Detroit River
INTERNATIONAL CROSSING
STUDY

Air Dispersion Modelling

Air or atmospheric dispersion modelling is an essential step in the air quality assessment process as it is the only way to evaluate the impact of future changes in air pollutant emission sources. With respect to the Detroit River International Crossing (DRIC) study, these changes include implementation of alternatives, changes in fuels, vehicle technologies and traffic volumes.

How the Analysis was Done

Dispersion modelling is used to predict atmospheric concentrations of pollutants at specific locations. The process involves using a computer model to mimic the way pollutants are emitted from sources, and how the atmosphere disperses them. The model takes emissions from a source, estimates how high into the atmosphere they will go, how widely they will spread and how far they will travel based on hourly meteorological data. The model then outputs the concentrations that will occur at the selected receptors.

For the analysis of Practical Alternatives, an air dispersion model was set up for each of the alternative access roads, plazas, and crossings. The selected dispersion model was the CAL3QHCR model, which is specifically designed for roads and highways, and is approved for use in Ontario by the Ontario Ministry of the Environment (MOE). The model assesses emissions from moving vehicles differently from those that are queued and idling at intersections and inspection plazas. The model also differentiates between at-grade, depressed and elevated sources. In addition, the evaluation of the tunnel alternative (Alternative 3) requires assessment of tunnel ventilation buildings and emissions from the tunnel entrance and exit portals. This was done using the ISCST3 air dispersion model in combination with the CAL3QHCR model.

The approach, methods and computer models used to conduct the air dispersion modelling is documented in the *DRIC Air Quality Impact Assessment Work Plan*, which was reviewed by MOE, Health Canada, as well as other agencies and the public early in the project.

Model Inputs and Set-up

Air dispersion models typically require the following inputs: hourly meteorological data, receptors, source characteristics, and emission rates.

Meteorological Data

Air dispersion models use hourly meteorological data over a five year period to simulate all of the possible meteorological conditions that could be experienced in an area. The data typically includes mixing height, temperature, cloud cover, cloud opacity, wind speed and wind direction.

For the assessment of Practical Alternatives, one set of model runs was conducted using meteorological data from 2000 through 2004. The model results indicated that the meteorological data from 2003 resulted in the highest atmospheric concentrations for both contaminants to be evaluated (NO_x and $PM_{2.5}$). Thus, the analysis for all alternatives will be completed using 2003 meteorological data.

Receptors

A network of receptors covering the Area of Continued Analysis (ACA) as well as other areas in south and west Windsor, LaSalle and Tecumseh outside the ACA, was created. Sensitive receptors (schools, churches, parks, etc.) were specifically identified and included in the model runs.

Source Characteristics and Emissions

Each emission source included in an air dispersion model is described and input separately. Source characteristics required for input to the CAL3QHCR model include road segment identification with geographic coordinates, segment width, traffic volumes for free-flowing and idling traffic, and emission factors. Additional information on signal timing and intersection capacity is required for road segments where vehicles queue, such as intersections. The Universal Transverse Mercator (UTM) coordinates of all road segments and intersections were determined from digital AutoCAD maps in combination with Geographic Information Systems (GIS). Over 700 free-flowing roadway sources and almost 150 queue sources were included in each model run for the assessment of the access road alternatives.

Hourly traffic volumes were provided for the air dispersion modelling analysis by the study team. Hourly volumes of domestic and international cars and trucks on each roadway segment were used to estimate emissions of $PM_{2.5}$ and NO_x from each source. Separate weekday and weekend traffic patterns were used to represent actual expected traffic conditions. Idling traffic volumes and queue lengths were calculated by the CAL3QHCR air dispersion model based on the number of vehicles that approach an intersection, the signal timing and the capacity of each intersection. The approach volumes were conservatively assumed to be same as the free-flowing traffic volume.

Emission factors were developed separately for vehicle exhaust and surface roadway emissions (i.e. road dust) using Environment Canada's MOBILE 6.2C model and U.S. Environmental Protection Agency emission factor methodologies. Separate emission factors were developed for cars and trucks, and incorporate:

- regulatory changes in fuels and engine technologies
- differences in Canadian and U.S. fuels and vehicles
- Canadian and U.S. fleet turnover rates.

In regards to traffic movements, the following assumptions were made:

- Vehicles on the highway will be moving.
- Vehicles on service roads (and north of E.C. Row Expressway) will move, but will queue at signalized intersections.
- Inbound vehicles at the inspection plaza will queue at booths.
- Outbound vehicles at the inspection plaza will not queue.

The traffic conditions at the inspection plazas were modelled using the same queuing algorithm that was used for the intersections. The amount of queuing at the plazas was estimated using the hourly traffic volume and the number of inspection booths estimated to be open during each hour, in addition to the average duration of each vehicle at a booth. Cars and trucks were modelled separately. Design information regarding plaza operations and vehicle processing rates were provided by the study team.

Tunnel Ventilation Buildings

The tunnel ventilation buildings are not a roadway source, and thus require the use of a different model. The ISCST3 model, which is used for assessing the impact of stationary emission sources such as industrial stacks, was used to model the tunnel entrance/exit portals and ventilation buildings. The tunnel conceptual design is such that emissions should not escape from the portals (i.e. exhaust flow is always greater than supply flow, such that air is continually drawn into the tunnel through the ramps and portals). However, there is a "piston effect" as cars drive out of the tunnel, which will result in some emissions from these areas. A total of 5% of the emissions were assumed to escape from the tunnel at these locations. The hourly predicted concentrations from the vent buildings and portals were added to the hourly predicted concentrations from the roadway sources (i.e. from the CAL3QHCR model) to determine the total model predicted concentrations.

Remaining Activities

As discussed earlier, air dispersion models calculate air pollutant concentrations at the receptor locations specified. For this project, receptors along the roadway were identified, in addition to specific sensitive receptor locations. The maximum predicted concentrations for each alternative will be compared to predicted concentrations at the same locations without implementing the alternatives (i.e. the future do nothing case). In this manner, the benefits and potential impacts of each alternative will be assessed. The results will also be compared to federal and provincial air quality criteria and standards. In instances where exceedances occur, an analysis of the frequency of, and/or change in the frequency of, exceedance will be carried out.