Construction activities (including demolition, excavation, and material transfer) can have an enormous impact on the local environment, especially on existing facilities adjacent to the construction site (like Figure 1).

Fugitive dust and vehicle emissions can infiltrate into existing buildings, resulting in poor indoor air quality that may be a nuisance or threaten the health of workers and occupants. This is especially significant if the building is a hospital or long-term care facility where the well-being of patients or residents may already be compromised.

Noise and vibration impacts are also associated with construction activities. High levels of noise or vibration may reduce the comfort of occupants, upset the operation and performance of sensitive equipment, and cause physical damage in nearby buildings.

Attention to these impacts leads to a safer and more comfortable environment for workers and occupants as well as protects sensitive equipment and artifacts. This Technote discusses the issues and mitigation options for the following environmental impacts:

- fugitive dust
- diesel odors
- environmental noise
- ground-borne vibration
FUGITIVE DUST

Dust can originate from many construction activities. However, the greatest dust emissions are typically from truck traffic. Heavy trucks, traveling on paved or unpaved roads, will lift dust from the roadway that can be in-turn carried by the wind.

High levels of airborne dust will reduce both building and external air quality, foul filters, and reduce visibility. In hospitals, increased dust loading is also associated with an increased probability of infection. This is especially true with respect to aspergillosis, the group of diseases caused by the aspergillus spores located in soils, that often become airborne due to construction activities. The importance of dust on air quality has been recognized by LEED, which requires a dust control plan for LEED-NC certification.

Dust concentrations typically exceed air quality standards without dust control measures in place, particularly at locations close to construction activities.

A dust management plan is essential for reducing the impact of dust on local air quality. To assess the performance of various dust mitigation strategies, dispersion modeling can be conducted (see the end of this Technote for more details). Some examples of dust mitigation strategies include:

- water and/or clean roads and work surfaces
- use tire wash stations for vehicles entering and leaving the construction site (see Figure 2)
- relocate intakes to better-protected locations using plywood 'hoarding' or metal ducts (see Figure 3)
- add temporary pre-filters to increase life of air handling unit filters
- relocate work spaces, including roads, drop-off areas, and equipment

DIESEL ODORS

Large diesel-powered vehicles are frequently present during construction activities. Diesel exhaust from vehicles is not typically a health concern unless vehicles operate or idle close to outside air intakes or pedestrian areas. However, odors from diesel exhaust can be very persistent, often leading to complaints from the occupants of buildings near construction activities.

RWDI has conducted odor panel testing to quantify the impacts of diesel odors, since there are no known air quality standards for diesel odors. Often the level of mitigation needed to reduce diesel odors to a generally acceptable level is not achievable. Therefore, the best that can be achieved is to reduce the intensity of the odors and the frequency with which they occur. (Refer to RWDI Technote Issue 8 for more details on the odor sampling and control.)

As with fugitive dust, dispersion modeling can greatly aid in determining the most effective mitigation strategies. These strategies include:

- use activated carbon filtration with thin, temporary construction filters (low pressure drop, easy to fit into existing air handling units)
- relocate intakes to better protect them from diesel exhaust emissions (see Figure 3)
- relocate equipment to locations where intakes will be better protected
- use alternate fuels, such as propane or bio-diesel, that have less offensive emissions
ENVIRONMENTAL NOISE

Intrusive noise can be generated from construction activities and equipment and can vary at different stages of development. Noise is mostly a nuisance concern but more substantial impacts can occur with greater noise. For example, higher ambient noise levels have been linked to slower patient recovery time in hospitals and the disruption of courthouse operations.

ASHRAE provides recommended design guidelines for background noise in different classifications of spaces as Noise Criterion (NC) curves. Each curve, identified by its index, represents a maximum background sound level in each octave band. Preferably, the level of noise intruding into given building spaces should not exceed the recommended maximum background noise level. However, because of the short-term nature of construction activities, noise levels exceeding the recommended maximum background level may be tolerable by up to 10 NC points for intermittent sources.

The building façade, separating the construction activities from the indoor noise-sensitive spaces, significantly affects the level of sound transmission. Sound transmission modeling can usefully predict and allow for modifications to the construction program to limit noise levels. This can include consideration of the specific source emission levels, the proximity of the source to the building façade, and the specific sound emission loss characteristics of the building.

The following mitigative strategies can be considered to reduce noise impacts:

- schedule noise-intensive work for the least noise-sensitive time of the day
- increase the separation distance between noisy equipment and noise-sensitive locations
- install noise barriers around active areas to screen and protect noise sensitive areas
- close operable windows and install storm windows over acoustically weak windows (see Figure 4)
- relocate noise-sensitive building spaces to less-impacted locations
- review the construction plan to produce limits on noise emissions emitted by construction equipment
- require all vehicle engines to have working mufflers

GROUND-BORNE VIBRATION

Vibration generated by construction activities is categorized into ground-borne and sound-generated vibration. Ground-borne vibrations are of much greater concern.

Vibrations produced during construction activities are transmitted through the ground to nearby structures. This can result in complaints from nearby residents and disruption of vibration sensitive procedures (e.g., production, research, imaging). Vibration can also cause damage to artifacts within historical buildings and museums (see Figure 5) and, in extreme cases, structural damage to nearby buildings.

The propagation of vibration is site specific and dependent on the characteristics of the soil and substrata. Propagation efficiency tests, involving vibration measurements taken at varying distances from a controlled impact force, are recommended to determine these properties.

Using the vibration propagation characteristics and the vibration levels for typical construction equipment and activities, the resulting vibration levels can be predicted. This data is useful for providing adequate isolation methods or separation distance when siting equipment and activities.

![Figure 4: Temporary storm windows can be used to reduce the transmission of noise through windows](image)

![Figure 5: Construction equipment, if not sited properly, can damage sensitive objects, including museum artifacts (representative only and not for construction)](image)
If construction equipment and/or activities must be sited closer than recommended, the following measures should be taken:

- conduct a pre-construction assessment to measure the ambient vibration levels, determine the vibration propagation characteristics of the soil, and survey the surrounding areas for existing cracks and structural damage
- isolate vibration-sensitive processes, equipment and artifacts using isolation tables
- temporarily relocate vibration-sensitive processes, equipment, and artifacts
- monitor vibration at sensitive areas during construction and, if necessary, reduce or shut down high vibration-generating activities
- select less vibration-intensive construction techniques

**SUMMARY**

Construction activities can have a wide variety of environmental impacts on the surrounding site, including:

- nuisance and health impacts on occupants of nearby buildings
- disruption of sensitive processes
- physical damage of equipment, artifacts, and buildings

As part of the construction plan, the impacts of dust, diesel odors, noise, and vibration on the surrounding areas should be considered. These environmental impacts can be predicted through a variety of modeling techniques and, where necessary, help quantify mitigative strategies that can be implemented to minimize the negative effects on nearby people and property.

**DISPERSION MODELING TECHNIQUES USED TO ASSESS DUST AND DIESEL IMPACTS FROM CONSTRUCTION SITES**

Dispersion modeling is a useful tool for quantifying the dust concentrations and diesel odors at locations of concern. The predicted impact of construction activities can be estimated by comparing the results of the dispersion modeling to air quality standards and odor thresholds. More importantly, dispersion modeling can be used to quantify the effectiveness of different mitigation methods.

Dust and diesel odors from construction activities are typically near-field concerns. The following selection of dispersion modeling techniques is suitable for evaluating these impacts on nearby facilities.

**Wind Tunnel (Physical) Simulation**

- most accurate modeling technique available
- accounts for air flow patterns around complicated building and site geometries
- most applicable for complex building geometries or complex terrain (see wind tunnel photograph)

**ASHRAE (Numerical) Dilution Equations**

- intended to provide a screening-level estimate of exhaust dispersion from a source to a receptor on the same building
- requires judgement to interpret the results
- more suited for simple building configurations

**ISC-Prime / AERMOD (Numerical) Modeling**

- considers building wake-region and meteorological effects
- accounts for simple building geometries
- best suited for identifying impacts at buildings separated from construction activities

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Rowan Williams Davies & Irwin Inc.

RWDI AIR Inc.

(519) 823-1311  www.rwdi.com

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