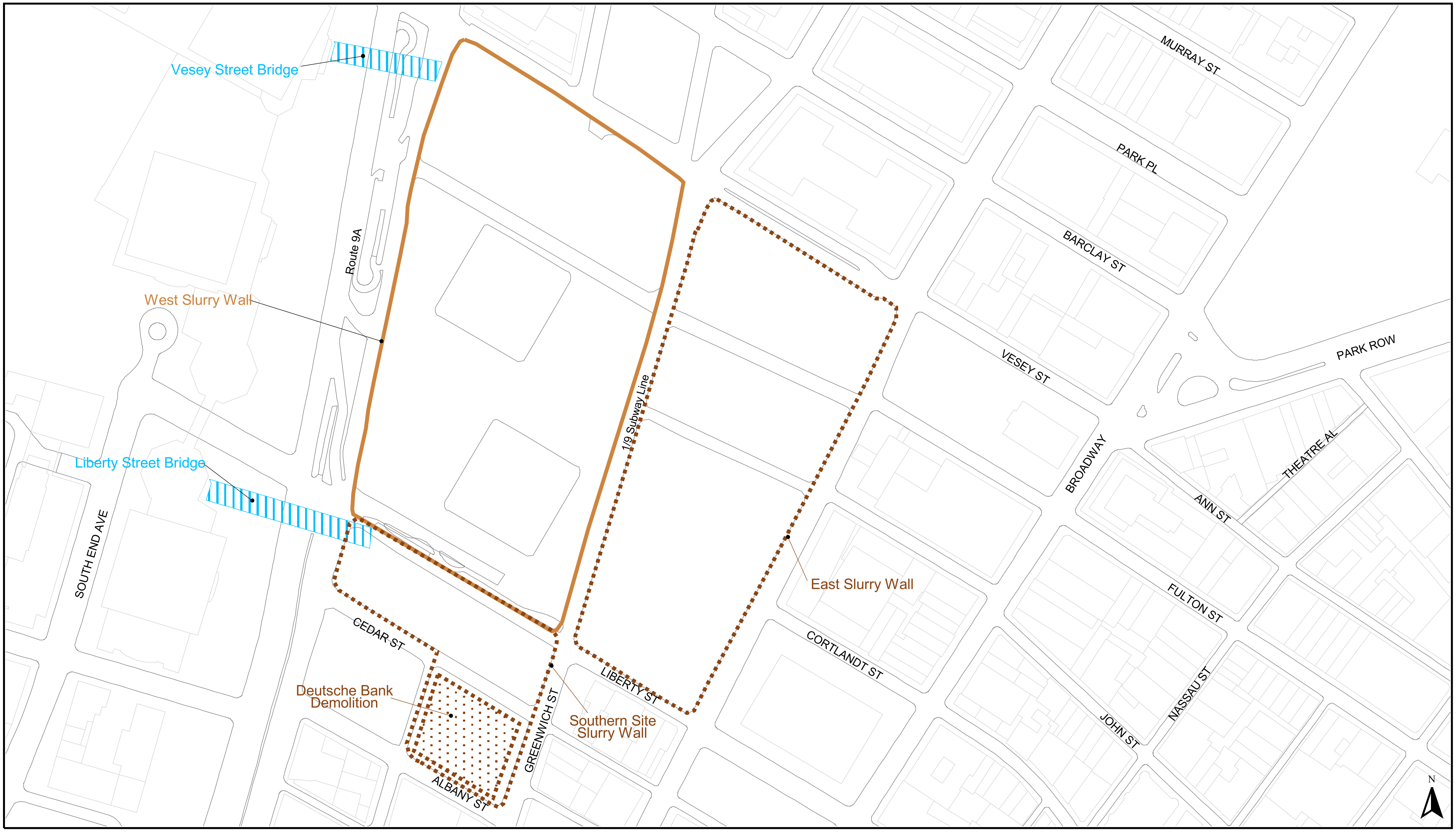
For the purposes of impact assessment, and in the absence of a formal construction plan, a conceptual construction schedule has been developed for all construction activities on the Project Site (see Appendix J-1). The conceptual schedule is intended to capture the most intensive, yet realistic, combination of construction activities that could potentially occur on a large integrated construction project. The schedule described below is based upon preliminary information provided by stakeholders such as the Port Authority, LMDC, net lessees, and their designated contractors and consultants. Detailed descriptions of individual construction activities, and the potential for such activities to generate environmental impacts, are discussed later in this chapter. The construction schedule for the Proposed Action would be coordinated with the schedule for the permanent WTC PATH Terminal. It is assumed that, following completion of the early action items, the sub-grade construction would occur concurrently with the construction of the permanent WTC PATH Terminal. See Figures 21-1 through 21-14 for a conceptualized construction schedule for the entire Project Site.

Most construction activities are expected to commence in September 2004. Prior to any major construction commencing on site, a comprehensive program of utility relocation would be undertaken that would require removal of the street surfaces on Church, Vesey, and Liberty Streets and Broadway.

By the end of 2005, the full build out of the sub-grade space of the site would have commenced; this would involve the construction of sub-grade retail, concourse, and utility space in all areas of the site except the area beneath the temporary PATH concourse (which would be excavated following the construction of an alternative temporary exit to Church Street for PATH passengers). As part of this work, the foundations and core of the Freedom Tower would be constructed early. These activities would be largely complete by the end of 2006. It is likely that the construction of the first tower (Freedom Tower) in the northwest quadrant would be fast-tracked. For the purposes of impact assessment, it is assumed that the building would be built using a rapid floor-to-floor cycle and that interior fit-out may lag well behind installation of the structural steel. The topping out of the Freedom Tower up to the 70th floor, exclusive of the iconic top, is anticipated in the 3rd quarter of 2006.

Due to the volume of construction activity in 2006, this year has been designated as the peak year for analysis purposes, and is likely to generate the largest number of construction related vehicle traffic, and equipment use on site. In general, construction activities in 2006 have the greatest potential to create impacts to the area surrounding the WTC Site. Elsewhere on the site in 2006, it is assumed that construction of the below grade build out of the site east of the No. 1/9 IRT line (the southeast and northeast quadrants of the site) would be complete by the 4th quarter. The expanded Southern Site (south of Liberty Street) would have been excavated by the beginning of 2006, and the sub-grade build out of that space would continue through until early 2007. Approximately in mid-2006, the fit-out and installation of the curtain wall for the Freedom Tower would commence. In the 3rd quarter the east bathtub retail fit-out would commence. The Memorial itself, and associated cultural and open spaces, would be commenced in late 2006. Construction of the Memorial, cultural space, Freedom Tower and retail fit-out, would continue until mid to late 2008. 2006 also represents a critical year for the PATH project; the staged overbuild of the platforms and mezzanine would be complete by 4th quarter 2006, and all tunneling and underpass construction is expected to be ongoing throughout the year.

In 2007 and the first half of 2008, the majority of the activities on the site would relate to the interior fit-out of the Freedom Tower, street level retail space, and the construction of the

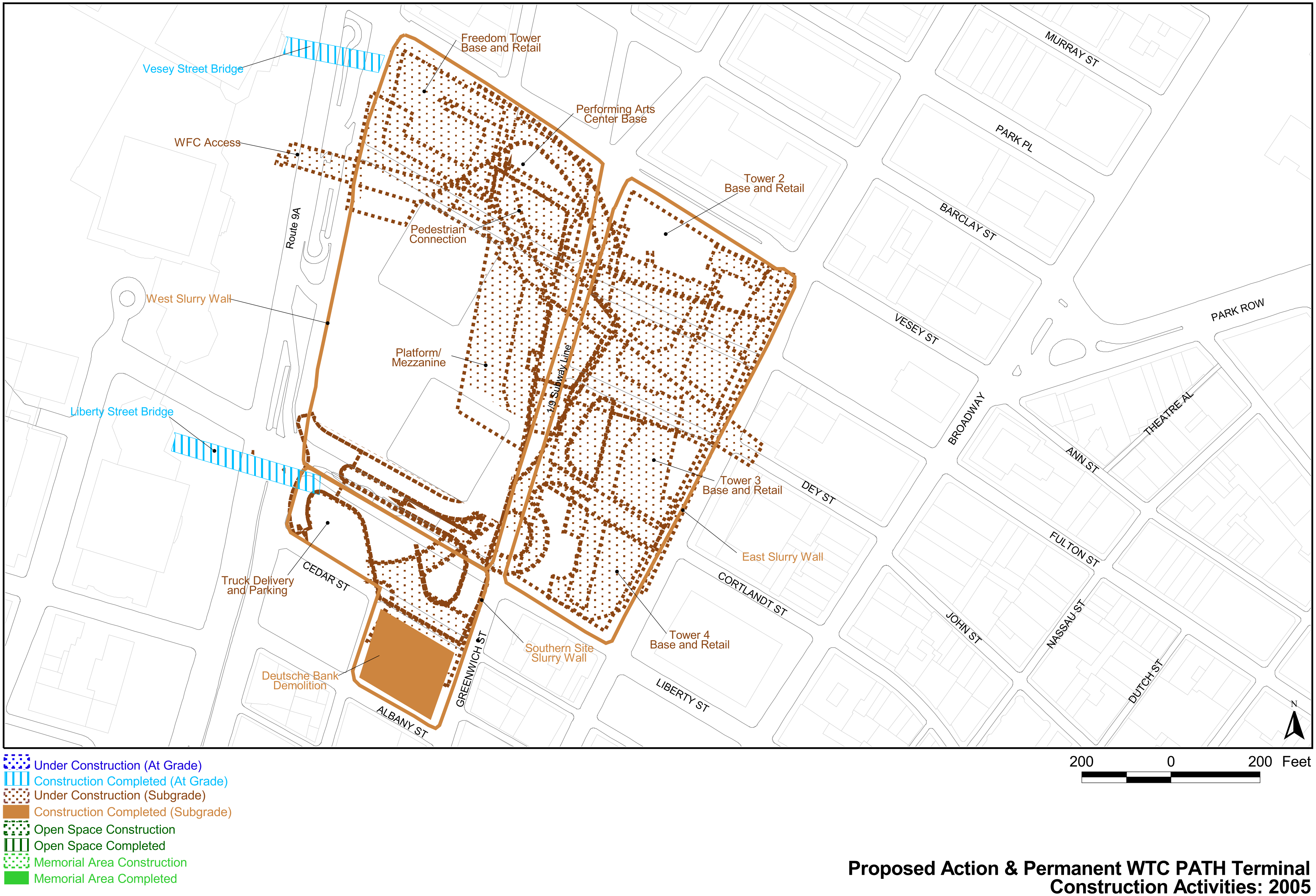


200 0 200 Feet

Under Construction (At Grade)
Construction Completed (At Grade)
Under Construction (Subgrade)
Construction Completed (Subgrade)
Open Space Construction
Open Space Completed
Memorial Area Construction
Memorial Area Completed

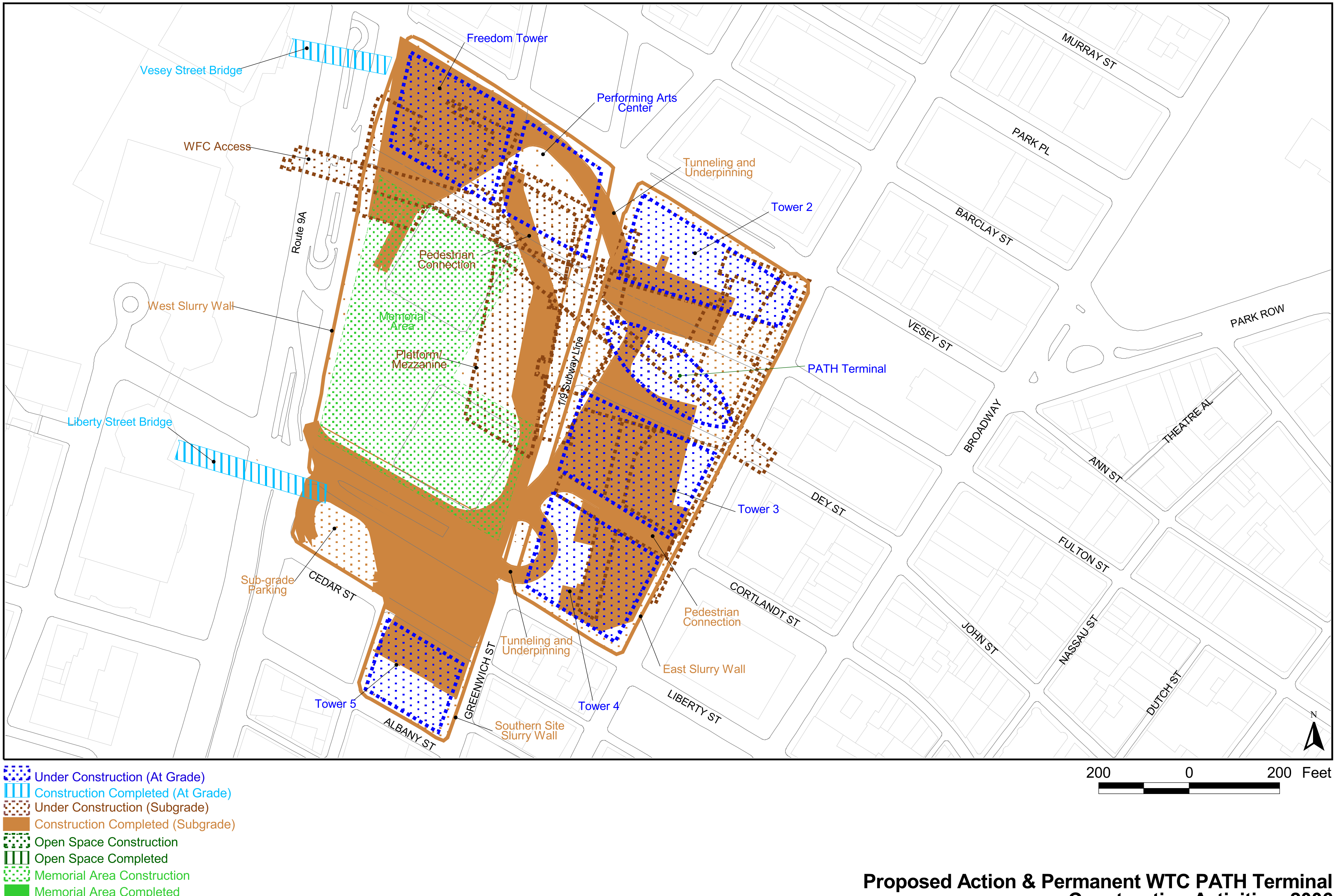
World Trade Center Memorial and Redevelopment Plan

Proposed Action & Permanent WTC PATH Terminal
Construction Activities: 2004
Figure 21-1



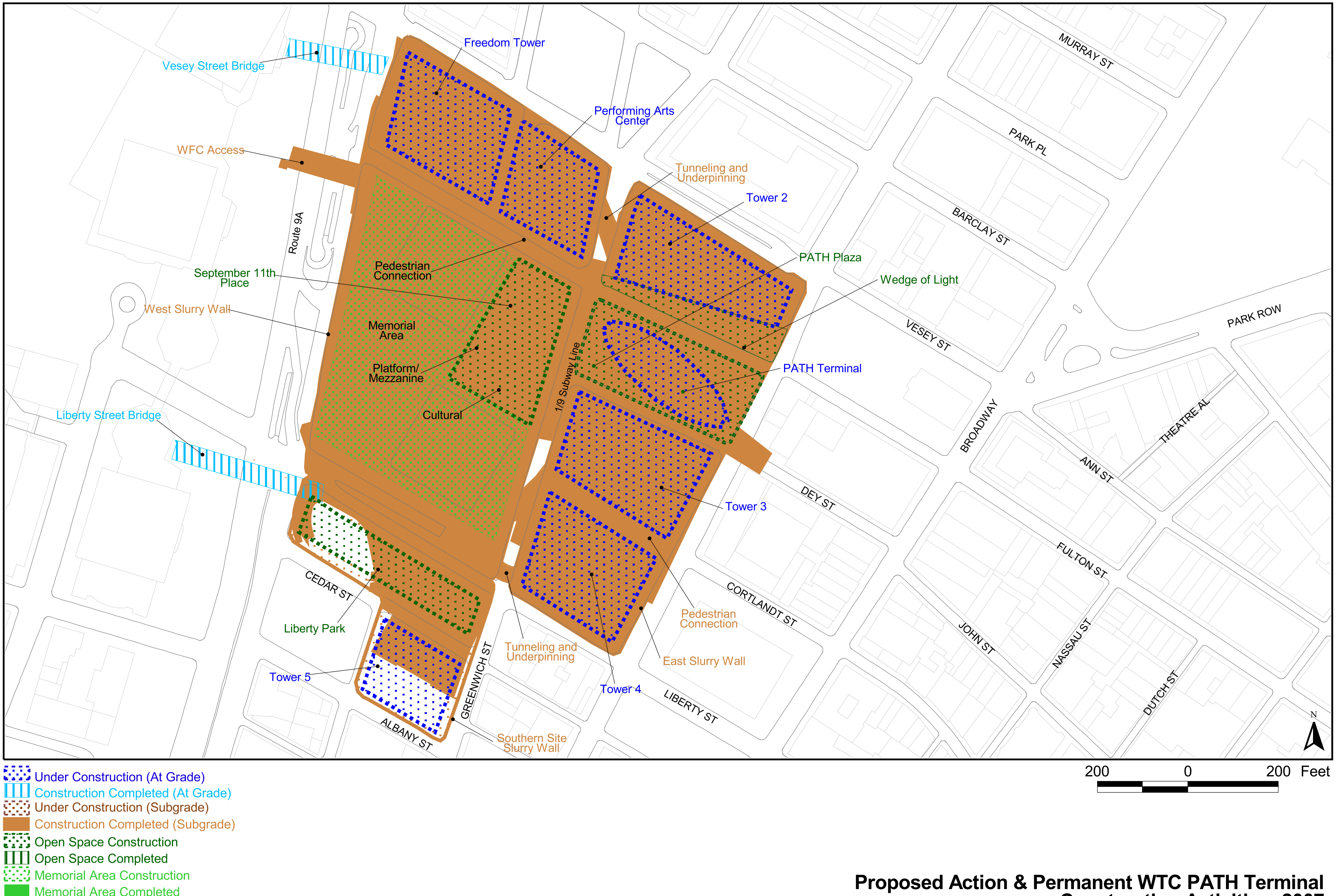
World Trade Center Memorial and Redevelopment Plan

Proposed Action & Permanent WTC PATH Terminal
Construction Activities: 2005
Figure 21-2



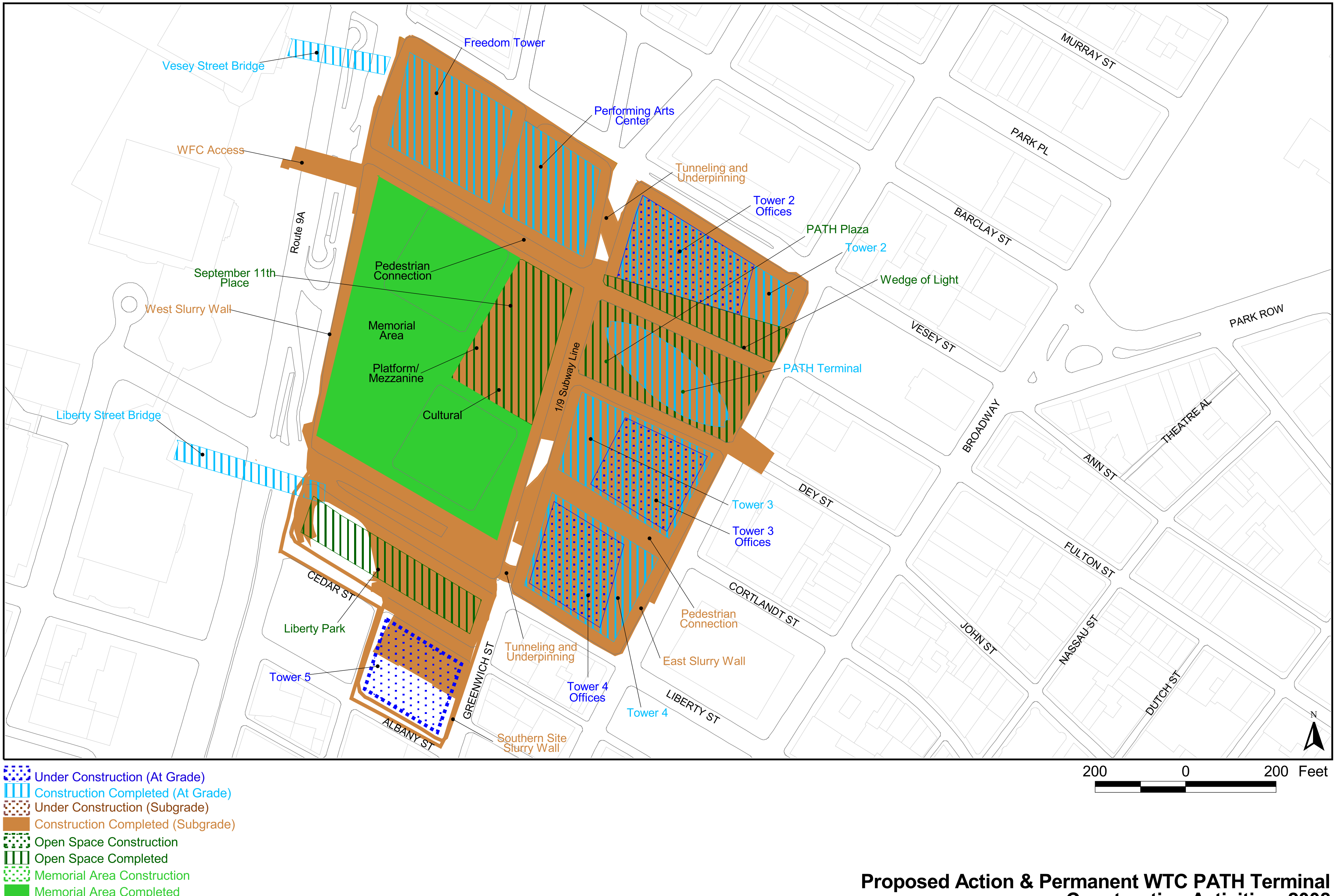
World Trade Center Memorial and Redevelopment Plan

Proposed Action & Permanent WTC PATH Terminal Construction Activities: 2006
Figure 21-3



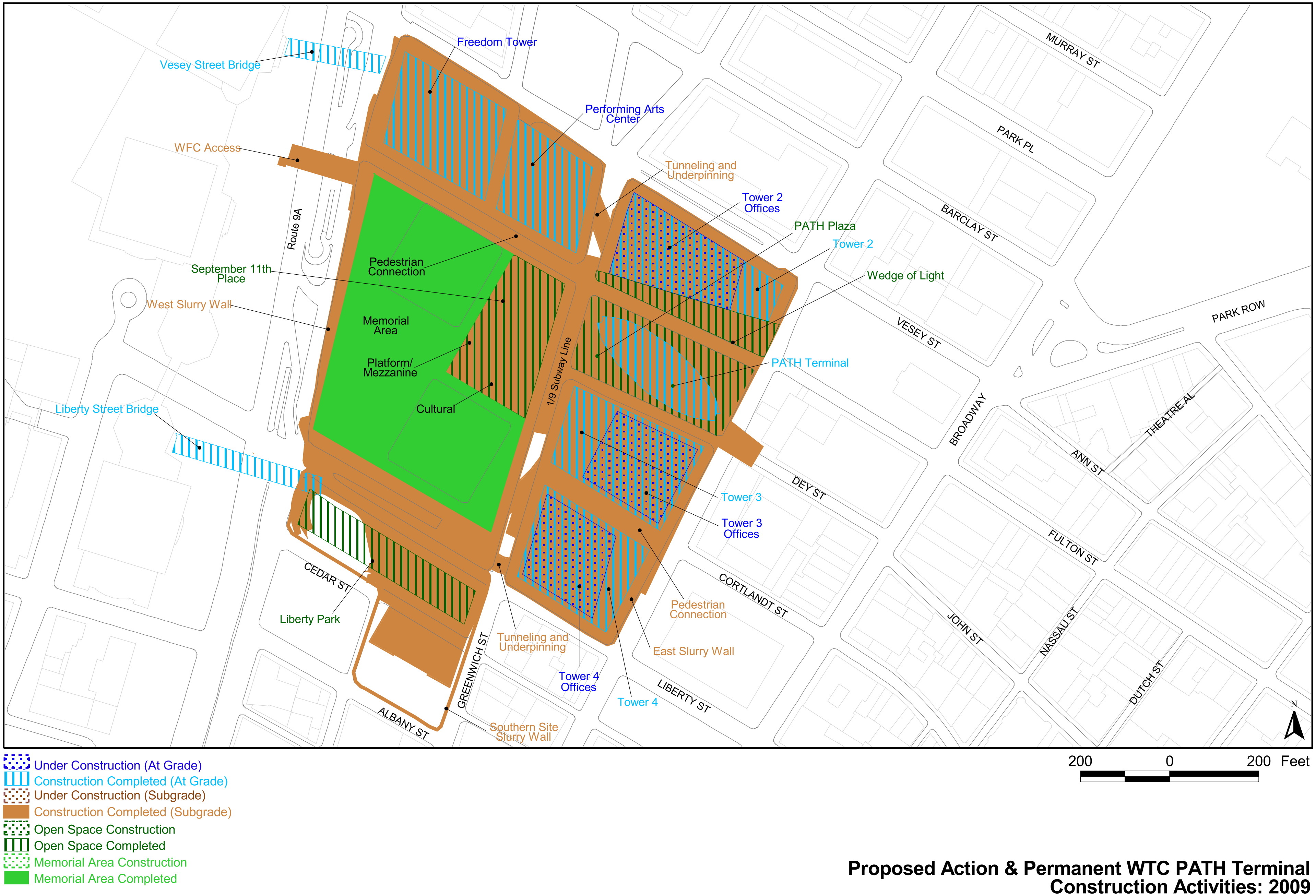
World Trade Center Memorial and Redevelopment Plan

Proposed Action & Permanent WTC PATH Terminal
Construction Activities: 2007
Figure 21-4



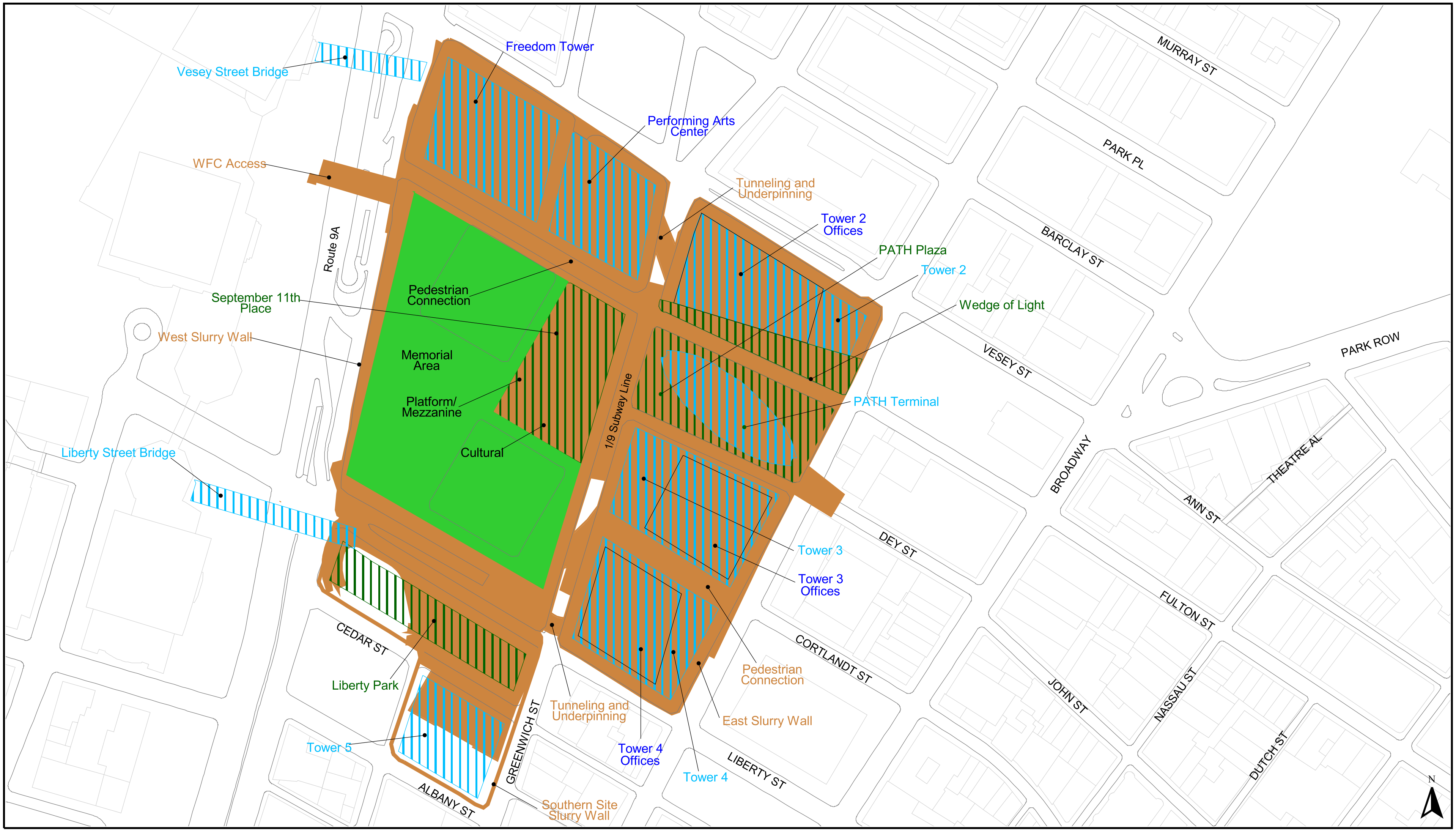
World Trade Center Memorial and Redevelopment Plan

Proposed Action & Permanent WTC PATH Terminal
Construction Activities: 2008
Figure 21-5



World Trade Center Memorial and Redevelopment Plan

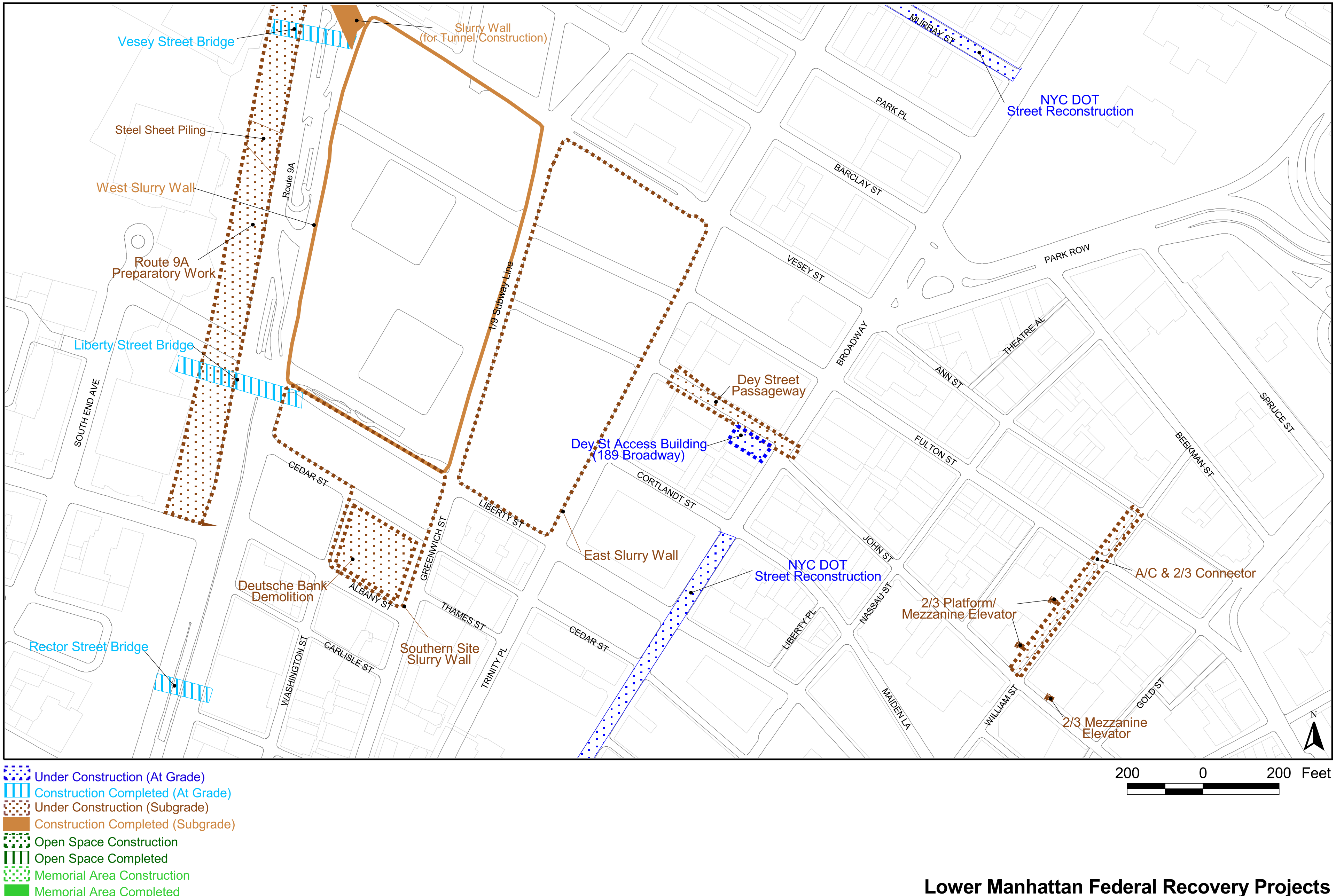
Proposed Action & Permanent WTC PATH Terminal
Construction Activities: 2009
Figure 21-6



Under Construction (At Grade)
Construction Completed (At Grade)
Under Construction (Subgrade)
Construction Completed (Subgrade)
Open Space Construction
Open Space Completed
Memorial Area Construction
Memorial Area Completed

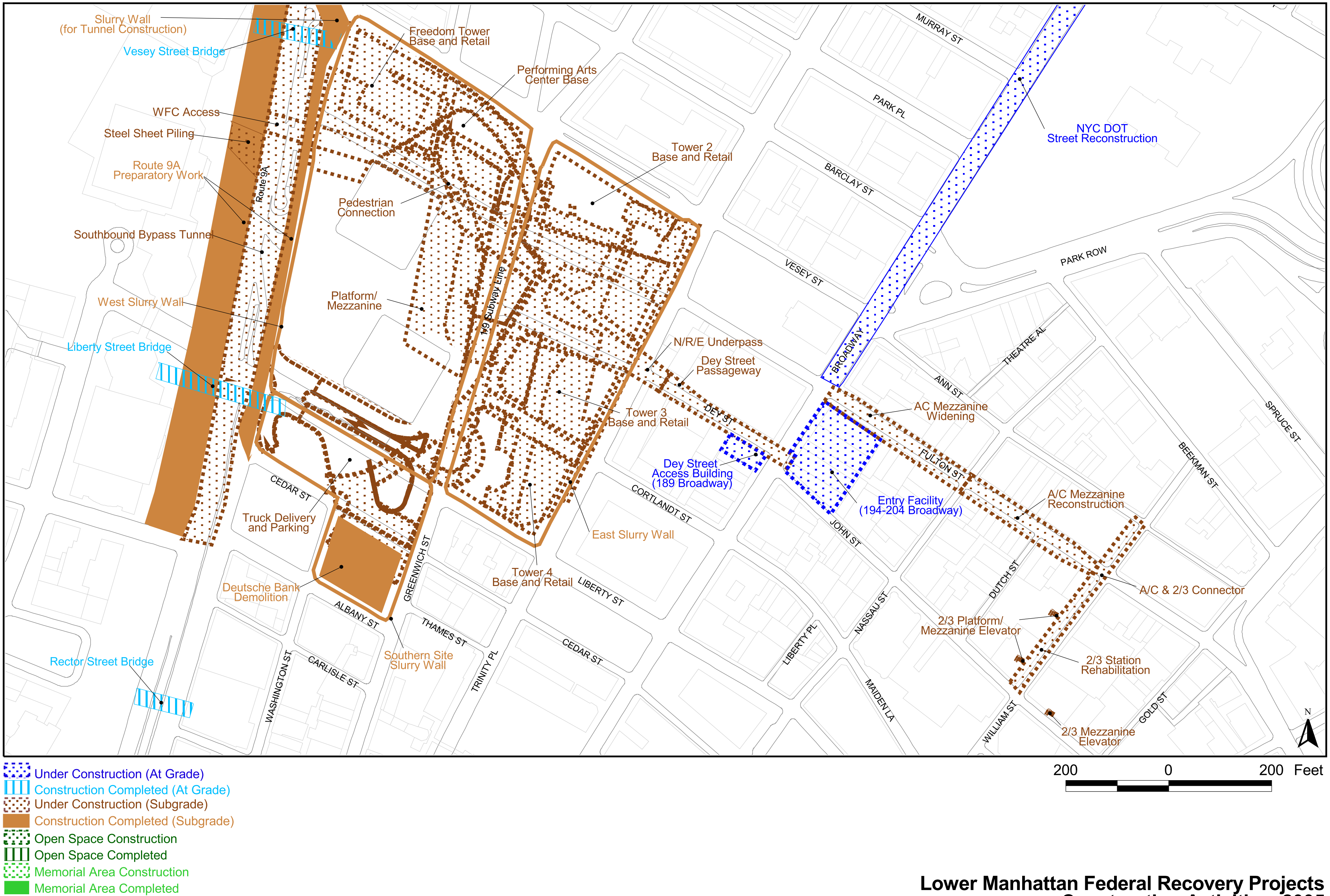
Proposed Action & Permanent WTC PATH Terminal Construction Activities: 2015
Figure 21-7

World Trade Center Memorial and Redevelopment Plan



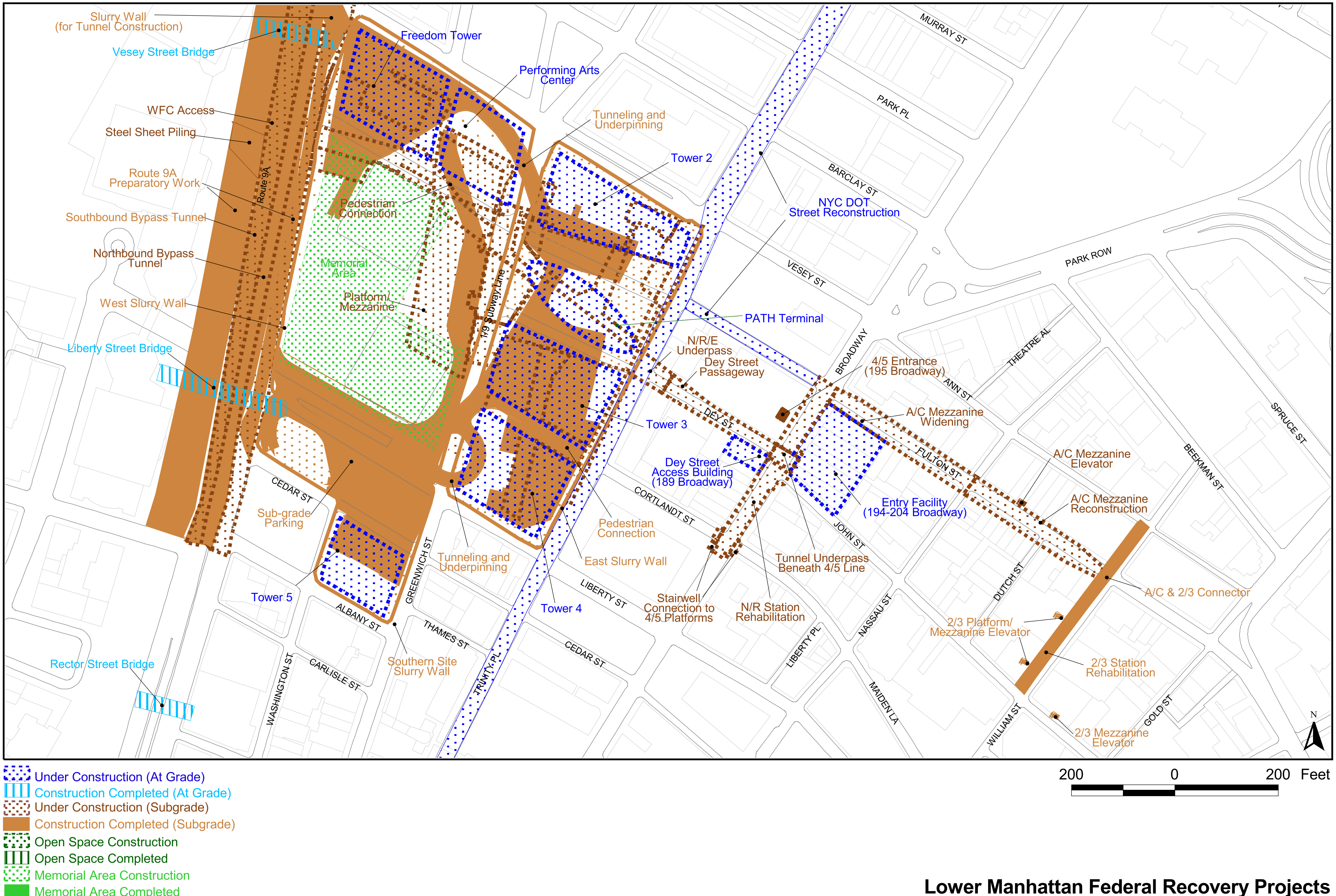
World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2004
Figure 21-8



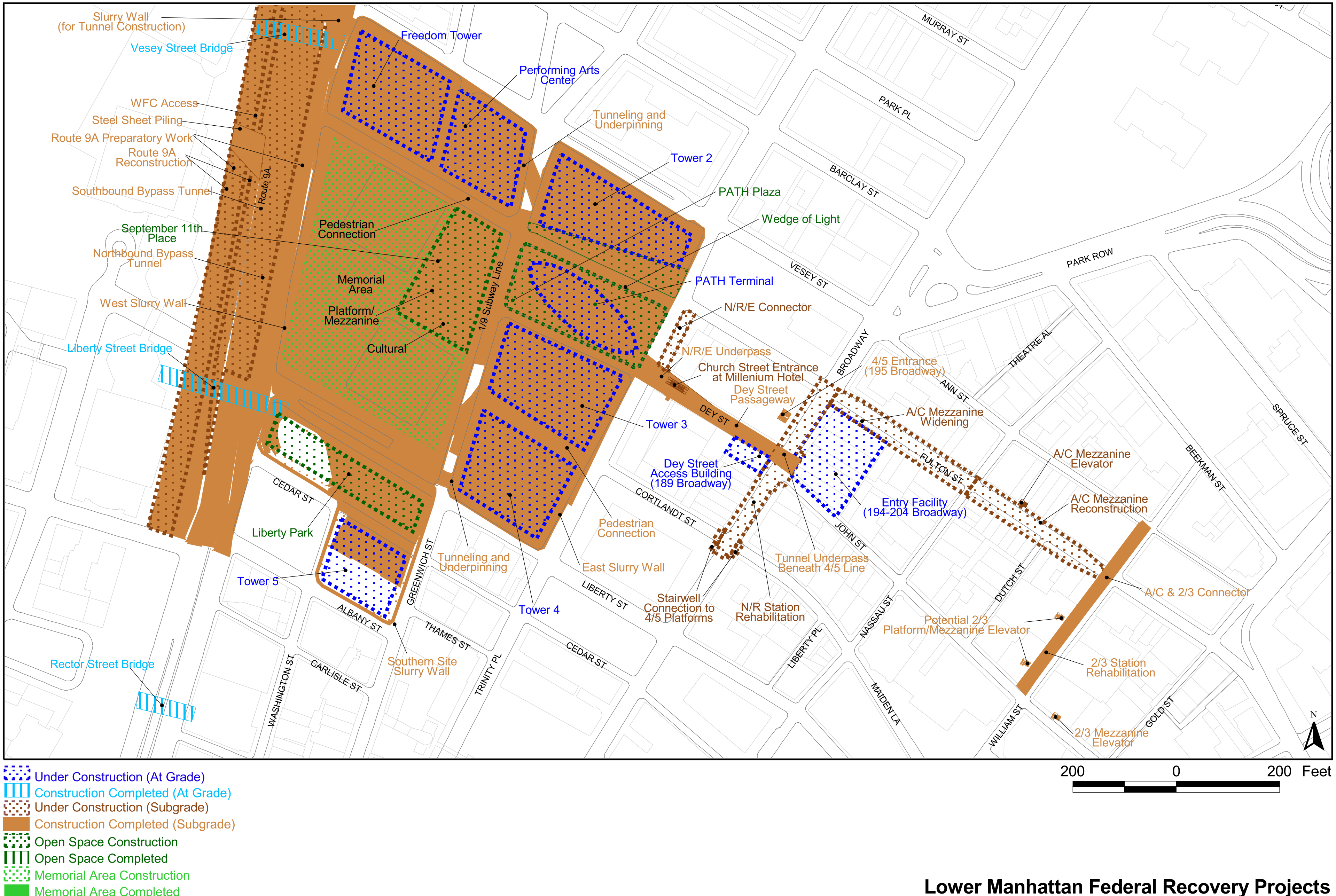
World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2005
Figure 21-9



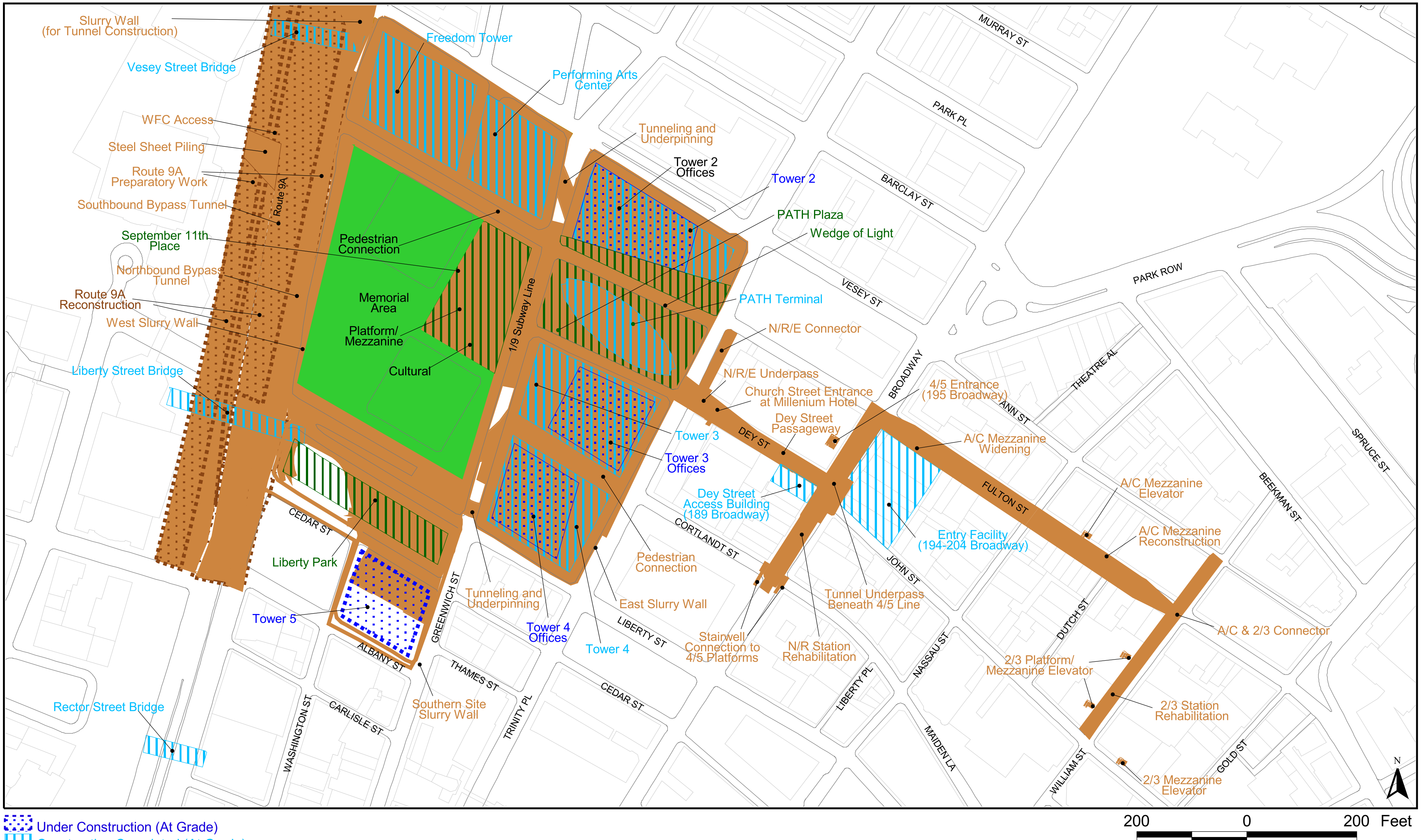
World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2006
Figure 21-10



World Trade Center Memorial and Redevelopment Plan

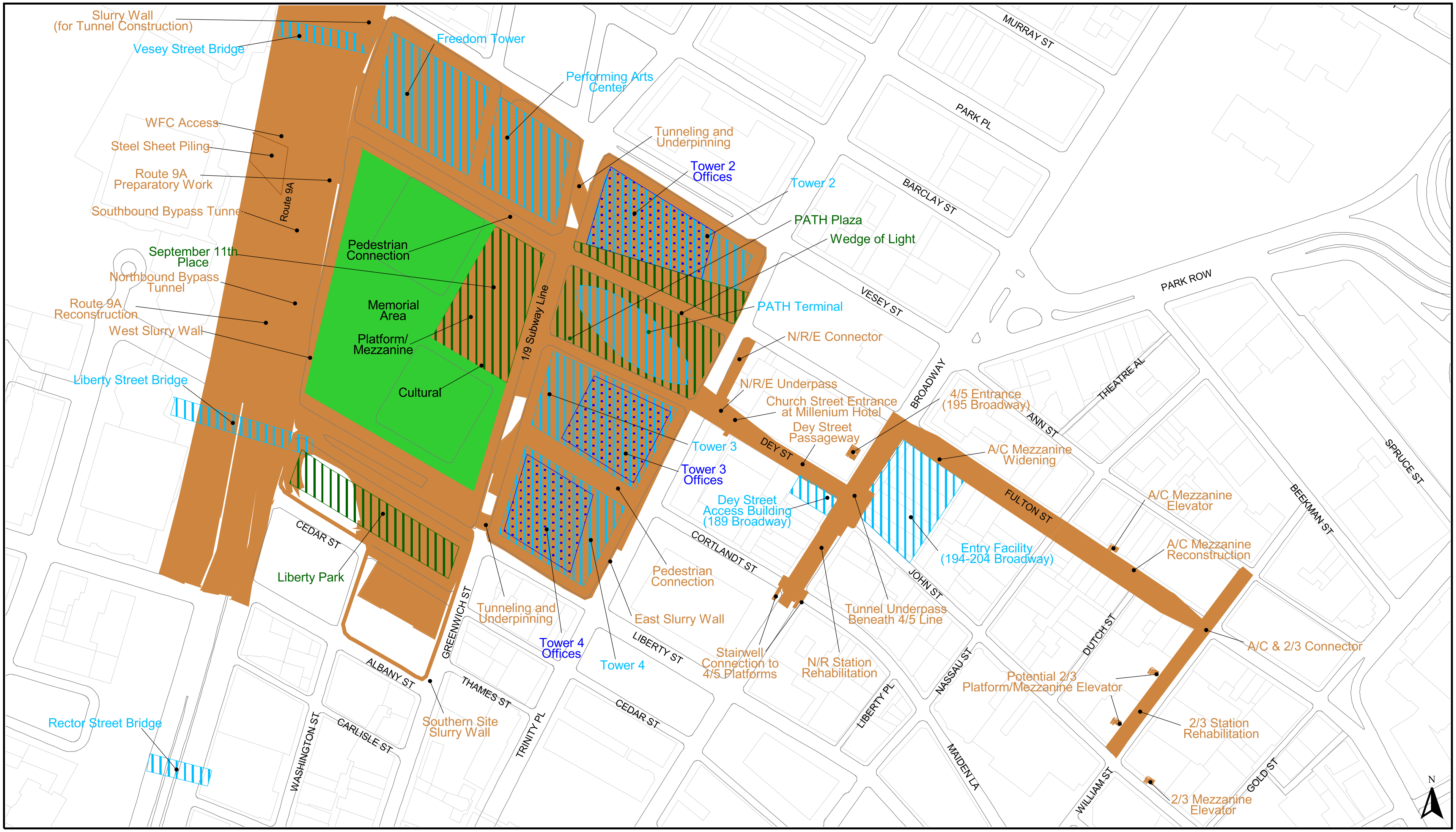
Lower Manhattan Federal Recovery Projects
Construction Activities: 2007
Figure 21-11



Under Construction (At Grade)
Construction Completed (At Grade)
Under Construction (Subgrade)
Construction Completed (Subgrade)
Open Space Construction
Open Space Completed
Memorial Area Construction
Memorial Area Completed

World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2008
Figure 21-12

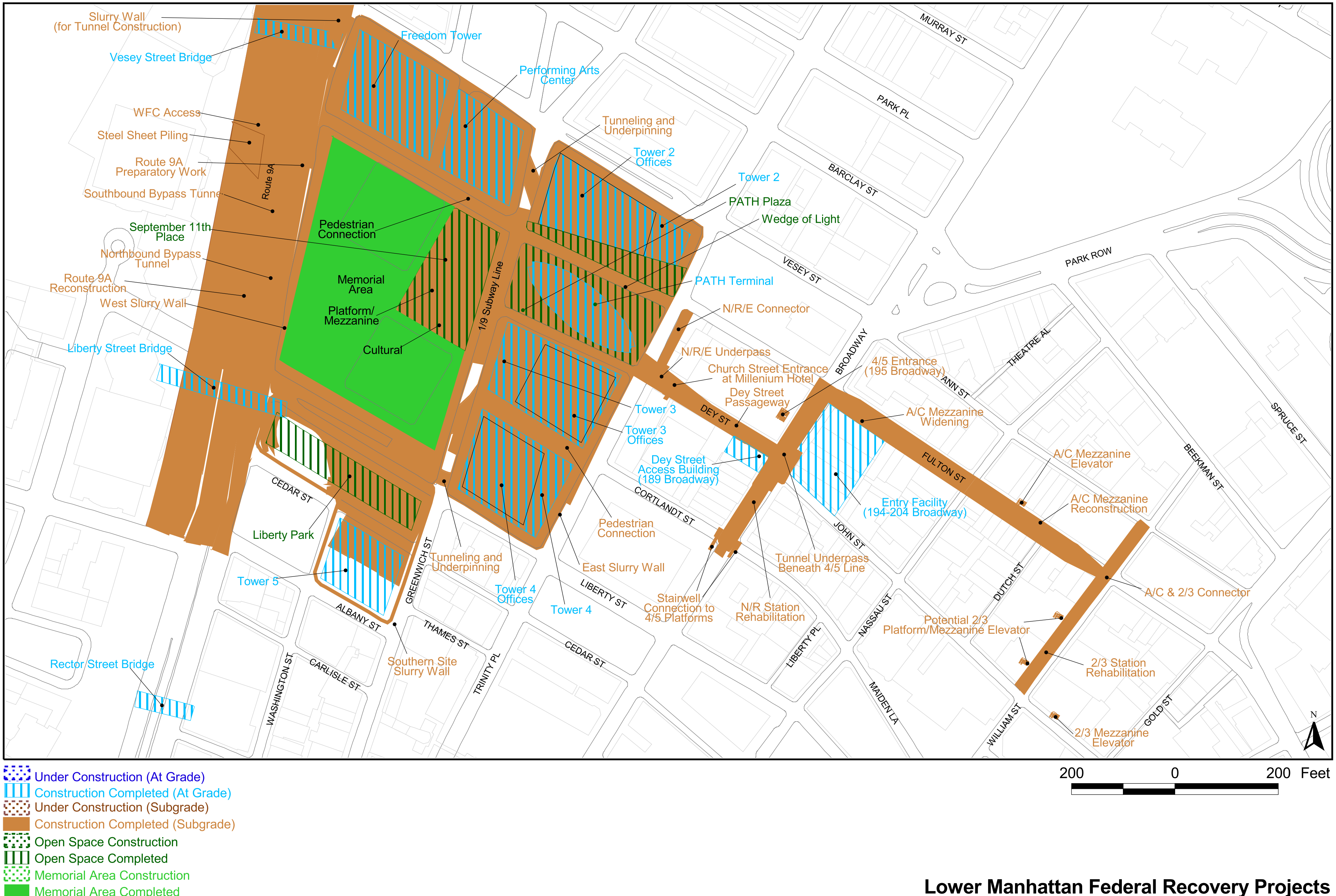


Under Construction (At Grade)
Construction Completed (At Grade)
Under Construction (Subgrade)
Construction Completed (Subgrade)
Open Space Construction
Open Space Completed
Memorial Area Construction
Memorial Area Completed

200 0 200 Feet

World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2009
Figure 21-13



World Trade Center Memorial and Redevelopment Plan

Lower Manhattan Federal Recovery Projects
Construction Activities: 2015
Figure 21-14

Memorial, open space, and cultural space. By 2007, it is assumed that construction could commence on at least the second tower. The other towers would be built in sequence as commercial office demand dictates until the construction and occupancy of all office space is projected to be complete by 2015.

DERIVE CONSTRUCTION ASSUMPTIONS

In order to derive realistic equipment and vehicle estimates, assumptions regarding construction methods, staging and lay-down areas, and other project-specific details have been established. These assumptions were developed through observance of actual practices on prior projects; and in coordination with relevant agencies, contractors, and other consultants involved in the project. In general, the construction assumptions capture the "worst-case" scenario for the purposes of impact assessment, but do not include overly conservative methods that are unlikely to be undertaken for this project. Detailed descriptions of all project-specific assumptions are presented in Appendix J-2. A summary of the major assumptions relating to the Proposed Action are presented at the end of this section.

EQUIPMENT AND CONSTRUCTION VEHICLE ESTIMATION

Estimates were derived for each sub-task that would generate uniform daily usage of certain types and volumes of construction equipment and constructed-related vehicles. The equipment and vehicle-trip estimates were based on "bottom-up" task-level estimates so that on-going changes to the proposed construction schedule, and the addition of new project elements, can be incorporated into the analysis without the need to revisit original assumptions. Tables are compiled for each sub-task that detail the numbers and types of vehicles employed, and the number and types of construction equipment used. Construction equipment estimates were further refined through the use of a "Percentage Use" factor, that describes the proportion of any day that a particular piece of equipment can be expected to be in operation. The impacts of construction trucks idling on site during concrete deliveries and excavation are also captured by the Percentage Use factor. Construction trucks are categorized into trailers, concrete trucks, dump trucks, and service, fuel, and sub-contractor light truck types. Equipment and truck generation tables also present "Peak Day" figures; numbers that could be expected to occur on particularly intensive days, and "Typical Day" numbers, that represent the average activity on site. The derivation of Peak Day totals and Typical Day totals are discussed subsequently.

IDENTIFY PEAK DAY TOTALS

A reasonable "peak day" for the purposes of equipment usage and trucks generation was derived. This represents a combination of events that could be expected to occur regularly (once or twice over a two-week period). The peak day was calculated by combining concurrent sub-tasks as they appear on the construction schedule. Individual daily equipment and truck totals are added to create peak totals. Under this method, the contribution to peak day totals of concrete trucks has to be reduced to account for the non-standard nature of concrete construction. As described in the construction assumptions below, concrete construction is an activity that cannot be evenly distributed over sub-task durations; concrete pours occur intermittently, require most of an entire construction day to complete, and usually monopolize site resources. As such, assumptions were made concerning the maximum number of concrete pours that could be expected to occur simultaneously within the Project Site, and on other Lower Manhattan projects (although most major construction tasks are expected to involve concrete construction to some degree, it is overly conservative to assume that all elements would require major concrete pours on the same day).

IDENTIFY TYPICAL DAY IMPACTS

Resources categories such as an air quality analysis, require a temporal cumulative addition of individual daily impacts of equipment and truck numbers. As such, typical day numbers have been developed for all construction sub-tasks. In this case, all equipment usage, truck types and numbers (inclusive of concrete deliveries) are evenly distributed over the duration of the sub-task.

SUMMARY OF CONSTRUCTION PROCEDURES

The following represents a summary of the major construction-related *procedures* used for the purposes of impact assessment. A full list of *these procedures* is provided in Appendix J-2.

- Shift and Work Hours – it is assumed that most construction activity would occur within a single 10-hour shift commencing at 7 am and finishing at 6 pm with a one hour lunch. Work days would be Monday through Saturday;
- Construction Worker Travel – the majority of construction workers would travel to the site using public transportation. Sub-contractors would be permitted site access for project-related vehicles only;
- Slurry Wall Construction – Lateral earth retention system for the creation of the new sub-grade bathtubs would be of slurry wall construction (see section 21.4);
- Methods of Excavation – site excavation would occur in multiple locations simultaneously; the northeast quadrant, southeast quadrant, and expanded Southern Site. The rate of excavation is determined by the physical rate at which a 15 cubic yard (CY) dump truck is able to load; and
- Concrete Pours – in the peak analysis year of 2006, a maximum of *four* simultaneous concrete pours can be expected to occur on any peak day within the WTC Site. Each pour would consist of 600 CY of concrete delivered to the site.

21.3 OVERVIEW OF CONSTRUCTION ACTIVITIES: PROPOSED ACTION

21.3.1 UTILITY WORKS

Prior to the commencement of any major construction activities, the sub-grade utilities beneath Route 9A, Vesey, Liberty, and Church Streets would require repair, upgrading, and/or replacement. Typical sub-grade utilities expected to be encountered in association with the redevelopment of the Project Site include gas, steam, electric, telecommunications, water, and sewer. Prior to completion of site surveys proposed during the Preliminary Engineering of the Project Site, currently known locations of utilities are approximate. Utility plans provided by utility owners are frequently indicative only, and provide an approximate number and configuration of underground services. Typically, 1:250-scale plans may contain errors of between 3 and 30 feet in lateral position. Utility relocation requires the pavement surface of the street, and sometimes the sidewalk, to be opened, and the sub-grade course to be excavated to a depth of approximately 5 feet, depending on the nature of the utilities. Commonly, this involves the use of pavement breakers, jack hammers, and backhoes. Utility modification commonly requires the use of grinders, welding machines, and "ringing and ripping" equipment used to pry open cast iron conduits for telecommunication services.

Throughout the period of utility modification, Vesey and Liberty Streets would be closed to vehicular traffic. Traffic would be confined to *two* lanes on Church Street. It is anticipated that pedestrian access would be maintained in all locations. The various services would be either temporarily suspended in place during construction or temporarily or permanently relocated, depending on the impacts on the project design. In many instances, new utilities would have to be installed prior to the decommissioning of existing services. Utility design would proceed after the completion of a comprehensive study of all existing facilities, which would be refined to include the potential temporary and/or permanent locations for relocated utilities. A more detailed discussion of utilities is presented in Chapter 12, "Infrastructure."

21.3.2 DEMOLITION

There are remaining structures from the former WTC complex and existing infrastructure that must be demolished prior to construction of new structures on the WTC Site. In all cases, structures would be incrementally dissembled and removed from the site. Blasting, wrecking balls, or induced collapse methods would not be used for this project. It should be noted that an attempt will be made to incorporate remaining structures into new building programs depending upon the condition of the structure and its ability to be incorporated into a new building program.

Portions of the original H&M station that was in use prior to the construction of the WTC in the 1970's still exists below street level on the eastern portion of the WTC Site. As part of the construction of the east bathtub, this structure would be demolished and removed from the site. The station consists of a track base, concrete platforms, and a station house structure. At present, the structure is capped with a concrete slab. Concrete saws and impact hammers would be used to break-up the structure and remove the debris. Heavier track mounted equipment would be used than is expected for 6 WTC, due to the reduced sensitivity of the structure. In addition to the old station, there a numerous remnants of existing sub-grade structure on the east of the site that are required to be removed prior to excavation for construction of the east bathtub (discussed below).

21.3.3 SUB-GRADE EXCAVATION AND LATERAL EARTH RETENTION

A critical activity in the preparation of the site for new construction would be the creation of two new sub-grade basement excavations ("bathtubs"); one east of the No. 1/9 IRT line, and another south of Liberty Street. The additional bathtubs would be similar in construction, and scale, to the original bathtub that survived the collapse of the towers on September 11. The existing bathtub is bounded by Route 9A, Vesey, and Liberty Streets and the No. 1/9 IRT line. The new excavations encompass the remainder of the original site east of the No. 1/9 IRT line, and the expanded site south of Liberty Street. It is intended that the southern bathtub ultimately be fully connected along its north boundary with the original bathtub to form a continuous sub-grade structure that extends beneath Liberty Street. The incorporation of the existing bathtub in the new site development complies with the *Sustainable Design Guidelines*.

The new sub-grade spaces would house the foundations, and sub-grade floor levels, of the Proposed Action. Construction of sub-grade space would entail two major activities: the installation of a lateral earth retention system to create a contiguous water-tight barrier around the excavation, and the subsequent excavation of the site to the new design level. In the case of the Project Site, the new design elevation of the proposed excavations approximately coincides with the top of the rock strata. As such, no major rock excavation, or piled foundations, is anticipated.

The new east bathtub would initially be divided into two zones; the northeast and southeast quadrants would be constructed first and would be separated by the portion of the site that lies beneath the temporary WTC PATH station. As alternative exits and entrance corridors are created by the sub-grade build-out of the site, the remaining fill beneath the station would be excavated, linking the north and south spaces creating a single bathtub east of the No. 1/9 IRT line.

SLURRY WALL LATERAL EARTH RETENTION SYSTEM

The new excavations are to be constructed in soil fill and would extend to below the ambient groundwater elevation. As such, the excavations would require the installation of a water-tight lateral earth retention wall along the boundary of the excavation. There are several different types of lateral earth support systems that may be used depending upon site conditions, depth of water table, type of soil, and proximity of adjacent building foundations. These include slurry wall construction, driven sheet-piles and drilled concrete secant piles. For the purposes of the analysis, slurry walls have been assumed to be the method that would be used, as this method is considered to have the greatest potential for adverse environmental impacts and allows the 'worst-case' scenario to be evaluated. Driven sheet piles are pre-fabricated steel sheets that are driven, or forced, into the sub-grade material. This method can cause substantial noise and vibration impacts and is not considered a likely method for construction of a permanent wall.

Slurry wall construction is a lateral earth retention wall that creates a hydrostatically contiguous barrier to limit the ingress and localized draw-down of the ground water table. Slurry wall construction is so-named because it employs an inert Bentonite, or surrounding polymer, "slurry" mix to replace soil that is removed in vertical slots excavated from the surface. The sequential excavations are made using a crane-mounted clam-shell excavator attachment. The slurry mix is used to counteract the significant earth and hydrostatic pressures that occur within deep excavations in soil. A steel reinforcement cage is then pushed down into the mix. The slurry mix is then gradually displaced by a concrete mix injected at the base through the use of extended jets. As the slurry is displaced it is fed into a mobile recycling plant located on site. Slurry wall construction does not require the use of pile driving equipment. Disadvantages include the fact that slurry walls may be thicker than conventional retaining structures, they require substantial site space to locate the slurry batch plant and recycling facility. In addition, slurry must be properly handled to prevent leakage into underground storm water systems.

EXCAVATION OF SPOILS

As the lateral earth retention system is installed, excavation may commence. The slurry wall would be laterally restrained as it becomes exposed. For the WTC Site, it is anticipated that the wall would be retained by temporary rock anchors, drilled at an angle from inside the site. These anchors would extend beyond the boundaries of the site and would be socketed into rock, or would penetrate sufficiently into stiff soil strata to provide adequate lateral support. Due to the large volumes of spoils that would be excavated, it is expected that a coordinated process of continuous earthmoving would be established. Fleets of 15 CY dump trucks in constant operation would stage on Greenwich Street, enter the site at multiple points, load, and then exit the site. As described in Section 21.5, each of the sites of major excavation (two on the east and one in the south) would be accessible by a temporary ramp structure that would permit dump trucks to load directly at the point of excavation. This would limit the amount of "double-handling" that is required, and would decrease the cycle time for each trip.

PROPOSED CONSTRUCTION SEQUENCE TO MAINTAIN TRAFFIC ACCESS ON LIBERTY STREET

In order to link the new excavated sub-grade space south of Liberty Street (southern bathtub) with the original bathtub, while simultaneously maintaining vehicular and pedestrian access on Liberty Street between Route 9A and Church Street, a temporary structure is proposed to re-route the roadway. The proposed construction sequence is as follows:

- Prior to the removal of the existing roadway, construct a temporary structural steel platform that re-routes the roadway within the boundaries of the existing bathtub walls (parallel to the southern boundary of the existing bathtub);
- Close the existing street, and re-route vehicular and pedestrian traffic on to the temporary roadway;
- Proceed with excavation and construction of the expanded Southern Site. As the new sub-grade levels reach street level, reinstate Liberty Street in its original location; and
- Demolish temporary roadway structure and remove from site.

21.3.4 HIGH-RISE OFFICE TOWER CONSTRUCTION

The Proposed Action includes the construction of five high-rise commercial office towers that would reinstate over 10 million square feet of office space on the Project Site. As discussed, the proposed towers range in height from 70 stories (plus iconic element) to 55 stories. High-rise tower construction has the potential to create different impacts than the construction of smaller facilities, and would differ from methods used to build-out the sub-grade space of the site. Due to the highly repetitive nature of the floor designs, high-rise construction is usually much faster than other forms of building construction. Of particular relevance to this analysis would be the construction of the Freedom Tower, as schedule constraints would require this building to be constructed at an accelerated pace. As such, this discussion would make reference to this structure.

It is expected that the towers would be founded directly on to rock and that piled foundations would not be used. Dependent upon the final structural design, rock anchor bolts may or may not be used to provide lateral stability to the core and external columns. Rock anchor bolts are installed with a drilling rig that embeds a permanent anchor deep into the rock strata. As the base of the excavation is cleared, large spread concrete footings are constructed to support the base of the external and core columns.

It is expected that the primary structure of the building would be comprised of structural steel columns and beams, with in-fill concrete floors. The core (the structural spine of the building that usually encases the elevator shafts, mechanical, HVAC, and other services) would be constructed of reinforced concrete. In high-rise construction, the installation of the structural steel precedes the pouring of the concrete floors by six to eight floors. It is anticipated that these would be installed in tiers of approximately two stories. The sequence of construction below the structural steel erection level is anticipated as follows:

1. Two to four floors below the point of initial erection, the building structure would be plumbed, bolted and metal deck pourstops and shear studs installed;
2. Five to six floor below – concrete on metal deck floors would be placed;
3. Seven to eight floors below – the reinforced concrete core would be placed;
4. Nine to 10 floors below – concrete slabs within core structure (elevator landings etc.) would be placed;
5. 11 to 12 floors below – spray-on fireproofing would be installed; and
6. 13 to 14 floors below – curtain wall installation and fit-out would commence. Note: due to concerns regarding axial deflection of the structure due to its self-weight, this activity may be delayed by as much as 20 floors (four months minimum).

This process is repeated up to the top of the building including the roof deck.

After each concrete floor is poured, work would be started on the underside of the deck. This would include the installation of hangers for and the hanging of HVAC ductwork, piping, plumbing, fire protection, electrical conduits and other above ceiling systems as well as systems that penetrate floor to floor. At the same time, the operations stairs, platforms and concrete block wall enclosures would be constructed. Concurrent with the installation of the core would be the installation of the passenger and freight elevator steel cages and rails. At this phase any large equipment such as HVAC chiller units, electrical distribution transformers, fire protection system pumping stations, etc., would be brought into the building and put in place.

In typical high-rise construction, the installation of the pre-fabricated curtain wall would lag about three months behind the pouring of the floor decks. In the case of the construction of the Freedom Tower, this activity may be delayed due to the schedule considerations that place priority on completion of structural steel, and due to structural considerations related to the axial deflection of the steel frame due to the building's self-weight. After the curtain wall is connected to the structure, the fit out of the interior systems and architectural installation would commence. This would include the running of each floors HVAC distribution, electrical distribution, plumbing and waste, and fire protection systems. Also included would be the installation of drywall, doors, bathroom fixtures and partitions, HVAC diffusers, fire protection sprinkler heads, standard and emergency lighting, telephone conduits and switch rooms, water fountains, etc. These efforts would be followed by the installation of the hung ceiling, doors and associated hardware, painting and floor treatments.

If construction were to be accomplished on a fast track basis it is anticipated that two sets of two construction passenger elevators, two construction freight elevators and four tower cranes would be utilized. During the first 14 months of construction, it is expected that the tower cranes would be constantly employed erecting structural steel. Structural steel would be delivered to the Project Site and either immediately hoisted and installed, or stored temporarily on site until needed. Structural steel is generally installed during daylight hours due to safety requirements. The installation of typical concrete floors would most likely occur in halves every 2-3 days with a floor being completed every 4-5 days. Non-typical floors such as lobby and machine room floors will require a longer duration to complete. As stated previously, the pour must be complete within a single day, and an uninterrupted continuous supply of ready-mixed concrete must be available. Outside of these particular days, very little concrete would be poured as part of the tower construction.

With construction manpower and support personnel working an extended week such as eight hours a day for six days, 10 hours a day for five days, rolling 10 hours a day for four days or some other approach it would be expected that a 50 to 70 story structure could be completed in the range of one week per floor and would require very close coordination between all trades and the availability of engineering, design and architectural field support as required as well as the cooperation of appropriate agencies and departments of the Port Authority, state and city. The construction of Towers 2, 3, 4, and 5, would proceed in a similar manner to Tower 1. While the floor-to-floor cycle times on these buildings are likely to be similar to Tower 1; Towers 2, 3, and 4 would be built sequentially. As such, a regular concrete pour can be expected as part of the construction of the remaining towers every 2-3 days.

21.3.5 SUB-GRADE CONSTRUCTION

A significant proportion of construction activities that would occur on site would involve the general build-out of the sub-grade space to street level. Typically, this type of construction differs from above-ground, or high-rise, building construction due to its highly variable nature. The sub-grade build-out of the Project Site would contain non-standard floor designs, would involve the incorporation of parking lots, vehicle ramps, sub-grade retail concourses, and the installation of large pieces of site infrastructure such as HVAC plant and electrical substations. Furthermore, each sub-grade floor slab is required to be structurally connected to the site retention wall. The variable profile of the surface of the site retention wall would slow completion of the structure, which typically delays the interior fit-out. It is assumed that the sub-grade would be framed in structural steel and that floors would be cast-in-place concrete slabs. In certain locations such as parking lot space and loading docks that do not require finished ceiling, or false ceiling space, pre-fabricated beams could be employed that provide long column-free spans. For the purposes of environmental impacts, it was determined that cast-in-place concrete represents the most conservative, or “worst case” construction method.

It is expected that all columns would be supported on concrete spread footings founded directly onto rock and that piled foundations would be unnecessary. The structural steel beams and columns are delivered to the site by truck, and stored until required. The installation of structural steel is commonly referred to as “sticking” and requires a tower, or mobile, crane to hoist and position individual steel sections. Steelworkers then manually connect the sections using bolts or site welds. In the case of sub-grade construction, concrete floors are often poured soon after steel installation, to permit the installation of large permanent machinery and equipment. In the case of the WTC Site, the commencement of sub-grade build-out would require the removal of all temporary site infrastructure and contractor site sheds from the base of the existing and new excavations. As discussed previously, it is expected that site sheds would likely be relocated to a temporary multi-tiered platform built above Greenwich Street, and to a lesser extent, above sidewalks surrounding the site.

21.3.6 TUNNELING BENEATH NO. 1/9 IRT LINE

The conceptual design calls for the construction of tunnels for vehicular ramps beneath the No. 1/9 IRT line. In order to limit disruption to subway service, the tunneling operation would most likely be executed using an incremental underpinning sequence, in conjunction with a comprehensive monitoring of vibration and subway track movement. The following conceptual construction sequence is proposed where a tunnel is constructed beneath subway tracks.

GROUT INJECTION

The proposed sequence commences with a program of grout injection of the soil immediately beneath the tracks. This would transform the soil into a material with a cement-like strength and consistency. This procedure would reduce the need for temporary lateral support of the walls of the concourse tunnel, a complicated procedure that would have involved the installation of a temporary retaining wall with associated anchors. Consequently, by employing jet grouting, the track structures would be subject to less vibration and disruption, and would be founded on a firm, consistent strata. It is envisioned that grout injection of the soil beneath the lines would most likely be conducted from within the actual stations and subway tunnels. This would most likely necessitate the temporary closure of the line to permit movement and set-up of grouting equipment and the safe working conditions of operators. Consequently, this would most likely occur late at night to reduce impact to operations.

STAGED UNDERPINNING

A sequential process is then commenced, whereby excavation progresses through the tunnel in incremental steps of approximately three feet. Each sequence would require the removal of existing piles, the installation of new piles beneath the new concourse level, and the installation of new beams designed to span the entire width of the concourse to support the new columns or side walls that would then rest upon the new piles. This process is repeated until the tunnel is complete.

PILE DRIVING

This would involve the set-up of a temporary pile rig within the confines of the tunnel mouth. Due to head height restrictions, it is likely that small sections of piles would be driven at a time. The excessive vibration may necessitate the temporary closure of the transit line and extensive movement monitoring.

MATERIAL REMOVAL

All soil, debris, and used piling would be removed through the mouth of the excavation. Material may be stored and treated in a temporary staging area within the confines of the WTC Site.

TUNNEL CONSTRUCTION

The tunneling activities would entail to the use of jackhammers, back-hoes, air compressors, and small earthmoving equipment.

21.3.7 SURFACE FINISHES – STREETS AND LANDSCAPING

The concept design of the Project Site calls for the creation of numerous parks, open spaces, and for the extension of Greenwich and Fulton Street through the site. A full inventory of the proposed project elements can be found in Chapter 1, “Project Description.” Completion of the surface works can only occur as the sub-grade of the site is built out to street level.

LANDSCAPING

Landscaping to create parkland would entail the delivery of clean uncontaminated top soil to the Project Site. This would be transported in 15 CY dump trucks. As new soil beds are prepared, landscaping, street furniture, and lighting infrastructure would be delivered to the site.

Specifically, landscaping proposals that include grown trees or large sculptures may be required to be delivered at night on over-sized vehicles.

ROADWORK

As part of its conceptual design, the Proposed Action includes the extension of Fulton Street between Greenwich and Church Streets, Greenwich Street between Vesey and Liberty Streets, Equipment associated with the construction of the new roadways are detailed in Appendix J-3.

21.4 CONSTRUCTION METHODS: OTHER LOWER MANHATTAN PROJECTS

21.4.1 CONSTRUCTION METHODS: PERMANENT WTC PATH TERMINAL

This construction methodology describes the approximate scope of activities relating to the construction of the permanent WTC PATH Terminal. This project includes the platforms, and mezzanine, pedestrian concourses, and terminal structure of the permanent WTC PATH Terminal at the WTC Site. As stated, neither the preliminary design, nor the construction plan has been finalized for this project. In the absence of such project-specific information, this document has been based upon conceptual construction plans prepared by the Port Authority included in the Stage I Study and from previous practices employed on large comparable civil/facility projects in New York City.

This study has aggregated the construction sequence into the following major components:

- *6 WTC* – The remaining below grade parking lot slabs of 6 WTC, in the northwest corner of the site, that were not destroyed on September 11, have been temporarily retained to brace the existing slurry wall. In order to clear the site for new construction, these slabs and columns are required to be demolished and temporary anchors installed to provide lateral support for the wall. As the structure spans the operational PATH tracks, it would be carefully dissembled and removed piece by piece. Concrete saws, impact hammers, cranes, loaders, and small track-mounted backhoes would be used, and the demolition would proceed in a top down, incremental manner;
- *Platform and Mezzanine* – the staged overbuild of the temporary station and mezzanine;
- *Tunnels under No. 1/9 IRT Line* – the construction of the concourse underpass, and the truck and bus tunnels at the north and south end of the site;
- *Excavation/Deconstruction East Bathtub Temporary Concourse* – the temporary station and concourse east of the 1/9 IRT line. Includes the construction of a permanent retention wall at the eastern and western boundaries of the Zone. Existing structure below grade would be demolished and excavated to same depth as the “Bathtub” to the west of the site;
- *East Bathtub Terminal* – the construction of the permanent terminal. Following excavation and demolition on the space, the permanent concourses and atrium terminal would be built; and
- *Ventilation Shafts* – the construction of ventilation shafts for the PATH tunnels.

CONSTRUCTION PHASING

For the purposes of impact assessment, the following construction phasing is assumed. It is envisaged the bulk of the work would be split into essentially two time periods. The first period would encompass all work west of the No. 1/9 IRT line and includes the conversion of the temporary platforms into the permanent platforms, platform space enlargement, mezzanine and concourse construction (to Route 9A). Prior to the commencement of the second phase, it is necessary for the southeast quadrant of the site to be complete to street level in order to provide alternative pedestrian access for PATH passengers to access Church Street. Once passengers are re-routed away from the temporary concourse, the temporary station east of the No. 1/9 IRT line can be demolished and the permanent terminal built in its place. As it is envisaged that construction west of the No. 1/9 IRT line would occur concurrently with the build-out of the southeast corner of the site, it is most likely that construction would commence west of the No. 1/9 IRT line well in advance of the areas to the east. In addition, the tunneling effort under the No. 1/9 IRT line would occur concurrently with the construction of the platform and mezzanine. A graphical summary of schedule phasing is shown in Figures 21-1 through 21-14.

PLATFORM AND MEZZANINE

The temporary PATH platforms would be sequentially replaced with permanent structure. This sequence calls for the closure of one half of a temporary platform at a time, and the subsequent replacement of temporary structure with permanent structural steel, concrete and finishes. It is envisaged that the permanent steel work would be installed first, followed by the mezzanine roof walls, and mezzanine floor. As part of this process, a sixth track and platform would be added, and the temporary platforms would be extended to accommodate 10-car PATH trains.

The concourse that links the mezzanine to Route 9A would be constructed at approximately the same time as the other components west of the No. 1/9 IRT line.

TUNNELS UNDER NO. 1/9 IRT LINE

The conceptual design of the permanent WTC PATH complex calls for three tunnels beneath the existing No. 1/9 IRT line, which is located beneath Greenwich Street, and one level beneath the N/R line beneath Church Street. At present, there is one existing tunnel beneath the No. 1/9 IRT line; the old WTC underpass from the original PATH station. It is proposed that the largest of the three new penetrations be based on an enlargement of this existing underpass. The two minor tunnels are intended to provide bus and truck access between the east and west of the site. The tunnel beneath the N/R line is required to complete the pedestrian concourse connection between the WTC Site and the FSTC. In order to limit disruption to the subway services, the tunneling operations would most likely be executed using an incremental underpinning sequence, in conjunction with a comprehensive monitoring of vibration and subway track movement.

The existing No. 1/9 IRT line is founded on piles that pass through undisturbed soil to the rock strata below. Tunneling work would proceed in a similar manner to that employed on the WTC Site, where sub-grade material is jet-grouted and excavation proceeds in staged increments.

EXCAVATION/DECONSTRUCTION EAST BATHTUB TEMPORARY CONCOURSE

At present, the temporary concourse extends from the underpass beneath the No. 1/9 IRT line to Church Street. Once the permanent southern concourse is constructed, this temporary space can be de-commissioned. The temporary steel work and concrete slabs would be dismantled and removed. New retaining walls (most likely slurry walls) along the Church Street boundary, and the No. 1/9 IRT line, would be constructed prior to excavation of this portion of the site. For a detailed description of the impacts of different methods of retaining wall construction, see the section entitled Construction Methods: Project Site.

The temporary concourse is situated over the old H&M rail station (the original trans-Hudson station that pre-dates the construction of the World Trade Center). Consequently, clearing the site would require a combination of deconstruction of existing structure, and excavation of undisturbed soil. The conceptual design proposes to excavate the site to the depth of the original "Bathtub". This depth approximately corresponds with the elevation of rock strata east of the No. 1/9 IRT line. Conservatively, it would be assumed that there would be some degree of rock excavation required. This could be executed with blasting equipment, rock drills and saws, or jack hammers. The base of the excavation would then be graded to create an even surface.

EAST BATHTUB TERMINAL

Following the excavation and preparation, the permanent terminal structure would be constructed. In the absence of preliminary architectural plans, it is envisaged that the sub-grade levels (including sub-grade concourses, truck parking etc.) would be constructed of standard structural steel with concrete floors. However, conceptual architectural plans call for a "grand" feature space at street level that would create a large column-free internal atrium. The roof of this space would require long span structural steel members of non-standard dimension.

21.4.2 CONSTRUCTION METHODS: ROUTE 9A *RECONSTRUCTION PROJECT* ALTERNATIVE

New York State Department of Transportation (NYSDOT) proposes to reconstruct Route 9A immediately to the west of the WTC Site between Barclay and Albany Streets. *Three alternatives are currently under consideration for analysis in the SDEIS currently being prepared by the NYSDOT for this project. The No Action alternative would make permanent the six-lane roadway that was opened in March 2002 adjacent to the WTC site and was damaged from the events of September 11. The second At-Grade alternative would reconstruct eight lanes—four northbound and four southbound—in front of the WTC site. This alternative would also provide pedestrian overpasses to facilitate movement of pedestrians across West Street. A planted median would be included to provide improved aesthetics and provide pedestrian refuge areas between the northbound and southbound traffic lanes. The third alternative, the Short Bypass Alternative would restore eight lanes in front of the WTC site by depressing four lanes and providing four lanes at-grade. Through traffic would travel below grade, and local traffic would remain on the surface lanes. The northern limit of the bypass would be Murray Street; options for the southern limit of the bypass are currently being studied. This alternative calls for 75 percent of vehicular traffic to be re-routed through a short sub-grade bypass to create a pedestrian link between the WTC Site and Battery Park City.*

The construction of the Short Bypass is heavily influenced by the requirement to maintain four traffic lanes throughout the project. Because it has the most construction activity and potential of construction-related impacts, the Short Bypass alternative is used for analysis purposes in this chapter. For impact assessment, the project has been disaggregated into five stages (see schedule in Appendix J-4, and described below).

Early Action Items – Repair, modify or replace existing utilities within the Route 9A right-of-way.

Stage I – Construct temporary north and south roadways adjacent to the site of the proposed sub-grade bypass. This activity is expected to take around 6 months and commence early in 2005.

Stage II – Construct the southbound lanes of the sub-grade bypass. This would commence in the 4th quarter of 2005 and should be complete in the 1st quarter 2007.

Stage III – Construct the northbound lanes of the sub-grade bypass. Upon completion of the southbound lanes, traffic would be re-routed to create a clear zone for the construction of the northbound lanes. This would commence in 1st quarter 2007 and would be complete in the 1st quarter of 2008.

Stage IV – Surface and Tunnel Finishes. As the bypass is complete, permanent tunnel lining must be installed, and the local road surfaces reinstated at street level. This activity would commence in early 2008, and would be complete by mid-2008.

EARLY ACTION ITEMS – UTILITY RELOCATIONS

Prior to commencement of the sub-grade bypass works, or the temporary relocation of the north and south road lanes, there are a significant amount of utilities that require repair, modification, or replacement. The relocation of existing utilities within the Route 9A Right-of-Way (ROW) would be performed prior to the construction of temporary detour roadways and the permanent bypass structures. In particular, there is a sanitary interceptor sewer that runs parallel to the Route 9A alignment. Utilities relocations would be performed outside of the current travel lanes with possible lane closings for construction vehicle access and temporary staging areas.

STAGE I – TEMPORARY SOUTHBOUND & NORTHBOUND ROUTE 9A

For the purposes of assessment of environmental impacts, it is assumed that the temporary roadways for Route 9A southbound and northbound would be constructed on fill to provide protection for the relocated utilities and to provide sufficient cover to bridge over the WTC slurry wall projections at the PATH tunnels. After fill placement the temporary roadways would be paved with asphalt concrete and separated from the work zones by temporary concrete jersey type barrier. The temporary roadways would provide a total of 4 vehicle lanes and would be located to the east and west of the existing roadway.

STAGE II - SLURRY WALL AND SOUTHBOUND BYPASS TUNNEL

The proposed bypass is to be located in fill beneath the groundwater table. As such, the proposed structure is required to provide a contiguous hydrostatic barrier to prevent the ingress of water into the sub-grade roadway. For the purposes of assessment of environmental impacts, it is assumed that a slurry wall method of site retention would be employed. Permanent and temporary slurry walls would be built first and then excavation and tunnel construction would proceed. It is assumed that a permanent slurry wall would be constructed on the west of the bypass alignment, and that a temporary wall would be built to the east. The west wall would become part of the permanent structure, while the east wall would be demolished in Stage III to clear the site for the northbound bypass section. The west wall would also enclose the relocated sanitary interceptor sewer. The slurry wall would be excavated to bedrock to limit the drawdown of groundwater and to prevent the intrusion of Hudson River water into the excavation. Pressure grouting at the PATH tunnels would be necessary along the westerly slurry wall. It is assumed that the easterly slurry wall would tie into the existing WTC slurry wall projections to form a seal to the existing WTC bathtub.

Construction of the slurry walls would be from within the Stage II Work Zone. No lane closings are anticipated. After the slurry wall is complete, the excavation for the southbound bypass tunnel would be performed. The entire width between slurry walls would be excavated to the proposed invert of the sub-grade for the tunnel. It is assumed that temporary struts bridging the excavation would be utilized to support the slurry wall. Excavation work would be performed within the Stage II Work Zone and should not require any additional lane closings. Excavated spoils would be removed from the site by dump truck following the proposed truck routes.

The southbound bypass tunnel would be constructed within the excavated area between the slurry walls. In addition the relocated sanitary interceptor sewer would be constructed parallel to the tunnel along the western side. Tunnel construction assumes a 3-foot thick bottom slab with 3-inch wearing surface, 3-foot thick outer walls, 1-foot thick infill walls, a precast concrete beam top to support a 6-inch thick permanent surface roadway for Route 9A. The southbound bypass tunnel and sanitary interceptor sewer would be constructed entirely within the Stage II Work Zone. Accommodations at the northern and southern limits of the zone would be necessary to provide access to the Work Zone by concrete trucks and other material deliveries. It is assumed that all sub-grade concrete elements of the bypass structure would be constructed using cast-in-place concrete and that no pre-fabricated elements would be used. Concrete truck trips have been generated based on a worst case scenario of a possible maximum pour of 600 CY. The tunnel deck used to reinstate the street surface is likely to be constructed of prefabricated concrete beams that would be delivered to site by trailer and hoisted into position using track-mounted cranes.

STAGE III - CONSTRUCT NORTHBOUND BYPASS TUNNEL

Following completion of the southbound section of the bypass, 2 lanes of vehicle traffic would be re-routed below grade, while 2 lanes would be maintained at street level. This would permit construction to commence on the northbound section. The area between the western slurry wall of the WTC Site and the temporary slurry wall separating the southbound bypass tunnel work area would be excavated. Work would include the demolition of the temporary slurry wall created during construction of the southbound bypass tunnel. The slurry wall would only be demolished to the elevation of the bypass base slab. It is assumed that the entire width would be excavated with temporary sheeting/shoring to protect the duct banks to the east of the proposed northbound Bypass Tunnel. Truck access is assumed to be from Route 9A at the northern and southern terminus of the tunnel excavation.

Excavation work would be performed within the Stage III Work Zone and should not require any additional lane closings. Excavated spoils would be removed from the site by dump truck following the proposed truck routes. Accommodations at the northern and southern limits of the zone would be necessary to provide access to the Work Zone for dump trucks and other material deliveries. Similar to construction methods used on the southbound section, the northbound bypass tunnel would employ a 3-foot thick bottom slab with 3-inch wearing surface, 3-foot thick outer walls, 1-foot thick infill walls, a precast concrete beam top to support a 6-inch thick permanent surface roadway for Route 9A. The reinstated street level deck is assumed to be constructed of prefabricated concrete box beams.

STAGE IV - SURFACE AND TUNNEL FINISHES

The work of this stage includes completing all of the surface items such as street lamps, traffic signals, signage, landscaping and plantings, etc. Additionally, all final tunnel finishes such as permanent signing, lighting, ventilation would be completed. The work of this stage would involve landscaping and streetscape type activities. Work would be performed throughout the surface area and within the tunnels. Temporary lane closings would be required at various times to accomplish the final fitout of the project.

AT-GRADE ALTERNATIVE

In addition to the bypass alternative, NYSDOT is also considering an at-grade reconstruction of Route 9A. Since that alternative would involve considerably less construction activity than the bypass alternative, this chapter conservatively assumes that the bypass project would be selected and constructed concurrently with the Proposed Action.

21.4.3 CONSTRUCTION METHODS: FSTC

Similar to the above projects, the concept design and proposed construction methods for the FSTC have not yet been finalized and preliminary engineering has not been undertaken. In the absence of this project-specific information, this document has been based upon conceptual studies conducted by Arup and Partners in July 2002, the Systra Consulting *Lower Manhattan Access – Fulton Transportation Center Dey Street Passageway* study, and from previous practices employed on large comparable NYCT projects.

This study disaggregates the project into the following components:

1. *Tunneling for Underpasses* **–** beneath the N/R Line/Church St. and 4/5 Line/Broadway routes. Widening of 4/5 line northbound platform;
2. *Concourse Under Dey Street* **–** cut and cover construction;
3. *Building Stabilization* **–** specifically the Corbin Building, retrofit of the basement of the Millenium Hotel and structures adjacent to the 189 Broadway excavation;
4. *Transit Center Construction* **–** includes de-construction and overbuild;
5. *Widening Existing A/C Mezzanines – includes the widening of existing mezzanine levels of the A/C subway lines*; and
6. *Staging* **–** temporary equipment storage, truck parking, crane pick-up access, and loading area.

SCHEDULE AND SHIFT ASSUMPTIONS

For the purposes of impact assessment, and in the absence of a formal construction plan, the following summary construction schedule is proposed. It is envisioned that the construction of the Dey Street concourse, the deconstruction of existing structures on the FSTC site, and the widening of the N/R line underpass should commence first and may advance concurrently (see Appendix J-5). As the FSTC site becomes vacant, construction would commence on the Center itself. As the potential background development of the air-rights above the Proposed Action is an action to be undertaken by others and not related to the FSTC, construction of this structure would be discussed separately.

It is assumed that construction activity would follow a 24 hour/7 day week schedule. Truck movements may occur at any time, both at night, and at peak daylight hours.

STAGING

An analysis of construction staging is an evaluation of the logistics of equipment storage, site access, temporary truck parking, and crane access during construction. At this stage, it is envisaged that the transit center site would be cleared of all buildings in the early stages of the project. However, as it is intended that construction of the transit center would proceed almost immediately following deconstruction, there would be limited opportunities to use cleared site for staging activities. Construction contractors are most likely to require staging space immediately adjacent to the site in addition to larger space in a remote location. This analysis would be confined to a discussion of the former "on-site" staging requirements.

In the absence of a formal construction plan, it is envisaged that staging areas would be closed to pedestrian and vehicular traffic for the duration of the relevant construction activity. The preliminary list of staging areas is as follows:

- Dey Street – both lanes and both sidewalks (in addition to the Dey Street roadway surface)
- Broadway – one eastern lane and sidewalk
- Fulton Street. – both lanes and both sidewalks between Broadway and Nassau
- John Street – one lane and sidewalk
- Church Street – one eastern lane and sidewalk (for the width of Dey Street)

TUNNELING FOR UNDERPASSES

The current Transit Center conceptual design locates a concourse structure directly beneath the existing N/R line located beneath the existing 4/5 line located beneath Broadway. In addition, it is intended that the 4/5 line northbound platform be widened beneath the east side of Broadway. In order to maintain traffic on Broadway and Church Street, and to limit disruption to subway service, the tunneling operation would most likely require an incremental underpinning sequence of adjoining structures along the east side of Broadway between Fulton and John Streets, in conjunction with careful monitoring of vibration and subway track movement.

At present, it is assumed that the existing 4/5 line is most likely founded on soil overlaying the rock strata below. The following conceptual construction sequence is proposed. Tunneling work would proceed in a similar manner to that employed on the WTC Site, where sub-grade material is jet-grouted and excavation proceeds in staged increments. It must be noted that the 4/5 line is not founded on piles.

CONCOURSE CONSTRUCTION UNDER DEY STREET

At this stage, it is assumed that the rock strata elevation below Dey Street lies beneath the proposed depth of excavation. Consequently, it is probable that the concourse would be constructed using "cut and cover" construction methods.

Cut and cover construction, where the roadway surface is removed, utilities relocated, retaining walls installed, and the tunnel excavated from above, is a common method of construction in New York City. The majority of the rail and subway lines have been constructed in this manner. Newer sections of subway/station/concourse construction that are required to pass through sections of rock strata are excavated using Tunnel Boring Machines (TBMs), or conventional mining equipment. However, these methods are not anticipated to be used at this site.

Cut and cover construction typically involves the following: retaining wall construction; removal of street surface; excavation and relocation of utilities; installation of temporary roadway surface decking; sub-grade construction; and re-instatement of permanent roadway surface.

Specific details of the critical activities relating to cut and cover construction are discussed in detail below.

Retaining Wall Construction - Central to cut and cover construction methods is the stabilization of the side walls of the excavation prior to the removal of sub-grade material. There are several different types of retaining wall that may be used dependent upon site conditions, depth of water table, type of soil, and proximity of adjacent building foundations. For a full description of the different methods of retaining wall construction see section 21.4.3. Slurry wall construction (most notably used to construct the bathtub basement of the WTC) is a method that extends a watertight contiguous wall to the base of the required excavation.

Dey Street Basement Vaults - It is anticipated that the northern retaining wall would have to pass through existing concrete basement vaults beneath the sidewalk level. Consequently, the objective is to modify the vault structure in a manner that would permit the wall to pass through the space without requiring preliminary excavation of the vault.

Excavation and Relocation of Utilities - The known utilities beneath Dey Street include the standard electrical, water, steam, gas, and communications services. In addition there is a known sewer line approximately 13 feet below street level. As excavation progresses, the utilities would be temporarily protected and supported, or re-installed after the concourse is constructed. It must be noted that a new sewer must be installed at this location.

Dey Street Entrance House - The entrance house would occupy the 189 Broadway lot. The demolition, site retention, and excavation of the site would be incorporated within the concourse construction sequence. The entrance house excavation would extend to the same approximate depth as the concourse.

BUILDING STABILIZATION

In many cases, construction of the concourse, the new transit center, the widening of the A/C mezzanine, and the creation of new vertical circulation access points would entail excavation immediately adjacent to existing buildings. Prior to final design of temporary stabilization "as-built" structural plans of the existing buildings would be required in conjunction with comprehensive geo-technical reports of sub-grade conditions.

Lateral Retention Systems - Where retaining walls are constructed immediately adjacent to heavily loaded foundations, care must be taken to avoid 1) undermining existing spread footings by removing lateral support for sub-grade material, and 2) undermining "slab-on-ground" support for the building basement levels. Both cases are particularly relevant where soil material is loose and friable. For example, during typical slurry wall excavation, soil may "slump" into the Bentonite trench and cause excessive settlement of adjacent structures. To address this, typical measures include raising the resistive Bentonite pressure by temporarily raising the height of the wall above grade. Alternatively, retention wall construction and excavation could be staged in alternate segments, permitting lateral loads to be spread horizontally, as well as vertically.

The Corbin Building - It is assumed that the Corbin Building at 192 Broadway would be acquired by MTA-NYCT and the building occupants relocated. In the absence of preliminary engineering plans, it is assumed that the structure would be retained in some capacity (at a minimum, the building façade would be retained). Conservatively, it is assumed that the facade would require stabilization through the construction of a steel superstructure, and that this temporary structure would protrude into John Street. All design alternatives that incorporate the Corbin Building in some capacity would entail the construction of a retaining wall, either along the existing building's northern boundary, or along the John Street building line.

It must be noted that any proposal to excavate under, or adjacent to the existing building would entail a detailed sequence of staged underpinning and load transferal. Such a process would be time consuming and would require an extensive monitoring of the structure for movement.

TRANSIT CENTER CONSTRUCTION

A major component of this project is the construction of the Transit Center itself at the corner of Broadway and Fulton Street. The site is presently home to a variety of low to medium-rise commercial buildings that house a range of commercial and institutional tenants. Below grade, there is a labyrinth of access tunnels, stairwells and rail platforms. These are primarily located to the north and west of the site. The primary activities in this component of the project are as follows:

1. De-construction of existing buildings;
2. Retaining wall construction;
3. Sub-grade excavation; and
4. FSTC construction

De-Construction of Existing Buildings - First, all buildings in the project area would be vacated and stripped of all internal furnishings. A comprehensive system of contaminant assessment would then follow (this may be completed prior to the vacating of tenants) in order to determine level of potential airborne particulates from demolition activities, and to assess the nature of spoil for disposal.

Following internal contaminant removal, building shell demolition would proceed. In the absence of a detailed demolition sequence, it is contemplated that that full scale de-construction would commence with the 200, 204, and 194 Broadway buildings. These buildings range from between 1 and 3 stories and should not represent obvious demolition difficulties. Once the debris from these buildings has been removed from the site, de-construction of the shell of 198 Broadway would commence. This building is 12 stories high and would require staged demolition of each floor. Rubble and debris would then be systematically lowered to the cleared adjacent sites below. The material may be sorted on site, and then removed, or mixed debris may be removed and sorted in a remote location.

Retaining Wall Construction - Once the project site has been cleared to street level, the sub-grade boundaries of the site would be secured using some method of water tight site retention. For purposes of discussion, it is expected that a similar Bentonite slurry wall retention system would be used as was discussed in relation to the Dey Street cut and cover concourse construction. Refer to the previous section of this report for a full description of this process. It is envisioned that a permanent retention wall would be built along the southern and eastern boundaries of the site where the property line of the transit center abuts existing buildings. The wall would extend to a depth of approximately 60 feet as measured from street level. The construction of the wall would enable sub-grade excavation to progress without ingress of soil and water, and to prevent de-stabilization of adjacent roadways and buildings.

Sub-Grade Excavation - Similar to other areas of sub-grade construction, excavation progresses incrementally to permit the installation of temporary internal and/or external excavation support systems.

FSTC Construction - Following completion of sub-grade excavation and site retention, final construction may commence. This would involve driving piles for new foundations (the number and extent of which would depend on the scope of overbuild requirements). Site access for excavators, pile rigs, and other machinery would be required.

In the absence of detailed structural concepts for the design of the Center, it is envisaged that a typical sequence of steel erection, followed by concrete floor slab placement would then continue until the building is complete. As in-fill floor diaphragms and horizontal beam "braces" are installed, the temporary support systems rock anchors would be incrementally removed.

WIDENING OF A/C LINE MEZZANINE

At this stage, it is contemplated that the A/C line mezzanine would be widened and reconstructed using a "top-down" sequential cut and cover sequence similar to the concourse construction at Dey Street. While the amount of actual required volume of excavation is far less than that required for the Dey Street concourse, the A/C line mezzanine widening is complicated by the need to maintain operation of the A/C line platforms. In addition, the structure of the rail tunnel itself is extremely sensitive to reductions and increases of overburden stress applied to the modular tunnel rings. In the absence of existing structural details, proposed construction techniques, and knowledge of geo-technical conditions, the following sequence is proposed for the mezzanine widening.

Short lengths of the A/C line mezzanine would be incrementally de-commissioned along the mezzanine length beneath Fulton Street. Transit passengers would be re-routed to street level using temporary stairwells located on either side of the temporary closure.

1. Install temporary steel bracing above tunnel lining to prevent heave.
2. From surface, from existing wall of mezzanine, and from within tunnel, drill holes adjacent to where new retaining wall would be located. Inject grout to create a stiff block of treated ground that would maintain structural rigidity during new retaining wall construction.
3. Construct new retaining wall. Using secant piles or slurry wall methods install a section of new retaining wall beyond the northern existing wall. Great care must be taken not to damage tunnel lining.
4. Incrementally remove fill and brace new wall back to southern mezzanine wall. Note, at this stage it is contemplated that anchors would not be acceptable due to the excessive vertical loads they would create at the base of the new wall. Asymmetric vertical loads would compromise the structural integrity of the tunnel lining.
5. Construct new mezzanine base slab and roof slab.
6. Refill to street level, reopen section of street, and proceed to next segment.

21.4.4 CONSTRUCTION METHODS: SOUTH FERRY SUBWAY STATION

The South Ferry subway station project is expected to be in construction from mid-2004 to the end of 2007, with the peak construction activity occurring within a 12-month period from mid-2005 to mid-2006. The project would be constructed in components, as shown conceptually in Appendix J-6. The schedule bar chart assumes that all excavation and street restoration work would be complete by the end of 2006. The work that would occur from mid-2006 to the end of 2007 is finishing work to the terminal, tunnels, and bellmouth/fan plant, all of which would occur below ground and have limited access requirements to the surface; thus, the 2007 construction year is not shown on the schedule diagram. Street preparation work for the South Ferry subway station under Peter Minuit Plaza would occur first in 2004. Construction of the approach tunnels, including underpinning of the existing No. 1/9 IRT and 4/5 subway tunnels, in the eastern edge of Battery Park would occur next, from September 2004 through April 2005. Terminal construction would occur in 2005 and 2006, and the bellmouth and fan plant construction would occur in 2006. Again, finishing work would be ongoing from mid-2006 through 2007 and would occur underground.

It is assumed that construction would take place in two 8-hour shifts, six days per week for the majority of construction tasks. However, some activities, particularly sub-grade construction and finishing, safety related work and activities that require coordination with NYCT services, may occur anytime within a 24-hour/7-day week period. Truck movements may occur at any time within a 16-hour, 6-day week that includes morning and evening peak hours.

BELLMOUTH AND FAN PLANT

Construction of the bellmouth would require reconstruction of about 275 feet of existing subway tunnel. The reconstruction would require demolition of portions of the subway roof and sidewalls. New columns would be installed to define the widened tunnel and support the new, longer roof beams.

APPROACH TUNNEL

The approach tunnel is that portion of the new alignment that would pass beneath the eastern edge of Battery Park between the bellmouth and the new terminal. The tunnel would consist of two tracks and would include a double track crossover to permit flexible train routing into and out of the station.

TUNNELING

For the approach tunnels in Battery Park, the subsurface consists of soil and fill over rock. A review of existing available subsurface data indicates that the top of rock elevation varies over the extent of the proposed tunnel. It is anticipated that the proposed tunnel invert levels would generally rest on rock; however, the upper portion of the tunnel, to varying degrees, would be within soil.

SOUTH FERRY STATION

The South Ferry subway station would be constructed generally within the limits of Peter Minuit Plaza, and immediately north of the newly reconstructed Whitehall Ferry Terminal. Soil and rock excavation for the South Ferry subway station would be performed from the surface by conventional cut and cover methods. Steel sheet piling would be driven and braced to support the excavation. Portions of the excavation closest to the Whitehall Ferry Terminal would be supported by means of a secant pile retaining wall.

21.4.5 CONSTRUCTION METHODS: 130 LIBERTY STREET

The Proposed Action now includes not only the acquisition, but deconstruction of 130 Liberty Street by LMDC and other responsible public entities. While the timing and method have not been fully established, that work would be carried out in accordance with all engineering and environmental standards and in compliance with all applicable construction standards as described in Chapter 11, "Hazardous Materials.".

In particular, cleaning and removal of any remaining contaminants of 130 Liberty Street is expected to begin in Fall 2004 with the demolition to follow in early 2005 and to be completed by the end of that year.

It is expected that the deconstruction would take place within a fully enclosed scaffold. To assist the removal of debris, a mobile crane and a series of temporary hoists would be attached to the building. Lateral connection would be provided at regular floor intervals. Structural steel would be cut into small pieces and lowered down the existing elevator shafts to the ground. Fully enclosed scaffolding and the construction hoist would be lowered as work progresses.

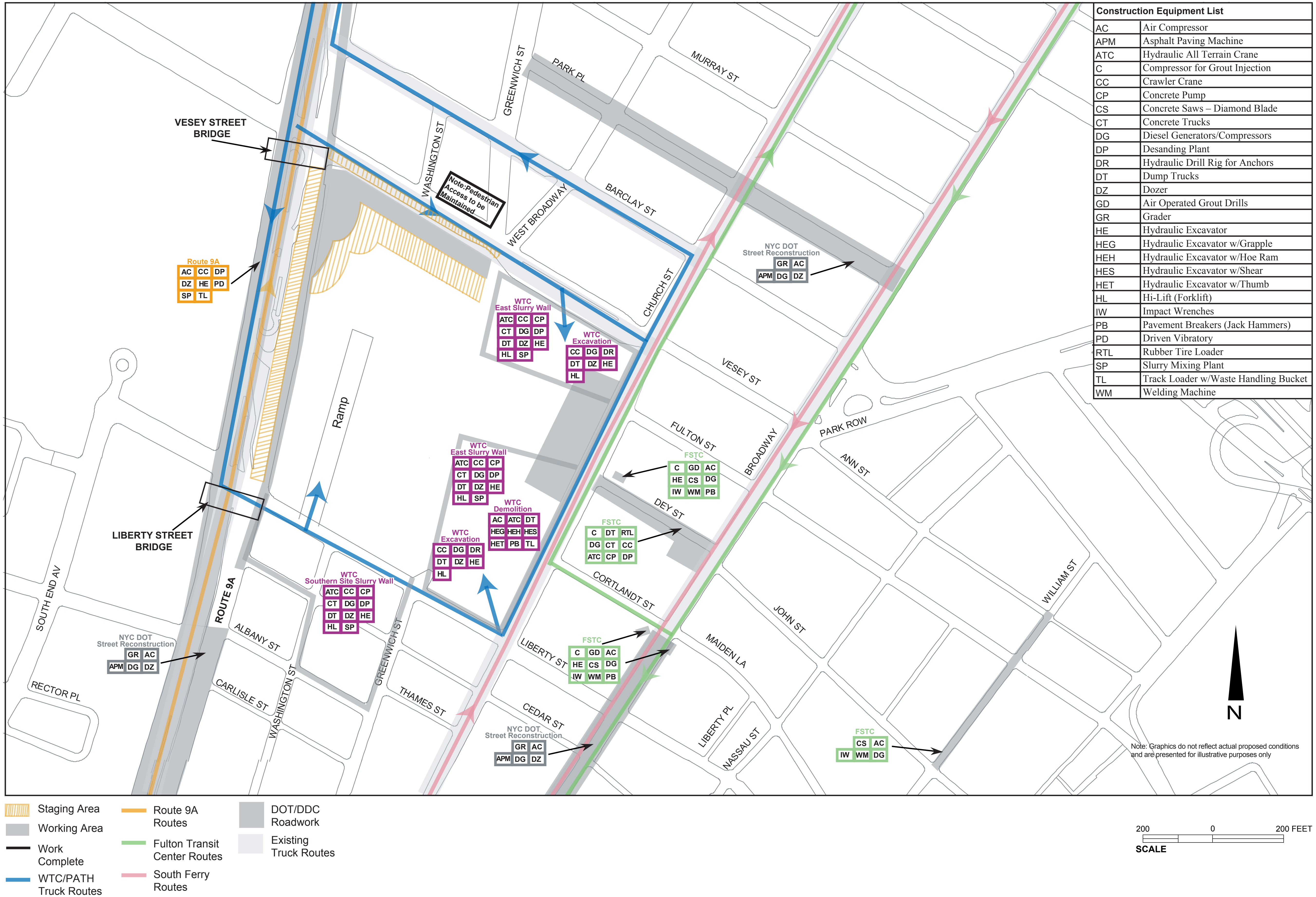
Following internal contaminant removal, building shell demolition would proceed. In the absence of a detailed demolition sequence, it is envisioned that the building would be a staged deconstruction. Concrete slabs would be broken up through the use of hand and backhoe-mounted jackhammers and concrete saws, and the debris lowered by hoist. Structural steel would be cut or unbolted, and lowered through central building shafts. Rubble and debris would then be systematically lowered to the cleared adjacent sites below. The material may be sorted on site, and then removed, or mixed debris may be removed and sorted in a remote location.

21.5 STAGING AND LAY-DOWN AREAS, STREET CLOSURES, AND SITE ACCESS

The following represents a year-by-year analysis of the likely staging and lay-down areas, extent of street closures due to construction activities, and the likely points of site access from the surrounding street network (see Figures 21-15 through 21-19).

Initial construction activities commence in early 2004, and primarily involve utility relocation and repair, and the demolition of the remnants of 6 WTC in the northwest corner of the site (not part of Proposed Action). It is expected that the southern lane of Vesey Street will be closed for the duration of 2004 between Route 9A and West Broadway. By third quarter 2004, work will have commenced on the excavation and site retention of the east bathtub east of the No. 1/9 IRT line. New construction access points to the site will be established to the northeast and southeast quadrants. The existing ramp access from Liberty Street will remain unchanged in 2004.

In 2005, the majority of construction activities will have commenced in various areas of the site. As such, the southern lane of Vesey between Route 9A and Church Street will be closed to vehicular and pedestrian traffic. The lane will be used for equipment storage, and the staging of concrete and steel delivery trucks. For similar reasons, the northern lane of Liberty between Route 9A and Church Street will be closed to non-construction traffic. It is proposed that Greenwich Street would be re-opened to traffic between Liberty and Vesey Streets by 2009, and will be made available to the contractor for the purposes of site access and staging. In addition, the air space above the street could be used for the location of a multi-tiered site trailer facility.

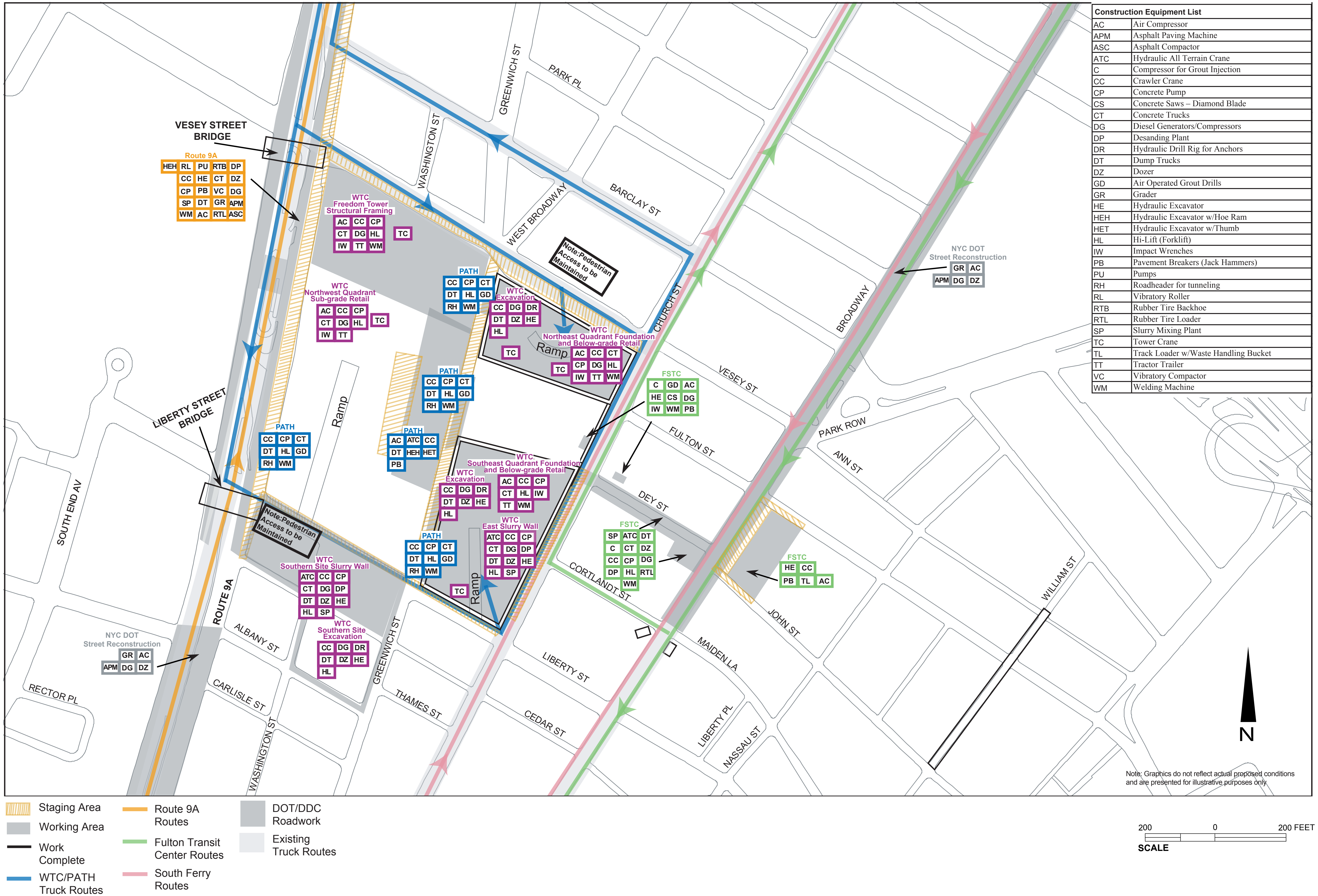


Construction Equipment List

AC	Air Compressor
APM	Asphalt Paving Machine
ATC	Hydraulic All Terrain Crane
C	Compressor for Grout Injection
CC	Crawler Crane
CP	Concrete Pump
CS	Concrete Saws – Diamond Blade
CT	Concrete Trucks
DG	Diesel Generators/Compressors
DP	Desanding Plant
DR	Hydraulic Drill Rig for Anchors
DT	Dump Trucks
DZ	Dozer
GD	Air Operated Grout Drills
GR	Grader
HE	Hydraulic Excavator
HEG	Hydraulic Excavator w/Grapple
HEH	Hydraulic Excavator w/Hoe Ram
HES	Hydraulic Excavator w/Shear
HET	Hydraulic Excavator w/Thumb
HL	Hi-Lift (Forklift)
IW	Impact Wrenches
PB	Pavement Breakers (Jack Hammers)
PD	Driven Vibratory
RTL	Rubber Tire Loader
SP	Slurry Mixing Plant
TL	Track Loader w/Waste Handling Bucket
WM	Welding Machine

Staging and Laydown Areas 2004

Figure 21-15



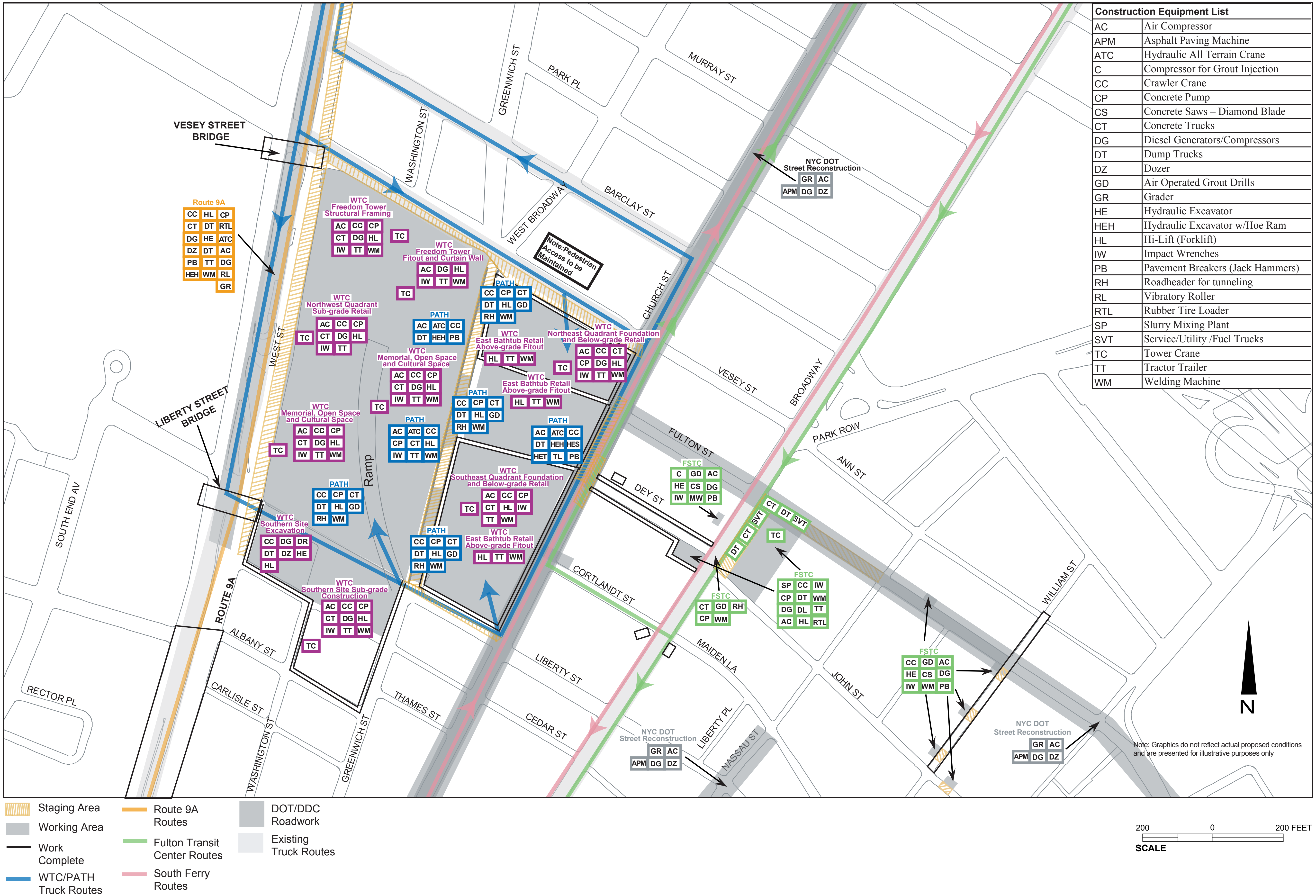
Construction Equipment List

AC	Air Compressor
APM	Asphalt Paving Machine
ASC	Asphalt Compactor
ATC	Hydraulic All Terrain Crane
C	Compressor for Grout Injection
CC	Crawler Crane
CP	Concrete Pump
CS	Concrete Saws – Diamond Blade
CT	Concrete Trucks
DG	Diesel Generators/Compressors
DP	Desanding Plant
DR	Hydraulic Drill Rig for Anchors
DT	Dump Trucks
DZ	Dozer
GD	Air Operated Grout Drills
GR	Grader
HE	Hydraulic Excavator
HEH	Hydraulic Excavator w/Hoe Ram
HET	Hydraulic Excavator w/Thumb
HL	Hi-Lift (Forklift)
IW	Impact Wrenches
PB	Pavement Breakers (Jack Hammers)
PU	Pumps
RH	Roadheader for tunneling
RL	Vibratory Roller
RTB	Rubber Tire Backhoe
RTL	Rubber Tire Loader
SP	Slurry Mixing Plant
TC	Tower Crane
TL	Track Loader w/Waste Handling Bucket
TT	Tractor Trailer
VC	Vibratory Compactor
WM	Welding Machine

World Trade Center Memorial and Redevelopment Plan

Staging and Laydown Areas 2005

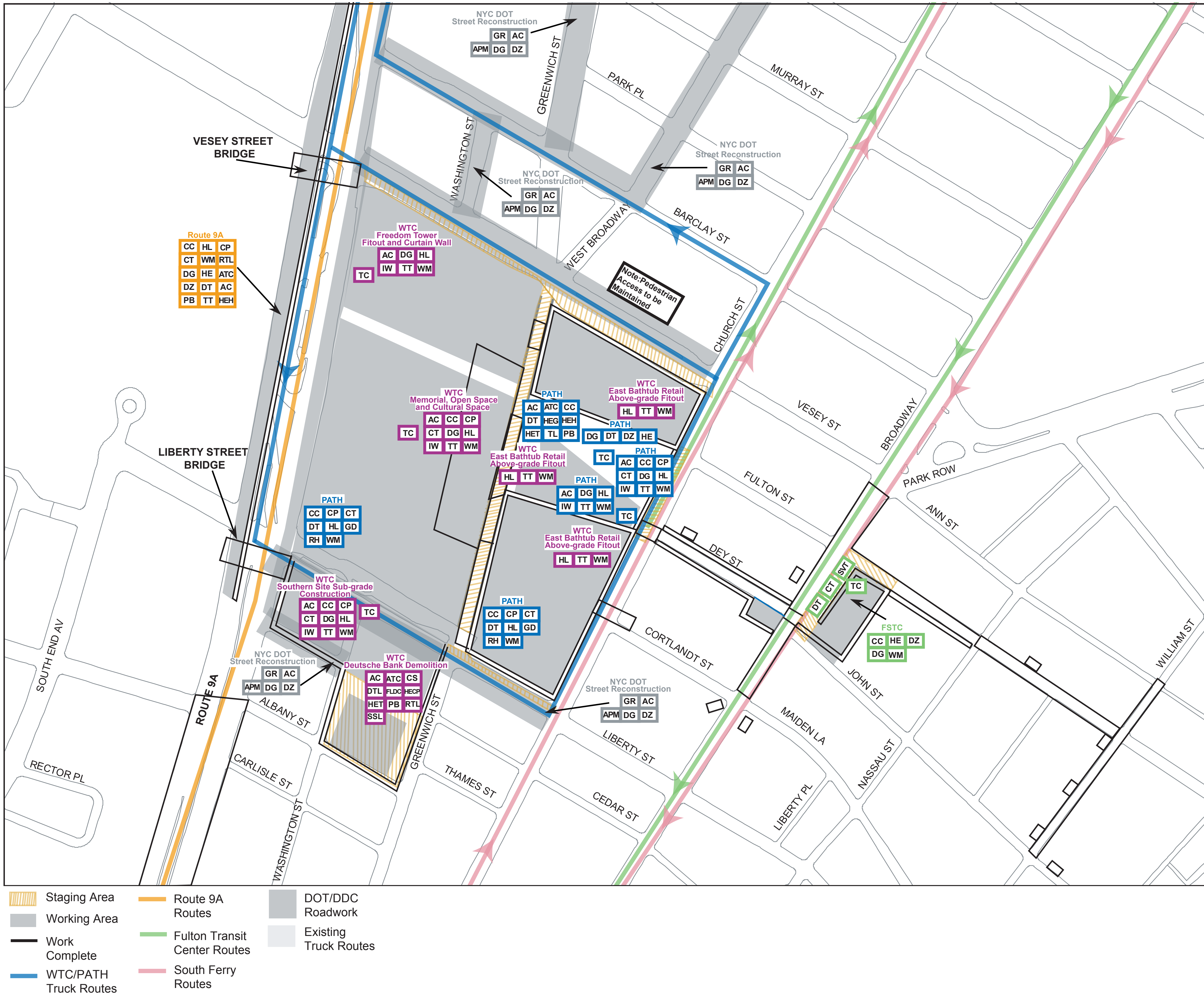
Figure 21-16



Construction Equipment List	
AC	Air Compressor
APM	Asphalt Paving Machine
ATC	Hydraulic All Terrain Crane
C	Compressor for Grout Injection
CC	Crawler Crane
CP	Concrete Pump
CS	Concrete Saws – Diamond Blade
CT	Concrete Trucks
DG	Diesel Generators/Compressors
DT	Dump Trucks
DZ	Dozer
GD	Air Operated Grout Drills
GR	Grader
HE	Hydraulic Excavator
HEH	Hydraulic Excavator w/Hoe Ram
HL	Hi-Lift (Forklift)
IW	Impact Wrenches
PB	Pavement Breakers (Jack Hammers)
RH	Roadheader for tunneling
RL	Vibratory Roller
RTL	Rubber Tire Loader
SP	Slurry Mixing Plant
SVT	Service/Utility /Fuel Trucks
TC	Tower Crane
TT	Tractor Trailer
WM	Welding Machine

Staging and Laydown Areas 2006

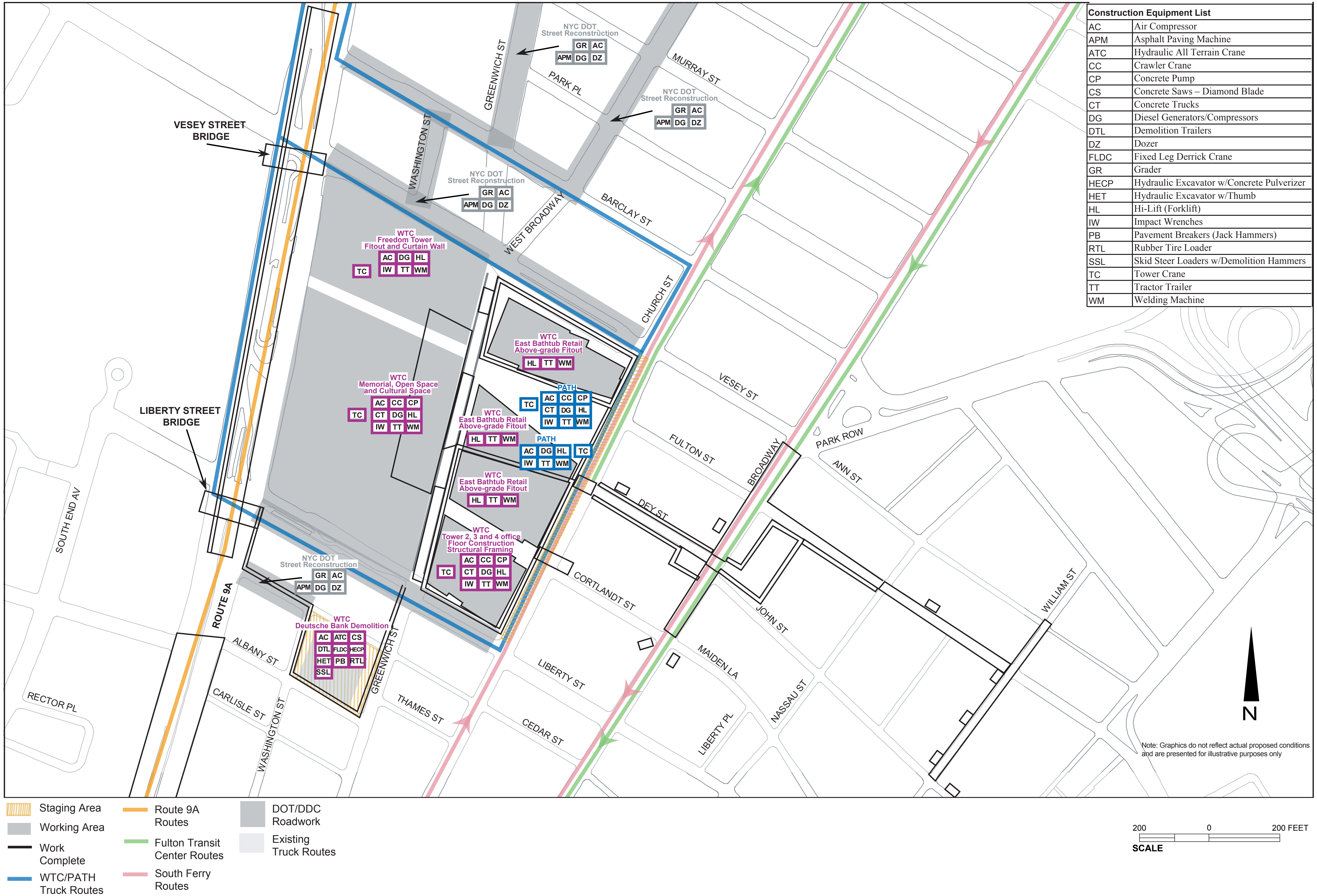
Figure 21-17



Construction Equipment List	
AC	Air Compressor
APM	Asphalt Paving Machine
ATC	Hydraulic All Terrain Crane
C	Compressor for Grout Injection
CC	Crawler Crane
CP	Concrete Pump
CS	Concrete Saws – Diamond Blade
CT	Concrete Trucks
DG	Diesel Generators/Compressors
DT	Dump Trucks
DZ	Dozer
GD	Air Operated Grout Drills
GR	Grader
HE	Hydraulic Excavator
HEH	Hydraulic Excavator w/Hoe Ram
HL	Hi-Lift (Forklift)
IW	Impact Wrenches
PB	Pavement Breakers (Jack Hammers)
RH	Roadheader for tunneling
RL	Vibratory Roller
RTL	Rubber Tire Loader
SP	Slurry Mixing Plant
SVT	Service/Utility /Fuel Trucks
TC	Tower Crane
TT	Tractor Trailer
WM	Welding Machine

Staging and Laydown Areas 2007

Figure 21-18



Construction Equipment List	
AC	Air Compressor
APM	Asphalt Paving Machine
ATC	Hydraulic All Terrain Crane
CC	Crawler Crane
CP	Concrete Pump
CS	Concrete Saws – Diamond Blade
CT	Concrete Trucks
DG	Diesel Generators/Compressors
DTL	Demolition Trailers
DZ	Dozer
FLDC	Fixed Leg Derrick Crane
GR	Grader
HECP	Hydraulic Excavator w/Concrete Pulverizer
HET	Hydraulic Excavator w/Thumb
HL	Hi-Lift (Forklift)
IW	Impact Wrenches
PB	Pavement Breakers (Jack Hammers)
RTL	Rubber Tire Loader
SSL	Skid Steer Loaders w/Demolition Hammers
TC	Tower Crane
TT	Tractor Trailer
WM	Welding Machine

Staging and Laydown Areas 2008
Figure 21-19

World Trade Center Memorial and Redevelopment Plan

However, if Greenwich Street is not opened prior to 2009 then the western sidewalk of Church Street would be required between Liberty and Vesey Streets for staging and lay-down purposes. Site access points will remain unchanged from 2004.

Temporary Platform to Maintain Traffic on Liberty Street - In 2005, work will commence on the expanded Southern Site south of Liberty Street. In order to link the new excavated sub-grade space south of Liberty Street (southern bathtub) with the original bathtub, while simultaneously maintaining vehicular and pedestrian access on Liberty Street between Route 9A and Church Street, a temporary structure is proposed to re-route the roadway. The proposed construction sequence is as follows:

1. Prior to the removal of the existing roadway, construct a temporary structural steel platform that re-routes the roadway within the boundaries of the existing bathtub walls (parallel to the southern boundary of the existing bathtub);
2. Close the existing street, and re-route vehicular and pedestrian traffic on to the temporary roadway;
3. Proceed with excavation and construction of the expanded Southern Site. As the new sub-grade levels reach street level, reinstate Liberty Street in its original location;
4. Demolish temporary roadway structure and remove from site.

Peak construction Year 2006 – In 2006 the full build-out of the site will be underway. As described in section 21.4, the Freedom Tower, central plant and permanent WTC PATH Terminal will be under construction, in addition to the sub-grade space in the northwest, southeast, northeast, and space south of Liberty Street. Staging and lay-down area, lane closures, and site access points will remain unchanged from 2005, with the exception of site access to the southwest (Memorial area) of the site. Due to the temporary relocation of Liberty Street, the street access point of the ramp will be moved to the corner of Greenwich and Liberty Streets. The northern lane of the remainder of Liberty Street between Greenwich and Church Street will remain closed to vehicular and pedestrian traffic.

Remainder of Project Schedule - By 2008, the majority of construction activities will have been completed on site. As such, much of the staging and lay-down areas will have been returned to the local street network. All lanes of Vesey and Liberty will be open to vehicular and pedestrian traffic. In 2008, the permanent WTC PATH Terminal building east of the No. 1/9 IRT, Tower 2, 3 and 4 will be under construction, in addition to the ongoing construction at 130 Liberty Street. Consequently, either the Greenwich Street or portions of the western sidewalk of Church Street will be used for staging purposes. This area is expected to be maintained throughout the construction of Towers 2, 3, and 4. Most staging, lay-down and lane closures south of Liberty Street will occur on Cedar Street between Route 9A and Greenwich Street. This work is expected to be complete at the end of 2008. However, as market conditions dictate, the construction of Tower 5 south of Liberty Street will entail the additional staging and lay-down areas that will be determined at that time.

21.6 CUMULATIVE CONSTRUCTION EFFECTS DURING PEAK PERIOD 2006

As discussed in Section 21.3, the potential cumulative effects from the five major projects occurring in and around the Project Site are analyzed to determine how similar activities occurring at the same time would increase the magnitude of impacts from projects and how receptors would be affected over the extended period of time, particularly during the 2006 peak period of construction in Lower Manhattan. Specific resource areas identified as requiring detailed analysis include:

- Access and Circulation;
- Air Quality;
- Noise and Vibration;
- Economic Effects; and
- Cultural Resources.

The cumulative construction period analysis includes the effects of those actions that overlap with the Proposed Action in time and space, that affect the same resource as those that may be affected by the Proposed Action, and that represent a change from conditions existing prior to September 11.

The cumulative effects analysis considers other major office and residential construction projects that incrementally contribute to the cumulative effects on resources affected by the Proposed Action during the peak construction year of 2006. Resource categories that are not affected by the Proposed Action, including those that may be affected by other projects, are not evaluated.

The cumulative construction period analysis would be conducted for the peak year (2006) of the combined construction activities of the major transportation recovery projects. This analysis also recognizes other commercial office and residential construction projects that may occur during the same time period, particularly during the peak year (2006). The potential effects of other major projects are included where applicable and appropriate to the specific resource. The conditions in 2006 would be projected based on the Current Conditions (2003) Scenario.

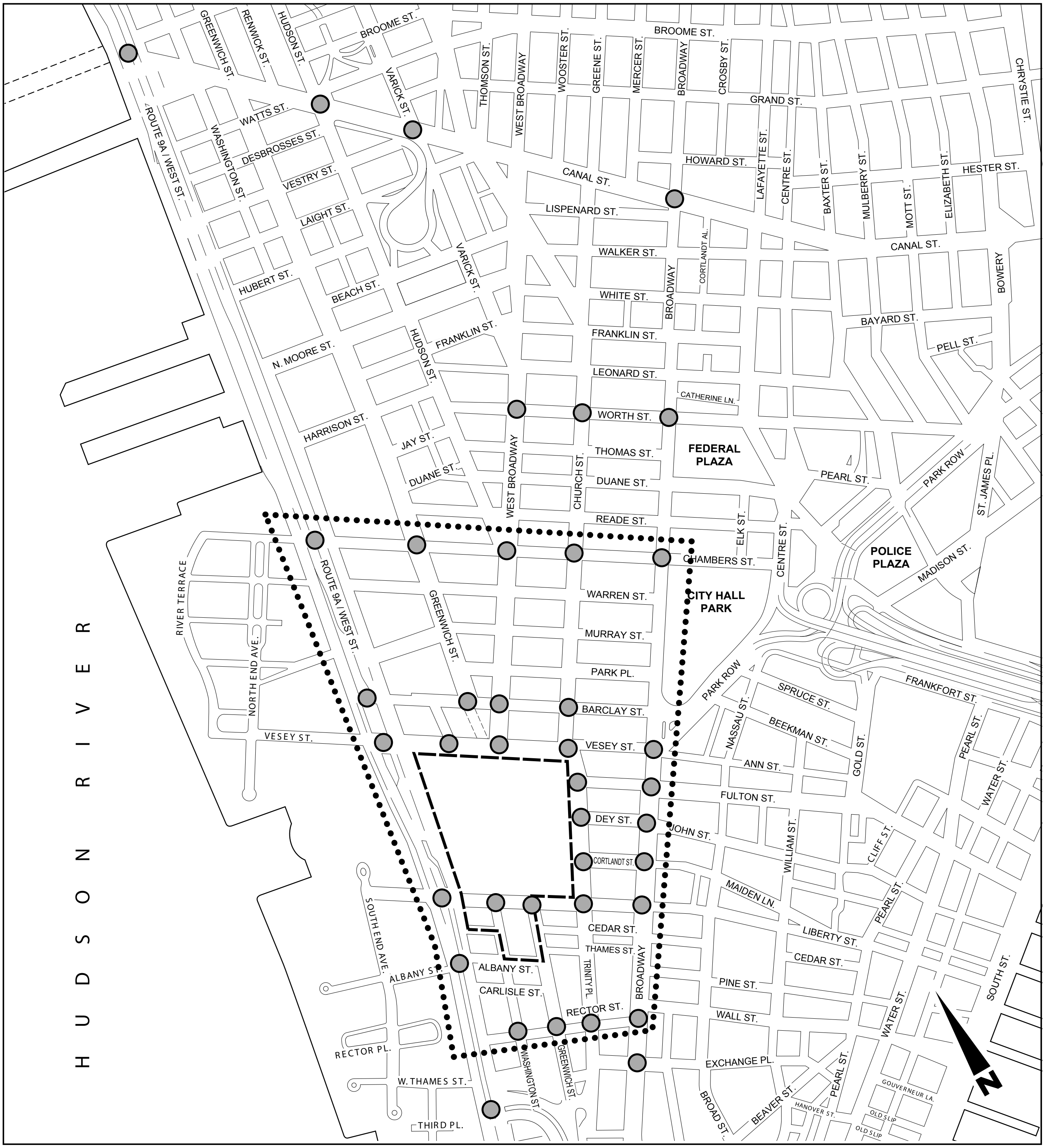
For impact analysis purposes, 2006 conditions with background growth and the construction of the major Lower Manhattan projects except the Proposed Action (see above) are compared against the same condition but including the Proposed Action. The increment between these two conditions represents the cumulative construction effects of the Proposed Action when added to background growth and construction activity of the other major Lower Manhattan projects.

21.6.1 VEHICULAR AND PEDESTRIAN TRAFFIC

VEHICULAR TRAFFIC METHODOLOGY

The same traffic study area (Lower Manhattan south of Canal Street) used to assess the impacts of the WTC operational traffic conditions was used to assess construction conditions (see Chapter 13A, "Traffic and Parking"). The intersections analyzed within the study area were determined based upon the projected path of construction vehicles traveling to the WTC Site, their relationship to air quality and noise receptor locations, proximity to the Proposed Action, and roadway traffic volumes. As a result, 24 of the 40 intersections analyzed for operational conditions within the study area were analyzed to assess construction conditions. The locations of the intersections studied for construction conditions are presented in Figure 21-20.

Similar to the operational traffic analyses, the 2006 construction traffic analyses were conducted using the methodologies presented in the 2001 *City Environmental Quality Review (CEQR) Technical Manual*. Quantitative analyses were performed for signalized and unsignalized intersections using the analytical procedures described in the *Highway Capacity Manual (HCM);*



Project Site Boundary

Primary Study Area Boundary

Project Site Boundary

2006 Traffic Analysis Locations

Figure 21-20

2000. The criteria presented in the *CEQR Technical Manual* were used to determine significant traffic impacts in the study area in 2006.

A total of five Lower Manhattan Recovery Projects including the Proposed Action, permanent WTC PATH Terminal, Route 9A Reconstruction, FSTC, and South Ferry Station were considered in the traffic analysis scenario of 2006 conditions. As discussed in Section 21.3, the Future Without the Proposed Action assumes that construction vehicles from four of the five Lower Manhattan Recovery Projects (without the Proposed Action) were considered in the traffic analysis. The Future With the Proposed Action assumes that construction vehicles from all of the five Lower Manhattan Recovery Projects in the traffic analysis.

The construction activities at the WTC Site with or without the Proposed Action would preclude through traffic for private vehicles on Vesey and Liberty Streets between Route 9A and Church Street. By 2006, it is assumed that Barclay Street between Church Street and Route 9A would be reinstated as a one-way westbound thoroughfare. It is also assumed that NYCDOT roadway reconstruction projects will be occurring in 2006 on Church Street and Broadway north of Vesey Street. Within the NYCDOT work areas, it is assumed that two travel lanes will be provided on Church Street and Broadway. During construction, the bus lane will be closed and on-street parking will be precluded on Church Street and Broadway.

The 2006 base traffic volumes within the study area were developed by applying an overall growth rate to the Current Condition (2003) traffic volumes at the 24 intersections identified previously for the AM, midday, and PM peak hours. The growth rate used was derived from for the MTA's Regional Transportation Forecasting Model (RTFM) using regional demographic forecasts. This rate includes all planned and committed developments through 2006 as part of the background growth for Lower Manhattan. The 2006 Baseline Condition AM, midday, and PM peak hour volumes were compared with the 2003 Existing and 2009 Future Without the Proposed Action volumes during the corresponding peak hours to confirm that they were within an acceptable range. The methodology used to calculate the 2006 Baseline Condition traffic volumes was consistent with methodology used to calculate the 2006 base traffic volumes for FSTC and the permanent WTC PATH Terminal, both of which are currently undergoing separate environmental reviews.

Future Without the Proposed Action Scenario

The generation of construction traffic for the permanent WTC PATH Terminal, South Ferry subway station, Route 9A Reconstruction, and FSTC projects was developed based on construction information provided for each of these projects and discussed earlier in this chapter. The construction information was developed based on input from the sponsors of the Lower Manhattan Recovery Projects, including the Port Authority (permanent WTC PATH Terminal) MTA/NYCT (South Ferry subway station and FSTC), and NYSDOT (Route 9A Reconstruction). The construction vehicles projected to be used to rebuild Lower Manhattan would be comprised of light vehicles such as contractor vans and pick up trucks and heavy vehicles such as concrete mixers, dump trucks, trailers, etc. The construction activities that are projected to occur in the peak analysis year were assumed to be comprised of construction vehicles in the percentages shown in Table 21-2. *A small number of construction workers would also be expected to arrive during the off-peak hours by personal vehicle. No parking would be provided for these vehicles on the WTC construction site (see Appendix J). As a result, construction workers would be expected to park personal vehicles off site at parking garages, of which there is adequate capacity (see Chapter 13A).*

Table 21-2
Projected Construction Vehicle Percentages

Vehicle Type	Percentage
Concrete	25%
Heavy Trucks (includes spoils transportation)	20%
Service/Utility/Fuel	25%
Subcontractors	30%
Source: Louis Berger Group, Inc.	

For analysis purposes, it was assumed that all concrete mixers and trailers carrying structural steel were heavy vehicles. The service/utility/fuel vehicles were assumed to be half heavy and half light vehicles. All subcontractor vehicles were assumed to be light vehicles. The daily peak construction vehicles projected for each of the Lower Manhattan Recovery Projects in 2006 in terms of total and percentage of heavy and light vehicles is summarized in Table 21-3.

Table 21-3
2006 Daily Construction Vehicles

Lower Manhattan Recovery Projects	Heavy Vehicles		Light Vehicles		Total Vehicles
	Number	Percentage	Vehicles	Percentage	
World Trade Center Memorial and Redevelopment Plan	694	69.1%	310	30.9%	1,004
Permanent WTC PATH Terminal	173	72.7%	65	27.3%	238
Route 9A Reconstruction	304	93.3%	22	6.7%	326
FSTC	262	78.9%	70	21.1%	332
South Ferry subway station	150	60.5%	98	39.5%	248
Total	1,583	73.7%	565	26.3%	2,148
Source: The Louis Berger Group, Inc.					

The assignment of construction vehicles to the Lower Manhattan traffic network was based on coordination among the sponsors of Lower Manhattan Recovery Projects with the objective to minimize impacts of truck traffic on the local roadway network. This was achieved by optimizing the use of existing NYCDOT truck routes and by limiting the overlap of truck routes for each project so that individual roadways would not get overburdened with construction vehicles. The distribution of construction vehicles of the Lower Manhattan Recovery Region to the traffic network is summarized in Table 21-4.

Table 21-4
Typical Daily Construction Vehicle Distribution

Vehicle Type	Percentage
Concrete	100% from Bronx, Brooklyn, and Queens
Heavy Trucks (includes spoils transportation)	100% New Jersey and points west
Service/Utility/Fuel Trucks	33% Manhattan, 33% Brooklyn/Queens, 33% New Jersey
Sub-contractor	50% Brooklyn/Queens, 50% New Jersey
Source: The Louis Berger Group, Inc.	

Based upon information provided by NYCT, a 16 hour work day (7:00 AM to 11:00 PM) was assumed for the South Ferry subway station and FSTC projects. The primary travel routes to be used by the South Ferry and FSTC projects by dedicated construction vehicles would be Broadway and Church Street. A 10 hour work day (7:00 AM to 5:00 PM) was assumed for the permanent WTC PATH Terminal *and a 20-hour day was assumed for Route 9A. For both the* Route 9A and the permanent WTC PATH Terminal projects, the primary travel route would be Route 9A. The construction vehicle haul routes in Lower Manhattan for each of these projects are shown in Figure 21-21. The construction vehicles projected to be generated by these Lower Manhattan Recovery Projects (permanent WTC PATH Terminal, Route 9A, FSTC, South Ferry subway station) in 2006 were added to the 2006 background traffic network for the weekday AM and PM peak hours.

Generally, truck routing around the WTC Site would be counter-clockwise. Liberty Street would operate as a one way eastbound street. Church Street would remain open to northbound traffic. Barclay Street would operate as a one way westbound street. Because of the construction related activities planned for Vesey Street (staging, lay-down, trailers, etc.), it would operate primarily as a one way eastbound street for construction vehicles serving the WTC Site. Since southbound left turns are not permitted at this location, it is assumed that construction vehicles traveling to southbound Route 9A (Brooklyn-Battery Tunnel) would travel west on Vesey Street to turn left on to Route 9A. It is assumed that truck routing for the WTC redevelopment and the permanent WTC PATH Terminal will utilize the same truck access and routing. Truck access to the WTC Site during construction will require the use of three ramps. The ramp locations include the northwest corner of Fulton Street and Church Street (Ramp 1), the southwest corner of Church and Vesey Streets (Ramp 2), and the northwest corner of Liberty and Greenwich Streets (Ramp 3).

The addition of the 2006 construction vehicles from the other Lower Manhattan projects (permanent WTC PATH Terminal, Route 9A, FSTC, and South Ferry subway station) to the 2006 Baseline condition volumes formed the 2006 Future Without the Proposed Action (see Figure 21-23). The total number of construction vehicles assigned to individual intersections in the study area by the construction of these projects is presented in Table 21-5.

Project Site Boundary

Construction Vehicle Haul Routes
Other Lower Manhattan Projects

Not to Scale

World Trade Center Memorial
and Redevelopment Plan

Proposed Construction Vehicle Haul Routes Other Lower Manhattan Projects

Figure 21-21

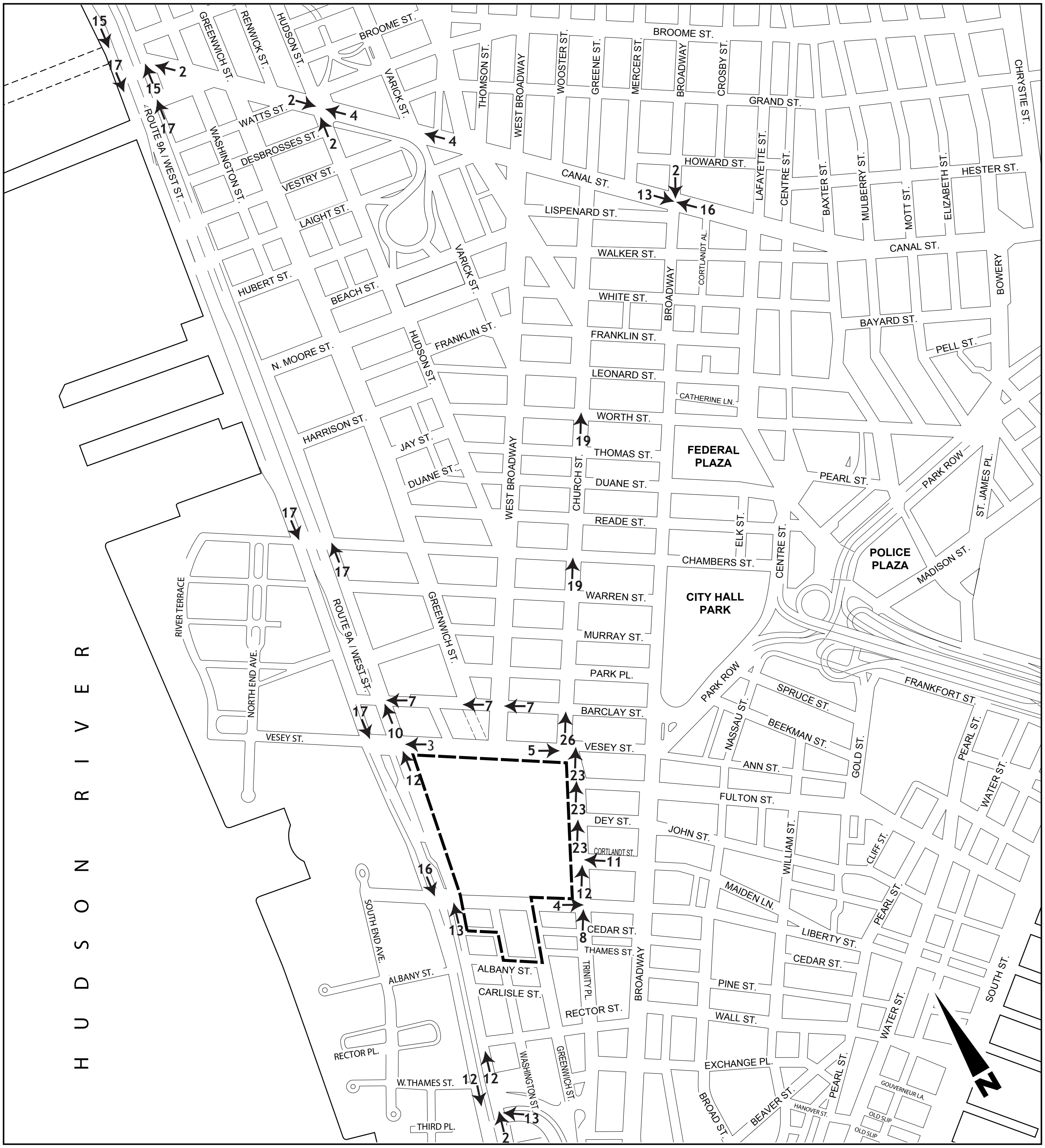
— — — Project Site Boundary

Construction Vehicle Haul Routes World Trade Center Memorial and Redevelopment Projects

Not to Scale

Proposed Construction Vehicle Haul Routes World Trade Center Memorial and Redevelopment Project

Figure 21-22



Project Site Boundary

Note: Overall intersection LOS is shown for signalized intersections

2006 Peak Hour Construction Vehicle Trips Future Without Proposed Action

Figure 21-23

World Trade Center Memorial and Redevelopment Plan

Table 21-5
Construction Vehicle Trips at Key Intersection Locations
Future Without the Proposed Action (2006) Condition

Intersection	Approach				Total
	Eastbound	Westbound	Northbound	Southbound	
Canal Street (North) & West Street	2	0	15	15	32
Canal Street (South) & West Street	0	0	17	17	34
Chambers Street & West Street	0	0	17	17	34
Vesey Street & West Street	0	3	12	17	32
Liberty Street & West Street	0	0	13	16	29
Rector Street & West Street	0	0	12	0	12
Brooklyn Battery Tunnel Exit & West Street	0	13	2	1	16
Barclay Street & West Street	0	7	10	17	34
Barclay Street & Greenwich Street	0	7	0	0	7
Canal Street & Hudson Street	2	4	2	0	8
Canal Street & Varick Street	0	4	0	0	4
Barclay Street & West Broadway	0	7	0	0	7
Worth Street & Church Street	0	0	19	0	19
Chambers Street & Church Street	0	0	19	0	19
Barclay Street & Church Street	0	0	26	0	26
Vesey Street & Church Street	5	0	23	0	28
Fulton Street & Church Street	0	0	23	0	23
Dey Street & Church Street	0	0	23	0	23
Cortlandt Street & Church Street	0	11	12	0	23
Liberty Street & Church Street	4	0	8	0	12
Canal Street & Broadway	13	16	0	2	31
Worth Street & Broadway	0	0	0	22	22
Chambers Street & Broadway	0	0	0	22	22
Vesey Street/Ann Street & Broadway	0	0	0	22	22

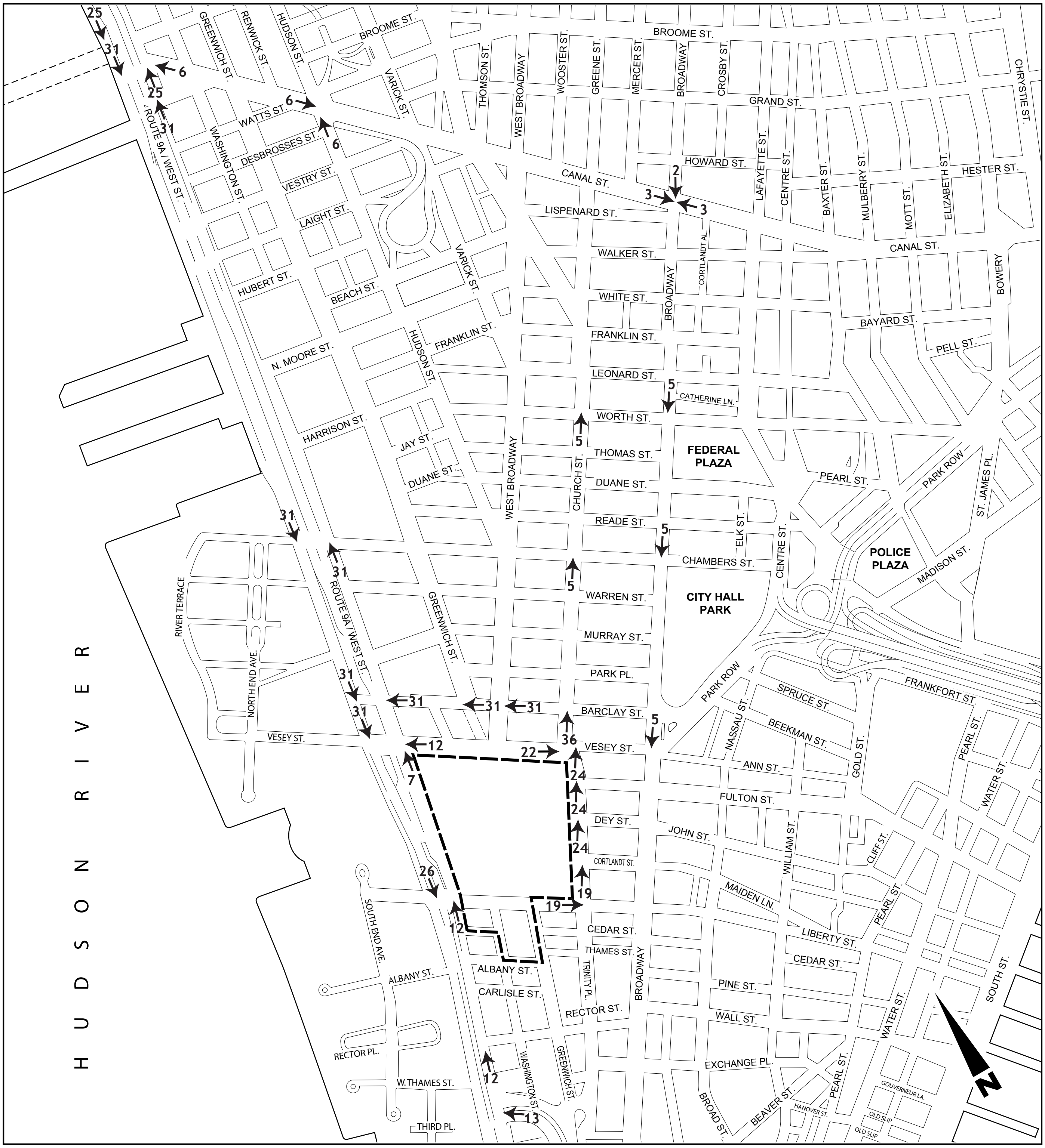
Source: The Louis Berger Group, Inc.

Future With the Proposed Action Scenario

The 2006 Future With the Proposed Action Build condition was developed by adding the WTC construction vehicles to the 2006 Future Without the Proposed Action volumes that were generated by the Baseline and four other major construction projects.

Based upon information provided by LMDC, a 10 hour work day (7:00 AM to 5:00 PM) was assumed for the Proposed Action. The primary travel route to be used by the Proposed Action would be Route 9A. The construction vehicle haul routes in Lower Manhattan for the Proposed Action (see Figure 21-24).

The 2006 Proposed Action construction vehicle traffic flow volumes were developed for the weekday AM and PM peak hours. The total number of construction vehicles assigned to individual intersections in the study area by the construction of the Proposed Action is presented in Table 21-6.



Project Site Boundary

Note: Overall intersection LOS is shown for signalized intersections

2006 Peak Hour Construction Vehicle Trips Proposed Action Only

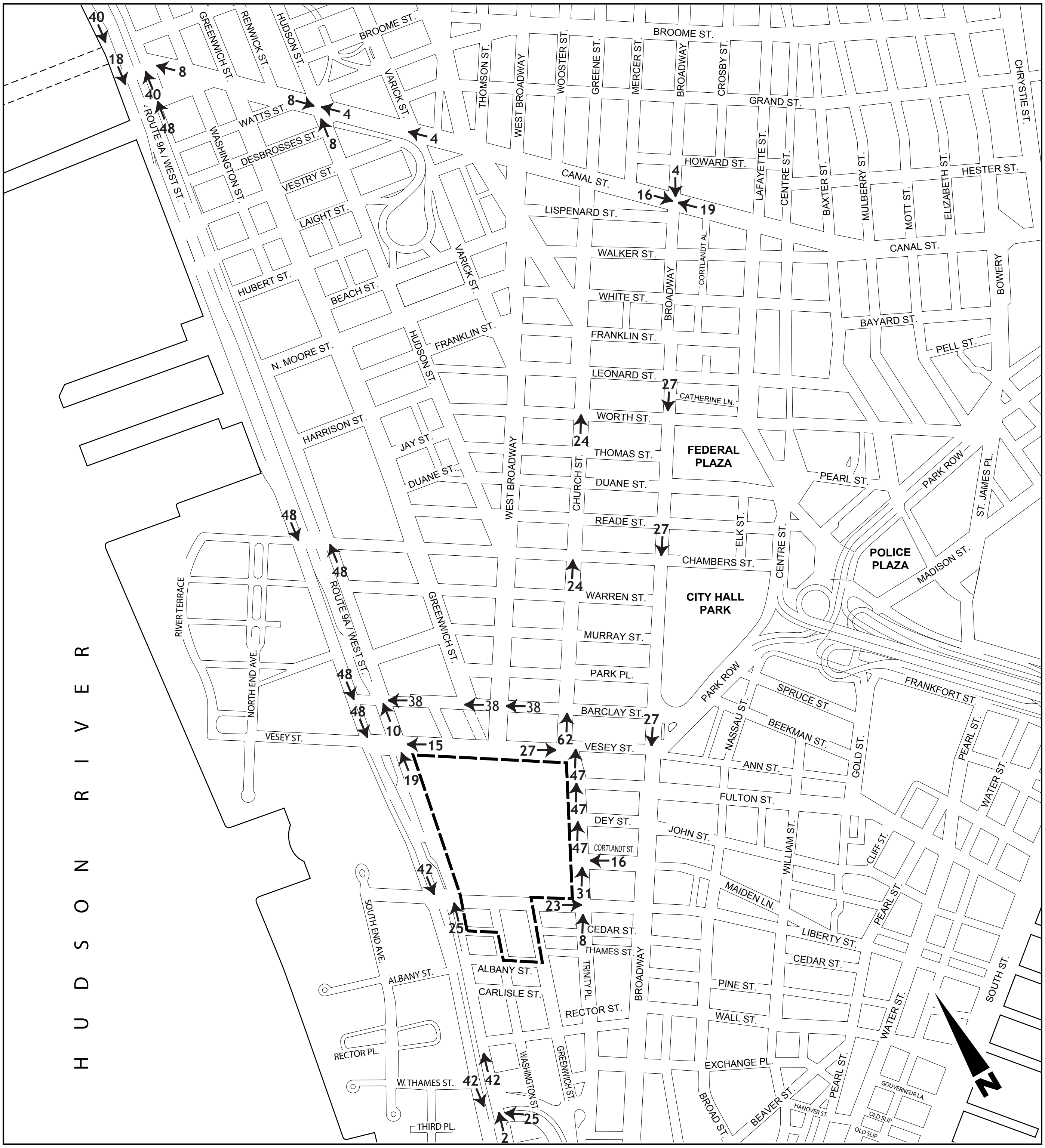
Figure 21-24

Table 21-6
Construction Vehicle Trips at Key Intersection Locations
Proposed Action Construction Only

Intersection	Approach				Total
	Eastbound	Westbound	Northbound	Southbound	
Canal Street (North) & West Street	6	0	25	25	56
Canal Street (South) & West Street	0	0	31	31	62
Chambers Street & West Street	0	0	31	31	62
Vesey Street & West Street	0	12	7	31	50
Liberty Street & West Street	0	0	12	26	38
Rector Street & West Street	0	0	12	0	12
Brooklyn Battery Tunnel Exit & West Street	0	12	0	0	12
Barclay Street & West Street	0	31	0	31	62
Barclay Street & Greenwich Street	0	31	0	0	31
Canal Street & Hudson Street	6	0	6	0	12
Canal Street & Varick Street	0	0	0	0	0
Barclay Street & West Broadway	0	31	0	0	31
Worth Street & Church Street	0	0	5	0	5
Chambers Street & Church Street	0	0	5	0	5
Barclay Street & Church Street	0	0	36	0	36
Vesey Street & Church Street	22	0	24	0	46
Fulton Street & Church Street	0	0	24	0	24
Dey Street & Church Street	0	0	24	0	24
Cortlandt Street & Church Street	0	5	19	0	24
Liberty Street & Church Street	19	0	0	0	19
Canal Street & Broadway	3	3	0	2	8
Worth Street & Broadway	0	0	0	5	5
Chambers Street & Broadway	0	0	0	5	5
Vesey Street/Ann Street & Broadway	0	0	0	5	5

Source: The Louis Berger Group, Inc.

The 2006 Future with the Proposed Action traffic flow volumes developed for the weekday AM and PM peak hours are presented in Figure 21-25. The total number of construction vehicles assigned to individual intersections in the study area by the construction of the all five Lower Manhattan Recovery Projects is presented in Table 21-7. This table is the sum of all construction vehicles shown in the two previous tables.



Project Site Boundary

Note: Overall intersection LOS is shown for signalized intersections

World Trade Center Memorial and Redevelopment Plan

2006 Peak Hour Construction Vehicle Trips Future With Proposed Action

Figure 21-25

Table 21-7
Construction Vehicle Trips at Key Intersection Locations
Future With Proposed Action (2006) Condition

Intersection	Approach				Total
	Eastbound	Westbound	Northbound	Southbound	
Canal Street (North) & West Street	8	0	40	40	88
Canal Street (South) & West Street	0	0	48	48	96
Chambers Street & West Street	0	0	48	48	96
Vesey Street & West Street	0	15	19	48	82
Liberty Street & West Street	0	0	25	42	67
Rector Street & West Street	0	0	24	0	24
Brooklyn Battery Tunnel Exit & West Street	0	25	2	1	28
Barclay Street & West Street	0	38	10	48	96
Barclay Street & Greenwich Street	0	38	0	0	38
Canal Street & Hudson Street	8	4	8	0	20
Canal Street & Varick Street	0	4	0	0	4
Barclay Street & West Broadway	0	38	0	0	38
Worth Street & Church Street	0	0	24	0	24
Chambers Street & Church Street	0	0	24	0	24
Barclay Street & Church Street	0	0	62	0	62
Vesey Street & Church Street	27	0	47	0	74
Fulton Street & Church Street	0	0	47	0	47
Dey Street & Church Street	0	0	47	0	47
Cortlandt Street & Church Street	0	16	31	0	47
Liberty Street & Church Street	23	0	8	0	31
Canal Street & Broadway	16	19	0	4	39
Worth Street & Broadway	0	0	0	27	27
Chambers Street & Broadway	0	0	0	27	27
Vesey Street/Ann Street & Broadway	0	0	0	27	27

Source: The Louis Berger Group, Inc.

TRAFFIC IMPACT ASSESSMENT

The 2006 Future With the Proposed Action analysis results for the AM, midday, and PM peak hours were compared to the 2006 Future Without the Proposed Action to determine the impact of the WTC generated construction traffic on the study area (see appendix J). The criteria presented in Chapter 13A, “Traffic and Parking” were used to determine traffic impacts in the study area in 2006.

A total of 24 intersections (21 signalized & 3 unsignalized) were analyzed in Lower Manhattan for construction traffic impacts.

The analysis results between the Future Without the Proposed Action and Future With the Proposed Action were calculated at the same 24 intersections and have been summarized in Table 21-8.

Table 21-8
Traffic Level of Service Summary Comparison
Future Without the Proposed Action (2006) vs. Future With the Proposed Action (2006) Scenarios

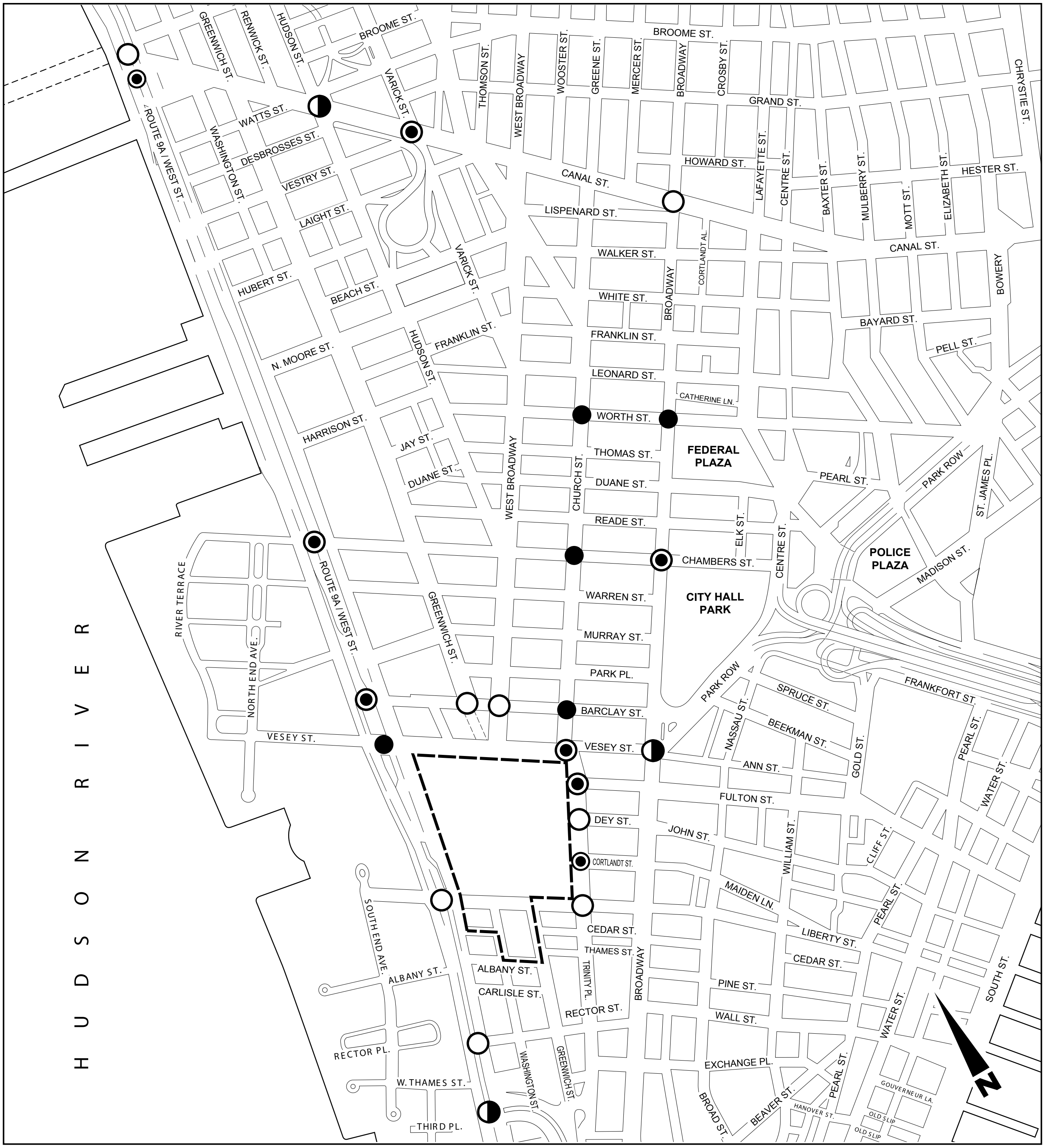
Signalized and Unsignalized Intersections	Without the Proposed Action (2006)			With the Proposed Action (2006)		
	AM	MD	PM	AM	MD	PM
Overall LOS A/B	8	12	9	7	13	10
Overall LOS C	8	4	5	7	4	4
Overall LOS D	3	3	3	5	3	3
Overall LOD E/F	5	5	7	5	4	7
No. of Movements at LOS E or F	15	14	17	16	14	17

During the AM peak hour (8:15-9:15 AM), the number of analyzed intersections operating at overall LOS E or F in the Future Without the Proposed Action is 5 (see Figure 21-26). This is projected to remain the same under the Future With the Proposed Action (2006) as shown in Figure 21-27. Another 5 intersections would operate at overall LOS D in the Future With the Proposed Action (2006) scenario. The number of specific traffic movements expected to operate at LOS E or F is projected to increase from 15 under the Future Without the Proposed Action (2006) to 16 under the Future With the Proposed Action (2006).

During the Midday peak hour (12:00-1:00 PM), the number of analyzed intersections operating at overall LOS E or F in the Future Without the Proposed Action is 5 (see Figure 21-28). This is projected to decrease to 4 under the Future With the Proposed Action (2006) as shown in Figure 21-29. Another 3 intersections would operate at overall LOS D in the Future With the Proposed Action (2006) scenario. The number of specific traffic movements expected to operate at LOS E or F is 14 under the 2006 Future Without the Proposed Action (2006) Condition and is projected to remain the same under the Future With the Proposed Action (2006).

During the PM peak hour (5:00-6:00 PM), the number of analyzed intersections operating at overall LOS E or F in the Future Without the Proposed Action is 7 (see Figure 21-30). This is projected to remain the same under the Future With the Proposed Action (2006) as shown in Figure 21-31. Another 3 intersections would operate at overall LOS D in the Future With the Proposed Action (2006) scenario. The number of specific traffic movements expected to operate at LOS E or F is 17 under the Future Without the Proposed Action (2006) Scenario and is projected to remain the same under the Future With the Proposed Action (2006) Scenario.

The 2006 Future Without the Proposed Action is compared with the 2006 Future With the Proposed Action to determine the impact of the Proposed Action generated construction traffic on the study area at various time periods. Table 21-9 summarizes the locations and time periods (for the AM, midday, and PM peak hours) that are projected to experience a traffic impact during the 2006 construction conditions (also see Appendix J-7).



Project Site Boundary

LOS A or B

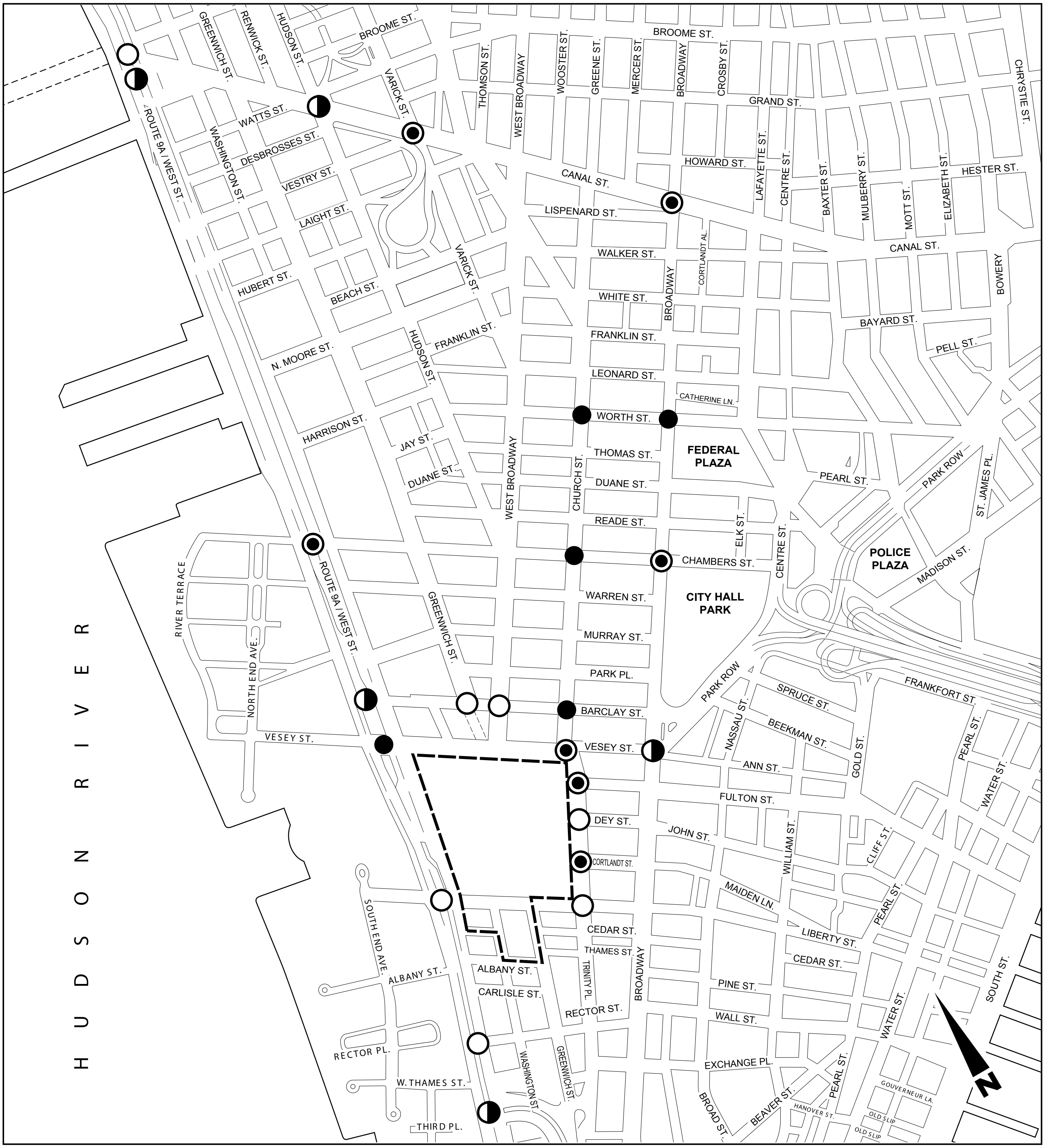
LOS C

LOS D

LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future Without the Proposed Action Conditions AM Peak Hour



Project Site Boundary

○ LOS A or B

◉ LOS C

◐ LOS D

● LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future With the Proposed Action Conditions AM Peak Hour

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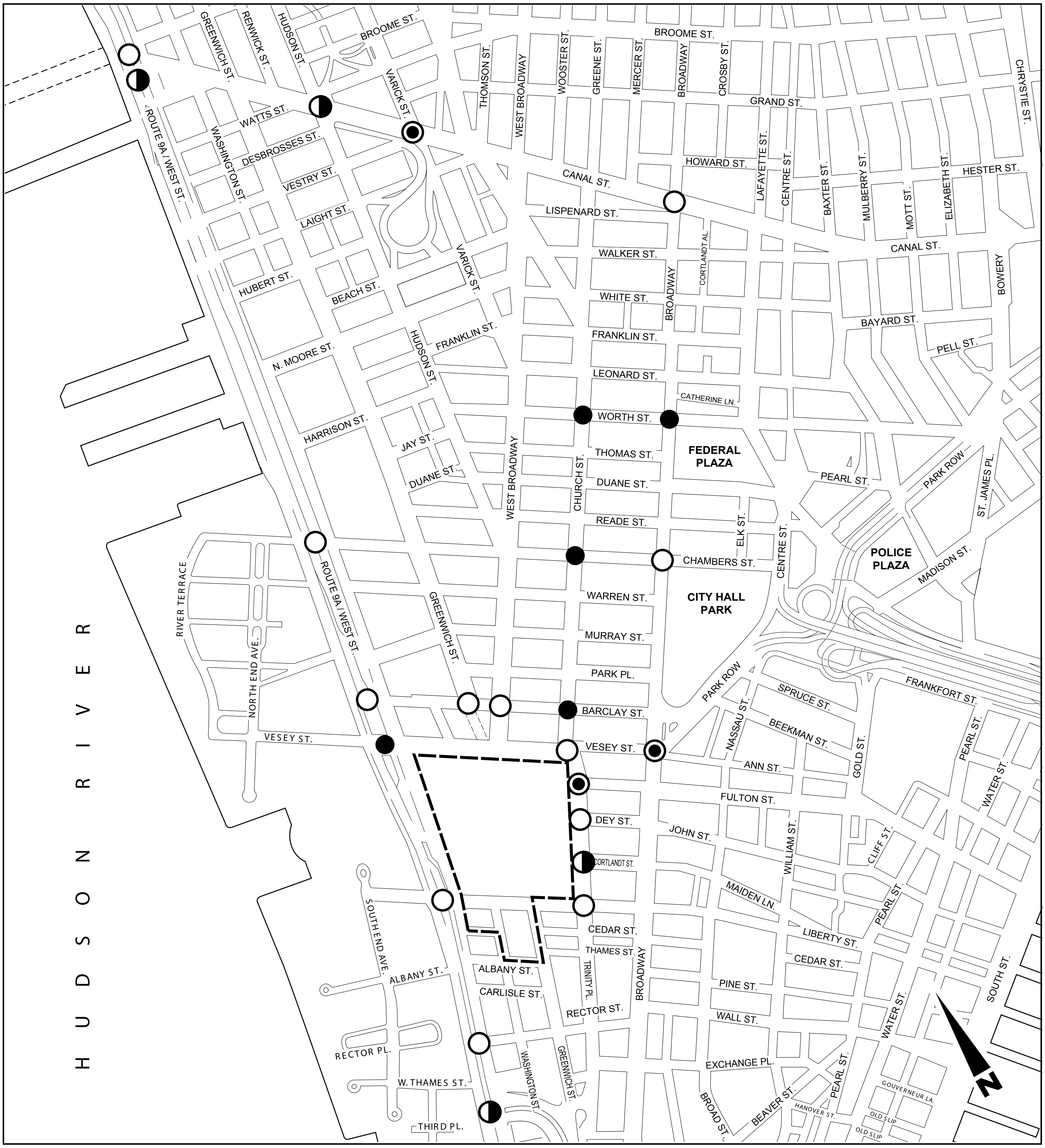
Figure 21-27



Project Site Boundary

LOS A or B

LOS C

LOS D

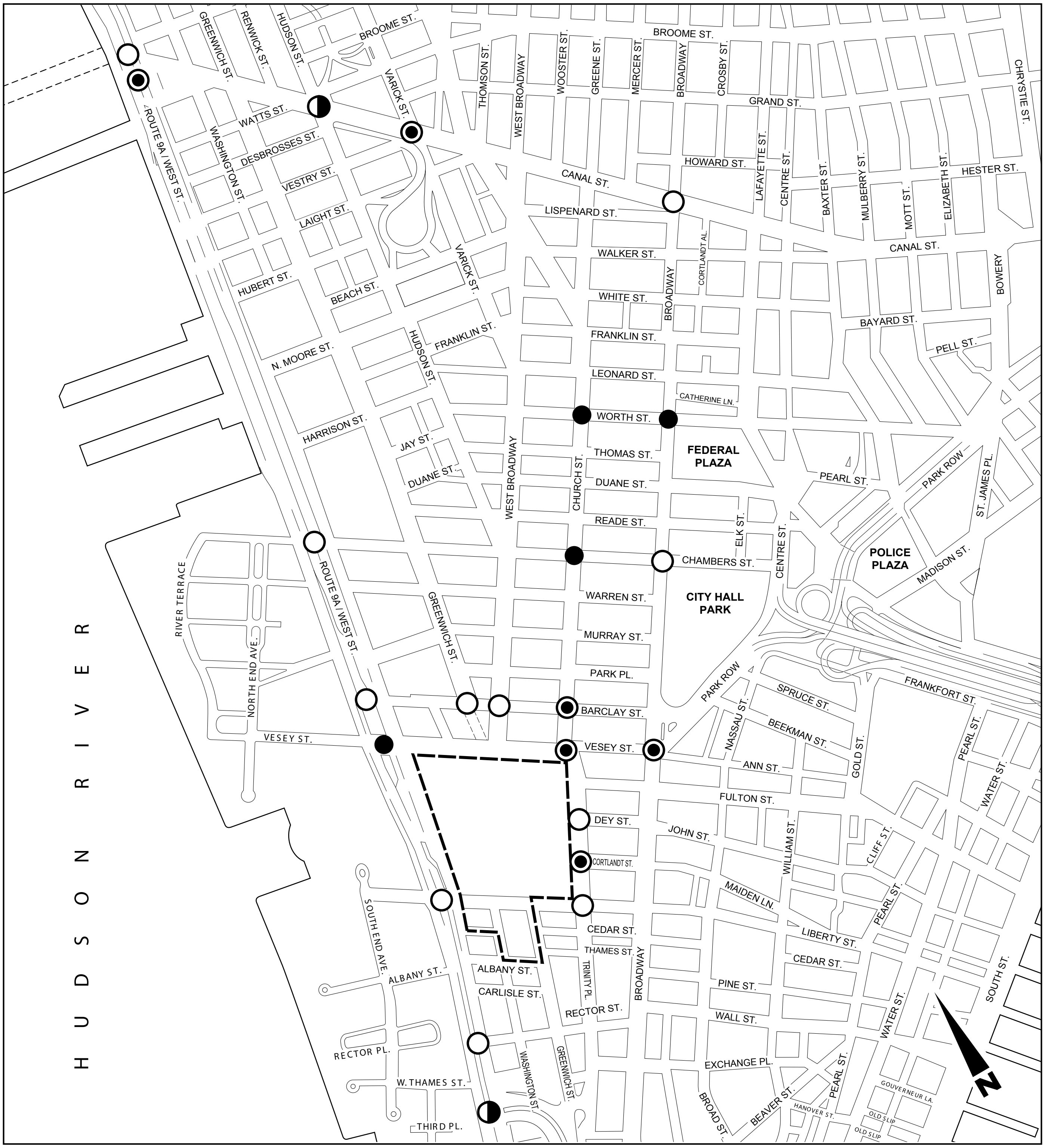
LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future Without the Proposed Action Conditions Midday Peak Hour

World Trade Center Memorial and Redevelopment Plan

Figure 21-28



Project Site Boundary

LOS A or B

LOS C

LOS D

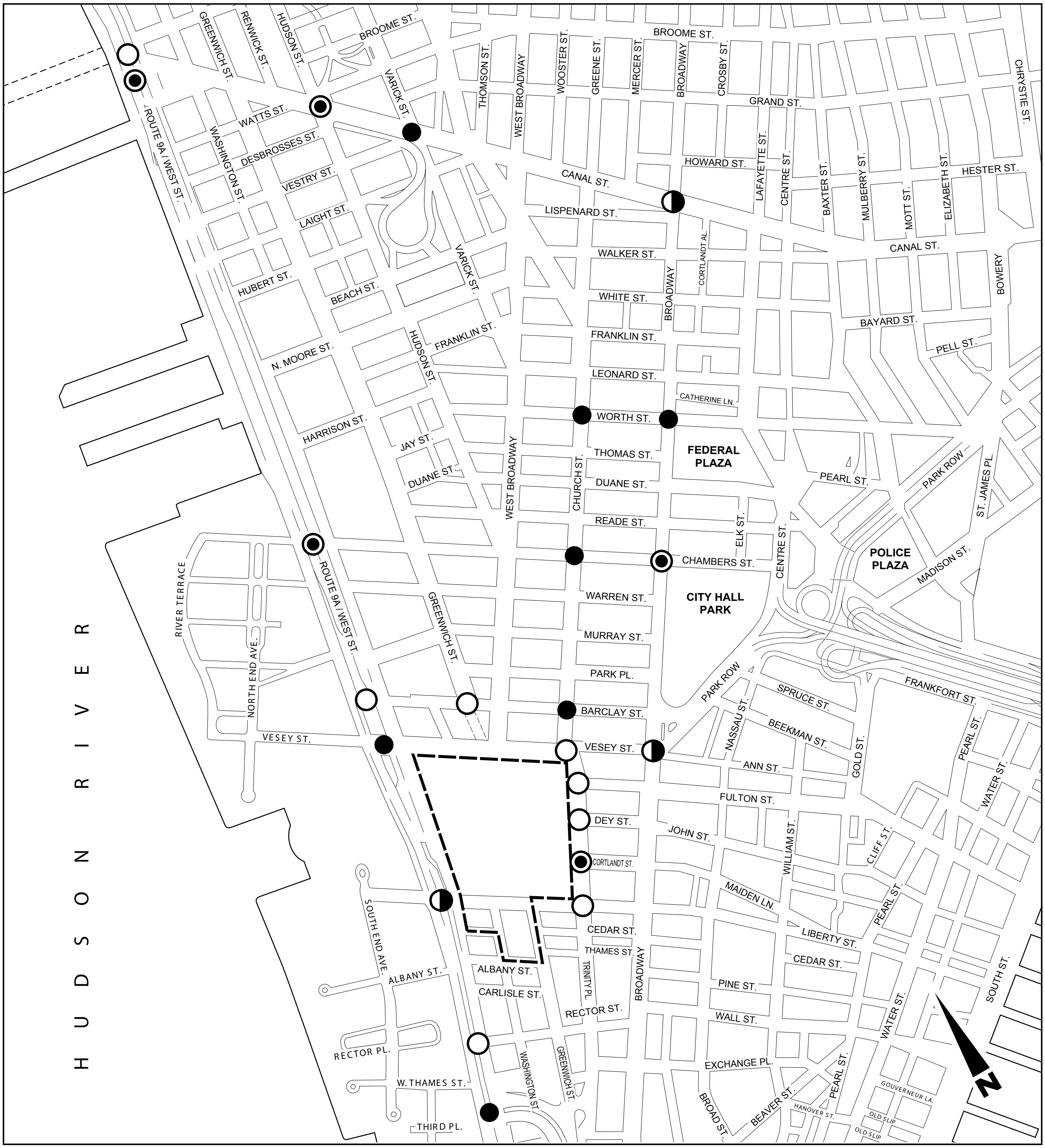
LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future With the Proposed Action Conditions Midday Peak Hour

World Trade Center Memorial and Redevelopment Plan

Figure 21-29



Project Site Boundary

LOS A or B

LOS C

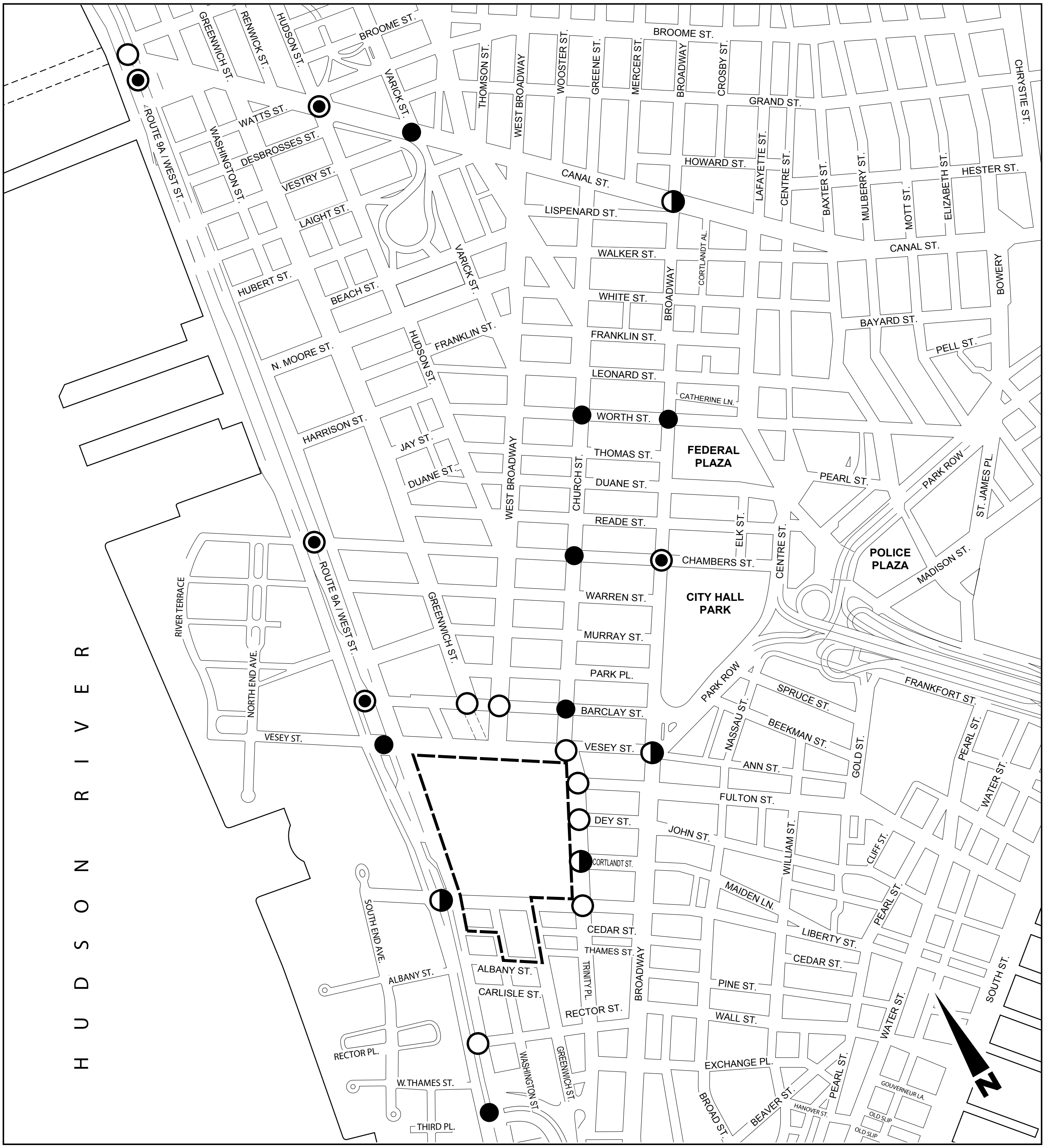
LOS D

LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future Without the Proposed Action Conditions PM Peak Hour

Figure 21-30



Project Site Boundary

LOS A or B

LOS C

LOS D

LOS E or F

Note: Overall intersection LOS is shown for signalized intersections

Traffic Levels of Service 2006 Future With the Proposed Action Conditions PM Peak Hour

World Trade Center Memorial and Redevelopment Plan

Figure 21-31

Table 21-9
Traffic Impact Assessment
2006 Construction Conditions

	AM	MD	PM
Vesey Street & Route 9A/West Street	■	-	-
Liberty Street & Route 9A/West Street	-	-	-
Canal Street & Hudson Street	-	-	-
Worth Street & Church Street	-	-	-
Chambers Street & Church Street	■	-	■
Barclay Street & Church Street	■	-	-
Cortlandt Street and Church Street	-	■	-
Canal Street & Broadway	-	-	■
Worth Street & Broadway	■	■	■
Vesey Street/Ann Street & Broadway	-	-	-

Note: ■ Represents Impacts
Source: The Louis Berger Group, Inc.

It was conservatively assumed that, absent mitigation, two lanes would be closed throughout the Church Street and Broadway corridors, including at major intersections, during the NYCDOT roadway reconstruction project.

As shown in Table 21-9, the traffic impacts identified along Church Street and Broadway during the AM, midday, PM peak hours due to WTC construction activity can be mitigated by coordinating with NYCDOT to close only one lane at a time within their work areas at major intersections along Church Street and Broadway. The additional lane could be used to provide an exclusive turning lane at these locations during the construction period.

Additional green time could be provided for the westbound approach at the Vesey and Route 9A intersection to mitigate the identified impact during the AM peak hour. The impact identified during the midday peak hour on the westbound approach of the Cortlandt Street and Church Street intersection could be mitigated by providing a dual right turn lane from Cortlandt Street.

PEDESTRIANS

Maintaining access to local businesses and points of interest such as the WTC Site itself for all pedestrians, including residents, tourists, and other visitors to the greatest extent practicable is recognized as an essential element of the construction plan.

To achieve this, pedestrian flow along Vesey and Liberty Streets will be maintained throughout the duration of construction except during limited periods of construction will require temporary closures. All closures will be kept to a minimum as much as possible. Such actions would implement an element of the *Sustainable Design Guidelines,* specifically SEQ-5 Construction Environment Plan which calls for the project sponsor to “avoid or minimize impacts and communicate plans with the public” as well as to “prepare contingency measures in the event established limits are exceeded.” The Construction Environment Plan’s need to include staging areas for trucks that would limit the impact on adjoining neighborhoods is reflected in this chapter’s discussion of construction activities.

Where activities require the closure of certain segments around the perimeter of the WTC Site, appropriate measure would be taken to offset such loss. For example, construction and staging activities proposed along the east side of the WTC Site between Liberty Street and Vesey Street would require the use of a portion of the existing west side sidewalk on Church Street. To mitigate the loss of sidewalk space at this location, the western curb lane on Church Street between Liberty Street and Vesey Street will be added to the remaining sidewalk to provide the requisite pedestrian flow.

In addition to the Construction Environment Plan (SEQ-5), the EPCs pertaining to Access and Circulation would be employed during construction. Such measures include:

- Development and implementation of project-specific pedestrian and vehicular Maintenance and Protection plan;
- Promoting public awareness through mechanisms such as: signage; telephone hotline; and Web site updates;
- Ensuring sufficient alternate street, building, and temporary and permanent WTC PATH Terminal and subway station access during construction period; and
- Maintaining regular communication with New York City Department of Transportation and participation in its construction coordination efforts.

21.6.2 AIR QUALITY

The analysis of the potential impact of activities related to the construction of the Proposed Action, and the potential cumulative impact of all Lower Manhattan reconstruction activities on air quality are described in this section. *Additionally, a region-wide inventory of potential emissions from the Proposed Action during all construction years, including both on-site and on-road emissions, is presented below.* Information regarding air quality in the context of the aftermath of September 11, air quality standards and benchmarks for determining the significance of impacts, background pollutant levels and general procedures for air quality modeling can be found in Chapter 14, “Air Quality.”

The analysis of potential construction related air quality impacts were based on the projected construction activities as described above. These activities included measures aimed at reducing air quality that LMDC is committed to, as delineated in the Environmental Performance Commitments (EPCs), such as the implementation of a rigorous dust suppression program, and the use of ultra low sulfur fuel diesel (ULSD) and engine emissions controls for non-road construction engines. Since various emission reduction technologies could be used under the EPCs, this analysis included the minimum predicted reductions in emissions based on the available technologies for the pollutants analyzed.

METHODOLOGY

The analyses delineated below include procedures for two types of air pollutant sources: mobile sources and stationary sources. Mobile sources include all on-road vehicular activity; stationary sources include all construction related activity on-site. The results of the *peak year* analyses were integrated, where appropriate, to reflect the complete impact of construction activity on air quality. *The potential impact of both on-site and on-road predicted emissions on local air quality was analyzed.*

Since almost all stationary construction equipment and trucks use diesel engines, the main pollutant of concern *on a local scale* is particulate matter, emitted both as engine exhaust and fugitive dust, and analyzed as $PM_{2.5}$ and PM_{10}. *Nitrogen dioxide (NO_2), which is also emitted from diesel engines, was also analyzed on a local scale.* Parking would not be provided for construction workers, neither onsite nor offsite, other than for a few working vehicles; construction workers would mostly be arriving via public transportation. Therefore, no significant increase in light duty gas vehicle trips is expected. Diesel engines emit very little carbon monoxide (CO). The diesel fuel used for on-road vehicles contains low concentrations of sulfur; pursuant to the EPCs, the on-site diesel construction non-road engines will be ULSD. Emissions of CO and sulfur dioxide (SO_2) are therefore not of concern. *The regional inventory included pollutants which are of concern on a regional scale: nitrogen oxides (nitrogen oxide and NO_2 combined—NO_x) and volatile organic compounds (VOC), which are precursors to ozone formation, and particulate matter.* A full discussion of these pollutants can be found in Chapter 14, "Air Quality."

As described above, the year analyzed is 2006, during which cumulative construction activity is predicted to peak.

The analysis included the modeling of three scenarios–

1. *No Action* - This scenario included no construction of any of the major Lower Manhattan projects, representing the existing condition with growth and other possible background projects in the region as of 2006;
2. *Future Without the Proposed Actio*n - This scenario included construction of the permanent WTC PATH Terminal, FSTC, Route 9A, and South Ferry subway station, in addition to growth and background projects; and
3. *Future With the Proposed Action* - This scenario included the cumulative operation of all construction projects in addition to background projects and other traffic.

The predicted maximum total concentrations are those calculated under scenario 3; those concentrations were compared with the National Ambient Air Quality Standards (NAAQS) to determine if the standards could potentially be exceeded as a result of the Proposed Action. The predicted potential incremental impacts of the project are the predicted increase in maximum concentrations from the Construction Without the Proposed Action scenario to the Proposed Action scenario (i.e. the results from scenario (3) minus (2) above); the comparison of those increments to applicable incremental benchmarks were the basis for determination of the significance of potential incremental impacts of the Proposed Action. The predicted potential cumulative increment in concentrations from all of the major projects is the predicted increase in maximum concentrations from the No Action scenario to the Proposed Action Construction scenario (i.e. results from scenario (3) minus (1) above).

Mobile Source Analysis

Mobile source analysis was conducted for the roadways surrounding the WTC Site—Vesey Street, Church Street, Liberty Street and Route 9A. These routes would serve the construction vehicles arriving and departing from the site. Since all construction vehicles converge on the site, the largest increase in traffic volumes due to the construction of the Proposed Action and the cumulative construction activities, and the ensuing maximum impact on air quality would occur in this area.

Since the traffic on Route 9A is a large background source in immediate proximity to the site that may not be included in measured background concentrations, this segment was included as a background condition to be modeled explicitly, in all scenarios.

The general procedures for mobile source modeling used in this analysis were identical to those used for predicting potential future operational mobile source impacts, as described in Chapter 14, "Air Quality," except modeling traffic volumes, patterns and emission factors for the year 2006. A description of the vehicle volumes, classes and temporal distribution can be found in section 21.7.1 above, "Pedestrian and Vehicular Traffic."

In order to predict average concentrations for the time periods corresponding to the appropriate standards and regulations, average emissions were modeled for both 24-hour and annual time periods. Both time periods were analyzed using the sustained peak weekday traffic volumes presented above. This approach results in conservatively high estimates of increments in annual average concentrations due to on-road sources, because peak weekday volumes are higher than weekend volumes, and would not be sustained throughout the entire year; however, it had little effect on the resulting maximum predicted incremental concentrations from the Proposed Action's construction activities, which were mostly from the construction site itself.

Stationary Source Analysis

Stationary source analysis was conducted for all construction engines predicted to be onsite, including trucks entering, exiting and idling when necessary as per the Construction Environment Plan SEQ-5 from the *Sustainable Design Guidelines* (such as ready mix concrete trucks that need to run their engines while mixing and dump trucks queuing).

All *off-road* diesel construction engines *powered by diesel fuel* would be using ULSD; where practicable, engines larger than 50 HP would include emissions reduction measures to reduce emissions of PM and volatile organic compounds (VOCs).[1] The *Sustainable Design Guidelines* currently allow the choice of either diesel oxidation catalysts (DOC) or diesel particulate filters (DPF); DPFs would control particulate emissions from diesel powered construction engines more than DOCs. For the purpose of the dispersion modeling performed for this analysis, it was conservatively assumed that PM emissions from all such engines would be reduced by 40 percent—the minimum expected reduction achieved by using only DOCs.[2,3] PM emissions may be further reduced in cases where DPFs would be used—85 percent reductions or higher can be achieved with this technology. Since it is uncertain at this time what emission reduction technologies will be most efficient with each equipment type, and since DOCs are more efficient at reducing VOC emissions, which are ozone precursors and are of regional concern, the EPCs provide the flexibility to utilize either DOC or DPF control technologies. Therefore, the minimum PM emissions reduction of DOCs was assumed for the local dispersion modeling.

Emission factors for all analyzed pollutants emitted from the combustion of fuel by onsite construction equipment (excluding delivery trucks/heavy vehicles) were developed using the Draft EPA NONROAD2002a Emissions Model (NONROAD)[4,5]. The model is based on source

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[1] *It should be noted that the agencies responsible for the Proposed Action are committed to employing emissions reduction technology on all engines 50 HP or greater.*

[2] NESCAUM, Memorandum - Diesel Emissions Resulting from Ground Zero Activity, April 8, 2002.

[3] Environment Canada, NESCAUM, Manufacturer of Emission Controls Association, *The Impact Of Retrofit Exhaust Control Technologies On Emissions From Heavy-Duty Diesel Construction Equipment*, SAE 199-01-0110.

[4] EPA, *EPA's Newest Draft Nonroad Emission Inventory Model*; www.epa.gov/otaq/nonrdmdl.htm, April 2003

inventory data accumulated for specific categories of nonroad equipment. Data provided in the output files from NONROAD were used to derive (i.e., back-calculate from regional emission estimates) the emission factors for each type of equipment that is expected to be present on-site during construction activities. Rates of emission from onsite trucks delivering or removing material were developed using the EPA MOBILE6.2 emissions model[6]. Emission rates associated with fugitive dust emissions were calculated using the procedures defined in EPA's AP-42[7]. *Engine emissions are generally predicted to diminish over the years, as newer technologies are introduced. For the multi-year regional emissions inventory, VOC and PM emissions were not assumed to decrease throughout the duration of the construction, since emissions of these pollutants are expected to be lower at the start of construction due to the introduction of new engines and additional emissions reductions technologies.* NO_x *emissions were predicted to gradually decrease over the years as newer technologies become available.*

In order to predict average concentrations for the time periods corresponding to the appropriate standards and regulations, emissions were modeled for two time periods: 24-hour and annual. These emissions were based on the construction activity predicted for each of those time scales, as described above and in Appendix J-8; typical daily activity emissions were calculated on a monthly basis and averaged over the year to produce annual emission rates for each work zone; peak day activity emissions were calculated on a monthly basis, and the values calculated for the month with the highest total emissions from all work zones were used for the 24-hour emission rates. Analysis of predicted peak emission activity for each month during 2006 resulted in the conclusion that the peak emissions, occurring in the month of July, would result in the highest predicted impacts and would therefore represent the worst case 24-hour average impacts. On the annual scale, since activity is restricted to the daytime hours during which meteorological conditions lead to increased pollutant dispersion, results were not expected to be appreciably sensitive to monthly emissions fluctuations; the annual average emissions were therefore used throughout the year to predict annual average impacts.

The resulting concentrations were predicted using the EPA's Industrial Source Complex (ISC) dispersion model. The general location of the sources and receptors used in the model are presented in Figure 21-32. Receptors were placed at ground level all along sidewalks and building lines surrounding the Project Site, as well as at elevated receptors on all residential buildings and hotels. Since the construction emissions would occur predominantly at ground level, the concentrations predicted at these locations would be considerably higher than concentrations at any greater distance from the site. A detailed description of emission factors from the various models described above and total emission rates based on construction activities in each zone can be found in Appendix J-8.

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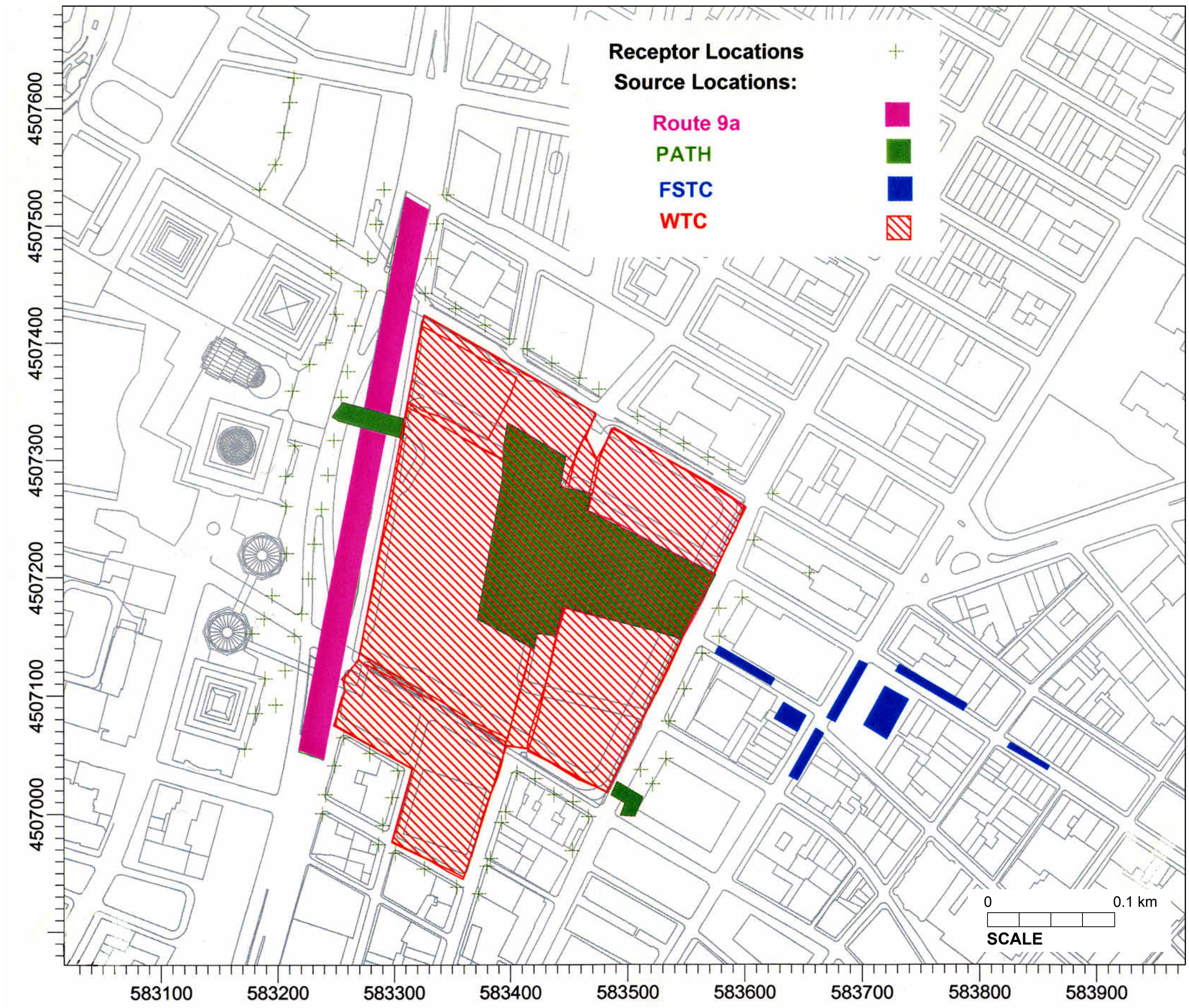
[5] EPA, *User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002*, EPA420-P-02-013, December 2002

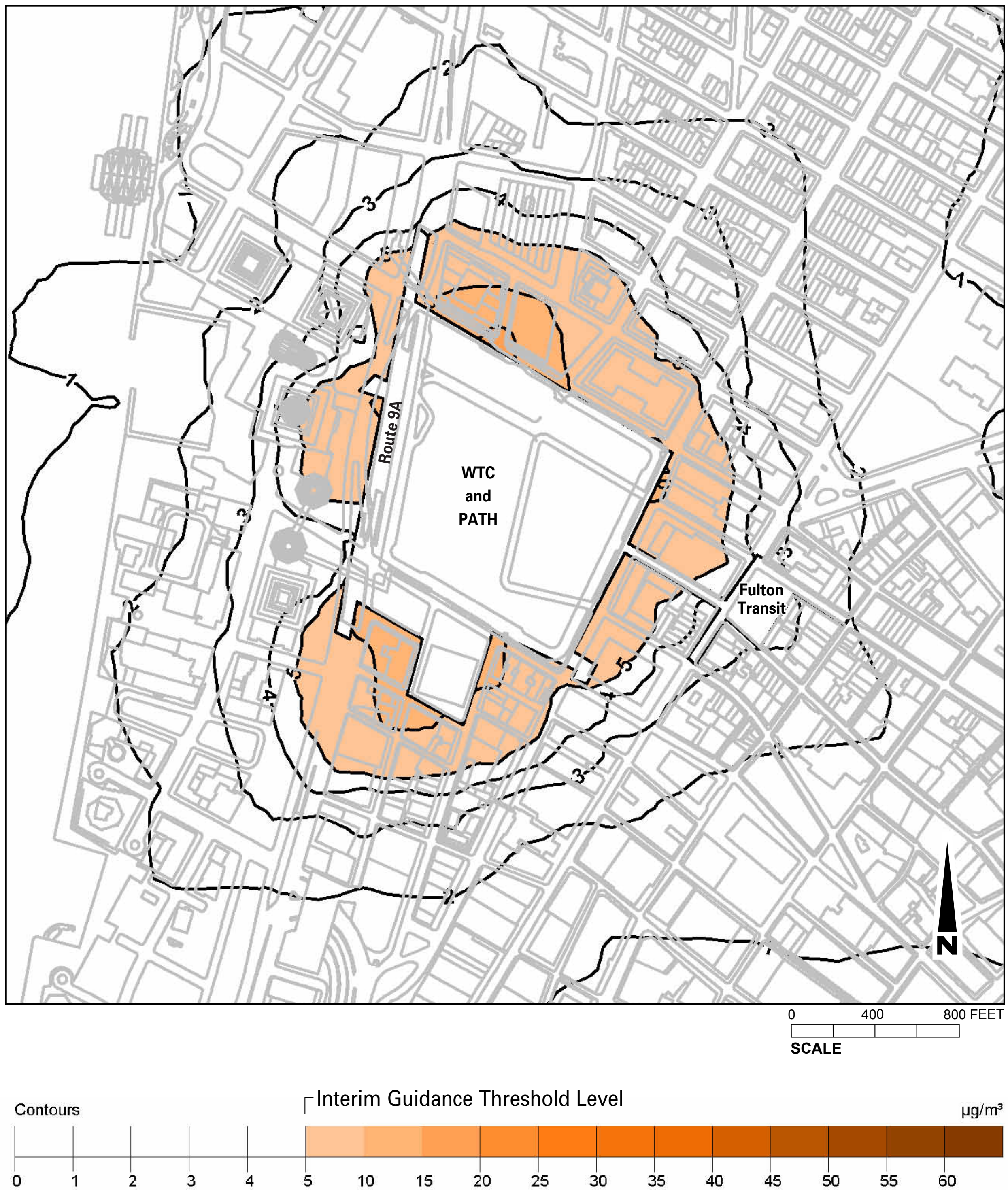
[6] EPA, *User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model*, EPA420-R-02-028, October 2002.

[7] EPA, *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources*, www.epa.gov/ttn/chief/ap42, NC, January 1995—updates and draft sections through 2003.



Location of Sources and Receptors in the Construction Site Air Quality Model

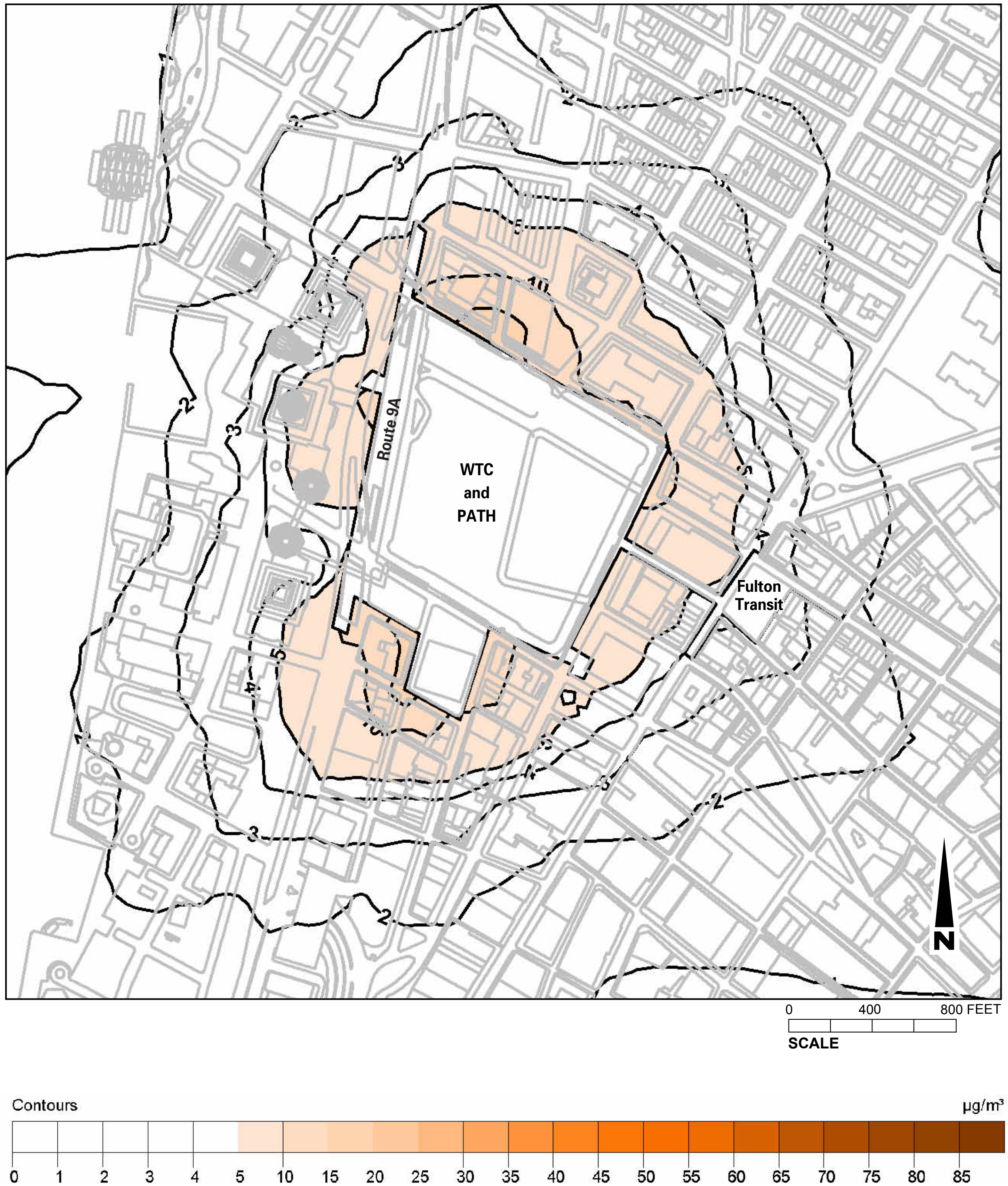
Figure 21-32



Increase in $PM_{2.5}$ Concentration ($\mu g/m^3$)

Maximum 24-Hour Average
$PM_{2.5}$ Construction Increment
WTC Only

Figure 21-33



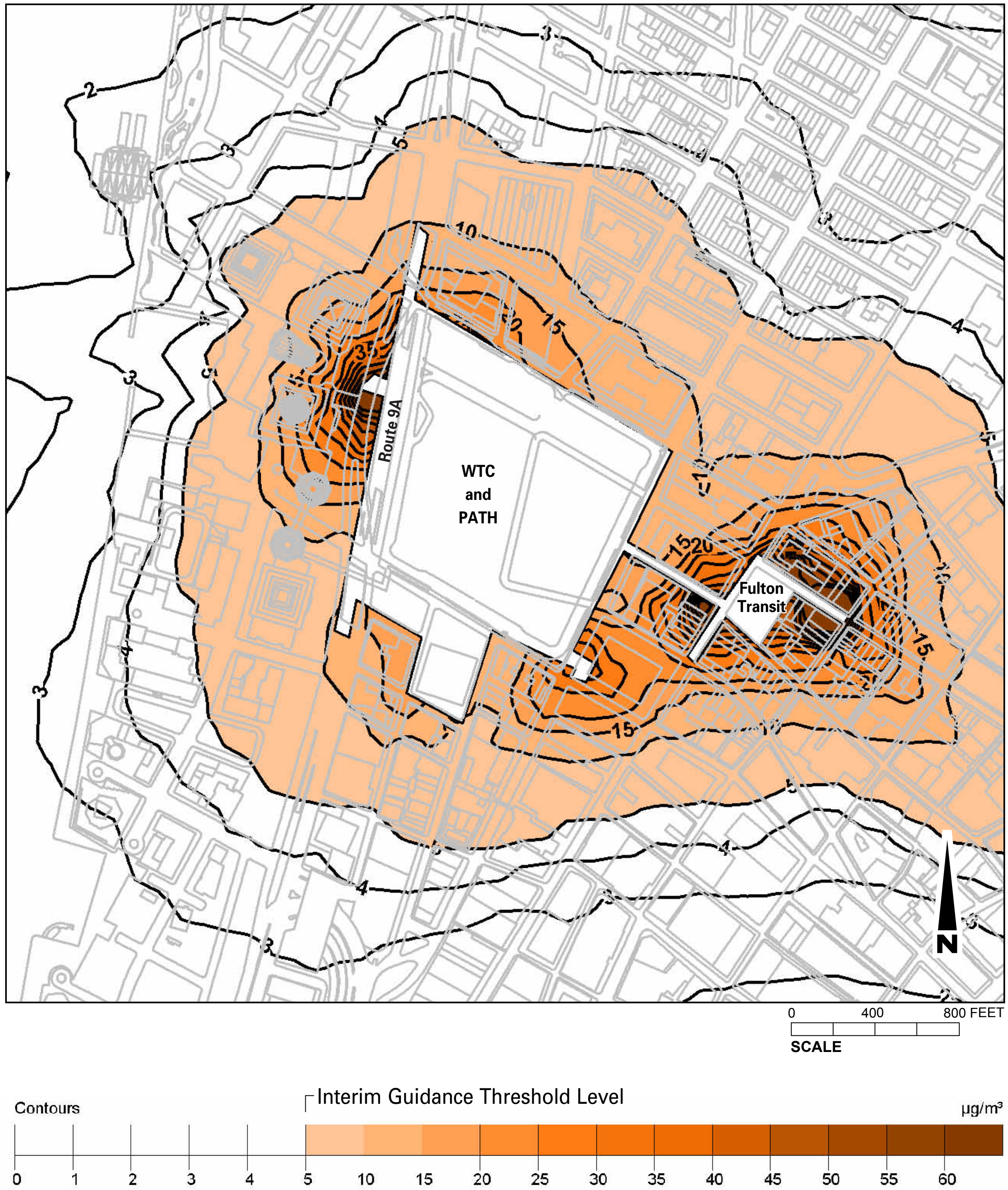
Increase in PM_{10} Concentration ($\mu g/m^3$)

Maximum 24-Hour Average
PM_{10} Construction Increment
WTC Only
Figure 21-34

4.1.04

Increase in PM_{10} Concentration ($\mu g/m^3$)

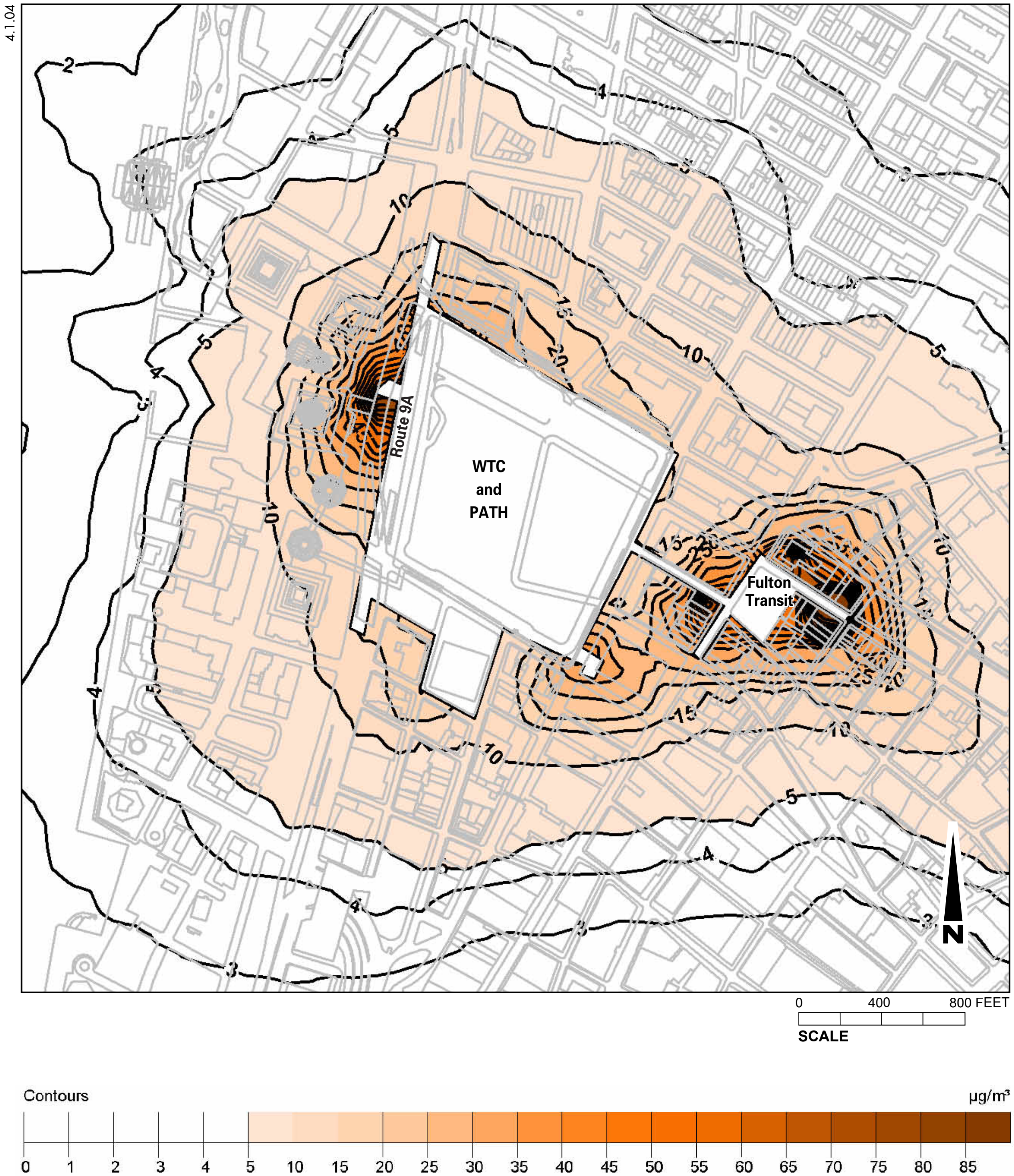
Maximum Annual Average
PM_{10} Construction Increment
WTC Only
Figure 21-35



Increase in $PM_{2.5}$ Concentration ($\mu g/m^3$)

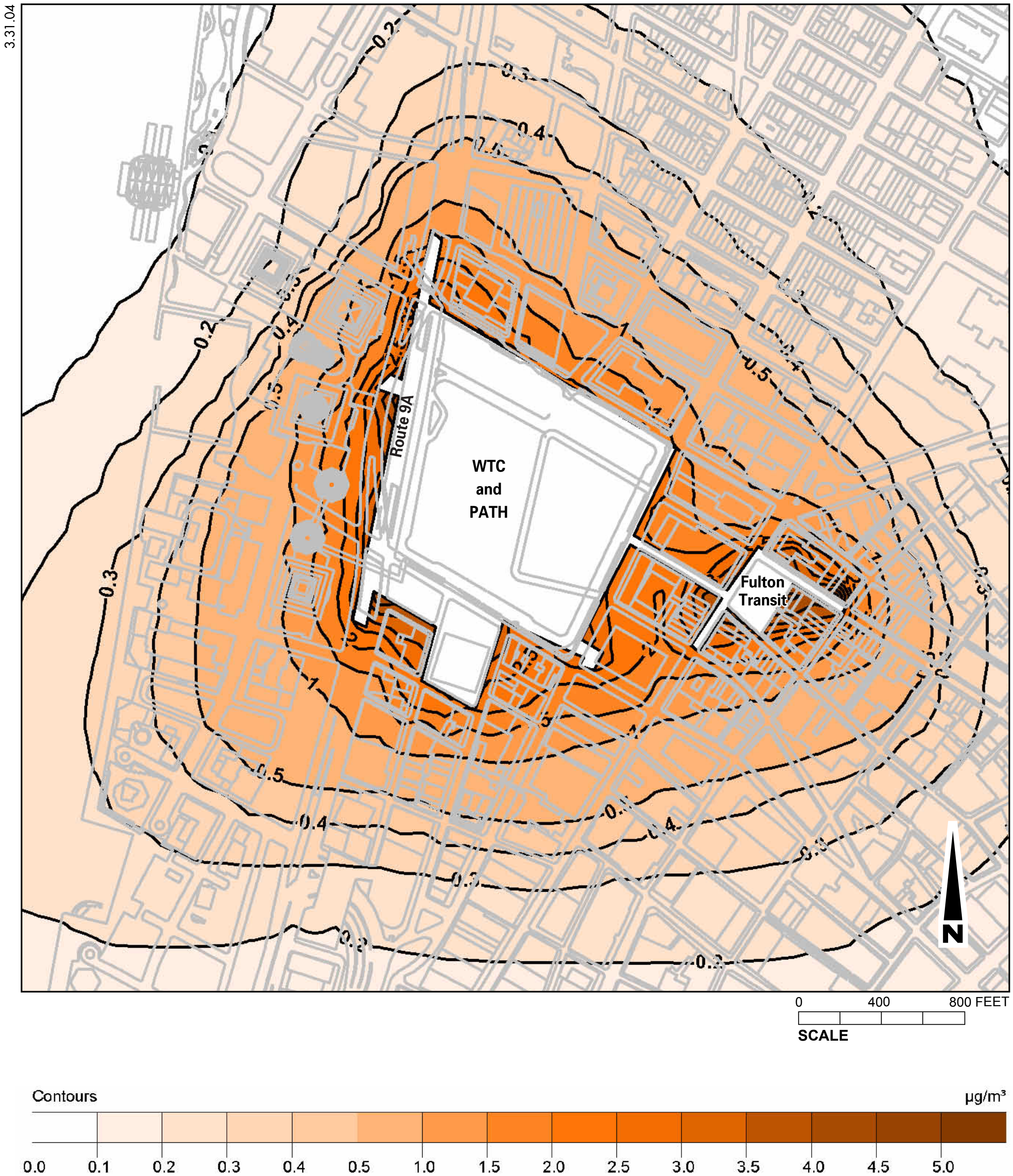
Maximum 24-Hour Average
$PM_{2.5}$ Construction Increment
Cumulative

Figure 21-36



Increase in PM_{10} Concentration ($\mu g/m^3$)

Maximum 24-Hour Average
PM_{10} Construction Increment
Cumulative
Figure 21-37



Increase in PM_{10} Concentration ($\mu g/m^3$)

Maximum Annual Average PM_{10} Construction Increment Cumulative

Figure 21-38

INVENTORY OF REGIONAL EMISSIONS FROM THE PROPOSED ACTION

An inventory of emissions from construction engines which would be operating on-site and from vehicles serving the construction operations of the Proposed Action on an annual basis was prepared based on the same assumptions presented above for mobile and stationary analyses.

The inventory includes all emissions related to the construction of the Proposed Action. Emission factors were modeled using EPA's MOBILE6.2, AP-42 and NONROAD emissions models, as described above for mobile and stationary sources.

All worker, supervisor, service, utilities and fuel trips were assumed to be a round-trip distance of 18.4 miles, which is the average distance traveled for work related trips as reported by the New York Metropolitan Transportation Council (NYMTC). Concrete trucks were assumed to travel a distance of 26.2 miles— the average distances to four major concrete plants that were identified as potential suppliers. All other materials and excavated material removed from the site were assumed to travel across the George Washington Bridge, a round trip distance of 20.6 miles within the New York Metropolitan area.

A detailed description of the construction process, the engines predicted to be operating on-site and emission factors for all engines and vehicles throughout the construction years can be found in Appendix J-8.

Total annual emissions from construction engines were obtained by multiplying the emission factor by the hours of operation per day and the duration in days for each engine. On-road emissions were calculated by multiplying the average region-wide emission factors for each vehicle type by the distance traveled for each trip. The sum of all of these emissions for each construction year and each pollutant is presented in Table 21-10.

Table 21-10
Total Regional Direct and Indirect Emissions
from Construction of the Proposed Action

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
PM_{10}	1.2	5.4	7.8	3.9	5.0	2.6	3.0	1.7	1.6	1.6
NO_x	27.7	103.5	120.9	55.7	79.5	44.9	44.7	22.2	18.1	17.4
VOCs	1.6	7.6	11.8	5.9	7.2	2.9	3.3	1.8	1.7	1.6

Notes: PM_{10} *emissions include both engine emissions and resuspended road dust.*

The total emission of NO_x *in the years 2004 through 2010 is predicted to exceed 25 tons per year—the threshold defined at 40 CFR § 93.153(b), above which a determination needs to be made regarding the regional significance of the emissions and the conformity with the state implementation plan (SIP) for ozone. Therefore, as discussed in Chapter 14, "Air Quality," LMDC has determined that a determination of general conformity with the ozone SIP is required. Emissions of other pollutants were predicted to be considerably lower than their applicable conformity determination thresholds, and therefore no further conformity determination is warranted.*

In the time period between the issuance of the DGEIS and FGEIS, LMDC representatives met with the Interagency Consultation Group to determine which components of the project may be subject to transportation conformity, so that the appropriate elements that may be subject to general conformity are identified, and included in the general conformity determination. Independently from this GEIS, LMDC is conducting an analysis to determine whether the Proposed Action conforms to the ozone SIP.

LOCAL IMPACT ASSESSMENT

The highest predicted *microscale (local)* increase in pollutant concentrations at various types of locations due to construction activity of the Proposed Action, and the cumulative impact of all projects combined are presented in Table 21-*11*. The concentrations at locations adjacent to the construction sites include contributions from both on-road sources and on-site construction activity emissions. The concentrations marked "Other locations along Access Routes" represent the highest predicted impacts from on-road sources at more distant locations that would not be impacted by the construction activity on-site.

Table 21-*11*
Highest Predicted Total Increase in Pollutant Concentrations

Pollutant	Average Period	Benchmark [μg/m³] *	Receptor Type	Maximum Increase [μg/m³]	
				Proposed Action	Cumulative
NO_2	*Annual*	*Not Applicable*	*Highest—All Receptors*	*20.5*	*27.7*
			Residential only	*20.5*	*26.3*
$PM_{2.5}$	24-hour	5.0	Highest—All Receptors	*16.5*	*70.2*
			Residential only	*13.8*	*36.6*
			Other Locations on Access Routes	*0.3*	*0.4*
	Annual**	0.1	Construction Area	*0.28*	*0.60*
			Other Locations on Access Routes	*0.04*	*0.06*
PM_{10}	24-hour	Not Applicable	Highest—All Receptors	*21.1*	*86.0*
			Residential	*16.6*	*43.4*
			Other Locations on Access Routes	*4.4*	*4.5*
	Annual	Not Applicable	Highest—All Receptors	*4.05*	*5.00*
			Residential	*3.26*	*4.37*
			Other Locations on Access Routes	*1.41*	*1.42*

Notes:
* Benchmark levels are NYCDEP interim guidance and NYSDEC draft policy threshold levels. For determination of potential impacts, these interim threshold values are compared to the Proposed Action only.
** Annual $PM_{2.5}$ concentrations are neighborhood scale.

The concentrations presented here, and in Figures 21-33 through 21-38, were predicted based on construction activity which would be carried out according to the EPCs, which include significant reductions in PM emissions from diesel construction engines due to the use of ULSD, and the employment of emissions reductions technology which were assumed to remove 40 percent of the PM from tailpipe emissions of all engines of 60 horsepower or greater. If construction were to be carried out in a conventional manner, without these measures, engines larger than 60 horsepower would emit 67 percent more, and smaller engines would emit 16 percent more PM than the emissions assumed here. It is estimated that under those conditions, the maximum predicted increase in PM concentrations would range *from approximately 50 percent to 67percent higher than those presented here for the Proposed Action with EPCs.*

In the immediate vicinity of the site, the increase in maximum PM_{10} concentrations is predicted to range up to a maximum of 21.1 µg/m^3 on a 24-hour basis, and 4.05 µg/m^3 on an annual basis due to the Proposed Action, and a cumulative increase, including other major construction projects, up to 86.0 µg/m^3 and 5.00 µg/m^3 on a 24-hour and annual basis, respectively. The maximum predicted cumulative impacts occur at different locations than those of the Proposed Action.

The predicted increase in maximum $PM_{2.5}$ concentrations in the immediate vicinity of the site would be up to a maximum of *16.5* µg/m^3 and *0.28* µg/m^3 on 24-hour and annual neighborhood scale basis, respectively, due to the Proposed Action, and up to a maximum of *70.2* µg/m^3 and *0.60* µg/m^3 on 24-hour and annual neighborhood scale basis, respectively, including other construction projects. *The predicted cumulative peak 24-hour increments in PM at the nearest residential or hotel locations would be significantly lower—roughly half the highest predicted at the nearest receptor*. Under worst case conditions, the predicted increase in $PM_{2.5}$ concentration exceeds New York City's interim guidance threshold values for both 24-hour and annual values. These values represent the peak construction impacts predicted for both the Proposed Action and cumulative impacts of all reconstruction projects in the immediate vicinity under the worst-case meteorological conditions.

Estimates of the predicted average annual diesel PM emissions from the construction of the Proposed Action in *2008, the second highest year, are 71 percent of the peak construction year (2006); in 2005, annual construction emissions are predicted to be 66 percent of the 2006 estimates; emissions in 2007, 2009 and 2010 are predicted to range from 41 to 47 percent of the peak year; emissions during all other construction years would be approximately 20 percent of the 2006 peak emissions.* Maximum cumulative impacts from all major projects are predicted at locations between the *Project Site* near the proposed FSTC and permanent WTC PATH Terminal sites. Emissions from all major projects are predicted to peak in 2006 and drop off significantly in subsequent years.

Construction activity of the Proposed Action is expected to have a significant adverse impact on $PM_{2.5}$ concentrations in the immediate vicinity of the project site. In consideration of these $PM_{2.5}$ predicted cumulative and Proposed Action impacts, LMDC will further specify the maximum practicable diesel emissions control technology to minimize emissions of particulate matter (see "Mitigation" section below.) concentrations along access roadways are not expected to exceed the interim guidance threshold values, and no significant adverse impact on $PM_{2.5}$ is expected at other locations along the access roads.

The total predicted PM_{10} concentrations presented in Table 21-*12*, including background levels, are not predicted to exceed the NAAQS at any location during construction; the Proposed Action is not predicted to have a significant adverse impact on PM_{10} concentrations. This is largely due to strict control of both engine emissions and fugitive dust emissions.

As discussed above, in years others than 2006, the construction emissions are projected to be substantially less than those estimated for 2006, and therefore, predicted pollutant concentrations resulting from these activities would also be substantially less than those reported in Table 21-12.

Table 21-12
Highest Predicted Total Particulate Matter Concentrations

Pollutant	Average Period	NAAQS [μg/m³]	Receptor Type	Maximum Concentration [μg/m³]	
				Proposed Action	Cumulative
NO_2	Annual	100	Highest—All Receptors	*92.5*	*99.7*
			Residential only	*92.5*	*98.3*
$PM_{2.5}$	24-hour	65	Highest—All Receptors	*63.4*	*117.2*
			Residential only	*59.6*	*83.0*
			Other Locations on Access Routes	*48.1*	*48.1*
	Annual*	15	Construction Area	*17.42*	*17.76*
			Other Locations on Access Routes	*17.14*	*17.16*
PM_{10}	24-hour	150	Highest—All Receptors	*81.6*	*146.4*
			Residential	*72.1*	*97.6*
			Other Locations on Access Routes	*63.6*	*63.7*
	Annual	50	Highest—All Receptors	*30.9*	*32.5*
			Residential	*28.7*	*31.0*
			Other Locations on Access Routes	*28.8*	*28.8*

Notes:
* Annual $PM_{2.5}$ concentrations are neighborhood scale.
All total concentrations include background contributions from local mobile sources, as well as regional background values as follows:
NO_2—Annual average 72 μg/m³
PM_{10}—Annual average 22 μg/m³; 24-hour average 50 μg/m³.
$PM_{2.5}$—Annual average 17.1 μg/m³ (highest of 2000-2002 annual values); 24-hour average 44.0 μg/m³ (highest of the three 2nd highest 24-hour averages in 2000-2002).
Cumulative and Proposed Action maximum concentrations may occur at a different time and/or location.

The highest measured 24-hour $PM_{2.5}$ background concentrations in the region in the years 2000-2002 ranged from 34 to 44 μg/m3. Based on the highest value of 44 μg/m3, it is predicted that, absent mitigation, the total predicted cumulative 24-hour average $PM_{2.5}$ concentrations at locations immediately adjacent to the site would substantially exceed the $PM_{2.5}$ 24-hour NAAQS level of 65 μg/m³. Current annual measured background levels of $PM_{2.5}$ exceed the NAAQS of 15 μg/m³; predicted increments are therefore compared with the threshold levels to determine the significance of impacts, as presented above. All predicted adverse impacts on PM concentrations are addressed in Chapter 22, "Mitigation."

The highest predicted concentration of NO_2 adjacent to the construction site, 92.5 μg/m³ with the Proposed Action only and 99.7 μg/m³ cumulative, were not predicted to exceed the NAAQS. These concentrations were calculated using a conservative NO_2/NO_x transformation ratio of 40 percent; since the receptors at which the highest concentrations were predicted are immediately adjacent to the site, less NO to NO_2 transformation would be likely to occur. Additionally, mitigation proposed to reduce PM would include emissions minimization (such as electrification) and would further reduce NO_x emissions as well. Therefore, actual NO_2 concentrations would likely be lower than those predicted here.

21.6.3 NOISE AND VIBRATION

This section describes the potential effects of elevated noise and vibration levels in and around the Project Site during the peak construction period of 2006. Section 21.7.3.1, "Construction

Noise" describes potential effects from both mobile sources (automobiles and trucks) and stationary sources (primarily construction equipment). Section 21.7.3.2, "Vibration and Ground-Borne Noise" describes the potential effects of construction equipment producing vibration levels and noise through the ground. The "Methodology" sections in both "Noise" and "Vibration and Ground-Borne Noise", provide a description of the applicable guidelines and criteria levels upon which potential effects will be measured against is provided.

METHODOLOGY

A total of five Lower Manhattan Recovery Projects including the Proposed Action, permanent WTC PATH Terminal, Route 9A Reconstruction, South Ferry subway station, and FSTC were considered in the traffic analysis. Three analysis scenarios were developed for the 2006 conditions. As discussed in Section 21.3, the Baseline Condition assumes no construction vehicles from the any of the five aforementioned Lower Manhattan Recovery projects would be included in this noise analyses. The Future Without the Proposed Action scenario includes all noise (mobile and stationary) sources and vibration (stationary construction) sources, from four of the five Lower Manhattan Recovery Projects (without the Proposed Action) were considered in the analyses. The Future With the Proposed Action assumes that all noise and vibration of the five Lower Manhattan Recovery Projects in the noise analyses.

The analyses were conducted for receptors discussed in Chapter 15, "Noise" to determine if construction activities during the peak construction period (2006) would impose unacceptable noise or vibration impacts on the identified structures or their inhabitants. The predominant current noise source affecting these receptors is the traffic on local streets. Based on the proposed construction activity and schedule information developed for the Proposed Action, future construction noise and vibration levels associated with mobile and stationary sources were calculated to identify any adverse impacts at receptors in the project area.

The construction noise analyses were conducted using the *CEQR Technical Manual* and New York State DEC guidelines as appropriate. In addition Federal Transit Administration's (FTA) *"Transit Noise and Vibration Impact Assessment" (1995*) was also employed for noise analyses. It should be noted that HUD guidelines do not provide specific guidance on construction noise analyses. The details of the CEQR, DEC, and FTA guidelines are described in the following sections

21.6.4 NOISE

METHODOLOGY

A total of five Lower Manhattan Recovery Projects including the Proposed Action, permanent WTC PATH Terminal, Route 9A Reconstruction, South Ferry subway station, and FSTC were considered in the traffic analysis. Three analysis scenarios were developed for the 2006 conditions. As discussed in section 21.3, the Baseline Condition assumes no construction vehicles from the any of the five aforementioned Lower Manhattan Recovery projects would be included in this noise analyses. The Future Without the Proposed Action scenario includes all noise (mobile and stationary) sources and vibration (stationary construction) sources from four of the five Lower Manhattan Recovery Projects (without the Proposed Action) were considered in the analyses. The Future With the Proposed Action scenario assumes that all noise and vibration of the five Lower Manhattan Recovery Projects in the noise analyses.

The analyses were conducted for receptors discussed in Chapter 15, "Noise" to determine if construction activities during the peak construction period (2006) would impose unacceptable noise or vibration impacts on the identified structures or their inhabitants. The predominant current noise source affecting these receptors is the traffic on local streets.

Based on the proposed construction activity and schedule information developed for the Proposed Action, future construction noise and vibration levels associated with mobile and stationary sources were calculated to identify any adverse impacts at receptors in the project area.

The construction noise analyses were conducted using the *CEQR Technical Manual* and New York State DEC guidelines as appropriate. In addition, FTA's *"Transit Noise and Vibration Impact Assessment" (1995)* was also employed for noise analyses. It should be noted that HUD guidelines do not provide specific guidance on construction noise analyses. The details of the CEQR, DEC, and FTA guidelines are described in the following sections.

CEQR Noise Criteria

The *CEQR Technical Manua*l contains noise exposure guidelines for use in City environmental impact review. As recommended in the *CEQR Technical Manual*, this study uses the following criteria to define a significant noise impact for construction noise associated with both mobile and stationary construction equipments are:

- An increase of 5 dBA or more in Action $L_{eq(1)}$ noise levels if the existing levels are less than 60 dBA $L_{eq(1)}$ and the analysis period is not a nighttime period.
- An increase of 4 dBA or more in Action $L_{eq(1)}$ noise levels (measured at receptors determined to be sensitive under the Future Without the Proposed Action) if the Existing levels are 61 dBA $L_{eq(1)}$ and the analysis period is not a nighttime period.
- An increase of 3 dBA or more in Action $L_{eq(1)}$ noise levels (measured at receptors determined to be sensitive under the Future Without the Proposed Action scenario) if the Existing levels are greater than 62 dBA $L_{eq(1)}$ and the analysis period is not a nighttime period.
- An increase of 3 dBA or more in Action $L_{eq(1)}$ noise levels (measured at receptors determined to be sensitive under the existing scenario) if the analysis period is a nighttime period (according to CEPO-CEQR standards, between 10 PM and 7 AM).

Based on noise measured at various receptor locations in the project study area, existing 2003 peak noise levels were all greater than 65 dBA (ranging between 66 and 85 dBA). Therefore, the third criteria (bullet) above an increase of 3 dBA or more in Proposed Action noise levels over existing noise levels is the appropriate threshold for noise impact determination.

DEC Guidelines

The 2000 DEC "Assessing and Mitigating Noise Impacts" also contains noise exposure guidelines for use in New York State environmental impact review. As recommended in the 2000 guideline, the criteria to define a significant noise impact for construction noise associated with both mobile and stationary construction equipments are:

- Increases ranging from 0-3 dB should have no appreciable effect on receptors;
- Increases from 3-6 dBA may have potential for adverse noise impact only in cases where the most sensitive of receptors are present;

- Sound level increases of more than 6 dBA may require a closer analysis of impact potential depending on existing sound pressure level (SPL) and the character of surrounding land use and receptors;
- An increase of 10 dBA deserves consideration of avoidance and mitigation measures in most cases;

In addition, the guideline also indicates that "the goal in an industrial/commercial area, where ambient SPLs are already at a high level, should be not to exceed the ambient sound pressure level (SPL)." Since the project area is within the central business district, which experiences high ambient noise levels (65 dBA or greater), this goal should be applicable to Proposed Action construction noise analyses. Based on acoustical principal, SPL of two sounds of same SPLs added together is equal to the single sound SPL plus 3 dBA. In other words, two identical SPLs added together will only add 3 dBA to that SPL. Therefore, an increase of 3 dBA or more in construction noise levels over existing scenario is considered to be the threshold for noise impact determination, the same criteria applicable from CEQR.

FTA Noise Criteria

The FTA guidance manual does not present standardized criteria for assessing airborne noise impacts from construction. However, it does contain criteria for levels that, if exceeded, may result in adverse community reaction; these stated criteria are used as the reference impact criteria for the Proposed Action. These criteria are a function of the land use of the affected areas near a transit project, and day and night 1- and 8-hour L_{eq} noise levels and L_{dn} noise levels.

In the case of construction noise criteria, which are more relevant for this project, FTA guidelines identify a set of threshold L_{eq} and L_{dn} levels for various construction activities. In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient levels by 10 dB or more. The noise criteria and the descriptors used to evaluate construction noise are dependent on the type of land use in the vicinity of the Proposed Action.

Table 21-13 provides the FTA's construction assessment impact values for both the general noise assessment and the detailed noise assessment conducted in accordance with FTA methodologies. For purposes of the impact assessment, an airborne noise impact would occur if noise levels during construction exceeded the FTA-recommended values.

Table 21-13
FTA Construction Noise Criteria

Land Use	One-hour L_{eq} (dBA)		8-hour L_{eq} (dBA)		L_{dn} (dBA)
	Day	Night	Day	Night	30-day Average
Residential	90	80	80	70	75(a)
Commercial	100	100	85	85	80(b)
Industrial	100	100	90	90	85(b)

Notes:
(a) In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient + 10 dB.
(b) Twenty-four hour L_{eq}, not L_{dn}.
Source: Federal Transit Administration, Transit Noise and Vibration Assessment, April 1995.

NOISE SOURCES

Mobile Sources

Assessment of noise levels during the peak construction year 2006 took into account increased noise from any traffic (i.e. truck hauling, driving to work site, detouring and diversion related) increases associated with the five Lower Manhattan Recovery projects expected to be under construction within the study area during 2006.

The changes in noise levels in each case were directly linked to the changes in traffic levels during the peak construction year 2006. To identify the potential for noise impacts at sensitive receptors, a screening analysis were conducted first to identify intersections where future PCEs (passenger car equivalents) would be double that of the existing PCEs, pursuant to the ratios provided in the *CEQR Technical Manual*. This local technical guidance is appropriate given the absence of any other available methodologies for screening of traffic related noise impacts in FTA guidelines. Noise level increases were calculated at the receptors identified in the screening analysis to achieve the threshold rate of traffic volume (PCE) increases. In those cases where the PCEs are at least double the existing PCEs, and where the noise contribution from operation of the proposed project would be considered significant, mitigation measures were assessed. Significant impacts were determined when the predicted traffic noise levels exceed the existing (pre-September 11) noise levels by more than 3 decibels.

Stationary Sources

Noise impacts due to construction activities were evaluated based on information related to the proposed construction activities, such as: time and duration of construction activities; equipment types; and equipment usage cycle.

Airborne noise from construction activities was estimated following the methodologies set forth in the FTA guidance manual and CEQR guidelines. In the case of FTA guidelines, both the general noise assessment and detailed noise assessment procedures were followed. In accordance with the manual, both procedures use an equation that accounts for the noise emissions of the construction equipment, the amount of time the equipment is in use, and the distance between the equipment and the receptor. C*onstruction activities were divided into work zones in which they would occur. Possible pieces of equipment associated with the activity were then placed within the work zones. For the peak and eight-hour analyses, it was conservatively assumed that all pieces of equipment may be placed along the perimeter of a work zone that is closes to the receptor. While this highly conservative method was employed, it is also acknowledged that not all equipment would be within the minimum distance between noise source and receptor. While useful, a second approach called the Average Distance Method was also conducted which places equipment in the middle of a work zone to depict a likely scenario of equipment in the middle of a zone and further away at most times.* The combination of noise from several pieces of (stationary) equipment operating during the same time period is obtained from addition of the noise level values for each piece of equipment.

For the general airborne noise assessment, it was assumed that the two noisiest pieces of equipment operate continuously at the same time. For the detailed airborne noise assessment, 8-hour L_{eq} values and 30-day average L_{dn} values was calculated assuming all appropriate usage factors for the specified time periods.

Typical noise emission levels from equipment such as bulldozers, vibratory compactors, generators, and pile driving operations were documented and utilized as a base to evaluate potential noise impacts at receptor locations in the study area. Noise and vibration impacts from construction activities (excluding vehicular traffic and truck routing) were assessed based on available construction information, such as construction scheduling and type and number of equipment.

Construction noise analyses evaluated potential impacts from various construction-related activities including, as applicable, the following:

- Tunneling (using cut and cover construction, mechanized boring machines).
- Use of heavy equipment such as pavement breakers, jackhammers and saws for breaking street surface (cut-and-cover).
- Underground blasting of rocks.
- Use of backhoes, dump trucks and cable-pulling trucks and other off road and on road heavy duty diesel vehicles.
- Pounding and friction activities such as jackhammers, rock drills, pile drivers and for compaction of sub-grade and other activities.
- Reverberation effect of pile driving for support decks.
- Vehicles traveling over temporary decking (plated trenches).
- Truck trips for mobilization of equipment, delivery of materials, spoils removal, and other needs.
- Increase in traffic and congestion from material delivery and use of private trucks and vehicles by construction workers.
- Clearing, demolition/excavation, and backfilling activities.
- Construction of retaining walls for excavations.
- Underpinning and other subsurface modifications to structures and foundations resulting in increased subsurface conductivity of vibrations.
- Construction and location of batch plant for cement, slurry walls and other uses.
- Use of backhoes and cranes for excavation related to underpinning of structures.
- Engine noise from on road and off road equipment, and idling on site.
- Use of backup horns on equipment.
- Use of enunciators or public address systems.
- Use of ventilation equipment such as air conditioners, pumps, cooling towers, compressors and other circulation devices, during construction and post-construction phases.
- General installation of finished materials within buildings and underground pedestrian connections (structural beams, electrical components, fixtures, tiles, pipes, vents, etc.).
- Increased traffic volume and congestion during construction period due to lane closures or interference with traffic lanes.

NOISE IMPACT ASSESSMENT

Future Without the Proposed Action Scenarios

Mobile Sources

The 2006 Future Without the Proposed Action scenario represents future background condition, including three other major construction projects (permanent WTC PATH Terminal, Route 9A Reconstruction and FSTC) but without the Proposed Action. Also, the South Ferry subway station is not included in this analysis because impacts are not anticipated due to the project's approximately ½ mile distance from the Proposed Action. Given the fact that the predominant noise source in the area is the on-street traffic, including buses and trucks, changes in future 2006 noise levels would be directly related to traffic volume changes in the area. Based on an evaluation of available traffic data information as discussed in Section 21.7.1, the 2006 Future Without the Proposed Action traffic volumes would not change substantially from 2003 existing and pre-September 11 conditions, except for Sites 16 and 17 on Barclay Street, which would carry construction related vehicles and trucks associated with other major construction activities in 2006. As a result, noise level increases associated with mobile sources are not expected to increase substantially (defined as 3 dBA or greater) at most receptor sites, except for sites 16 and 17 on Barclay Street.

Stationary Sources

Noise impacts associated with construction of major development projects, other than WTC, in the study area, were evaluated based on information related to the construction activities, such as: time and duration of the construction activities; equipment types; and equipment usage cycle. On site construction equipment include all stationary and movable equipment and trucks utilized at the Project Site or at adjacent construction areas of other Lower Manhattan projects. Typical noise emission levels from equipment such as bulldozers, jack hammers, vibratory compactors, generators, and dump trucks, etc., were documented and utilized as a base to evaluate potential noise impacts at receptor locations in the study area. Peak one-hour L_{eq}, 8-hour L_{eq}, and 30-day L_{dn} at each of 12 months in 2006 were calculated at each of 22 sites. Summary of Future Without the Proposed Action noise levels are presented in Tables 21-14 through 21-16. As shown in these tables, peak-hour noise levels would exceed CEQR construction noise impact threshold at 12 sites as the result of construction activities associated with all other major construction projects in the area. In addition, peak 8-hour noise levels would exceed FTA criteria at sites 4, 11, 13, 14, and 21 as the result of construction activities associated with all other major construction projects in the area. Furthermore, peak 30-day noise levels would exceed FTA criteria at site 14 as the result of construction activities associated with all other major construction projects in the area.

Table 21-14
Future Without the Proposed Action Noise Levels During Peak Hour CEQR Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2003 Existing Peak-Hour L_{eq} (dBA)	2006 Peak-Hour L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	72	72	*67*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	73	73	*73*	Yes
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	68	68	*74*	Yes
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	67	67	*87*	Yes
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	66	66	*69*	Yes
6	SW corner of Albany St & West Street (parking lot)	Residential	73	73	*78*	Yes
7	Cedar St & Washington St (Fence on Cedar St)	Residential	66	66	*73*	Yes
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	74	74	*73*	*No*
9	4 Albany St	Residential	69	69	*65*	*No*
10	120 Cedar St (on Greenwich St)	Institutional	69	69	*67*	*No*
11	114 Liberty St	Residential	71	71	*78*	*Yes*
12	95 Trinity Building	Institutional	76	76	*71*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	76	76	*83*	Yes
14	Hilton Millenium Hotel-Dey Street	Hotel	72	72	*96*	Yes
15	St. Peter's Church on Church St	Public Facilities & Institutions	75	75	*74*	*No*
16	100 Church Street-Barclay St Entrance	Commercial & Office	72	72	*66*	*No*
17	Barclay St & Washington Street Intersection	Commercial & Office	73	73	*73*	Yes
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	73	73	*69*	No
19	NE corner of Park Pl & West Broadway	Residential	71	71	*65*	No
20	Tower 270-Broadway & Chambers	Residential	75	75	*60*	No
21	NW corner of Broadway & Fulton St	Church	85	85	87	Yes
22	180 Broadway	Residential	76	76	80	Yes
23	Proposed *Fulton Street West*	Park	67	67	NA	NA
24	Proposed WTC Memorial	Park	67	67	NA	NA

Note: Since the existing noise levels all exceeded 65 dBA, the impact threshold defined by CEQR is 3 dBA increase from existing level. In other words, noise impacts occur if construction noise levels equal to existing levels, therefore, resulting in 3 dBA increase in overall noise levels.

Source: The Louis Berger Group, Inc. 2003.

Table 21-15
Future Without the Proposed Action Noise Levels
During a Peak 8-Hour FTA Detailed Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2006 Peak 8-Hour L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	80	*66*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	80	*72*	No
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	80	*73*	No
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	80	*85*	Yes
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	80	*68*	No
6	SW corner of Albany St & West Street (parking lot)	Residential	80	*77*	No
7	Cedar St & Washington St (Fence on Cedar St)	Residential	80	*72*	*No*
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	80	*72*	No
9	4 Albany St	Residential	80	*64*	No
10	120 Cedar St (on Greenwich St)	Institutional	80	*65*	No
11	114 Liberty St	Residential	80	*76*	Yes
12	95 Trinity Building	Institutional	80	*70*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	80	*82*	Yes
14	Hilton Millenium Hotel-Dey Street	Hotel	80	*94*	Yes
15	St. Peter's Church on Church St	Public Facilities & Institutions	80	*74*	No
16	100 Church Street-Barclay St Entrance	Commercial & Office	80	*65*	No
17	Barclay St & Washington Street Intersection	Commercial & Office	85	*67*	No
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	85	*64*	No
19	NE corner of Park Pl & West Broadway	Residential	80	*64*	No
20	Tower 270-Broadway & Chambers	Residential	80	*59*	No
21	NW corner of Broadway & Fulton St	Church	80	*85*	Yes
22	180 Broadway	Residential	80	78	No
23	Proposed *Fulton Street West*	Park	80	NA	NA
24	Proposed WTC Memorial	Park	80	NA	NA

Source: **The Louis Berger Group**, Inc. 2003.

Table 21-16
Future Without the Proposed Action Noise Levels During Peak 30-Day Period FTA Detailed Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2003 Existing L_{eq} (dBA)	2006 Peak 30-day L_{dn}/L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	87	77	*60*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	88	78	*68*	No
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	81	71	*69*	No
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	82	72	*81*	*No*
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	77	67	*63*	No
6	SW corner of Albany St & West Street (parking lot)	Residential	87	77	*72*	No
7	Cedar St & Washington St (Fence on Cedar St)	Residential	75	65	*68*	*No*
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	85	75	*67*	No
9	4 Albany St	Residential	79	69	*59*	No
10	120 Cedar St (on Greenwich St)	Institutional	80	70	*60*	No
11	114 Liberty St	Residential	81	71	*71*	No
12	95 Trinity Building	Institutional	88	78	*63*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	85	75	*73*	No
14	Hilton Millenium Hotel-Dey Street	Hotel	84	74	*93*	*Yes*
15	St. Peter's Church on Church St	Public Facilities & Institutions	85	75	*69*	No
16	100 Church Street-Barclay St Entrance	Commercial & Office	81	71	*60*	No
17	Barclay St & Washington Street Intersection	Commercial & Office	80	70	*63*	No
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	79	69	*60*	No
19	NE corner of Park Pl & West Broadway	Residential	83	73	*59*	No
20	Tower 270-Broadway & Chambers	Residential	86	76	*54*	No
21	NW corner of Broadway & Fulton St	Church	90	80	*83*	No
22	180 Broadway	Residential	89	79	*77*	No
23	WTC Bathtub	Proposed *Fulton Street West*	NA	NA	NA	NA
24	WTC Bathtub	Proposed Memorial Area	NA	NA	NA	NA

Note: 30-day L_{dn} is calculated for residential receptors, while 30-day Leq is calculated for commercial receptors per FTA methodology
Source: The Louis Berger Group, Inc. 2003.

FUTURE WITH THE PROPOSED ACTION

Noise levels and associated impacts during the construction of the WTC were analyzed. The results of the noise analysis are presented in the following discussion.

Mobile Sources

Noise levels during the peak construction year 2006 took into account increased noise from any traffic (i.e. truck hauling, driving to work site, detouring and diversion related) increases associated with other major development projects that have been approved, are in the process of being approved for construction, or are expected to be implemented by 2006 in the study area.

Noise impacts during the peak construction year 2006 for the Proposed Action scenario were evaluated by comparing the noise levels as described earlier in Section 21.3. The changes in noise levels in each case were directly linked to the changes in traffic levels during the peak construction year 2006. To identify the potential for noise impacts at sensitive receptors, a screening analysis were conducted first to identify roadway links where future PCEs would be double that of the existing PCEs, pursuant to the ratios provided in the CEQR Technical Manual. Noise level increases were calculated at the receptors identified in the screening analysis to achieve the threshold rate of traffic volume (PCE) increases. In those cases where the PCEs are at least double the existing PCEs and where the noise contribution from operation of the proposed project would be considered significant, mitigation measures were assessed. Significant impacts were determined when the predicted traffic noise levels exceeded the existing (pre-September 11) noise levels by more than 3 decibels.

Projected increases in noise levels as the result of the construction-related traffic volumes or associated PCEs in 2006 were calculated utilizing proportional methods, and are presented in Tables 21-17 and 21-19. As a result, 2006 Proposed Action traffic volumes would not change substantially from those of existing condition, except for Site 11 on Liberty Street and Sites 16 and 17 on Barclay Street. Therefore, noise level increases associated with mobile sources are not expected to increase substantially at most receptor sites, except for Sites 11, 16 and 17.

Future 2006 Proposed Action traffic volumes would experience 100% or more increases from Pre-September 11 condition at Site 17 on Barclay Street. In addition, 2006 Proposed Action traffic volumes would experience 100 percent or more increases from those of Future Without the Proposed Action Scenario at Site 11 on Liberty Street and Site 17 on Barclay Street. Therefore, noise level associated with mobile sources are not expected to increase substantially from (3 dBA or more) Pre-September 11 or Future Without the Proposed Action Scenarios at most receptor sites, except for Sites 11, 16 and 17.

Table 21-17
Traffic Volume, PCEs, Noise Level Differences
Future With the Proposed Action 2006 vs. 2003 Existing

Site ID	Site Name and Address	Land Use	Existing Volume	Existing PCE	2006 Future with the Proposed Action Traffic	2006 Action PCE	Percent Increase	dBA Increase
1	PS 89 Playground on West St	Public Facilities & Institutions	4,324	8,929	*4,648*	*12,566*	*40.7%*	*1.5*
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	4,454	9,222	*4,923*	*13,120*	*42.3%*	*1.5*
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	4,448	8,963	*4,741*	*11,572*	*29.1%*	*1.1*
4	World Financial Center / Dow Jones, on West St	Bikeway	4,280	10,192	*4,567*	*13,005*	*27.6%*	*1.1*
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	468	1,474	*493*	*1,553*	*5.4%*	*0.2*
6	SW corner of Albany St & West Street (parking lot)	Residential	3,692	7,421	*4,129*	*10,683*	*43.9%*	*1.6*
7	Cedar St & Washington St (Fence on Cedar St)	Residential	30	-	*0*	*0*	*-*	*-*
8	Marriott Hotel-85 West Street, side of Albany St.	Hotel	-	-	*0*	*0*	*-*	*-*
9	4 Albany St	Residential	-	-	*0*	*0*	*-*	*-*
10	120 Cedar St (Greenwich St)	Institutional	-	-	*0*	*0*	*-*	*-*
11	114 Liberty St	Residential	50	158	*76*	*928*	*487.1%*	*7.7*
12	95 Trinity Building	Institutional	765	5,386	*813*	*5,896*	*9.5%*	*0.4*
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public Open Space	765	5,386	*889*	*7,030*	*30.5%*	*1.2*
14	Hilton Millenium Hotel-Dey St.	Hotel	890	5,571	*1,147*	*8,447*	*51.6%*	*1.8*
15	St. Peter's Church on Church St	Public Facilities & Institutions	985	6,836	*1,099*	*9,254*	*35.4%*	*1.3*
16	100 Church Street-Barclay St Entrance	Commercial & Office	135	571	*138*	*1,502*	*163.1%*	*4.2*
17	Barclay St & Washington Street	Commercial & Office	50	212	*231*	*1,730*	*716.2%*	*9.1*
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	-	-	*53*	*120*	*-*	*-*
19	NE corner of Park Pl & West Broadway	Residential	164	-	*40*	*88*	*-*	*-*
20	Tower 270-Broadway & Chambers	Residential	1,768	8,150	*2,050*	*10,238*	*25.6%*	*1.0*
21	NW cor. Of Broadway & Fulton St	Church	1,152	4,689	*1,240*	*5,849*	*24.7%*	*1.0*
22	180 Broadway	Residential	1,000	4,310	*1,240*	*6,140*	*42.5%*	*1.5*
23	WTC Bathtub	Proposed *Fulton Street West*	4,280	10,192	*4,566*	*13,003*	*27.6%*	*1.1*
24	WTC Bathtub	Proposed Memorial Area	4,280	10,192	*4,567*	*13,005*	*27.6%*	*1.1*

Note: Blank cell represents that data is not available or traffic difference is negligible.
Source: The Louis Berger Group, Inc. 2003.

Table 21-18
Traffic Volume, PCEs, Noise Level Differences (2006 vs. Pre-September 11)
(Proposed Action vs. Pre-September 11)

Site ID	Site Name and Address	Land Use	Pre-September 11 Volume	Pre-September 11 PCE	2006 Action Traffic	2006 Action PCE	Percent Increase	dBA Increase
1	PS 89 Playground on West St	Public Facilities & Institutions	4,791	8,929	4,648	12,566	40.7%	1.5
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	5,096	9,222	4,923	13,120	42.3%	1.5
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	4,998	10,071	4,741	11,572	14.9%	0.6
4	World Financial Center/Dow Jones, on West St	Bikeway	5,208	10,192	4,567	13,005	27.6%	1.1
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	469	1,477	493	1,553	5.1%	0.2
6	SW corner of Albany St & West Street (parking lot)	Residential	5,410	10,874	4,129	10,683	-1.8%	-0.1
7	Cedar St & Washington St (Fence on Cedar St)	Residential	40	-	0	0	-	-
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	121	-	0	0	-	-
9	4 Albany St	Residential	55	-	0	0	-	-
10	120 Cedar St (on Greenwich St)	Institutional	371	864	0	0	-	-
11	114 Liberty St	Residential	300	945	76	928	-1.8%	-0.1
12	95 Trinity Building	Institutional	1,140	8,026	813	5,896	-26.5%	-1.3
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public Open Space	1,255	8,835	889	7,030	-20.4%	-1.0
14	Hilton Millenium Hotel-Dey Street	Hotel	1,625	10,173	1,147	8,447	-17.0%	-0.8
15	St. Peter's Church on Church St	Public Facilities & Institutions	1,710	11,867	1,099	9,254	-22.0%	-1.1
16	100 Church Street-Barclay St Entrance	Commercial & Office	346	848	138	1,502	77.2%	2.5
17	Barclay St & Washington Street Intersection	Commercial & Office	146	358	231	1,730	383.3%	6.8
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	404	941	53	120	-87.3%	-9.0
19	NE corner of Park Pl & West Broadway	Residential	1,064	2,415	40	88	-96.4%	-14.4
20	Tower 270-Broadway & Chambers	Residential	1,690	7,791	2,050	10,238	31.4%	1.2
21	NW corner of Broadway & Fulton St	Church	1,180	4,803	1,240	5,849	21.8%	0.9
22	180 Broadway	Residential	1,010	4,353	1,240	6,140	41.1%	1.5
23	WTC Bathtub	Under Construction	5,208	10,192	4,566	13,003	27.6%	1.1
24	WTC Bathtub	Under Construction	5,208	10,192	4,567	13,005	27.6%	1.1

Note: Black cell represents that data is not available or traffic difference is negligible.
Source: The Louis Berger Group, Inc. 2003.

Table 21-19
Traffic Volume, PCEs, Noise Level Differences
Action 2006 vs. Future Without the Proposed Action 2006

Site ID	Site Name and Address	Land Use	2006 Future Without the Proposed Action Traffic	2006 Future Without the Proposed Action PCE	2006 Action Traffic	2006 Action PCE	Percent Increase	dBA Increase
1	PS 89 Playground on West St	Public Facilities & Institutions	4,352	9,793	4,648	12,566	19.3%	0.8
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	4,352	9,793	4,923	13,120	18.3%	0.7
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	3,324	6,718	4,741	11,572	9.6%	0.4
4	World Financial Center/Dow Jones, on West St	Bikeway	4,302	11,117	4,567	13,005	9.1%	0.4
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	494	1,569	493	1,553	0.0%	0.0
6	SW corner of Albany St & West Street (parking lot)	Residential	4,079	8,806	4,129	10,683	8.0%	0.3
7	Cedar St & Washington St (Fence on Cedar St)	Residential	0	0	0	0	-	-
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	0	0	0	0	-	-
9	4 Albany St	Residential	0	0	0	0	-	-
10	120 Cedar St (on Greenwich St)	Institutional	0	0	0	0	-	-
11	114 Liberty St	Residential	58	239	76	928	204.4%	4.8
12	95 Trinity Building	Institutional	813	5,951	813	5,896	0.0%	0.0
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public Open Space	858	6,040	889	7,030	9.7%	0.4
14	Hilton Millenium Hotel-Dey Street	Hotel	1,123	7,645	1,147	8,447	10.3%	0.4
15	St. Peter's Church on Church St	Public Facilities & Institutions	1,103	8,328	1,099	9,254	14.6%	0.6
16	100 Church Street-Barclay St Entrance	Commercial & Office	178	1,577	138	1,502	209.1%	4.9
17	Barclay St & Washington Street Intersection	Commercial & Office	200	710	231	1,730	142.4%	3.8
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	0	0	53	120	0.0%	0.0
19	NE corner of Park Pl & West Broadway	Residential	0	0	40	88	0.0%	0.0
20	Tower 270-Broadway & Chambers	Residential	1,091	5,640	2,050	10,238	1.6%	0.1
21	NW corner of Broadway & Fulton St	Church	1,191	5,470	1,240	5,849	2.9%	0.1
22	180 Broadway	Residential	1,191	5,750	1,240	6,140	2.7%	0.1
23	WTC pit	Under Construction	4,302	11,117	4,566	13,003	9.1%	0.4
24	WTC pit	Under Construction	4,302	11,117	4,567	13,005	9.1%	0.4

Note: Blank cell represents that data is not available or traffic difference is negligible.
Source: The Louis Berger Group, Inc. 2003.

Stationary Sources

Noise and vibration impacts due to construction activities were evaluated based on information related to the proposed construction activities, such as: time and duration of the construction activities; equipment types; and equipment usage cycle. Typical noise and vibration emission levels from equipment such as bulldozers, jack hammers, vibratory compactors, generators, and dump trucks, etc. were documented and utilized as a basis to evaluate potential noise impacts at receptor locations in the study area. Noise and vibration impacts from construction activities (excluding vehicular traffic and truck routing) were assessed based on available construction information, such as construction scheduling, type and number of equipment utilized in each construction phase, and equipment locations within the construction zones.

Based on existing noise level measurement results and future traffic increases in the area adjacent to the proposed WTC Site, existing noise levels range between 65 and 85 dBA and future noise levels would be approximately the same or greater than those of existing condition. The noise levels are consistently above 65 dBA during most of day and evening hours and represent typical conditions of busy urban environments in the area. The major noise sources are vehicular traffic (i.e. commuter buses, delivery and garbage trucks, helicopters, police sirens, human voices, etc.). Nevertheless, even with these relatively high ambient airborne noise levels, construction activities associated with the Proposed Action would be expected, at times, to cause noticeable and substantial increases in noise levels. The times and locations where these increased noise conditions would occur would vary depending on the location of construction, the equipment and construction methods employed, and the distance between the noise source and the receptor. Because the Project Site is within close proximity to sensitive land uses (e.g., residential uses), the construction activities have the potential to result in perceptible changes in noise levels that may result in annoyance to nearby residents and office workers. Construction of the Proposed Action would occur close to active land uses due to close proximity of the existing neighborhoods in the area. Since most construction activities could take place 10 hours a day, significant airborne noise impacts may occur not only during the day, but also during nighttime and weekend periods. However, several of the noisiest activities, such as pile driving, would not occur during night time hours for the Proposed Action.

Both a general assessment and a detailed assessment were performed to examine the potential for noise impacts during construction. In order to calculate construction noise levels at each sensitive receptor, a set of noise emission levels and acoustical usage factors associated with construction equipment, which are expected to be utilized in the construction of the Proposed Action, are presented in Table 21-*20*. Since the construction equipment is not expected to run under full power for 100 percent of the time, an Acoustical Usage Factor is assigned to each piece of the equipment based on equipment usage cycles recommended by the equipment manufacturers. The Acoustical Usage Factor represents the percent of time that equipment is assumed to be running at full power while working on site.

Table 21-*20*
Proposed Action Construction Equipment
Noise Emission Levels and Acoustical Useage Factors

Equipment Description	Emission Levels at 50 feet (dB)	Acoustic Usage Factor
All other equipment > 5 HP	85	50%
Auger Drill Rig	85	20%
Backhoe	80	40%
Chain Saw	85	20%
Clam Shovel	93	20%
Compactor (ground)	82	20%
Compressor (air)	81	40%
Concrete Batch Plant	83	15%
Concrete Mixer Truck	85	40%
Concrete Truck Idle	*75*	*100%*
Concrete Pump	82	20%
Concrete Saw	90	20%
Concrete Vibrator	76	40%
Crane (mobile or stationary)	83	20%
Derrick Crane	88	20%
Dozer	85	40%
Dump Truck / *Dump Truck Idle*	88/*78*	40%/*100%*
Excavator	85	40%
Flat Bed Truck	84	40%
Front End Loader	85	40%
Generator	81	100%
Generator (25 KVA or less)	70	50%
Grader	85	40%
Horizontal Boring Hydraulic Jack	80	25%
Impact Pile Driver (diesel or drop)	101	20%
Impact Wrench	85	20%
Insitu Soil Sampling Rig	84	20%
Jackhammer	88	20%
Mounted Impact Hammer (hoe ram)	90	20%
Paver	89	50%
Pickup Truck	55	40%
Pneumatic Tools	85	50%
Pumps	76	50%
Rock Drill	98	20%
Roller	74	20%
Saw	76	40%
Scarifier	83	40%
Scraper	89	40%
Shovel	82	20%
Slurry Plant	78	100%
Slurry Trenching Machine	82	50%
Soil Mix Drill Rig	80	50%
Spike Driver	77	20%
Tractor	84	40%
Vacuum Street Sweeper	80	10%
Vibratory Concrete Mixer	80	20%
Vibratory Pile Driver	96	20%
Welder	73	40%

Notes: Noise emission levels and acoustical usage factors are developed based on information provided in the FTA "Transit Noise and Vibration Impact Assessment", 1995 and Parsons Brinckerhoff "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", 2000. Acoustical Usage Factor represents the percent of time that equipment is assumed to be running at full power while working on site.
Source: FTA "Transit Noise and Vibration Impact Assessment", April 1995 and Noise Control Engineering, J. 48 (5), modified by The Louis Berger Group, Inc. 2003.

In addition, typical peak hour L_{eq} noise levels for various types of construction equipment are presented in 21-21. As can be seen from Table 21-22, equipment with higher noise emission levels do not necessarily result in higher hourly L_{eq} levels, since the L_{eq} levels, averaged out over a one-hour period by taking the Acoustical Usage Factor into consideration . In other words, a piece of equipment with higher emission level but a small acoustical usage factor, which means it operated under full power for small portions of time, may result in a lower L_{eq} level than another piece of equipment with a middle range of noise emission level but very high acoustical usage factor. Furthermore, noise levels generally decrease as the distances between receptors and sources increase. Noise from construction equipment located at closer distances, e.g., 20 feet, can reach very high levels. However, noise levels can be substantially reduced at larger distances, e.g., 400 feet, even for louder equipment. For WTC construction, some sensitive receptors are located within close distances (within 100 feet) of the proposed construction activities and, therefore, would unavoidably experience high construction noise levels.

Table 21-21
Proposed Action Typical Noise Levels for Peak Hour Construction at Various Distances from Equipment Sources[1]

Equipment Utilized	Quantity	L_{max} (dBA) at 50 feet	Acoustical Usage Factor	One-Hour L_{eq} (dBA)						
				20 ft	50 ft	60 ft	100 ft	200 ft	300 ft	400 ft
Air Compressor	2	81	40%	88	80	78	74	68	64	62
Backhoe	2	80	40%	87	79	77	73	67	63	61
Wheel loader	2	85	40%	92	84	82	78	72	68	66
Dump truck	2	88	40%	95	87	85	81	75	71	69
Hydraulic truck crane	1	83	20%	84	76	74	70	64	60	58
Crawler crane	1	83	20%	84	76	74	70	64	60	58
Jack Hammer	3	88	20%	94	86	84	80	74	70	68
Water pump	2	76	50%	84	76	74	70	64	60	58
Portable generator	2	81	50%	89	81	79	75	69	65	63
Pick up truck	2	55	40%	62	54	52	48	42	38	36
Pile driver	1	101	20%	102	94	92	88	82	78	76
Compactor	1	82	20%	83	75	73	69	63	59	57
Space heater(propane), Chainsaw(gasoline), Welding machine (diesel)	3	85	50%	95	87	85	81	75	71	69
Overall Leq				105	97	95	91	85	81	79
Top-Two Leq				103	95	93	89	83	79	77

Notes: Shaded cells indicate noise levels exceed FTA criteria.
Source: The Louis Berger Group, Inc. November 14, 2003.

Based on construction plans and schedules, including equipment list, location, hours of operation, etc., histograms of noise levels in peak-hour L_{eq}, 8-hour L_{eq}, and 30-day L_{dn} were calculated *based on a [highly] conservative assumption that all noise emitting equipment at each construction site would be located at the portion of the site adjacent to the receptor*. The results of the predicted peak construction noise levels are summarized and presented in Tables 21-22 through 21-25. Noise levels *under this assumption* would exceed CEQR criteria at all receptor locations evaluated, except for sites 1, *12, and 18 to* 20. In addition, peak 8-hour noise levels would exceed FTA criteria at sites 4, 7 through 11, 13 through 15, and 21 as the result of construction activities associated with all major construction projects in the area. Peak 30-day noise levels would also exceed FTA criteria at sites 4, 7, 9 through 11, and 14. *Under the less conservative but more likely assumption that noise sources are spread over each construction site, anticipated noise levels would be reduced at all receptors. When the average distance method is employed for the peak 30-day analysis, there would be no exceedances at any of the receptor locations.*

It is noted that the average distance method is applicable only to the 30-day peak analysis. The peak hour and peak 8-hour analyses are intended to identify the highest one hour and eight periods throughout the construction period while the 30-day analysis only identifies the highest noise levels of each of the monthly average noise levels. Averaging construction noise levels during any one or eight hour period would not provide the true maximum noise levels. The monthly average noise levels are obtained by averaging the decibel levels of every minute of construction activity in each month. The highest, or peak month, represents the peak 30-day noise levels.

Table 21-22
Proposed Action 2006 Construction Noise Levels During Peak Hour CEQR Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2003 Existing Peak-Hour L_{eq} (dBA)	2006 Peak-Hour L_{eq} (dBA)	Cumulative Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	72	72	68	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	73	73	75	Yes
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	68	68	76	Yes
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	67	67	87	Yes
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	66	66	71	Yes
6	SW corner of Albany St & West Street (parking lot)	Residential	73	73	78	Yes
7	Cedar St & Washington St (Fence on Cedar St)	Residential	66	66	92	Yes
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	74	74	83	Yes
9	4 Albany St	Residential	69	69	92	Yes
10	120 Cedar St (on Greenwich St)	Institutional	69	69	92	Yes
11	114 Liberty St	Residential	71	71	89	Yes
12	95 Trinity Building	Institutional	76	76	74	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	76	76	87	Yes
14	Hilton Millenium Hotel-Dey Street	Hotel	72	72	97	Yes
15	St. Peter's Church on Church St	Public Facilities & Institutions	75	75	83	Yes
16	100 Church Street-Barclay St Entrance	Commercial & Office	72	72	71	No
17	Barclay St & Washington Street Intersection	Commercial & Office	73	73	73	Yes
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	73	73	70	No
19	NE corner of Park Pl & West Broadway	Residential	71	71	70	No
20	Tower 270-Broadway & Chambers	Residential	75	75	64	No
21	NW corner of Broadway & Fulton St	Church	85	85	87	Yes
22	180 Broadway	Residential	76	76	80	Yes
23	WTC Bathtub	Proposed Fulton Street West	67	67	Non-Existing	NA
24	WTC Bathtub	Proposed Memorial	67	67	Non-Existing	NA

Table 21-23
Proposed Action 2006 Construction Noise Levels
During Peak 8-Hour FTA Detailed Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold	2006 Peak 8-Hour L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	80	*66*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	80	*74*	No
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	80	*75*	No
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	80	*86*	Yes
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	80	*69*	No
6	SW corner of Albany St & West Street (parking lot)	Residential	80	*77*	*No*
7	Cedar St & Washington St (Fence on Cedar St)	Residential	80	*92*	Yes
8	Marriott Hotel-85 West Street, side of Albany Street	Hotel	80	*82*	Yes
9	4 Albany St	Residential	80	*92*	Yes
10	120 Cedar St (on Greenwich St)	Institutional	80	*92*	Yes
11	114 Liberty St	Residential	80	*88*	Yes
12	95 Trinity Building	Institutional	80	*72*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	80	*86*	Yes
14	Hilton Millenium Hotel-Dey Street	Hotel	80	*95*	Yes
15	St. Peter's Church on Church St	Public Facilities & Institutions	80	*81*	Yes
16	100 Church Street-Barclay St Entrance	Commercial & Office	80	*70*	No
17	Barclay St & Washington Street Intersection	Commercial & Office	85	*71*	No
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	85	*69*	No
19	NE corner of Park Pl & West Broadway	Residential	80	*68*	No
20	Tower 270-Broadway & Chambers	Residential	80	*65*	No
21	NW corner of Broadway & Fulton St	Church	80	*85*	Yes
22	180 Broadway	Residential	80	*79*	No
23	WTC Bathtub	Proposed *Fulton Street West*	80	NA	NA
24	WTC Bathtub	Proposed Memorial	80	NA	NA

Table 21-24
Proposed Action 2006 Construction Noise Levels
During Peak 30-Day Period FTA Detailed Analysis

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2003 Existing L_{dn} (dBA)	2006 Peak 30-day L_{dn}/L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	87	77	*62*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	88	78	*69*	No
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	81	71	*71*	No
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	82	72	*82*	Yes
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	77	67	*65*	No
6	SW corner of Albany St & West Street (parking lot)	Residential	87	77	*72*	No
7	Cedar St & Washington St (Fence on Cedar St)	Residential	75	65	*87*	Yes
8	Marriott Hotel-85 West Street, side of Albany Street	Residential	85	75	*77*	No
9	4 Albany St	Residential	79	69	*87*	Yes
10	120 Cedar St (on Greenwich St)	Institutional	80	70	*87*	Yes
11	114 Liberty St	Residential	81	71	*82*	Yes
12	95 Trinity Building	Institutional	88	78	*66*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	85	75	*80*	No
14	Hilton Millenium Hotel-Dey Street	Hotel	84	74	*93*	Yes
15	St. Peter's Church on Church St	Public Facilities & Institutions	85	75	*76*	No
16	100 Church Street-Barclay St Entrance	Commercial & Office	81	71	*65*	No
17	Barclay St & Washington Street Intersection	Commercial & Office	80	70	*67*	No
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	79	69	*64*	No
19	NE corner of Park Pl & West Broadway	Residential	83	73	*63*	No
20	Tower 270-Broadway & Chambers	Residential	86	76	*57*	No
21	NW corner of Broadway & Fulton St	Church	90	80	*83*	No
22	180 Broadway	Residential	89	79	*77*	No
23	Proposed WTC Memorial	Park	NA	NA	Non-Existing	NA
24	Proposed WTC Memorial	Park	NA	NA	Non-Existing	NA

Note: 30-day L_{dn} is calculated for residential receptors, while 30-day L_{eq} is calculated for commercial receptors per FTA methodology.

Source: The Louis Berger Group, Inc., 2003.

Table 21-25
Proposed Action 2006 Construction Noise Levels
During Peak 30-Day Period FTA Detailed Analysis – Average Distance Method

Site ID	Site Name and Address	Land Use	Criteria Threshold (dBA)	2003 Existing L_{dn} (dBA)	2006 Peak 30-day L_{dn}/L_{eq} (dBA)	Impact?
1	PS 89 Playground on West St	Public Facilities & Institutions	87	77	*56*	No
2	NW Corner of Murray St & West St	Open Space & Outdoor Recreation	88	78	*65*	No
3	Embassy Suites & Regal Cinemas on Vesey St	Hotel	81	71	*65*	No
4	World Financial Center/Dow Jones, side of West St (Vesey St & Liberty St)	Bikeway	82	72	*73*	*No*
5	Gateway Plaza (corner of Liberty St & South End Av)	Residential	77	67	*60*	No
6	SW corner of Albany St & West Street (parking lot)	Residential	87	77	*59*	No
7	Cedar St & Washington St (Fence on Cedar St)	Residential	75	65	*74*	*No*
8	Marriott Hotel-85 West Street, side of Albany Street	Residential	85	75	*70*	No
9	4 Albany St	Residential	79	69	*72*	*No*
10	120 Cedar St (on Greenwich St)	Institutional	80	70	*73*	*No*
11	114 Liberty St	Residential	81	71	*73*	*No*
12	95 Trinity Building	Institutional	88	78	*67*	No
13	SE corner of Liberty St & Trinity Pl (at Park corner)	Public open space	85	75	*72*	No
14	Hilton Millenium Hotel-Dey Street	Hotel	84	74	*74*	*No*
15	St. Peter's Church on Church St	Public Facilities & Institutions	85	75	*72*	No
16	100 Church Street-Barclay St Entrance	Commercial & Office	81	71	*61*	No
17	Barclay St & Washington Street Intersection	Commercial & Office	80	70	*63*	No
18	Park Pl & Greenwich St (corner of BMCC)	Commercial & Office	79	69	*61*	No
19	NE corner of Park Pl & West Broadway	Residential	83	73	*60*	No
20	Tower 270-Broadway & Chambers	Residential	86	76	*54*	No
21	NW corner of Broadway & Fulton St	Church	90	80	*64*	No
22	180 Broadway	Residential	89	79	*59*	No
23	Proposed WTC Memorial	Park	NA	NA	Non-Existing	NA
24	Proposed WTC Memorial	Park	NA	NA	Non-Existing	NA

Note: 30-day L_{dn} is calculated for residential receptors, while 30-day L_{eq} is calculated for commercial receptors per FTA methodology.
Source: The Louis Berger Group, Inc., 2003.

21.6.5 VIBRATION

The effects of ground-borne vibration include the discernable movement of building floors, rattling of windows, shaking of items on shelves or hangings on walls, and rumbling sounds. The rumble is the noise radiated from the motion of the room surfaces. In extreme cases, the vibration can cause damage to buildings. The amount of vibration energy is strongly dependant on such factors as the strength and frequency of the impacts. The vibration of the impact point "excites" the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. As the vibration propagates from the foundation through the remaining building structure, certain resonant, or natural, frequencies of various components of the building are excited.

Vibration consists of rapidly fluctuating motions with an average motion of zero. Because the net average of a vibration signal is zero, the root mean square (rms) amplitude is used to describe the average vibration amplitude. The rms of a signal is the average of the squared amplitude of the signal. The average is typically calculated over a one-second period. Decibel notation is commonly used for vibration. It acts to compress the range of numbers required to describe vibration. The approximate threshold of human perception for vibration is 65 VdB, and the approximate level of human annoyance for infrequent events is 85 VdB.

METHODOLOGY

FTA Construction Ground-Borne Noise Criteria

The FTA has developed impact criteria for ground-borne vibration causing human annoyance or interfering with the use of vibration-sensitive equipment, as contained in the *Transit Noise and Vibration Impact Assessment*. (CEQR and DEC Guidelines do not address vibration and ground-borne noise). The criteria are based on the maximum levels for a single event and take into account the frequency and duration of events by distinguishing between frequent and infrequent events, where frequent is defined as more than 70 events per day (see Table 21-26). The criteria are expressed in terms of root mean square (rms) velocity levels in decibels. The limits are specified for three land use categories: high sensitivity, residential and institutional. High sensitivity land uses consist of buildings where low ambient vibration is essential for interior operations. High sensitivity uses include vibration-sensitive research and manufacturing sites, and hospitals with vibration-sensitive equipment. The impact criteria for people in buildings subject to ground-borne vibration and noise from trains is based on *Transit Noise and Vibration Impact Assessment* (see Table 21-26).

Institutional vibration category 1 includes buildings where low ambient vibration is essential for the operations within the building. Such uses include vibration-sensitive research facilities, hospitals, and other uses that require precision. Memorials and historic buildings, particularly those consisting of plaster, are potentially sensitive to damage from frequent vibration levels higher than 65 VdB. Category 2 consists of all residential uses and any buildings where people sleep, such as hotels. Category 3 includes institutional uses, such as schools, churches, and quiet offices that do not have vibration-sensitive equipment but still have the potential for activity interference. Although it is generally appropriate to include office buildings in this category, it is not appropriate to include all office space. For example, most industrial buildings have office space, but buildings used primarily for industrial purposes are not intended to be included in this category. Industrial buildings are often categorized in the "ISO Workshop" environment at approximately 90 VdB. There are no primarily industrial buildings with ancillary offices within the study area.

Table 21-26
Ground-borne Vibration and Noise Impact Criteria

Land Use Category	Ground-borne Vibration Impact Levels (VdB re 1 micro inch/sec)		Ground-borne Noise Impact Levels (dBA re 20 micro pascals)	
	Frequent Events	Infrequent Events	Frequent Events	Infrequent Events
Category 1: Buildings where vibration would interfere with interior operations.	65	65	N/A	N/A
Category 2: Residences and buildings where people normally sleep.	72	80	35	43
Category 3: Institutional land uses with primarily daytime use.	75	83	40	48

Notes:
1. Frequent Events are defined as more than 70 vibration events per day.
2. Infrequent Events are defined as fewer than 70 vibration events per day.
3. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
4. Vibration-sensitive equipment is not sensitive to ground-borne noise.

Source: FTA Transit Noise and Vibration Impact Assessment, 1995.

FTA Construction Vibration Criteria

The threshold criteria defined by FTA and/or U.S. Bureau of Mines (USBM) was considered as appropriate for cumulative vibration impact assessment. In the case of fragile or extremely fragile buildings, threshold criteria defined by FTA were utilized. For example, fragile buildings experiencing future peak particle velocity (PPV) at or above 0.12 inch per second (ips) as a result of the Proposed Action construction activities were identified, since that level is the impact threshold for extremely fragile historic buildings as defined by FTA. In case of plaster damage to normal buildings, criteria defined by the USBM were utilized. For example, normal buildings experiencing future PPV at or above 0.5 ips as a result of the Proposed Action construction activities were identified, since that level is the plaster damage threshold for normal buildings as defined by USBM.

The primary sources for potential vibration and ground-borne noise in the project area are the existing underground subway facilities, which are located underneath and within the bathtub and footprints, and the No. 1/9 Route and N/R/E subway lines, which are located under Greenwich Street at the WTC Site and to the north of the WTC Site, respectively. Field observations made during the ambient noise measurements indicate that none of these existing facilities result in any noticeable vibration and ground-borne noise in the project area.

CONSTRUCTION VIBRATION AND GROUND-BORNE NOISE IMPACT ASSESSMENT

Similar to the Noise analyses, the vibration and ground-borne noise analyses conducted used three scenarios: Baseline Conditions; Future Without the Proposed Action, and Proposed Action

2006. The vibration levels in 2006 were compared with the FTA threshold criteria that have been established for stationary construction equipment.

Future Without the Proposed Action Scenarios

Mobile Sources

The 2006 Future Without the Proposed Action scenario represents future background condition, including three other major construction projects (permanent WTC PATH Terminal, Route 9A Reconstruction and FSTC) but Without the Proposed Action. Based on Federal Highway Administration (FHWA) research, vehicular traffic on the city streets with relatively good conditions (e.g. no large pot holes, etc.) usually generates minimal amount of vibration. Therefore, there would not be any significant vibration impacts from mobile sources.

Stationary Sources

Noise impacts associated with on-site construction activities of major development projects, other than the Proposed Action, in the study area, were evaluated based on information related to the construction activities for each of these projects. Due to the nature of the vibration event, the magnitude of the vibration peaks usually are correlated with the maximum force at the moment of impacts and last only 0.1 second or less. The vibration impacts usually degrade rapidly over distance and time. Therefore, it is very rare that two or multiple impacts could occur at the exact same moment and at the same location. In other words, two peak vibration levels generated by the impact equipments are not additive. However, vibration generated from vibratory pile drivers may have cumulative effects since it uses continuous vibration to "shake" the pile into the ground. It is not anticipated that the multiple vibratory pile drivers would be utilized in the construction of major Lower Manhattan projects. The vibration impacts associated with permanent WTC PATH Terminal, Route 9A and FSTC were evaluated as part of their respective environmental reviews. Details of the vibration for these projects are not presented in this chapter. However, it should be noted that the maximum vibration levels would not exceeded 0.12 ips, which is the FTA threshold criteria for fragile historic buildings. Therefore, there would be no significant vibration impacts at the receptor sites evaluated. Vibration impacts would still occur at sites in close proximities of the construction activities for each major construction project. These impacts were documented in the relevant environmental review for each of these projects, including FSTC, permanent WTC PATH Terminal, and Route 9A. The maximum vibration levels associated with each project are presented in Table 21-27.

Table 21-27
Summary of Future Without Proposed Action Vibration Levels

Site ID	Land Use	Criteria Threshold	FSTC (ips)	Route 9A (ips)	PATH Terminal (ips)
1	Public Facilities & Institutions	0.5	-	0.0011	0.0002
2	Open Space & Outdoor Recreation	0.5	-	0.0036	0.0003
3	Hotel	0.5	-	0.0036	0.0006
4	Bikeway	0.5	-	0.0367	0.0022
5	Residential	0.5	-	0.0029	0.0007
6	Residential	0.5	-	0.0000	0.0004
7	Residential	0.5	-	0.0190	0.0010
8	Residential	0.5	-	0.0080	0.0005
9	Residential	0.5	-	0.0030	0.0007
10	Institutional	0.5	-	0.0020	0.0017
11	Residential	0.5	-	0.0020	0.0049
12	Institutional	0.5	-	0.0011	0.0021
13	Public open space	0.5	-	0.0010	0.0239
14	Hotel	0.5	0.1160	0.0008	0.0169
15	Public Facilities & Institutions	0.5	-	0.0006	0.0012
16	Commercial & Office	0.5	-	0.0008	0.0007
17	Commercial & Office	0.5	-	0.0072	0.0007
18	Commercial & Office	0.5	-	0.0014	0.0005
19	Residential	0.5	-	0.0010	0.0005
20	Residential	0.5	-	0.0003	0.0002
21	Church	0.5	0.0320	0.0005	0.0009
22	Residential	0.5	0.0160	0.0005	0.0009
23	Park	0.5	-	-	-
24	Park	0.5	-	-	-

Source: The Louis Berger Group, Inc., 2003

Future With the Proposed Action Scenario

Construction activities have the potential for producing high vibration levels that may be perceptible. Architectural and even structural damage could occur if appropriate precautions are not taken during construction. Even where vibration levels are lower or imperceptible, vibrations can nonetheless produce ground-borne noise. Construction of the Proposed Action will include activities in which vibration is an inherent part of the work. Examples potentially include the use of impact tools such as pile driving, jackhammers, soil compactors and rock blasting.

Operation of construction equipment causes ground vibrations that spread through the ground and diminish in strength with distance. Buildings founded on the soil or rock in the vicinity of the construction site respond to these vibrations, with varying results ranging from no perceptible effects at the lowest levels, low rumbling sounds and sensible vibrations at moderate levels and slight damage at the highest levels. Ground vibrations from most construction activities rarely reach the levels that can damage structures, but can achieve the audible and sensible ranges in buildings close to the site. However, some heavy construction activities, such as blasting, pile driving, clam shovel drops, and pavement breakers have the potential to cause substantial damage to nearby buildings under the favorable geological conditions. Typical vibration levels for construction equipment at various distances are listed in Table 21-28. In general, the highest vibration levels are generated by the pile driving operations. The clam shovel used in slurry wall construction will also result in some impacts at close distances.

Table 21-28
Proposed Action Vibration Levels for Construction Equipment from Equipment Source

Equipment		PPV (ips)					
		25 ft	50 ft	100 ft	150 ft	200 ft	300 ft
Pile Driver (impact)	upper range	1.518	0.537	0.190	0.103	0.067	0.037
	typical	0.644	0.228	0.081	0.044	0.028	0.015
Pile Driver (sonic)	upper range	0.734	0.260	0.092	0.050	0.032	0.018
	typical	0.170	0.060	0.021	0.012	0.008	0.004
Clam shovel drop (slurry wall)		0.202	0.071	0.025	0.014	0.009	0.005
Hydromill (slurry mill)	in soil	0.008	0.003	0.001	0.001	0.000	0.000
	in rock	0.017	0.006	0.002	0.001	0.001	0.000
Large bulldozer		0.089	0.031	0.011	0.006	0.004	0.002
Caisson drilling		0.089	0.031	0.011	0.006	0.004	0.002
Loaded trucks		0.076	0.027	0.010	0.005	0.003	0.002
Jackhammer		0.035	0.012	0.004	0.002	0.002	0.001
Small bulldozer		0.003	0.001	0.000	0.000	0.000	0.000

Source: FTA; Modified by The Louis Berger Group, Inc., 2003.

Recent research indicates that structures respond differently to vibration depending upon their construction and upon the frequency of the blast vibration. The recognized threshold for vibration damage criterion is 0.50 ips for normal buildings, 0.20 ips for fragile buildings, or 0.12 ips for extremely fragile historic buildings, according to United States Bureau of Mining and FTA's *Transit Noise and Vibration Impact Assessment* guidelines. Therefore, peak vibration levels at each receptor sites were calculated for each month in 2006 based on construction plans and schedules developed for the Proposed Action. Table 21-29 presents the calculated vibration level results at five sensitive receptor sites located closest to the Proposed Action's construction activities. As can be shown in Table 21-29, the peak vibration level would not exceed 0.12 ips at any sensitive receptors evaluated during year 2006. Therefore, vibration impacts during the Proposed Action construction are not expected to occur.

Table 21-29
2006 Monthly Maximum Construction Vibration PPV Level (Inch/Second)

Site	Site 7	Site 9	Site 10	Site 11	Site 14
Site Name and Address	Cedar St & Washington St (Fence on Cedar St)	4 Albany St	120 Cedar St (on Greenwich St)	114 Liberty St	Hilton Millenium Hotel-Dey Street
Land Use	Residential	Residential	Institutional	Residential	Hotel
Distance to Nearest Construction Activities (feet)	24	39	69	81	69
Jan	0.0946	0.0457	0.0194	0.0128	0.0166
Feb	0.0808	0.0390	0.0166	0.0128	0.0166
March	0.0808	0.0390	0.0166	0.0128	0.0166
April	0.0808	0.0390	0.0166	0.0128	0.0166
May	0.0808	0.0390	0.0166	0.0128	0.0166
June	0.0808	0.0390	0.0166	0.0128	0.0166
July	0.0808	0.0390	0.0166	0.0128	0.0166
Aug	0.0808	0.0390	0.0166	0.0128	0.0166
Sept	0.0808	0.0390	0.0166	0.0128	0.0166
Oct	0.0808	0.0390	0.0166	0.0130	0.0166
Nov	0.0808	0.0390	0.0166	0.0130	0.0166
Dec	0.0808	0.0390	0.0166	0.0130	0.0166

Source: The Louis Berger Group, Inc., 2003.

21.6.6 ECONOMIC EFFECTS

CONSTRUCTION BENEFITS

Major construction projects occurring in 2006 include the permanent WTC PATH Terminal, the FSTC, the Route 9A Reconstruction and the South Ferry subway station. All of these projects would generate economic activity, jobs and tax revenues.

The economic and fiscal benefits of the Proposed Action for the initial construction to be complete in 2009 and for the full construction anticipated to be complete by 2015 are presented above in Chapter 9, "Socioeconomics." In order to assess the potential economic benefits in the construction analysis year of 2006, the figure for all construction to 2009 were divided by five and the results are shown below. This is a conservative estimate of economic benefits in 2006 because 2006 is expected to be the year of peak construction activity. All monetary amounts are expressed in 2003 dollars.

- In 2006 the Proposed Action would generate about 4,136 person-years of construction employment and about 6,373 person-years of employment in New York City and about 7,853 person-years of employment in New York State.
- Construction activity would have a total effect on the local economy, measured as economic output or demand for local industries, equal to about $1.33 billion in New York State, of which $1.02 would occur in New York City.
- In 2006 construction of the Proposed Action would create tax revenues, exclusive of property-related payment, equal to $53.09 million.

In addition to the effects on the local economy, businesses in the immediate vicinity of the Project Site would benefit from daily expenditures by the construction workforce at the Project Site. This would provide an expanded customer base for retail and convenience stores, as well as restaurants, delicatessens, and pharmacies. This demand will not only be created by the workforce associated with the Proposed Action, but also by workers associated with other large construction projects in the immediate vicinity, such as the permanent WTC PATH Terminal, the FSTC and the Route 9A Reconstruction.

BUSINESS DISRUPTIONS RELATED TO CONSTRUCTION

Construction activities in general have the potential to disrupt business and retail operations as a result of restricted access by pedestrians (customers) and vehicles (deliveries). The Proposed Action itself is unlikely to directly restrict access, as most of the construction is contained within the Project Site. Some access restrictions may occur on the streets surrounding the Project Site as a result of construction. A detailed discussion of these conditions is presented under the discussion of Transit and Pedestrian impacts during construction.

An overview is presented below of other projects in the vicinity of the Project Site to assess the potential for cumulative effects on business and economic interests. The projects whose construction most directly overlaps with that of the Proposed Action include the construction of the permanent WTC PATH Terminal on the Project Site, the construction of the FSTC and the construction of the Route 9A Reconstruction Project. In addition, roadway reconstruction by NYCDOT is anticipated to be ongoing north of the Project Site.

Construction of the FSTC would include construction of the Dey Street Passageway between Broadway and Church Street and the pedestrian connector between the N/R subway station at Church Street and the E subway terminal at the Project Site. The construction at Dey Street would affect deliveries to Dey Street and in particular Century 21, a major department store in the area. Access to Century 21 could also be affected by construction truck traffic associated with the FSTC, the permanent WTC PATH Terminal and the Proposed Action as well as the proposed reconstruction of Church Street by NYCDOT.

To address the potential for construction impacts to adjacent properties, the construction plan for the FSTC would be coordinated by MTA/NYCT with LMDC, the Port Authority and NYCDOT. It is projected that pedestrian and vehicular access along Dey Street, Fulton Street, and Broadway in the vicinity of the projects would be maintained during most of the construction period. Construction techniques such as decking and coordinating work with other agencies will eliminate redundant operations (e.g., excavation and utility relocation) by other projects (e.g., roadway reconstruction at Dey Street by NYCDOT). This will ensure that inconvenience to the traveling public will be kept to a minimum.

Vehicular access to portions of Dey Street and Fulton Street would be temporarily disrupted in certain locations; however alternate access points would be made available for service and deliveries. For example, alternative loading areas could be established on the north side of Cortlandt Street during construction to enable truck access to Century 21.

The FSTC project will include a Maintenance and Protection of Traffic (MPT) Plan, as described in the FSTC DEIS. Therefore, it is not anticipated that these commercial operations will be significantly affected by cumulative construction activities. MTA/NYCT would implement the EPCs, which require appropriate signage for affected businesses and amenities to maintain their visibility, when obscured as a result of construction activities.

Subway and bus access in the vicinity of the commercial and retail in the vicinity of the Project Site would be maintained by the FSTC project throughout the duration of its construction. Access to the subway system will be maintained during construction through minor schedule adjustments of subway lines as is commonly done for NYCT rehabilitation projects.

The Route 9A Reconstruction Project will include a plan for the maintenance of traffic along the roadway during construction. In addition NYSDOT has built a pedestrian bridge across Route 9A at Vesey Street that connects to an at-grade protected pedestrian walkway along Vesey Street from the temporary WTC PATH station entrance on Church Street. Together these temporary measures maintain access between Church Street and Battery Park City for businesses, workers, commuters, and residents.

LMDC and the Port Authority are working together to minimize disruptions to businesses during construction of the Project Site. Many of the buildings and businesses to the north and south of the Project Site (the areas closest to the proposed construction) were damaged and closed due to the terrorist attacks on September 11. To the north, the Barclay-Vesey Building and the Federal Office Building/Post Office are being restored. While both are expected to have reopened by 2006, neither have pedestrian access off Vesey Street and access to their entries would be maintained throughout the construction period. Similarly access would be maintained to 7 WTC, which is being completely reconstructed.

South of the Project Site, 90 West Street, which was heavily damaged on September 11 is being restored and converted to residential use. It is expected that this building will be reopened by 2006. While its main residential entrance will be on Route 9A and its garage entrance will be on Albany Street away from the Project Site, it is expected to have retail frontage on Cedar Street. The access to this use would be maintained from West Street. While construction noise might be an adverse impact on this use, some types of commercial uses would benefit from large number of workers on the Project Site. Any temporary adverse impacts would be more than off-set once Liberty Park South is completed and in use. South of the existing 130 Liberty Street building on the Southern Site, the ground floor retail commercial has not been open for business since September 11. However, there are active commercial uses that have reopened along both the south side of Liberty Street and the east side of Greenwich Street south of Cedar Street. These businesses may be adversely effected by construction noise and air quality, but they would also likely benefit from the large number of construction workers. Assess to the east end of Liberty Street south of the WTC Site would be maintained throughout the construction process for the Fire Station in this block.

Church Street would remain open throughout the construction period, although the western lane may be closed for much of the time. While access to Dey Street would be restricted during construction of the Dey Street Passageway by MTA/NYCT as part of the FSTC, access to key destinations, such as the Century 21 department store would be maintained by MTA/NYCT. In sum, it is not expected that access to retail uses or other businesses on the east side of Church Street in this area would be would be restricted so much that the businesses would be adversely impacted.

21.6.7 CULTURAL RESOURCES

ARCHAEOLOGICAL RESOURCES

This section considers the full range of impacts to archaeological and historic resources. However, effects to archaeological resources may occur sooner in areas that would be excavated sooner, and there would be the potential for effects to historic resources later as construction progresses to the sites that would be developed later.

Accordingly, there is no basis to believe that the Proposed Action would contribute to any potential cumulative archaeological impacts in the area.

The potential for historic period archaeological resources (shaft features, such as privies, cisterns, wells, and cesspools pre-dating the 1850s) has been identified in limited areas of *the WTC Site* (see Chapter 5, "Historic Resources"). Phase IB testing would be carried out on the potentially sensitive areas of the WTC Site prior to excavation and if necessary any mitigation and retrieval activities could be accomplished before or during excavation for construction.

Potential 18th and 19th century shaft features as well as wharf and/or cribbing features may also on the Southern Site and within the beds of *Liberty, Washington, Cedar and Albany Streets* that would be disturbed during construction of the Proposed Action. Since avoidance of these potentially sensitive areas is not feasible, Phase IB investigation is recommended to document potential shaft features and potential wharf and cribbing features. The Phase IB investigations would consist of archaeological monitoring during excavation following a plan developed in consultation with *the State Historic Preservation Office (*SHPO) *and Landmarks Preservation Commission (LPC).*

The potential below grade pedestrian connection under Church Street from the permanent WTC PATH Terminal to Liberty Plaza is being considered in the environmental review for the permanent WTC PATH Terminal and, if necessary based on the findings of the research report, further investigation and mitigation would be carried out.

Taken *cumulatively, no significant* adverse impacts to archaeological resources would be anticipated from the Proposed Action and the other major construction projects.

HISTORIC RESOURCES

Construction of the Proposed Action has the potential to cause damage to nearby historic resources from ground-borne vibrations, dewatering (for the bathtub on the east side of the site and for the expansion of the existing bathtub to the south), and other activities. Buildings or sites located within 90 feet of the Project Site are considered to be in the area of potential effect for construction activities. Historic resources in this area include the Barclay-Vesey Building at 140 West Street, the Federal Office Building/U.S. Post Office at 90 Church Street, 30 Vesey Street, St. Paul's Chapel Cemetery at Church Street between Vesey and Fulton Streets, the East River Savings Bank at *26 Cortlandt* Street, *the Beard Building at 125 Cedar Street*, 114-118 Liberty Street, the Western Electric Company Factory at 125 Greenwich Street, the American Stock Exchange at 86 Trinity Place, the Hazen Building at 120 Greenwich Street, 123 Washington Street, and 90 West Street. In addition there are potential historic resources at 106, 110, and 112

Liberty Street; *130 Cedar Street; and,* 137-139 Greenwich Street (see Chapter 5, "Historic Resources").

In the analysis year of 2006 construction activity would be in progress across the WTC Site and the Southern Site. Activities on the perimeters of these sites would be the most likely to have impacts on historic resources in the surrounding area. On the northwest quadrant of the WTC Site below grade retail space would be in construction while the structural faming would be erected in the first half of the year. This construction would be taking place immediately south of the Barclay-Vesey Building across Vesey Street.

On the two eastern quadrants construction of the foundations and below grade structure would be completed during the year and construction of the retail bases of Towers 2, 3, and 4 would be begun. This work would be across Vesey Street from the Federal Office Building/U.S. Post Office, across Church Street from the graveyard of St. Paul's Chapel and the East River Savings Bank, and across Liberty Street from 114-118 Liberty Street and *the Beard Building*. On the portion of the Southern Site along Liberty Street (excluding the area of the building at 130 Liberty Street) excavation inside the new slurry walls would be completed during the year and construction of the below-grade structure would be largely completed by the end of the year. This work, which would involve dewatering, would take place across Cedar Street from 90 West Street.

To avoid any adverse impacts to standing structures throughout the construction period, construction protection plans would be developed in consultation with *SHPO*, as described in Chapter 5, "Historic Resources." *Typical protective measures in construction plans are described below:*

1. To the extent permitted, a preconstruction inspection of the buildings will be undertaken by an engineering firm licensed to practice in the State of New York (the "Inspecting Engineer"), to determine existing foundation and structural condition information and ascertain any pre-existing damage, existing structural distress, and any potential structural weakness of the foundations or structures of these buildings. The Inspecting Engineer will have experience with historic structures.

2. A written report would be prepared by the Inspecting Engineer documenting any potential weakness or structural distress and an assessment of the stability of any applied ornament, together with a protocol addressing any recommended remediation and steps taken to secure problem areas prior to the commencement of any construction activities. The written report would be submitted to SHPO and will be supplemented with photo-documentation—in the form of 8 inch x 10 inch black-and-white photographs keyed to a map or plan—in order to provide a clear record of existing conditions and any problem areas.

3. Controls on construction vibration would be required as per the Landmarks Preservation Commission (LPC) standards, or the specifications of the Inspecting Engineer if the latter is lower. LPC requirements limit maximum peak particle velocity to 0.5 inches per second for historic structures and 2.0 inches per second for non-historic structures.

4. The Construction Contractor would thereafter ensure that the appropriate vibration limits and any other criteria deemed appropriate by the Inspecting Engineer are incorporated into the sub-contracts for the excavation work, which may include rock removal operations. The Construction Contractor will be responsible for monitoring these controls with periodic inspection by the owner's representative.

5. Under supervision of the Inspecting Engineer, the Construction Contractor will provide continuous seismic monitoring at the Project Site and inside the buildings during excavation and any other construction operations that would cause vibrations. Seismographs will be installed on the interior and exteriors of the buildings, to the extent permitted by building owners. These units will be located such that they are away from the general public but that they are accessible to the technicians who must monitor them. The seismographs will measure vibration levels during excavation and construction. Prior to the commencement of excavation operations, the seismographs will be installed and tested to ensure that they are in working order and to enable taking baseline readings. Daily logs of the seismic monitoring will be maintained and submitted to SHPO upon request.

6. If any excessive vibration (that which meets or exceeds the peak particle velocity level) is detected, the Inspecting Engineer will stop the work causing this excessive vibration. Buildings will be inspected for any structural degradation that may have occurred. The Inspecting Engineer will submit a report to SHPO detailing the reason for exceeding the peak particle velocity level and the presence or lack of damage to buildings. If any damage was sustained, it will be secured, and the work that caused any damage will be altered to reduce the vibration levels to within acceptable limits. The resumption of work, if damage was sustained, must be authorized by SHPO.

7. In addition, during excavation the Inspecting Engineer will monitor any exposed vertical rock faces or fissures, joint orientation, and potential weaknesses to ensure that underground utilities serving the identified buildings are protected from damage.

8. Should any cracking occur in any of the buildings during excavation or construction, crack monitors will be installed over each crack and monitored on a weekly basis until the Inspecting Engineer deems the cracks to be stable.

9. All substantive requirements of the New York City Building Code applicable to construction activities, protection of adjacent structures (including party wall exposure) and utilities, and specific sections dealing with excavation and foundation operations will be met or exceeded. Construction of the Proposed Action will be performed in a safe manner with controlled inspections as required by the New York City Department of Buildings. Inspections will include but will not be limited to structural stability and foundation concrete. The Inspecting Engineer is required to be present during these and other operations to monitor the construction progress and conformance with contract documents.

Taken cumulatively, there would likely not be any adverse impacts to historic resources adjacent to the Project Site. Taken cumulatively, it is not expected that there *would be any significant* adverse impact on historic resources.

21.7 OTHER CONSTRUCTION IMPACTS OF THE PROPOSED ACTION

21.7.1 LAND USE

All construction staging and laydown areas for the Proposed Action would occur on either the Project Site or within portions of travel lanes of public streets such as Church, Vesey, and Liberty Streets. The use of these areas would be temporary and limited to the construction period. It is anticipated that staging and laydown areas that are required for Tower 2 beyond the peak construction period of 2006 would require the temporary use of portions of Vesey and Church Streets. All practicable efforts would be made to avoid using areas closer to the Memorial, Wedge of Light Plaza and areas to the west and south of Tower 2. Similarly, staging and laydown areas for other Towers would be limited to areas farthest away from the privately owned land uses, public spaces, and the Memorial. As a result, the construction activities of the Proposed Action would have no significant impacts upon land uses in the project area.

21.7.2 URBAN DESIGN AND VISUAL RESOURCES

Construction activities to be undertaken as part of the Proposed Action would temporarily change the visual resources and design landscape from and to the Project Site from viewpoints in the immediate area of the Project Site. Views of the Project Site from the surrounding area would include construction equipment and activities that are typical throughout the City. While such activities would temporarily change the visual elements around the Project Site, there would be no significant impact to visual resources in the area.

21.7.3 OPEN SPACE

Staging and laydown areas would not be located within any existing open space resources identified in Chapter 6, “Open Space.” Open space resources within the immediate area would remain open at all times. As a result, the Proposed Action’s construction activities would not block or limit access to open space resources. No significant impacts upon open space resources are anticipated.

21.7.4 SHADOWS

The proposed construction activities and equipment anticipated to be utilized are not anticipated to result in any greater shadow impacts to the study area than already identified in 7, “Shadows.” It is anticipated that the greatest impacts upon shadows would occur from the use of tower cranes atop the towers under construction, resulting in a greater shadow effect. Such impacts are anticipated to be temporary and minor in nature.

21.7.5 COMMUNITY FACILITIES AND SERVICES

Access to all community facilities would be maintained at all times. Engine Company 10 and Ladder Company 10 located at 124 Liberty Street would have vehicular and pedestrian access maintained at all times. Engine Company 7 and Ladder Company 1 located at Duane Street are outside of the immediate construction zones. Therefore, no staging and laydown or deliveries are anticipated to block access to and from these locations. Similarly, access to all health care facilities, public schools and libraries would remain open during the construction.

21.7.6 NEIGHBORHOOD CHARACTER

During the peak construction period, the Project Site and the immediately surrounding neighborhoods would feel much the same as they do today. In its current state, the Project Site has a blighting effect on the surrounding neighborhood. A significant portion of the WTC Site resembles a construction zone. With the exception of commuters traveling to and from the temporary WTC PATH station at the beginning and end of the workday and a number of PATH employees and other workers at the station, the site remains substantially underutilized, barren, and largely unpopulated. Aside from the viewing areas and the temporary WTC PATH station, the site is fenced-off and not accessible to the public.

In 2006, the area would continue to be dominated and defined by the ongoing construction activities at the Project Site. Greater numbers of construction workers, vehicles and equipment would occupy the site, resulting in increased noise levels, potentially affecting the activities of residents, workers, and visitors to the Project Site and the surrounding area.

LMDC and the Port Authority are working together to minimize disruptions to area residents and businesses during construction of the Project Site. To ensure minimum disruption around the Project Site and in adjoining neighborhoods and to maintain and protect the overall character of the neighborhood, the *Sustainable Design Guidelines* Policy SEQ-5 Construction Environment Plan would be implemented, resulting in the development of truck staging zones and phased development plans. Such mitigation measures would help to ensure that area residents, workers, and visitors can continue to engage in their normal, everyday activities.

Even with such mitigation measures, however, it is likely that neighborhood character would be affected during the construction period. Businesses and residents located in buildings immediately south of the WTC Site or the Southern Site may be adversely affected by construction noise and air quality. On the other hand, businesses would also likely benefit from the large number of construction workers. It is not expected that access to retail uses or other businesses at the perimeter of the Project Site would be restricted so much that the businesses would be adversely impacted. Residents would continue to have access to neighborhood stores, amenities, and transportation.

As discussed above, maintaining access to local businesses and points of interest such as the WTC Site itself for all pedestrians, to the greatest extent practicable, is recognized as an essential element of the construction plan. Pedestrian flow along Vesey and Liberty Streets will be maintained throughout the duration of construction except during limited periods. All closures would be kept to a minimum as much as possible. The WTC Site would continue to dominate the area, acting as a physical barrier between the Financial District to the east and BPC to the west, and between the Tribeca and Greenwich South neighborhoods to the north and south. Overall, conditions at the Project Site and throughout the surrounding area may diminish slightly but would not worsen to such an extent as to constitute a significant adverse impact on neighborhood character.

21.7.7 HAZARDOUS MATERIALS

The evaluation of hazardous materials at the Project Site revealed that no significant adverse impacts related to hazardous materials are anticipated due to the Proposed Action. Hazardous materials identified at the Project Site include PAHs and metals in soil, asbestos and dust from the events of September 11 adhered to the surfaces of structures, and low concentrations of volatile organic compounds (VOCs) present in groundwater. During construction they would be managed or isolated to protect public health and the environment. Construction measures, including the implementation of site-specific Health and Safety Plans (HASPs), dust control measures, contaminated soil and groundwater management plans, and abatement of hazardous building materials prior to construction, would aid in the avoidance of adverse health impacts to workers and the general public. Because hazardous materials would be abated, managed or remediated during construction, no significant adverse impacts are expected during construction of the Proposed Action

21.7.8 INFRASTRUCTURE

Excavation and other activities within public rights-of-way such as under Liberty Street may require the temporary disruption or relocation of underground utilities during the construction period. LMDC remains committed to making efforts to maintain the viability and accessibility of local businesses and maintaining the quality of life for residents, businesses, and visitors to the area. As such, any disruptions to electricity, water, sewer, gas, steam, telecommunications and other infrastructure needs would be kept to a minimum. LMDC's ongoing public outreach and communication with other agencies is anticipated to result in close coordination of construction activities and minimization of utility disruptions.

21.7.9 COASTAL ZONE

It is anticipated that all permanent activities of the Proposed Action are consistent with coastal policies. While the New York City Local Waterfront Revitalization Program and New York State coastal policies are focused on permanent activities within the coastal zone, it is anticipated that all construction activities proposed within the coastal zone would also be consistent with the coastal policies. Specifically, the construction activities would maintain physical and visual access to the shoreline and coastal zone and would encourage the use of existing commercial and residential uses within the coastal zone. As a result, no significant impacts are anticipated.

21.7.10 FLOODPLAIN

Construction activities occurring within the 100-year floodplain include: western portions of the bathtub on the WTC Site; a western portion of the Southern Site; *and* the Hudson River pump station. None of the proposed construction activities within or adjacent to the 100-year floodplain would exacerbate flooding conditions within the floodplain itself or within the project area.

21.7.11 NATURAL RESOURCES

The Proposed Actions' construction activities are not anticipated to have significant impacts to natural resources in the project vicinity. While limited rehabilitation and repair activities may be conducted for the Hudson River pump station, no major construction activities area anticipated within the Hudson River.

21.7.12 ENVIRONMENTAL JUSTICE

The Proposed Action would not produce disproportionately high or adverse effects on low income or minority communities. The proportion of low income and minority residents in the primary study area is lower than that for Lower Manhattan, New York County (Manhattan), or New York City as a whole, indicating a low potential for disproportionate impacts to communities of concern in the immediate vicinity of the Proposed Action. In the secondary study area, the portion of Chinatown within the study area boundaries represents a community of concern for environmental justice. This community is, however, far removed from the Project Site and would not be subject to disproportionately high or adverse impacts during the construction or operational periods.

The Proposed Action would not result in disproportionately high or adverse human health or quality-of-life impacts to any community of concern related to construction at the Project Site and construction truck traffic off-site. Demographic and income conditions along routes necessary for construction-related truck traffic are similar to those of Lower Manhattan as a whole, the increase in traffic along these established truck corridors in communities of concern would not be disproportionately greater than that for other portions of the study areas, and the overall increase in truck traffic is anticipated to be low.

A discussed earlier in this chapter, construction activity would produce significant economic benefits in terms of output and jobs for New York City and the region as a whole during the 10-year construction period. Similarly, completion of the Proposed Action is expected to improve economic vitality and increase the number of job opportunities. This would benefit a wide range of residents and businesses, including those low-income and minority communities. Jobs created on site during the operation of the Proposed Action are expected to encompass a wide range of skills, wage levels, and occupations in office, retail, government agency, and cultural facilities employment.

21.7.13 WATER QUALITY

During construction, groundwater collected from existing sump pumps on the WTC Site would continue to be treated and disposed of in the same manner as currently conducted by the Port Authority and would be regulated by a NYCDEP permit, including filters as necessary.

To prevent stormwater runoff and pollution prevention, the project will include, as applicable, a Construction Storm Water Runoff and Pollution Prevention (SWPP) plan *(SEQ-6, Construction Storm Water Runoff and Pollution Prevention)* to reduce impacts on water systems from construction activities and vehicles. The SWPP *would conform to EPA's 832/R-92-005 document which details stormwater management and best practices for construction activities. The SWPP* would be implemented *as part of the* ***Sustainable Design Guidelines'*** SEQ-5, Construction Environment Plan. Among the items the plan may include are contingency measures established in case limits are exceeded will also help to reduce potential water pollution.

The SWPP would include measures to ensure that construction period stormwater runoff from the site would enter combined sewer catch basins located in the streets bounding the site. (There is no separate storm sewer system in Manhattan.) To prevent sediment, including sediments containing hazardous materials (e.g., PAHs and metals), from entering the sewer system, control measures (consistent with the guidance provided in "Guidelines for Urban Erosion & Sediment Control" distributed by the Empire State Chapter of the Soil and Water Conservation Society,) would be implemented during construction. Examples of control measures include the construction of swales, directed runoff, and catch basin protection. Implementation of these measures would prevent sediment and hazardous materials from entering the system thus limiting the potential for discharges to CSOs during severe precipitation events. Water that collects on the construction site would be discharged to the sewers in accordance with NYCDEP permits.

21.7.14 WASTE DISPOSAL

Construction activities of the Proposed Action that would result in large amounts of construction material include the demolition of remaining subgrade portions within the eastern portion of the WTC Site and excavated material throughout the Project Site, including the WTC Site, Southern

Site, and under Liberty, Greenwich and Albany Streets. All told, over 1.2 million cubic yards of waste material would be removed from the site.

LMDC is committed to the *Sustainable Design Guidelines* policy of reusing and conserving resources where possible. As a result, waste material would be reused in other applications such as landfill cover or for fill in other projects outside of the project area to the greatest extent possible.

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