Chapter 3M: Modular Construction

A. INTRODUCTION

The modular construction method is different from conventional construction in that a substantial amount of the necessary project components are constructed or assembled off-site. Currently, Building 2 on the Arena Block is being constructed using the modular construction method, which is being considered for other Project buildings. The construction of a high-rise building using modular construction is relatively new in New York City. Upon completion, the 32-story Building 2 will be the first modular building above 7 stories built in New York City. The Brooklyn Navy Yard modular factory serves as the manufacturing hub for Building 2, and it is anticipated that it would continue to manufacture the modules for subsequent Project buildings if they were to be constructed using modular construction methods. Building 2's design and construction process was tailored to conform to the New York City Building Code and is consistent with the 2009 Modified General Project Plan (MGPP) and the Design Guidelines. In addition, the modular units were sized so they can logistically maneuver through the local street networks between the Brooklyn Navy Yard and the project site. The manufacturing process and delivery logistics, which continue to be refined as Building 2 is constructed, would be adapted and further refined for other Project buildings that are constructed using modular construction methods. Information provided by the project sponsors and experience gained during the course of constructing Building 2 serve to inform the assessment of the potential effects of using modular construction rather than conventional construction methods for other buildings on the project site.

Since conventional methods would generally result in more intense on-site construction activities, the Supplemental Environmental Impact Statement (SEIS) conservatively assumes, in order to assess the reasonable worst-case conditions, that Phase II buildings would be constructed using conventional construction methods. The section below discusses the differences between conventional and modular construction methods, and where relevant, discusses the differences in the potential environmental impacts related to these different methods.

PRINCIPAL CONCLUSIONS

The technical areas where differences in conventional and modular construction methods could result in different potential environmental impacts include socioeconomic conditions, transportation, air quality, and noise.

The construction of the Phase II development using modular techniques would generate substantial economic and fiscal benefits for the city and the state, though these benefits would be expected to be lower from modular construction than those from conventional construction. Based on the preliminary estimates, the investment for construction of Phase II of the Project using modular construction methods is estimated to equal about $1.90 billion in 2013 dollars. This would represent about a 22 percent reduction from costs using conventional construction methods. However, modular construction methods would allow for year-round (instead of seasonal) employment for construction workers and the opportunity for apprentices to receive training and practice in a controlled environment.

On-site building activities using modular techniques is expected to have shorter construction durations and fewer daily on-site workers and truck trips as compared to the use of conventional construction techniques, and would therefore be less disruptive overall. The Maintenance and Protection of Traffic (MPT) requirements for modular construction would be similar to the MPT requirements for conventional construction methods although MPT areas for modular construction may be wider and longer than those for conventional construction methods in order to accommodate wide-load deliveries of modules. With respect to parking, transit, and pedestrians, no significant adverse impacts attributable to construction were identified for Phase II construction using conventional construction methods. Similarly, modular construction would not result in any significant adverse impacts in these areas. At intersections where Phase II of the Project is predicted to result in significant adverse construction traffic impacts, these impacts are expected to be less for construction under modular construction methods as compared with construction under conventional construction methods.

Demolition, excavation, and foundation activities under modular construction methods would be the same as those under conventional construction methods. Therefore, since the construction air quality analyses were conducted for the representative worst-case short-term and annual periods where demolition, excavation, and foundation activities would be the dominant activities at the project site, the maximum predicted air pollutant concentrations resulting from Phase II construction of the Project using modular construction methods would be similar to the results shown in the air quality analyses for conventional construction methods. Since no significant adverse construction-related air quality impacts were identified for conventional construction methods, no significant adverse construction-related air quality impacts are expected if Phase II of the Project is constructed using modular construction methods.

The construction tasks with the greatest potential to result in increased noise levels at most nearby noise receptors are the excavation and foundation tasks, which would occur in the same manner and over the same duration with either conventional or modular construction. With modular construction, less equipment would be used on-site and fewer trucks would travel to and from each building site during the superstructure, exterior façade, and interior finishing tasks. Therefore, noise levels with modular construction during these construction tasks would be somewhat lower than those predicted for conventional construction. Consequently, the calculated noise levels and resultant predicted construction noise impacts shown in the analysis of conventional construction are conservatively representative of the noise conditions that would be expected with modular construction. Modular construction would result in a shorter overall duration of construction for each building built using these methods. If one or more buildings included in Phase II were constructed using modular construction rather than conventional construction, elevated noise levels resulting from construction activities for that building would be expected to last for a shorter duration. While night-time delivery of modules would occur, these deliveries would not be expected to result in a perceptible increase in the $L_{eq(1h)}$. Operation of the trucks used for night-time module deliveries in close proximity to noise receptors would result in increases in noise level for short periods of time. Such increases in noise level would occur only when the trucks would operate adjacent to the noise receptor and would be comparable in magnitude and duration to that which would result from operation of any heavy truck on the roadway adjacent to the receptor. Consequently, these short-term increases in noise level during night-time module deliveries would not constitute a significant adverse noise impact. Overall, it is not expected that the use of modular construction for the Phase II buildings would result in significant adverse noise impacts beyond those identified for conventional construction in Chapter 3J, "Construction Noise."

In summary, it is not expected that the use of modular construction for the Phase II buildings would result in significant adverse impacts in the relevant technical areas beyond those identified for conventional construction.

B. MODULAR CONSTRUCTION TECHNIQUES

Under conventional construction methods, the first task is to abate any potential hazardous materials in any pre-existing structures at the building site, followed by the demolition of any pre-existing structures. Excavation of the soils is next along with the construction of the new building's foundation. When the below-grade construction is completed, on-site construction of the superstructure of the new building begins. The superstructure includes the building's framework (beams and columns) and floor decks. On-site construction of the interior structures, or cores, of the building includes elevator shafts; vertical risers for mechanical, electrical, and plumbing (MEP) systems; electrical and mechanical equipment rooms; core stairs; and restroom areas. As the building progresses upward, the exterior façade of the building is erected on-site (including attaching masonry or other exterior cladding materials and exterior glazing) and on-site interior finishing begins. Interior finishing includes the construction of interior partitions, installation of lighting fixtures, interior finishes (flooring, painting, glass and glazing, door and hardware, etc.), and mechanical and electrical work, such as the installation of elevators and plumbing and fire protection fit-out work.

The abatement and demolition, excavation and foundation, and miscellaneous closeout activities (i.e., site work, roof and penthouse work, elevator work, ground floor lobby work, retail space work, façade work, and commissioning work) are the same for modular and conventional construction. However, the construction activities for the building's superstructure, exterior façade, and interior finishing differ for modular construction. With the modular construction method, a steel bracing frame is erected on-site and then the fully finished modular units, which have been fabricated off-site, are attached to the bracing frame. The modules are transported to the construction site by trucks, and lifted, stacked, and attached to the building's steel frame using an on-site crane, after which they are plated and bolted together. With the exception of the ground floor (the ground floor serves as the structural platform onto which modules are stacked) and bracing frame, the exterior façade, plumbing/electrical infrastructure and interior finishing are constructed using modular construction methods. For example, Building 2 would consist of approximately 930 individual modular units, fabricated in a modular factory in the Brooklyn Navy Yard.

It is expected that each module would be fabricated off-site and fitted-out (i.e., carpentry, bathroom pods, wall panels, drywall, insulation, painting, flooring, tiles, electrical wiring, mechanical and plumbing lines, and waterproofing) before being delivered to the construction site.

Project buildings constructed with modular techniques would be required to comply with the Design Guidelines and New York City Building Code. The advantages of modular construction over conventional construction methods include a weatherproof construction environment in the module factory, fewer overall and on-site truck deliveries, less on-site equipment and construction activities, less construction waste, more efficient and faster construction, and lower overall cost. Based on current information, on-site building superstructure construction and fit-out activities using modular techniques is projected to have approximately one-third to three-quarter fewer daily on-site workers depending on the on-site activities (i.e., superstructure construction, fit-out activities), and approximately half as many daily truck trips to the site as compared to the use of conventional construction techniques. In addition, as a result of more efficient construction, the overall construction duration of a future Project building under modular construction methods is expected to be up to one-third shorter than the overall duration of constructing a future Project building using conventional construction methods.[1] This is in part because modular construction methods allow for overlapping work of on-site activities (i.e., excavation and foundation, bracing frame work, and stacking of modular units) and off-site manufacturing as well as a streamlined manufacturing process under a weatherproof construction environment.

The size and shape of each individual modular unit would vary based on building design and the location of the module in the building. Each individual module is expected to be self-contained and waterproof and would arrive at the construction site with fixtures and finishes.

The modules would be transported to the construction site on a New York City Department of Transportation (NYCDOT)-approved truck route via a wide-load truck. Since a permit is required for every oversize load, there would be a continuous approval process from the trucking division of NYCDOT. The module delivery route from the Brooklyn Navy Yard to the project site would be determined and approved through coordination with NYCDOT, which would include the examination of a series of route and geometric surveys. For safety reasons, each oversize truck would be expected to be accompanied by a lead vehicle and a chase vehicle during delivery.

Each Project building undergoing construction using the modular method would have an individual MPT plan, including a NYCDOT-approved modular delivery protocol and truck route. The MPT for Building 2 is described below to illustrate the type of issues that the MPTs for other Project buildings are expected to address. For Building 2, the delivery route is as follows: 1) exit right out of Brooklyn Navy Yard onto Flushing Avenue; 2) turn left onto Navy Street; 3) turn right onto Tillary Street; 4) turn left onto Flatbush Avenue; and 5) turn left from Flatbush Avenue directly onto Dean Street and into Building 2's construction site (this turn is permitted with appropriate traffic control personnel supervising each delivery). Currently, for Building 2, a maximum of four daytime deliveries and four nighttime deliveries are permitted per day. Each delivery is released individually from the Brooklyn Navy Yard and will only be released when the preceding module is delivered to the site and has been placed appropriately on-site**.** Currently, NYCDOT permits daytime deliveries between 10 AM and 2 PM to avoid overlapping with commuter traffic peak hours (8 AM to 9 AM and 5 PM to 6 PM). In addition, overnight deliveries are permitted during the time period from 10 PM to 5 AM to facilitate on-site construction the following morning. For Building 2, two overnight deliveries will be accommodated within the site's construction fence. When there are four nighttime deliveries (maximum permitted at Building 2), two modules will be stored overnight just outside of the construction fence on the north side of Dean Street. The pedestrian path adjacent to the MPT

[1] Since the construction of a high-rise building using modular construction methods is relatively new in New York City, the level of uncertainty in the estimates for modular construction methods is higher than the projections for conventional construction methods. Estimates stated above may not hold true for Building 2 as it is the first Project building to be constructed using modular construction methods.

area of Building 2 will be closed and signed when modules are being stored overnight on Dean Street. Although the shared vehicular and bicycle lane of eastbound Dean Street will be maintained, pedestrians traveling in the east-west direction will be redirected to the south side of Dean Street during the overnight hours. In addition, during the daytime, pedestrians are currently being redirected to the south side of Dean Street while individual modules are being lifted and placed. All modules delivered overnight will remain on the bed of the truck (the truck cabs will be disconnected from the truck beds after they have reached the designated location on the construction site) as no picking or module assembly will occur during the nighttime. When work commences at 7 AM, the two modules that are stored outside of the construction fence will be picked first.

The MPT plan for other Project buildings, using the modular construction method, is expected to be typical of an MPT plan for a building erected using the conventional method: the adjoining sidewalk and curb-lane may be temporarily closed during the construction period. As with conventional construction methods, pedestrian flow would be maintained, to the extent practicable, via sidewalk bridges or temporary sidewalks where a sidewalk closure is necessary. Approval of MPT plans and implementation of the closures would be coordinated with NYCDOT's Office of Construction Mitigation and Coordination (OCMC). As with the curb lane and sidewalk closures, NYCDOT's OCMC is expected to provide the appropriate MPT stipulations to ensure that loss of or diminished traffic capacities would be minimized to the extent practicable.

Based on current information provided by the project sponsors, additional deliveries of materials and equipment to the construction site could require approximately eight truck trips per day per building (as compared to approximately 15 to 35 truck trips per day per building required for conventional construction methods) in addition to the truck trips for delivery of the modules to the site. Since modular construction methods require less on-site equipment and construction activities, there would be fewer materials and equipment deliveries to the construction site overall than what would be required for conventional construction methods. As discussed above, Building 2 construction using modular techniques is projected to have approximately half as many truck trips to the site, as compared to the use of conventional construction techniques.

A crane would be used on-site to lift and stack the modules in place. Once in position, modules would be plated and bolted together. On-site construction would also include MEP connections between modules which would be undertaken with battery-operated hand tools. On-site steel brace frame construction would be needed every one to two weeks to advance the building superstructure upwards for the stacking of modular units. The brace frames would be lifted by a crane and bolted together with impact wrenches. Once module erection work is complete, miscellaneous activities including site work, roof and penthouse work, elevator work, ground floor lobby work, retail space work, façade work, and commissioning work would commence. Based on current information provided by the project sponsors, it is expected that these miscellaneous activities will take approximately three months to complete per building. The miscellaneous activities are the same for modular and conventional construction.

C. TECHNICAL ANALYSIS AREAS

The technical areas where differences in conventional and modular construction methods could result in different potential environmental impacts include socioeconomic conditions, transportation, air quality, and noise. These technical areas are discussed in more detail below.

SOCIOECONOMICS

OVERVIEW OF ECONOMIC AND FISCAL BENEFITS OF MODULAR CONSTRUCTION

The construction of the Phase II development would generate substantial economic and fiscal benefits for the city and the state. As described below, these benefits would be expected to be lower from modular construction than those from conventional construction. However, modular construction methods would allow for year-round (instead of seasonal) employment for construction workers and the opportunity for apprentices to receive training and practice in a controlled environment.

The principal model used to estimate the effects on the City's economy of constructing the projected development program is the Regional Input-Output Modeling System (RIMS II), developed by the U.S. Department of Commerce, Bureau of Economic Analysis. The model contains data for New York City on more than 400 economic sectors, showing how each sector affects every other sector as a result of a change in the quantity of its product or service. A similar RIMS II model for New York State, also developed by the U.S. Department of Commerce, has been used to trace the effects on the State economy. The models have been adjusted to reflect the most recent changes in the New York metropolitan area price level. Using these models and the specific characteristics of the project, the total effect has been projected for New York City and State.

The dollar values in this section are in constant 2013 dollars. Employment is expressed in person-years; a person-year is the equivalent of one person working full time for a year. When presented in constant dollars and person-years, the estimates for the three illustrative construction phasing plans analyzed in this SEIS would be essentially identical. Phasing does not affect the real dollar value of the economic benefits or the amount of employment, although it is generally more desirable to have the benefits and employment sooner rather than later.

VALUE OF CONSTRUCTION

Construction benefits are generally a function of expenditures by the developer during the construction period. In order to provide an estimate of the possible effects on benefits which might result from modular construction methods, the construction costs associated with the development were projected by the project sponsors. Based on the preliminary estimates, the investment for construction of Phase II of the Project using modular construction methods is estimated to equal about $1.90 billion ($1,895.66 million) in 2013 dollars. This would represent about a 22 percent reduction from costs using conventional construction methods. The amount includes the construction of the same development as was analyzed for conventional construction methods. The above figure includes site preparation and hard costs (actual construction), and design, legal, and related costs. The total estimated amount of $1.90 billion reflects the cost of physical improvements to the site, and therefore excludes other values (such as financing, insurance, the value of the development rights and the land, marketing, etc.) not directly a part of the expenditures for construction. The total cost—including financing, the value of the land, real estate payments, management, initial marketing expenditures, and similar expenditures—would be substantially more. The construction costs enumerated above serve as the primary input to the RIMS II model, i.e., economic impacts such as number of construction jobs are derived from the total construction cost using the RIMS II model.

ECONOMIC AND FISCAL ANALYSIS

An analysis of the economic and fiscal impacts associated with the construction expenditures for each of the uses in the projected development program has again been conducted using the RIMS II models for New York City and New York State. An illustrative example of the projected employment and economic benefits from construction of the Phase II development using modular construction methods is presented in **Table 3M-1**.

Employment

The $1.90 billion represents the direct expenditures during the construction period using modular construction methods. As a result of the direct expenditures, the direct employment for constructing the entire Phase II development program using modular construction methods is estimated at about 8,214 person-years of employment, a reduction of about 934 person-years from construction using conventional construction methods. In addition to direct employment, total employment resulting from construction expenditures would include jobs in business establishments providing goods and services to the contractors and resulting in indirect employment. Based on the model's economic multipliers for New York City industrial sectors, the construction of the entire development program using modular construction methods would generate an additional 4,275 person-years of employment within New York City, bringing the total direct and generated jobs from the construction of the program to 12,489 person-years (see **Table 3M-1**), a reduction of about 1,420 person-years from construction using conventional construction methods. In the larger New York State economy, the model estimates that the projected development using modular construction methods would generate 6,840 person-years of indirect employment, bringing the total direct and generated jobs from construction of the projected development to 15,054 person-years of employment, a reduction of about 1,711 person-years from construction using conventional construction methods.

The direct wages and salaries during the Phase II construction period using modular construction methods are estimated at $574.26 million, in 2013 dollars (see **Table 3M-1**). This would represent about a 22 percent reduction from construction using conventional construction methods. Total direct and generated wages and salaries resulting in New York City from construction of the entire Phase II development program using modular construction methods are estimated at $820 million. In the broader New York State economy, total direct and generated wages and salaries from construction of the entire Phase II development program are estimated at about $975 million. These estimates would again represent about a 22 percent reduction from construction using conventional construction methods.

Fiscal Impacts

The construction activity would also generate tax revenues for New York City, the Metropolitan Transportation Authority (MTA), and New York State. As indicated above, the total cost for constructing the entire Phase II development program using modular construction methods (excluding financing and similar costs) is estimated at approximately $1.90 billion. Based on the U.S. Bureau of Economic Analysis' RIMS II model for New York City and State, the total economic activity, including indirect expenditures (those generated by the direct expenditures), that would result from construction of the entire projected development program for Phase II is estimated at $3.65 billion ($3,654 million) in New York State, of which $2.80 billion ($2,797 million) would occur in New York City (see **Table 3M-1**). These figures would represent about a $1.02 billion and $783 million reduction, respectively, from those that would be estimated for Phase II using conventional construction methods.

Table 3M-1
Illustrative Employment and Economic Benefits from Construction of the Phase II Development Using Modular Construction Methods

	Portion in New York City	Total New York City and State
Total Employment (Person-Years)*		
Direct (Construction)	8,214	8,214
Indirect (Secondary and Induced)	4,275	6,840
Total	12,489	15,054
Total Wages and Salaries (Millions of 2013 dollars)		
Direct (Construction)	$574.26	$574.26
Indirect (Secondary and Induced)	$245.50	$400.66
Total	$819.76	$974.92
Total Economic Output or Demand** (Millions of 2013 dollars)		
Direct (Construction)	$1,895.66	$1,895.66
Indirect (Secondary and Induced)	$901.57	$1,758.60
Total	$2,797.23	$3,654.26
	Fiscal	
Total Tax Revenues, Exclusive of Real Estate*** (Constant 2013 dollars)		
New York City Taxes	$42,372,700	
MTA Taxes	$5,512,200	
New York State Taxes	$83,798,000	
Total	$131,682,900	

Notes: The above estimates are meant to be illustrative of the possible effects on benefits which might result from modular construction. Because building with modular construction methods for such large buildings is relatively new in New York City, the level of uncertainty of the estimates is higher than the projections for conventional construction, presented previously.

* A person-year is the equivalent of one person working full-time for a year.

** The economic output or total effect on the local economy derived from the direct construction spending.

*** Includes personal income taxes, corporate and business taxes, sales tax on indirect activities, and numerous other taxes on construction and secondary expenditures.

Source: The characteristics and projected construction cost of the proposed development; RIMS II, U.S. Department of Commerce, Bureau of Economic Analysis; the U.S. Census Bureau, *Economic Census, Construction, New York*; and the tax rates by applicable jurisdiction.

In total, the construction of the entire projected Phase II development is estimated to generate approximately $131.68 million in tax revenues for New York City, MTA, and New York State, in 2013 dollars (see **Table 3M-1**). This is approximately 76 percent of those estimated using conventional construction techniques. Of these tax revenues, the largest portion would come from personal income taxes, corporate and business taxes, sales tax on indirect activities, and related taxes on direct and generated economic activity. New York State would receive about $83.80 million, the MTA would receive about $5.51 million, and New York City would receive about $42.37 million of these tax revenues from construction of the Phase II development using modular construction methods.

In addition, as was the case with conventional construction methods, New York City would receive revenue from the mortgage recording fees and real property transfer tax from the condominium units, which would be additional.

TRANSPORTATION

As discussed above in "Modular Construction Techniques," on-site building superstructure and fit-out activities using modular techniques is expected to have approximately one-third to three-quarter fewer daily on-site workers depending on the on-site activities (i.e., superstructure construction, fit-out activities), approximately half as many daily trucks trips to the site, and more efficient construction resulting up to one-third shorter construction duration, as compared to the use of conventional construction techniques, and would therefore be less disruptive overall. However, the demolition, excavation, and foundation tasks would generate the same levels of construction activities for both modular and conventional construction methods. The MPT requirements for modular construction would be similar to the MPT requirements for conventional construction methods—maintaining vehicular and pedestrian access throughout and limiting closures to sidewalks and curb lanes to the extent possible, and where necessary providing sidewalk bridges and temporary sidewalks to facilitate safe and adequate pedestrian circulation, with the exception of limited redirecting of pedestrian flow in accordance with NYCDOT stipulations. However, MPTs for modular construction may be wider and longer than those for conventional construction methods in order to accommodate wide-load deliveries of modules. Approval of MPT plans and implementation of the closures would be coordinated with NYCDOT's Office of Construction Mitigation and Coordination (OCMC). As with the curb lane and sidewalk closures, NYCDOT's OCMC is expected to provide the appropriate MPT stipulations to ensure that loss of or diminished traffic capacities would be minimized to the extent practicable. The overall predicted impacts for the selected peak construction worst-case periods would be same or less with modular construction.

As discussed in Chapter 3H, "Construction Transportation," two worst-case periods—the 4th quarter of 2027 and the 1st quarter of 2032, both under Construction Phase Plan 3—were selected for the detailed analyses of potential significant adverse transportation-related impacts during peak construction. The analyses showed that significant adverse traffic impacts would be expected to occur at 15 intersections during peak construction in the 4th quarter of 2027 and at 36 intersections during peak construction in the 1st quarter of 2032**.** While the impacts identified at seven intersections could not be fully mitigated, the measures recommended for implementation to mitigate impacts to the extent practicable, which include standard traffic engineering capacity improvements via signal timing adjustments, lane restriping, and curbside regulation changes, etc., can be similarly implemented for impacts of lesser magnitudes potentially resulting from modular construction. For parking, transit, and pedestrians, since no significant adverse impacts attributable to construction were identified for Phase II construction using conventional construction methods, modular construction would also not result in any significant adverse impacts. However, at intersections where Phase II of the Project is predicted to result in significant adverse construction traffic impacts, these impacts are expected to be less for construction under modular construction methods as compared with construction under conventional construction methods.

As described above, outside of the peak hours analyzed for conventional construction, up to eight daily module deliveries have been planned for the construction of Building 2 during off-peak hours—four daytime between 10 AM and 2 PM and four nighttime between 10 PM and 5 AM—when traffic levels would be lower and roadway capacities would be able to readily accommodate intermittent disruptions to normal traffic flow. Since a permit is required for every oversize load, there would be a continuous approval process from the trucking division of NYCDOT to ensure conformance to proper truck routing and delivery protocols. Due to space limitations at the Building 2 construction site, the storage of modules (up to two) delivered overnight that would not be picked and assemble until the morning is expected to require the use of additional space along the north side of Dean Street. Although the shared vehicular and bicycle lane of eastbound Dean Street would be maintained, pedestrians traveling in the east-west direction would be redirected to the south side of Dean Street during the overnight hours. For the Phase II buildings, where there would be more staging areas available along their street frontages, the need to redirect pedestrian flow to accommodate nighttime module storage is expected to occur on a more limited basis, if at all, than anticipated for Building 2.

AIR QUALITY

In general, air emissions are most affected by the most intense construction activities, which would occur during the demolition, excavation, and foundation tasks, which require the use of a few, large non-road equipment with diesel engines. While superstructure, exterior façade, and interior finishing tasks would follow, those efforts would result in much lower air emissions since they would require fewer pieces of heavy duty diesel equipment. The equipment required for these tasks would generally have small engines and would be dispersed vertically throughout the building, resulting in low concentration increments in adjacent areas. As described above under "Modular Construction Techniques," demolition, excavation, and foundation activities under modular construction methods are similar to those under conventional construction methods. Therefore, since the construction air quality analyses were conducted for the representative worst-case short-term and annual periods where demolition, excavation, and foundation activities would be the dominant activities at the project site, the maximum predicted air pollutant concentrations resulting from Phase II construction of the Project using modular construction methods would be similar to the results shown in the air quality analyses for conventional construction methods. Since no significant adverse construction-related air quality impacts were identified for conventional construction methods, no significant adverse construction-related air quality impacts are expected if Phase II of the Project is constructed using modular construction methods.

NOISE

As described above, for each individual building, modular construction differs from conventional construction methods primarily during the superstructure, exterior façade, and interior finishing tasks of construction. Additionally, modular construction may include regular night-time deliveries of modules.

NOISE RESULTING FROM DAY-TIME MODULAR CONSTRUCTION ACTIVITIES

With modular construction, the superstructure, exterior façade, and interior finishing construction tasks would have a substantially shorter duration, include different on-site equipment, and require many fewer truck and worker vehicle trips to and from the project site.

The quantified analysis of noise from conventional construction of Phase II predicted the potential for elevated noise levels at nearby receptors resulting from all construction tasks of some buildings included in Phase II, but the construction tasks with the greatest potential to result in increased noise levels at most nearby noise receptors are the excavation and foundation tasks, which would occur in the same manner and over the same duration with either conventional or modular construction. Consequently, the maximum predicted noise level increases resulting from Phase II construction of the Project would be expected to occur regardless of the construction method. With modular construction, less equipment would be used on-site and fewer trucks would travel to and from each building site during the superstructure, exterior façade, and interior finishing tasks. Subsequent to the completion of excavation and foundation activities, the equipment expected to be in use at each building site with modular construction would be a tower crane, a construction hoist, pneumatic impact wrenches, and small hand tools, each at comparable quantities to those that would be expected with conventional construction. Typically, the only truck deliveries during these phases with modular construction would be the deliveries of completed modules and one or two miscellaneous delivery trucks per building, per hour. The smaller complement of equipment and especially the lower number of trucks operating on site during these construction tasks would be expected to produce less noise than the corresponding tasks using conventional construction at each individual building. Under each construction phasing plan, each individual building's construction schedule overlaps with those of the other buildings, and the construction tasks that are different with modular versus conventional construction (i.e., superstructure, exterior façade, and interior finishing) typically overlap with one of the construction tasks that is the same with conventional or modular construction (i.e., excavation or foundation work) at an adjacent or nearby building. In this scenario, the dominant noise source would likely be the construction equipment associated with the building undergoing the more intense construction task (i.e., excavation or foundation work), and the decrease in noise generated with modular construction at the adjacent or nearby building would not be realized as a substantial decrease in noise levels at the nearby receptors. However, at some receptors that do not have a line of sight to multiple buildings under construction simultaneously, during the construction tasks that are different with modular versus conventional construction (i.e., superstructure, exterior façade, and interior finishing), noise levels with modular construction would be somewhat lower than those predicted for conventional construction. Consequently, the calculated noise levels and resultant predicted construction noise impacts shown in the analysis of conventional construction are conservatively representative of the noise conditions that would be expected with modular construction.

Additionally, modular construction would result in a shorter overall duration of construction for each building built using these methods. If one or more buildings included in Phase II were constructed using modular construction rather than conventional construction, elevated noise levels resulting from construction activities for that building would be expected to last for a shorter duration.

NOISE RESULTING FROM NIGHT-TIME MODULE DELIVERIES

Modular construction would include regular night-time deliveries of modules. Each delivery would involve a tractor delivering a module on a trailer to the building site, and leaving the loaded trailer at the site. No unloading or module lifting activities would occur during the night-time delivery process. Based on the current practices, it is expected that a maximum of approximately four night-time deliveries could be made per building, per night. This would be expected to result in no more than one night-time delivery per building, per hour. Based on current logistics and the number of buildings to simultaneously undergo the construction tasks that would include module deliveries, this would be expected to result in approximately two module deliveries to the project site in a single hour.

These deliveries would generate noise at receptor sites adjacent to the areas where modules are delivered at each building site. This noise would primarily result from operation of the module delivery truck, including its engine and back-up alarm. As described in the "Noise Reduction Measures" section of Chapter 3J, "Construction Noise," where practicable and feasible, construction sites would be configured to minimize back-up alarm noise and trucks would not be allowed to idle more than three minutes at the construction site. Furthermore, trucks used for night-time module deliveries would use adaptive back-up alarms that adjust the volume of the alarm with the ambient noise level, so that the back-up alarm is quieter when background conditions are quieter. The other noises associated with module deliveries include the decoupling of the trailer from the tractor and the trailer touching down on the roadway surface. Both of these sounds occur for a very short period of time during each delivery. The lead and chase vehicles used during night-time module deliveries would also be required to avoid engine idling to the extent feasible and practicable. With these measures, the noise generated by operation of the module delivery vehicles on-site would be minimized, and noise generated by night-time module deliveries at nearby noise receptors would result primarily from operation of the vehicles on roadways.

While the number of night-time module deliveries expected to occur adjacent to any noise receptor during a single hour is approximately two, four module deliveries occurring adjacent to a receptor in a single hour, was examined to account for a "worst-case" condition. The Traffic Noise Model (TNM) version 2.5 (the model used to calculate noise levels resulting from traffic on roadways, as described in detail in Chapter 4G "Operational Noise") was used to calculate the level of noise that would be generated by four night-time module deliveries adjacent to a single receptor location in one hour. The 1-hour equivalent noise level ($L_{eq(1h)}$), which is the descriptor used to evaluate the potential for noise impacts from construction, resulting solely from four night-time module deliveries in a single hour adjacent to a single receptor location was calculated to be in the mid 50s dBA. Night-time existing $L_{eq(1h)}$ noise levels at receptors adjacent to the project site range from approximately the high 50s dBA to low 70s dBA. The combination of the background $L_{eq(1h)}$ noise levels and the $L_{eq(1h)}$ noise level resulting from the night-time module deliveries would not be perceptibly greater (i.e., less than 3 dBA greater) than the background noise levels. The night-time module deliveries would consequently not be expected to result in any significant adverse construction noise impacts.

While the night-time module deliveries would not be expected to result in a perceptible increase in the $L_{eq(1h)}$, operation of the trucks used for night-time module deliveries in close proximity to noise receptors would result in increases in noise level for short periods of time. Such increases in noise level would occur only when the trucks would operate adjacent to the noise receptor and would be comparable in magnitude and duration to that which would result from operation of any heavy truck on the roadway adjacent to the receptor. Consequently, these short-term increases in noise level during night-time module deliveries would not constitute a significant adverse noise impact.

Consequently, it is not expected that the use of modular construction for the Phase II buildings would result in significant adverse noise impacts beyond those identified for conventional construction in Chapter 3J, "Construction Noise."

In summary, based on the information presented above, it is not expected that the use of modular construction for the Phase II buildings would result in significant adverse impacts in the relevant technical areas beyond those identified for conventional construction. ✷