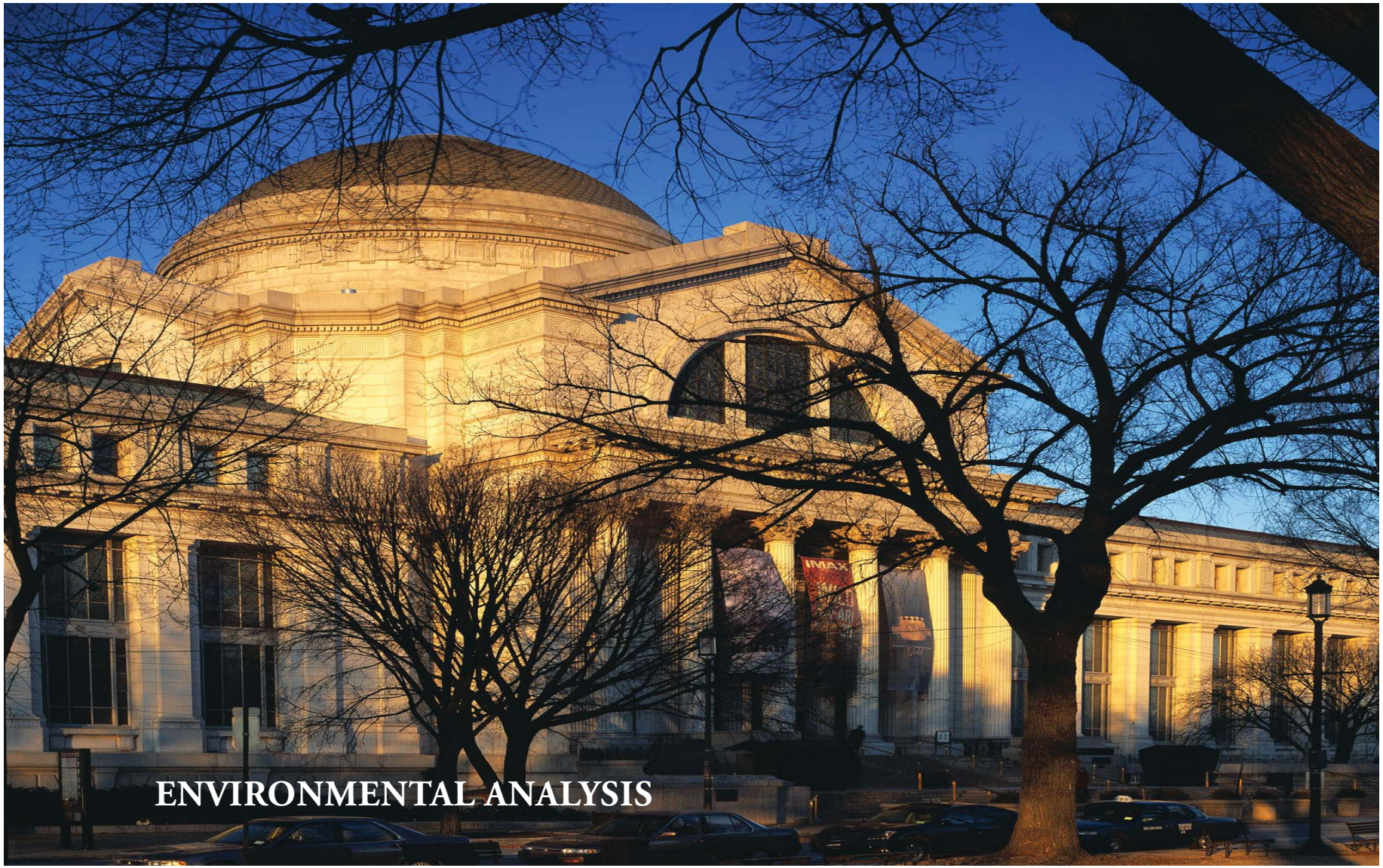

ENVIRONMENTAL ANALYSIS

AECOM

ROOFTOP LABORATORY EXHAUST SYSTEM
OFEO Project Number 0700110
Submission Date: May 29, 2009

Smithsonian
National Museum of Natural History

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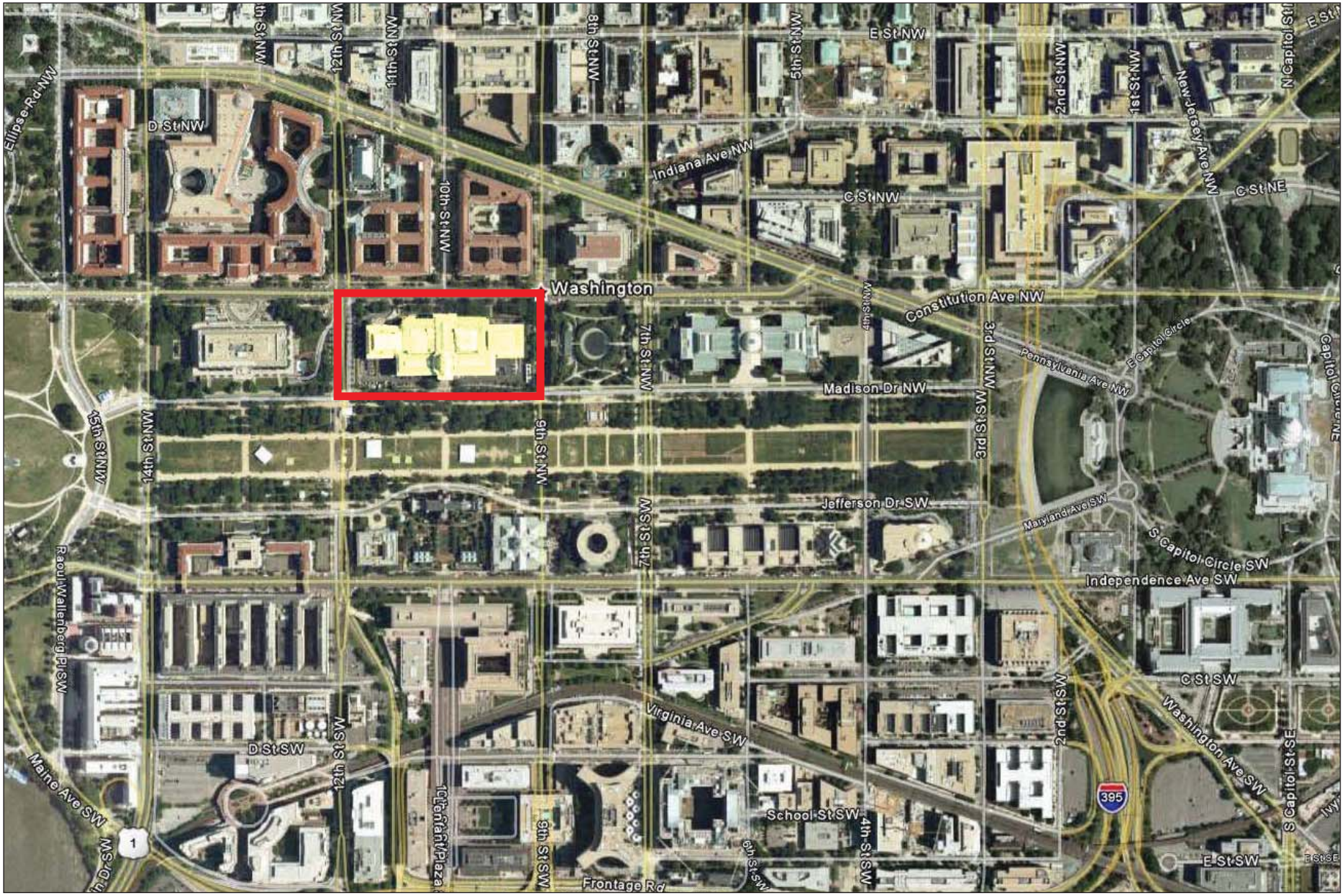

VICINITY MAP

National Museum of Natural History, Washington, DC

1.0 Introduction

On June 5, 2009, the Smithsonian Institution (SI) will submit a design proposal to install laboratory exhaust fans on the West Wing of the National Museum of Natural History, for review and approval by the National Capital Planning Commission (NCPC) at the July 9 Commission meeting. In preparation for the submission the SI, with the consulting firm AECOM, have prepared this Environmental Analysis. This Analysis will be placed on the NCPC web site preceding the submission so that public comments can be garnered before NCPC completes its review process. The intention is that the public comment period applies to both the National Environmental Policy Act and National Historic Preservation Act, Section 106 (36 CFR 800.2(d)(3)) processes. NCPC will be the Lead Responsible Federal Agency for the NEPA compliance effort.

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1.1 Project Information

Project Title:	Rooftop Laboratory Exhaust System, National Museum of Natural History
SI Project Number:	0700110
Location:	12th Street and Constitution Avenue, NW, Washington, DC
Project Staff:	Walter Ennaco, Project Executive for NMNH, Office of Planning and Project Management, OFEO Won Thomas Louie, Design Manager, Office of Engineering Design and Construction, OFEO
Preliminary Construction Budget:	$15,000,000-$18,000,000

1.2 Summary

The Rooftop Laboratory Exhaust System, National Museum of Natural History, is connected with the Smithsonian Institution's ongoing renovation of the East and West Wings of the National Museum of Natural History in Washington, DC. The comprehensive renovation includes updating existing laboratories and associated offices for all seven Research and Collections divisions. New improved facilities for the Laboratory of Analytical Biology (LAB) and for the Scanning Electron Microscope (SEM) Lab are proposed on the Ground and First Floors in the West Wing.

One of the main objectives of the design is to provide a safe, code-compliant environment for personnel working in the lab facilities while mitigating the impact of necessary lab exhausts to others, both inside and outside of the Natural History Building (NHB). AECOM Design has developed several potential exhaust strategies and a final proposed design for the building that are discussed in this report. Planning for future laboratory and alcohol room exhausts for renovations of the second through fifth floors of the West Wing has been considered in addition to the ground and first floor project's laboratory and alcohol exhaust requirements.

The Smithsonian Institution (SI) has determined that the preferred alternative has no adverse effect on cultural and historic resources. The SI has consulted with the D.C. State Historic Preservation Officer regarding this determination. A copy of the DC SHPO letter of concurrence is included in Appendix A. Based on this consultation and the analysis that follows in this report, the SI has determined a Finding of No Significant Impact for the work associated with the preferred alternative.

1.3 Background

The Smithsonian Institution's National Museum of Natural History (NMNH), an international center for the study and exhibition of natural history, attracts over five million visitors annually and is home to over 125 million specimens and artifacts. As the Smithsonian Institution's largest museum and research facility, the museum is organized into seven departments (Anthropology, Botany, Entomology, Invertebrate Zoology, Mineral Sciences, Paleobiology, and Vertebrate Zoology) and houses scientific, educational, administrative, and support staff facilities in addition to public exhibit spaces. Since first opening its doors to the public in 1910, the museum has grown to over 1.3 million square feet in the Natural History Building (NHB), and with this growth comes an increasing demand on the building's infrastructure and organization.

The East and West Wings of the Museum were constructed in the 1960's to support NMNH research and collectrions activities, and as the Museum's collections grew, the Museum Support Center (MSC) in Suitland, Maryland was built to house primarily NMNH collections and provide additional laboratory spaces. Even with these additions, advances in science and research have required modernization of the existing labs and collections areas in the East and West Wings in order to continue the high-profile research within the museum's historic structure.

1.4 Purpose and Need

The proposed ground and first floor Project, with associated Rooftop Exhaust System, follows the recommendations of the NMNH Comprehensive Facility Development Plan, dated December 2007. The overall goals of this plan are:

- Create a comprehensive, achievable and manageable plan for fulfilling physical requirements of the Museum for five to 20 years or more.
- Support and enhance the Museum's mission, strategic goals, and facilities plan.
- Support and enhance the current NMNH Space Use Plan.

The NMNH Lab Project supports the NMNH facilities planning objectives as well as the planning criteria and planning directives included in the 2006 NMNH Space Use Plan.

The NMNH facilities planning objectives include:

- Improve storage conditions for the 125-million specimens.
- Move alcohol collections to code-compliant facilities.

One key planning criterion in the Space Use Plan is:

- Advance research and collections by creating state-of-the-art equipment and facility spaces, improving logical adjacency relationships, and upgrading the quality of research and collection spaces.

Specific planning directives from the Museum are:

- Relocate the Laboratory of Analytic Biology (LAB) to the two lowest floors of the East Wing of the NHB.1
- Locate new alcohol storage rooms in the West Wing of the NHB.

During the planning period for the Comprehensive Facility Development Plan (CFDP), the Museum Director and the Executive Committee identified three programs as top priority, one being the LAB on the First Floor, West Wing.

An Infrastructure Needs Analysis of the NHB existing building systems was completed during Phase 2 of the CFDP. The amount of existing exhaust air was determined by locating and evaluating all existing equipment in the building. The anticipated future exhaust air requirements were determined through input from NMNH and by evaluation of requirements for the NMNH West Wing Basement renovation as well as requirements for future alcohol storage in the West Wing. It was proposed that the LAB on the West Wing First Floor would have its own separate make up air unit and dedicated exhaust fans.

The following pages describe in detail several options considered for the rooftop exhaust system. The chart below offers an overall comparison of the options and how well they accommodate specific design criteria. Option F is presented as the Proposed Action due to its overall high rankings.

	AIR QUALITY	SOUND LEVELS	ENERGY REQUIREMENTS	SOLID WASTE	ECONOMIC RESOURCES (FIRST COST)	ECONOMIC RESOURCES (MAINTENANCE)	HISTORIC AND AESTHETIC FEATURES	SUPPORTS MUSEUM'S MISSION
OPTION 0	1	1	1	1	1	1	1	5
OPTION A	2[1]	1	3	5	5	5	3	2[2]
OPTION B	1	2	3	1	3	2	4	1
OPTION C	1	2	3	1	3	2	4	1
OPTION D	2[1]	1	3	5	4	5	2	2[2]
OPTION E	1	2	3	1	4	2	4	1
OPTION F	1	2	3	1	2	2	3	1
		1 GOOD	2	3	4	5 NOT GOOD		

1 - Potential of breakthrough of contaminants if system is not maintained
2 - Limits flexibility of lab procedures

2.0 Proposed Action – Option F

2.1 Description

This proposed action utilizes three induction type laboratory fume exhaust fans that will transmit the exhaust of interior fume hoods from the ground and first floors of the current project. Upon renovation of the additional West Wing upper floors (floors two through five), it is anticipated that two additional induction type laboratory fume exhaust fans will be added. The proposed exhaust fans mix large volumes of outdoor air with the lab exhaust air in order to substantially dilute the exhaust and discharge it at high velocities, safely disperesing it into the free airstream and preventing it from re-entering the building. The proposed fans were selected for their modular construction, low profile design, low maintenance operation, low noise levels and lower operating costs. An informational sheet from a sample induction type fan is included in Appendix C at the end of this report.

2.1.1 Location

The induction fans and associated ductwork will be located on the east side of the West Wing Penthouse Roof as close to the center of the roof as possible.

2.1.2 Uses

Two small laboratory exhaust fans are dedicated to the first floor LAB Pre PCR (DNA sequencing) processes. In this laboratory, specimens are isolated in an exhaust cabinet with HEPA filtered outdoor air provided to their enclosed environment in order to keep them from becoming contaminated by room air. This air must be exhausted separately in order to prevent cross contamination with other laboratory processes. Laboratory exhaust fans will be required due to the use of chemicals during one of the laboratory processes.

One larger laboratory exhaust fan will be used to exhaust the combined fume hood exhaust air from the ground and first floors. The ground floor houses one fume hood while the first floor spaces have a total of six laboratory fume hoods.

It is anticipated that the renovation of the second and third floor for Botany research facilities will require one fume exhaust fan of equivalent size to the larger fan of the current project. Similarly the renovation of the fourth and fifth floors for Botany and Invertebrate Zoology research facilities will also require an exhaust fan of this size. Spaces such as the Pre PCR that require isolated independent fans are not anticipated for future renovations.

2.1.3 Design Concept
An exterior induction fume exhaust fan receives diluted chemical fumes from its associated interior fume hoods. The air is moved from the fume hood through ductwork to a roof mounted system that consists of an induction mixing plenum, exhaust fan, entrainment wind band, sound attenuator and exhaust nozzle. As laboratory fume exhaust proceeds from the duct into the fan mixing plenum, outdoor air is induced into this suction side providing dilution before the mixture reaches the fan. Mixed air is discharged from the fan up a fume stack with attenuator and additional outdoor air is entrained at the wind band section. Air is then discharged at high velocities through the exit nozzle or cone. The ratio of induced/entrained air to exhaust air from the laboratories is typically in the range of 3 to 1.

A minimum exhaust stack of ten feet is prescribed by ANSI/AHIA Z9.5-2003 to protect maintenance workers from direct contamination from the exhaust. A minimum exhaust velocity of 3000 feet per minute is also prescribed by this standard to prevent reingestion of air into building intakes.

In designing these systems for their actual environmental setting, additional factors must also be taken into account. These factors are the prevailing wind direction, average summer and winter wind speeds and 1% occurrence wind speed, as well as the building length, width and height and surrounding building locations and geometries. Using this geometric method for the NMNH, a required physical stack height of thirty four feet would be required to protect against reingestion. However, using the dilution technology provided by the induction fans, effective stack heights (physical stack height plus the added exhaust plume rise) of forty to seventy feet can be achieved depending on wind velocity. The design concept of dilution is based upon providing a resulting dilution ratio of clean air to a contaminant of 5000:1 per 1000 cubic feet per minute of exhaust air, as prescribed by ASHRAE Handbook Chapter 13. This prescribed dilution ratio is based on an evaporating chemical spill (the contaminant) in a laboratory hood exhausted at a rate of 7.5 liters per second.

2.1.4 Other Issues
This design concept for induction type laboratory exhausts fans is common for the majority of research and forensic laboratories. Similar exhaust systems may be seen at the Smithsonian Institution's Museum Support Center. This type of system requires minimal routine maintenance consisting of re-greasing of the motor bearings on 18-month intervals. Fans are direct drive and come with extended grease lines for ease of maintenance.

3.0 Proposed Action's Environmental Effects

3.1 Summary
The SI has determined that this proposed action would have no adverse effect under NHPA Section 106. The DC SHPO concurs with this determination. Additionally, the SI has determined a Finding of No Significant Impact for work associated with implementing this alternative.

3.1.1 Natural/Ecological Features
Under the proposed action, all new construction would be contained to the roof of the West Wing and will not alter any existing natural or ecological features on the site. The existing tree line between Madison Drive and the Mall on the south side of the building provides substantial screening of the top of the West Wing during all seasons, minimizing the visual appearance of the proposed fans. Phased construction and appropriate best management practices shall be implemented to minimize vegetation disturbance during construction.

3.1.2 Air Quality
Short-term construction-related impacts to air quality would occur as a result of emissions from construction equipment and from trucks hauling construction materials to the site and demolished materials from the site.

The laboratory fume exhaust fans will be running continuously, although at reduced speeds during non use hours. The fans and hoods will be continuously monitored. Upon a hood or fan failure, the system will alarm such that researchers will shut down their experiments. Automatic controls will provide a controlled means of shutting down the system to provide interior and exterior worker safety.

The chemical lists provided by the NMNH laboratory departments for the ground and first floor renovations indicate typical laboratory chemical usage. Amounts of chemicals used are considered low. These low quantities, coupled with the

system design presented above, provide for a highly diluted air stream discharging at high velocity from the cone of the exhaust system. The effective plume height of this action is sufficient to not only protect against reingestion into NMNH but to propel the exhaust stream into the wind stream well above the surrounding buildings.

The fume exhaust fans in the proposed action dilute the exhaust air stream with outdoor air. This dilution results in a mixed air stream that is near ambient conditions. A visible plume would only occur if both the outdoor air and exhaust air stream are saturated. The exhaust air stream will be saturated if the condition in the lab space is at 100% relative humidity. This indoor condition will not occur if the air handling system is working properly and maintaining indoor design conditions; therefore, it is not anticipated that a visible plume will ever occur.

3.1.3 Sound Levels

The District of Columbia limits weekday construction and demolition noise to 80 dBA from 7 a.m. to 7 p.m., unless granted a variance. The construction equipment anticipated to be used on-site under the proposed project is not expected to reach this noise level at any time. Construction noise levels would be expected to be within the District limits due to the type of construction and equipment required and the planned time of day for construction. During the workday, pedestrians, motorists, office workers, and visitors to NMNH would be subject to very limited construction noise on the roof area of the West Wing.

A sound analysis was conducted by an acoustic consultant for the three induction fans related to this project and the two projected induction fans that will serve the future renovations of floors through five of the West Wing (See Appendix B). A noise modeling program was used to develop a model of the projected noise levels at different distances from the NMNH. Target areas of study were the National Mall and nearby buildings along Constitution Avenue. The model incorporated CAD topography surveys of the NMNH site, the National Mall and the other surrounding buildings and land. The model also incorporated building elevations of the buildings located in the topographic surveys. Manufacturer's fan performance and sound data were incorporated into the simulation program.

Two noise simulations were run for the proposed action. The first simulation modeled all induction fans running with no sound attenuation. The second simulation modeled all fans running with sound attenuators incorporated into the fume stacks of the three larger fans. The two smaller PCR fans have non attenuated sound levels that are less than the larger fans with attenuation and were not fitted with attenuators in the model.

The model results indicate that without sound attenuation, the weighted average sound level with all fans running at mid Mall (144 meters) was 42dBA. At the IRS building across Constitution Avenue, the level was 43 dBA. With sound attenuation incorporated into the larger fans, the levels were 34 dBA at mid Mall and 36 dBA at the IRS building.

From the shape of the sound spectrum for the non-attenuated model, the noise may be characterized as a bright or "hissing" type sound compared to the attenuated sound level which may be characterized as more of a bland sound similar to a low level breeze. Also, at the 63 hertz frequency band (low frequency), there is a tonal component to the noise that may be perceived as a drone type noise and is more pronounced in the non-attenuated fan model. The difference between the non attenuated fans and the attenuated fans at the Mall is approximately 8 dBA. At the IRS building the difference is 7 dBA. These differences are considered significant.

Background levels during the day were measured at 55 dBA which is slightly over 10 times higher than the level from the non-attenuated fans. This fan noise would not be considered disruptive but may be noticeable by most people due to the tonal nature. These noise levels would be more noticeable in the evening hours.

Due to the significant difference in the non-attenuated versus the attenuated fan sound levels and the fact that the non-attenuated fans may be noticeable at the Mall level, sound attenuation on the larger fans is recommended.

3.1.4 Water Supply, Wastewater and Storm Water Runoff

There is no anticipated impact on existing water supply, wastewater generation or storm water runoff under this project as the general use of the renovated spaces will not be changing from their current use.

3.1.5 Energy Requirements and Conservation

The proposed action utilizes five fume exhaust fans to exhaust the laboratory spaces within the West Wing. The PCR fans will run at a constant volume while the remaining three fans will modulate at a variable volume. Assuming all five fans will be operating for 24 hours a day, 7 days a week throughout the year, the proposed action would use an estimated 617,554 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $68,425 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour.

3.1.6 Solid Waste

Non-hazardous solid waste is generated by the operation of NMNH and is removed for disposal or recycling. Non-operational activities such as construction activities generate solid waste that requires separate waste haulers. Several landfills are located near the District for the disposal of various types of non-hazardous solid wastes.

Construction of the proposed project would generate amounts of construction-related non-hazardous solid waste. This generation of solid waste would have a short-term impact on the method and frequency of collecting, hauling, and disposing of solid waste. Additional collection facilities designed for demolition and solid waste would be required in the vicinity of the construction activity. To minimize potential adverse impacts to solid waste systems from the construction of the proposed project, the following mitigation measures are recommended: (1) Recycle building materials where possible; and (2) Promote cost-effective waste reduction and recycling activities.

3.1.7 Transportation

Under the proposed action, the existing use of the renovated floors in the West Wing does not change. Therefore, there is no impact on or change to the existing modes of transportation surrounding NMNH.

3.1.8 Community Facilities and Services

Cultural Facilities:

The NMNH is a significant cultural institution with national and international prominence. The proposed project, with its renovation of research and collections areas in the West Wing, will have a significant positive impact on the functioning of the Museum, and its ability to meet its mission as both a museum and research institution.

Other Facilities:

The nearest public safety facilities are the First District Police Station at 415 4th Street, SW, and Engine 13 at 450 6th Street, SW. There are no religious facilities in the immediate area.

3.1.9 Economic Resources

Due to the fact that the proposed project would not affect commercial space, there should be no direct economic or fiscal impacts as a result of implementation.

There would be no fiscal impacts related to property taxes; no property tax is currently received from the Mall area because the buildings and land are owned by federal entities.

It is anticipated that there would be an increase in the maintenance budget for NMNH in order to maintain the motors on the proposed fans approximately every 18 months as well and for repair and/or replacement parts in the future.

3.1.10 Historic and Aesthetic Features

3.1.10.1 Historic Plans for the Mall

In 1790, President Washington asked Pierre Charles L'Enfant to develop a plan for the new federal city. Completed in 1791, L'Enfant's Plan is one of the best American examples of a comprehensive Baroque city plan. The L'Enfant Plan is characterized by a coordinated system of radiating avenues, parks and vistas overlaid upon an orthogonal grid of streets. It defined the physical and symbolic character of the nation's capital city through its arrangement of buildings, structures, and views. The Mall in L'Enfant's Plan, running from Third Street in the east to Fourteenth Street in the west, is a central tree-lined avenue flanked on both sides by buildings raised on higher grassy ground. A public building was shown on the future site of the National Museum of Natural History.

At the end of the 19th century, the appearance of the Smithsonian Park, stretching between 7th and 12th Streets NW, bore the stamp of the 1851 landscape plan for the public grounds designed by Andrew Jackson Downing. Winding paths and drives snaked through the park, shaded by various species of densely planted trees.

In 1902, the Senate Park Commission, under the leadership of Daniel Burnham, published a report highlighting the need for a comprehensive plan for redesign of the capital city. According to the principles of the City Beautiful Movement, aesthetic improvements of urban environments could contribute to improved quality of life for city residents. The Senate Park Plan, or McMillan Plan, placed great emphasis on the Mall as the city's ceremonial core. The plan referenced the L'Enfant Plan's formality, the importance of public spaces, and spatial relationships. The plan replaced the grand processional avenue of the L'Enfant Plan with a wide tapis vert lined on either side by rows of regularly spaced trees. The McMillan Plan called for the Mall to be 800 feet wide, and no buildings were to encroach upon the tapis vert. The new National Museum, which eventually became the Natural History Museum, was sited in accordance with the McMillan Plan.

3.1.10.2 Historic Buildings

The Natural History Building (NHB) housing the National Museum of Natural History is currently included on the National Register of Historic Places as a contributing resource to The National Mall. The National Mall was listed on the National Register in 1966 as an historic site. In 1981, an update to the National Mall listing was prepared, although it only addressed the Mall and not the individual buildings located on the Mall.

The NHB is eligible for individual listing on the National Register at the national level of significance under Criterion A (Social History) and Criterion C (Architecture). Its eligibility is in recognition of the NMNH's contributions as an institution for the study of natural history and anthropology, for the architectural excellence of its Classically-inspired design, and for its significance as the first public edifice on the National Mall built under the influence of the McMillan Plan.

The proposed Rooftop Laboratory Exhaust System will impact the structure and construction of the West Wing penthouse roof of the NHB in order to support the weight of the proposed exhaust fan equipment. It is anticipated that the modifications required on the penthouse roof will be minimal and will not alter the appearance of the existing building. The stacks from the new exhaust fan units will have some impact on the exterior appearance of the West Wing.

As noted earlier, the SI has determined that this alternative would have no adverse effect under Section 106 of the National Historic Preservation Act of 1966. The DC SHPO concurs with this determination. In addition, the SI has determined a Finding of No Significant Impact related to implementing this alternative.

3.1.10.3 Visual Resources

In order to minimize the visual impact of the stacks projecting beyond the penthouse roof plane, the proposed location of the new exhaust units will be as close to the center of the penthouse roof as possible. These stacks will not be visible from public spaces surrounding the NHB with two exceptions: from the intersection of 12th Street and Constitution Avenue and for a short distance west of this intersection on Constitution Avenue, and from the intersection of 12th Street and Madison Drive and on Madison Drive directly east of this intersection.

In addition, to minimize the visual impact, the new equipment including the stacks will be finished to match the color of the existing granite panels of the penthouse screen walls.

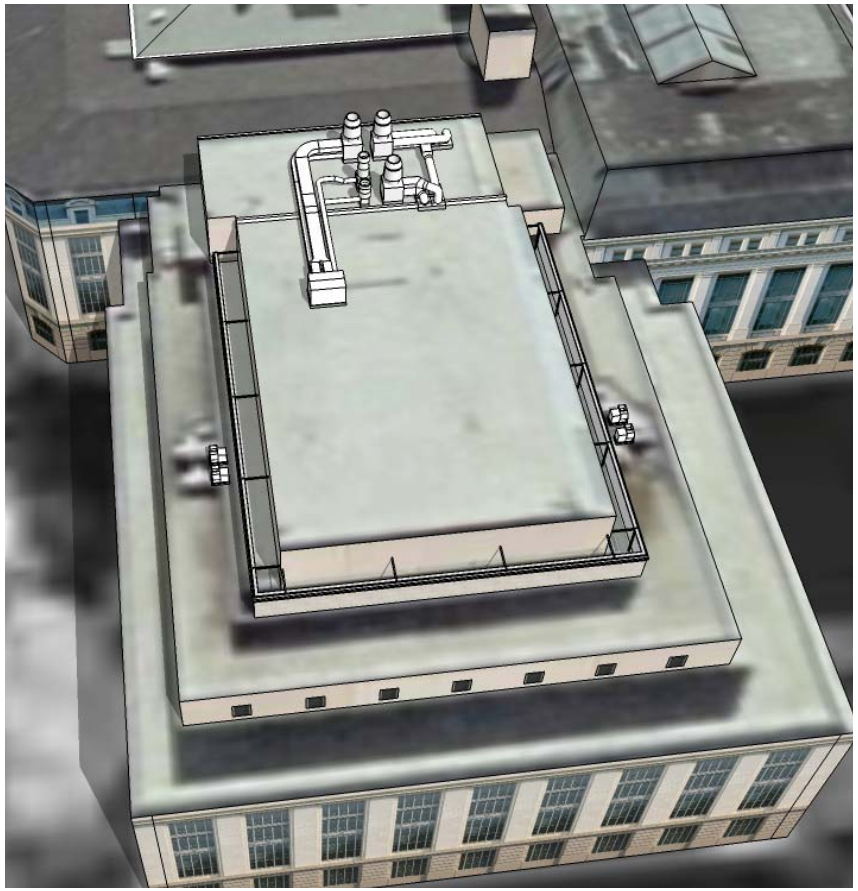
The proposed action has minimal visual impact on the West and East Wings when compared to the other alternatives studied, which require higher screen walls on the West Wing with a similar construction on the East Wing to balance the symmetry of the two wings.

3.1.11 Environmental Justice

The NMNH is one of the several public government buildings that front the National Mall along the north side. The nearest residential neighborhoods are Penn Quarter to the north, Capitol Hill to the east, and Southwest to the south.

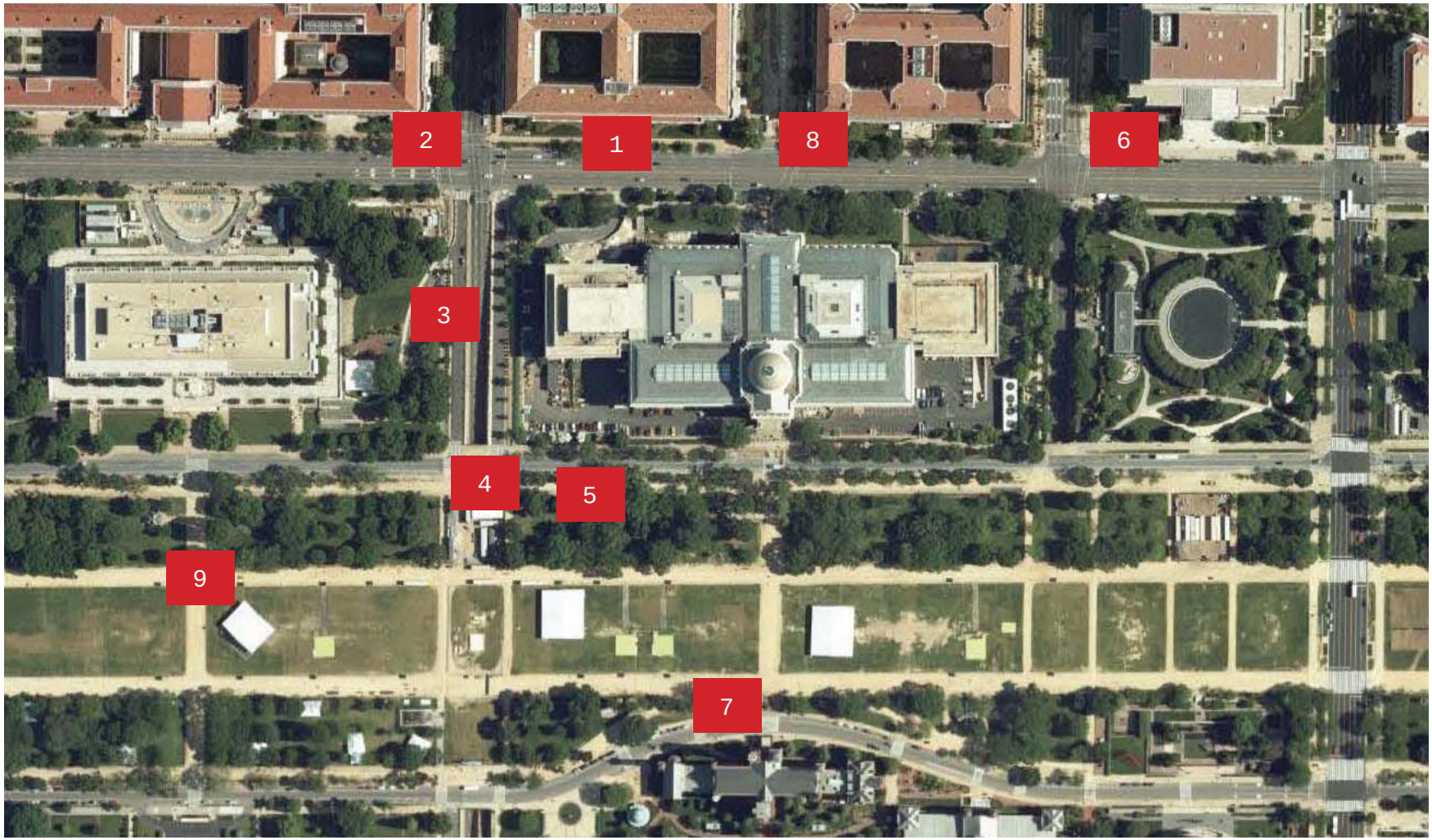
The Mall is located in Ward 2, in Census Tract 62.2. According to the 2000 Census, Tract 62.2 has a total of 12 residents, five of whom were identified as black and the other seven identified as white. Therefore, no community group should be concerned with the proposed project at the NMNH in relation to environmental justice.

NMNH Northwest Aerial Perspective - Existing



NMNH Northwest Aerial Perspective - Proposed

Proposed Action



Proposed Action - Image Key Plan

NMNH North Elevation - Existing

1

NMNH North Elevation - Proposed

NMNH Northwest Perspective - Existing

2

NMNH Northwest Perspective - Proposed

NMNH West Elevation - Existing

3

NMNH West Elevation - Proposed

NMNH Southwest Perspective - Existing

4

NMNH Southwest Perspective - Proposed

NMNH South Elevation - Existing

5

NMNH South Elevation - Proposed

NMNH Northeast Perspective - Existing

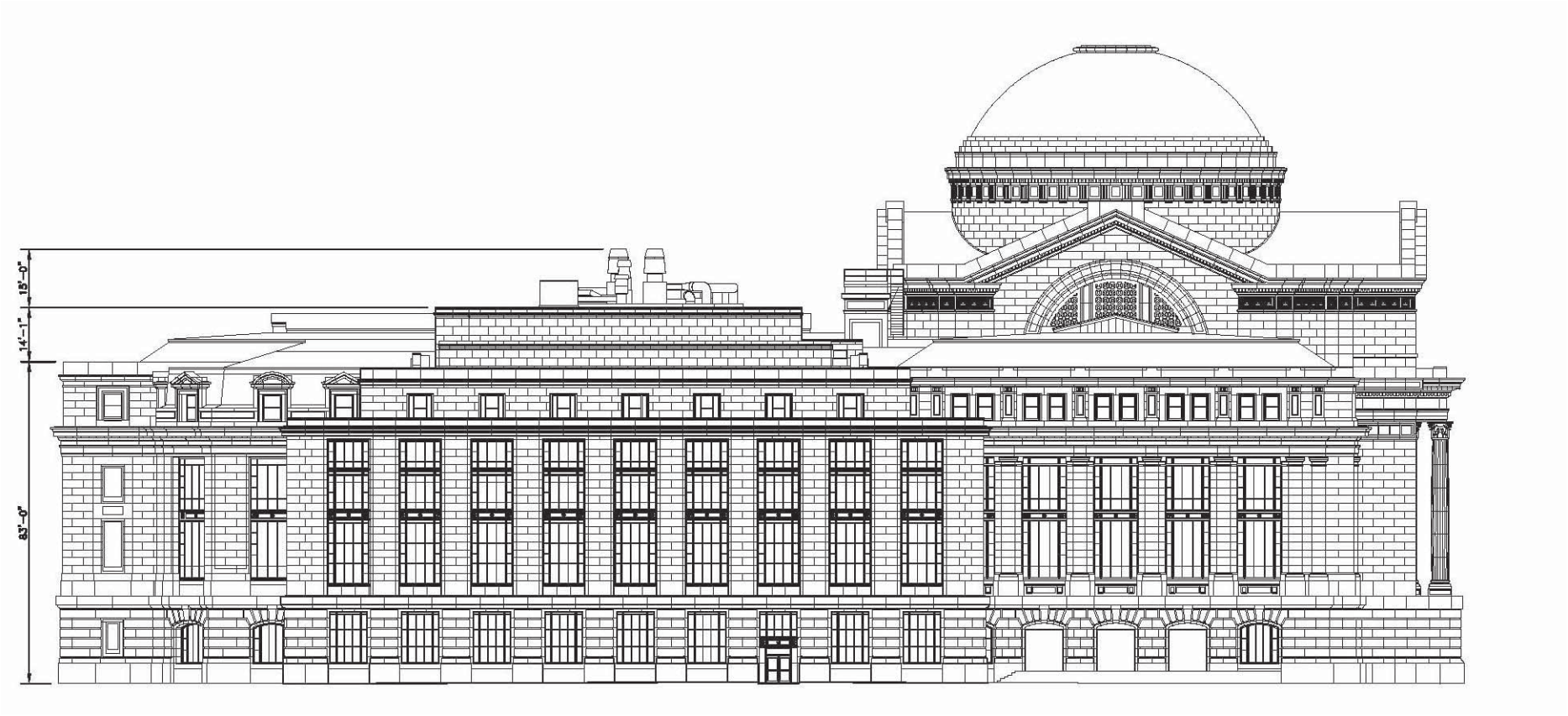
6

NMNH Northeast Perspective - Proposed

7

8

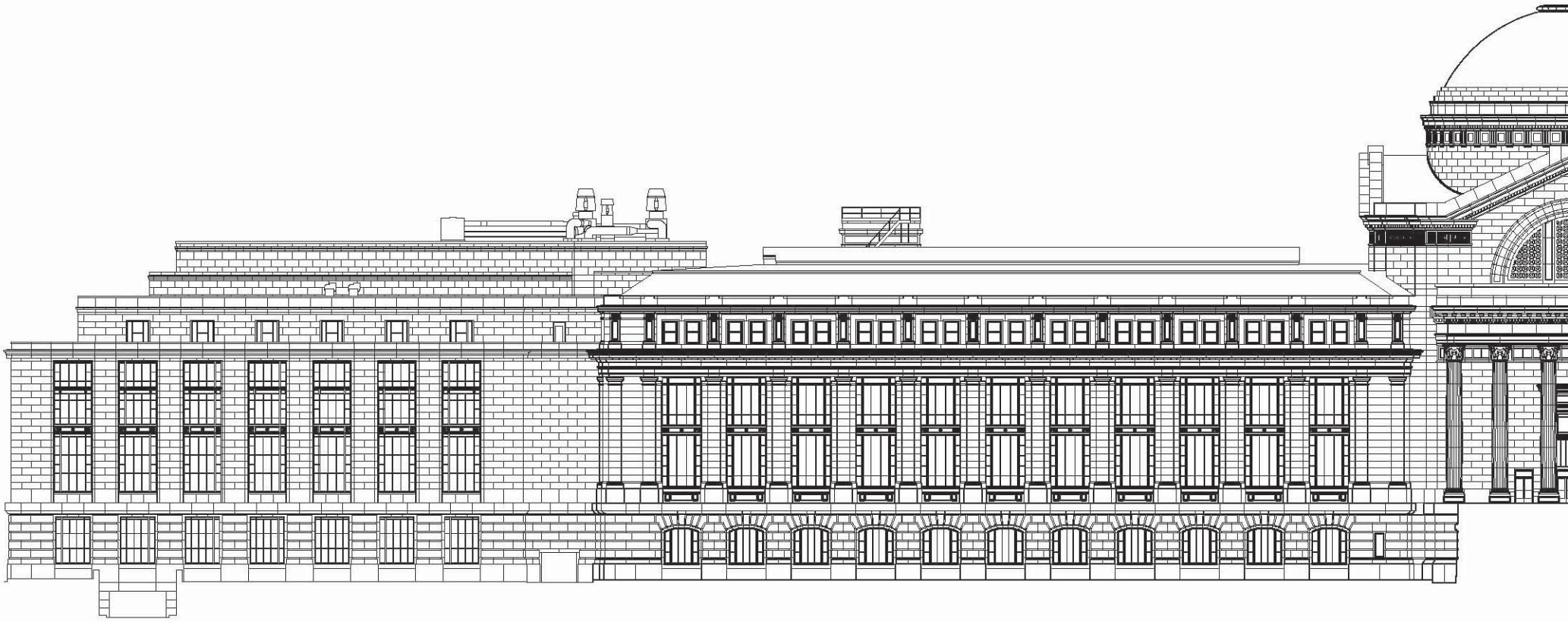
9



12TH STREET
WEST ELEVATION

1:500

10000 0 10000 20000



MADISON DRIVE
SOUTH ELEVATION

National Museum of Natural History, Washington, DC

1:500

10000 0 10000 20000

CONSTITUTION AVENUE
NORTH ELEVATION

National Museum of Natural History, Washington, DC

1:500

10000 0 10000 20000

12th & Constitution Ave.
Northwest Perspective

12th & Madison Drive
Southwest Perspective

Northwest Aerial Perspective

OPTION 0

4.0 Other Alternatives Considered

4.1 – Options Considered But Dismissed

4.1.1 - Move All Lab Functions to Museum Support Center

This option would severely restrict the the research and collections activities within NMNH. Lab capabilities are required for the researchers working in the East and West Wings, and removing the research functions from the Museum would mean that the main function of the Wings would be drastically altered.

Currently, NMNH is the largest research facility on the Mall and is one of the only museums to house significant research activities along with major public exhibitions. A large portion of the Museum's mission would become unattainable should lab and research functions be moved from the building.

4.1.2 – Move All Lab Functions to Lease Space

This option was dismissed for the same reasons listed above.

4.2 – Option 0 – No Action

4.2.1 - Challenges

The Smithsonian Institution is the world's largest museum complex and research organization composed of 19 museums and 9 research centers. At the NMNH, eminent scientists are provided a university-like setting where they can research the history of our planet through collections from all over the world. These collections are meticulously preserved and catalogued and form the largest, most comprehensive natural history collection in the world. Collections-based research is performed in both the East and West Wing that answers questions about our past and examines issues important to our future. The NMNH location in the heart of Washington, DC promotes sharing of these research findings with key decision makers and researchers from around the world. Its location also attracts important donors who can visit the Nation's Capital to view this important research and meet scientists that are leaders in their respective research fields. The current project will provide state-of-the-art facilities such that the NMNH can continue to be the destination for collections-based research.

No Action will eventually cause all laboratory research that requires fume exhaust to be discontinued at the NMNH, as most spaces are currently inadequate for the work that these researchers perform and do not comply with current codes that were not in effect when they were originally constructed. No Action will prevent the research spaces in the West Wing from being updated from their 1960's spaces to code-compliant research areas. Since the East and West Wings were built to house research and collection activities, a No Action alternative has a significant negative impact on the mission of the Museum.

4.2.2 – Impact

Option 0 will not impact the exterior of the building, exterior noise or air quality. Energy use will likely decrease as computer systems and related high tech equipment would eventually be required to move to code-compliant facilities.

12th & Constitution Ave.
Northwest Perspective

12th & Madison Drive
Southwest Perspective

Northwest Aerial Perspective

OPTION A

4.3 – Option A – Scrubbers on 6th Floor Roof with Screening

Chemical lists of the ground and first floor project were provided to a manufacturer of carbon scrubber systems. Carbon chemical scrubber assemblies were developed using pre manufactured carbon trays of specialty blended carbon media that would adsorb/filter the majority of laboratory compounds found on this list. The systems were selected for the air flows of this project. The proposed assemblies consist of a series of modules. A typical scrubber for this project may consist of 28-30 modules. Each module contains ten carbon trays filled with carbon media. Air is drawn under negative pressure from the laboratories in to a plenum fan and then pushed through a prefilter and the carbon scrubber module assembly. The carbon blend adsorbs chemicals from the air stream. Air will then be exhausted by a second fan up a ten foot stack. Combined laboratory exhausts from Ground and First Floor would be scrubbed by one carbon chemical scrubber. The two Pre PCR exhausts would each have its own separate scrubber system. These three scrubbers would be located on the north side of the West Wing sixth floor. Laboratory exhausts from the renovation of the second and third floor and the fourth and fifth floors would each have one scrubber system located on the sixth floor roof on the south side of the West Wing. Gas monitors would be used to evaluate the contamination of the air at different measuring stations. Gas sensors may be placed where air enters the first set of modules, between the modules and after the last module.

A new masonry veneer screen wall would be constructed on top of the 6th Floor Roof to screen the scrubbers and fans from being viewed from the street level. An identical set of screen walls would be constructed above the 6th Floor of the East Wing in order to maintain the symmetry of the building elevation even though no scrubbers are expected to be required on the east side.

4.3.1 - Challenges

Scrubber systems are not commonly used for general laboratory applications where quantities of chemicals used are small. Scrubber manufacturers typically design scrubber systems for industrial applications that have targeted compounds for removal. ANSI/AIHA Z9.5, American National Standard for Laboratory Ventilation, allows filtration if the filters clean the discharge air to a state that it could be recirculated. However, its commentary admits that this is not practical and states that it is beyond the scope of the standard to discuss appropriate methods for filtering laboratory exhaust. OSHA 29 CFR 1910.11450, Occupational Exposure to Hazardous Chemicals in Laboratories references the National Research Council, “Prudent Practices in the Laboratory, Handling and Disposal of Chemicals.” Prudent Practices states that contaminant removal is technologically challenging for laboratories as compared to industrial emissions because of the low concentration of contaminants in the lab exhaust and the wide array of chemicals that may be used.

Another difficulty of the carbon scrubbing system is the potential for breakthrough of contaminants if the systems are not maintained on a regular basis and monitored carefully. When breakthrough occurs, it typically occurs quickly, allowing pass through of the contaminants and potential for re-entrainment at nearby building air intakes. To prevent breakthrough, a strict maintenance program must be developed based on how quickly the modules actually load with contaminants. This program will have to be monitored and adjusted as laboratory research changes from year to year. Should high concentrations of organics or hydro carbons be carried into the carbon bed, as would occur with a chemical spill in a fume hood, there is the potential for an exothermic reaction that may cause a fire in the scrubber. Another challenge is waste disposal. Initially, and then periodically thereafter, the carbon trays will need to be tested to determine if they should be classified as hazardous waste. If classified as hazardous waste, a strict removal and disposal protocol will be required. If not classified hazardous, they trays may be recycled.

Maintenance access to the penthouse roof will require substantial improvement such that replacement carbon trays may be easily carried to the roof by workers and spent rays may be carried down.

Historically, the Smithsonian has had difficulty sufficiently funding adequate maintenance operations at its facilities. NMNH continues to struggle with both short and long term maintenance issues due to inadequate funding. The installation of high-maintenance scrubbers on site would compound this current situation and there is an increased risk of contamination if the equipment is not properly maintained.

Additional challenges of this option were the impact of vibration from the scrubbers on the 6th Floor below, the impact of added structural/architectural work on the existing building structure and the need to create a symmetrical screen wall on the East Wing.

4.3.2 Air Quality Impact

Air Quality impact of the scrubber system is dependent on the adherence to strict laboratory operational procedures and maintaining the same chemicals in the lab that the scrubber system carbon media were selected to remove. It is also dependent on adherence to a strict maintenance program that has been developed based on monitoring data of the actual scrubbers to determine the rate at which the carbon media loads. Scrubbers are a low profile option. Should a breakthrough occur, the contaminated exhaust will not have a plume height to be able to be picked up in the prevailing wind stream. Upturned stacks will need to be provided at the exhaust side of the scrubber to protect maintenance workers should this occur while they are on the roof.

The outlet fans for the scrubber system in Option A emit exhaust air directly to the outdoors without diluting the exhaust air stream. On a winter design day, there could be a significant difference between the outdoor temperature and the exhaust stream temperature. A plume would only occur if the outdoor air is saturated and mixes with a very humid exhaust stream. For example, a plume might occur on a cold, rainy day (35°F) if the lab space condition, and therefore the exhaust stream, is 70°F and 80% relative humidity. This indoor condition will not occur if the air handling system is working properly and maintaining indoor design conditions.

4.3.3 Noise Impact

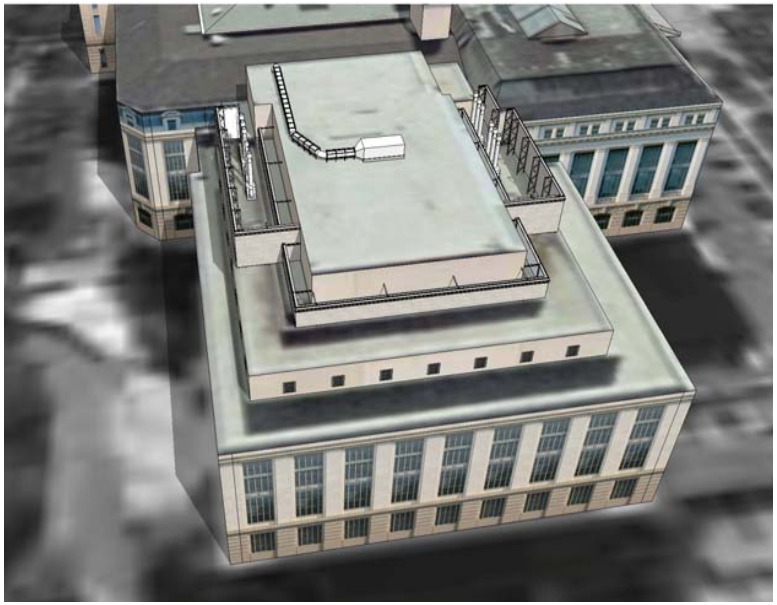
This scrubber option located on the penthouse roof (Option D) was analyzed for sound. It is anticipated that Option A would produce equal or better results; therefore, this option should not substantially produce any significant noise impact. The resultant noise levels of these fans have no apparent peaks in any of the frequency bands and resultant levels are expected to be below typical conversational levels and below the Washington, DC noise code requirement for residential areas.

4.3.4 Energy Impact

Option A utilizes six scrubber systems to exhaust the laboratory spaces within the West Wing. Each scrubber system includes both an inlet and an outlet fan. The PCR fans will run at a constant volume while the remaining eight fans will modulate at a variable volume. Assuming all twelve fans will be operating for 24 hours a day, 7 days a week throughout the year, Option A would use an estimated 592,459 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $65,645 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour.

12th & Constitution Ave.
Northwest Perspective

12th & Madison Drive
Southwest Perspective



Northwest Aerial Perspective

OPTION B

4.4 – Option B

Fans/Stacks on 6th Floor Roof with Screening

Five induction type laboratory exhaust fans would be located on the sixth floor roof and screened form view. Two induction fans will exhaust the Pre PCR space. One induction fan set will exhaust the combined fume exhaust of the ground and first floor renovation. Future renovations of the second and third floors and the fourth and fifth floors are expected to require one induction fan set each. A new masonry veneer screen wall would be constructed on top of the 6th Floor Roof to screen the fan stacks from being viewed from the street level. An identical set of screen walls would be constructed above the 6th Floor of the East Wing in order to maintain the symmetry of the building elevation even though no induction fans are expected to be required on the east side.

4.4.1 Challenges

Selection of fans/stacks that would minimize the overall equipment height to in turn minimize the screen wall height that would surround them. Even with a screen wall to screen these fans from view, the exhaust cones or nozzles will need to project above the screen wall about three feet to prevent potential entrainment of the exhaust near the wall. Additional challenges of this option were the impact of vibration from exhaust fans on the 6th Floor below, the impact of added structural/architectural work on the existing building structure and the need to create a symmetrical screen wall on the East Wing.

4.4.2 Air Quality Impact

The fume exhaust fans in Option B dilute the exhaust air stream with outdoor air. This dilution results in a mixed air stream that is near ambient conditions. A plume would only occur if both the outdoor air and exhaust air stream are saturated. The exhaust air stream will be saturated if the condition in the lab space is at 100% relative humidity. This indoor condition will not be met if the air handling system is working properly and maintaining indoor design conditions; therefore, a plume will not be generated.

Short-term construction-related impacts to air quality would occur as a result of emissions from construction equipment and from trucks hauling construction materials to the site and demolished materials from the site. Emissions produced during construction would vary daily depending on the type of activity.

The laboratory fume exhaust fans will be running continuously although at reduced speeds during non use hours. The fans and hoods will be continuously monitored. Upon a hood or fan failure, the system will alarm such that researchers will shut down their experiments. Automatic controls will provide a controlled means of shutting down the system to provide interior and exterior worker safety.

The chemical lists provided by the laboratory departments for the ground and first floor renovations indicate typical laboratory chemical usage including some acids, caustics and some toxic chemicals. Amounts of chemicals used are considered low. These low quantities, coupled with the system design presented above, provide for a highly diluted air stream discharging at high velocity from the cone of the exhaust system. The effective plume height of this action is sufficient to not only protect against reingestion into the NMNH but to propel the exhaust stream into the wind stream well above the surrounding buildings.

4.4.3 Noise Impact

The noise impact was not modeled for fans on the sixth floor roof with screening. However ,it would be expected that the screens and penthouse walls would reduce or shield the noise transmitted to the Mall and surrounding buildings. Non-attenuated fan sound levels should be less than in Option F at the mall and IRS building.

4.4.4 Energy Impact

Option B utilizes five fume exhaust fans to exhaust the laboratory spaces within the West Wing. The PCR fans will run at a constant volume while the remaining three fans will modulate at a variable volume. Assuming all five fans will be operating for 24 hours a day, 7 days a week throughout the year, Option B would use an estimated 617,554 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $68,425 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour.

12th & Constitution Ave.
Northwest Perspective

12th & Madison Drive
Southwest Perspective

Northwest Aerial Perspective

OPTION C

4.5 – Option C

Fans/Stacks on Penthouse Roof with Redundant Fans- No Screening

Five induction type laboratory exhaust fans would be located on the penthouse roof and screened form view. Two induction fans will exhaust the Pre PCR space. One induction fan set with redundant fan will exhaust the combined fume exhaust of the ground and first floor renovation. Future renovations of the second and third floors and the fourth and fifth floors are expected to require one induction fan set each. Redundant fans were requested by the User in case one fan failed.

4.5.1 Challenges

The redundant fan option required a much greater footprint than Option B. Option C proved to take too much space per fan set and made layout on the roof aesthetically unmanageable.

4.5.2 Air Quality Impact

The fume exhaust fans in Option C dilute the exhaust air stream with outdoor air. This dilution results in a mixed air stream that is near ambient conditions. A plume would only occur if both the outdoor air and exhaust air stream are saturated. The exhaust air stream will be saturated if the condition in the lab space is at 100% relative humidity. This indoor condition will not be met if the air handling system is working properly and maintaining indoor design conditions; therefore, a plum Short-term construction-related impacts to air quality would occur as a result of emissions from construction equipment and from trucks hauling construction materials to the site and demolished materials from the site. Emissions produced during construction would vary daily depending on the type of activity.

The laboratory fume exhaust fans will be running continuously although at reduced speeds during non use hours. The fans and hoods will be continuously monitored. Upon a hood or fan failure, the system will alarm such that researchers will shut down their experiments. Automatic controls will provide a controlled means of shutting down the system to provide interior and exterior worker safety.

The chemical lists provided by the laboratory departments for the ground and first floor renovations indicate typical laboratory chemical usage including some acids, caustics and some toxic chemicals. Amounts of chemicals used are considered low. These low quantities, coupled with the system design presented above, provide for a highly diluted air stream discharging at high velocity from the cone of the exhaust system. The effective plume height of this action is sufficient to not only protect against reingestion into the NMNH but to propel the exhaust stream into the wind stream well above the surrounding buildings.

4.5.3 Noise Impact

The noise impact was not modeled for this option; however, due to the additional fans compared to Option F, resulting noise levels are expected to be higher. Generally, each additional fan will add one to two dBA.

4.5.4 Energy Impact

Option C utilizes five fume exhaust fans to exhaust the laboratory spaces within the West Wing. The PCR fans will run at a constant volume while the remaining three fans will modulate at a variable volume. Assuming all five fans will be operating for 24 hours a day, 7 days a week throughout the year, Option C would use an estimated 617,554 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $68,425 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour.

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Northwest Perspective

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Southwest Perspective

Northwest Aerial Perspective

OPTION D

4.6 – Option D

Scrubbers on Penthouse Roof - No Screening

Chemical lists of the ground and first floor project were provided to a manufacturer of carbon scrubber systems. Carbon chemical scrubber assemblies were developed using pre manufactured carbon trays of specialty blended carbon media that would adsorb/filter the majority of laboratory compounds found on this list. The systems were selected for the air flows of this project. The proposed assemblies consist of a series of modules. A typical scrubber for this project may consist of 28-30 modules. Each module contains ten carbon trays filled with carbon media. Air is drawn under negative pressure from the laboratories in to a plenum fan and then pushed through a prefilter and the carbon scrubber module assembly. The carbon blend adsorbs chemicals from the air stream. Air will then be exhausted by a second fan up a ten foot stack. Combined laboratory exhausts from Ground and First Floor would be scrubbed by one carbon chemical scrubber. The two Pre PCR exhausts would each have its own separate scrubber system. These three scrubbers would be located on the Penthouse roof. Laboratory exhausts from the renovation of the second and third floor and the fourth and fifth floors would each have one scrubber system located on the penthouse roof. Gas monitors would be used to evaluate the contamination of the air at different measuring stations. Gas sensors may be placed where air enters the first set of modules, between the modules and after the last module.

4.6.1 Challenges

Scrubber systems are not commonly used for general laboratory applications where quantities of chemicals used are small. Scrubber manufacturers typically design scrubber systems for industrial applications that have targeted compounds for removal. ANSI/AIHA Z9.5, American National Standard for Laboratory Ventilation, allows filtration if the filters clean the discharge air to a state that it could be recirculated. However, its commentary admits that this is not practical and states that it is beyond the scope of the standard to discuss appropriate methods for filtering laboratory exhaust. OSHA 29 CFR 1910.11450, Occupational Exposure to Hazardous Chemicals in Laboratories references the National Research Council, “Prudent Practices in the Laboratory, Handling and Disposal of Chemicals. “Prudent Practices states that contaminant removal is technologically challenging for laboratories as compared to industrial emissions because of the low concentration of contaminants in the lab exhaust and the wide array of chemicals that may be used.

Another difficulty of the carbon scrubbing system is the potential for breakthrough of contaminants if the systems are not maintained on a regular basis and monitored carefully. When breakthroughs occur, they typically happen quickly allowing pass through of the contaminants and potential for re entrainment at nearby building air intakes. To prevent breakthrough, a strict maintenance program must be developed based on how quickly the modules actually load with contaminants. This program will have to be monitored and adjusted as laboratory research changes from year to year. Should high concentrations of organics or hydro carbons be carried into the carbon bed, as would occur with a chemical spill in a fume hood, there is the potential for an exothermic reaction that may cause a fire in the scrubber. Another challenge is waste disposal. Initially, and then periodically thereafter, the carbon trays will need to be tested to determine if they should be classified as hazardous waste. If classified as hazardous waste, a strict removal and disposal protocol will be required. If not classified hazardous, they trays may be recycled.

Maintenance access to the penthouse roof will also require substantial improvement such that replacement carbon trays may be easily carried to the roof by workers and spent rays may be carried down.

Historically, the Smithsonian has had difficulty sufficiently funding adequate maintenance operations at its facilities. NMNH continues to struggle with both short and long term maintenance issues due to inadequate funding. The installation of high-maintenance scrubbers on site would compound this current situation and there is an increased risk of contamination if the equipment is not properly maintained.

4.6.2 Air Quality Impact

Air Quality impact of the scrubber system is dependent on the adherence to strict laboratory operational procedures and maintaining the same chemicals in the lab that the scrubber system carbon media were selected to remove. It is also dependent on adherence to a strict maintenance program that has been

developed based on monitoring data of the actual scrubbers to determine the rate at which the carbon media loads. Scrubbers are a low profile option. Should a breakthrough occur, the contaminated exhaust will not have a plume height to be able to be picked up in the prevailing wind stream. Upturned stacks will need to be provided at the exhaust side of the scrubber to protect maintenance workers should this occur while they are on the roof.

The outlet fans for the scrubber system in Option D emit exhaust air directly to the outdoors without diluting the exhaust air stream. On a winter design day, there could be a significant difference between the outdoor temperature and the exhaust stream temperature. A plume would only occur if the outdoor air is saturated and mixes with a very humid exhaust stream. For example, a plume might occur on a cold, rainy day (35°F) if the lab space condition, and therefore the exhaust stream, is 70°F and 80% relative humidity. This indoor condition will not occur if the air handling system is working properly and maintaining indoor design conditions; therefore, a plume will not be generated.

4.6.3 Noise Impact

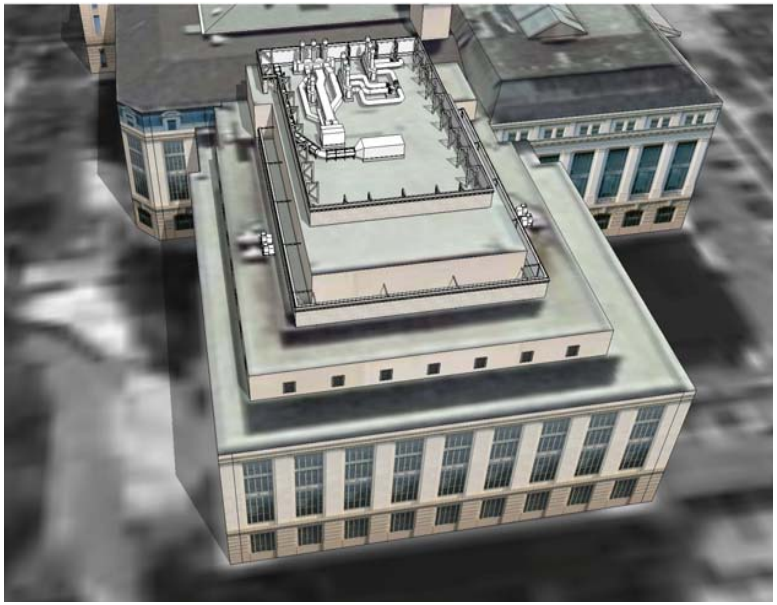
This scrubber option located on the penthouse roof was analyzed for sound. This option should not produce any significant noise impact. A maximum of 45 dBA is predicted at the National Mall and is 10 dBA below the 55 dBA Washington DC noise code requirement for residential areas. However, the resultant noise levels of these fans have no apparent peaks in any of the frequency bands and no tonal components.

4.6.4 Energy Impact

Option D utilizes six scrubber systems to exhaust the laboratory spaces within the West Wing. Each scrubber system includes both an inlet and an outlet fan. The PCR fans will run at a constant volume while the remaining eight fans will modulate at a variable volume. Assuming all twelve fans will be operating for 24 hours a day, 7 days a week throughout the year, Option D would use an estimated 592,459 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $65,645 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour.

12th & Constitution Ave.
Northwest Perspective

12th & Madison Drive
Southwest Perspective



Northwest Aerial Perspective

OPTION E

4.7 – Option E

Fans/Stacks on Penthouse Roof - With Screening

Five induction type laboratory exhaust fans would be located on the penthouse roof. Screen walls will not be provided to shield them from view. Two induction fans will exhaust the Pre PCR space. One induction fan set will exhaust the combined fume exhaust of the ground and first floor renovation. Future renovations of the second and third floors and the fourth and fifth floors are expected to require one induction fan set each. A new masonry veneer screen wall would be constructed on top of the existing penthouse roof to screen the fan stacks from being viewed from the street level. An identical screen wall would be constructed on the Penthouse Roof of the East Wing in order to maintain the symmetry of the building elevation even though no induction fans are expected to be required on the east side.

4.7.1 Challenges

Selection of fans/stacks that would minimize the overall equipment height to in turn minimize the screen wall height that would surround them. Even with a screen wall to screen these fans from view, the exhaust cones or nozzles will need to project above the screen wall about three feet to prevent potential entrainment of the exhaust near the wall. Additional challenges of this option were the impact of added structural/architectural work on the existing building structure and the need to create a symmetrical screen wall on the East Wing. The new screen walls also drastically alter the massing of the existing building.

4.7.2 Impact

The fume exhaust fans in Option E dilute the exhaust air stream with outdoor air. This dilution results in a mixed air stream that is near ambient conditions. A plume would only occur if both the outdoor air and exhaust air stream are saturated. The exhaust air stream will be saturated if the condition in the lab space is at 100% relative humidity. This indoor condition will not be met if the air handling system is working properly and maintaining indoor design conditions; therefore, a plume will not be generated.

Short-term construction-related impacts to air quality would occur as a result of emissions from construction equipment and from trucks hauling construction materials to the site and demolished materials from the site. Emissions produced during construction would vary daily depending on the type of activity.

The laboratory fume exhaust fans will be running continuously although at reduced speeds during non use hours. The fans and hoods will be continuously monitored. Upon a hood or fan failure, the system will alarm such that researchers will shut down their experiments. Automatic controls will provide a controlled means of shutting down the system to provide interior and exterior worker safety.

The chemical lists provided by the laboratory departments for the ground and first floor renovations indicate typical laboratory chemical usage including some acids, caustics and some toxic chemicals. Amounts of chemicals used are considered low. These low quantities, coupled with the system design presented above, provide for a highly diluted air stream discharging at high velocity from the cone of the exhaust system. The effective plume height of this action is sufficient to not only protect against reingestion into the NMNH but to propel the exhaust stream into the wind stream well above the surrounding buildings.

4.7.3 Noise Impact

The noise impact was not modeled for fans on the penthouse roof with screening. However, it would be expected that the screens would reduce or shield the noise transmitted to the Mall and surrounding buildings. Non attenuated fan sound levels should be less than in Option F at the mall and IRS building due to the screening, However, the additional fans of this option may somewhat offset the shielding.

4.7.4 Energy Impact

Option E utilizes five fume exhaust fans to exhaust the laboratory spaces within the West Wing. The PCR fans will run at a constant volume while the remaining three fans will modulate at a variable volume. Assuming all five fans will be operating for 24 hours a day, 7 days a week throughout the year, Option E would use an estimated 617,554 kilowatt-hours of electricity. The energy consumption for these fans would amount to an estimated annual utility bill of $68,425 when calculated per the Energy Information Administration's average electricity cost for the District of Columbia, which is 11.08 cents per kilowatt-hour

5.0 Agencies and Persons Consulted

The following Federal and Local agencies were consulted over the course of the environmental analysis process for the proposed project:

- National Capital Planning Commission (NCPC)
- Commission of Fine Arts (CFA)
- DC State Historic Preservation Office (DCSHPO)

6.0 References

NMNH Comprehensive Facility Development Plan. *HSMM AECOM and EDAW AECOM.* **December 2007**

NMNH Cultural Landscape Report. *HSMM and EDAW.* **April 2006**

NMNH Historic Structures Report. *HSMM and Commonwealth Architects.* **August 2008**

NMNH Space Use Master Plan. *Quinn Evans Architects.* **March 2006**

ANSI/AIHA Z9.5- 2003. *American National Standard for Laboratory Ventilation.* **Appendix 3**

ASHRAE 1999 HVAC Applications handbook. *Chapter 43*

7.0 End Notes

1 The 2006 LAB Evaluation Study (OFEO Project No. 0300115) and subsequent CFDP workshops determined that the LAB will be located on the First Floor of the West Wing, effectively changing this specific planning directive.

APPENDIX A
SECTION 106 REVIEW

GOVERNMENT OF THE DISTRICT OF COLUMBIA
STATE HISTORIC PRESERVATION OFFICER

May 28, 2009

Ms. Amy Ballard
Historic Preservation Specialist
Smithsonian Institution
Post Office Box 37012 MRC 511
Washington, DC 20013-7012

RE: Proposed Rooftop Laboratory Exhaust System; National Museum of Natural History; West Wing

Dear Ms. Ballard:

Thank you for contacting the DC State Historic Preservation Office (SHPO) regarding the above-referenced undertaking. We have reviewed the project information and are writing in accordance with Section 106 of the National Historic Preservation Act to provide our comments regarding effects on historic properties.

Based upon our review of the project information, we understand that the proposed rooftop laboratory exhaust system is a critical component of the on-going renovation of the National Museum of Natural History (NMNH), a property that contributes to the significance of the Mall. We also understand that the Smithsonian Institution (SI) hosted a March 30th meeting with the Commission of Fine Arts (CFA) and the National Capitol Planning Commission (NCPC) to discuss seven options that were developed for consideration. Options D and F were selected for further evaluation during that meeting.

On May 13th, we conducted a site visit with SI staff to determine the degree to which the exhaust system might be visible. In our estimation, the photographic simulations provided with the project submittal accurately depict that the rooftop equipment will be somewhat visible from a variety of vantage points – particularly from the northwest corner of Constitution Avenue and 12th Street, N.W. However, we noted that rooftop visibility from the Mall would be significantly limited during the majority of the year when the trees that surround the NMNH are covered with leaves.

The site visit prompted a number of questions regarding possible modifications that might be used to further reduce the visual impact. For example, we questioned if all of the equipment could be consolidated into a smaller area to make it even less visible. We also requested additional information to justify the selection of Option F as the preferred alternative. Through the exchange of subsequent emails and receipt of a copy of the draft Environmental Analysis that was prepared for the project, we determined that our suggested modifications were not feasible and that, even though Option D might have less of a visual effect, it could be dismissed for technical reasons.

Given these circumstances, it appears as if Option F is the alternative that best meets the stated purpose and need of the project while simultaneously minimizing the overall visual impact. Although Option F will introduce visual elements directly into the setting of the NMHH and the Mall, these elements will be so minor as to not diminish the integrity of these properties' significant historic features. Therefore, we concur with SI's determination of "no adverse effect" for this undertaking. Further consultation will only be required if SI elects to pursue a different or revised option as a result of CFA or NCPC review.

2000 14th Street, N.W., 4th Fl., Washington, D.C. 20009 202-442-7600, fax 202-442-7637

Before closing, we point out that this project has underscored the importance of identifying and protecting important views of the NMNH and other SI museums. During our review of the rooftop exhaust project, we noted how significantly the two rectangular elements circled in red in the photograph below distract from the prominence of the dome and the view down 10th Street, N.W. Although these elements, which apparently serve as "air towers" for the courtyards, were probably reviewed when they were constructed in the 1990s, greater efforts should be undertaken to avoid such significant visual impacts in the future.

One way to help ensure that such effects do not occur again might be to first identify the important views that should be protected. Views from the Mall are important, but those views are usually considered in project planning because of their prominence. On the other hand, views from within the city towards the various museums, such as the view to the NMNH down 10th Street, N.W., tend to be considered less frequently. To address this disparity, we propose working with SI to prepare a map that identifies the significant view corridors. Hopefully, this map can eventually be used as a tool to ensure that visual impacts on important views can avoided or minimized.

If you should have any questions or comments regarding these matters, please contact me at andrew.lewis@dc.gov or 202-442-8841. Otherwise, we look forward to working with you to identify and map the important view corridors in the near future and thank you for providing this opportunity to review and comment.

Sincerely,

/S/

C. Andrew Lewis
Senior Historic Preservation Specialist
DC State Historic Preservation Office

09-092
cc: Frederick Lindstrom, CFA
Gene Keller, NCPC

2000 14th Street, N.W., 4th Fl., Washington, D.C. 20009 202-442-7600, fax 202-442-7637

APPENDIX B
SOUND ANALYSIS

MILLER, BEAM & PAGANELLI, INC.
CONSULTANTS IN ACOUSTICS, VIBRATION & AUDIOVISUAL SYSTEM DESIGN

May 6, 2009

S. Belinda Redd
AECOM Design
448 Viking Drive Suite 145
Virginia, Beach, Virginia 23452

RE: SMITHSONIAN NATIONAL MUSEUM OF NATURAL HISTORY

Dear Ms. Redd:

An acoustical analysis has been performed of the National Museum of Natural History in Washington, D.C. The analysis was performed to determine noise levels in the surrounding area taking into account several different fume exhaust options. The CADNA program was used for the analysis. An acoustical survey was also performed of the surrounding area to determine typical background noise in order to evaluate possible response to the change in noise level.

We offer the following to facilitate an understanding of the sound levels discussed below. Typically, a 3 dB change is only slightly perceptible, even though this represents double the amount of energy for an increase (1/2 the energy for a decrease). In order for a clearly noticeable difference in sound level to be perceived, a 5 dB change is necessary, provided that the energy distribution in the frequency spectrum of the sound remains constant. It typically requires a change of 10 dB for most people to perceive a sound as half or twice as loud. This same relationship generally applies to NC, RC, and STC ratings since these systems are also based on the decibel scale. As noted above, when there is a change in the frequency spectrum, especially in the frequency range of 500 Hz to 2 kHz where human hearing is most sensitive, then the apparent change could be perceived as more significant than the actual change in overall sound level or rating.

The analysis of the fan noise was performed for 3 different fan selections which will be referred to as options 1, 2, and 3. Options 1 and 2 are different variations of the induction fume exhaust fans (Architect Option F). Options 1A and 1B include single fans for the smaller fume exhaust on the first floor, two double fan units for the future upper floors, and a triple fan unit for the ground and first floors. The multiple fans run simultaneously and are not redundant. Options 2A and 2B, are all single fan units with one large fan and two small fans serving the ground and first floors and two large fans serving the future upper floors. Option 3 is comprised of six chemical scrubber units with fans to serve the ground, first, and future floors. For options 1 and 2, an analysis was performed with silencers and also without silencers on the fans. The 1A and 2A options were performed with no silencers and options 1B and 2B were performed with silencers on the new fans.

The modeling results for options 1A and 1B are shown in Figures 1 and 2, respectively. As can be seen by the plot, the highest noise level in the National Mall area (marked by a black and white dot) is 46 dBA without silencers and 38 dBA with silencers. The difference of 8 dBA between these 2 options, while not quite the 10 dBA normally associated with a sound that is generally perceived as half as loud, is still a significant difference in sound level.

Background levels due to traffic, planes, and people were performed in the middle afternoon on April 8, 2009 and are shown in Figures 3 and 4. The location of the measurements is shown in Figure 2. As can be seen, the lowest average sound level of 55 dBA is 9 dBA greater than the sound level produced from the fans in the loudest area of the Mall (south side). Typically, a noise this far below the background noise is not noticeable. The exception is for noises with significant discrete tones of a particular frequency, especially in the 500 Hz to 2 kHz range as discussed above, or those that significantly deviate from a typical NC or RC curve shape. Sounds that do conform to an NC or RC curve shape with the associated 5 dB slope per octave frequency band tend to be perceived as fairly bland such as from a low level breeze through a forest in winter time (no rustling leaves which would add higher frequency noise).

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However, the noise from the fans does noticeably deviate from an RC curve shape as shown in Figure 5. The noise spectrum has a relatively higher level of high frequency noise which typically adds a hissy character to the sound. Also, there is a noticeable tonal component to the noise in the 125 Hz frequency band, which tends to result in a drone-type noise. Therefore, without silencers, the noise level is expected to be slightly noticeable during the day, if listening for the noise. It is likely that most people will not be listening for the noise, and given the background level, probably would not notice it. At night, when other noises would significantly reduce, the noise would be more noticeable due to the lower background level. With silencers, there is a slight reduction in the tonal nature of the sound. With the lower level and slight change in noise character, the noise level should not be noticeable during daytime and may only be slightly noticeable at night.

The sound level plots for options 2A and 2B are shown in Figures 6 and 7. As can be seen, the level at the loudest point on the Mall is 48 dBA without silencers and 37 dBA with silencers, which is comparable with the overall levels obtained with the alternate fan configuration above. The most apparent difference between options 1 and 2 is the shift in the tonal component at 125 Hz to one octave lower in the 63 Hz frequency band as shown in Figure 8. This is expected to still have a drone-type character, but should be less noticeable due to the lower frequency. Also, there is a slight relative increase in the 1 kHz frequency band which may increase the perception of a hissy-type noise character.

Option 3 sound levels are plotted in Figure 9. The reference location on the Mall shows a level of 47 dBA, which is comparable to that produced from options 1A and 2A. Also, for this option, the loudest point on the mall was not at the same location. The loudest point has a level of 50 dBA, which is slightly louder than option 1 and 2 above. It should be noted that most options are approximately 10 dBA below the Washington D.C. noise code of 55 dBA for residential areas. Although this would be the most stringent limit to apply, in our estimation, the limit for commercial zones would be a more appropriate limit for a public park type area such as the Mall, which would give a limit of 60 dBA at the property line. However, for this type of noise such as from mechanical equipment, section 2801.2 of the noise code also applies a limit of 60 dBA. The input data used for each option discussed above is listed in Tables 1 and 2 for reference purposes. Feel free to call regarding any questions on the above analysis.

Sincerely,

Kelton Mitchell

Kelton Mitchell
Consultant

Reviewed by:

Douglas P. Koehn

Douglas P. Koehn, M.S.
Senior Consultant

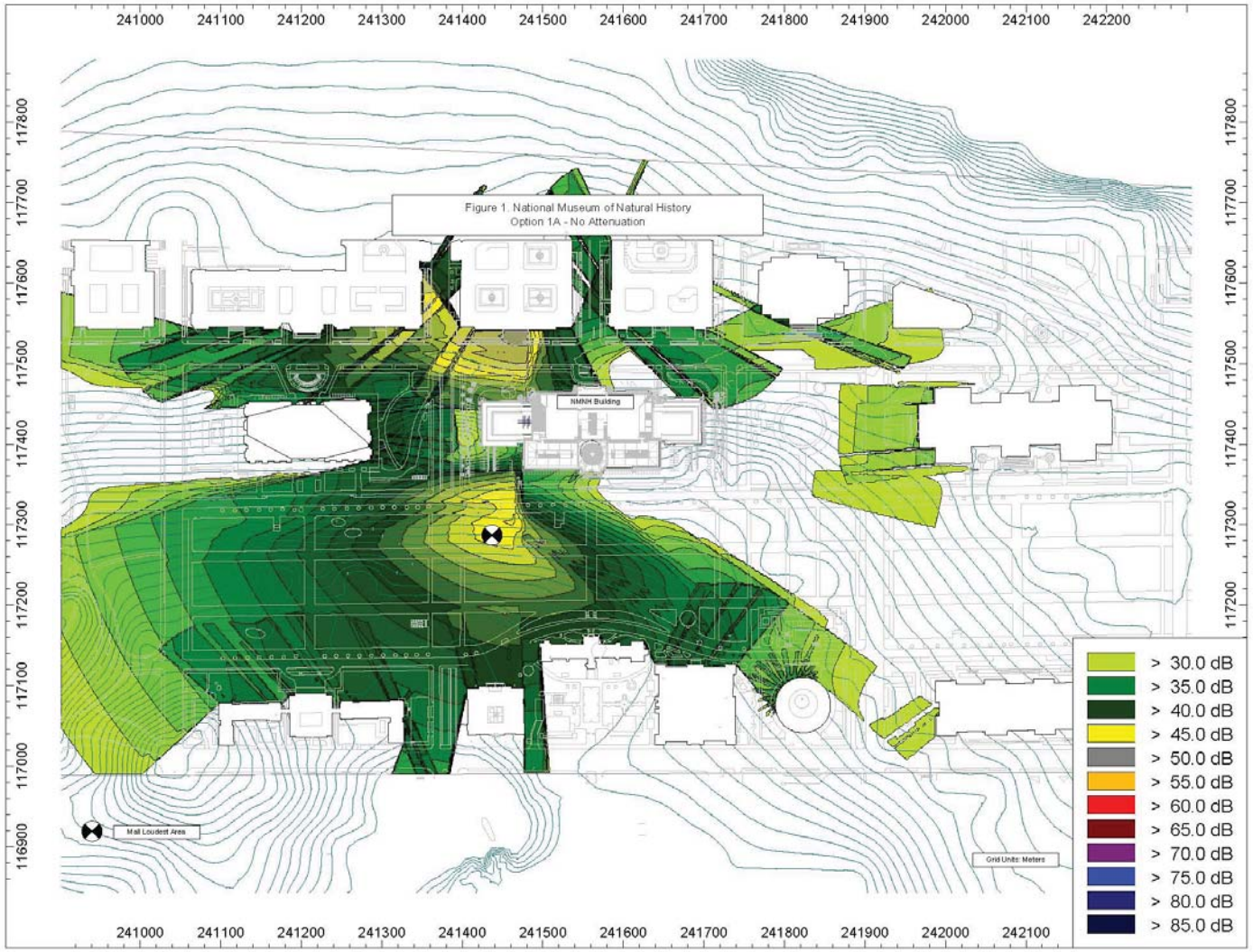
Figure 1. National Museum of Natural History
Option 1A - No Attenuation
NMNH Building
Mall Loudest Area
Grid Units: Meters
241000
241100
241200
241300
241400
241500
241600
241700
241800
241900
242000
242100
242200
116900
117000
117100
117200
117300
117400
117500
117600
117700
117800
> 30.0 dB
> 35.0 dB
> 40.0 dB
> 45.0 dB
> 50.0 dB
> 55.0 dB
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> 70.0 dB
> 75.0 dB
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> 85.0 dB

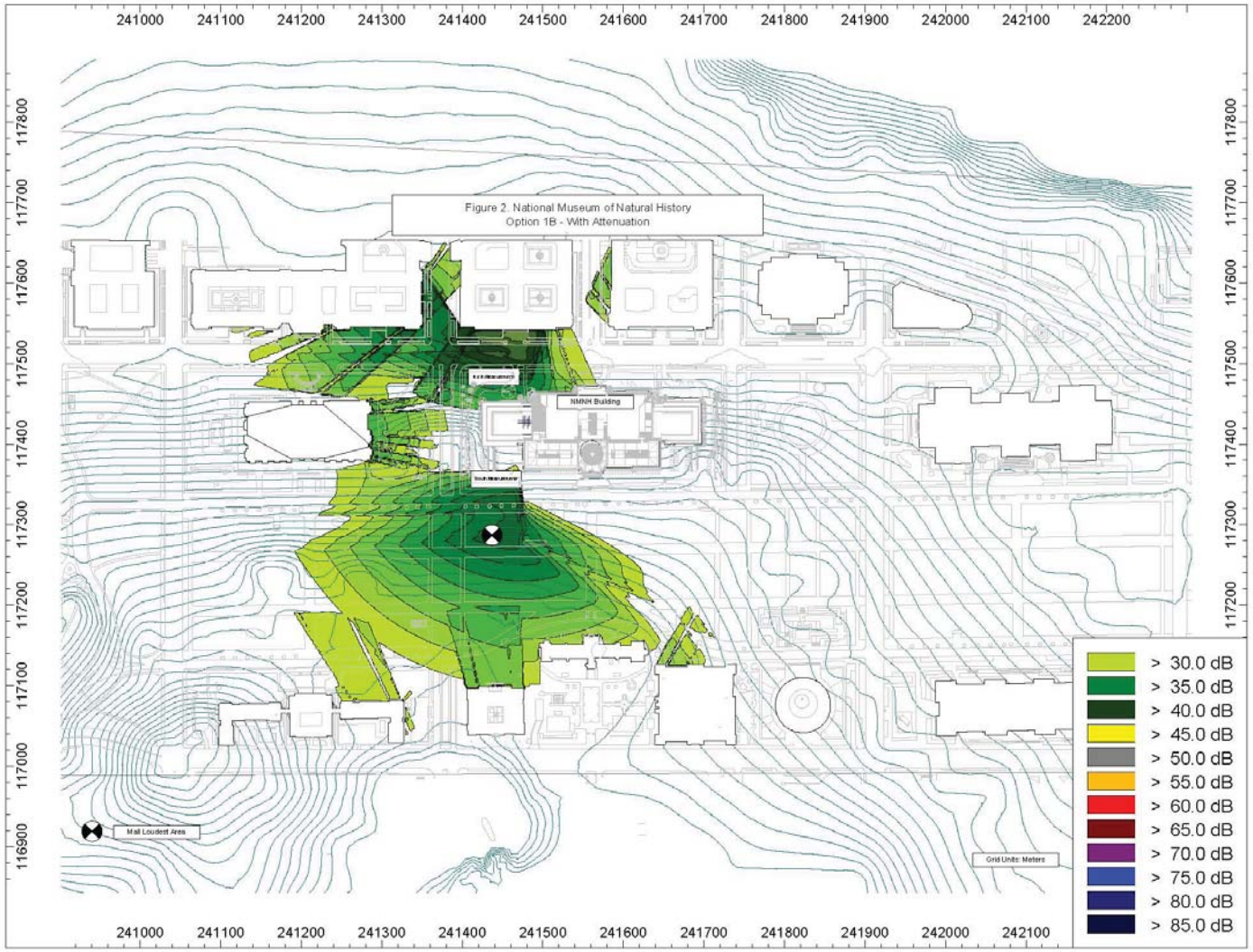
Figure 2. National Museum of Natural History
Option 1B - With Attenuation
NMNH Building
Mall Loudest Area
Grid Units: Meters
241000
241100
241200
241300
241400
241500
241600
241700
241800
241900
242000
242100
242200
116900
117000
117100
117200
117300
117400
117500
117600
117700
117800
> 30.0 dB
> 35.0 dB
> 40.0 dB
> 45.0 dB
> 50.0 dB
> 55.0 dB
> 60.0 dB
> 65.0 dB
> 70.0 dB
> 75.0 dB
> 80.0 dB
> 85.0 dB

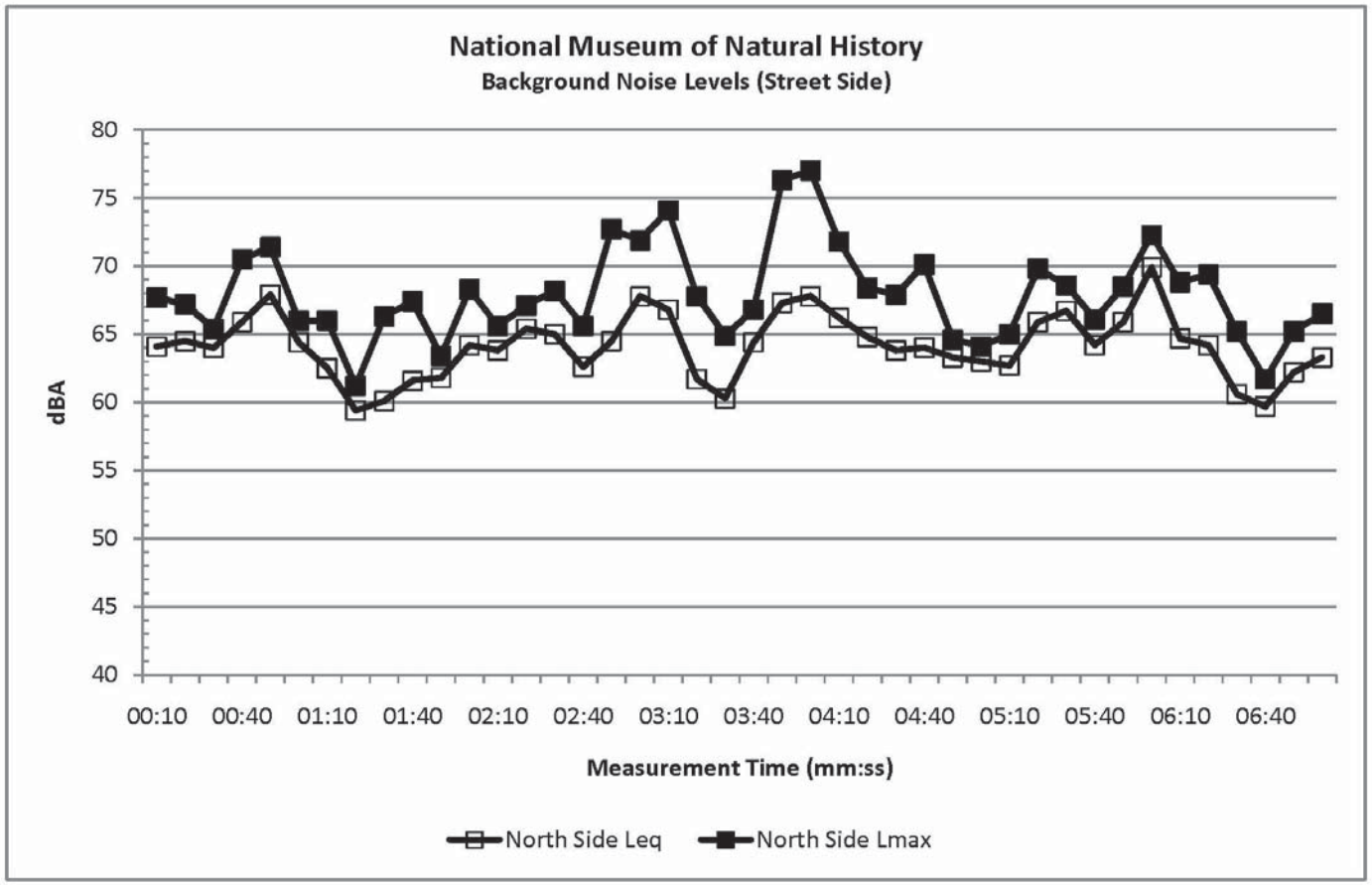

Figure 3

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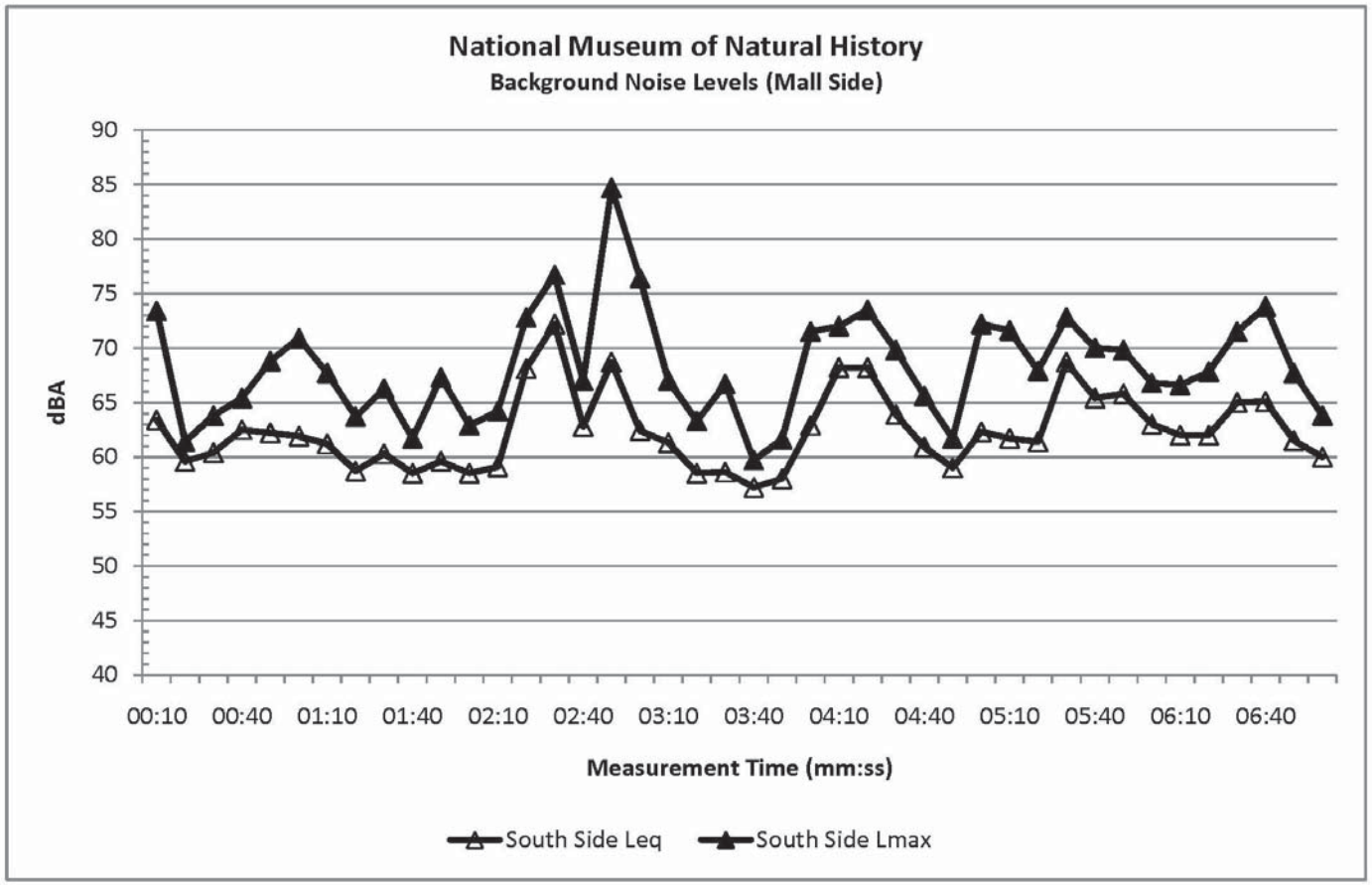

Figure 4

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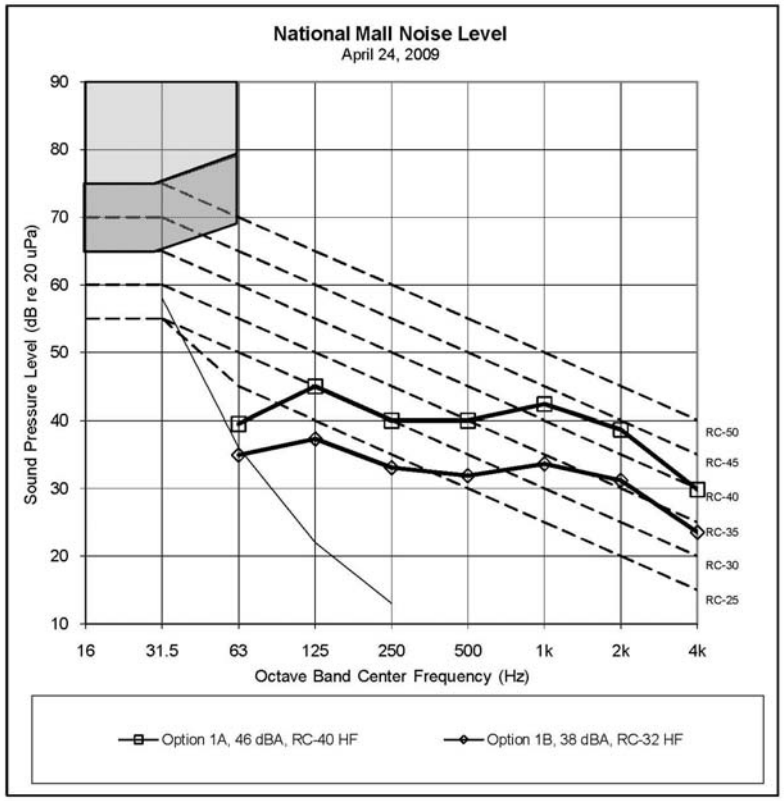

Figure 5

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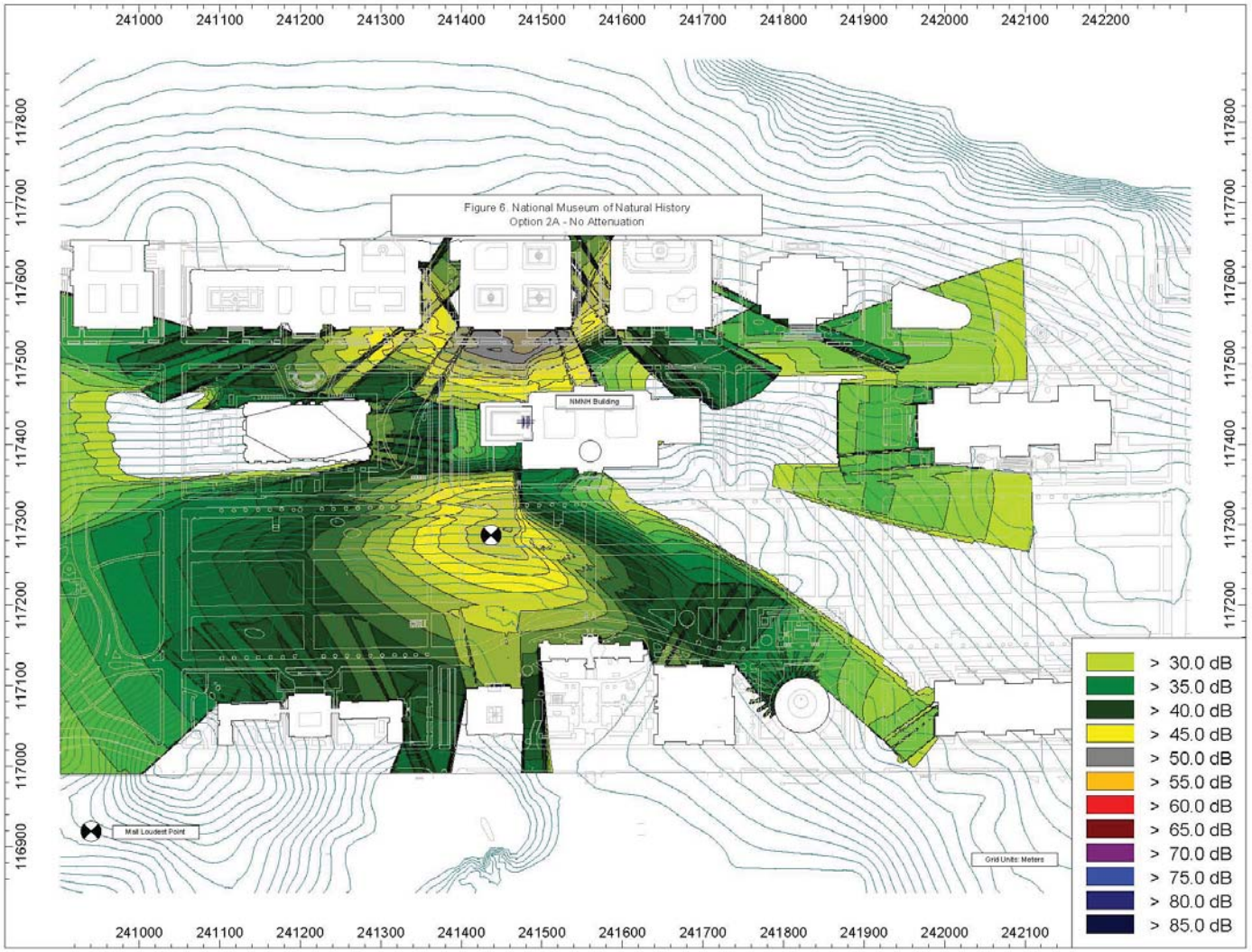
Figure 6. National Museum of Natural History
Option 2A - No Attenuation
NMNH Building
Mall Loudest Point
Grid Units: Meters
241000
241100
241200
241300
241400
241500
241600
241700
241800
241900
242000
242100
242200
117800
117700
117600
117500
117400
117300
117200
117100
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116900
> 30.0 dB
> 35.0 dB
> 40.0 dB
> 45.0 dB
> 50.0 dB
> 55.0 dB
> 60.0 dB
> 65.0 dB
> 70.0 dB
> 75.0 dB
> 80.0 dB
> 85.0 dB

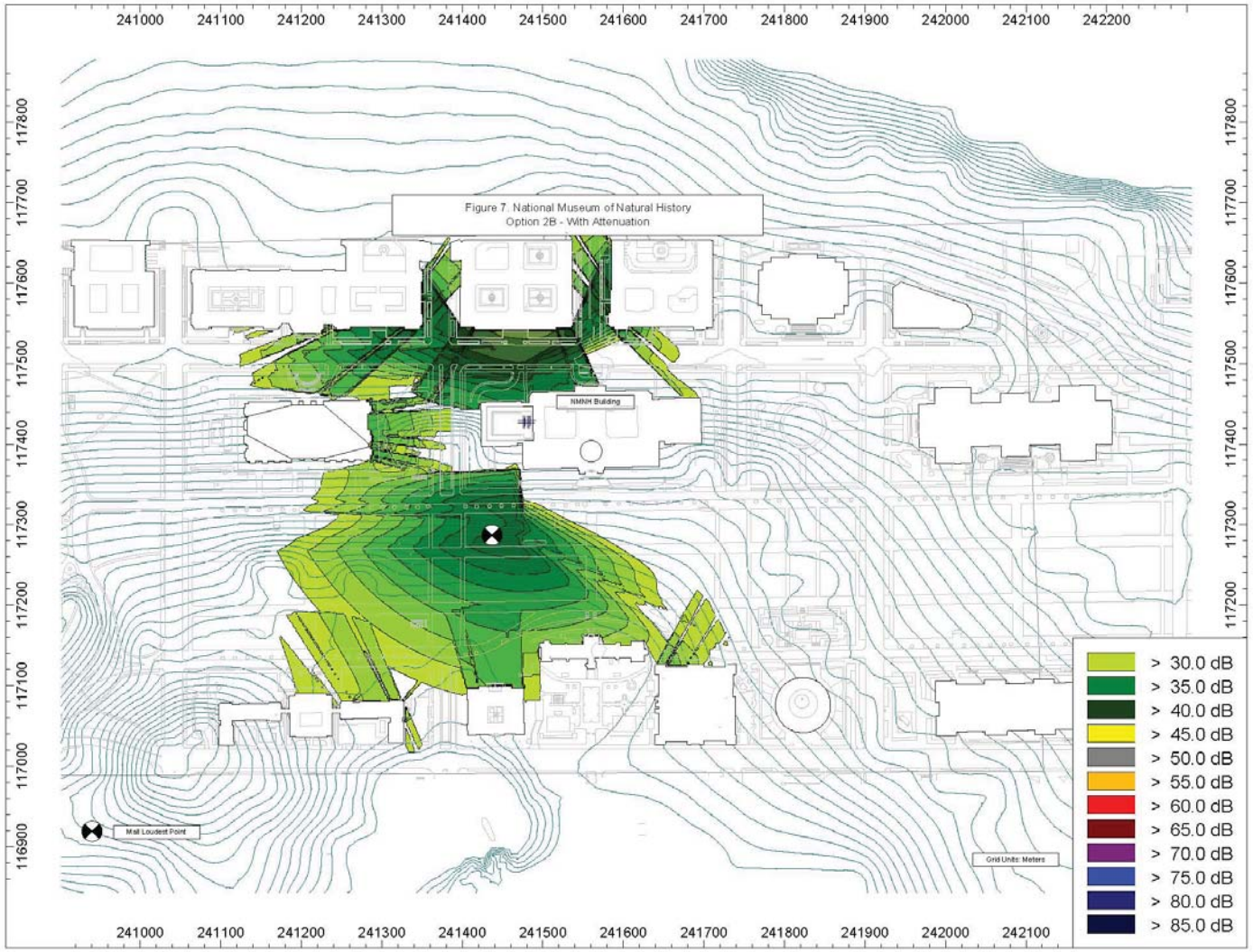
Figure 7. National Museum of Natural History
Option 2B - With Attenuation
NMNH Building
Mall Loudest Point
Grid Units: Meters
241000
241100
241200
241300
241400
241500
241600
241700
241800
241900
242000
242100
242200
116900
117000
117100
117200
117300
117400
117500
117600
117700
117800
> 30.0 dB
> 35.0 dB
> 40.0 dB
> 45.0 dB
> 50.0 dB
> 55.0 dB
> 60.0 dB
> 65.0 dB
> 70.0 dB
> 75.0 dB
> 80.0 dB
> 85.0 dB

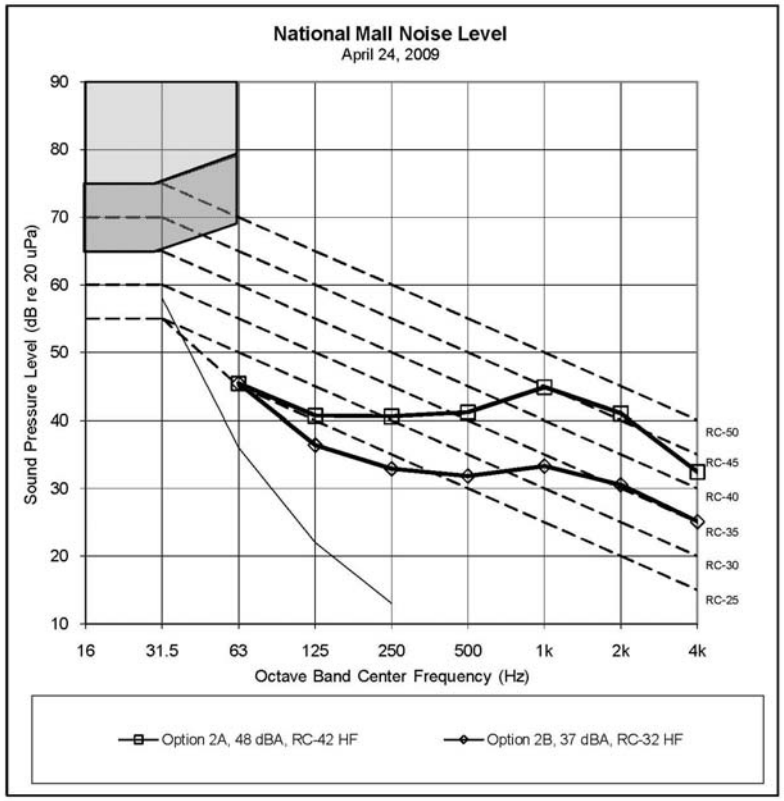

Figure 8

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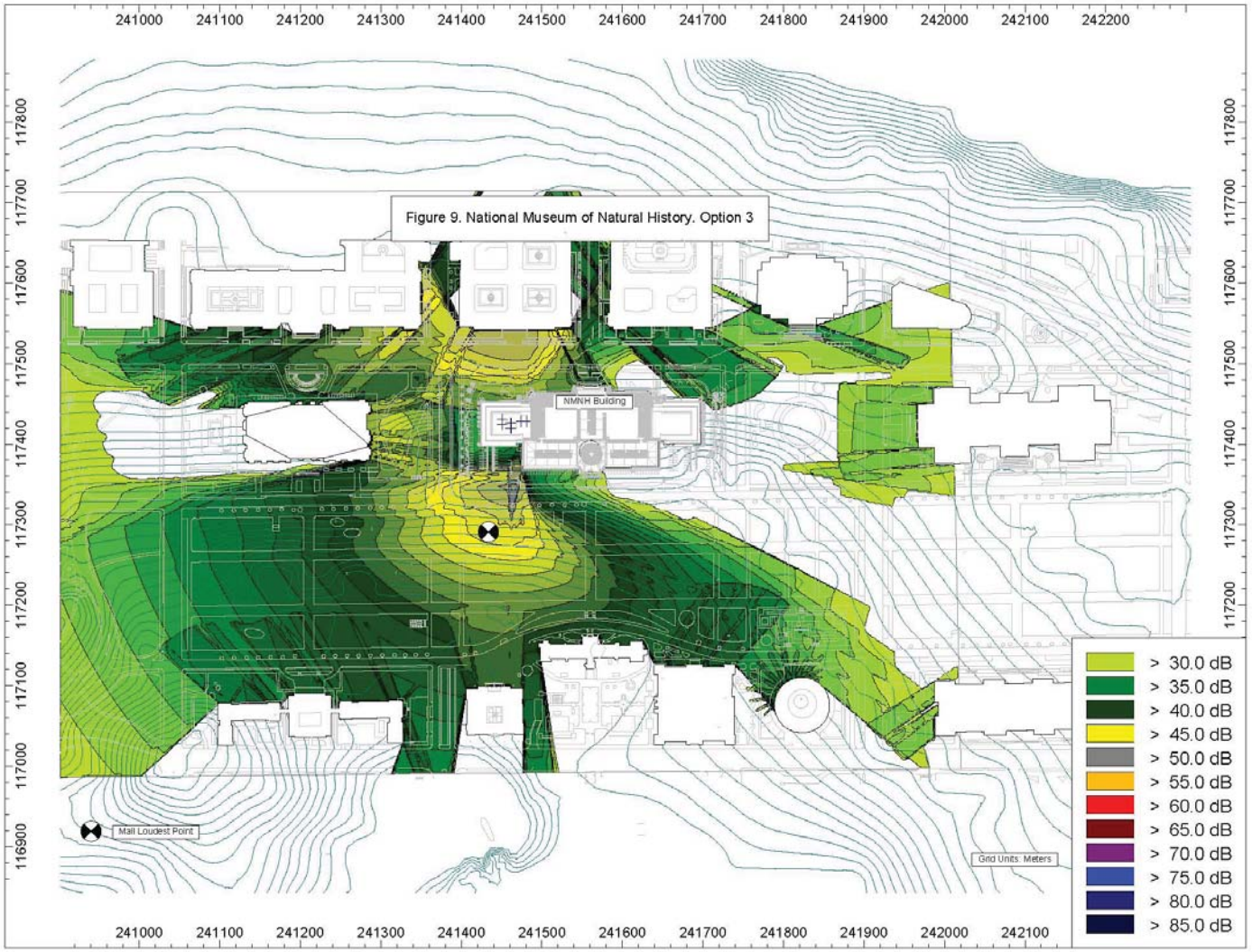


Figure 9. National Museum of Natural History. Option 3
NMNH Building
Mall Loudest Point
Grid Units: Meters
241000
241100
241200
241300
241400
241500
241600
241700
241800
241900
242000
242100
242200
116900
117000
117100
117200
117300
117400
117500
117600
117700
117800
> 30.0 dB
> 35.0 dB
> 40.0 dB
> 45.0 dB
> 50.0 dB
> 55.0 dB
> 60.0 dB
> 65.0 dB
> 70.0 dB
> 75.0 dB
> 80.0 dB
> 85.0 dB

Table 1. Fan Sound Power Levels.

Fan Mark	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Notes
EF1-1 (option 1)	95	101	99	98	97	93	88	78	1
EF1-1 (option 2)	99	94	96	95	96	92	86	79	2
EF1-2 (options 1 & 2)	88	86	92	88	89	85	82	72	3
EF1-3 (options 1 & 2)	75	84	89	89	87	86	80	71	4
EF2-3, 4-5 (option 1)	97	102	99	97	96	92	86	77	5
EF2-3, 4-5 (option 2)	99	94	96	95	96	92	86	79	6
Option 3									
PCR/BSC Inlet	84	84	81	79	76	71	67	64	7
PCR Outlet	82	83	81	83	82	77	74	71	8
BSC Outlet	81	82	80	82	82	76	73	69	9
Inlet 2-3, 4-5	99	100	98	96	92	90	86	81	10
Outlet 2-3, 4-5	92	89	91	88	84	82	79	75	11
Inlet G1, G2	98	99	95	92	89	87	83	80	12
Outlet G1, G2	92	86	90	88	83	81	78	74	13

Table 2. Silencer Insertion Loss.

Nozzle Silencer	5	8	9	11	12	12	10	6	Option 2B
3 ft Outlet Silencer (EF1-1)	0	4	9	11	12	13	9	4	Option 1B
4 ft Outlet Silencer (EF2-3, 4-5)	0	5	11	14	15	15	10	6	Option 1B

Notes:

1. Triple induction fan unit serving ground and first floors.
2. Single induction fan unit serving ground and first floors.
3. PCR space induction fan.
4. Biosafety cabinet (BSC) induction fan.
5. Double induction fan units. One unit serving floors 2 and 3, another unit serving floors 4 and 5.
6. Single induction fan units. One unit serving floors 2 and 3, and another unit serving floors 4 and 5.
7. PCR space and BSC inlet fans for scrubbers.
8. PCR space outlet fan for scrubber.
9. BSC outlet fan for scrubber.
10. Inlet fans for scrubbers serving floors 2 and 3 and floors 4 and 5.
11. Outlet fans for scrubbers serving floors 2 and 3 and floors 4 and 5.
12. Inlet fans for scrubbers serving ground and first floors.
13. Outlet fans for scrubbers serving ground and first floors.

Miller, Beam, & Paganelli, Inc.
Reston, Virginia

APPENDIX C
SAMPLE INDUCTION FAN PRINCIPLES OF OPERATION

A subsidiary of MET PRO CORPORATION

Strobic Air Corporation

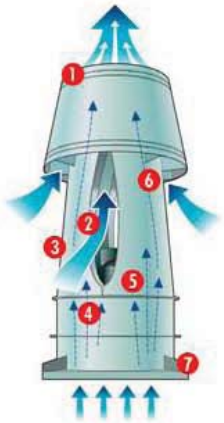
Tri-Stack™ Laboratory Fume Hood Ventilation & Process Exhaust Systems

Low Profile, Quiet Solutions to Pollution Abatement and Odor Control for Laboratory Workstations, Industrial Processing and Other Specialized Applications

Principles of Operation — Previous Page

What is a TriStack™ Fume Exhaust System?

Click Here to watch a 9 minute video with more details.



1. Wind band entrains outside air above fan motor to enhance discharge volume and effective stack height
2. Up to 170% of free outside air introduced into the airstream prevents odor and re-entrainment
3. Special materials and coatings are available for severe environment duty
4. Specially designed, mixed flow impellers provide high pressure and volume, with no stall region, and at low RPM. The impeller mounts directly to the motor shaft without belts or pulleys
5. Direct drive motors are virtually maintenance-free with typical bearing lifetimes of L-10 100,000 hours
6. Modular construction speeds and simplifies installation, reduces costs and downtime
7. Extremely low vibration levels eliminate the need for spring isolation and flex connections

Tri-Stack™ systems operate on a unique principle of internal and external exhaust stream dilution. They entrain outside air (up to 170% by volume) with the primary exhaust stream to produce a substantially diluted exhaust stream. A unique exhaust nozzle design enhances flow and pressure to increase stack outlet velocities while minimizing horsepower requirements. The resultant discharge plume (up to 350' high) produces an effective stack height sufficient to penetrate the building boundary layer and safely disperse exhaust into the free air stream. Once there, it cannot be re-entrained into building inlets or adjacent buildings.

Because Tri-Stack mixed flow fans introduce up to an additional 160% of free outside air under their windbands and through their motor chamber areas, a substantially greater airflow is possible for a given amount of exhaust without additional horsepower. Outstanding dilution performance effective eliminates pollution and odor problems with extremely high efficiency.

— Previous Page

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A Subsidiary of Met-Pro Corporation
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Pollution Control Technologies Inc.
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Vaughan, Ontario, Canada L4K 5K8
Phone: 866-556-5564
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