Detroit River
INTERNATIONAL CROSSING
STUDY

Tunnelling Types

The Detroit River International Crossing (DRIC) study team is evaluating a tunnel as one of five practical alternatives for the access road from Highway 401 to E.C. Row Expressway. Plans, profiles and cross sections have been developed for this alternative and will be analyzed and compared with the other access road alternatives. All alternatives will be assessed according to the seven major evaluation factors for this project.

Findings to Date

An assessment made by the study team's geotechnical experts has determined that there is a high water table and generally poor soil conditions, especially at the north and west ends of the Area of Continued Analysis (ACA). It has also been found that there is the potential for encountering hydrogen sulfide gases.

How the Analysis was Done

Two basic types of tunnel construction have been considered, namely "cut and cover" and "bored".

Cut and Cover Tunnels

Cut and cover tunnels are constructed using conventional excavation techniques and can include the initial construction of the side walls to minimize the overall width of the excavation.

Although there is a high water table and generally poor soils, an assessment by the study team's geotechnical experts has concluded that cut and cover tunnelling is a feasible construction method. Several cut and cover methods of construction are likely to be employed at various locations along the alignment. These include:

1) *Conventional (2:1 slopes)*. This alternative requires extensive excavation and backfill, and is not generally being considered where it would result in severe property impacts. This alternative will be considered in areas where property is available.
2) *Caisson Wall, Cut and Cover-Bottom-up*. This alternative utilizes drilling (auger) rigs to install caissons, which will form part of the tunnel walls. This alternative is typically constructed by the 'Bottom-Up' Method and has reduced property requirements relative to the Conventional Method. Once the caissons are in place, the soil between the walls is excavated to a depth below the tunnel floor. The tunnel floor slab is poured, followed by the side walls of the tunnel, which are constructed from the 'bottom-up'. Once the tunnel walls have been completed, the roof of the tunnel is constructed, and the surface roadway on top of the tunnel is completed.
3) *Diaphragm Wall, Cover and Cut-Top-Down*. This method utilizes a trench cutter for installation of concrete walls using bentonite slurry to stabilize trench. This method can achieve higher production rates than caisson wall system, and also has reduced property requirements relative to the Conventional Method. Once the concrete walls of the tunnel have been built, the roof of the tunnel is constructed, and the surface roadway on top of the tunnel is completed. Excavation proceeds from the roof of the tunnel 'top-down' to below the tunnel floor. The tunnel floor slab is constructed last.

The cut and cover tunnel can be constructed in stages so that traffic can be maintained within the corridor throughout construction. Base stability conditions may require special construction techniques at deeper excavation depths, where the soils are poorest.

Bored Tunnels

Bored tunnels are constructed with the use of tunnel boring machines, which are pre-fabricated prior to actual construction. Open cut construction is required at each end of the tunnel (the portals) as well as at locations along the tunnel where access ramps are planned.

The largest boring machines currently being made in the world are slightly over 15 m (49 ft) in diameter. A 15 m (49 ft) diameter tunnel cannot accommodate the required cross-section of the access road. The proposed cross-section includes three 3.75 m (12 ft) wide lanes, plus inside and outside shoulder widths of 3.0 m (9.8 ft) each; based on Ontario highway design standards. Additional speed change lanes would be included near access ramps as required. To accommodate this cross-section, a tunnel boring machine exceeding 19 m (62 ft) in diameter would be required. This is notably larger than any that have been built in the world to date. The 19 m (62 ft) diameter tunnel boring machine would be required to construct the northbound lanes. A second 19m (62 ft) diameter boring machine could be used to construct the southbound lanes. Alternatively a single 19m (62 ft) diameter boring machine could be used to first bore the northbound lanes and after completion then bore the southbound lanes. This would greatly increase the length of time to construct.

Construction of two bored tunnels would result in a limited thickness of soil above the tunnels. Surface settlements are estimated to be between 100 mm to 200 mm (4 to 8 in).This would result in extensive damage to existing buildings along the corridor, the surface roadway and to all utilities.

Due to the inadequate size of a tunnel boring machine, as well as the risks associated with the generally poor soil conditions, the potential for settlements at the surface and the high groundwater table bored tunnels are not being considered further, especially when an alternative tunnelling method (cut and cover) is considered feasible.

Highway Safety

Studies show that overall, operating speeds are generally lower in the tunnel, since drivers typically react to the different driving environment (enclosed by concrete walls) by slowing down. While the potential consequences of catastrophic crashes within the contained area of a tunnel are greater than on an open road, these types of incidents are infrequent. The occurrence of general traffic crashes is similar for these two types of facilities. Collected evidence suggests that placing an urban freeway in a tunnel should result in a safety performance that is no worse than using a surface freeway. However, there is no reference data that can be used to determine if mainline merge, diverge, and/or weaving areas caused by on and off ramps in the tunnel significantly affect safety performance.

Ventilation

Mechanical ventilation of a long tunnel such as the one being considered is required to control air quality and visibility in the tunnel and at the portals.

A mechanical ventilation system consisting of air flow ducts in the tunnel and one or more ventilation buildings with fans to force air in/out of the tunnel would be required. These ventilation systems would also be designed to control the direction of air flow and smoke in the case of an emergency. It is estimated that the ventilation building(s) would be about 18 m (59 ft) high (i.e. 4-5 storeys) plus the height of the stack. The total height including the stack could be up to 45 m (147 ft). Preliminary locations for ventilation buildings have been developed and are indicated on the drawings on display at the Public Information Open Houses (PIOH).

Safety Features

Several safety features will have to be incorporated into the design of a tunnel. These include:

- ventilation systems and buildings
- illumination

- Closed Circuit Television (CCTV)
- Intelligent Transportation Systems (ITS)
- emergency access between tunnels
- emergency access and egress between the tunnel and the surface
- ice prevention at portals and ramps
- emergency telephone systems
- containment of spills
- flood prevention system
- smoke detector, carbon monoxide and dioxide monitoring system
- fire suppression systems
- emergency power supply
- storage for emergency supplies
- additional training for Emergency Services staff and education for motorists.

These features are being considered as part of the development of the tunnel alternative and the study team will have further discussion with Emergency Services providers in this regard.

Remaining Activities

The cut and cover tunnel alternative will be evaluated as one of the five practical alternatives. Shorter tunnel sections may be considered in combination with other concepts. Further cost estimating and analysis including development of ventilation systems and fire/life safety systems are required. Risk assessment studies are ongoing as the study team continues to assess issues related to tunnelling and the other access road options.