Chapter 11: Greenhouse Gas Emissions and Climate Change

A. INTRODUCTION

This chapter addresses the greenhouse gas (GHG) emissions that would be generated by the proposed Memorial Sloan-Kettering Cancer Center (MSK)/The City University of New York (CUNY)-Hunter project and measures that would be implemented to limit those emissions, as well as measures that would be taken to increase the proposed project's resilience to the potential effects of climate change.

There is general consensus in the scientific community that the global climate is changing as a result of increased concentrations of GHGs in the atmosphere. GHGs are those gaseous constituents of the atmosphere, from both natural and anthropogenic emission sources (i.e., resulting from the influence of human beings), that absorb infrared radiation (heat) emitted from the earth's surface, the atmosphere, and clouds. This property causes the general warming of the earth's atmosphere, or the "greenhouse effect."

As discussed in the *City Environmental Quality Review (CEQR) Technical Manual*, climate change could have wide-ranging effects on the environment, including rising sea levels, increases in temperature, and changes in precipitation levels. Although this is occurring on a global scale, the environmental effects of climate change are also likely to be felt at the local level. Through PlaNYC, the City has established sustainability initiatives and goals for greatly reducing GHG emissions and for adapting to climate change in the City.

Per the *CEQR Technical Manual*, the citywide 2030 GHG reduction goal is currently the most appropriate standard by which to analyze a project under CEQR. The *CEQR Technical Manual* recommends that a GHG consistency assessment be conducted for any project resulting in 350,000 square feet (sf) or more of development and other energy-intense projects. The proposed project would result in over one million gross square feet (gsf) of developed floor area and would include substantial energy systems. Accordingly, A GHG consistency assessment is provided. In addition, given the coastal location of the proposed project, an assessment of the proposed project's resilience in the face of future climate conditions is provided as well.

PRINCIPAL CONCLUSIONS

As discussed in the following sections, the building energy use and vehicle use associated with the proposed project would result in up to approximately ~~27,000~~ 21,000-22,000 metric tons of carbon dioxide equivalent (CO_2e) emissions per year. Of that amount, up to ~~20,000~~ 16,000 metric tons of CO_2e would be generated by MSK's new ambulatory care center (MSK ACC) uses, while up to ~~7,000~~ 6,000 metric tons of CO_2e would be generated by the proposed Hunter College Science and Health Professions Building (CUNY-Hunter Building) uses. ~~While the above result includes the incorporation of substantial building energy reduction measures, the proposed project is investigating additional options for reducing energy consumption and the ensuing GHG emissions, which could further reduce GHG emissions by up to approximately 5,800 metric tons of CO_2e.~~ Additional GHG emissions associated with the production of materials to be used by the proposed project (not included in the above estimate) would be reduced by the selection of lower-carbon alternatives where practicable.

The proximity of the proposed project to public transportation and efficient design are all factors that contribute to energy efficiency. At this time, the proposed project is intending to meet or exceed the requirements for the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Silver certification. As such, specific measures would need to be incorporated into the design of the proposed project to qualify for the LEED rating, which would decrease the potential GHG emissions from the proposed project as described above. Based on these project components and efficiency measures, the proposed project would be consistent with the City's emissions reduction goal, as defined in the *CEQR Technical Manual*.

B. GHG EMISSIONS

POLLUTANTS OF CONCERN

GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the general warming of the Earth's atmosphere, or the "greenhouse effect." Water vapor, carbon dioxide (CO_2), nitrous oxide, methane, and ozone are the primary greenhouse gases in the Earth's atmosphere.

There are also a number of entirely anthropogenic (resulting from human activity) greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, which also damage the stratospheric ozone layer (contributing to the "ozone hole"). Since these compounds are being replaced and phased out due to the 1987 Montreal Protocol, there is no need to address them in project-related GHG assessments for most projects. Although ozone itself is also a major greenhouse gas, it does not need to be assessed as such at the project level since it is a rapidly reacting chemical and efforts are ongoing to reduce ozone concentrations as a criteria pollutant (see Chapter 10, "Air Quality").

Similarly, water vapor is of great importance to global climate change, but is not directly of concern as an emitted pollutant since the negligible quantities emitted from anthropogenic sources are inconsequential.

CO_2 is the primary pollutant of concern from anthropogenic sources. Although not the GHG with the strongest effect per molecule, CO_2 is by far the most abundant and, therefore, the most influential GHG. CO_2 is emitted from any combustion process (both natural and anthropogenic), from some industrial processes such as the manufacture of cement, mineral production, metal production, and the use of petroleum-based products, from volcanic eruptions, and from the decay of organic matter. CO_2 is removed ("sequestered") from the lower atmosphere by natural processes such as photosynthesis and uptake by the oceans. CO_2 is included in any analysis of GHG emissions.

Methane and nitrous oxide also play an important role since the removal processes for these compounds are limited and they have a relatively high impact on global climate change as compared to an equal quantity of CO_2. Emissions of these compounds, therefore, are included in GHG emissions analyses when the potential for substantial emission of these gases exists.

The *CEQR Technical Manual* lists six GHGs that could potentially be included in the scope of an EIS: CO_2, nitrous oxide (N_2O), methane, Hydrofluorocarbons (HFCs), Perfluorocarbons

(PFCs), and Sulfur Hexafluoride (SF_6). This analysis focuses mostly on CO_2, N_2O, and methane. There are no significant direct or indirect sources of HFCs, PFCs, or SF_6 associated with the proposed project.

To present a complete inventory of all GHGs, component emissions are added together and presented as carbon dioxide equivalent (CO_2e) emissions—a unit representing the quantity of each GHG weighted by its effectiveness using CO_2 as a reference. This is achieved by multiplying the quantity of each GHG emitted by a factor called global warming potential (GWP). GWPs account for the lifetime and the radiative forcing of each chemical over a period of 100 years (e.g., CO_2 has a much shorter atmospheric lifetime than SF_6, and therefore has a much lower GWP). The GWPs for the main GHGs discussed here are presented in **Table 11-1**.

Table 11-1
Global Warming Potential (GWP) for Major GHGs

Greenhouse Gas	100-year Horizon GWP
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 to 11,700
Perfluorocarbons (PFCs)	6,500 to 9,200
Sulfur Hexafluoride (SF_6)	23,900

Note: The GWPs presented above are based on the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (SAR) to maintain consistency in GHG reporting. The IPCC has since published updated GWP values that reflect new information on atmospheric lifetimes of GHGs and an improved calculation of the radiative forcing of CO_2. In some instances, if combined emission factors were used from updated modeling tools, some slightly different GWP may have been used for this study. Since the emissions of GHGs other than CO_2 represent a very minor component of the emissions, these differences are negligible.
Source: 2012 *CEQR Technical Manual*

POLICY, REGULATIONS, STANDARDS, AND BENCHMARKS FOR REDUCING GHG EMISSIONS

As a result of the growing consensus that human activity resulting in GHG emissions has the potential to profoundly impact the earth's climate, countries around the world have undertaken efforts to reduce emissions by implementing both global and local measures addressing energy consumption and production, land use, and other sectors. Although the U.S. has not ratified the international agreements which set emissions targets for GHGs, in a step toward the development of national climate change regulation, the U.S. has committed to reducing emissions to 17 percent lower than 2005 levels by 2020 and to 83 percent lower than 2005 levels by 2050 (pending legislation) via the Copenhagen Accord.[1] Without legislation focused on this goal, the U.S. Environmental Protection Agency (EPA) is required to regulate greenhouse gases under the Clean Air Act (CAA), and has already begun preparing and implementing regulations. For example, on March 27, 2012, EPA proposed a Carbon Pollution Standard for New Power Plants that would, for the first time, set national limits on the amount of carbon pollution that power plants can emit. EPA expects to expand this program in the future to limit emissions from additional stationary source. In coordination with the National Highway Traffic Safety Administration (NHTSA), EPA has also begun to regulate GHG emissions from newly manufactured on-road vehicles. In addition, EPA

[1] Todd Stern, U.S. Special Envoy for Climate Change, letter to Mr. Yvo de Boer, UNFCCC, January 28, 2010.

regulates transportation fuels via the Renewable Fuel Standard program, which will phase in a requirement for the inclusion of renewable fuels increasing annually up to 36.0 billion gallons in 2022.

There are also regional, state, and local efforts to reduce GHG emissions. In 2009, Governor Paterson issued Executive Order No. 24, establishing a goal of reducing GHG emissions in New York State by 80 percent, compared to 1990 levels, by 2050, and creating a Climate Action Council tasked with preparing a climate action plan outlining the policies required to attain the GHG reduction goal (that effort is currently under way[1]). The 2009 New York State Energy Plan[2] outlines the state's energy goals and provides strategies and recommendations for meeting those goals (a new plan will be published on or before March 15, 2013). The state's goals include:

- Implementing programs to reduce electricity use by 15 percent below 2015 forecasts;
- Updating the energy code and enacting product efficiency standards;
- Reducing vehicle miles traveled by expanding alternative transportation options; and
- Implementing programs to increase the proportion of electricity generated from renewable resources to 30 percent of electricity demand by 2015.

New York State has also developed regulations to cap and reduce CO_2 emissions from power plants to meet its commitment to the Regional Greenhouse Gas Initiative (RGGI). Under the RGGI agreement, the governors of 10 northeastern and Mid-Atlantic states have committed to regulate the amount of CO_2 that power plants are allowed to emit, gradually reducing emissions to 10 percent below the 2009 levels by 2018. The 10 RGGI states and Pennsylvania have also announced plans to reduce GHG emissions from transportation, through the use of biofuel, alternative fuel, and efficient vehicles.

Many local governments worldwide, including New York City, are participating in the Cities for Climate Protection™ (CCP) campaign and have committed to adopting policies and implementing quantifiable measures to reduce local GHG emissions, improve air quality, and enhance urban livability and sustainability. New York City's long-term sustainability program, PlaNYC 2030, includes GHG emissions reduction goals, specific initiatives that can result in emission reductions, and initiatives aimed at adapting to future climate change impacts. The goal to reduce citywide GHG emissions to 30 percent below 2005 levels by 2030 was codified by Local Law 22 of 2008, known as the New York City Climate Protection Act (the "GHG reduction goal").[3] The City has also announced a longer-term goal of reducing emissions to 80 percent below 2005 levels by 2050, and is currently engaged in the preparation of a plan to achieve that goal. For certain projects subject to CEQR (e.g., projects with 350,000 gsf or more of development or other energy intense projects), an analysis of the projects' contribution of GHG emissions is required to determine their consistency with the City's citywide reduction goal, which is currently the most appropriate standard by which to analyze a project under CEQR, and is therefore applied in this chapter.

In December 2009, the New York City Council enacted four laws addressing energy efficiency in new and existing buildings, in accordance with PlaNYC. The laws require owners of existing buildings larger than 50,000 sf to conduct energy efficiency audits every 10 years, to optimize

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[1] http://www.dec.ny.gov/energy/80930.html

[2] New York State, *2009 New York State Energy Plan*, December 2009.

[3] Administrative Code of the City of New York, §24-803.

building energy efficiency, and to "benchmark" the building energy and water consumption annually, using an EPA online tool. By 2025, commercial buildings over 50,000 sf will also require lighting upgrades, including the installation of sensors and controls, more efficient light fixtures, and the installation of submeters, so that tenants can be provided with information on their electricity consumption. The legislation also creates a local New York City Energy Code, which along with the New York State Energy Conservation Code (as updated in 2010), requires equipment installed during a renovation to meet current efficiency standards.

A number of benchmarks for energy efficiency and green building design have also been developed. For example, the LEED system is a benchmark for the design, construction, and operation of high performance green buildings that includes energy efficiency components. It is noteworthy that the proposed project will strive to attain LEED Silver or higher certification. In addition to helping the proposed project meet MSK and CUNY's sustainability objectives for capital projects, attaining LEED certification would also be consistent with DASNY's sustainability policy. Pursuing LEED certification would follow DASNY's sustainability policy intentions, including pursuing appropriate points that truly serve the proposed project's objectives and encouraging creativity.

EPA's Energy Star is a voluntary labeling program designed to identify and promote the construction of new energy efficient buildings, facilities, and homes and the purchase of energy efficient appliances, heating and cooling systems, office equipment, lighting, home electronics, and building envelopes.

METHODOLOGY

Although the contribution of any single project's emissions to climate change is infinitesimal, the combined GHG emissions from all human activity are severely impacting global climate. While the increments of criteria pollutants and toxic air emissions are assessed in the context of health-based standards and local impacts, there are no established thresholds for assessing the significance of a project's contribution to climate change. Nonetheless, prudent planning dictates that all sectors address GHG emissions by identifying GHG sources and practicable means to reduce them. Therefore, this chapter presents the total GHG emissions potentially associated with the proposed project and identifies measures that would be implemented and measures that are still under consideration to limit emissions.

The analysis of GHG emissions that would be generated by the proposed project is based on the methodology presented in the *CEQR Technical Manual*. Estimates of emissions of GHGs from the proposed project have been quantified, including off-site emissions associated with use of electricity and steam, on-site emissions from heat and hot water systems, and emissions from vehicle use attributable to the proposed project. GHG emissions that would result from construction and renovation of the proposed project are discussed as well.

CO_2 is the primary pollutant of concern from anthropogenic emission sources and is accounted for in the analysis of emissions from all development projects. GHG emissions for gases other than CO_2 are included where practicable or in cases where they comprise a substantial portion of overall emissions. The various GHG emissions are added together and presented as metric tons of carbon dioxide equivalent (CO_2e) emissions per year (see "Pollutants of Concern," above).

BUILDING OPERATIONAL EMISSIONS

Emissions due to electricity, steam, and fuel oil use were developed using projections of energy consumption developed specifically for the proposed project by the project engineers and the emission factors referenced in the 2011 inventory of GHG emissions for New York City.[1]

The project team is currently evaluating many energy options for various components of the proposed project, with the objective of reducing energy consumption and the ensuing emissions and costs. For the purposes of this analysis, ~~a scenario meeting the minimum energy efficiency requirements of the proposed project is~~ the current design, both with and without the MSK ACC turbine, are presented as a reasonable worst-case development scenario (RWCDS). ~~This RWCDS would reduce energy costs by at least 10 percent as compared to a baseline which meets code, as per the requirements of LEED certification. It is likely that some further measures would be included, as~~ Energy efficiency measures included in the current design are discussed in detail later in this chapter ("Elements of the Proposed Project That Would Reduce GHG Emissions"). The RWCDS includes measures that the design team has already determined would be included in the design. ~~Because the measures currently known to be incorporated in the MSK ACC design do not yet meet the minimum LEED requirements to which the proposed project is committed, the RWCDS assumes the inclusion of a natural gas turbine providing cogeneration of electricity and heat as a worst-case assumption; although this option would not result in GHG reductions, it would substantially reduce energy costs, qualifying for LEED credit, and would therefore represent a conservative scenario with the highest GHG emissions.~~

Detailed energy consumption data was obtained from the output of energy modeling prepared for the proposed project. GHG emission factors for natural gas and grid supplied electricity were taken from New York City's greenhouse gas inventory. The energy consumption of the RWCDS and the emission factors used are detailed along with the results (**Table 11-3** below).

MOBILE SOURCE EMISSIONS

The number of annual weekday vehicle trips by mode (cars, taxis, trucks, and ambulances) that would be generated by the proposed project was calculated using the transportation planning assumptions developed for the analysis and presented in Chapter 9, "Transportation." The assumptions used in the calculation include average daily weekday person trips and delivery trips by proposed use, the percentage of vehicle trips by mode, and the average vehicle occupancy. To calculate annual totals, Saturday and Sunday trips for all uses were assumed to be five percent of weekday trips. Travel distances shown in Table 18-4 of the *CEQR Technical Manual* were used in the calculations of annual vehicle miles traveled by cars, taxis, and trucks. The average truck trip was assumed to be 38 miles, as per the *CEQR Technical Manual*. Table 18-6 of the *CEQR Technical Manual* was used to determine the percentage of vehicle miles traveled by road type and the mobile GHG emissions calculator was used to obtain an estimate of car, taxi, and truck GHG emissions attributable to the projects.

EPA estimates that the well-to-pump GHG emissions of gasoline and diesel are more than 20 percent of the tailpipe emissions.[2] Although upstream emissions (emissions associated with

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[1] The City of New York Mayor's Office of Long-Term Planning and Sustainability, *Inventory of New York City Greenhouse Gas Emissions*, December 2012.

[2] Environmental Protection Agency, *MOVES2004 Energy and Emission Inputs*, Draft Report, EPA420-P-05-003, March 2005.

production, processing, and transportation) of all fuels can be substantial and are important to consider when comparing the emissions associated with the consumption of different fuels, fuel alternatives are not being considered for the proposed project, and as per the *CEQR Technical Manual* guidance, the well-to-pump emissions are not considered in the analysis for the proposed project. The assessment of tailpipe emissions only is in accordance with the *CEQR Technical Manual* guidance on assessing GHG emissions and the methodology used in developing the New York City GHG inventory, which is the basis of the GHG reduction goal.

The projected annual vehicle miles traveled, forming the basis for the GHG emissions calculations from mobile sources, are summarized in **Table 11-2**.

Table 11-2
Annual Vehicle Miles Traveled
(miles per year)

Mode	MSK ACC	CUNY-HUNTER Building	Total Annual Miles
Car	2,449,606	897,696	3,347,302
Taxi	315,694	104,044	419,738
Truck	2,765,300	1,001,740	3,767,041
Total	**5,530,601**	**2,003,481**	**7,534,081**

CONSTRUCTION EMISSIONS

Emissions associated with construction have not been estimated explicitly for the project, but analyses of similar projects have shown that construction emissions (both direct and emissions embedded in the production of materials, including on-site construction equipment, delivery trucks, and upstream emissions from the production of steel, rebar, aluminum, and cement used for construction) are equivalent to the total emissions from the operation of the projects over approximately 5 to 10 years.

EMISSIONS FROM SOLID WASTE MANAGEMENT

The proposed project would not fundamentally change the City's solid waste management system. Therefore, as per the *CEQR Technical Manual*, the GHG emissions from solid waste generation, transportation, treatment, and disposal are not quantified.

PROJECTED GHG EMISSIONS FROM THE PROPOSED PROJECT

BUILDING OPERATIONAL EMISSIONS

The fuel consumption, emission factors, and resulting GHG emissions from each of the project components under the RWCDS are presented in detail in **Table 11-3**.

MOBILE SOURCE EMISSIONS

The detailed mobile source related GHG emissions from each of the project components are presented in detail in **Table 11-4**.

Table 11-3
Building Operational Emissions—RWCDS

	Natural Gas	Electricity	Total
Annual Fuel Consumption (million Btu)			
MSK ACC w/o turbine	51,380	74,670	**126,050**
MSK ACC w' turbine	~~73,161~~ 112,100	~~67,268~~ 42,695	**~~240,429~~ 154,795**
CUNY-Hunter Building	~~15,918~~ 18,625	~~59,750~~ 58,494	**~~75,668~~ 77,119**
*Total Site Energy— w/o turbine**	*70,005*	*133,164*	***203,169***
*w' turbine**	*130,725*	*101,189*	***231,914***
~~*Total*~~	~~*189,079*~~	~~*127,018*~~	**~~316,096~~**
*Emission Factor (metric tons/million Btu) **	0.0532	0.0874	
GHG Emissions (metric tons CO_2e/year)			
MSK ACC w/o turbine	2,731	6,528	**9,260**
MSK ACC w' turbine	5,959	3,733	**9,692**
CUNY-Hunter Building	990	5,114	**6,104**
Total w/o turbine	*3,721*	*11,642*	***15,364***
*Total w' turbine**	*6,949*	*8,847*	***15,796***
~~MSK ACC~~	~~9,205~~	~~5,881~~	**~~15,086~~**
~~CUNY-Hunter Building~~	~~846~~	~~5,224~~	**~~6,070~~**
~~*Total*~~	~~*10,051*~~	~~*11,105*~~	***~~21,156~~***

Note: * From PlaNYC inventory (for 2011)

Table 11-4
Mobile Source Emissions (metric tons CO_2e)

Roadway Type	Passenger Vehicle	Taxi	Truck	Total
MSK ACC				
Local	533	62	1,084	*1,679*
Arterial	708	82	1,459	*2,249*
Int/Exp	312	36	698	*1,046*
Subtotal	*1,553*	*180*	*3,241*	***4,974***
CUNY-Hunter Building				
Local	195	21	79	*295*
Arterial	259	27	107	*393*
Int/Exp	114	12	51	*177*
Subtotal	*569*	*59*	*237*	***865***
Proposed Project Total	**2,123**	**239**	**3,478**	***5,839***

SUMMARY

A summary of GHG emissions by source type is presented in **Table 11-5**. Note that if the proposed buildings were to be constructed elsewhere to accommodate the same number of patients, visitors, and workers the emissions from the use of electricity, energy for heating and hot water, and vehicle use could equal or exceed those of the proposed project, depending on their location, access to transit, building type, and energy efficiency measures. As described in the "Methodology" section above, construction emissions were not modeled explicitly, but are estimated to be equivalent to approximately 5 to 10 years of operational emissions, including both direct energy and emissions embedded in materials (extraction, production, and transport). The proposed project is not expected to fundamentally change the City's solid waste management system, and therefore emissions associated with solid waste are not presented.

Table 11-5
Summary of Annual GHG Emissions 2015 RWCDS (metric tons CO2e)

~~Emissions Source~~	~~MSK ACC~~	~~CUNY-Hunter Building~~		~~Total~~	
~~Building Operations~~	~~15,086~~	~~6,070~~		~~21,156~~	
~~Mobile~~	~~4,974~~	~~865~~		~~5,839~~	
~~**TOTAL**~~	~~**20,060**~~	~~**6,935**~~		~~**26,995**~~	
Emissions Source	**MSK ACC w' Turbine**	**MSK ACC w/o Turbine**	**CUNY-HUNTER**	**Total w' Turbine**	**Total w/o Turbine**
Building Operations	9,692	9,260	6,104	*15,796*	15,364
Mobile	4,974		865	*5,839*	
TOTAL	**14,666**	**14,234**	**6,969**	**21,635**	**21,203**

The operational emissions from building energy use include on-site emissions from fuel consumption as well as emissions associated with the production and delivery of the electricity to be used on-site. It is anticipated that the proposed project would, at a minimum, achieve Silver certification under the LEED Green Building Design and Construction rating system (the CUNY-Hunter Building would be LEED for New Construction and MSK ACC would be LEED for Healthcare). To attain LEED Silver certification, the proposed project would need to meet energy efficiency requirements that exceed code, such as those demonstrated in the above analysis (see more detail in the following section.) Overall, the incorporation of energy efficient design measures have reduced the proposed project's building energy carbon footprint by approximately 26 percent as compared to the same buildings if they were designed to meet but not exceed the building code energy requirements. (Note that the cogeneration system, while potentially providing benefits not quantified here such as peak load shaving, does not provide a net reduction in GHG emissions.) ~~Therefore, the minimum energy efficiency requirements needed to achieve the LEED rating are included in the estimate of emissions from building operations under the RWCDS.~~ The proposed project would limit the emissions associated with electricity consumption and heating through energy-efficient design, and reduce emissions associated with transportation because of the available alternatives to driving. ~~It is likely that GHG emissions would be lower, since the project is considering many energy options which would further reduce energy consumption (see more detail in the following section).~~

ELEMENTS OF THE PROPOSED PROJECT THAT WOULD REDUCE GHG EMISSIONS

The proposed project would include a number of sustainable design features which would, among other benefits, result in lower GHG emissions. Many of the measures that may be included in the proposed project to achieve LEED certification would result in a smaller carbon footprint. In general, as a prerequisite for LEED certification, the proposed project would have an energy expenditure ~~use~~ at least 10 percent less ~~energy~~ than it would if built to meet but not exceed the building code. These energy efficiency assumptions were included in the GHG emissions calculations presented above. In general, the dense, mixed-use development with access to transit and existing roadways are consistent with sustainable land use planning and smart growth strategies to reduce the carbon footprint of new development. These features and other measures currently under consideration are discussed in this section, addressing the PlaNYC goals as outlined in the *CEQR Technical Manual*.

BUILD EFFICIENT BUILDINGS

The proposed project's energy systems will utilize high-efficiency heating, ventilation, and air conditioning (HVAC) systems, with many components designed to reduce energy consumption. The buildings will have high-albedo roofs to reduce energy consumption and reduce the buildings' contribution to the urban heat-island effect. Motion sensors and lighting and climate controls will be incorporated resulting in efficient energy consumption. Efficient lighting, elevators, and Energy Star rated appliances will be installed to reduce electricity consumption. Exterior lighting will be energy efficient and directed for optimal efficiency. Third-party fundamental building energy systems commissioning upon completion will ensure energy performance. Water conserving fixtures, exceeding building code requirements, will be installed to reduce water consumption, indirectly reducing energy consumption associated with potable water production and delivery. Storage and collection of recyclables will be incorporated in building design. Electricity, water, hot water, and chilled water will be sub-metered.

The proposed project would likely also be designed with an energy efficient building envelope, and incorporate window glazing to optimize the combination of daylighting, heat loss, and solar heat gain.

Other measures under consideration include the installation of a green roof for the MSK ACC and in some areas of the CUNY-Hunter Building; maximizing interior daylighting in the buildings' design; and a storm water reclamation system for cooling tower make-up water and irrigation will be installed for both buildings.

~~The project design team has prepared an initial assessment of the potential benefits of the various building energy measures under consideration. The potential reduction in GHG emissions associated with the various measures as compared to the RWCDS presented above and overall reductions as compared to the building code baseline are presented in **Table 11-6**. As presented in the table, the RWCDS would result in 8.4 percent and 19.7 percent less GHG emissions from MSK ACC and the CUNY-Hunter Building, respectively, than would otherwise occur under baseline conditions. Further measures currently under consideration (in addition to the measures included in the RWCDS) could potentially reduce the building energy emissions displayed above for the RWCDS by up to 33.8 percent for MSK ACC and up to 11.3 percent for the CUNY-Hunter Building, resulting in up to a total of 5,786 metric tons CO_2e lower total emissions for the proposed project. (Note that the reductions presented in Table 11-6 are in reference to the baseline building code scenario, and the cumulative reductions are not the sum of all components presented due to interactions between measures—see table notes.)~~

Since the publication of the DEIS, the design has proceeded to include additional energy efficiency components. Of the ~~analyzed~~ additional potential measures, two are of note for their potential to substantially reduce GHG emissions: reducing the air exchange rate and adding energy recovery for MSK ACC. Reducing equipment and fan power, and adding and condensing boilers for MSK ACC and heat recovery chiller for the CUNY-Hunter Building would also reduce emissions. Other measures, while beneficial, would reduce GHG by smaller amounts, although depending on cost and other factors may still be worth considering. Note that these ~~are preliminary~~ results ~~which~~ are based on a design still in progress, may change as the design progresses and some of these options may ultimately prove to be infeasible while others may arise.

The inclusion of natural gas powered turbines providing combined heat and power for the proposed project components were not projected to result in the reduction of GHG emissions;

this is a result of differences between the local turbine and the electricity produced for the grid (including low-carbon sources and renewables), which offsets the benefit of combining heat and power generation. Note that on-site power generation may result in some GHG and other benefits not addressed in this analysis associated with the beneficial impact of reducing peak power demand, and could result in considerable energy cost savings, and may, therefore, be considered nonetheless. Note that in the preliminary analysis presented here above, the total potential GHG benefits of the MSK ACC with the turbine are less than without the turbine due to differences between the carbon intensity of the electricity grid and on-site production, and due to the sizing of the system; this may change if the sizing of the system is adjusted so as not to exceed the heat demand or if the additional waste heat is used for another adjacent system such as CUNY.

Table 11-6
Reduction in Potential CO2e Emissions from Potential Design Measures as Compared to Baseline Design Meeting Building Code

Potential Measure	MSK ACC	CUNY-Hunter Building
RWCDS	8.4%	19.7%
Additional Performance Enhancements:		
Improved Glazing	0.2%	1.0%
Improved Walls and Roof	0.0%	0.0%
Reduced Equipment	2.7%	5.4%
Reduced Fan Power	3.1%	2.2%
Reduced Air Change Rate	14.6%	NA
Additional Systems and Features:		
Daylight Controls	0.6%	0.3%
Energy Recovery	14.9%	NA
Heat Recovery Chiller	0.8%	1.9%
Condensing Boilers	4.7%	0.4%
Natural Gas Turbine	*	0.3%
Total Potential	**39.3%****	**28.8%**

Notes: Total potential reductions may be less than the combined stand-alone measures because of system interactions. For example, improved building envelope performance would reduce the benefit of more efficient heating systems because it would reduce the heating demand.

Baseline Basic design meeting ASHRAE 90.1 2007 and New York City Building Code.
RWCDS Reasonable worst-case development scenario meets minimum LEED requirement.
NA Not Applicable
* This measure was included in the RWCDS. See "Methodology" section for further explanation.
** Note that in this preliminary analysis, the benefit is smaller with the turbine than w/o, but this could change if the turbine sizing is adjusted so as not to exceed heat demand or if the additional waste heat is used for another adjacent system such as CUNY.

USE CLEAN POWER

Both components of the proposed project would use natural gas, a lower carbon fuel, for the normal operation of the heat and hot water systems and for electricity generation turbines, if included (see above).

TRANSIT-ORIENTED DEVELOPMENT AND SUSTAINABLE TRANSPORTATION

The proposed project is located in an area supported by many transit options (bus, select bus service, and existing subway service are all within walking distance of the project). In December 2016, MTA expects to open the first phase of the Second Avenue Subway which will have a station at 72nd Street. In addition, the proposed project is located next to two major bike routes on First Avenue and the East River Esplanade.

The CUNY-Hunter Building would not be providing vehicular parking. The majority of the building population is expected to rely heavily on mass transit and/or bicycles for access. MSK-ACC will provide parking for patients only (not for staff), and will provide showers/changing rooms for staff to encourage cycling.

Both MSK and CUNY offer their employees the option of paying for transit with pre-tax income, reducing transit costs, and encouraging the use of transit.

REDUCE CONSTRUCTION OPERATION EMISSIONS

Construction will include an extensive diesel emissions reduction program including diesel particle filters for large construction engines and other measures. These measures would reduce particulate matter emissions; while particulate matter is not included in the list of standard GHGs ("Kyoto gases"), recent studies have shown that black carbon—a constituent of particulate matter—may play an important role in climate change.

USE BUILDING MATERIALS WITH LOW CARBON INTENSITY

Recycled steel will be required explicitly for all structural steel, and cement replacements such as fly ash and/or slag will be required as well. Construction contracts will require at least 90 percent of all steel to be recycled, and at least 25 percent cement replacement from recycled sources (e.g., fly ash or slag). The design team is working to maximize efficiency of the structural systems and potentially reduce the height of both structures in order to minimize the amount of steel and concrete required. Both facilities intend to use interior materials produced regionally, rapidly renewable materials, and materials that contain recycled content where appropriate. The proposed project is also considering requiring wood products to be certified sustainable.

The proposed project will implement a construction waste management plan and divert waste from landfills.

CONCLUSION

The projects will include substantial energy efficiency measures and design elements which would result in energy efficient buildings, the use of clean power, transit-oriented development and the use of sustainable transportation. Based on these project components and efficiency measures, the proposed project would be consistent with the City's emissions reduction goal, as defined in the *CEQR Technical Manual*.

C. ADAPTATION TO CLIMATE CHANGE

Since most of the proposed project is located within the current 100-year floodplain, the potential effects of global climate change on the proposed project have been considered.

Currently, standards and a framework for analysis of the effects of climate change on a proposed project are not included in CEQR. However, the recently proposed revisions to the Waterfront Revitalization Program (WRP)[1] address climate change and sea level rise. If finalized, the WRP would require consideration of climate change and sea level rise in planning and design of waterfront development. As set forth in more detail in the *CEQR Technical Manual*, the provisions of the WRP are applied by the New York City Department of City Planning (DCP) and other city agencies when conducting environmental review. Since the proposed project site is on the waterfront, the potential effects of global climate change on the proposed project are considered and measures that would be implemented as part of the project to improve its resilience to climate change are identified.

DEVELOPMENT OF POLICY TO IMPROVE CLIMATE CHANGE RESILIENCE

In recognition of the important role that the federal government has to play to address adaptation to climate change, a federal executive order signed October 5, 2009 charged the Interagency Climate Change Adaptation Task Force, composed of representative from more than 20 federal agencies, with recommending policies and practices that can reinforce a national climate change adaptation strategy. A recent report by the Task Force included recommendations to build resilience to climate change in communities by integrating adaptation considerations into national programs that affect communities, facilitating the incorporation of climate change risks into insurance mechanisms, and addressing additional cross-cutting issues, such as strengthening resilience of coastal, ocean, and Great Lakes communities.[2]

The New York State Sea Level Rise Task Force was created to assess potential impacts on the state's coastlines from rising seas and increased storm surge. The Task Force has prepared a final report of its findings and recommendations including protective and adaptive measures.[3] The recommendations are to provide more protective standards for coastal development, wetlands protection, shoreline armoring, and post-storm recovery; to implement adaptive measures for habitats; integrate climate change adaptation strategies into state environmental plans; and amend local and state regulations or statutes to respond to climate change. The Task Force also recommended the formal adoption of projections of sea level rise. The New York State Climate Action Plan will also include strategies for adapting to climate change. The Climate Action Plan Interim Report identified a number of policy options and actions that could increase the climate change resilience of natural systems, the built environment, and key economic sectors—focusing on agriculture, vulnerable coastal zones, ecosystems, water resources, energy infrastructure, public health, telecommunications and information infrastructure, and transportation.[4]

In New York City, the Climate Change Adaptation Task Force is tasked with securing the city's critical infrastructure against rising seas, higher temperatures, and fluctuating water supplies projected to result from climate change. The Task Force is composed of over 35 New York City and State agencies, public authorities, and companies that operate, regulate, or maintain critical

[1] City of New York Department of City Planning, The New York City Waterfront Revitalization Program: Proposed Revisions for Public Review, March 2012, http://www.nyc.gov/html/dcp/html/wrp/wrp_revisions.shtml

[2] The White House Council on Environmental Quality, Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National climate Change Adaptation Strategy, October, 2010.

[3] New York State Sea Level Rise Task Force, *Report to the Legislature*, December 2010.

[4] NYSERDA, New York State Climate Action Plan Interim Report, November, 2010.

infrastructure in New York City. The approaches suggested for the City to create a city-wide adaptation program include ways to assess risks, prioritize strategies, and examine how standards and regulations may need to be adjusted in response to a changing climate.

To assist the task force, the New York City Panel on Climate Change (NPCC), has prepared a set of climate change projections for the New York City region[1] which was recently updated,[2] and has suggested approaches to create an effective adaptation program for critical infrastructure. The NPCC includes leading climatologists, sea-level rise specialists, adaptation experts, and engineers, as well as representatives from the insurance and legal sectors. The climate change projections include a summary of previously published baseline and projected climate conditions throughout the 21st century including heat waves and cold events, intense precipitation and droughts, sea level rise, and coastal storm levels and frequency. In 2009, the NPCC projected that sea levels are likely to increase by 12 to 23 inches by the end of the century, with a possible increase of up to 55 inches in the event of rapid ice melt. After the publication of the DEIS, in June 2013, NPCC updated its climate change projections for the New York City area, and published specific data for the 2020s and 2050s, with end-of-century updates expected to follow in the coming months. In general, the probability of higher sea levels is characterized as "extremely likely," but there is high uncertainty regarding the probability of a rapid ice melt scenario. Intense hurricanes are characterized as "more likely than not" to increase in intensity and/or frequency, and the likelihood of changes in other large storms ("Nor'easters") are characterized as unknown. Therefore, the projections for future 1-in-100 coastal storm surge levels for New York City include only sea level rise at this time ~~(excluding the rapid ice melt scenario)~~, and do not account for changes in storm frequency.

The New York City Green Code Task force has also recommended strategies for addressing climate change resilience in buildings and for improving storm water management.[3] Some of the recommendations call for further study, while others could serve as the basis for revisions to building code requirements. Notably, one recommendation was to develop flood maps that reflect projected sea-level rise and increases in coastal flooding through 2080 and to require new developments within the projected future 100-year floodplain to meet the same standards as buildings in the current 100-year flood zone. The City is currently working with the Federal Emergency Management Agency (FEMA) to revise the Flood Insurance Rate Maps (FIRMs) using the recently acquired detailed Light Detection and Ranging (LiDAR) data.

The New York City Department of Environmental Protection (DEP) is evaluating adaptive strategies for City water and wastewater infrastructure. The City has already developed a *New York City Green Infrastructure Plan*[4], and a *Sustainable Stormwater Management Plan.*[5] Many of the strategies discussed in these plans would improve the City's resilience to climate change.

Overall, strategies and guidelines for addressing the effects of climate change are rapidly being developed on all levels of government. However, there are currently no specific requirements or accepted recommendations for development projects in New York City. However, the recently

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[1] New York City Panel on Climate Change, *Climate Change Adaptation in New York City: Building a Risk Management Response*, Annals of the New York Academy of Sciences, May 2010.

[2] New York City Panel on Climate Change, Climate Risk Information 2013: Observations, Climate Change Projections, and Maps, June 2013.

[3] New York City Green Codes Task Force, *Recommendations to New York City Building Code*, February 2010.

[4] New York City, New York City Green Infrastructure Plan, September 2010.

[5] New York City, Sustainable Stormwater Management Plan, December 2008.

proposed revisions to the WRP, if finalized, would require consideration of climate change and sea level rise in planning and design of waterfront development. As set forth in more detail in the City's *CEQR Technical Manual*, the provisions of the WRP are applied by DEP and other city agencies when conducting environmental review. The proposed WRP revisions, among other provisions,[1] would require waterfront developments to:

- Consider potential risks related to coastal flooding to features specific to the project, including but not limited to critical electrical and mechanical systems, residential living areas, and public access areas;
- Minimize losses from flooding and erosion by employing non-structural and structural management measures appropriate to the condition and site, the use of the property to be protected, and the surrounding area;
- Integrate consideration of the latest New York City projections of climate change and sea level rise (as published by the NPCC, or any successor thereof) into the planning and design of projects in the city's Coastal Zone;
- Incorporate design techniques in projects that address the potential risks identified and/or which enhance the capacity to incorporate adaptive techniques in the future. Climate resilience techniques should aim to protect lives, minimize damage to systems and natural resources, prevent loss of property, and, if practicable, promote economic growth and provide additional benefits such as provision of public space and intertidal habitat;
- The project should also provide a qualitative analysis of potential adverse impacts on existing resources (including ecological systems, public access, visual quality, water-dependent uses, infrastructure, and adjacent properties) as a result of the anticipated effects of climate change;
- Projects that involve construction of new structures directly in the water or at the water line should be designed to protect inland structures and uses from flooding and storm surge when appropriate and practicable;
- As appropriate and to the extent practicable:
  - Promote the greening of the waterfront with a variety of plant material for aesthetic and ecological benefit;
  - Use water- and salt-tolerant plantings in areas subject to flooding and salt spray;
  - Maximize water-absorption functions of planted areas;
  - Preserve and enhance natural shoreline edges;
  - Design shoreline edges that foster a rich marine habitat; and
  - Design sites that anticipate the effects of climate change, such as sea level rise and storm surges.

Climate change considerations may be incorporated into state and/or local laws prior to the development of the proposed project, and any development would be constructed to meet or exceed the codes in effect at the time of construction. Nonetheless, since the proposed project is located within the current 100-year floodplain, climate change considerations and measures that

[1] Full details of the requirements can be found at http://www.nyc.gov/html/dcp/html/wrp/wrp_revisions.shtml; the most relevant details are in Policy Six.

would be implemented to increase climate resilience are discussed, addressing the above proposed WRP measures as applicable.

RESILIENCE OF THE PROPOSED PROJECT TO CLIMATE CHANGE

In reviewing the potential climate related impacts and resilience measures discussed above, the only issue for which the project can prepare, within its context and location, is potential future flooding, i.e., designing the project to withstand and recover from flooding and to ensure that hazardous materials and other potentially dangerous items would not end up in floodwaters. This section discusses the project's approach to these items.

Given the location of the site near the East River, the MSK ACC design team has taken a proactive approach to reducing the likelihood of flood damage and enabling quicker recovery after potential flooding events. FEMA has identified the flood elevation of 10.8 feet national geodetic vertical datum (NGVD) 1929 as the level at which there is a 1 percent chance of flooding in any given year (the 1-in-100 flood) in this area.[1] This is equivalent to elevation 8.1 feet Borough President of Manhattan Datum (BPMD—all project elevations below are presented in this datum). The Base Flood Elevation (BFE) ~~has been~~ was originally established at 8.25 BPMD and the subsequent Design Flood Elevation (DFE) for the proposed project ~~has been~~ was set at 10.25 per the New York City Building Code. In June 2013, FEMA released the Best Available Flood Hazard Data (BAFHD) for New York City—a draft product preceding the publication of new Flood Insurance Rate Maps (FIRMs). ~~At the end of February 2012, FEMA published Advisory Base Flood Elevations (ABFEs) for Manhattan.~~ Although not yet adopted formally by FEMA, ~~these ABFEs are considered to be more accurate and more up-to-date~~ FEMA encourages communities to use the BAFHD when making decisions about floodplain management and post-Hurricane Sandy recovery efforts, and these levels have been adopted by New York City for zoning purposes, allowing projects to account for higher base flood elevations for height and other zoning requirements. ~~The Mayor has also recognized these elevations via Executive Order 233, allowing for projects who adopt these levels for planning purposes to obtain certain zoning allowances to enable planing for the higher flood levels projected in many areas.~~ The 1-in-100 flood in the proposed project area is projected to be approximately 1 foot ~~3 feet~~ higher in the ~~ABFE~~ BAFHD than the level currently in effect, resulting in 1-in-100 flood level of ~~11.1~~ 9.5 BPMD.[2] However, the NPCC has projected that by the ~~end of the~~ mid-century sea level will rise by 1.0 to ~~1.9~~ 2.0 feet (central estimate), ~~with a higher~~ and end-of-century levels could rise by ~~of~~ up to 4.6 feet ~~in the event of rapid ice-melt~~. This would result in an end-of-century 1-in-100 flood level ranging ~~from elevation 12.1~~ up to ~~15.6~~ 14.1 feet BPMD. [3]

The proposed project's design team has reviewed the above information and has also reexamined its design in light of the flooding that occurred in the area during Hurricane Sandy. MSK-ACC is located at the low end of the site with a lobby entry elevation of 11.0 feet; entry to

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[1] FEMA, Flood Insurance Study—City of New York, 340497V000A, Revised September 5, 2007.

[2] Note that elevations are presented at a precision of 0.1 feet in this document in order to reflect datum conversion factors, but the FEMA maps, including BAFHD are given only in whole feet, so all levels should be treated as having a precision of ±0.5 feet.

[3] Since the 2013 update does not yet include end-of-century data, the high end level presented here is the high-end of the 2009 data including "rapid ice-melt scenario", because the mid-range 2013 estimate for 2020s and 2050s was equivalent to the "rapid ice-melt scenario" in the 2009 data. The 2013 data no longer includes a "rapid ice-melt scenario" because all foreseeable conditions have now been included, while accounting for their probability.

the below-grade parking garage is at elevation 10.25 feet. The CUNY-Hunter Building is located on the higher end of the site, with a main lobby elevation of 13.0. The CUNY-Hunter Building loading entry elevation is slightly higher at 16.5 feet and the loading dock and adjacent mechanical space is higher still at 19.5 feet. The MSK-ACC has two levels of below-grade parking and the CUNY-Hunter Building has two levels of classroom program space below grade. The design team is making every effort to locate critical infrastructure at elevations above future projected flood levels: most of MSK ACC's critical infrastructure would be at the second floor level (36.25 feet) or higher, and the CUNY-Hunter Building's critical infrastructure would be at 19.5 feet or higher, with most at the sixth floor (100 feet) or higher—in all cases, above the flood levels discussed above. Some infrastructure that would remain at lower levels would be sealed or otherwise protected, as described below. The entire below-grade perimeter of both facilities will be dry flood proofed.

MSK ACC

The following preemptive design decisions were made to ensure resilience of MSK ACC's critical infrastructure in the face of future flooding events:

1. The building's electrical service would be on the third floor, in a standard, interior secondary service Con Edison vault configuration.
2. The building's incoming telephone and data connection and distribution rooms, and other related building technology spaces would be on the third floor.
3. The building's air handling, ventilation, and exhaust systems serving the parking garage, lobby, and loading dock would be on the third floor.
4. The building's chilled water plant would be located on the second floor.
5. The building's hot water boiler plant would be located on the 23rd floor.
6. The building's emergency generators would be located on the roof.
7. Medical air compressors and vacuum pumps would be located on the second floor or higher.
8. Domestic hot water heaters would be located on the second floor, 19th floor, and 23rd floor.
9. Building heating systems would be located on the second floor, 19th floor, and 23rd floor.
10. Incoming water service would be connected at the ground floor level, but the pumps would be located on the second floor, and a 10,000 gallon suction tank will be incorporated as backup storage volume should potable water delivery to the building be compromised. The suction tank would supply sufficient water for one day's use.
11. The fire pumps would be located on the second floor. In addition, 40,000 gallons of water storage located at the roof level would serve as a second source of water for the fire protection system.
12. The storm water detention tank and associated water filtration system and pumps, which collect rainwater from the building's rooftops for re-use in irrigation and as condenser water system makeup, would be located at the sub-basement level. Although there is no physical and economical solution for locating this tank at a higher elevation, the team is considering relocating the pumps and filters to the basement level (one level above the tank) to provide some level of protection in the event of lesser floods (these systems need to be in close proximity to the tank). This system is not critical to the operation of the building and would

be repaired or replaced as needed if damaged in the event of a major flood. As backup, a second source of condenser water make-up has been incorporated into the design via a duplex pump set located on the second floor.

13. The fuel oil storage tank serving both the emergency generators and backup for the hot water boiler plant would be located at the lowest elevation of the building, as required by the building code. In order to protect fuel oil storage tank and transfer pumps, the vault would be designed to be waterproof. This may include enhancements to the vault walls, submarine type access doors, watertight sealing of all pipe penetrations, and potentially bubble tight dampers for ventilation ducts that penetrate the vault wall. In addition, fuel oil pumping strategies may include submersible fuel oil pumps located within the tank which will pump up to a secondary set of fuel oil pumps on the second floor, above the flood zone; this is not an as-of-right alternative, but would be presented to the New York City Department of Buildings (DOB) for approval. Alternatively, a direct buried double wall fiberglass tank with a similar pumping configuration may be considered. The location of the fuel oil tank vent would be extended to the second floor and the fuel oil inlet would be mounted in a sealed enclosure in the building's façade and the alarm and vent system would be at an elevation of 20 feet or higher.
14. Locating the gas meter room on the second floor is the design team’s preferred option, but will require approval from Con Edison and the New York City Fire Department (this option is not as-of-right). This option would most likely require special venting and fire rated high pressure gas risers, but may be practicable. Alternatively, the gas meter room may be located in the basement level; since the boilers are dual fuel and are backed up by the on-site fuel oil plant, this system is not critical to the operation of the building and would be repaired or replaced as needed if damaged in the event of a major flood.
15. Medical gas cylinder storage would be located in the loading dock area. As part of MSK ACC’s emergency management plans, in preparation for potential flooding events, all medical gas cylinders would be relocated to a safe elevation.
16. With regard to electrical distribution, the amount of distribution below the ground floor would be minimized to the extent practicable. Electrical distribution for below-grade critical systems, such as the submersible fuel oil pumps, would be designed to be watertight.

CUNY-HUNTER BUILDING

The following preemptive design decisions were made to ensure resilience of the CUNY-Hunter Building critical infrastructure in the face of future flooding events:

1. The building's electrical service would be located on the sixth floor in a standard interior secondary service Con Edison vault configuration.
2. The building's incoming telephone and data connection and distribution rooms, and other related building technology spaces would be on the first floor.
3. The building's air handling, ventilation, and exhaust systems serving the lobby and lower level program areas would be located on the sixth floor.
4. The building's chilled water plant would be located on the 16th floor.
5. The building's hot water boiler plant would be located on the 15th floor.
6. The building's emergency generators would be located on the roof.

7. The lab air compressors would be located at 15th floor.
8. The lab vacuum pumps would be located on the sixth floor.
9. Domestic hot water heaters would be located on the sixth and the 15th floors.
10. Building heating systems would be located on the 15th floor.
11. The storm water detention tank and associated water filtration system and pumps, which collect rainwater from the building's rooftops for re-use in irrigation and as condenser water system makeup, would be located at the sub-basement level. Although there is no physical and economical solution for locating this tank at a higher elevation, the team is considering relocating the pumps and filters to the basement level (one level above the tank) to provide some level of protection in the event of lesser floods (these systems need to be in close proximity to the tank). This system is not critical to the operation of the building and would be repaired or replaced as needed if damaged in the event of a major flood. As backup, a second source of condenser water make-up has been incorporated into the design via a duplex pump set located on the second floor.
12. The fuel oil storage tank serving both the emergency generators and hot water boiler plant would be located at the lowest elevation of the building, as required by the building code. To protect fuel oil storage tank and transfer pumps, the vault would be designed to be waterproof. This may include enhancements to the vault walls, submarine type access doors, watertight sealing of all pipe penetrations, and potentially bubble tight dampers for ventilation ducts that penetrate the vault wall. In addition, fuel oil pumping strategies may include submersible fuel oil pumps located within the tank which will pump up to a secondary set of fuel oil pumps on the first floor and first floor mezzanine, above the flood zone; this is not an as-of-right alternative, but would be presented to DOB for approval. Alternatively, a direct buried double wall fiberglass tank with a similar pumping configuration may be considered. The location of the fuel oil tank vent would be extended to the second floor and the fuel oil inlet would be mounted in a sealed enclosure in the building's façade; the alarm and vent system would be at an elevation of 25 feet or higher.
13. The following services would be located at the ground level which is at 19.5 feet elevation. Although at ground level, this level is above future projected flood levels.
    - Incoming domestic water system and domestic water pumps.
    - Fire Pump.
    - Incoming gas service.
    - Acid neutralization system.
    - The building's air handling, ventilation and exhaust systems that serve the loading dock.
14. With regard to electrical distribution, the amount of distribution below the ground floor would be minimized to the extent practicable. Electrical distribution for below-grade critical systems, such as the submersible fuel oil pumps, would be designed to be watertight.

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