RESILIENT INFRASTRUCTURE
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INCORPORATION OF ROUNDABOUTS AT HOLT RD INTERCHANGE

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1. PROJECT OVERVIEW AND BACKGROUND

The planned refurbishment of the Darlington Nuclear Generating Station (DNGS) by the Ontario Power Generation (OPG), scheduled to commence in late-2016 and extend until 2026, will result in significant employment growth and increased traffic volumes that cannot be supported by the area's roadway network. In particular, the original Highway 401/Holt Road interchange, located approximately 40 km east of Toronto and serving as the primary access route for employee traffic into and out of the DNGS, was in need of significant upgrade and improvement in advance of commencing the refurbishment. The original interchange provided partial access to the highway only, while an intersection between an adjacent service road and the eastbound off-ramp was considered both unconventional and potentially hazardous to drivers unfamiliar with the unique configuration. Further, the original Holt Road underpass structure precluded the necessary capacity additions required along both the crossing road and Highway 401 through the interchange. Consequently, the Ontario Ministry of Transportation (MTO) hired AECOM to provide Preliminary and Detail Design services for upgrading of the Highway 401/Holt Road interchange to address both the existing concerns and meet the future requirements of the area. The recommended design included provision of roundabouts at both the north and south ramp terminals, and a third successive multi-lane roundabout at a service road directly south of the interchange. The provision of roundabouts at freeway ramp terminals, in place of traffic signals, represents the first time such a design has been used on an MTO facility.

2. PROJECT STUDY PROCESS AND EVALUATION

The Preliminary Design and Environmental Assessment component of the assignment included a detailed review of existing environmental and built features and constraints, confirmation of the need for improvements, and the assessment and evaluation of a range of interchange improvement alternatives to address the identified problems. Given the relatively high projected future traffic volumes at the interchange and the apparent availability of adjacent land to accommodate a larger interchange footprint, it had been thought prior to commencing the analysis that a standard Parclo A4-style configuration would likely be the preferred configuration for the modified interchange. Although a Parclo A4 configuration utilizes a larger overall footprint and is generally more costly than other configurations, it has historically been considered the preferred design in locations with high traffic volumes given the improved traffic operations and safety conditions. As the study progressed and additional site constraints were identified, a modified configuration involving roundabouts at both the north and south ramp terminals was developed, with a third successive multi-lane roundabout directly south of the interchange at the adjacent Energy Drive. By utilizing roundabouts at the three intersections in lieu of traffic signals, the overall footprint could be reduced as Energy Drive could be realigned closer to the south ramp terminal intersection than could be accomplished with signalized intersections at each location. This reduced footprint would enable the design to avoid encroachment into lands designated for a future Hydro One transformer station, as well as minimizing impacts to a woodlot and former landfill site in the southwest quadrant of the interchange.

A detailed traffic operational analysis was subsequently completed to confirm projected operations of vehicles through the closely spaced roundabouts. Utilizing a combination of both ARCADY (static analysis) and VISSIM (microsimulation analysis) software, the roundabout alternative was carefully analyzed to identify potential weaving concerns between the roundabouts, the impacts of heavy truck traffic and farm equipment through the roundabouts,

and the general ability of the roundabouts to handle the heavy traffic flows projected through the interchange during the short peak periods associated with employee shift changes at the DNGS. Despite the high peak period traffic volumes, the analysis identified relatively good overall operations at the interchange and through the three roundabouts, which were considered equivalent to or better than the Parclo A4 configuration operations. An overall assessment and evaluation of the various interchange alternatives was subsequently undertaken, which considered impacts to all aspects of the environment as well as transportation considerations and cost. Utilizing a reasoned argument method of evaluation, the roundabout alternative was identified as preferred or equally preferred in all categories relative to the conventional Parclo A4 configuration and was selected as the preferred configuration.

3. THE RECOMMENDED DESIGN, KEY BENEFITS AND DESIGN CHALLENGES

The recommended design for the Holt Road interchange, illustrated in Figure 1, is similar to a Parclo A / Diamond configuration with provision of roundabouts at both the north and south ramp terminals and a third successive multi-lane roundabout directly south of the interchange at Energy Drive. The most notable benefits of this configuration, relative to a standard Parclo A4 design with signals, include:

Traffic Operations and Safety

- Improved and continuous traffic flow through the interchange and reduction in potential vehicular conflict points relative to a signalized intersection, resulting in reduced number and severity of vehicular collisions;
- Avoidance of a southbound to westbound on-ramp in the northwest quadrant of the interchange. This type of ramp, which would have been required with a Parclo A4 configuration, would have resulted in potential weaving concerns along Highway 401 between the on-ramp and future ramp to the northbound East Durham Link (Highway 418) located 1.5 km to the west;

Reduced Overall Interchange Footprint

- Utilization of roundabouts in lieu of traffic signals allowed the alignment of the adjacent Energy Drive to be located closer to the south ramp terminal, avoiding impacts to lands designated for a major Hydro One transformer station;
- Impacts to agricultural lands north of Highway 401 are reduced.

Figure 1: Recommended Design

Lower Construction and Maintenance Cost

- Speed change lanes across Holt Road between the north and south ramp terminals are avoided, reducing the size and construction cost of the underpass structure;
- Two interchange ramps and associated speed change lanes along Highway 401 are avoided.
- Ongoing maintenance costs of three traffic signals along Holt Road and additional ramps are avoided.

One of the most notable challenges with the roundabout interchange included the design of adequate signage between and at the approaches to the roundabouts that would minimize driver confusion and improve traffic operations. Given the close spacing of the roundabouts, it was not possible to achieve standard spacing of advance signage between the roundabouts and a modified signage approach was required. A combination of standard ground mounted and overhead signs approaching and between the roundabouts was ultimately employed. The incorporation of adequate pedestrian and cyclist friendly crossing measures at the roundabouts was another key design consideration, and additional approach curvature and gaps in the splitter island were subsequently incorporated at the south approach to the Energy Drive roundabout. The development of a construction staging plan that would accommodate the access requirements of an operating nuclear power plant throughout the duration of the project with only minimal disruption represented another key challenge. Following preparation of the contract package in late 2013, construction of the new interchange commenced in May 2014. The new interchange including the three roundabouts was fully opened to traffic in January, 2016.