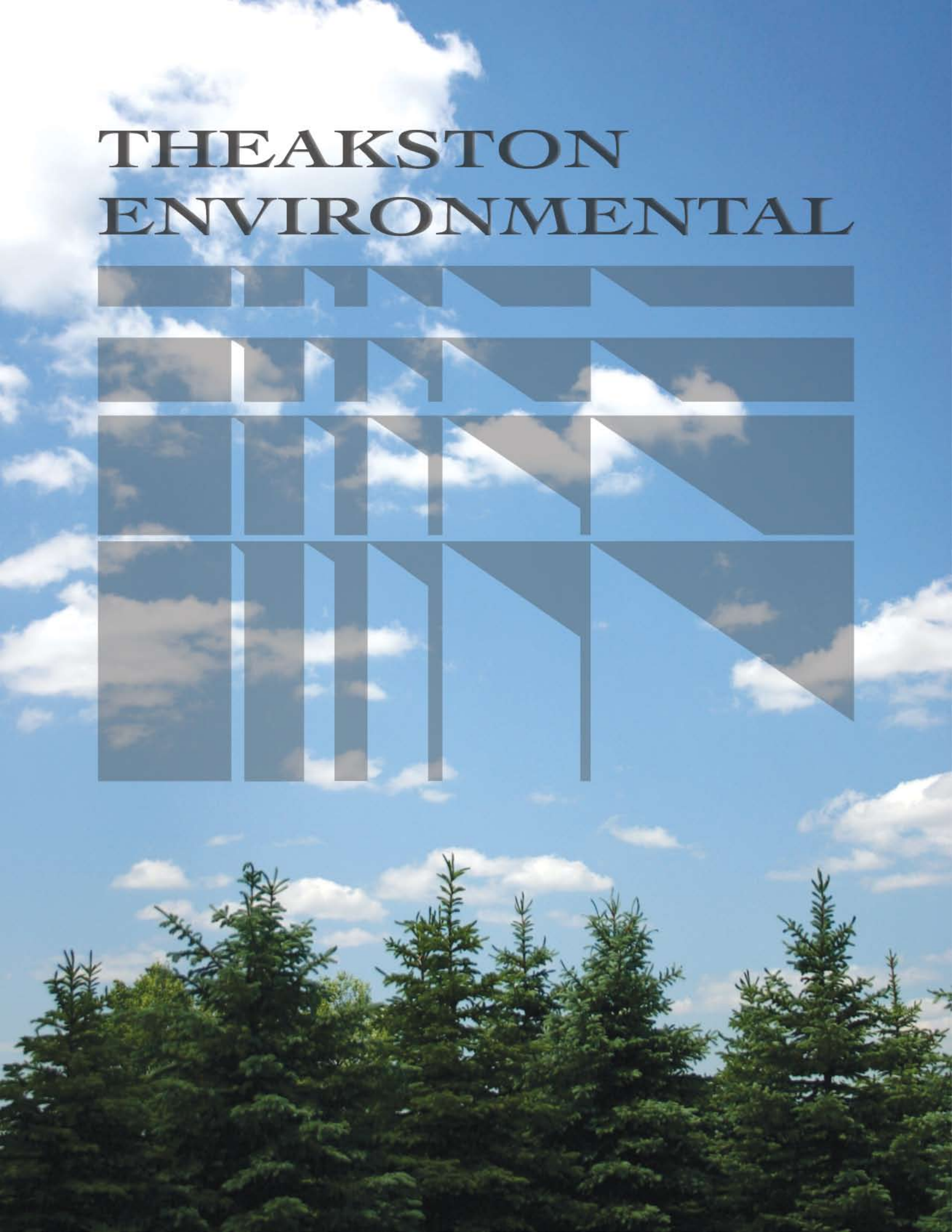

THEAKSTON
ENVIRONMENTAL

We'll help you predict and control the natural environment.

Theakston Environmental

is a Canadian company offering unique Consulting Engineering services as experts in predicting and controlling the natural environment. The firm provides services to both private and public sectors across Canada, the United States, and abroad. The scope of studies has evolved to include wind pressure analysis, numerical and physical exhaust gas dispersion, pedestrian level wind velocity studies, snow accumulation studies, sun/shade studies, force balance analysis, and particulate dispersion modeling.

Theakston Environmental provides you, the client, with practical, cost effective solutions at the planning stage or upon realization of an existing or potential problem. Theakston Environmental is committed to ensuring the effectiveness of the proposed solution not only during laboratory testing but upon implementation at your site.

Problems confronting architects, planners, and engineers are studied efficiently by constructing exact scale models of the existing site and proposed structures. Model testing in combination with computational analysis provides complete understanding of the environment under study.

We offer consulting services independently, or, as part of a team able to take a broad view of our client's needs. Our people seek to provide appropriate solutions, taking into account the human and environmental dimensions of the project. We use modern methods including physical model analysis and computational analysis to provide accurate, detailed results.

We specialize in wind engineering issues

Our Services Include:

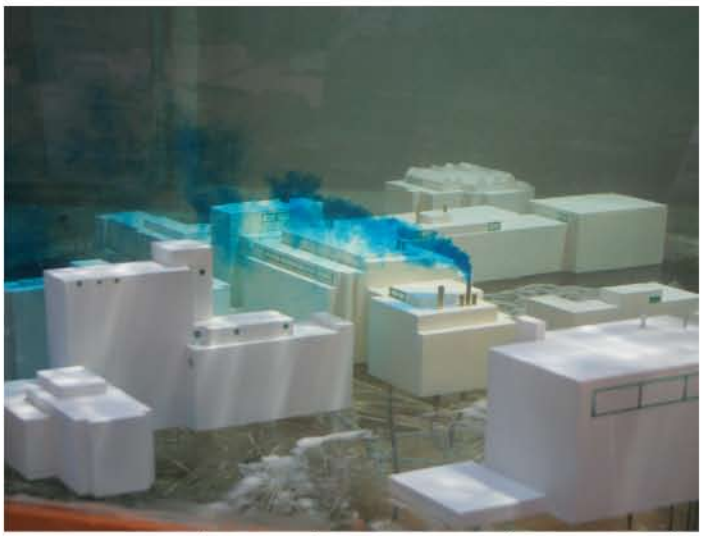
Physical modeling and analysis
Computer modeling and analysis
Wind pressure
Exhaust gas dispersion
Pedestrian comfort
Snow
Sun/shade
Force balance
Particulate dispersion
Air quality
Environmental approvals
Expert testimony
Consultations and design reviews
Existing projects or problems
Research and development

Physical Modeling & Analysis

Open Channel Water Flume

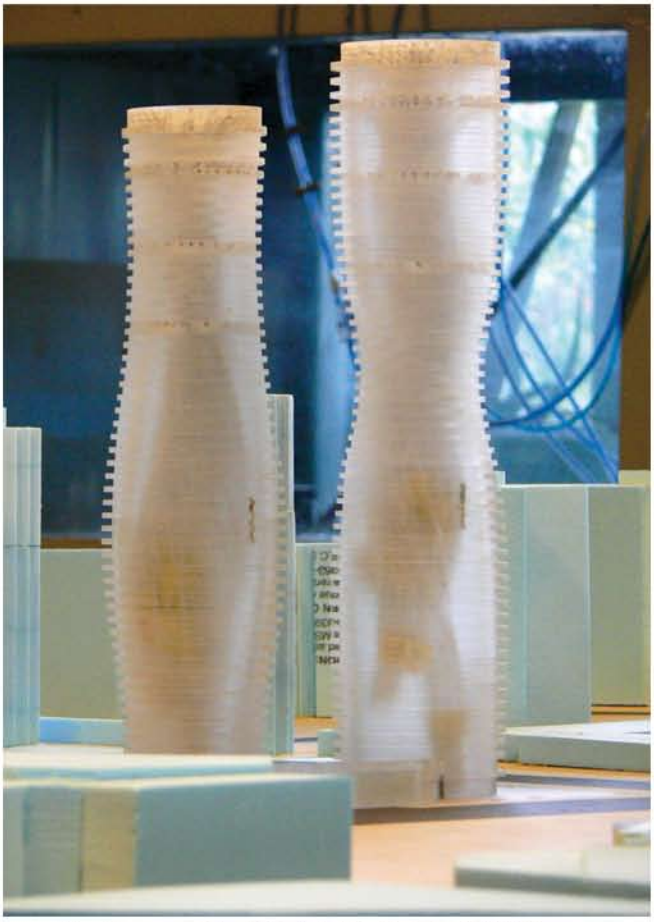
An open channel water flume is one method used by Theakston Environmental to conduct modular analysis. Water simulates the flow characteristics of wind allowing detailed evaluation of anticipated microclimatic conditions for the site. The results are superior when visual examination or quantitative analysis are advantageous in decision making.

Wind Tunnel model used to assess wind pressure on cladding and structural loading

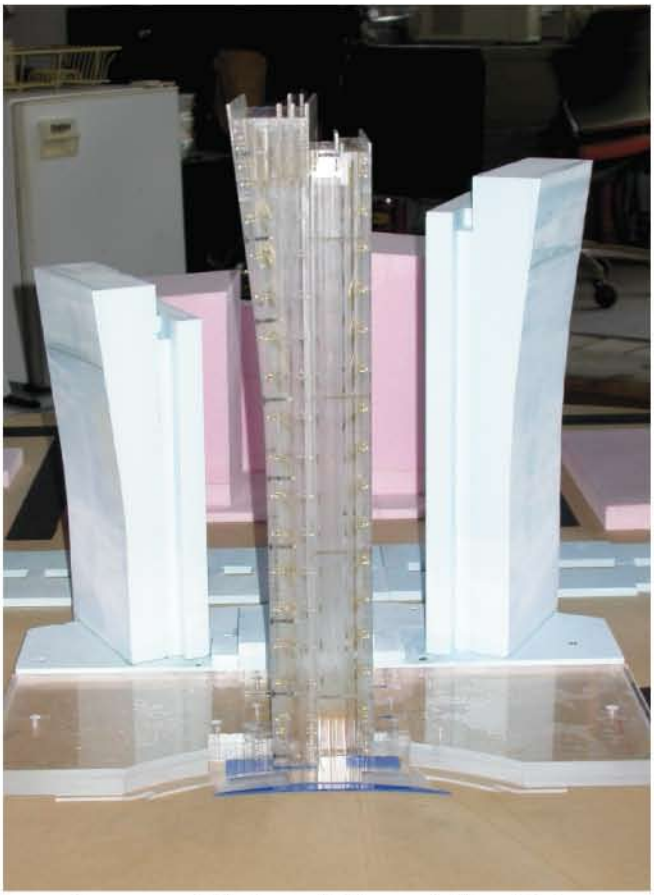


Quantitative exhaust gas dispersion testing for University of Edmonton, Centennial Centre for Interdisciplinary Science

Snow accumulation study using silica sand in the water flume



Pressure model: Absolute Condos in Mississauga



Pressure model: Emerald Towers in Kazakhstan

Wind Pressure Analysis

The Suction of Wind

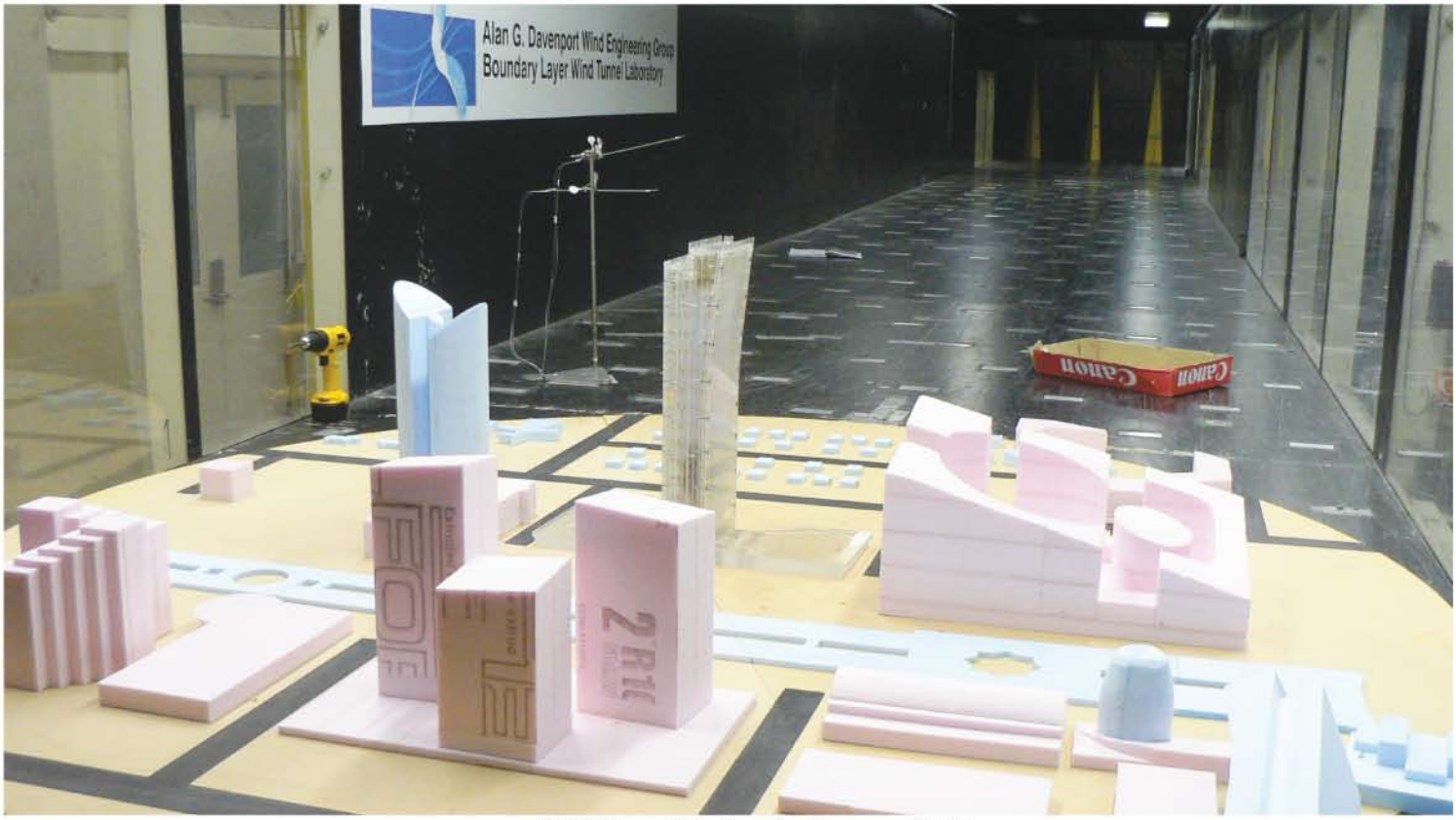
The John Hancock building in Boston is a classic example of failure due to unanticipated wind induced loading. In this case the glazing system was not designed to withstand the negative pressure experienced. Consequently, windows were literally "sucked" from the building. Tall buildings, irregularly shaped buildings, or buildings in close proximity create unique wind flow patterns. These may result in excessively high pressures that are difficult to anticipate based on experience alone. A better understanding of the wind's interactions with buildings more than negates these concerns; it allows innovative building forms, along with optimized structural systems.

How Can You Anticipate Wind Pressure Problems?

Wind pressure analysis will determine the magnitude of the pressures required for design, to prevent dangerous failures and keep costs in line. These analyses can be applied to the entire structure or to specific design features.

Site Model:

Wind pressure analysis requires construction of a detailed scale model of the proposed building and other significant structures in the vicinity. Pressure taps situated on the surface of the proposed structure(s) permit measurement of detailed surface pressure distribution.



Wind Tunnel Testing of a Pressure Model

Testing:

The model is tested in the University of Western Ontario's boundary layer wind tunnel under appropriate conditions for the site. Pressure readings are taken with a high speed data acquisition system for the equivalent of one hour at full scale.

Analysis:

Wind pressure data provides peak, mean, minimum, and rms coefficients of exterior pressure at each tap location for 36 wind directions. These are combined with the statistical wind climate for the area to provide predictions of peak exterior pressures and suctions for various return periods. The resultant predicted peak exterior pressure and suctions are often presented as pressure contour diagrams produced to overlay the various building profiles. Interior pressures induced by air infiltration and mechanical systems are estimated and their effect is added to the measured exterior pressures to provide maximum differential exterior pressures and suctions for the building cladding. The results are used to design wall and window systems, roof surfaces, ventilation intakes, exhausts, and accesses, eliminating what have proven to be potential problem areas on numerous occasions.

Mean Wind-Induced Forces:

The mean exterior pressure coefficients can be integrated over the facade of a building to provide mean shears, torque, and bending moments at various heights along the building for each wind azimuth direction. Mean data is used because peak pressures do not occur simultaneously. This data provides a check against force balance data and is used to provide the mean load distribution required to determine the effective static load distribution.

Exhaust Gas Dispersion

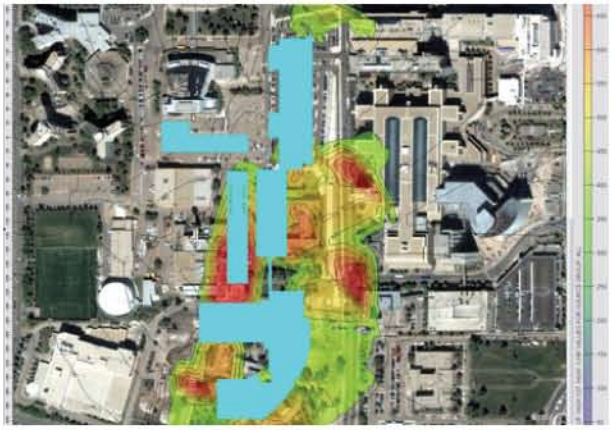
Smoke can be Lethal

Pollutants discharged from power plants, commercial buildings, industrial processes, or hospitals can be carried for some distance with fallout occurring on neighbouring properties.

Stack emissions are often ingested into fresh air intakes or a neighbouring building's ventilation system and subsequently distributed throughout the building. Corrective measures can be taken for these and other conditions contributing to SICK BUILDING SYNDROME.

Numerical Modeling:

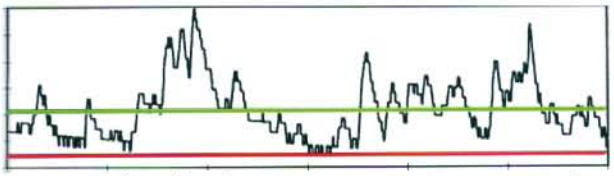
Due to the complexity of variables involved, computational plume dispersion models are typically designed to yield conservative concentration results. Numerical models are used by Theakston Environmental as a preliminary assessment tool to ascertain potential problem areas which are subsequently assessed with quantitative exhaust dispersion modeling. A typical contour plot from numerical modeling using AERMOD exhaust gas dispersion modeling is shown.



Typical contour plot from numerical modeling using AERMOD

Qualitative Physical Modeling:

Exhaust gas dispersion is simulated by introducing dyed water as the stack emission into a model placed in the water flume. This procedure provides immediate visual results since it permits observation of potential problem areas. Theakston Environmental employs specialized photographic equipment and techniques to capture and document plume trajectory.



Typical results of instantaneous concentrations of diesel exhaust at a given point. The green line represents the mean and the red line respresents the health limit

Quantitative Physical Modeling:

The media used to simulate exhaust is introduced into the modular environment as a stack emission at elevated temperature. Resultant downstream temperature changes are monitored using sensitive thermistors and a multi-channel data acquisition system. The technique used for physical modeling is unique to Theakston Environmental and allows complete mapping of 3-D plume trajectories and determination of concentrations at critical points of impingement.

Typical probe inserted into the scale model to make instantaneous measurements

Pedestrian Level Wind Velocity

The Power of Wind

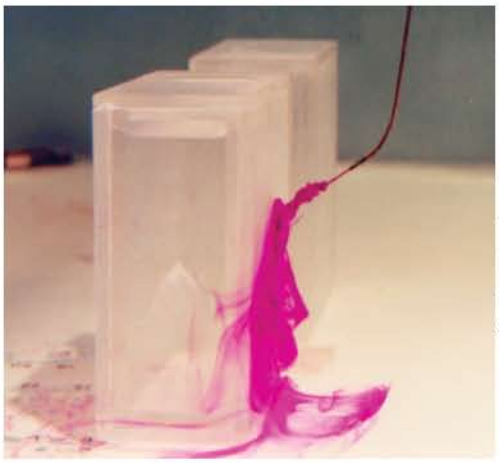
Wind can be downright dangerous. Kitchener, Ontario built a new city hall where the wind funnelled so hard against the front doors that people could not open them on windy days.

Three people on the outdoor jogging track on top of the first story of the Toronto City Hall were whisked into the air by a gust and dropped to the concrete below.

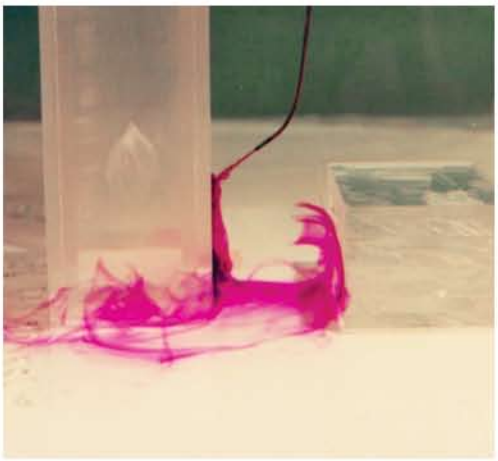
At most airports, the wind around the buildings can be so fierce that passengers making their way from planes to the terminal are blown off their feet.

What Causes Wind Prolems?

Structures such as buildings, the surrounding terrain, landscape features, street corridors, and open areas such as fields, parks, parking lots, and bodies of water all significantly affect microclimatic wind patterns. Very often these features create or exacerbate wind problems at the pedestrian level. Some of the adverse effects buildings have on wind are shown below utilizing flow visualization in the water flume (flow is from right to left).



Downwash Effect
(Side View)
The wind is deflected down to the street level, creating swirling turbulence at the pedestrian level.



Horseshoe Vortex
(Side View)
The downwash effect is intensified when wind curls up against an adjacent building.

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Every object has an effect on the wind. To ensure the comfort and safety of people, Theakston Environmental is employed by architects, planners, and engineers to consider building design, location of buildings, road placement, parks, and open spaces.

Site Model:

Using site and aerial photographs, survey footprint maps, and computerized digital data when available, Theakston technicians build an accurate physical scale model.

Testing:

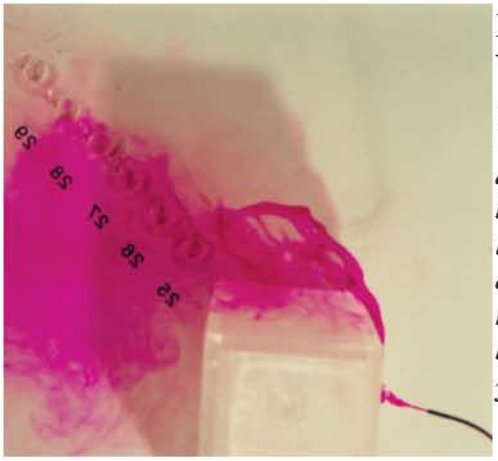
The model is tested in a water flume where the movement of water simulates wind currents. Special wind velocity probes determine wind speeds at key locations and wind velocity under various wind speed and direction scenarios.

Analysis:

A specially designed computer program processes the data collected. The analysis shows comfort levels of the key locations, pinpointing problems before construction.

Recommendations:

Areas identified as unsafe or uncomfortable through physical model analysis are mitigated and subsequently retested at the facility to ensure the desired comfort criteria is achieved.



Karman Vortex
(Top View)
Wind divides around a building, swirls on the downward side creating a vortex, resulting in that blast of wind as you turn a corner.

Venturi Effect
(Top View)
Wind accelerates through narrow openings such as high buildings flanking narrow streets. Conditions are even more severe in tunnels.

Snow Accumulation Studies

Winter Hazards

Blowing and accumulating snow is a potential hazard for people and structures. In Montreal, the roof of a large distribution centre collapsed because of the heavy accumulation of snow.

Highway accidents often result from "white-out" conditions and black ice, caused by the combined action of wind and snow. Near Barrie, Ontario, 12 people died in a massive automobile accident on Highway 400 due to "white-outs".

Theakston participated in the inquest and found that simple wind altering devices could have prevented the "white-out" condition which lead to the accident.

Testing:

Snowstorms are simulated by using silica sand to represent snow, and flowing water to represent wind. The ground snow load is determined using the National Building Code and is duplicated in the laboratory facility.

Analysis:

The result of introducing the sand into the model is a photographic illustration, including depth measurements, of what the snow patterns would be. Areas that are scrubbed clean by whirling vortex winds can be seen as well as points of high accumulation.

Recommendations:

Mitigative devices are often simple adjustments or additions to the site plan to alter the wind patterns. Such alterations improve the comfort of the area and protect the structural integrity of the building.

Power of the Sun

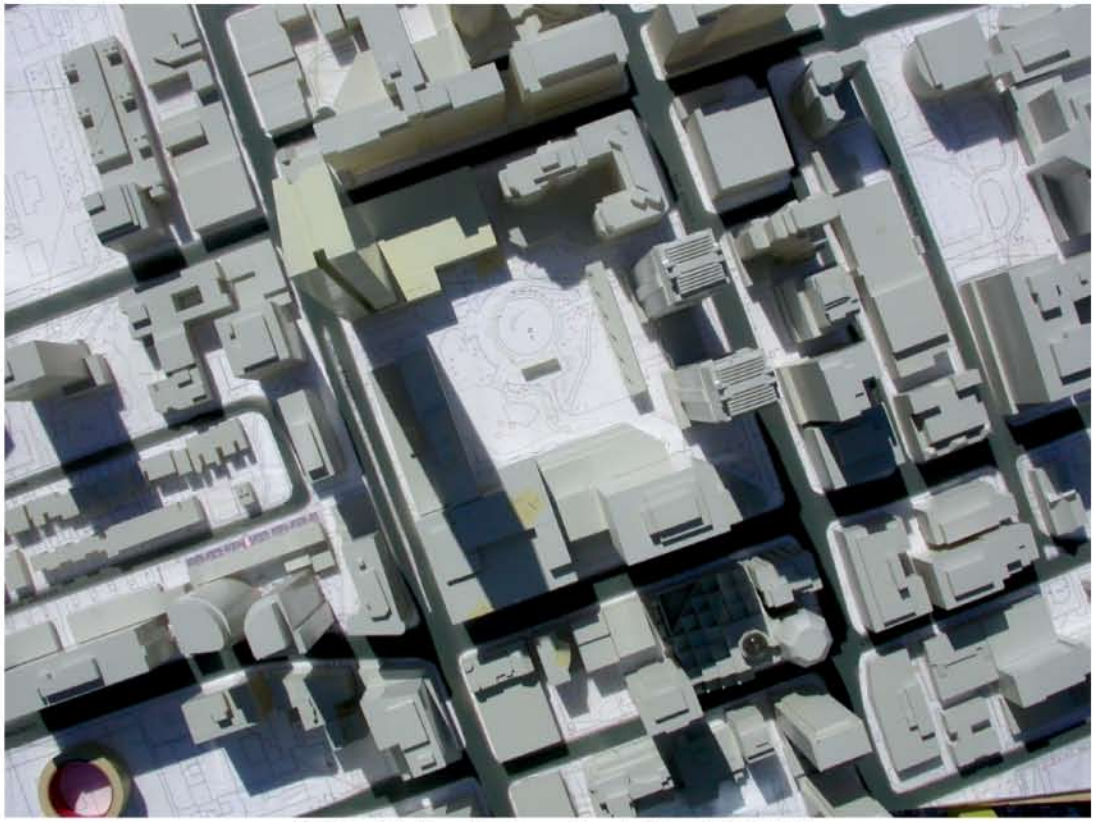
The maximization of sunlight is becoming an increasingly important environmental consideration in urban planning. The evaluation of shadows cast by tall buildings in urban areas is required in many municipalities and is often included in guidelines established by City Planning and Development Departments. Most urban developments have established minimum sun penetration criteria for sidewalks, parks, and recreation areas.

Testing:

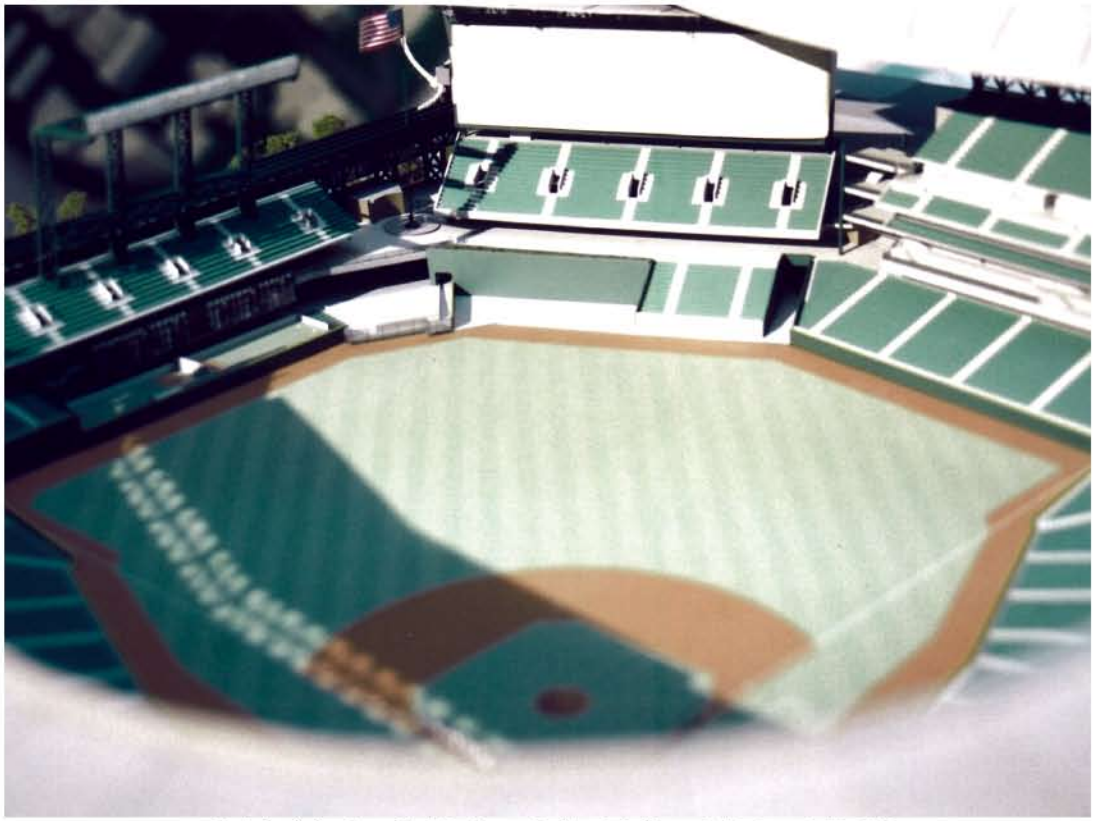
The laboratory at Theakston Environmental contains a specially designed Heliodon. A powerful parallel light source illuminates the model, creating shadows that are photographed for analysis. The Heliodon includes a 24-hour clock turntable so that the angle of the sun can be adjusted to simulate any geographic location, time of day, and season.

Sun/ Shade Studies

The model is photographed under lighted conditions and the photographic record indicates the time of day, day of the month, and month of the year for all hours of daylight. The photographs from a sun/shade study using the Heliodon provide an excellent indication of the location and duration of the shadows for the existing and proposed scenarios. Theakston Environmental also conducts computer generated analyses for the required sun/shade information when digital information for the site is available.



Model of College Park on March 21 at 12:18 PM



Model of the Seattle Mariners Safeco Field on July 1 at 6:00 PM

Force Balance Analysis

Wind Force on Buildings

Models constructed from high density ridged foam can be used to predict the dynamic response of structures to wind. Knowledge of modal forces acting upon tall buildings, irregularly shaped buildings, or buildings in close proximity, is useful when engineering building structural systems.

High Frequency Force Balance Analysis

Ultralight, ridged foam models mounted on a sensitive high-frequency balance and subject to an appropriately structured wind environment provide an excellent description of the full scale structure's modal forces acting on a building, as they are a function of the aerodynamic shape of the building.

Site Model:

High frequency force balance analysis requires construction of a detailed scale model of the proposed building and other significant structures within the vicinity. The principal building is mounted on the balance: a rigid frame with force links and miniature load cells capable of measuring six components.

Testing:

The model is tested in a wind tunnel under appropriate boundary layer conditions for the site. Force readings are taken with a high speed computerized data acquisition system for the approximate equivalent of one hour full scale. The system is capable of measuring six channels at high frequencies.

Analysis:

Force Balance data provides linear elastic responses for peak, mean, and rms for 36 wind directions. These are combined with the statistical wind climate for the area to provide predictions of wind induced loading and their effects. The results are based on estimates of dynamic properties provided and often presented as predictions of full scale responses to wind effects. These are wind induced base bending moments and torque, accelerations, deflections, effective loads, and joint loading of members. The results are used to design structural systems, removing the guess work from structural design.

Particulate Dispersion Modeling, Asphalt Plants, and Quarries

Annoying Blowing Dust

Particulate can be described as minute separate particles of any kind that have the tendency to move by wind forces. Particulate is carried by wind to areas beyond a project site and, as a rule, upsets the local environment. Particulate dispersion can be brought into compliance with regulatory bodies by proper control of emissions through mitigation.

Theakston has conducted studies for asphalt plants, quarries, open pit mining operations, landfill sites, and compost sites. The highly visible nature of the water flume has allowed Theakston to create tests for wind-borne particulate.

Testing and Analysis

Dye or silica sand is used to provide a highly visible indication of the route that dust or odour will travel. Photographic records of the dye and sand dispersal patterns are analysed along with wind velocity measurements to determine the route the emissions travel and their downwind effects.

Recommendations

Theakston Consultants will suggest how the surrounding area could be altered to reduce the impact of particulate emissions. Mitigative devices are designed, installed, and tested before being recommended for site installation.

THEAKSTON ENVIRONMENTAL

An International Reputation for Excellence

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