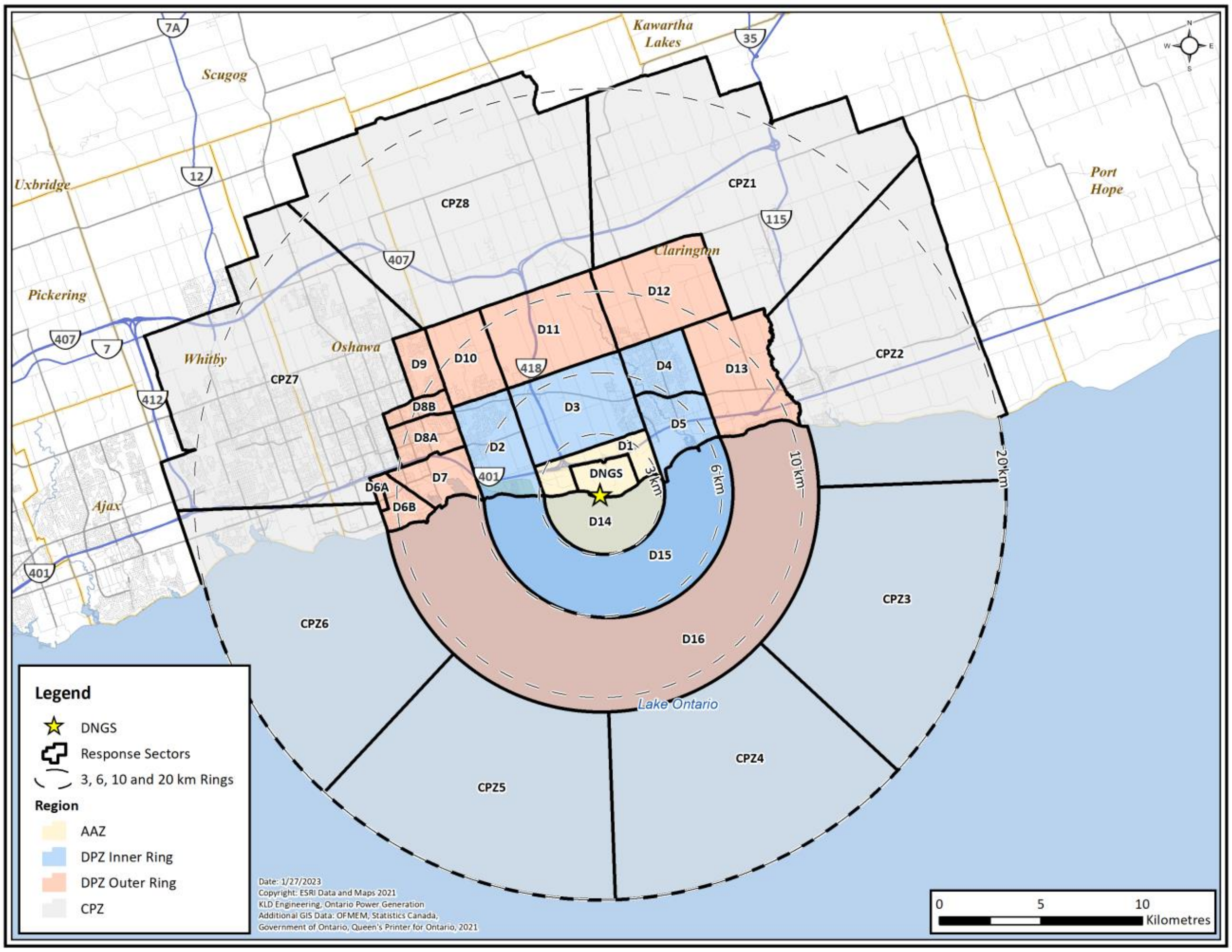
*Darlington Nuclear Generating Station*

*Development of Evacuation Time Estimates*

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**March 27, 2023** **Final Report, Rev. 0** **KLD TR – 1307**

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## EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Darlington Nuclear Generating Station (DNGS) located in the Municipality of Clarington in Durham Region, Ontario. This study provides Ontario Power Generation (OPG), the Province, and the Region with the estimated times to evacuate the Planning Zones (PZs) and various subsets of the PZs. Current Provincial Nuclear Emergency Response Plans indicate pre-planned protective actions are to be developed for the Detailed Planning Zone Outer Ring (DPZ – Outer Ring) and *contingency* planning and arrangements are to be made for the Contingency Planning Zone (CPZ). As such, this report focuses on the DPZ Outer Ring, but provides information, including data, analyses and results, for the CPZ for contingency planning purposes.

A traffic/evacuation simulation model (Dynamic Evacuation Simulation Model, or DYNEV-II) is used to compute ETE using the procedure shown in Figure ES-1. The supply input to DYNEV II is in the form of a link-node analysis network – a computerized replica of the roadway system within the study area (see Appendix K). The link-node analysis network is calibrated to include roadway characteristics such as free speed (speed that drivers are comfortable traveling at in the lack of traffic congestion), number of lanes, type of traffic control (signal, stop sign, manned), etc. that were collected during a field survey in 2022. Resident population from 2021 Statistics Canada data was extrapolated to 2023. Employee and transient data were obtained from Statistics Canada, 2021 labour force data and Commuting Flow Survey, Regional Municipality of Durham, OPG and supplemented by data from the previous ETE study and aerial imagery. The supply and demand are input to DYNEV-II. The two main outputs of the DYNEV-II model are ETE for general population (evacuees with personal vehicles) and route-specific evacuation speeds, which are used to compute the ETE for special facilities (schools, medical facilities, colleges/universities, summer day camps, etc.) and the transit-dependent population.

The general population ETE are presented in Table 7-1 and Table 7-2. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. For definitions of scenarios (demand changes due to temporal variations) and regions (area to be evacuated varies with wind direction and speed), see Section 6 and Appendix H, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the PZs (and from the Shadow Region (CPZ) for an evacuation of the Automatic Action Zone (AAZ), DPZ Inner Ring, and DPZ Outer Ring).

Critical findings of the study include:

- The majority of the ETEs computed for this study are longer than the ETEs computed in the previous study (KLD TR-1065, dated February 27,2019). The permanent resident population inside the PZs has increased by 9%. The external traffic that traverses the PZ increased by 114%[1]. Shadow evacuation participation has increased by an additional 10%[2]. An increase in evacuating traffic demand, without a comparable increase in roadway capacity, will increase ETE.
- General population ETE were computed for 700 unique cases – a combination of 50 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document the ETE for the 90$^{th}$ and 100$^{th}$ percentiles. These 90$^{th}$ percentile ETE range from 1:35 (hr:min) to 10:10.
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100$^{th}$ percentile are significantly longer than those for the 90$^{th}$ percentile, ranging from 4:15 to 7:35 for Regions R01 through R03 and 8:15 to 12:30 for Region R04. This is a result of the significant congestion within the PZ. See Sections 7.3 and 7.4.
- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation protective action strategy provides no benefit to evacuees from within the AAZ (3km) and adversely impacts many evacuees located beyond the AAZ. See Section 7.7 for additional discussion.
- Comparison of Scenarios 9 (winter, weekend, midday with good weather) and 13 (winter, weekend, midday with good weather) indicates that the special event - Apple Fest and Craft Sale in Bowmanville - has little impact on the ETE for the 90$^{th}$ percentile ETE (at most 15-minutes) but has an impact on the ETE for the 100$^{th}$ percentile (at most 35 minutes, R20). See Section 7.6 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that events such as adverse weather or traffic accidents which closes a lane on Hwy 401 westbound from the interchange with Hwy 418 to the interchange with Thickson Rd/Rt 26, has little impact on the 90$^{th}$ percentile ETE (at most 15-minutes) but has a significant impact on the ETE for the 100$^{th}$ percentile (up to 1 hour 15 minutes for Regions R03, R25, R26, R27). See Section 7.6 for additional discussion.
- The majority of the DPZ is congested during an evacuation of the DPZ Outer Ring. All congestion within the DPZ clears by 5 hours and 25 minutes after the Emergency Bulletin to evacuate for a winter, midweek, midday with good weather scenario (Scenario 6). All congestion within the study area (DPZ + CPZ) clears by 6 hours. See Section 7.3 and Figures 7-3 through 7-10 for additional discussion.
- Separate ETE were computed for schools, medical facilities, and transit-dependent persons. See Section 8 for additional discussion.

[1] The 114% increase in external traffic vehicles is due to the time to establish access control establish increasing from 2 hours to 4 hours and the Highway 407 being fully operational. Within that extra 2-hour window, the same number of external traffic vehicles traverse the study area compared to the first 2 hours. Thus, increasing the number of external traffic vehicles compared to the previous ETE report.
[2] The increase from 20% to 30% was based on discussions with the Ministry of Transportation of Ontario (MTO) and OPG.

- Section 8 indicates that based on discussions with local school bus providers, when evacuating schools, local school bus providers will make multiple trips to Temporary Holding Centres (THC), as needed for an evacuation of Region R03. Durham Region Transit (DRT) vehicles will be used to evacuate the transit dependent population. Several of the medical facilities have their own transportation resources or have agreements with DRT that will be used during an evacuation. In addition, some medical facilities may require transportation assistance or multiple bus trips to evacuate[3] all patients. See Table 8-1 for a summary of transportation resources required to evacuate the DPZ and CPZ.
- The general population ETE at the 100$^{th}$ percentile is not impacted in reductions or increases in the base trip generation time of 4 hours and 15 minutes (non-heavy snow conditions) since the 100$^{th}$ percentile ETE for Region R03 is dictated by the time to clear congestion within the DPZ and not the time for evacuees to mobilize. See Table M-1.
- The general population ETE for the DPZ is affected by the voluntary evacuation of vehicles in the Shadow Region (CPZ). See Table M-2.
- The general population ETE for the DPZ is affected by the number of external traffic vehicles that traverse the study area. The number of external vehicles is controlled by the time it takes to establish access control. See Section M.3.
- Projected ETE values for 2033 through 2088 per decade basis are provided as a sensitivity study in Appendix M. See Section M.4 for future results.

[3] Formal plans to assist with the evacuation of individuals in those settings are not currently available, but the Region is developing plans to find alternative solutions to address this issue.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, Detailed Planning Zone Outer Ring and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R02** | 3:35 | 3:55 | 3:25 | 3:45 | 3:00 | 3:35 | 3:55 | 4:20 | 3:25 | 3:40 | 4:15 | 3:00 | 3:30 | 3:35 |
| **R03** | 3:45 | 4:00 | 3:35 | 3:45 | 3:00 | 3:45 | 4:05 | 4:40 | 3:35 | 3:45 | 4:25 | 3:00 | 3:30 | 3:55 |
| **R04** | 7:40 | 8:35 | 7:10 | 7:50 | 6:50 | 8:00 | 8:40 | 10:10 | 7:05 | 7:45 | 9:00 | 6:45 | 7:05 | 7:45 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 3:45 | 4:10 | 3:40 | 4:00 | 3:20 | 3:45 | 4:10 | 4:50 | 3:40 | 3:55 | 4:30 | 3:15 | 3:40 | 3:55 |
| **R06** | 4:05 | 4:30 | 3:55 | 4:20 | 3:35 | 4:05 | 4:30 | 5:20 | 4:00 | 4:15 | 5:00 | 3:35 | 3:55 | 4:10 |
| **R07** | 4:10 | 4:30 | 3:55 | 4:15 | 3:40 | 4:15 | 4:30 | 5:15 | 3:55 | 4:15 | 4:50 | 3:30 | 4:00 | 4:10 |
| **R08** | 4:00 | 4:15 | 3:55 | 4:05 | 3:40 | 4:05 | 4:15 | 4:55 | 3:55 | 4:00 | 4:35 | 3:35 | 3:55 | 4:05 |
| **R09** | 3:50 | 3:55 | 3:45 | 3:55 | 3:35 | 3:50 | 4:00 | 4:30 | 3:45 | 3:50 | 4:20 | 3:30 | 3:45 | 3:50 |
| **R10** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R11** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R12** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R13** | 3:20 | 3:40 | 3:00 | 3:05 | 2:45 | 3:25 | 3:40 | 4:15 | 3:00 | 3:15 | 3:55 | 2:40 | 2:50 | 3:20 |
| **R14** | 3:20 | 3:40 | 3:00 | 3:05 | 2:45 | 3:25 | 3:40 | 4:15 | 3:00 | 3:15 | 3:55 | 2:40 | 2:50 | 3:20 |
| **R15** | 7:30 | 8:05 | 6:55 | 7:35 | 6:30 | 7:40 | 8:20 | 9:40 | 6:55 | 7:35 | 8:35 | 6:30 | 6:55 | 7:20 |
| **R16** | 7:20 | 8:00 | 6:50 | 7:30 | 6:25 | 7:35 | 8:15 | 9:35 | 6:50 | 7:25 | 8:25 | 6:25 | 6:45 | 7:15 |
| **R17** | 7:40 | 8:20 | 7:05 | 7:45 | 6:45 | 7:50 | 8:30 | 10:00 | 7:00 | 7:40 | 8:55 | 6:45 | 7:00 | 7:30 |
| **R18** | 7:35 | 8:15 | 7:05 | 7:40 | 6:40 | 7:50 | 8:20 | 9:55 | 6:55 | 7:30 | 8:45 | 6:35 | 7:00 | 7:25 |
| **R19** | 7:40 | 8:15 | 6:55 | 7:40 | 6:40 | 7:45 | 8:30 | 9:50 | 7:00 | 7:35 | 9:00 | 6:45 | 6:55 | 7:30 |
| **Evacuate Detailed Planning Zone Outer Ring and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R20** | 4:30 | 4:50 | 4:10 | 4:35 | 3:30 | 4:25 | 4:55 | 5:45 | 4:10 | 4:40 | 5:25 | 3:30 | 4:05 | 4:25 |
| **R21** | 4:45 | 5:10 | 4:25 | 4:55 | 3:40 | 4:50 | 5:20 | 6:10 | 4:20 | 4:40 | 5:40 | 3:35 | 4:25 | 4:50 |
| **R22** | 4:25 | 4:55 | 4:10 | 4:30 | 3:25 | 4:20 | 4:45 | 5:40 | 4:10 | 4:30 | 5:20 | 3:30 | 4:15 | 4:25 |
| **R23** | 4:25 | 4:55 | 4:10 | 4:30 | 3:25 | 4:20 | 4:45 | 5:40 | 4:10 | 4:30 | 5:20 | 3:30 | 4:15 | 4:25 |
| **R24** | 4:00 | 4:20 | 3:45 | 4:00 | 3:15 | 3:55 | 4:15 | 4:50 | 3:40 | 3:55 | 4:25 | 3:20 | 3:55 | 3:55 |
| **R25** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **R26** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |
| **R27** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |
| **R28** | 4:05 | 4:30 | 3:50 | 4:05 | 3:20 | 4:05 | 4:15 | 4:55 | 3:45 | 4:00 | 4:35 | 3:20 | 3:45 | 3:55 |
| **R29** | 4:05 | 4:30 | 3:50 | 4:05 | 3:20 | 4:05 | 4:15 | 4:55 | 3:45 | 4:00 | 4:35 | 3:20 | 3:45 | 3:55 |
| **R30** | 7:35 | 8:20 | 7:00 | 7:40 | 6:40 | 7:45 | 8:30 | 10:00 | 6:50 | 7:25 | 8:55 | 6:40 | 6:50 | 7:30 |
| **R31** | 7:35 | 8:20 | 7:00 | 7:40 | 6:40 | 7:45 | 8:30 | 10:00 | 6:50 | 7:25 | 8:55 | 6:40 | 6:50 | 7:30 |
| **R32** | 7:45 | 8:25 | 7:00 | 7:45 | 6:45 | 7:55 | 8:35 | 10:05 | 7:05 | 7:40 | 8:55 | 6:45 | 7:00 | 7:40 |
| **R33** | 7:30 | 8:15 | 6:55 | 7:35 | 6:40 | 7:45 | 8:25 | 9:50 | 7:00 | 7:35 | 8:50 | 6:45 | 6:55 | 7:30 |
| **R34** | 7:40 | 8:25 | 7:00 | 7:45 | 6:50 | 7:45 | 8:35 | 10:00 | 6:55 | 7:40 | 8:55 | 6:40 | 7:00 | 7:30 |
| **Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R35** | 4:00 | 4:10 | 3:55 | 4:15 | 3:40 | 4:00 | 4:15 | 5:00 | 3:50 | 4:20 | 4:50 | 3:35 | 3:55 | 4:05 |
| **R36** | 4:10 | 4:30 | 4:10 | 4:30 | 3:40 | 4:15 | 4:45 | 5:25 | 4:05 | 4:25 | 5:15 | 3:50 | 4:15 | 4:20 |
| **R37** | 4:10 | 4:35 | 4:05 | 4:20 | 3:50 | 4:15 | 4:40 | 5:30 | 4:05 | 4:15 | 5:10 | 3:50 | 4:05 | 4:10 |
| **R38** | 4:00 | 4:15 | 4:00 | 4:15 | 3:55 | 4:05 | 4:20 | 5:15 | 3:55 | 4:05 | 4:45 | 3:50 | 4:00 | 4:05 |
| **R39** | 3:50 | 3:55 | 3:45 | 3:55 | 3:35 | 3:55 | 4:05 | 4:30 | 3:45 | 3:55 | 4:20 | 3:35 | 3:50 | 3:55 |
| **R40** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R41** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R42** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R43** | 3:35 | 3:45 | 3:25 | 3:35 | 3:10 | 3:40 | 3:40 | 4:25 | 3:15 | 3:35 | 4:30 | 3:10 | 3:20 | 3:25 |
| **R44** | 3:35 | 3:45 | 3:25 | 3:35 | 3:10 | 3:40 | 3:40 | 4:25 | 3:15 | 3:35 | 4:30 | 3:10 | 3:20 | 3:25 |
| **R45** | 7:35 | 8:20 | 7:05 | 7:40 | 6:50 | 7:45 | 8:25 | 9:50 | 7:00 | 7:40 | 8:55 | 6:45 | 6:55 | 7:30 |
| **R46** | 7:25 | 8:10 | 7:00 | 7:35 | 6:45 | 7:35 | 8:20 | 9:40 | 6:50 | 7:30 | 8:45 | 6:40 | 6:50 | 7:20 |
| **R47** | 7:50 | 8:30 | 7:20 | 7:55 | 7:05 | 8:00 | 8:35 | 10:10 | 7:05 | 7:50 | 9:00 | 6:55 | 7:10 | 7:40 |
| **R48** | 7:35 | 8:25 | 7:10 | 7:50 | 7:00 | 8:00 | 8:30 | 9:55 | 7:10 | 7:40 | 9:05 | 6:55 | 7:05 | 7:35 |
| **R49** | 7:45 | 8:15 | 7:15 | 7:50 | 6:55 | 7:50 | 8:30 | 9:55 | 7:10 | 7:50 | 9:05 | 6:55 | 7:05 | 7:30 |
| **R50** | 7:45 | 8:45 | 7:25 | 7:55 | 7:00 | 8:00 | 8:50 | 10:10 | 7:10 | 7:50 | 9:20 | 7:00 | 7:15 | 8:00 |

**Table 7-2. Time to Clear the Indicated Area of 100 Percent of the Affected Population**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Inner Ring, Detailed Planning Zone and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 4:50 | 5:00 | 4:25 | 5:00 | 4:25 | 4:25 | 5:05 | 6:30 | 4:25 | 4:50 | 6:05 | 4:25 | 4:25 | 4:50 |
| **R03** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R04** | 9:30 | 10:40 | 8:50 | 9:40 | 8:25 | 10:10 | 10:30 | 12:30 | 8:40 | 9:25 | 11:00 | 8:15 | 8:40 | 9:35 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 5:05 | 5:20 | 4:50 | 5:30 | 4:30 | 5:20 | 5:35 | 6:40 | 4:55 | 4:55 | 6:05 | 4:30 | 4:55 | 5:10 |
| **R06** | 6:25 | 6:30 | 6:05 | 6:25 | 4:45 | 6:40 | 7:00 | 7:45 | 6:00 | 6:05 | 7:05 | 5:40 | 6:00 | 6:25 |
| **R07** | 6:25 | 6:30 | 5:40 | 5:40 | 4:45 | 6:35 | 6:35 | 7:45 | 5:45 | 6:00 | 6:55 | 5:35 | 6:00 | 6:25 |
| **R08** | 6:25 | 6:25 | 5:10 | 5:20 | 4:45 | 6:30 | 6:30 | 7:20 | 5:40 | 5:40 | 6:25 | 5:30 | 6:00 | 6:25 |
| **R09** | 4:35 | 4:55 | 4:35 | 4:35 | 4:30 | 4:55 | 5:05 | 5:55 | 4:35 | 4:35 | 5:15 | 4:30 | 4:35 | 4:55 |
| **R10** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R11** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R12** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R13** | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:25 | 4:30 | 4:30 | 5:10 | 4:30 | 4:30 | 4:30 |
| **R14** | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:25 | 4:30 | 4:30 | 5:10 | 4:30 | 4:30 | 4:30 |
| **R15** | 8:55 | 9:50 | 8:25 | 9:10 | 7:50 | 9:10 | 10:10 | 11:50 | 8:15 | 9:15 | 10:45 | 7:45 | 8:15 | 8:55 |
| **R16** | 8:55 | 9:50 | 8:25 | 9:10 | 7:50 | 9:10 | 10:10 | 11:50 | 8:15 | 9:15 | 10:45 | 7:45 | 8:15 | 8:55 |
| **R17** | 9:20 | 10:10 | 8:40 | 9:20 | 8:05 | 9:30 | 10:10 | 12:00 | 8:30 | 9:25 | 11:00 | 8:10 | 8:35 | 9:20 |
| **R18** | 9:10 | 9:55 | 8:25 | 9:20 | 8:05 | 9:30 | 10:10 | 12:00 | 8:30 | 9:10 | 10:30 | 8:00 | 8:35 | 9:10 |
| **R19** | 9:15 | 10:00 | 8:25 | 9:20 | 8:10 | 9:35 | 10:25 | 12:00 | 8:35 | 9:10 | 11:00 | 8:15 | 8:35 | 9:25 |
| **Evacuate Detailed Planning Zone Inner Ring and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R20** | 6:00 | 6:40 | 5:45 | 6:10 | 4:45 | 5:55 | 7:25 | 7:55 | 5:30 | 6:25 | 7:30 | 5:00 | 6:05 | 6:40 |
| **R21** | 6:55 | 7:40 | 6:35 | 7:25 | 6:00 | 7:05 | 7:55 | 8:25 | 6:50 | 6:55 | 8:05 | 5:45 | 6:50 | 6:55 |
| **R22** | 6:55 | 6:55 | 6:35 | 6:40 | 5:45 | 7:05 | 7:05 | 8:25 | 6:50 | 6:55 | 8:05 | 5:35 | 6:50 | 6:55 |
| **R23** | 6:55 | 6:55 | 6:35 | 6:40 | 5:45 | 7:05 | 7:05 | 8:25 | 6:50 | 6:55 | 8:05 | 5:35 | 6:50 | 6:55 |
| **R24** | 6:40 | 6:55 | 6:30 | 6:30 | 5:40 | 7:05 | 7:05 | 8:00 | 6:05 | 6:30 | 7:45 | 4:50 | 6:25 | 6:45 |
| **R25** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **R26** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R27** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R28** | 6:15 | 7:30 | 5:40 | 6:00 | 4:55 | 6:05 | 6:20 | 7:35 | 5:25 | 6:00 | 7:15 | 4:50 | 5:40 | 6:40 |
| **R29** | 6:15 | 7:30 | 5:40 | 6:00 | 4:55 | 6:05 | 6:20 | 7:35 | 5:25 | 6:00 | 7:15 | 4:50 | 5:40 | 6:40 |
| **R30** | 9:15 | 10:15 | 8:35 | 9:30 | 8:10 | 9:40 | 10:30 | 12:30 | 8:30 | 9:15 | 11:00 | 8:15 | 8:30 | 9:15 |
| **R31** | 9:15 | 10:15 | 8:35 | 9:30 | 8:10 | 9:40 | 10:30 | 12:30 | 8:30 | 9:15 | 11:00 | 8:15 | 8:30 | 9:15 |
| **R32** | 9:30 | 10:20 | 8:45 | 9:30 | 8:15 | 9:45 | 10:30 | 12:30 | 8:40 | 9:20 | 11:00 | 8:15 | 8:40 | 9:35 |
| **R33** | 9:20 | 10:15 | 8:35 | 9:25 | 8:15 | 9:35 | 10:30 | 12:15 | 8:20 | 9:20 | 11:00 | 8:10 | 8:40 | 9:25 |
| **R34** | 9:20 | 10:15 | 8:35 | 9:30 | 8:15 | 9:35 | 10:30 | 12:15 | 8:20 | 9:25 | 11:00 | 8:10 | 8:40 | 9:35 |
| **Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R35** | 5:10 | 5:20 | 5:00 | 6:00 | 4:45 | 5:20 | 5:35 | 6:40 | 5:00 | 6:25 | 6:25 | 5:05 | 5:00 | 5:10 |
| **R36** | 6:25 | 6:30 | 6:10 | 6:45 | 4:45 | 6:45 | 7:05 | 9:00 | 6:25 | 6:25 | 8:55 | 5:40 | 6:30 | 6:35 |
| **R37** | 6:25 | 6:30 | 6:00 | 6:25 | 4:45 | 6:35 | 6:35 | 8:00 | 5:45 | 6:00 | 6:55 | 5:40 | 6:00 | 6:25 |
| **R38** | 6:25 | 6:25 | 5:10 | 5:50 | 4:45 | 6:30 | 6:30 | 8:00 | 5:45 | 5:55 | 6:25 | 5:40 | 6:00 | 6:25 |
| **R39** | 4:35 | 4:55 | 4:35 | 4:35 | 4:30 | 5:05 | 5:05 | 6:05 | 4:35 | 4:35 | 5:15 | 4:30 | 4:35 | 5:20 |
| **R40** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R41** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R42** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R43** | 4:35 | 4:35 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:35 | 4:30 | 4:30 | 5:30 | 4:30 | 4:30 | 4:35 |
| **R44** | 4:35 | 4:35 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:35 | 4:30 | 4:30 | 5:30 | 4:30 | 4:30 | 4:35 |
| **R45** | 9:25 | 10:00 | 8:25 | 9:25 | 8:20 | 9:10 | 10:15 | 12:10 | 8:35 | 9:15 | 11:05 | 8:10 | 8:35 | 9:25 |
| **R46** | 9:25 | 10:00 | 8:25 | 9:25 | 8:20 | 9:10 | 10:15 | 12:10 | 8:35 | 9:15 | 11:05 | 8:10 | 8:35 | 9:25 |
| **R47** | 9:30 | 10:10 | 8:50 | 9:40 | 8:20 | 9:45 | 10:25 | 12:25 | 8:40 | 9:25 | 11:05 | 8:25 | 8:40 | 9:30 |
| **R48** | 9:10 | 10:00 | 8:40 | 9:30 | 8:15 | 9:45 | 10:20 | 12:15 | 8:35 | 9:20 | 11:00 | 8:20 | 8:35 | 9:15 |
| **R49** | 9:25 | 10:00 | 8:50 | 9:30 | 8:15 | 9:50 | 10:25 | 12:15 | 8:35 | 9:35 | 11:00 | 8:25 | 8:40 | 9:25 |
| **R50** | 9:35 | 10:50 | 9:05 | 9:40 | 8:25 | 10:10 | 11:00 | 12:30 | 8:45 | 9:40 | 11:35 | 8:35 | 8:55 | 9:35 |

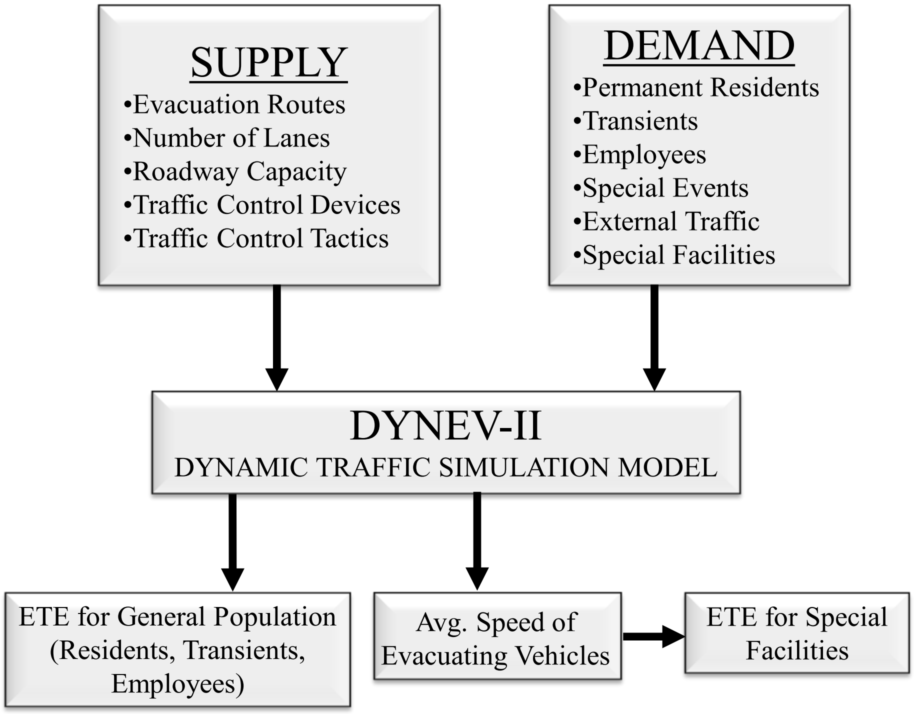


**Figure ES-1. ETE Methodology**

# 1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Darlington Nuclear Generating Station (DNGS), located in the Municipality of Clarington in Durham Region, Ontario. This ETE study provides Ontario Power Generation (OPG) provincial, regional and municipal governments with site-specific information needed for protective action decision-making.

In the performance of this effort, guidance is provided by documents published by national and international federal governmental agencies. Most important of these are:

- Emergency Management and Fire Protection, Nuclear Emergency Preparedness and Response REGDOC-2.10.1, Version 2 February 2016.
- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, Rev. 1, February 2021.
- Title 10, Code of Federal Regulations, Appendix E to Part 50 (10CFR50), Emergency Planning and Preparedness for Production and Utilization Facilities, NRC, 2011.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/Radiological Emergency Preparedness Program Manual, FEMA P-1028, December 2019.
- Provincial Nuclear Emergency Response Plan (PNERP) Implementing Plan for the Darlington Nuclear Generating Station (DNGS), January 2019.

The work effort reported herein was supported and guided by OPG and other major stakeholders who contributed suggestions, critiques, and the local knowledge base required. Table 1-1 presents a summary of stakeholders and interactions. The ETE computed, for this study, is in compliance with NUREG/CR-7002, Rev. 1, February 2021, as shown in the checklist located in Appendix N. .

## 1.1 Overview of the ETE Process

The following outline presents a brief description of the work effort in chronological sequence:

1. Information Gathering:
    a. Defined the scope of work in discussions with representatives from OPG.
    b. Attended a project kick-off meeting with personnel from OPG, provincial, regional and municipal emergency management offices to discuss methodology, project assumptions and to identify issues to be addressed and resources available.
    c. Conducted a detailed field survey of the highway system and of the area traffic conditions within the Planning Zone (PZ)[1] in April 2022.

[1] The Planning Zone represents entire study area which includes the Automatic Action Zone, Detailed Planning Zone (Inner and Outer Rings) and the Contingency Planning Zone.

d. Reviewed the OPG and existing provincial and regional Emergency Operations Plans.
e. Conducted an online demographic survey of PZ residents (See Appendix F).
f. Obtained demographic data from the 2021 Statistics Canada Census. Projected the 2021 Statistics Canada Census data to the base year 2023 (see Section 3.1).
g. Conducted a data collection effort to create the database of special facilities (i.e., schools, summer day camps, colleges/universities, and medical facilities), major employers, transportation providers/resources available, the special event, and other important information.

2. Estimated distributions of trip generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the online demographic survey.

3. Defined Evacuation Scenarios (see Section 6). These scenarios reflect the variation in demand, in trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Reviewed the existing traffic management plan to be implemented by the Durham Region Police in the event of an incident at the plant. All Evacuation Traffic Points (TCPs) listed at stop and yield signs inside the Nuclear Emergency Annex B1 Traffic Control/Sector Book Darlington Guide for Durham Region were not modelled as TCPs based on discussions with emergency management personnel from Durham Region. See Section 9 and Appendix G.

5. According to the 2019 Provincial Nuclear Emergency Response Plan (PNERP) Implementing Plan for the DNGS guidance defined in Section 2.5, Figure 2.2 and Figure 2.3, the DPZ is subdivided into 19 Response Sectors and the CPZ is subdivided into 8 Response Sectors along major roadways and physical landmarks such as streams and Lake Ontario, which were used to define Evacuation Regions. “Regions” are groups of contiguous Response Sectors for which ETE are calculated. The configurations of these Regions reflect wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a “key-hole section” within the PZs as recommended by NUREG/CR-7002, Rev. 1.

6. Estimated demand for transit services for persons at schools, summer day cares, colleges/universities, medical facilities and for transit-dependent persons at home.

7. Prepared the input streams for DYNEV II which computes ETE (see Appendices B and C).
   a. Estimated the evacuation traffic demand, based on the available information derived from Statistics Canada, data provided by OPG, Durham Region, and from the demographic survey.

b. Applied the procedures specified in the 2022 Highway Capacity Manual (HCM 2022[2]) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes[3].
c. Updated the link-node representation of the evacuation network using the field survey and aerial imagery, which is used as the basis for the computer analysis that calculates the ETE.
d. Calculated the evacuating traffic demand for each Region and for each Scenario.
e. Specified selected candidate destinations for each "origin" (location of each "source" where evacuation trips are generated over the mobilization time) to support evacuation travel consistent with outbound movement relative to the location of the plant.

8. Executed the DYNEV II model to determine optimal evacuation routing and compute ETE for all residents, transients and employees ("general population") with access to private vehicles. Generated a complete set of ETE for all specified Regions and Scenarios.
9. Documented ETE in formats in accordance with NUREG/CR-7002, Rev.1.
10. Calculated the ETE for all transit activities including those for special facilities (schools, summer day camps, colleges/universities, and medical facilities) and for the transit-dependent population (which includes commuter college students without vehicles).

While data was gathered, analyses were conducted, and results were obtained for both the DPZ and CPZ, this report primarily focuses on the DPZ since pre-planned protective actions are implemented in the DPZ and contingency planning and arrangements are made for the CPZ according to the PNERP Implementing Plan for the DNGS.

## 1.2 The Darlington Nuclear Generating Station Location

The DNGS is located along the northern shore of Lake Ontario in the Municipality of Clarington, Durham Region, Ontario. The site is approximately 70 kilometres east of Toronto, Ontario. Figure 1-1 shows the location of DNGS relative to Toronto, as well as the communities and roadways in the area.

## 1.3 Preliminary Activities

These activities are described below.

<u>Field Surveys of the Highway Network</u>

In April 2022, KLD personnel drove the entire highway system within the DPZ and CPZ, which consists of the area between the DPZ Outer Ring boundary and approximately 20 kilometres radially from the plant. The characteristics of each section of highway were recorded. These characteristics are shown in Table 1-2.

[2] Highway Capacity Manual (HCM 2022), Transportation Research Board, National Research Council, 2022.
[3] The 2008 Canadian Capacity Guide was reviewed and considered for the estimation of capacity where applicable. However, the estimates for capacity in this study are based on the HCM 2022 as it is more up to date.

Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 15-7 in the HCM 2022 indicates that a reduction in lane width from 12 feet (3.66 metres) (the "base" value) to 10 feet (3.05 metres) can reduce free flow speed (FFS) by 1.1 mph (1.77 kph) – not a material difference – for two-lane highways. Exhibit 15-46 in the HCM 2022 shows little sensitivity for the estimates of Service Volumes (SV) at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographic information systems (GIS) shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the DYNEV II System. Roadway types were assigned based on the following criteria:

- Freeway: limited access highway, 2 or more lanes in each direction, high free flow speeds
- Freeway Ramp: ramp on to or off of a limited access highway
- Major Arterial: 3 or more lanes in each direction
- Minor Arterial: 2 lanes in each direction
- Collector: single lane in each direction
- Local Roadway: single lane in each direction, local road with low free flow speeds

As documented on page 15-6 of the HCM 2022, the capacity of a two-lane highway is 1,700 passenger cars per hour in one direction. For freeway sections, a value of 2,250 vehicles per hour per lane is assigned, as per Exhibit 12-37 of the HCM 2022. The road survey has identified several segments which are characterized by adverse geometrics on two-lane highways which are reflected in reduced values for both capacity and speed. These estimates are consistent with the service volumes for LOS E presented in HCM 2022 Exhibit 15-46. Link capacity is an input to DYNEV II which computes the ETE. Further discussion of roadway capacity is provided in Section 4 of this report.

Traffic signals are either pre-timed (signal timings are fixed over time and do not change with the traffic volume on competing approaches) or are actuated (signal timings vary over time based on the changing traffic volumes on competing approaches). Actuated signals require detectors to provide the traffic data used by the signal controller to adjust the signal timings. These detectors are typically magnetic loops in the roadway, or video cameras mounted on the signal masts and pointed toward the intersection approaches. If detectors were observed on the approaches to a signalized intersection during the road survey, detailed signal timings were not collected as the timings vary with traffic volume. TCPs at locations which have control devices are represented as actuated signals in the DYNEV II system.

If no detectors were observed, the signal control at the intersection was considered pre-timed and detailed signal timings were gathered for several signal cycles. These signal timings were input to the DYNEV II system used to compute ETE, as per NUREG/CR-7002, Rev. 1 guidance.

Figure 1-2 presents the link-node analysis network that was constructed to model the evacuation roadway network in the PZ. The directional arrows on the links and the node numbers have been removed from Figure 1-2 to clarify the figure. The detailed figures provided in Appendix K depict the analysis network with directional arrows shown and node numbers provided. The observations made during the field survey and aerial imagery was used to calibrate the analysis network.

The link-node analysis network that was used for the previous study was updated to include newly constructed and on-going roadway improvements based on data collected during the road survey. There have been several major roadway changes within the study area, including the construction of the following:

- The extension of Hwy 407 (2 lanes eastbound and 2 lanes westbound) from Rundle Road to the interchange with Rt 115/35.
- The construction of Hwy 418 (2 lanes northbound and 2 lanes southbound) between Hwy 401 to Hwy 407 at Rundle Road.

In addition, the link-node analysis network was expanded to include additional roadways and intersections as needed for an accurate representation of the roadway system. Aerial imagery, the roadway survey and roadway design plans (to the extent available) were used to update the network.

<u>Demographic Survey</u>

An online sample demographic survey was performed to gather information needed for the ETE study. Appendix F presents the survey instrument, the procedures used, and tabulations of data compiled from the survey responses.

The demographic survey results were utilized to develop estimates of vehicle occupancy to estimate the number of evacuating vehicles during an evacuation and to estimate elements of the mobilization process. This database was also referenced to estimate the number of transit-dependent residents.

<u>Computing the Evacuation Time Estimates</u>

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analysed and converted into vehicle demand data. The vehicle demand was loaded onto appropriate “source” links of the analysis network using GIS mapping software. The DYNEV II system was then used to compute ETE for all Regions and Scenarios.

<u>Analytical Tools</u>

The DYNEV II System that was employed for this study is comprised of several integrated computer models. One of these is the DYNEV (<u>DY</u>namic <u>N</u>etwork <u>EV</u>acuation) macroscopic simulation model, a new version of the IDYNEV model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

DYNEV II consists of four sub-models:

- A macroscopic traffic simulation model (for details, see Appendix C).
- A Trip Distribution (TD), model that assigns a set of candidate destination (D) nodes for each "origin" (O) located within the analysis network, where evacuation trips are "generated" over time. This establishes a set of O-D tables.
- A Dynamic Traffic Assignment (DTA), model which assigns trips to paths of travel (routes) which satisfy the O-D tables, over time. The TD and DTA models are integrated to form the DTRAD (Dynamic Traffic Assignment and Distribution) model, as described in Appendix B.
- A Myopic Traffic Diversion model which diverts traffic to avoid intense, local congestion, if possible.

Another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System), was used to expedite data entry and to automate the production of output tables.

The dynamics of traffic flow over the network are graphically animated using the software product, EVAN (EVacuation ANimator), developed by KLD. EVAN is GIS based, and displays statistics, output by the DYNEV II System, such as LOS, vehicles discharged, average speed, and percent of vehicles evacuated. The use of a GIS framework enables the user to zoom in on areas of congestion and query road name, town name and other geographical information.

The procedure for applying the DYNEV II System within the framework of developing ETE is outlined in Appendix D. Appendix A is a glossary of terms.

For the reader interested in an evaluation of the original model, I-DYNEV, the following references are suggested:

- NUREG/CR-4873 – Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code
- NUREG/CR-4874 – The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths of travel that will expedite their travel from their respective points of origin to points outside the DPZ and/or CPZ.
- Restrict movement toward the plant to the extent practicable and disperse traffic demand so as to avoid focusing demand on a limited number of highways.
- Move traffic in directions that are generally outbound, relative to the location of the plant.

DYNEV II provides a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to represent the behavioural responses of evacuees. The effects of these countermeasures may then be tested with the model.

## 1.4 Comparison with Prior ETE Study

The 90th percentile ETE increased by as much as 1 hour and 10 minutes for the DPZ (Region R03) and 1 hour and 35 minutes for all PZs (Region R04) when compared with the previous study. The 100th percentile ETE for the majority of ETEs increased significantly by at most 2 hours and 10 minutes for Region R03 and 1 hour and 5 minutes for Region R04.

Table 1-3 presents a comparison of the present ETE study with the 2019 ETE study (KLD TR-1065, dated February 27, 2019). The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study are:

- The permanent resident population was calculated using the 2021 Statistics Data projected to 2023, versus the 2016 Census data projected to 2018 in the previous study[4]. The DPZ population grew by approximately 7%, the CPZ population grew by 10%, and the full PZ population grew by approximately 9% resulting in additional evacuating vehicles, which can increase ETE.
- Note that in the previous study, major employers were considered those with 50 or more total employees, while this study considered employers with 200 or more employees working in a single shift as major employers, as per the NUREG/CR-7002, Rev. 1 guidance. As such, the number of fast mobilizing employees commuting into the PZ decreased by approximately 10%. In general, decreases in this quick mobilizing population group can cause the 90th percentile ETE to increase as it will take a longer time to reach an evacuation of 90% of all vehicles. A decrease in the number of employee vehicles could decrease the 100th percentile ETE, as there is fewer overall population demand within the PZ, increasing the available roadway capacity for evacuees[5].
- The transient population increased by 34% within the PZ. An increase in this quickly mobilizing population group can cause the 90th percentile ETE to decrease as it will take lesser time to reach an evacuation of 90% of all vehicles. An increase in the number of transient vehicles could increase the 100th percentile ETE, as there is additional population demand overall within the PZ, reducing roadway capacity for evacuees[5].
- The shadow and voluntary evacuation percentage increased from 20% to 30%, as per discussions with the Ministry of Transportation of Ontario (MTO) and OPG. The increase in the shadow evacuation percentage increases the evacuating traffic outside of the area being evacuated, thereby reducing the available capacity for evacuees and increasing the ETE.
- The time needed to establish access control points at the perimeter of the response sectors doubled, as per discussions with MTO. External traffic vehicles can enter the PZs for 4 hours compared to 2 hours in the previous ETE study. In addition, the completion of Hwy 407 eastbound to Hwy 115/35 introduced additional external traffic vehicles. Therefore, the external traffic along Hwy 401, Hwy 407 and Rt 115/35 increased by

[4] The previous study was completed in 2019, but the permanent resident population was extrapolated to year 2018.
[5] This is valid assuming the roadway capacity remains the same and other factors remain constant.

114%. An increase in external traffic reduces the available capacity for evacuees and increase ETE.

- Trip mobilization (also known as trip generation), based on the data collected from the demographic survey and the "Time Distribution for Population to Prepare to Evacuate", from the demographic survey, for the following population groups have changed:
  - The employees and transients decreased by 45 minutes.
  - The permanent residents with commuters decreased by 1 hour during non-heavy snow conditions and 30 minutes during heavy snow conditions.
  - The permanent residents without commuters decreased by 30 minutes during non-heavy snow and heavy snow conditions.
  - Decreases in mobilization can increase ETE in the 90th percentile and potentially decrease the ETE in the 100th percentile.
- Significant roadway improvements were completed since the previous study, which includes the extension of Hwy 407 (eastbound/westbound) to Rt 115/35 and Hwy 418 extension southbound to Hwy 401which increases roadway capacity and alternate routes to evacuates in the area, thereby, may reduce the ETEs[6].

The majority of the factors, discussed above, that can increase ETE outweigh those that can decrease the ETE, thereby explaining why the 90th percentile ETE has significantly increased while the 100th percentile ETE has increased and in some cases decreased in this study relative to the previous ETE study (KLD TR-1065).

[6] This is valid assuming that other contributing factors remain constant.

**Table 1-1. Stakeholder Interaction**

| Stakeholder | Nature of Stakeholder Interaction |
|---|---|
| Ontario Power Generation (OPG) | Attended kick-off meeting to define project methodology and data requirements. Set up contacts with provincial, regional, and municipal government agencies.<br>Provided existing emergency plans, employment data for DNGS and confirmed and/or updated special facility data. Reviewed and approved all project assumptions and draft report.<br>Attended final meeting where the ETE study results were presented. |
| Government of Ontario Emergency Management | Attended Kick-off meeting to discuss the project methodology, key project assumptions and to define data needs.<br>Provided special facility data, emergency plans, and traffic control plans. Reviewed and provided comments on all project assumptions. Engaged in the ETE development and informed of the study results.<br>Attended final meeting where the ETE study results were presented[7]. |
| Durham Region | |
| Durham Emergency Management Office (DEMO) | |
| Ministry of Transportation of Ontario (MTO) | |
| Ontario Provincial Police | |
| Darlington Regional Police | |

**Table 1-2. Highway Characteristics**

- Number of lanes
- Lane width
- Shoulder type & width
- Interchange geometries
- Lane channelization & queuing capacity (including turn bays/lanes)
- Geometrics: curves, grades (>4%)
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Intersection configuration (including roundabouts where applicable)
- Traffic signal type
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, toll booths, etc.

[7] This is true for all agencies except for the Government of Ontario Emergency Management Agency, presentation materials and meeting notes were provided.

**Table 1-3. ETE Study Comparisons**

| Topic | Previous ETE Study | Current ETE Study |
|---|---|---|
| **Resident Population Basis** | 2016 Statistics Canada data projected to 2018; area ratio method used:<br>DPZ Population = 130,781<br>CPZ Population = 244,812<br>PZ Total Population = 375,593 | 2021 Statistics Canada data projected to 2023; area ratio method used:<br>DPZ Population = 140,117<br>DPZ Resident Vehicles = 65,056<br>CPZ Population = 270,207<br>CPZ Resident Vehicles = 125,476<br>PZ Total Population = 410,324<br>PZ Resident vehicles = 190,532 |
| **Resident Population Vehicle Occupancy** | Based on 2016 Census Data, 2015 and 2018 telephone surveys.<br>Within DNGS only: 2.70 persons/household, 1.24 evacuating vehicles/household yielding: 2.18 persons/vehicle.<br>Within overlap of DNGS and Pickering Nuclear Generating Station (PNGS): 2.8 persons/household, 1.24 evacuating vehicles/household yielding: 2.26 persons/vehicle. | Based on 2021 Census Data projected to 2023 and the 2022 demographic surveys.<br>2.95 persons/household, 1.37 evacuating vehicles/household yielding: 2.15 persons/vehicle. |
| **Employee Population** | Employee estimates based on data provided in 2015, and 2016 Commuting Flow census. Based on the telephone survey, employee vehicle occupancy is 1.09 employees per vehicle.<br>DPZ Employees = 12,732<br>CPZ Employees = 21,944<br>PZ Total Employees = 34,676 | Employee estimates based on data received from OPG, Statistics Canada, and 2021 labour force data and Commuting Flow survey. Based on the demographic survey, employee vehicle occupancy is 1.15 employees per vehicle. Note: For Durham Region which encompasses the entire PZ, employee occupancy rate of one (1) employee per vehicle are used.<br>DPZ Employees = 12,943<br>DPZ Employee Vehicles= 12,943<br>CPZ Employees = 18,347<br>CPZ Employee Vehicles= 18,347<br>PZ Total Employees = 31,290<br>PZ Total Employee Vehicles= 31,290 |

| Topic | Previous ETE Study | Current ETE Study |
|---|---|---|
| **Transit-Dependent Population** | Estimates based upon 2016 Statistics Canada data projected to 2018 and the results of the 2018 telephone survey.<br>The total of people who do not have access to a vehicle:<br>DPZ = 858 people in 74 buses to evacuate.<br>CPZ = 1,607 in 58 buses to evacuate.<br>PZ Total = 2,465 in 132 buses to evacuate. | Estimates based upon 2021 Statistics Canada data projected to 2023 and the results of the 2022 demographic survey.<br>The total number of people who do not have access to a vehicle:<br>DPZ = 1,474 people in 55 buses to evacuate.<br>CPZ = 2,842 in 97 buses to evacuate.<br>PZ Total = 4,316 in 152 buses to evacuate. |
| **Transient Population** | Data collected from 2015 ETE study, aerial imagery and internet searches:<br>Transients in DPZ = 6,816<br>Transients in CPZ = 16,975<br>Total Transients in PZ = 23,791 | Data collected for the 2019 ETE study data (reviewed and confirmed by OPG and the OROs), aerial imagery and internet searches:<br>Transients in DPZ = 6,471<br>Transient vehicles in DPZ = 2,220<br>Transients in CPZ = 25,371<br>Transient vehicles in CPZ = 9,624<br>Total Transients in PZ = 31,842<br>Total Transient vehicles in PZ = 11,844 |
| **Medical Facilities** | Special facility population based on the 2015 study and provided by OPG.<br>Current DPZ census = 778 (Buses Required = 27, Wheelchair Bus Required = 9, Ambulances Required = 15)<br>Current CPZ census = 3,703 (Buses Required = 83, Wheelchair Bus Required = 119, Ambulances Required = 350)<br>Current total census = 4,481 (Buses Required = 110, Wheelchair Bus Required = 128, Ambulances Required = 365) | Special facility population estimates based on the 2019 ETE study data (reviewed and confirmed by OROs and OPG).<br>Current DPZ census = 699 (Buses Required = 24, Wheelchair Vans Required = 21, Ambulances Required = 15)<br>Current CPZ census = 3,645 (Buses Required = 82, Wheelchair Vans Required = 333, Ambulances Required = 343)<br>Current total census = 4,344 (Buses Required = 106, Wheelchair Vans Required = 354, Ambulances Required = 358) |

| Topic | Previous ETE Study | Current ETE Study |
|---|---|---|
| **School, Summer Day Camps & College/University Population** | School population based on information provided by local school boards in 2015 and internet searches.<br>School/Day Camps Enrolment in DPZ = 22,021; College Enrolment in DPZ = 0;<br>School/Day Camps Enrolment in CPZ = 39,918; College Enrolment in CPZ = 20,983;<br>School/Day Camps Enrolment in PZ = 61,389; College Enrolment in PZ = 20,983; | School population based on the 2019 ETE study data (reviewed and confirmed by OPG), supplemented by internet searches and aerial imagery for parking spaces where data is missing.<br>School/Summer Day Camps Enrolment in DPZ = 22,021; College/University Enrolment in DPZ = 0;<br>School/Summer Day Camps Enrolment in CPZ = 39,867; College/University Enrolment in CPZ = 22,070<br>School/Summer Day Camps Enrolment in PZ = 61,888; College/University Enrolment in PZ = 20,070; |
| **Voluntary evacuation from within PZ in areas outside region to be evacuated** | 20% of the population within the PZ, but not within the Evacuation Region (see Figure 2-1) | 30% of the population within the PZ, but not within the Evacuation Region (see Figure 2-1) |
| **Shadow Evacuation & Population** | 20% of people outside of the PZ within the Shadow Region (5 kilometres radially from the DPZ boundary) – only considered for the AAZ, middle ring, and DPZ analyses (see Figure 7-2) | 30% of people between DPZ boundary Outer Ring to the CPZ boundary (20 km radially from the plant) – only considered for the AAZ, DPZ Inner Ring, and DPZ Outer Ring analyses (see Figure 7-2). |
| **Network Size** | 2,880 links; 1,992 nodes | 3,705 links; 2512 nodes |
| **External Through Traffic** | External-to-External traffic considered on Hwy 401, Hwy 401 and Rt 155/35. Diversion access control points will be established at 120 minutes after the Emergency Bulletin to divert this traffic.<br>Total External Traffic = 19,570 vehicles | External-to-External traffic considered on Hwy 401, Hwy 401 and Rt 155/35. Diversion access control points will be established at 240 minutes after the Emergency Bulletin to divert this traffic, as per MTO.<br>Total External Traffic = 41,896 vehicles |
| **Roadway Geometric Data** | Field surveys conducted in June 2018. Roads and intersections were video archived.<br>Road capacities based on 2010 HCM. | Field surveys conducted in April 2022. Roads and intersections were video archived.<br>Road capacities based on 2022 HCM. |
| **School Evacuation** | Direct evacuation to designated Temporary Holding Centre (THC) for DPZ evacuation and the nearest Reception Centres for the full PZ (DPZ & CPZ) evacuation. | Direct evacuation to designated Temporary Holding Centre (THC) for DPZ evacuation and Reception Centres for the full PZ (DPZ & CPZ) evacuation. |

| Topic | Previous ETE Study | Current ETE Study |
|---|---|---|
| **Ridesharing** | 91.8% of transit-dependent persons will evacuate with a neighbour or friend, based on the 2018 telephone survey. | 70.6% of transit-dependent persons will evacuate with a neighbour or friend, based on the 2022 demographic survey. |
| **Trip Generation for Evacuation** | Based on the 2018 residential telephone survey of specific pre-trip mobilization activities:<br>Residents with commuters returning leave within 315 minutes for all scenarios.<br>Residents without commuters returning leave within 225 minutes (255 minutes during heavy snow scenarios).<br>Employees and transients leave within 120 minutes.<br>All times measured from the ATE. | Based on the 2022 residential demographic survey of specific pre-trip mobilization activities:<br>Residents with commuters returning leave within 255 minutes (285 minutes during heavy snow scenarios).<br>Residents without commuters returning leave within 195 minutes (225 minutes during heavy snow scenarios).<br>Employees and transients leave within 75 minutes.<br>All times measured from the Emergency Bulletin to evacuate. |
| **Weather** | Normal, Rain, or Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain and 20% for snow. | Normal, Rain/Light Snow, or Heavy Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain/light snow. For Heavy Snow scenarios a speed and capacity reduction of 15% and 25% are used, respectively. |
| **Modelling** | DYNEV II System – Version 4.0.19.2 | DYNEV II System – Version 4.0.21.0 |
| **Special Events** | Apple Festival and Craft Sale in Bowmanville | Apple Festival and Craft Sale in Bowmanville |
| **Evacuation Cases** | 50 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 700 unique cases. | 50 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 700 unique cases. |
| **Evacuation Time Estimates Reporting** | ETE reported for 90$^{th}$ and 100$^{th}$ percentile population for the base year of 2018 and projected to 2024 and 2028. Results presented by Region and Scenario. | ETE reported for 90$^{th}$ and 100$^{th}$ percentile population for the base year of 2021 and projected to 2023 and projected to 2033 through 2088, per decade basis for future year analyses. Results presented by Region and Scenario. |
| **Evacuation Time Estimates for the entire DPZ, 90$^{th}$ percentile** | Winter Midweek Midday, Good Weather: 3:05<br>Summer Weekend, Midday, Good Weather: 2:45 | Winter Midweek Midday, Good Weather: 3:45<br>Summer Weekend, Midday, Good Weather: 3:35 |

| Topic | Previous ETE Study | Current ETE Study |
|---|---|---|
| **Evacuation Time Estimates for the entire DPZ, 100th percentile** | Winter Midweek Midday, Good Weather: 5:25<br><br>Summer Weekend, Midday, Good Weather: 5:25 | Winter Midweek Midday, Good Weather: 5:40<br><br>Summer Weekend, Midday, Good Weather: 5:25 |
| **Evacuation Time Estimates for the entire CPZ, 90th percentile** | Winter Midweek Midday, Good Weather: 7:20<br><br>Summer Weekend, Midday, Good Weather: 6:10 | Winter Midweek Midday, Good Weather: 8:00<br><br>Summer Weekend, Midday, Good Weather: 7:10 |
| **Evacuation Time Estimates for the entire CPZ, 100th percentile** | Winter Midweek Midday, Good Weather: 9:45<br><br>Summer Weekend, Midday, Good Weather: 8:15 | Winter Midweek Midday, Good Weather: 10:10<br><br>Summer Weekend, Midday, Good Weather: 8:50 |

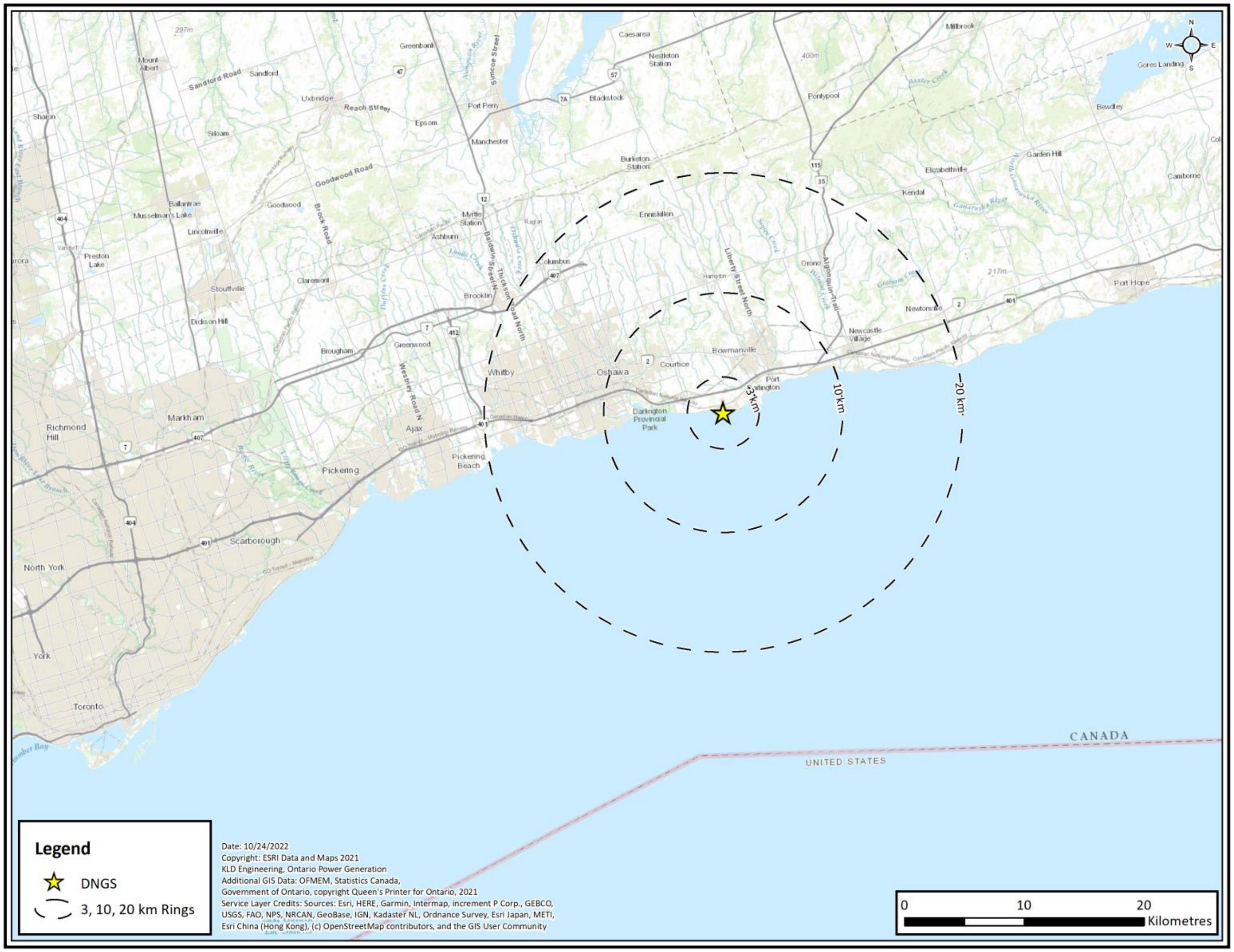


**Figure 1-1. DNGS Location**

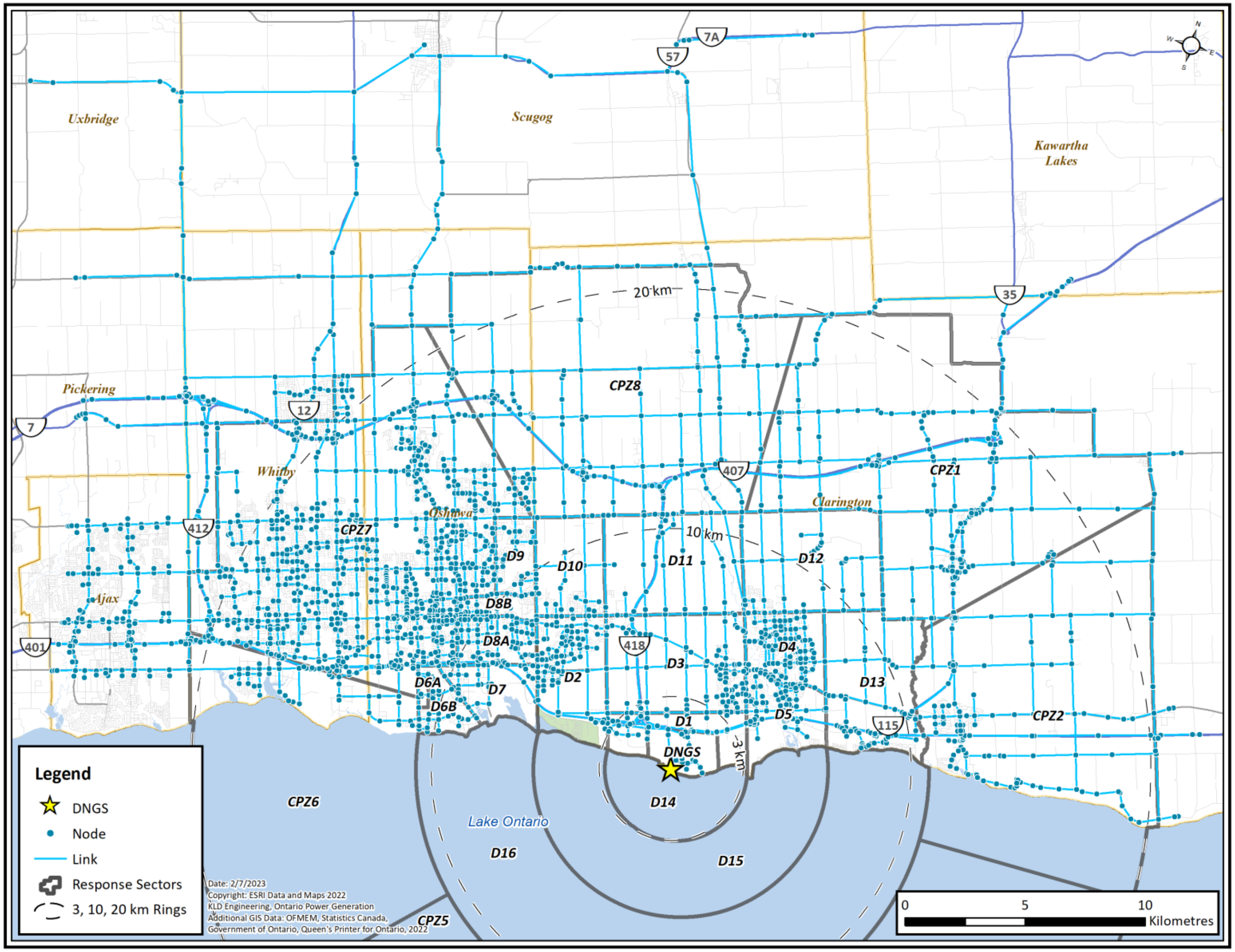


**Figure 1-2. DNGS Link-Node Analysis Network**

# 2 STUDY ESTIMATES AND ASSUMPTIONS

This section presents the estimates and assumptions utilized in the development of the evacuation time estimates (ETEs).

## 2.1 Data Estimates

1. The Planning Zone[1] (PZ) permanent resident population are based on the 2021 Statistics Canada population data[2], extrapolated to 2023 as the base year. Population is also projected to 2088 on a per decade basis, as per the CNSC REGDOC 2.10.1 guidance for the Automatic Action Zone (AAZ[3]), Detailed Planning Zone (DPZ) Inner Ring[3] and DPZ Outer Ring[3]; see Section 3.1.
2. The Darlington New Nuclear Project [DNNP] Small Modular Reactor [SMR] will be fully operational by 2033. As such DNNP employees was only considered for future year analyses (see Appendix M.4).
3. Population estimates at major employers are based on data provided by Statistics Canada. The DNGS plant, DNGS Refurbishment and DNNP site preparation employee estimates are based upon data provided by OPG[4]. The percentage of employees within the PZs that originate from outside the PZ are based on the 2021 labour force data and Commuting Flow survey[5] provided by Statistics Canada (released on November 30, 2022). See Section 3.4.
4. Population estimates at transient and special facilities are based on the data confirmed still accurate from the previous ETE study, the municipalities within the PZ and emergency plans, supplemented by internet searches and aerial imagery for parking spaces where data is missing. When aerial imagery is used, it is assumed that parking lots are full during peak times.
5. Current census at nursing homes and assisted living centres are assumed to be equal to the capacity of that facility.
6. The relationship between permanent resident population and evacuating vehicles was based on the results of the Census data as well as the 2022 online demographic survey results (see Appendix F). The estimated average household size of the PZ from the Census data is 2.95 persons per household. The results of the demographic survey

[1] The Planning Zone represents the entire study area which includes the Automatic Action Zone, Detailed Planning Zone (Inner and Outer Rings) and the Contingency Planning Zone.
[2] https://www.statcan.gc.ca/eng/start
[3] The AAZ represents 0 to 3 km from the plant, the DPZ inner ring represents 0 to 6 km from the plant, and the DPZ outer ring represents 0 to 10 km from the plant.
[4] Some OPG employees can work from home (WFH) 2 days a week. However, the current WFH agreement might change during the next Collective Agreement and there could be more or less employees who WFH. In addition, there are a number of contractors that are on site that are present at the site every day. The number of contractors fluctuates daily. As such, the percentage of employees who WFH was disregarded and it is conservatively assumed that during the peak time, the maximum shift is present at the site on average. Essentially, it is assumed the WFH employees are offset by the additional contractors that are present on site each day.
[5] http://www12.statcan.gc.ca/nhs-enm/index-eng.cfm

indicate on average, households will utilize 1.37 vehicles to evacuate. Thus, the Census population estimate of 2.95 people per household and 1.37 evacuating vehicles per household (Figure F-11, sub-section F.3.2) are used for the permanent resident population in the PZ.

7. On average, the relationship between persons and vehicles for transients (see Section 3.3) and the special event (see Section 3.8) are estimated to be as follows:
    a. Beaches: 2.95 people per vehicles
    b. Campgrounds: 2.83 people per vehicles
    c. Golf Courses: 1.80 people per vehicle
    d. Historic Sites: 2.74 people per vehicle
    e. Marinas: 2.27 people per vehicle
    f. Museum: 2.79 people per vehicle
    g. Parks and Conservation Areas: 2.55 people per vehicle
    h. Other Recreational Areas: 2.95 people per vehicle
    i. Lodging Facilities: 2.70 people per vehicle
    j. Special event: 3.00 people per vehicle
    k. Where data is not provided, the average household size is assumed to be the vehicle occupancy rate for transient facilities.
8. Based on the demographic survey, there are 1.15 employees per vehicle (assuming two people per carpool, on average, see Appendix F, sub-section F.3.1 and Figure F-7), but based on discussions with Durham Emergency Management, the employee occupancy rate of one (1) employee per vehicle was used for this study.
9. The maximum bus speed assumed within the PZ is 100 kph based on school bus speed limits for regional routes in Durham and average posted speed limits on major roadways within the PZ.
10. Roadway capacity estimates are based on field surveys performed in April 2022 (verified by aerial imagery), and the application of the U.S. Highway Capacity Manual 2022 and the Canadian Capacity Guide where applicable.
    a. In accordance with NUREG/CR-7002, Rev. 1, only those roadway construction projects that are completed prior to the finalization of this report are considered in an ETE study. As identified by OPG, the extension of Holt Road southbound from 2$^{nd}$ Line East up to Lakeshore Road (as part of the construction of the DNNP SMR) is considered in the base case for this study.
11. Five percent (5%) heavy vehicle traffic are assumed for all cases.

## 2.2 Study Methodological Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly progressing severe accident that requires evacuation, and includes the following[6] (as per NRC guidance):
    a. The Emergency Bulletin to evacuate is announced coincident with the activation of the notification.
    b. Mobilization of the general population will commence within 15 minutes after notification.
    c. The ETE are measured relative to the Emergency Bulletin to evacuate.
2. The centre-point of the plant is located at the centre of the vacuum building at 43° 52' 05.64" N and 78° 43' 29.38" W.
3. The DYNEV II[7] system (DYnamic NEtwork EVacuation), macroscopic simulation model is used to compute ETE in this study.
4. All actions set forth in provincial, regional, and municipal emergency response plans are assumed to be implemented as described in the plans.
5. Evacuees drive safely, travel radially away from the plant to the extent practicable given the roadway network, and obey all traffic control devices and traffic guides. All major evacuation routes are used in the analysis.
6. The existing PZ and Response Sector boundaries are used. See Figure 3-1.
7. The CPZ is considered as the Shadow Region, for an evacuation of the AAZ or the DPZ. See Figure 7-2. It is assumed that there is no shadow evacuation beyond the CPZ.
8. Evacuation percentages are as follows (see Figure 2-1):
    a. One hundred percent (100%) of the people within the impacted keyhole will evacuate, as indicated in Figure 2-2 of U.S. NUREG/CR-7002 Rev. 1 guidance.
    b. A voluntary evacuation of thirty percent (30%) of the people is considered as part of this study to account for people who live within the PZ but outside of the area being evacuated, as shown in Figure 2-1.
    c. A shadow evacuation of 30% of the area between DPZ boundary to the CPZ boundary (20 km radially from the plant) is considered for a full evacuation of the AAZ and the DPZ. Sensitivity studies explore the effect on ETE when changing the percentage of voluntary evacuees in the Shadow Region (see Appendix M).

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[6] We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:

1. Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Section 2.13 of NUREG/CR-6863.
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is likely that a longer time will elapse between the various stages of an emergency.

[7] The models of the I-DYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment.

9. The CPZ population characteristics (household size, evacuating vehicles per household, and mobilization time) were assumed to be the same as that of the permanent resident population within the AAZ and DPZ.
10. The ETEs are developed for the emergency PZs within the DNGS study area including the AAZ, DPZ, CPZ, and as well as various combinations of the Response Sectors within these PZs.
11. The ETE are presented at the 90th and 100th percentiles for each Region and for each Scenario in graphical and tabular format. The percentile ETE is defined as the elapsed time from the Emergency Bulletin to evacuate issued to a specific Region of the PZ, to the time that Region is clear of the indicated percentile of evacuees.
12. The ETE also includes the consideration of "through" (External-External traffic that originates its trip outside of the PZ and has its destination outside of the PZ) trips during the time that such traffic is permitted to enter the evacuated Region. External-External traffic is assumed along Highway (Hwy) 401, Hwy 407, and Hwy 115/35. The volumes used as External-External traffic are the 30th highest hourly traffic volume of the year, a conservative approach.
13. This study does not assume that roadways are empty at the start of the evacuation. Rather, there is an initialization period (often referred to as "fill time" in traffic simulation) wherein the anticipated traffic volumes from the beginning of the evacuation are loaded onto roadways in the PZ. The amount of initialization/fill traffic that is on the roadways in the PZ at the start of the evacuation depends on the scenario and the region being evacuated.
14. To account for boundary conditions (roadway conditions outside the PZ that are not specifically modelled due to the limited radius of the PZ) beyond the PZ, this study assumed a 25% reduction in capacity on two-lane roads and multilane highways for roadways that have traffic signals downstream. The 25% reduction in capacity is based on the prevalence of actuated traffic signals outside the PZ and the fact that the evacuating traffic volume ("main street") is more significant than the competing ("side street") traffic volume at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time. There is no reduction in capacity for freeways due to boundary conditions.
15. It is assumed that tolls within the PZ would be waived in an evacuation.

## 2.3 Assumptions on Mobilization Times

1. Essentially 100% of the PZ population can be notified within 45 minutes after the Emergency Bulletin to evacuate, based on discussions with Provincial emergency managers and OPG. (This does not include the 50km ingestion pathway zone [IPZ]). Current regulations do not define time expectations for notifying the PZ. For the purposes of this study, an assumption of the time required to notify the population in the PZ is necessary to produce ETEs. A value of 45 minutes has been assumed as

reasonable to the extent possible, given the use of the sirens and land line telephone alerting in the DPZ together with NAAD[8] and wireless public alerting in the DPZ, CPZ and IPZ as required.

2. Commuter percentages (and percentage of residents awaiting the return of a commuter) are based on the results of the 2022 demographic survey. According to the survey results, approximately 91% of the households in the PZ have at least 1 commuter see Appendix F, sub-section F.3.1); 72% of those households with commuters will await the return of a commuter before beginning their evacuation trip (see Appendix F, sub-section F.3.2). Therefore, 66% (91% x 72% = 65.5%, rounded up to 66%) of PZ households will await the return of a commuter, prior to beginning their evacuation trip.

3. According to the results of the demographic survey, approximately 68% of commuters who utilize rail will return to their parked vehicle within the CPZ prior to evacuating. Of those who would return to their car, about 95% indicated they would return home before evacuating. The remaining 5% would evacuate directly from the train station at which their car is parked. These concepts and percentages are applied to the commuters that utilize rail in this analysis.

4. Trip generation times (also known as mobilization time, or the time required by evacuees to prepare for the evacuation) are based upon the results of the online 2022 demographic survey, as per U.S. NRC guidance. It is assumed that stated events take place in sequence such that all preceding events must be completed before the current event can occur. The distributions based on the results of the online 2022 demographic survey are as follows (see Section 5):

    a. Employees/Transients will leave between 5 and 75 minutes after the Emergency Bulletin to evacuate.
    b. Permanent resident population with commuters will leave between 30 and 255 minutes after the Emergency Bulletin to evacuate (longer in snow).
    c. Permanent resident population without commuters will leave between 15 and 195 minutes after the Emergency Bulletin to evacuate (longer in snow).

## 2.4 Transit Dependent Assumptions

1. The percentage of transit-dependent people who rideshare with family, neighbours, and friends (reducing the demand for buses) are based on the results of the 2022 demographic survey. According to the survey results, approximately 71% of the transit-dependent population rideshare (see Appendix F, sub-section F.3.1, and Figure F-5).

[8] https://alerts.pelmorex.com/

2. Transit vehicles are used to transport those without access to private vehicles:
   a. Schools and day care centres
      i. If schools are in session, school (black and yellow buses), provided by various bus contractors in the area, will evacuate students directly to the designated Temporary Holding Schools (THS). Depending on what buses are available, several buses may be used to make multiple trips to the THS.
      ii. It is assumed that parents will pick up children at day care centres prior to evacuation.
      iii. No schoolchildren will be picked up by their parents prior to the arrival of the buses, except for day care centres.
      iv. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
   b. Medical Facilities
      i. Buses, wheelchair vans, and ambulances evacuate patients at medical facilities (which also includes any senior living facilities) that have these resources or agreements in place for these resources, within the PZ.
      ii. Wherein data was not provided, the breakdown of ambulatory, wheelchair bound, and bedridden patients are computed using average percentages from the previous study.
   c. Transit-dependent permanent residents:
      i. Transit-dependent (those that do not own or have access to a private vehicle) general population, who require radiological treatment, are evacuated to reception centres using buses and the pre-existing routes along the Durham Region Transit and GO Transit bus and rail lines, as per discussions with Durham Region Emergency Management.
      ii. Access and/or functional needs population[9] may require assistance (ambulance, bus, or wheelchair transport) to evacuate. It is assumed that direction on how to get assistance will be provided within the Emergency Bulletin to evacuate[10] and arrangements will be made for a special vehicle to be sent to their home on an on-demand basis.
      iii. Households with 3 or more vehicles were assumed to have no need for transit vehicles.
   d. Analysis of the number of required round-trips (“waves”) of evacuating transit vehicles is presented in Section 8.

[9] Access and/or functional needs population refers to those people that need special assistance during an evacuation that do not reside in special facilities.
[10] Durham Region Emergency Management is currently developing a process to ensure individuals in this category are supported through appropriate channels.

3. Transit vehicle capacities:
    a. School buses = 72 students per bus for elementary schools and 60 students per bus for middle schools and 48 students per bus for high schools
    b. Ambulatory transit-dependent persons and medical facility patients = 30 persons per bus[11]
    c. Ambulances = 1 bedridden person (includes advanced and basic life support)
    d. Wheelchair vans = 4 wheelchair bound persons
4. Transit vehicle mobilization times, which are considered in ETE calculations:
    a. Vehicles for schools and medical facilities without transportation arrive at these facilities to be evacuated within 90 minutes of the Emergency Bulletin to evacuate.
    b. It is likely buses for the transit dependent population are mobilized almost instantaneously. It is assumed there are buses available by the time 90% of residents with no commuters have completed their mobilization at approximately 2 hours after the emergency bulletin to evacuate is issued (see Figure 5-4). If necessary, multiple waves of buses will be utilized to gather transit dependent people who mobilize more slowly.
    c. It is assumed that patients can be mobilized concurrently and within the time it would take vehicles to mobilize.
5. Transit Vehicle loading times:
    a. Concurrent loading on multiple buses/transit vehicles is assumed.
    b. School buses are loaded in 15 minutes.
    c. Transit Dependent buses require 1 minute of loading time per passenger.
    d. Buses for medical facilities require 30 minutes to load ambulatory passengers.
    e. Wheelchair transport vehicles require at least 45 minutes to load passengers.
    f. Ambulances are loaded in 60 minutes.
6. Drivers for all transit vehicles, identified in Table 8-1, are available.

## 2.5 Diversion Traffic and Access Control Assumptions

1. Diversion Traffic Control Points or Access Control Points (ACP) to stop the flow of external traffic through the PZs as defined in the approved regional and provincial emergency plans, are assumed to be staffed within approximately 240 minutes following the Emergency Bulletin to evacuate, to divert traffic attempting to enter the PZs, as per discussions with the Ministry of Transportation Ontario (MTO) personnel. Earlier evacuation of ACP locations could delay returning commuters, including those using GO trains. It is assumed that no through traffic or GO trains will enter the PZs after this 240-minute time period.

[11] Durham Regional Transit (DRT) indicated that their full-size buses can accommodate 78 passengers at peak times. During an evacuation, however, it is likely that evacuees will carry personal items such as luggage and pets that will take up some of the available seating capacity. Hence, it is conservatively assumed that each bus can carry approximately 30 people.

2. Evacuation Traffic Points or Traffic Control Points (TCPs) within the PZs are assumed to be staffed within approximately 4 hours, beginning at the Emergency Bulletin to evacuate, as per discussions with MTO personnel. Their number and location will depend on the Region to be evacuated and resources available. TCPs at signalized intersections within the Durham Region are assumed to be established immediately[12]. TCPs at unsignalized intersections within Durham Region will not be staffed[13].

## 2.6 Scenarios and Regions

1. A total of 14 "Scenarios" representing different temporal variations (season, time of day, day of week) and weather conditions are considered. Scenarios considered are defined in Table 2-1:
   a. The Apple Festival and Craft Sale in Bowmanville located in Response Sectors D4 and D5 is considered as the special event (single or multi-day event that attracts a significant population into the CPZ; for Scenario 13.
   b. One lane outbound on a freeway must be closed for a roadway impact scenario for Scenario 14, as per U.S. NUREG/CR-7002, Rev. 1 guidance. This study considers the closure of a single lane on Highway 401 from the interchange with Hwy 418 to the interchange with Thickson Rd/Rt 26.
2. Two types of adverse weather scenarios are considered. Rain may occur for either winter or summer scenarios; snow occurs in winter scenarios only. It is assumed that the rain or snow begins earlier or at about the same time the evacuation advisory is issued. Thus, no weather-related reduction in the number of transients who may be present in the PZ is assumed. It is further assumed that snow removal equipment is available, the appropriate agencies are clearing/treating the major evacuation routes as they would normally when snowing, and the roads are passable albeit at lower speeds and capacities.
3. Adverse weather scenarios affect roadway capacity and the free flow roadway speeds, based on recent transportation research[14]. In accordance with Table 3-1 of the U.S. NUREG/CR-7002, Rev. 1, this study assumes a 10% reduction in speed and capacity for rain and light snow. The "heavy snow" scenarios considered assume that there was a significant snowfall such that minor roadways and driveways have snow on them. Major roadways have been plowed but still have a coating of snow on them that will slow traffic down and reduce roadway capacity. During "heavy snow" scenarios a speed and capacity reduction of 15% and 25% are used, respectively.

[12] Durham Region has a Traffic Management Centre (TMC) in which almost all traffic signals are wired. As a result, the Region has the ability to instantaneously manipulate signal timings as needed to control the flow of traffic.
[13] Based upon discussions with Durham Region, there may be a shortfall of resources to staff the TCPs at non-signalized intersections within the PZs and officers would be deployed based on the immediate needs of the impacted intersections. As such, it is conservatively assumed that all TCPs at unsignalized intersections will not be staffed.
[14] Agarwal, M. et. al. Impacts of Weather on Urban Freeway Traffic Flow Characteristics and Facility Capacity, Proceedings of the 2005 Mid-Continent Transportation Research Symposium, August 2005.

4. Extreme weather conditions and natural disasters are considered more extraordinary cases of adverse weather. Given the rarity of these events, they are not considered in the ETE study. Rather, extreme weather and natural disasters would be deemed “impediments to evacuation”.
5. It is assumed for “heavy snow” scenarios that some evacuees will need additional time to clear their driveway and access the public roadway system. The distribution of time for this activity was gathered through a demographic survey of the public and takes up to 105 minutes (1 hour and 45 minutes) for permanent residents (See Section 5.3 and Table 5-6). It is assumed that the time needed by evacuees to remove snow from their driveways is sufficient time for snow removal crews to mobilize and clear/treat major roadways. There are additional activities that a person will have to do before they actually begin their evacuation trip, which will delay their departure time. This allows additional time to plow the minor roads, as needed.
6. Employment is reduced slightly (4% reduction) in the summer for vacations.
7. Mobilization and loading times for transit vehicles are slightly longer in adverse weather. It is assumed that mobilization times are 10 minutes and 20 minutes longer in rain/light snow and heavy snow, respectively. It is assumed that loading times for schools/transit buses are 5 minutes and 10 minutes longer in rain/light snow and heavy, respectively. Refer to Table 2-2.
8. Regions to be considered are based on keyhole logic documented in U.S. guidance and discussions with OPG. These Regions, as defined, display irregular boundaries reflecting the geography of the Sectors included within these underlying configurations. Regions to be considered are defined in Table 6-1 and Table 6-2. It is assumed that everyone within the group of Response Sectors forming a Region that is issued an Emergency Bulletin to evacuate will, in fact, respond and evacuate in general accord with the planned routes.
9. Each Response Sector that intersects the keyhole is included in the Region. There are instances when a small portion of a Response Sector is within the keyhole and the population within that small portion is low (500 people or 10% of Zone population, whichever is less). Under those circumstances, the Response Sector is not included in the Region.
10. Staged evacuation is considered as defined in U.S. NUREG/CR-7002, Rev. 1 – those people beyond the AAZ will shelter-in-place until 90% of the AAZ has evacuated, then they will evacuate. See Regions R35 through R50 in Table 6-2.

**Table 2-1. Evacuation Scenario Definitions**

| Scenario | Season[15] | Day of Week | Time of Day[16] | Weather | Special |
|---|---|---|---|---|---|
| 1 | Summer | Midweek | Midday | Good | None |
| 2 | Summer | Midweek | Midday | Rain | None |
| 3 | Summer | Weekend | Midday | Good | None |
| 4 | Summer | Weekend | Midday | Rain | None |
| 5 | Summer | Midweek, Weekend | Evening | Good | None |
| 6 | Winter | Midweek | Midday | Good | None |
| 7 | Winter | Midweek | Midday | Rain/Light Snow | None |
| 8 | Winter | Midweek | Midday | Heavy Snow | None |
| 9 | Winter | Weekend | Midday | Good | None |
| 10 | Winter | Weekend | Midday | Rain/Light Snow | None |
| 11 | Winter | Weekend | Midday | Heavy Snow | None |
| 12 | Winter | Midweek, Weekend | Evening | Good | None |
| 13 | Winter | Weekend | Midday | Good | Special Event: Apple Festival and Craft Sale in Bowmanville |
| 14 | Summer | Midweek | Midday | Good | Roadway Impact: Single Lane Closure Highway 401 Westbound[17] |

**Table 2-2. Model Adjustment for Adverse Weather**

| Scenario | Highway Capacity* | Free Flow Speed* | Mobilization Time for General Population | Mobilization Time for Transit Vehicles | Loading Time for School/Summer Day Camp Buses | Loading Time for Transit Buses[18] |
|---|---|---|---|---|---|---|
| Rain/ Light Snow | 90% | 90% | No Effect | 10-minute increase | 5-minute increase | 5-minute increase |
| Snow | 75% | 85% | Clear driveway before leaving home (See Figure F-19) | 20-minute increase | 10-minute increase | 10-minute increase |
| *Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable. | | | | | | |

[15] Winter means that school is in session at normal enrollment levels (also applies to spring and autumn). Summer means that school is not in session, at summer school enrollment levels (lower than normal enrollment).
[16] The terms midday and evening cover the full 24 hours of the day. Midday is the time during which children are typically at school and employees are at work – roughly from 8am to 5pm. Evening is the time when the family is united at home – roughly from 5pm to 8am.
[17] Closure of a single lane on Highway 401 westbound from interchange with Hwy 418 to the interchange with Thickson Rd/Rt 26.
[18] Does not apply to medical facilities as loading times for these people are already conservative.

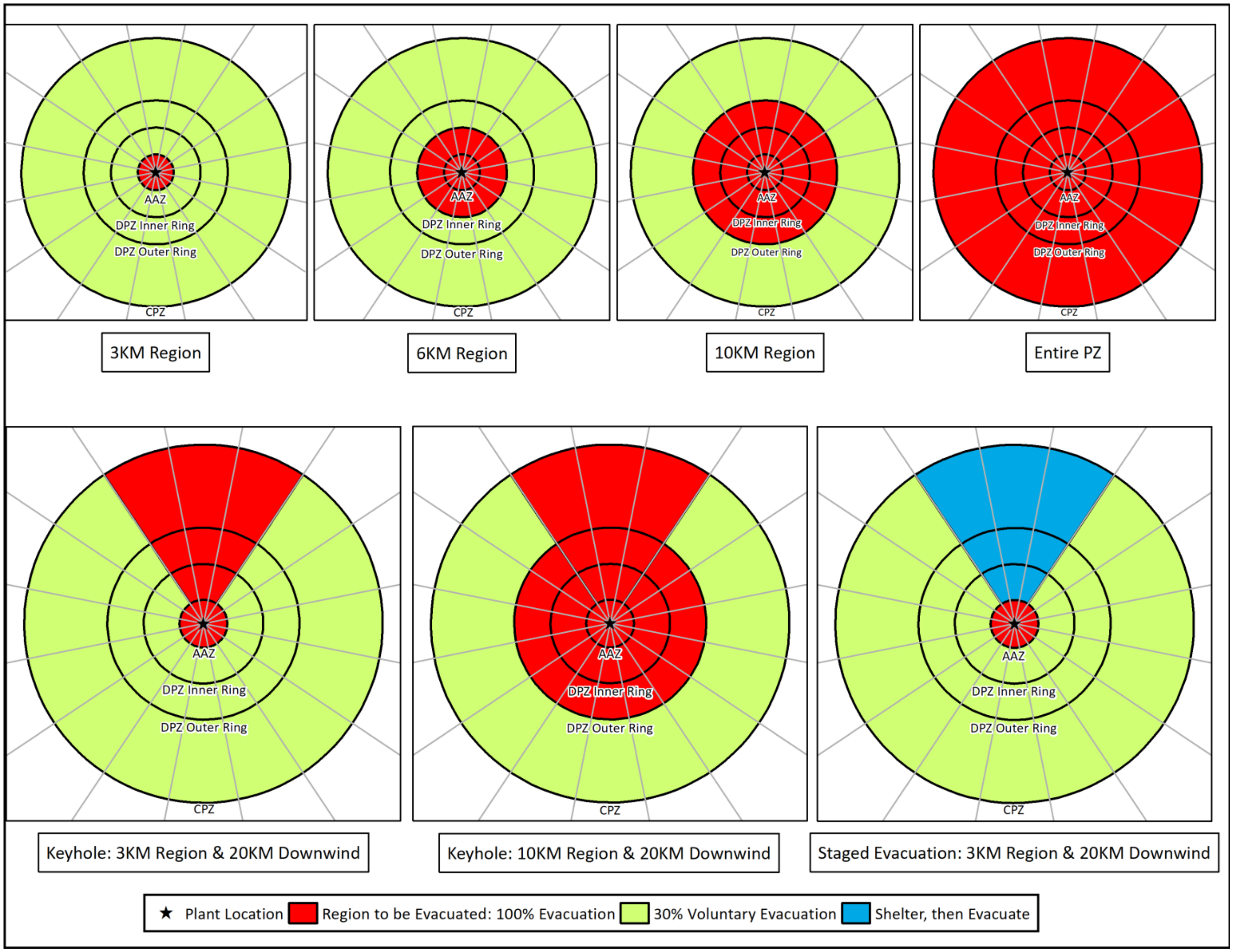


**Figure 2-1. Voluntary Evacuation Methodology**

# 3 DEMAND ESTIMATION

The estimates of demand, expressed in terms of people and vehicles, constitute a critical element in developing an evacuation plan. These estimates consist of three components:

1. An estimate of population within the Planning Zones (PZs), stratified into groups (resident, employee, transient).
2. An estimate, for each population group, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.
3. An estimate of potential double-counting of vehicles.

Appendix E presents much of the source material for the population estimates. Our primary source of population data, the 2021 Statistics Canada Census data, however, is not adequate for directly estimating some transient groups.

Throughout the year, vacationers and tourists enter the PZs. These non-residents may dwell within the PZs for a short period (e.g., a few days or one or two weeks) or may enter and leave within one day. Estimates of the size of these population components must be obtained, so that the associated number of evacuating vehicles can be ascertained.

The potential for double-counting people and vehicles must be addressed. For example:

- A resident who works and shops within the PZs could be counted as a resident, again as an employee and once again as a shopper.
- A visitor who stays at a hotel and spends time at a park, then goes shopping could be counted three times.

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. Estimating counts of vehicles by simply adding up the capacities of different types of parking facilities will tend to overestimate the number of transients and can lead to ETE that are too conservative.

Analysis of the population characteristics of the DNGS PZs indicates the need to identify three distinct general population groups – those with access to their own vehicle:

- Permanent residents - people who are year-round residents of the PZs.
- Transients - people who reside outside of the PZs who enter the area for a specific purpose (shopping, recreation) and then leave the area.
- Employees - people who reside outside of the PZs and commute to businesses within the PZs on a daily basis.

Estimates of the population and number of evacuating vehicles for each of the population groups are presented for each Response Sector and by polar coordinate representation (population rose). The entire DNGS PZ is subdivided into 27 Response Sectors – 19 Response Sectors in the DPZ and 8 Response Sectors in the CPZ. The PZs are shown in Figure 3-1.

## 3.1 Permanent Residents

The primary source for estimating permanent population is the latest 2021 Statistics Canada[1] Census data. Statistics Canada provides annual population updates for each Census Subdivision[2] (municipality) by Province. The population estimates[3] used for this study are for the time period from July 1, 2016 to July 1, 2021. This data is presented in Table 3-1 by municipality. The Census boundaries for the DNGS study area are shown in Figure 3-2.

Using the compound growth formula (Equation 1), where *g* is the annual growth rate and *XX* is the number of years projected forward from the Year 2021, the permanent resident population was projected to 2023 for the base year of this analysis. The compound growth formula can be solved for g as shown in Equation 2. The data provided in Table 3-1 for the years 2016 and 2021 were used in Equation 2 to compute the annual growth rate for each municipality in the study area (DPZ plus CPZ) using X = 5.00 (5 years from July 1, 2016 to July 1, 2021) and is presented in Table 3-1.

The most detailed data should always be used when forecasting population. In terms of detailed data, the municipal data is the finest level of detail provided by Statistics Canada during an intercensal period. Statistics Canada does not provide population data specific to the boundaries of the study area. As such, the appropriate municipality growth rate was only applied to those census dissemination blocks located within the study area. All other Census dissemination blocks outside the study area were not considered as a part of the PZs population, even if they are located within one of the municipalities that intersect the study area.

Using GIS mapping software, the appropriate annual growth rate was applied to each census dissemination block within the study area depending on which municipality the block is located within. The population was then projected to March 1 of 2023 using Equation 1[4].

**Equation 1. Compound Growth Rate**

$$(Compound\ Growth\ for\ XX\ years):$$

$$Population\ 202X\ =\ Population\ 2021\ \times (1\ +\ g)^{(XX-21)}$$

**Equation 2. Annual Growth Rate**

$$(Solving\ for\ the\ annual\ growth\ rate):$$

$$g\ =\ (Population\ 2021\ \div\ Population\ 2016)^{1/(21-16)} - 1$$

[1] https://www.statcan.gc.ca/eng/start
[2] Source: Statistics Canada, Annual population estimates by age and sex, Census Subdivisions, Ontario, July 1, 2016 to July 1, 2021. Reproduced and distributed on an "as is" basis with the permission of Statistics Canada.
[3] Detailed methodology of intercensal population estimates can be found at the following Statistics Canada webpage: https://www150.statcan.gc.ca/n1/pub/91-214-x/91-214-x2022001-eng.htm
[4] The same methodology was employed for the future year ETE discussed in Appendix M.

The permanent resident population is estimated by cutting the census dissemination block polygons by the Response Sector and PZs boundaries. A ratio of the original area of each census dissemination block and the updated area (after cutting) is multiplied by the total block population to estimate what the population is within the PZs. This methodology (referred to as the "area ratio method") assumes that the population is evenly distributed across a census dissemination block. (Note: Response Sector D6A is exclusively comprised of the General Motors (GM) parking lot.) Table 3-2 provides the permanent resident population within the PZs, by Response Sector, for 2021 (based on the most recent Canadian Census) and 2023 (based on the methodology discussed above). As shown in Table 3-2, the permanent resident population within the PZs has increased by 3.53% since 2021.

The extrapolated permanent resident population is divided by the average household size and then multiplied by the average number of evacuating vehicles per household in order to estimate number of vehicles. An average household size of 2.95 persons per household (See Appendix F, Sub-Section F.3.1) and the number of 1.37 evacuating vehicles per household (See Appendix F, Sub-Section F.3.2), obtained from the 2022 demographic survey results, were applied to the dissemination blocks within the study area.

Permanent resident population and vehicle estimates are presented in Table 3-3. Figure 3-3 and Figure 3-4 present the permanent resident population within the DPZ and CPZ, respectively, by sector and distance from the DNGS. Figure 3-5 and Figure 3-6 present the permanent resident vehicle estimates within the DPZ and CPZ, respectively, by sector and distance from the DNGS. This "rose" was constructed using GIS software.

## 3.2 Shadow Population

A portion of the population living outside the DPZ extending to 20 kilometres (to CPZ boundary) radially from the DNGS may elect to evacuate without having been instructed to do so when the DPZ, or portions of the DPZ, is evacuated. This area is considered the Shadow Region for an evacuation of the AAZ or the DPZ. Based on discussions with OPG and the offsite response agencies, it is assumed that 30% of the permanent resident population, based on the extrapolated 2023 Census data, in the Shadow Region will elect to evacuate. No Shadow Region is considered for an evacuation for the CPZ.

The same methodology was used to estimate this population as described in Section 3.1. Shadow (CPZ) population characteristics (household size, evacuating vehicles per household, mobilization time) are assumed to be the same as that for the AAZ and DPZ permanent resident population. Table 3-4, Figure 3-4, and Figure 3-6 present estimates of the shadow population and vehicles, by sector. This population is within the CPZ and was assumed to evacuate according to the methodology shown in Figure 2-1 for an evacuation of the full PZ.

## 3.3 Transient Population

Transient population groups are defined as those people (who are not permanent residents, nor commuting employees) who enter the study area for a specific purpose (shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. Data for transient facilities was provided by the Regional Municipality of Durham and supplemented by data from the previous study. The transient facilities within the DNGS PZs are summarized as follows[5]:

- Beaches – 960 transients (432 in the DPZ; 528 in the CPZ); 325 vehicles (135 in the DPZ; 190 in the CPZ)
- Campgrounds – 4,124 transients (1,926 in the DPZ; 2,198 in the CPZ); 1,456 vehicles (642 in the DPZ; 814 in the CPZ)
- Golf Courses – 1,849 transients (359 in the DPZ; 1,490 in the CPZ); 1,028 vehicles (168 in the DPZ; 860 in the CPZ)
- Historic Sites and Museums – 2,793 transients (140 in the DPZ; 2,653 in the CPZ); 1,000 vehicles (50 in the DPZ; 950 in the CPZ)
- Marinas – 975 transients (375 in the DPZ; 600 in the CPZ); 430 vehicles (135 in the DPZ; 295 in the CPZ)
- Parks and Conservation Areas – 5,331 transients (2,916 in the DPZ; 2,415 in the CPZ); 2,093 vehicles (913 in the DPZ; 1,180 in the CPZ); (NOTE: Local parks are not included; visitors to these facilities are likely local residents and have already been counted as permanent residents in Section 3.1.)
- Oshawa Zoo (in the CPZ) – 80 transients; 40 vehicles
- Other Recreational Areas (all in the CPZ) – 10,850 transients; 3,662 vehicles
- Lodging Facilities – 4,880 transients (323 in the DPZ; 4,557 in the CPZ); 1,810 vehicles (177 in the DPZ; 1,633 in the CPZ)

Appendix E summarizes the transient data that was gathered for the PZs. Table E-6 through Table E-8 present the number of transients and vehicles at recreational areas, while Table E-9 presents the number of transients and vehicles at lodging facilities within the PZs.

In total, there are 31,842 transients evacuating in 11,844 vehicles (an average of 2.69 transients per vehicle) in the PZs. Table 3-5 presents transient population and transient vehicle estimates by Response Sector. Figure 3-7 through Figure 3-10 present these data by sector and distance from the plant.

## 3.4 Employees

Employees who work within the PZs fall into two categories:

- Those who live and work in the PZs.
- Those who live outside of the PZs and commute to jobs within the PZs.

[5] To avoid double counting, people (and vehicles) who travel from within the PZs to each facility were removed from the values discussed in this section and shown in Table E-6 through Table E-8.

Those of the first category are already counted as part of the permanent resident population. To avoid double counting, we focus only on those employees commuting from outside the PZs who will evacuate along with the permanent resident population.

The labour force population data[6] obtained from the 2021 Census Profile from Statistics Canada was used to estimate the number of employees commuting into the PZs. The finest level of this data available is dissemination area[7]. In each dissemination area, the number of employees is broken down by 2017 North American Industry Classification System (NAICS)[8] sectors. Since not all employees are working at facilities within the PZs at one time, a maximum shift (Max Shift) reduction was applied. Assuming maximum shift employment occurs Monday through Friday between 9 AM and 5 PM, jobs in the following industry sectors take place outside the typical 9-5 workday:

- Manufacturing – takes place in shifts over 24 hours
- Arts, Entertainment, and Recreation – takes place in evenings and on weekends
- Accommodations and Food Services – peaks in the evenings

The number of employees in remaining industry sectors represents the maximum number of employees present in the PZs at any one time. Using GIS software with the same area ratio methodology that was used for permanent residents (see Section 3.1), the maximum number of employees was estimated within each Response Sector and within the PZs. Note, the dissemination areas with less than 200 employees (during the maximum shift) were considered as small-size employers (employing mostly local residents) and were not included in this study, as per NUREG/CR-7002, Rev. 1 guidance.

Data obtained from the 2021 Commuting Flow survey provided by Statistics Canada[9] was used to calculate the percent of employees that work within the PZs but live outside. The survey provides the inflow/outflow of commuting employees by Census Subdivision (municipality) for Clarington, Oshawa and Whitby. These values – 24.5%, 18.8% and 24.0% – respectively, were applied to the maximum shift employment to compute the number of people commuting into the PZs to work at peak times. Note, the employment data for the DNGS, including the total employment (3,042 employees) and percent of employees living outside of the PZs (52%), was provided by OPG. The plant employment data is reflected in Table E-5 in Appendix E.

As per discussions with Durham Emergency Management (DEM), a vehicle occupancy rate of 1 employee per vehicle was used in the Durham Region, which encompasses the entire study area, to determine the number of evacuating vehicles.

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[6] Total labour force population aged 15 years and over by Industry - NAICS 2017 - 25% sample data. According to Statistics Canada, a sample of approximately 25% of Canadian households received a mandatory long-form questionnaire, which includes employment related questions. All other households received a short-form questionnaire. Additional details about the questionnaire can be found in the following website: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getMainChange&Id=152274
[7] https://www150.statcan.gc.ca/n1/en/catalogue/92-169-X
[8] https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553
[9] https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=9810045901

### 3.4.1 GO Transit Station Commuters

In addition to the employees discussed above, this study also considered those who work outside of the PZs but commute from a GO Transit station within the PZs. Based on the results from the 2022 demographic survey, 5% of commuters (see Appendix F, Sub-Section F.3.1) who work outside of the PZs would return to their cars and evacuate in their personal vehicles from a rail station within the PZs without returning homes first. There are two GO Transit stations within the PZs – Oshawa and Whitby. The peak ridership for each rail station is estimated based on parking capacity obtained from GO Transit website[10]. Applying the 5% factor and the vehicle occupancy rate discussed above, the estimates of vehicles and employees evacuating from each rail station are summarized in Table 3-6.

### 3.4.2 DNGS Refurbishment and Darlington Small Modular Reactor (DNNP) Employees

In addition to the DNGS employees in Response Sector DNGS, two other employee groups were also considered in this study – DNGS Refurbishment Employees and DNPP Site Preparation Employees. Based on information provided by OPG, there are an additional 1,150 employees in Response Sector DNGS (1,000 DNGS refurbishment employees and 150 DNNP Site Preparation Employees). To be conservative, all 1,150 employees commute from outside the PZ. Similar to the DNGS employees, a vehicle occupancy of 1 employee per vehicle was used. As such, a total of 1,150 additional employee vehicles was considered in Response Sector DNGS.

Table 3-7 presents employees commuting into the PZs, accounting for those employees who would evacuate directly from the GO Transit station, DNGS Refurbishment employees, DNNP site preparation employees, and their vehicles by Response Sector. Figure 3-11 through Figure 3-14 present these data by sector.

## 3.5 Medical Facilities

Population estimates at medical facilities from previous ETE study were reviewed and confirmed to be still accurate by the Regional Municipality of Durham. Since these facilities are transit dependent, no personal evacuating vehicles are considered. Table E-4 in Appendix E summarizes the data provided. Table 3-8 presents the census of medical facilities in the PZs. As shown in these tables, a total of 4,344 people has been identified as living in, or being treated in, these facilities[11]. This data includes the number of ambulatory, wheelchair-bound and bedridden patients at each facility.

The transportation required for the medical facility population, presented in Table 3-8, were calculated in the event an evacuation of these facilities is necessary. The number and type of evacuating vehicles that need to be provided depend on the patients' state of health. It is estimated that buses can transport up to 30 people; wheelchair vans up to 4 people; and ambulances, up to 1 person. To evacuate medical facility population within the study area, 106 bus runs, 354 wheelchair van runs and 358 ambulance runs. Buses are represented as two

[10] https://www.gotransit.com/en/stations-stops-parking/find-a-station-or-stop

[11] The Canadian census does not include population from those medical facilities, as stated on their website: https://www12.statcan.gc.ca/census-recensement/2021/ref/98-304/2021001/app-ann1-3-eng.cfm#a1. This was verified this in GIS. Therefore, double counting at special facilities was eliminated.

vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

## 3.6 School, College/University, and Summer Day Camp Population Demand

School, college/university, and summer day camp population and transportation requirements for the direct evacuation of all facilities within the PZs are presented in Table 3-9, Table 3-10 and Table 3-11, respectively. Student enrolment information from the previous ETE study were reviewed and updated and/or confirmed to be still accurate by stakeholders, supplemented by internet searches and aerial imagery for parking spaces where data was missing. The column in these tables entitled "Buses Required" specifies the number of buses required for each school, college/university, or summer day camps under the following set of assumptions and estimates:

- No schoolchildren will be picked up by their parents prior to the arrival of the buses, except for day care centres. Children at day care centres are assumed to be picked up by parents directly and therefore no buses were considered.
- While many high school students commute to school using private automobiles (as discussed in Section 2.4 of NUREG/CR-7002, Rev.1), the estimate of buses required for school evacuation do not consider the use of these private vehicles.
- Bus capacity, expressed in students per bus, is set to 72 for primary schools, 60 for middle schools, and 48 for high schools.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism, typically 3 percent daily.
- It is estimated that 1,606 of the 8,539 students at the Durham College – Oshawa Campus would need transit assistance to evacuate (see Section 3.6.1 for further discussion). Using an occupancy of 30 people per bus, a total of 54 buses would be required to evacuate this population.
- It is estimated that 2,242 of the 9,732 students at the Ontario Tech University would need transit assistance to evacuate (see Section 3.6.1 for further discussion). Using an occupancy of 30 people per bus, a total of 75 buses would be required to evacuate this population.
- It is estimated that 346 of the 1,839 students at the Durham College – Whitby Campus would need transit assistance to evacuate (see Section 3.6.1 for further discussion). Using an occupancy of 30 people per bus, a total of 12 buses would be required to evacuate this population.
- It is estimated that 464 of the 1,960 students at the Trent University – Durham GTA Campus would need transit assistance to evacuate (see Section 3.6.1 for further discussion). Using an occupancy of 30 people per bus, a total of 16 buses would be required to evacuate this population.

It is recommended that the provincial Ministry of Education introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot, to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. The need for buses would be reduced by any high school students who have evacuated using private automobiles (if permitted by school authorities). Those buses originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing.

Students from each school (black and yellow buses), within the PZs, provided by various bus contractors in the area, will be transported to designated temporary holding centres (THCs) where they will be subsequently retrieved by their families. Several buses may be used to make multiple trips to the THS. School buses are represented as two vehicles in the ETE simulation due to their larger size and more sluggish operating characteristics.

### 3.6.1 Colleges and Universities

The college and university enrolment data were obtained from various sources, including the Regional Municipality of Durham, Ontario Government, facility websites, aerial imagery and data from the previous ETE study. There are several colleges and universities within the DNGS study area, including small-sized colleges, such as polytechnic colleges, where the majority of students are likely to reside within the PZs and are already counted as part of the permanent residents. To avoid double counting, these small-sized colleges are not considered in this study. Based on the size of enrolment, there are four colleges/universities within the DNGS study area (all located within the CPZ). To estimate the number of evacuating vehicles and transit-dependent buses, the percentage of ridesharing (71%) was obtained from the 2022 demographic survey[12] .

Durham College – Oshawa Campus:

- Located in Response Sector CPZ7, 16.1 km west-northwest of the DNGS.
- The latest college enrolment database from Ontario Government[13] shows a total of 8,539 students enrolled in Oshawa Campus.
- As indicated in the college website[14], the on-campus housing can accommodate up to 1,360 students. As such, it is estimated 1,360 students live on-campus and 7,179 (8,539 – 1,360) students live off campus.
- Durham College was contacted to obtain the capacity of parking lots, but no information was provided. As such, the capacity of parking lots at Oshawa Campus used is 3,000, based on the data from the previous study. As such, the maximum number of students that have private vehicles is 3,000, which is 35.13% (3,000 ÷ 8,539) of the total students.
- Applying the percentage of students with private vehicles (35.13%) to the numbers of on- and off-campus students, resulting in 478 (1,360 x 35.13%) on-campus students and 2,522 (7,179 x 35.13%) off-campus students with private vehicles.

[12] For additional information, refer to Section F.3.1 and Section F.3.2 in Appendix F.
[13] https://data.ontario.ca/dataset/university-enrolment
[14] https://durhamcollege.ca/student-life/student-services/housing/on-campus-housing

- According to the 2022 demographic survey, approximately 71% of transit-dependent people would rideshare with a neighbour or friend (see Appendix F, Sub-Section F.3.2) in the event of an emergency. As such, it is assumed that 626 ((1,360 on-campus total students – 478 on-campus students with private vehicles) x 71%) on-campus students and 3,307 ((7,179 off-campus total students – 2,522 off-campus students with private vehicles) x 71%) off-campus students would rideshare with fellow classmates, leaving a total of 1,606 students, which includes 256 (1,360 – 478 – 626) on-campus students and 1,350 (7,179 – 2,522 – 3,307) off-campus students, who have no access to private vehicles and would be evacuated by a bus. Using the capacity of 30 people per bus, the total number of transit-dependent buses needed for Oshawa Campus is 54 (1,606 ÷ 30 = 54, rounded up) or 108 vehicles (1 bus is equivalent to 2 passenger vehicles).
- In summary, there is a total of:
    - 6,933 commuting/ridesharing students, which includes 1,104 (478 + 626) on-campus students and 5,829 (2,522 + 3,307) off-campus students, evacuating in 3,000 vehicles, and
    - 1,606 transit-dependent students evacuating in 54 buses or 108 vehicles.

Durham College – Whitby Campus:

- Located in Response Sector CPZ7, 11.2 km west of the DNGS.
- The latest college enrolment database from Ontario Government[15] shows Whitby Campus has a total enrolment of 1,839 students.
- Based on the information from college website[16], Whitby Campus has a newly built on-campus housing that can accommodate 68 students. As such, it is estimated there are 68 on-campus students and 1,771 (1,839 – 68) off-campus students.
- Based on data from the previous study (as more recent data requested by Durham Region was not available), the parking lot capacity at Whitby Campus is 2,000, which exceeds the total number of students. The percentage of students own private vehicles is unavailable. Assuming the students at Whitby Campus have the same vehicle ownership rate (35.13%) as those at Oshawa Campus, there is estimated 646 evacuating vehicles for Whitby Campus, including 24 (68 x 35.13%) vehicles for students living on-campus and 622 (1,771 x 35.13%) vehicles for students living off-campus.
- For the remaining 44 (68 on-campus total students – 24 on-campus students with private vehicles) on-campus students and 1,149 (1,771 off-campus total students – 622 off-campus students with private vehicles) off-campus students that do not have private vehicles, applying with the same percentage of ridesharing (71%) and transit-dependent bus capacity (30 people per bus) discussed above, there are 31 (44 x 71%) on-campus students and 816 (1,149 x 71%) off-campus students evacuate by ridesharing, and a total of 346 students, which includes 13 (68 – 24 – 31) on-campus students and 333 (1,771 – 622 – 816), evacuating in 12 buses (346 ÷ 30 = 12, rounded up) or 24 vehicles.

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[15] https://data.ontario.ca/dataset/university-enrolment
[16] https://durhamresidence.ca/faq-whitby/#1

- In summary, there is a total of:
  - 1,493 commuting/ridesharing students, which includes 55 (24 + 31) on-campus students and 1,438 (622 + 816) off-campus students, evacuating in 646 vehicles, and
  - 346 transit-dependent students evacuating in 12 buses or 24 vehicles.

Trent University – Durham Greater Toronto Area (Durham GTA) Campus:

- Located in Response Sector CPZ7, 13.6 km west of the DNGS.
- The university website[17] shows Durham GTA Campus has a total enrolment of 1,960 students. The university website[18] also shows on-campus housing provide 200 beds. As such, it is estimated there are 200 on-campus students and 1,760 (1,960 – 200) off-campus students.
- The aerial imagery shows there are approximately 360 parking spaces in Durham GTA Campus. As such, the maximum number of students have private vehicles is 360, which is 18.37% (360 ÷ 1,960) of the total students.
- Applying the same estimation approach used for Durham College – Oshawa Campus, it is estimated 37 (200 x 18.37%) on-campus students and 323 (1,760 x 18.37%) off-campus students have private vehicles, 116 ((200 total on-campus students – 37 on-campus students with private vehicles) x 71%) on-campus students and 1,020 ((1,760 total off-campus students – 323 off-campus students with private vehicles) x 71%) off-campus students can evacuate via ridesharing, and the remaining 464 students, including 47 (200 – 37 – 116) on-campus students and 417 (1,760 – 323 – 1,020) off-campus students, would evacuate in 16 buses (464 ÷ 30 = 16, rounded up) or 32 vehicles.
- In summary, there is a total of:
  - 1,496 commuting/ridesharing students, which includes 153 (37 + 116) on-campus students and 1,343 (323 + 1,020) off-campus students, evacuating in 360 vehicles, and
  - 464 transit-dependent students evacuating in 16 buses or 32 vehicles.

Ontario Tech University:

- Located in Response Sector CPZ7, 16.1 km west-northwest of the DNGS.
- Data from the latest university database[19]maintained by Ontario Government shows this university has a total of 9,732 students.
- As shown in the university website[20], over 1,300 students live on-campus. As such, it is estimated there are 1,300 on-campus students and 8,432 (9,732 – 1,300) off-campus students.
- Based on data from the previous study (as the more recent data requested by Durham College was unavailable), the parking lots in this university can accommodate up to 2,000

[17] https://www.trentu.ca/about/trent-numbers
[18]https://www.trentu.ca/durham/about-trent/expansion/meet-our-partners/builder-funder-campus-living-centres#:~:text=Trent%20University%20is%20working%20with,on%20the%20Durham%20GTA%20campus.
[19] https://data.ontario.ca/dataset/university-enrolment
[20] https://uoit.ca/about/uoit-info/fact-sheet.php

vehicles. As such, the maximum number of students have private vehicles is 2,000, accounting for 20.56% (2,000 ÷ 9,732) of the total students.

- Applying the same estimation approach discussed above, resulting in 267 (1,300 x 20.56%) on-campus students and 1,734 (8,432 x 20.56%) off-campus students with private vehicles, 733 ((1,300 – 267) x 71%) on-campus students and 4,756 ((8,432 – 1,734) x 71%) off-campus students evacuating via ridesharing, leaving a total of 2,242 students, including 300 (1,300 – 267 – 733) on-campus students and 1,942 (8,432 – 1,734 – 4,756) off-campus students, evacuating in 75 buses (2,242 ÷ 30 = 75, rounded up) or 150 vehicles.
- In summary, there is a total of:
    - 7,490 commuting/ridesharing students, including 1,000 (267 + 733) on-campus students and 6,490 (1,734 + 4,756) off-campus students, evacuating in 2,000 vehicles, and
    - 2,242 transit-dependent students evacuating in 75 buses or 150 vehicles.

Overall, in total, there are 17,412 commuting/ridesharing students and 4,658 transit-dependent students evacuating in 6,006 vehicles and 157 buses (314 vehicles). Table E-2 in Appendix E presents the number of commuting/ridesharing students and evacuating vehicles for each college/university.

### 3.6.2 Summer Day Camps

There are 28 schools/facilities within the PZs that serve as day camps during the summer (See Table 3-11 and Table E-3). Since summer day camps are not in session during school hours, these students are considered separately from school children even though they may in fact be the same children. Based on the previous study, YMCA officials, estimate the number of children at each facility within the DPZ at approximately 50 during the summer months for a total of 550 students. Each of the day camps within the DPZ will evacuate to THCs, identical to those of their school counterparts, where they will be subsequently retrieved by their families. A total of 11 buses (one bus per day camp – See Table 3-11) or 22 vehicles (1 bus is equivalent to 2 passenger vehicles) have been incorporated for summer day camps within the DPZ. For the summer day camps within the CPZ, it is assumed that parents will pick up their children prior to evacuation due to a potential shortfall of buses. Thus, no transit vehicles are considered for those facilities.

## 3.7 Transit Dependent Population

The demographic survey (see Appendix F) results were used to estimate the portion of the population requiring transit service:

- Those persons in households that do not have a vehicle available.
- Those persons in households that do have vehicle(s) that would not be available at the time the evacuation is advised.

In the latter group, the vehicle(s) may be used by a commuter(s) who does not return (or is not expected to return) home to evacuate the household.

Table 3-12 presents estimates of transit-dependent people. Note:

- Estimates of persons requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the schoolchildren. The actual need for transit vehicles by residents is thereby less than the given estimates. However, estimates of transit vehicles are not reduced when schools are in session.
- It is reasonable and appropriate to consider that many transit-dependent persons will evacuate by ridesharing with neighbours, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario[21] who did not use their own cars, shared a ride with neighbours or friends. Other documents report that approximately 70 percent of transit dependent persons were evacuated via ride sharing. Based on the results of the demographic survey, 71% of transit dependent population will rideshare and was used in this study.

The estimated number of bus trips needed to service transit-dependent persons is based on an estimated average bus occupancy of 30 persons[22] at the conclusion of the bus run. Transit vehicle seating capacities typically equal or exceed 60 children (roughly equivalent to 40 adults). If transit vehicle evacuees are two thirds adults and one third children, then the number of "adult seats" taken by 30 persons is 20 + (2/3 x 10) = 27. On this basis, the average load factor anticipated is (27/40) x 100 = 68%. Thus, if the actual demand for service exceeds the estimates of Table 3-12 by 50 percent, the demand for service can still be accommodated by the available bus seating capacity if passenger's belongings are stored on their laps or under the seat in front of them.

$$\left[20 + \left(\frac{2}{3} \times 10\right)\right] \div 40 \times 1.5 = 1.00$$

Table 3-12 indicates that transportation must be provided for 1,474 people inside the DPZ and 2,842 people in the CPZ. Therefore, a total of, 50 and 95 buses are needed from a capacity standpoint for the DPZ and CPZ, respectively. In order to service all of the transit dependent population and have at least one bus drive through each of the Response Sectors to pick up transit dependent people, **152 bus runs,** 55 for the DPZ and 97 for the CPZ are used in the ETE calculations, see Section 8.1 and Section 10 for further discussion. The availability of these buses is subject to their release from the bus depot. These buses are represented as two vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.

[21] Institute for Environmental Studies, University of Toronto, THE MISSISSAUGA EVACUATION FINAL REPORT, June 1981. The report indicates that 6,600 people of a transit-dependent population of 8,600 people shared rides with other residents; a ride share rate of 77% (Page 5-10).

[22] Durham Regional Transit (DRT) indicated that their full-size buses can accommodate 78 passengers at peak times. During an evacuation, however, it is likely that evacuees will carry personal items such as luggage and pets that will take up some of the available seating capacity. Hence, it is conservatively assumed that each bus can carry approximately 30 people.

To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses, B, required for the DNGS DPZ:

$$P = No. of\ HH \times \sum_{i=0}^{n} \{(\%\ HH\ with\ i\ vehicles) \times [(Average\ HH\ Size) - i]\} \times A^i C^i$$

Where,

A = Percent of households with commuters

C = Percent of households who will not await the return of a commuter

$$P = 47{,}497 \times [(0.0051 \times 1) + (0.195 \times (2.12 - 1) \times (0.909 \times 0.276)^1) + (0.562 \times (3.29 - 2) \times (0.909 \times 0.276)^2)] = 5{,}012$$

$$B = [(1 - 0.706) \times P] \div 30 = [(0.294 \times 5{,}012) \div 30] = (1{,}474 \div 30) \approx 50$$

These calculations, based on the 2022 demographic survey results, for the DPZ, are explained as follows:

- All members (1.00 avg.) of households (HH) with no vehicles (0.51%) will evacuate by public transit or rideshare. The term 47,497 (number of households) x 0.0051 x 1.00, accounts for these people.
- The members of HH with 1 vehicle away (19.5%), who are at home, equal (2.12 – 1). The number of HH where the commuter will not return home is equal to 47,497 x 0.195 x 1.12 x $(0.909 \times 0.276)^1$, as 90.9% of PZs households have a commuter, 27.6% of which would not return home in the event of an emergency. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (56.2%), who are at home, equal (3.29 – 2). The number of HH where neither commuter will return home is equal to 47,497 x 0.562 x 1.29 x $(0.909 \times 0.276)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms (the last term is squared to represent the probability that neither commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in the HH with no vehicles, 1 vehicle, and 2 vehicles that are away from home.

Data was not provided on those within the PZ that have access and/or functional needs. As such, it is assumed that those with access and/or functional needs who may also need assistance and do not reside in special facilities are included in these calculations. Based on discussions with OROs, it is assumed that direction on how to get assistance will be provided within the Emergency Bulletin to evacuate[23], and arrangements will be made for a special vehicle to be sent to their home on an on-demand basis.

[23] Durham Region Emergency Management is currently developing a process to ensure individuals in this category are supported through appropriate channels.

## 3.8 Special Event

A special event can attract large numbers of transients to the DPZ for short periods of time, creating a temporary surge in demand as per Section 2.5.1 of NUREG/CR-7002, Rev. 1. The municipal and regional emergency management agencies were polled regarding potential special events in the PZ. The Apple Festival and Craft Sale in Bowmanville was chosen as the special event (Scenario 13), because it brings the largest transient population within the PZ. This event occurs on a weekend annually in October (considered a winter scenario[24]) during the day. The festival is located in downtown Bowmanville on King St from Old Simcoe St to Division St (located in Response Sectors D3 and D4).

Based on information forwarded by OPG, the Applefest Director of Bowmanville Business Improvement Association estimated that there are 50,000 attendees for this event, with approximately 5,000 people at any given time in the downtown. It is assumed that 100% of attendees (in the downtown) are transients as a conservative estimate, and the estimated vehicle occupancy is 3 people per vehicle, which results in 1,667 additional transient vehicles.

The special event vehicle trips were generated utilizing the same mobilization distributions as transients. Vehicles were loaded throughout the municipality of Bowmanville for this scenario. No public transportation is considered for the special event.

## 3.9 External Traffic

Vehicles will be traveling through the PZs (external-external trips) at the time of an accident. After the Emergency Bulletin to evacuate is announced, these through-travellers will also evacuate. These through vehicles are assumed to travel on the major routes traversing the PZs – Hwy 401, Hwy 407and Route 115/35. It is assumed that this traffic will continue to enter the PZs during the first 4 hours following the Emergency Bulletin to evacuate, as per the Ministry of Transportation of Ontario (MTO).

Average Annual Daily Traffic (AADT) data was obtained from the MTO[25] and 407 ETR[26] to estimate the number of vehicles per hour on the aforementioned routes.

The AADT was multiplied by the K-Factor, which is the proportion of the AADT on a roadway segment or link during the design hour, resulting in the design hour volume (DHV). The design hour is usually the 30$^{th}$ highest hourly traffic volume of the year, measured in vehicles per hour (vph). The DHV is then multiplied by the D-Factor, which is the proportion of the DHV occurring in the peak direction of travel (also known as the directional split). The resulting values are the directional design hourly volumes (DDHV) and are presented in Table 3-13, for each of the routes considered. The DDHV is then multiplied by 4 hours (when diversion traffic control points or

[24] Winter means that school is in session at normal enrollment levels, which also applies to spring and autumn months.
[25] 2016 Ontario Ministry of Transportation Provincial Highways Annual Average Daily Traffic (AADT); https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Theme.aspx?r=702797&f=files%2FProvincial+Highways+Traffic+Volumes+2016+AADT+Only.pdf&m=resource
[26] 407 ERT Usage Statistics (https://www.407etr.com/en/highway/corporate/usage-statistics.html)

access control points – ACP – are assumed to be activated) to estimate the total number of external vehicles loaded on the analysis network.

As indicated, there are 41,896 vehicles entering the study area as external-external trips prior to the activation of the ACP and the diversion of this traffic. This number is reduced by 60% for evening scenarios (Scenarios 5 and 12) as discussed in Section 6.

## 3.10 Background Traffic

Section 5 discusses the time needed for the people in the PZ to mobilize and begin their evacuation trips. As shown in Table 5-9 and Table 5-10, there are 15 time periods during which traffic is loaded on to roadways in the PZ to model the mobilization time of people in the PZ. Note, there is no traffic generated during the 15$^{th}$ time period, as this time period is intended to allow traffic that has already begun evacuating to clear the study area boundaries.

This study does not assume that roadways are empty at the start of Time Period 1. Rather, there is an initialization time period (often referred to as "fill time" in traffic simulation) wherein the traffic volumes from the start of the evacuation (Time Period 1) are loaded onto roadways in the PZ. The amount of initialization/fill traffic that is on the roadways in the PZ at the start of Time Period 1 depends on the scenario and the region being evacuated (see Section 6). There are 5,293 vehicles on the roadways in the PZ at the end of fill time for an evacuation of the entire DPZ (Region R03) under Scenario 6 (winter, midweek, midday, good weather) conditions.

## 3.11 Heavy Vehicles

Roadway grade (slope of the roadway) is only a factor in ETE when there is a significant percentage of heavy vehicles present in the evacuation stream. Heavy vehicles have difficulty climbing grades. As such, for a single lane road, a heavy vehicle climbing a grade could inhibit the egress of all vehicles behind it. If there are multiple lanes, vehicles behind the heavy vehicle can pass.

People are not likely to evacuate in heavy vehicles. The only significant presence of heavy vehicles would be in external traffic – through truck traffic passing through the study area along major highways/freeways – which will be diverted within four hours of the emergency bulletin to evacuate. Exhibit 7-1(b) of the HCM 2022[27] shows that grade has a limited impact on service volume (vehicles per hour – veh/h) for a freeway segment in that service volume decreases from 5,100 veh/h at a 2% grade to 4,400 veh/h at a 6% grade – a 13% decrease in service volume for a 200% increase in grade. Most grades observed during the road survey of the study area were 3% or less.

[27] The Highway Capacity Manual for 2022 is authored by the Transportation Research Board (TRB) in the United States. The figures, equations and examples used in the HCM 2022 use English units (miles, miles per hour, etc.) by default. See Section 4 for further details.

Exhibit 12-7 of the HCM 2022 shows that capacity of a freeway decreases from 2,400 passenger cars per hour per lane (pc/h/ln) at a free flow speed (FFS) of 75mph (121kph) to 2,250 pc/h/ln at 55mph (89kph). As discussed in Section 4.3.3, this study conservatively assumed a capacity of 2,250 pc/h/ln for all freeways, corresponding to a FFS of about 90kph, despite observed FFS well in excess of 100kph on all freeways (see Table K-1) in the study area during the road survey. Any reduction in speed caused by grade and the presence of heavy vehicles on freeways is already accounted for in the conservative capacity estimate of 2,250 pc/h/ln for freeways.

Exhibit 12-8 of the 2022 HCM shows that capacity of a multilane highway decreases from 2,300 pc/h/ln at a FFS of 70mph (113kph) to 1,900 pc/h/ln at a FFS of 45mph (72kph). As discussed in Section 4.3.2, this study conservatively assumed a capacity of 1,900 pc/h/ln for multilane highways, corresponding to a FFS of about 72kph, despite observed FFS in excess of 80kph on most multilane highways in the study area during the road survey.

The presence of heavy vehicles in the evacuating traffic stream is expected to be minimal. The presence of heavy vehicles and grades within the study area are also expected to have minimal impact on roadway capacity and ETE. Nonetheless, based on discussions with OPG and OROs, 5% of heavy vehicle traffic is assumed for all evacuation cases based on discussions with local stakeholders.

## 3.12 Summary of Demand

A summary of population and vehicle demand is provided in Table 3-14 and Table 3-15, respectively. This summary includes all population groups described in this section. A total of 652,136 people is considered in this study, where 269,787 people are in the DPZ (includes 30% of the permanent resident population shadow evacuation - 81,062 people) and 382,349 people are located in the CPZ. A total of 324,694 vehicles are considered in this study, where 120,477 vehicles are within the DPZ (includes 30% of the shadow evacuation vehicles - 37,643 vehicles), 162,321 vehicles are within the CPZ, and 41,896 are considered external traffic vehicles.

Table 3-1. Municipality Annual Growth Rate from July 1, 2016 to July 1, 2021

| Municipality | 2016 Population | 2021 Population | Percent Change | Annual Growth Rate |
|---|---|---|---|---|
| **Clarington** | 95,003 | 104,234 | 9.72% | 1.87% |
| **Oshawa** | 164,602 | 181,440 | 10.23% | 1.97% |
| **Whitby** | 132,268 | 145,108 | 9.71% | 1.87% |

Table 3-2. PZ Permanent Resident Population

| Response Sector | 2021 Population | 2023 Extrapolated Population |
|---|---|---|
| **DNGS** | 0 | 0 |
| **D1** | 74 | 77 |
| **D2** | 18,965 | 19,619 |
| **D3** | 11,202 | 11,590 |
| **D4** | 23,625 | 24,445 |
| **D5** | 9,133 | 9,452 |
| **D6A (GM Parking Lot)** | 0 | 0 |
| **D6B** | 14,515 | 15,041 |
| **D7** | 4,761 | 4,933 |
| **D8A** | 16,789 | 17,398 |
| **D8B** | 5,998 | 6,214 |
| **D9** | 13,696 | 14,200 |
| **D10** | 7,986 | 8,263 |
| **D11** | 1,973 | 2,043 |
| **D12** | 4,387 | 4,538 |
| **D13** | 2,228 | 2,304 |
| **D14 (Lake Ontario)** | 0 | 0 |
| **D15 (Lake Ontario)** | 0 | 0 |
| **D16 (Lake Ontario)** | 0 | 0 |
| **DPZ Total:** | **135,332** | **140,117** |
| **CPZ1** | 4,233 | 4,380 |
| **CPZ2** | 11,939 | 12,352 |
| **CPZ3 (Lake Ontario)** | 0 | 0 |
| **CPZ4 (Lake Ontario)** | 0 | 0 |
| **CPZ5 (Lake Ontario)** | 0 | 0 |
| **CPZ6** | 8,266 | 8,557 |
| **CPZ7** | 227,188 | 235,228 |
| **CPZ8** | 9,357 | 9,690 |
| **CPZ Total:** | **260,983** | **270,207** |
| **PZ Total:** | **396,315** | **410,324** |
| **PZ Population Growth (2021-2023):** | | **3.53%** |

**Table 3-3. PZ Permanent Resident Population and Vehicles by Response Sector**

| Response Sector | 2023 Extrapolated Population | 2023 Resident Vehicles |
|---|---|---|
| **DNGS** | 0 | 0 |
| **D1** | 77 | 34 |
| **D2** | 19,619 | 9,111 |
| **D3** | 11,590 | 5,383 |
| **D4** | 24,445 | 11,355 |
| **D5** | 9,452 | 4,384 |
| **D6A (GM Parking Lot)** | 0 | 0 |
| **D6B** | 15,041 | 6,986 |
| **D7** | 4,933 | 2,291 |
| **D8A** | 17,398 | 8,075 |
| **D8B** | 6,214 | 2,883 |
| **D9** | 14,200 | 6,595 |
| **D10** | 8,263 | 3,837 |
| **D11** | 2,043 | 947 |
| **D12** | 4,538 | 2,106 |
| **D13** | 2,304 | 1,069 |
| **D14 (Lake Ontario)** | 0 | 0 |
| **D15 (Lake Ontario)** | 0 | 0 |
| **D16 (Lake Ontario)** | 0 | 0 |
| **DPZ Total:** | **140,117** | **65,056** |
| **CPZ1** | 4,380 | 2,034 |
| **CPZ2** | 12,352 | 5,741 |
| **CPZ3 (Lake Ontario)** | 0 | 0 |
| **CPZ4 (Lake Ontario)** | 0 | 0 |
| **CPZ5 (Lake Ontario)** | 0 | 0 |
| **CPZ6** | 8,557 | 3,974 |
| **CPZ7** | 235,228 | 109,233 |
| **CPZ8** | 9,690 | 4,494 |
| **CPZ Total:** | **270,207** | **125,476** |
| **PZ Total:** | **410,324** | **190,532** |

**Table 3-4. Shadow Population and Vehicles by Sector**

| Sector | 2023 Extrapolated Population | Evacuating Vehicles |
|---|---|---|
| N | 2,028 | 941 |
| NNE | 2,043 | 948 |
| NE | 2,214 | 1,029 |
| ENE | 11,623 | 5,402 |
| E | 0 | 0 |
| ESE | 0 | 0 |
| SE | 0 | 0 |
| SSE | 0 | 0 |
| S | 0 | 0 |
| SSW | 0 | 0 |
| SW | 0 | 0 |
| WSW | 0 | 0 |
| W | 91,804 | 42,635 |
| WNW | 125,760 | 58,396 |
| NW | 32,553 | 15,112 |
| NNW | 2,182 | 1,013 |
| **TOTAL** | **270,207** | **125,476** |

**Table 3-5. Summary of Transients and Transient Vehicles**

| Response Sector | Transients | Transient Vehicles |
|---|---|---|
| DNGS | 0 | 0 |
| D1 | 0 | 0 |
| D2 | 4,626 | 1,452 |
| D3 | 0 | 0 |
| D4 | 0 | 0 |
| D5 | 856 | 372 |
| D6A (GM Parking Lot) | 0 | 0 |
| D6B | 194 | 72 |
| D7 | 324 | 108 |
| D8A | 166 | 75 |
| D8B | 0 | 0 |
| D9 | 54 | 27 |
| D10 | 65 | 27 |
| D11 | 0 | 0 |
| D12 | 186 | 87 |
| D13 | 0 | 0 |
| D14 (Lake Ontario) | 0 | 0 |
| D15 (Lake Ontario) | 0 | 0 |
| D16 (Lake Ontario) | 0 | 0 |
| **DPZ Total:** | **6,471** | **2,220** |
| CPZ1 | 1,380 | 525 |
| CPZ2 | 2,171 | 810 |
| CPZ3 (Lake Ontario) | 0 | 0 |
| CPZ4 (Lake Ontario) | 0 | 0 |
| CPZ5 (Lake Ontario) | 0 | 0 |

| Response Sector | Transients | Transient Vehicles |
|---|---|---|
| **CPZ6** | 1,906 | 890 |
| **CPZ7** | 18,301 | 6,785 |
| **CPZ8** | 1,613 | 614 |
| **CPZ Total:** | **25,371** | **9,624** |
| **PZ Total:** | **31,842** | **11,844** |

**Table 3-6. Summary of Employee Vehicles and Employees Evacuating from GO Transit Stations**

| Response Sector | GO Station | Parking Spaces | Employee Vehicles | Employees |
|---|---|---|---|---|
| CPZ6 | GO Station–- Whitby | 4,230 | 212 | 212 |
| CPZ7 | GO Station–- Oshawa | 2,390 | 120 | 120 |

**Table 3-7. Summary of Employees and Employee Vehicles Commuting into the PZs**

| Response Sector | Employees | Employee Vehicles |
|---|---|---|
| **DNGS** | 2,732 | 2,732 |
| **D1** | 189 | 189 |
| **D2** | 1,925 | 1,925 |
| **D3** | 970 | 970 |
| **D4** | 2,289 | 2,289 |
| **D5** | 592 | 592 |
| **D6A (GM Parking Lot)** | 0 | 0 |
| **D6B** | 468 | 468 |
| **D7** | 252 | 252 |
| **D8A** | 630 | 630 |
| **D8B** | 239 | 239 |
| **D9** | 1,063 | 1,063 |
| **D10** | 727 | 727 |
| **D11** | 279 | 279 |
| **D12** | 425 | 425 |
| **D13** | 163 | 163 |
| **D14 (Lake Ontario)** | 0 | 0 |
| **D15 (Lake Ontario)** | 0 | 0 |
| **D16 (Lake Ontario)** | 0 | 0 |
| **DPZ Total:** | **12,943** | **12,943** |
| **CPZ1** | 161 | 161 |
| **CPZ2** | 851 | 851 |
| **CPZ3 (Lake Ontario)** | 0 | 0 |
| **CPZ4 (Lake Ontario)** | 0 | 0 |
| **CPZ5 (Lake Ontario)** | 0 | 0 |
| **CPZ6** | 755 | 755 |
| **CPZ7** | 15,936 | 15,936 |
| **CPZ8** | 644 | 644 |
| **CPZ Total:** | **18,347** | **18,347** |
| **PZ Total:** | **31,290** | **31,290** |

**Table 3-8. Medical Facility Transit Demand**

| Response Sector | Facility Name | Municipality | Capa-city | Current Census | Ambula-tory Patients | Wheel-chair Patients | Bed-ridden Patients | Bus Runs | Wheel-chair Van Runs | Ambulance Runs |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | | | |
| D2 | White Cliffe Terrace Retirement Residence | Courtice | 114 | 114 | 114 | 0 | 0 | 4 | 0 | 0 |
| D3 | Seasons Clarington | Bowmanville | 120 | 112 | 84 | 28 | 0 | 3 | 7 | 0 |
| D4 | Glen Hill–- Strathaven Retirement Residence | Bowmanville | 199 | 199 | 158 | 40 | 1 | 6 | 10 | 1 |
| D5 | Lakeridge Health | Bowmanville | 77 | 60 | 40 | 7 | 13[28] | 2 | 2 | 13 |
| D10 | Harmony Estate Senior Residence Inc. | Courtice | 10 | 9 | 9 | 0 | 0 | 1 | 0 | 0 |
| CPZ2 | Fosterbrooke Long Term Care | Newcastle | 88 | 88 | 76 | 10 | 2 | 3 | 3 | 2 |
| | | *Clarington DPZ Total:* | *520* | *494* | *405* | *75* | *14* | *16* | *19* | *14* |
| | | *Clarington CPZ Total:* | *88* | *88* | *76* | *10* | *2* | *3* | *3* | *2* |
| | | *Clarington Total:* | *608* | *582* | *481* | *85* | *16* | *19* | *22* | *16* |
| **OSHAWA, ONTARIO** | | | | | | | | | | |
| D7 | Traditions of Durham Retirement Community | Oshawa | 140 | 132 | 131 | 1 | 0 | 5 | 1 | 0 |
| D8A | Cedarcroft Place Retirement Residence | Oshawa | 77 | 73 | 69 | 3 | 1 | 3 | 1 | 1 |
| CPZ7 | Park View Place | Oshawa | 60 | 60 | 30 | 24 | 6 | 1 | 6 | 6 |
| CPZ7 | The Carriage House | Oshawa | 30 | 30 | 15 | 12 | 3 | 1 | 3 | 3 |
| CPZ7 | Livita Centennial Retirement Residence | Oshawa | 20 | 20 | 10 | 8 | 2 | 1 | 2 | 2 |
| CPZ7 | Faith Place | Oshawa | 180 | 180 | 91 | 70 | 19 | 4 | 18 | 19 |
| CPZ7 | Hillsdale Estates | Oshawa | 300 | 300 | 152 | 117 | 31 | 6 | 30 | 31 |
| CPZ7 | Lakeridge Health Oshawa | Oshawa | 363 | 363 | 184 | 141 | 38 | 7 | 36 | 38 |
| CPZ7 | Hillsdale Terrace | Oshawa | 200 | 200 | 101 | 78 | 21 | 4 | 20 | 21 |
| CPZ7 | Extendicare Oshawa | Oshawa | 175 | 175 | 89 | 68 | 18 | 3 | 17 | 18 |
| CPZ7 | Revera Thornton View Long Term Care | Oshawa | 154 | 154 | 78 | 60 | 16 | 3 | 15 | 16 |
| CPZ7 | Chartwell Wynfield Long Term Care Residence | Oshawa | 252 | 172 | 172 | 0 | 0 | 6 | 0 | 0 |
| CPZ7 | Chartwell Wynfield Retirement Residence | Oshawa | 107 | 102 | 102 | 0 | 0 | 4 | 0 | 0 |
| | | *Oshawa DPZ Total:* | *217* | *205* | *200* | *4* | *1* | *8* | *2* | *1* |
| | | *Oshawa CPZ Total:* | *1,841* | *1,756* | *1,024* | *578* | *154* | *40* | *147* | *154* |
| | | *Oshawa Total:* | *2,058* | *1,961* | *1,224* | *582* | *155* | *48* | *149* | *155* |

[28] Lakeridge Health includes 1 Acute Care patient as Bedridden Patient that also requires an ambulance to evacuate.

| Response Sector | Facility Name | Municipality | Capa-city | Current Census | Ambula-tory Patients | Wheel-chair Patients | Bed-ridden Patients | Bus Runs | Wheel-chair Van Runs | Ambulance Runs |
|---|---|---|---|---|---|---|---|---|---|---|
| WHITBY, ONTARIO | | | | | | | | | | |
| CPZ6 | Lakeridge Health | Whitby | 74 | 73 | 38 | 28 | 7 | 2 | 7 | 7 |
| CPZ7 | Sunnycrest Nursing Homes Ltd | Whitby | 136 | 136 | 69 | 53 | 14 | 3 | 14 | 14 |
| CPZ7 | Tekoa Manor | Whitby | 125 | 125 | 63 | 49 | 13 | 3 | 13 | 13 |
| CPZ7 | Glen Hill Terrace | Whitby | 174 | 174 | 88 | 68 | 18 | 3 | 17 | 18 |
| CPZ7 | Bloomsdale Seniors Home | Whitby | 20 | 20 | 10 | 8 | 2 | 1 | 2 | 2 |
| CPZ7 | Bowling Green Towers | Whitby | 80 | 80 | 41 | 31 | 8 | 2 | 8 | 8 |
| CPZ7 | Centre–- DRLHC | Whitby | 16 | 16 | 8 | 6 | 2 | 1 | 2 | 2 |
| CPZ7 | Windsor Place | Whitby | 104 | 104 | 52 | 41 | 11 | 2 | 11 | 11 |
| CPZ7 | The Court At Pringle Creek | Whitby | 119 | 119 | 60 | 47 | 12 | 2 | 12 | 12 |
| CPZ7 | Amica at Whitby | Whitby | 139 | 139 | 70 | 54 | 15 | 3 | 14 | 15 |
| CPZ7 | Chartwell Colonial Retirement Residence | Whitby | 96 | 96 | 49 | 37 | 10 | 2 | 10 | 10 |
| CPZ7 | Fairview Lodge | Whitby | 198 | 198 | 100 | 77 | 21 | 4 | 20 | 21 |
| CPZ7 | Village of Taunton Mills | Whitby | 184 | 184 | 93 | 72 | 19 | 4 | 18 | 19 |
| CPZ7 | Oakwood Retirement Communities | Whitby | 125 | 125 | 63 | 49 | 13 | 3 | 13 | 13 |
| CPZ7 | Lynde Creek Manor Retirement Community | Whitby | 94 | 94 | 47 | 37 | 10 | 2 | 10 | 10 |
| CPZ7 | The Court at Brooklin | Whitby | 118 | 118 | 60 | 46 | 12 | 2 | 12 | 12 |
| | | *Whitby DPZ Total:* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| | | *Whitby CPZ Total:* | *1,802* | *1,801* | *911* | *703* | *187* | *39* | *183* | *187* |
| | | *Whitby Total:* | *1,802* | *1,801* | *911* | *703* | *187* | *39* | *183* | *187* |
| | | **DPZ TOTAL:** | **737** | **699** | **605** | **79** | **15** | **24** | **21** | **15** |
| | | **CPZ TOTAL:** | **3,731** | **3,645** | **2,011** | **1,291** | **343** | **82** | **333** | **343** |
| | | **TOTAL:** | **4,468** | **4,344** | **2,616** | **1,370** | **358** | **106** | **354** | **358** |

**Table 3-9. School Population Demand Estimates**

| Response Sector | School Name | Enrolment | Buses Required |
|---|---|---|---|
| **CLARINGTON, ONTARIO SCHOOLS** | | | |
| D2 | Holy Trinity Catholic Secondary School | 770 | 17 |
| D2 | Good Shepherd Catholic Elementary School | 438 | 7 |
| D2 | Lydia Trull Public School | 331 | 5 |
| D2 | Dr. G.J. MacGillivray Public School | 850 | 12 |
| D2 | Dr. Emily Stowe School | 326 | 5 |
| D2 | Mother Teresa Catholic Elementary School | 420 | 6 |
| D2 | Courtice Secondary School | 694 | 15 |
| D2 | Courtice North Public School | 448 | 7 |
| D2 | Oxford Learning Academy | 50 | 1 |
| D3 | Dr. Ross Tilley Public School | 497 | 7 |
| D3 | Holy Family Catholic Elementary School | 659 | 10 |
| D3 | Clarington Central Secondary School | 850 | 18 |
| D4 | Four Winds Montessori School | 20 | 1 |
| D4 | Central Public School | 161 | 3 |
| D4 | Duke of Cambridge Public School | 890 | 13 |
| D4 | Bowmanville High School | 970 | 21 |
| D4 | Durham Christian High School | 155 | 4 |
| D4 | St. Stephen Catholic Secondary School | 995 | 21 |
| D4 | Knox Christian School | 291 | 5 |
| D4 | Saint Elizabeth Catholic Elementary School | 462 | 7 |
| D4 | Charles Bowman Public School | 715 | 10 |
| D4 | John M. James School | 414 | 6 |
| D4 | Harold Longworth Public School | 492 | 7 |
| D5 | Waverley Public School | 365 | 6 |
| D5 | Blaisdale Montessori | 1,094 | 16 |
| D5 | St. Joseph Catholic Elementary School | 496 | 7 |
| D10 | S.T. Worden Public School | 210 | 3 |
| D10 | Monsignor Leo Cleary Catholic Elementary School | 188 | 3 |
| CPZ1 | Ummati School | 70 | 1 |
| CPZ1 | Orono Public School | 131 | 2 |
| CPZ1 | Kirby Centennial Public School | 92 | 2 |
| CPZ2 | Newcastle Public School | 579 | 9 |
| CPZ2 | The Pines Senior Public School | 193 | 4 |
| CPZ2 | Clarke High School | 313 | 7 |
| CPZ8 | M J Hobbs Senior Public School | 223 | 4 |
| CPZ8 | Hampton Junior Public School | 174 | 3 |
| CPZ8 | Enniskillen Public School | 191 | 3 |
| | *Clarington DPZ Total:* | *14,251* | *243* |
| | *Clarington CPZ Total:* | *1,966* | *35* |
| | *Clarington Total:* | *16,217* | *278* |

| Response Sector | School Name | Enrolment | Buses Required |
|---|---|---|---|
| OSHAWA, ONTARIO SCHOOLS | | | |
| D6B | Lakewoods Public School | 333 | 5 |
| D6B | G L Roberts Collegiate and Vocational Institute | 481 | 11 |
| D6B | Dr C F Cannon Public School | 415 | 6 |
| D6B | Monsignor Philip Coffey Catholic School | 247 | 4 |
| D6B | Glen Street Public School | 395 | 6 |
| D7 | Bobby Orr Public School | 262 | 4 |
| D7 | Monsignor John Pereyma Catholic Secondary School | 489 | 11 |
| D8A | Campbell School | 250 | 4 |
| D8A | John XXIII Catholic School | 205 | 3 |
| D8A | Forest View Public School | 430 | 6 |
| D8A | Clara Hughes Public School | 565 | 8 |
| D8A | David Bouchard Public School | 576 | 8 |
| D8A | St Hedwig Catholic School | 113 | 2 |
| D8B | College Park Elementary School | 196 | 3 |
| D8B | Kingsway College Private High School | 182 | 4 |
| D8B | Vincent Massey Public School | 427 | 6 |
| D8B | Eastdale Collegiate & Vocational Institute | 1,124 | 24 |
| D8B | Durham Elementary Private School | 72 | 1 |
| D8B | Coronation Public School | 458 | 7 |
| CPZ7 | Harmony Heights Public School | 346 | 5 |
| CPZ7 | Sir Albert Love Catholic School | 244 | 4 |
| CPZ7 | Village Union Public School | 337 | 5 |
| CPZ7 | Durham Continuing Education | 184 | 0[29] |
| CPZ7 | Walter E Harris Public School | 565 | 8 |
| CPZ7 | Mary Street Community School | 145 | 3 |
| CPZ7 | Ééc Corpus-Christi | 282 | 4 |
| CPZ7 | Saint Thomas Aquinas Catholic School | 288 | 4 |
| CPZ7 | Hillsdale Public School | 149 | 3 |
| CPZ7 | Gordon B Attersley Public School | 382 | 6 |
| CPZ7 | College Hill Public School | 243 | 4 |
| CPZ7 | ’'Neill Collegiate and Vocational Institute | 1,187 | 25 |
| CPZ7 | St Joseph Catholic School | 470 | 7 |
| CPZ7 | Durham Alternative Secondary Education School/Grove School & Treatment Centre | 250 | 6 |
| CPZ7 | St. Kateri Tekakwitha Catholic School | 329 | 5 |
| CPZ7 | DR S J Phillips Public School | 710 | 10 |
| CPZ7 | Beau Valley Public School | 279 | 4 |
| CPZ7 | Waverly Public School | 380 | 6 |
| CPZ7 | Maxwell Heights Secondary School | 1,573 | 33 |
| CPZ7 | St Christopher Catholic School | 407 | 6 |
| CPZ7 | Woodcrest Public School | 300 | 5 |
| CPZ7 | Blaisdale Montessori Oshawa Campus | 60 | 2 |

[29] The students at Durham Continuing Education evacuate in 160 personal vehicles and do not require a bus.

| Response Sector | School Name | Enrolment | Buses Required |
|---|---|---|---|
| CPZ7 | Jeanne Sauvé Public School | 720 | 10 |
| CPZ7 | École élémentaire Antonine-Maillet | 193 | 3 |
| CPZ7 | St. John Bosco Catholic School | 515 | 8 |
| CPZ7 | Sherwood Public School | 780 | 11 |
| CPZ7 | Queen Elizabeth Public School | 450 | 7 |
| CPZ7 | R.S. McLaughlin CVI | 1,000 | 21 |
| CPZ7 | Adelaide McLaughlin Public School | 323 | 5 |
| CPZ7 | Monsignor Paul Dwyer Catholic High School | 854 | 18 |
| CPZ7 | Sunset Heights Public School | 315 | 5 |
| CPZ7 | Father Joseph Venini Catholic School | 269 | 4 |
| CPZ7 | Stephen G. Saywell | 400 | 6 |
| CPZ7 | Immanuel Christian School | 126 | 2 |
| CPZ7 | Kedron Public School | 436 | 7 |
| CPZ7 | Columbus Private School | 29 | 1 |
| CPZ8 | Norman G. Powers Public School | 789 | 11 |
| CPZ8 | Seneca Trail Public School | 706 | 10 |
| | *Oshawa DPZ Total:* | *7,220* | *123* |
| | *Oshawa CPZ Total:* | *17,015* | *284* |
| | *Oshawa Total:* | *24,235* | *404* |
| **WHITBY, ONTARIO SCHOOLS** | | | |
| CPZ6 | Whitby Shores Public School | 674 | 10 |
| CPZ7 | Bellwood Public School | 470 | 7 |
| CPZ7 | Dr. Robert Thornton Public School | 305 | 5 |
| CPZ7 | Saint Paul Catholic School | 297 | 5 |
| CPZ7 | Kendalwood Montessori & Elementary School | 107 | 2 |
| CPZ7 | St Theresa Catholic School | 236 | 4 |
| CPZ7 | Ééc Jean-Paul II | 305 | 5 |
| CPZ7 | Anderson Collegiate and Vocational Institute | 900 | 19 |
| CPZ7 | John Dryden Public School | 715 | 10 |
| CPZ7 | C E Broughton Public School | 320 | 5 |
| CPZ7 | St Mark the Evangelist Catholic Elementary School | 304 | 5 |
| CPZ7 | Sir Samuel Steele Public School | 500 | 7 |
| CPZ7 | Pringle Creek Public School | 720 | 10 |
| CPZ7 | Trafalgar Castle School | 205 | 4 |
| CPZ7 | Sir William Stephenson Public School | 425 | 6 |
| CPZ7 | Julie Payette Public School | 953 | 14 |
| CPZ7 | Glen Dhu Public School | 466 | 7 |
| CPZ7 | Blyth Academy–- Whitby Campus | 60 | 2 |
| CPZ7 | Hatch House Montessori School | 61 | 1 |
| CPZ7 | Henry Street High School | 1,000 | 21 |
| CPZ7 | Father Leo J Austin Catholic Secondary School | 817 | 18 |
| CPZ7 | St Bernard Catholic School | 335 | 5 |
| CPZ7 | Fallingbrook Public School | 411 | 6 |
| CPZ7 | Saint Marguerite ’'Youville Catholic School | 415 | 6 |
| CPZ7 | West Lynde Public School | 450 | 7 |

| Response Sector | School Name | Enrolment | Buses Required |
|---|---|---|---|
| CPZ7 | E A Fairman Public School | 240 | 4 |
| CPZ7 | Sinclair Secondary School | 1,600 | 34 |
| CPZ7 | Ormiston Public School | 400 | 6 |
| CPZ7 | Immanuel Christian School Society | 58 | 1 |
| CPZ7 | Saint Matthew the Evangelist Catholic School | 457 | 7 |
| CPZ7 | Saint John the Evangelist Catholic School | 220 | 4 |
| CPZ7 | Whitby Montessori and Elementary School | 112 | 2 |
| CPZ7 | Jack Miner Public School | 530 | 8 |
| CPZ7 | Donald A. Wilson Secondary School | 1,520 | 32 |
| CPZ7 | École Secondaire Catholique Saint-Charles-Garnier | 100 | 3 |
| CPZ7 | All Saints Catholic Secondary School | 817 | 18 |
| CPZ7 | Colonel J E Farewell Public School | 450 | 7 |
| CPZ7 | Captain Michael Vandenbos Public School | 650 | 10 |
| CPZ7 | Saint Luke the Evangelist Catholic School | 65 | 1 |
| CPZ7 | Robert Munsch Public School | 635 | 9 |
| CPZ7 | Blair Ridge Public School | 740 | 11 |
| CPZ7 | Williamsburg Public School | 711 | 10 |
| CPZ7 | Blessed Pope John Paul II Catholic School | 130 | 3 |
| | *Whitby DPZ Total:* | *0* | *0* |
| | *Whitby CPZ Total:* | *20,886* | *361* |
| | *Whitby Total:* | *20,886* | *361* |
| | **DPZ TOTAL:** | **21,471** | **366** |
| | **CPZ TOTAL:** | **39,867** | **680** |
| | **TOTAL:** | **61,338** | **1,046** |

**Table 3-10. College/University Population Demand Estimates**

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Total Enrolment | Transit-dependent Students | Commuter/ Ridesharing Students | Commuter/ Ridesharing Student Vehicles | Buses Required |
|---|---|---|---|---|---|---|---|---|---|---|
| **OSHAWA, ONTARIO** | | | | | | | | | | |
| CPZ7 | 13.6 | W | Trent University - Durham GTA Campus | 55 Thornton Rd S | Oshawa | 1,960 | 464 | 1,496 | 360 | 16 |
| CPZ7 | 16.1 | WNW | Durham College - Oshawa Campus | 2000 Simcoe St N | Oshawa | 8,539 | 1,606 | 6,933 | 3,000 | 54 |
| CPZ7 | 16.1 | WNW | Ontario Tech University | 2000 Simcoe St N | Oshawa | 9,732 | 2,242 | 7,490 | 2,000 | 75 |
| | | | | | *Oshawa DPZ Total:* | *0* | *0* | *0* | *0* | *0* |
| | | | | | *Oshawa CPZ Total:* | *20,231* | *4,312* | *15,919* | *5,360* | *145* |
| | | | | | *Oshawa Total:* | *20,231* | *4,312* | *15,919* | *5,360* | *145* |
| **WHITBY, ONTARIO** | | | | | | | | | | |
| CPZ7 | 11.2 | W | Durham College - Whitby Campus | 1610 Champlain Ave | Whitby | 1,839 | 346 | 1,493 | 646 | 12 |
| | | | | | *Whitby DPZ Total:* | *0* | *0* | *0* | *0* | *0* |
| | | | | | *Whitby CPZ Total:* | *1,839* | *346* | *1,493* | *646* | *12* |
| | | | | | *Whitby Total:* | *1,839* | *346* | *1,493* | *646* | *12* |
| | | | | | **DPZ TOTAL:** | **0** | **0** | **0** | **0** | **0** |
| | | | | | **CPZ TOTAL:** | **22,070** | **4,658** | **17,412** | **6,006** | **157** |
| | | | | | **TOTAL:** | **22,070** | **4,658** | **17,412** | **6,006** | **157** |

**Table 3-11. Summer Day Camp Population Estimates[30]**

| Response Sector | Distance (km) | Direc-tion | Summer Day Camp Name[31] | Street Address | Municipality | Enrol-ment | Buses Required |
|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | |
| D2 | 5.9 | NW | Good Shepherd Catholic Elementary School | 20 Farmington Dr | Courtice | 50 | 1 |
| D2 | 6.2 | NW | Lydia Trull Public School | 80 Avondale Dr | Courtice | 50 | 1 |
| D2 | 6.8 | NW | Dr. Emily Stowe School | 71 Sandringham Dr | Courtice | 50 | 1 |
| D2 | 7.1 | NW | Courtice North Public School | 1675 Nash Rd | Courtice | 50 | 1 |
| D4 | 7.4 | NNE | Charles Bowman Public School | 195 Bons Ave | Bowmanville | 50 | 1 |
| D4 | 7.8 | NNE | Harold Longworth Public School | 350 Longworth Ave | Bowmanville | 50 | 1 |
| D10 | 8.2 | WNW | S.T. Worden Public School | 1462 Nash Rd | Courtice | 50 | 1 |
| CPZ2 | 11.1 | ENE | Pryde At St Francis Of Assisi | 1774 Rudell Rd | Newcastle | N/A | 0 |
| CPZ2 | 12.4 | ENE | Newcastle Glass Court YMCA Child Care Centre | 50 Glass Ct | Newcastle | N/A | 0 |
| CPZ8 | 11.7 | N | Hampton Hampton YMCA Centre | 43 Ormiston St | Hampton | N/A | 0 |
| CPZ8 | 17.1 | NNW | Enniskillen YMCA Centre | 8145 Old Scugog Rd | Hampton | N/A | 0 |
| | | | | | *Clarington DPZ Total:* | *350* | *7* |
| | | | | | *Clarington CPZ Total:* | N/A | 0 |
| | | | | | *Clarington Total:* | *350* | *7* |
| **OSHAWA, ONTARIO** | | | | | | | |
| D6B | 10.1 | W | Dr. C.F. Cannon Public School | 1196 Cedar St | Oshawa | 50 | 1 |
| D8A | 8.2 | WNW | John XXIII Catholic School | 195 Athabasca St | Oshawa | 50 | 1 |
| D8A | 9.1 | WNW | Clara Hughes Public School | 610 Taylor Ave | Oshawa | 50 | 1 |
| D8B | 11.0 | WNW | Oshawa Coronation YMCA Centre | 445 Adelaide Ave E | Oshawa | 50 | 1 |
| CPZ7 | 11.5 | WNW | Oshawa Mary St. YMCA | 99 Mary St N | Oshawa | N/A | 0 |
| CPZ7 | 12.7 | NW | Oshawa St. Kateri Tekakwitha YMCA Centre | 1425 Coldstream Dr | Oshawa | N/A | 0 |
| CPZ7 | 12.8 | WNW | Oshawa Dr. SJ Phillips YMCA Centre | 625 Simcoe St N | Oshawa | N/A | 0 |
| CPZ7 | 13.3 | W | Oshawa Waverly YMCA Centre | 100 Waverly St S | Oshawa | N/A | 0 |
| CPZ7 | 13.4 | WNW | Oshawa St. Christopher YMCA Centre | 431 Annapolis Ave | Oshawa | N/A | 0 |

[30] Summer Day Camps are assumed to be open only during Weekdays in Summers. They are closed for the rest of the year.
[31] For the summer day camps within the CPZ, it is assumed that parents will pick up their children prior to evacuation. Thus, no transit vehicles are considered for those facilities.

| Response Sector | Distance (km) | Direc-tion | Summer Day Camp Name[31] | Street Address | Municipality | Enrol-ment | Buses Required |
|---|---|---|---|---|---|---|---|
| CPZ7 | 13.7 | NW | Oshawa St. John Bosco YMCA Centre | 1600 Clearbrook Dr | Oshawa | N/A | 0 |
| CPZ7 | 14.4 | WNW | Oshawa Father Joseph Venini YMCA Centre | 120 Glovers Rd | Oshawa | N/A | 0 |
| CPZ7 | 15.2 | NW | Oshawa Kedron YMCA Child Care Centre | 1935 Ritson Rd N | Oshawa | N/A | 0 |
| CPZ8 | 12.6 | NW | Oshawa Norman G. Powers YMCA Centre | 1555 Coldstream Dr | Oshawa | N/A | 0 |
| | | | | | *Oshawa DPZ Total:* | *200* | *4* |
| | | | | | *Oshawa CPZ Total:* | N/A | 0 |
| | | | | | *Oshawa Total:* | *200* | *4* |
| **WHITBY, ONTARIO** | | | | | | | |
| CPZ7 | 15.3 | WNW | Whitby St. Paul YMCA Centre | 200 Garrard Rd | Whitby | N/A | 0 |
| CPZ7 | 18.5 | WNW | Whitby St. Matthew YMCA Child Care Centre | 60 Willowbrook Dr | Whitby | N/A | 0 |
| CPZ7 | 19.9 | W | Whitby Colonel JE Farewell YMCA Centre | 810 McQuay Blvd | Whitby | N/A | 0 |
| CPZ7 | 20.7 | WNW | Brooklin St. John Paul II YMCA Centre | 160 Cachet Blvd | Whitby | N/A | 0 |
| | | | | | *Whitby DPZ Total:* | N/A | 0 |
| | | | | | *Whitby CPZ Total:* | N/A | 0 |
| | | | | | *Whitby Total:* | N/A | 0 |
| | | | | | **DPZ TOTAL:** | **550** | **11** |
| | | | | | **CPZ TOTAL:** | N/A | 0 |
| | | | | | **TOTAL:** | **550** | **11** |

**Table 3-12. Transit-Dependent Population Estimates**

| 2023 PZs Population | | Survey Average HH Size with Indicated No. of Vehicles | | | Estimated No. of Households | Survey Percent HH with Indicated No. of Vehicles | | | Survey Percent HH with Commuters | Survey Percent HH with Non-Returning Commuters | Total People Requiring Transport | Estimated Ridesharing Percentage | People Requiring Public Transit | Percent Population Requiring Public Transit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | | 0 | 1 | 2 | | | | | | |
| DPZ | 140,117 | 1.00 | 2.12 | 3.29 | 47,497 | 0.51% | 19.5% | 56.2% | 90.9% | 27.6% | 5,012 | 70.6% | 1,474 | 1.1% |
| CPZ | 270,207 | 1.00 | 2.12 | 3.29 | 91,596 | 0.51% | 19.5% | 56.2% | 90.9% | 27.6% | 9,666 | 70.6% | 2,482 | 1.1% |
| Total | 410,324 | | | | 139,093 | | | | | | 14,678 | | 4,316 | |

**Table 3-13. DNGS PZ External Traffic**

| Up Node | Down Node | Road Name | Direction | AADT[32] | K-Factor[33] | D-Factor[33] | Hourly Volume | External Traffic |
|---|---|---|---|---|---|---|---|---|
| 8000 | 1696 | Hwy 401 | WB | 98,000 | 0.091 | 0.35 | 3,121 | 12,484 |
| 8019 | 1493 | Hwy 401 | EB | 98,000 | 0.091 | 0.5 | 4,459 | 17,836 |
| 8997 | 1854 | Hwy 407 | EB | 13,414 | 0.116 | 0.5 | 778 | 3,112 |
| 8956 | 1897 | Hwy 115/35 | SB | 98,000 | 0.091 | 0.15 | 1,338 | 5,352 |
| | | | SB | 13,414 | 0.116 | 0.5 | 778 | 3,112 |
| | | | | | | | **TOTAL:** | **41,896** |

[32] 2016 Ontario Ministry of Transportation Provincial Highways Annual Average Daily Traffic (AADT). https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Theme.aspx?r=702797&f=files%2FProvincial+Highways+Traffic+Volumes+2016+AADT+Only.pdf&m=resource & 407 ERT Usage Statistics (https://www.407etr.com/en/highway/corporate/usage-statistics.html)
[33] Highway Capacity Manual 2022

**Table 3-14. Summary of Population Demand**

| Response Sector | Permanent Residents | Transit-Dependent | Transients | Employees | Medical Facilities | Schools | Summer Day Camps | On-Campus Students | Commuter/ Ridesharing Students | Special Event[34] | Shadow Population[35] | External Traffic | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DNGS** | 0 | 0 | 0 | 2,732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,732 |
| **D1** | 77 | 0 | 0 | 189 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 266 |
| **D2** | 19,619 | 206 | 4,626 | 1,925 | 114 | 4,327 | 200 | 0 | 0 | 0 | 0 | 0 | 31,017 |
| **D3** | 11,590 | 122 | 0 | 970 | 112 | 2,006 | 0 | 0 | 0 | 3,333 | 0 | 0 | 18,133 |
| **D4** | 24,445 | 258 | 0 | 2,289 | 199 | 5,565 | 100 | 0 | 0 | 1,667 | 0 | 0 | 34,523 |
| **D5** | 9,452 | 100 | 856 | 592 | 60 | 1,955 | 0 | 0 | 0 | 0 | 0 | 0 | 13,015 |
| **D6A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D6B** | 15,041 | 159 | 194 | 468 | 0 | 1,871 | 50 | 0 | 0 | 0 | 0 | 0 | 17,783 |
| **D7** | 4,933 | 52 | 324 | 252 | 132 | 751 | 0 | 0 | 0 | 0 | 0 | 0 | 6,444 |
| **D8A** | 17,398 | 183 | 166 | 630 | 73 | 2,139 | 100 | 0 | 0 | 0 | 0 | 0 | 20,689 |
| **D8B** | 6,214 | 65 | 0 | 239 | 0 | 2,459 | 50 | 0 | 0 | 0 | 0 | 0 | 9,027 |
| **D9** | 14,200 | 149 | 54 | 1,063 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15,466 |
| **D10** | 8,263 | 87 | 65 | 727 | 9 | 398 | 50 | 0 | 0 | 0 | 0 | 0 | 9,599 |
| **D11** | 2,043 | 21 | 0 | 279 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,343 |
| **D12** | 4,538 | 48 | 186 | 425 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,197 |
| **D13** | 2,304 | 24 | 0 | 163 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,491 |
| **D14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Shadow** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 81,062 | 0 | 81,062 |
| **DPZ Total:** | **140,117** | **1,474** | **6,471** | **12,943** | **699** | **21,471** | **550** | **0** | **0** | **5,000** | **81,062** | **0** | **269,787** |

[34] According to The Applefest Director of Bowmanville Business Improvement Association, there are 5000 people at any given time during the Applecart Festival.100% of this population is assumed to be transients.
[35] Shadow population is located between the DPZ outer ring and the CPZ boundary. Since 30% of this population is assumed to voluntarily evacuate, 30% of the total shadow population (shown as "CPZ Total" in Table 3-3) is shown in this table. Refer to Figure 2-1 for additional information.

| Response Sector | Permanent Residents | Transit-Dependent | Transients | Employees | Medical Facilities | Schools | Summer Day Camps | On-Campus Students | Commuter/ Ridesharing Students | Special Event[34] | Shadow Population[35] | External Traffic | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CPZ1 | 4,380 | 46 | 1,380 | 161 | 0 | 293 | 0 | 0 | 0 | 0 | There are no Shadow Population Beyond the CPZ. | 0 | 6,260 |
| CPZ2 | 12,352 | 130 | 2,171 | 851 | 161 | 1,085 | 0 | 0 | 0 | 0 | | 0 | 16,750 |
| CPZ3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| CPZ4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| CPZ5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| CPZ6 | 8,557 | 90 | 1,906 | 755 | 0 | 674 | 0 | 0 | 0 | 0 | | 0 | 11,982 |
| CPZ7 | 235,228 | 7,132[36] | 18,301 | 15,936 | 3,484 | 35,548 | 0 | 2,312[37] | 15,284[38] | 0 | | 0 | 333,225 |
| CPZ8 | 9,690 | 102 | 1,613 | 644 | 0 | 2,083 | 0 | 0 | 0 | 0 | | 0 | 14,132 |
| **CPZ Total:** | **270,207** | **7,500** | **25,371** | **18,347** | **3,645** | **39,683** | **0** | **2,312** | **15,284** | **0** | **0** | **0** | **382,349** |
| N/A[39] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | **410,324** | **8,974** | **31,842** | **31,290** | **4,344** | **61,154** | **550** | **2,312** | **15,284** | **5,000** | **81,062** | **0** | **652,136** |

[36] The transit dependent population shown includes a total of 4,658 transit-dependent college students (2,242 students at the Ontario Tech University, 1,606 students from Durham College – Oshawa Campus, 346 students at the Durham College – Whitby, and 464 students at Trent University – Durham FTA Campus) located in Response Sector CPZ7.
[37] The 2,312 On-Campus Students represent on-campus students that have a personal vehicle on campus.
[38] The commuter/ridesharing students shown also includes 184 students from Durham Continuing Education as the students at this facility behave similarly as commuter students instead.
[39] External Traffic vehicles is considered to begin outside of the DPZ and CPZ.

**Table 3-15. Summary of Vehicle Demand**

| Response Sector | Permanent Residents | Transit-Dependent | Transients | Employees | Medical Facilities[40] | Schools[41] | Summer Day Camps | On-Campus Students | Commuter/ Ridesharing Students | Special Event[42] | Shadow Population[43] | External Traffic | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DNGS** | 0 | 0 | 0 | 2,732 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,732 |
| **D1** | 34 | 0 | 0 | 189 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 223 |
| **D2** | 9,111 | 14 | 1,452 | 1,925 | 8 | 150 | 8 | 0 | 0 | 0 | 0 | 0 | 12,668 |
| **D3** | 5,383 | 10 | 0 | 970 | 13 | 70 | 0 | 0 | 0 | 1,112 | 0 | 0 | 7,558 |
| **D4** | 11,355 | 18 | 0 | 2,289 | 23 | 196 | 4 | 0 | 0 | 555 | 0 | 0 | 14,440 |
| **D5** | 4,384 | 8 | 372 | 592 | 19 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 5,433 |
| **D6A** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D6B** | 6,986 | 12 | 72 | 468 | 0 | 64 | 2 | 0 | 0 | 0 | 0 | 0 | 7,604 |
| **D7** | 2,291 | 4 | 108 | 252 | 11 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 2,696 |
| **D8A** | 8,075 | 14 | 75 | 630 | 8 | 62 | 4 | 0 | 0 | 0 | 0 | 0 | 8,868 |
| **D8B** | 2,883 | 6 | 0 | 239 | 0 | 90 | 2 | 0 | 0 | 0 | 0 | 0 | 3,220 |
| **D9** | 6,595 | 10 | 27 | 1,063 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7,695 |
| **D10** | 3,837 | 6 | 27 | 727 | 2 | 12 | 2 | 0 | 0 | 0 | 0 | 0 | 4,613 |
| **D11** | 947 | 2 | 0 | 279 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,228 |
| **D12** | 2,106 | 4 | 87 | 425 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,622 |
| **D13** | 1,069 | 2 | 0 | 163 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,234 |
| **D14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **D16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Shadow** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37,643 | 0 | 37,643 |
| **DPZ Total:** | **65,056** | **110** | **2,220** | **12,943** | **84** | **732** | **22** | **0** | **0** | **1,667** | **37,643** | **0** | **120,477** |

[40] Vehicles for medical facilities (including retirement centres) include buses, wheelchair vans, and ambulances. Buses are represented as two passenger vehicles.
[41] Buses represented as two passenger vehicles. Refer to Sections 3.6.2 for additional information.
[42] Vehicle occupancy of 3 is used to estimate the number of vehicles for the Apple Festival and Craft Sale.
[43] Shadow vehicles are located between the DPZ outer ring and the CPZ boundary. Since 30% of these vehicles are assumed to voluntarily evacuate, 30% of the total shadow vehicles (shown as "CPZ Total" in Table 3-3) is shown in this table. Refer to Figure 2-1 for additional information.

| Response Sector | Permanent Residents | Transit-Dependent | Transients | Employees | Medical Facilities[40] | Schools[41] | Summer Day Camps | On-Campus Students | Commuter/ Ridesharing Students | Special Event[42] | Shadow Population[43] | External Traffic | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CPZ1** | 2,034 | 4 | 525 | 161 | 0 | 10 | 0 | 0 | 0 | 0 | There are no Shadow Vehicles Beyond the CPZ. | 0 | 2,734 |
| **CPZ2** | 5,741 | 10 | 810 | 851 | 11 | 40 | 0 | 0 | 0 | 0 | | 0 | 7,463 |
| **CPZ3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| **CPZ4** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| **CPZ5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 |
| **CPZ6** | 3,974 | 6 | 890 | 755 | 18 | 20 | 0 | 0 | 0 | 0 | | 0 | 5,663 |
| **CPZ7** | 109,233 | 480[44] | 6,785 | 15,936 | 811 | 1,228 | 0 | 806[45] | 5,360[46] | 0 | | 0 | 140,639 |
| **CPZ8** | 4,494 | 8 | 614 | 644 | 0 | 62 | 0 | 0 | 0 | 0 | | 0 | 5,822 |
| **CPZ Total:** | **125,476** | **508** | **9,624** | **18,347** | **840** | **1,360** | **0** | **806** | **5,360** | **0** | **0** | **0** | **162,321** |
| **N/A[47]** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **41,896** | **41,896** |
| **TOTAL** | **190,532** | **618** | **11,844** | **31,290** | **924** | **2,092** | **22** | **806** | **5,360** | **1,667** | **37,643** | **41,896** | **324,694** |

[44] The buses for the transit-dependent permanent resident population are represented as two passenger vehicles in this column. The transit dependent vehicles shown also includes a total of 314 vehicles (150 vehicles at the Ontario Tech University, 108 vehicles from Durham College – Oshawa Campus, 24 vehicles at the Durham College – Whitby, and 32 vehicles at Trent University – Durham FTA Campus) in Response Sector CPZ7.
[45] The 806 On-Campus Student vehicles represent on-campus students that have a personal vehicle on campus.
[46] The commuter/ridesharing student vehicles shown also includes 160 personal vehicles from the Durham Continuing Education students (see Table 3-9), as they behave similarly to college/university commuter students.
[47] External Traffic is considered to begin outside of the DPZ and CPZ.

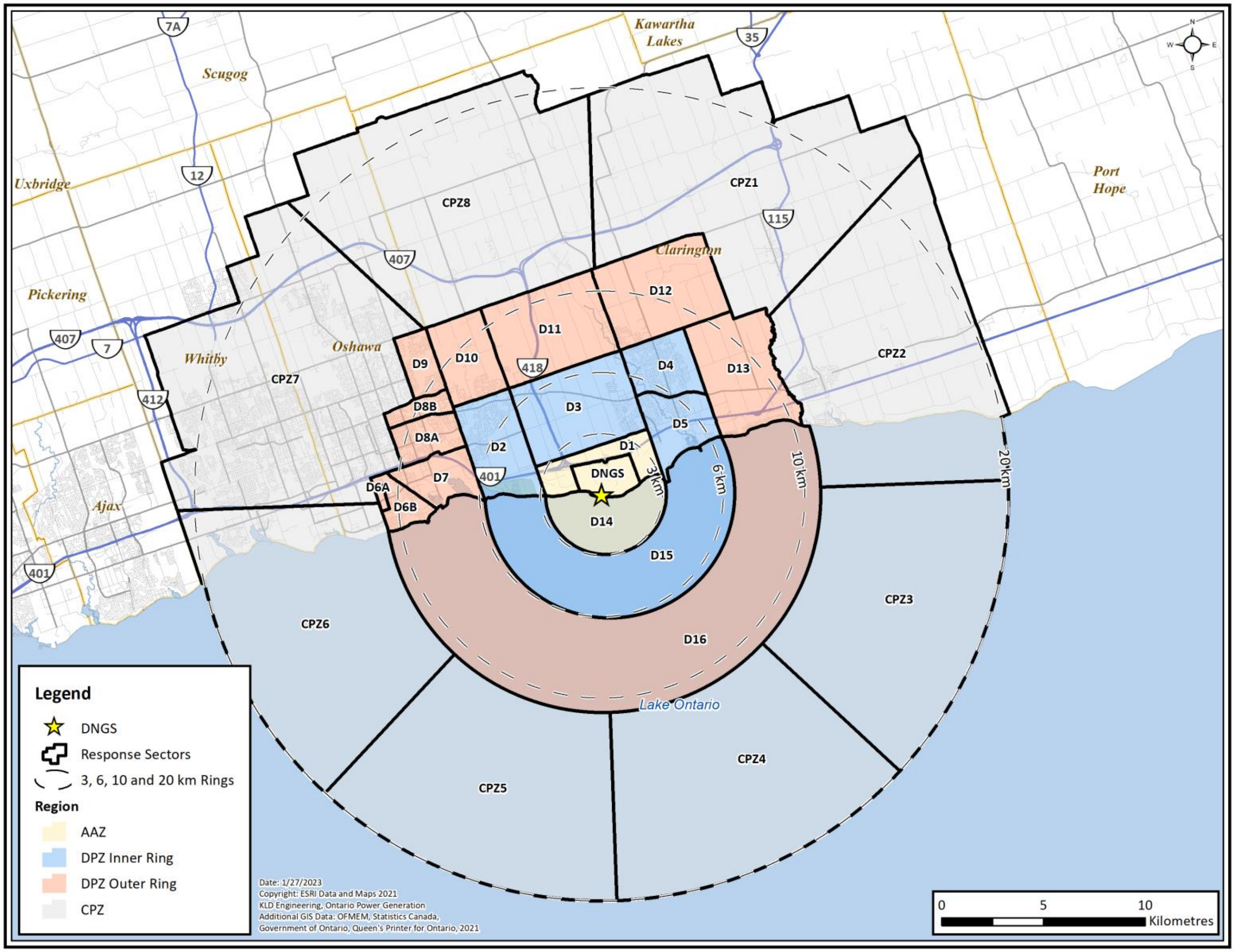



**Figure 3-1. Response Sectors Comprising the DNGS PZs**

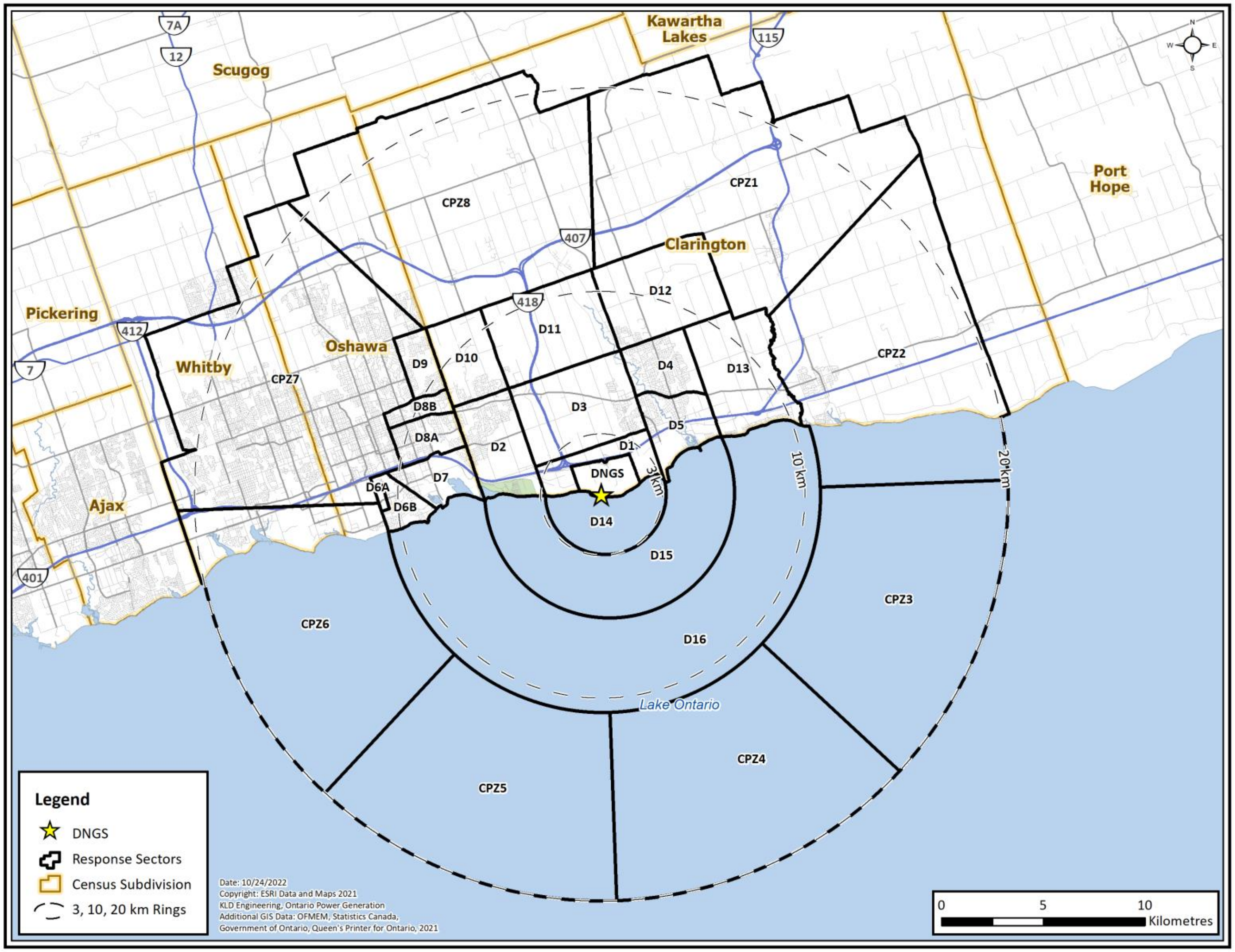
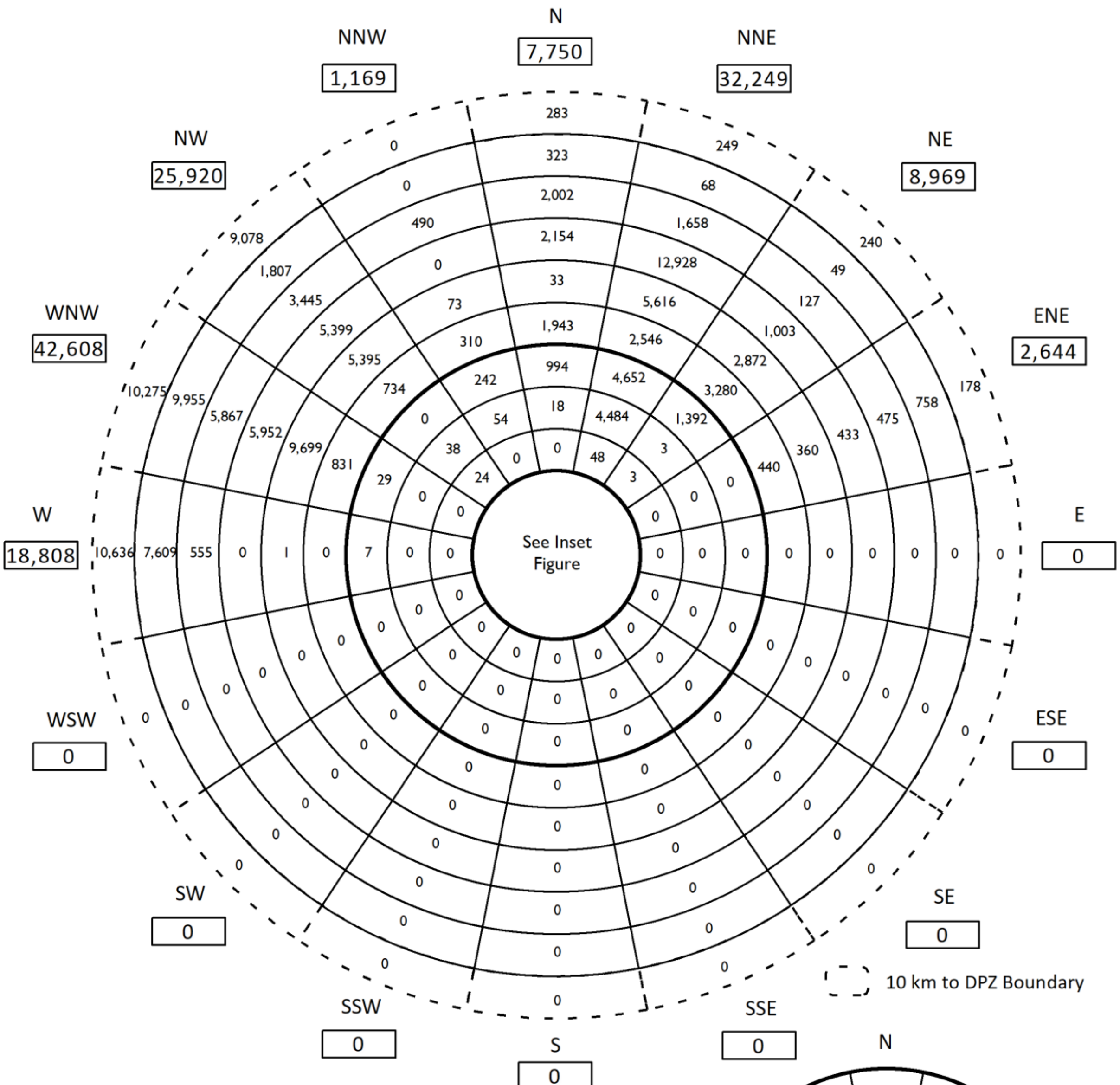



**Figure 3-2. Census Subdivision Boundaries within the DNGS Study Area**




## 2023 Extrapolated Resident Population (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 0 | 0 |
| 1 - 2 | 0 | 0 |
| 2 - 3 | 75 | 75 |
| 3 - 4 | 4,597 | 4,672 |
| 4 - 5 | 7,316 | 11,988 |
| 5 - 6 | 10,084 | 22,072 |
| 6 - 7 | 24,049 | 46,121 |
| 7 - 8 | 27,869 | 73,990 |
| 8 - 9 | 14,619 | 88,609 |
| 9 - 10 | 20,569 | 109,178 |
| 10 - DPZ | 30,939 | 140,117 |
| | Total: | 140,117 |

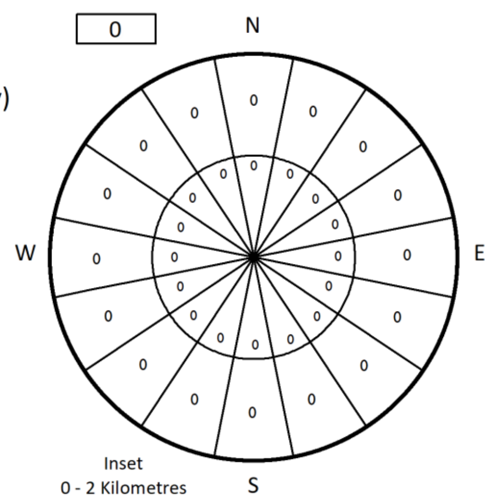
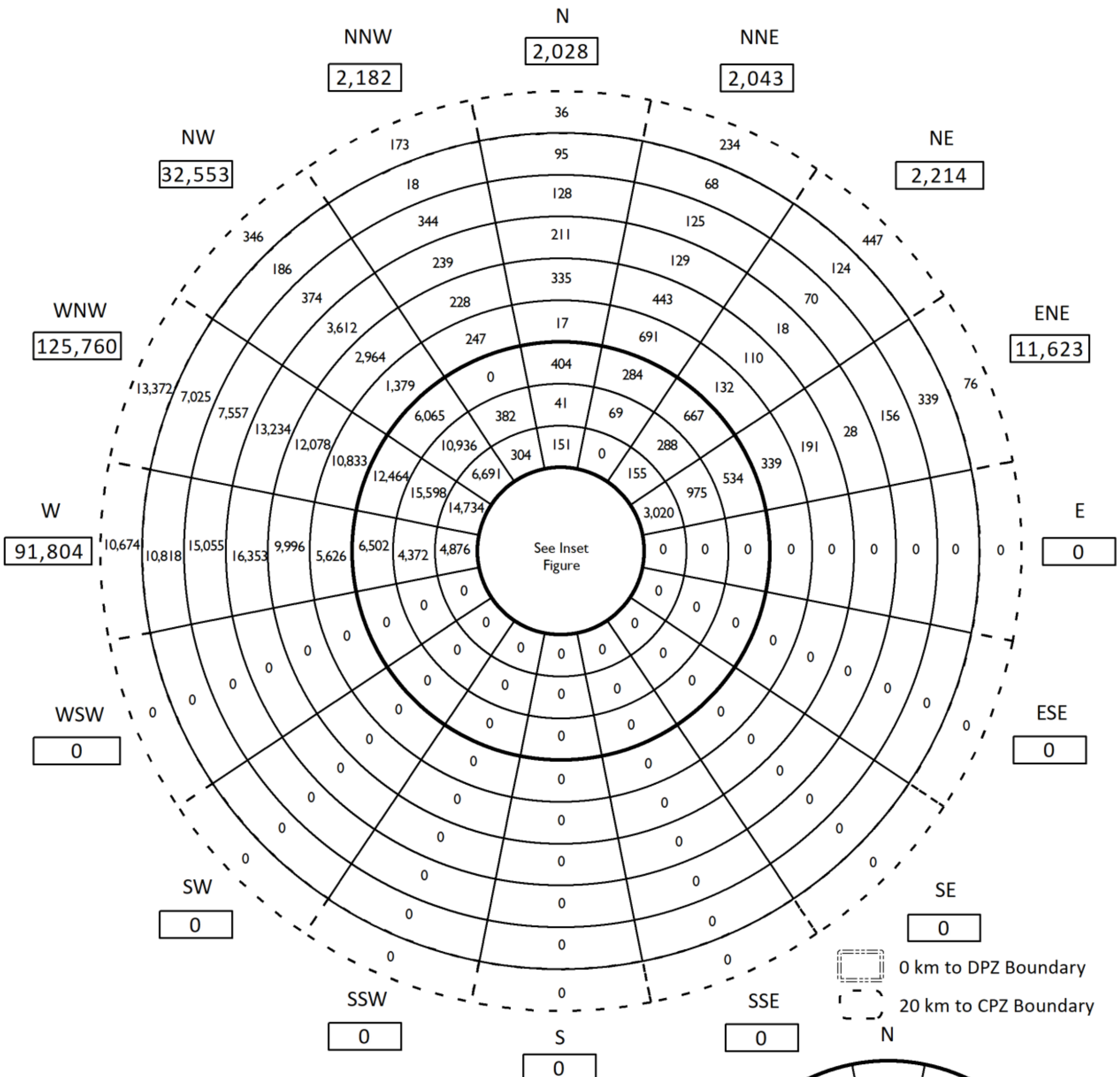



**Figure 3-3. Permanent Resident Population within the DPZ by Sector**




2023 Extrapolated Resident Population (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 6,594 | 6,594 |
| 11 - 12 | 26,828 | 33,422 |
| 12 - 13 | 29,931 | 63,353 |
| 13 - 14 | 32,661 | 96,014 |
| 14 - 15 | 26,920 | 122,934 |
| 15 -16 | 19,264 | 142,198 |
| 16 - 17 | 26,345 | 168,543 |
| 17 - 18 | 33,824 | 202,367 |
| 18 - 19 | 23,809 | 226,176 |
| 19 - 20 | 18,673 | 244,849 |
| 20 - CPZ | 25,358 | 270,207 |
| | Total: | 270,207 |

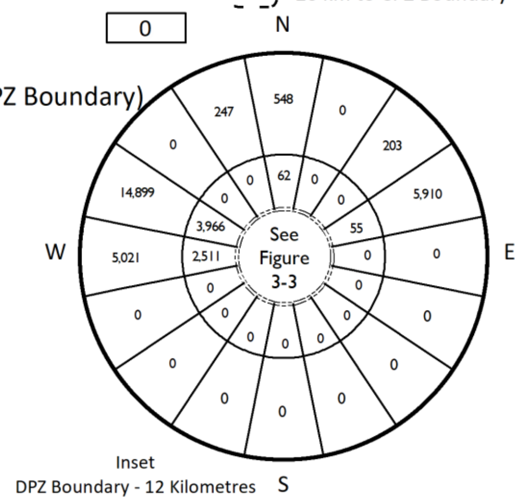
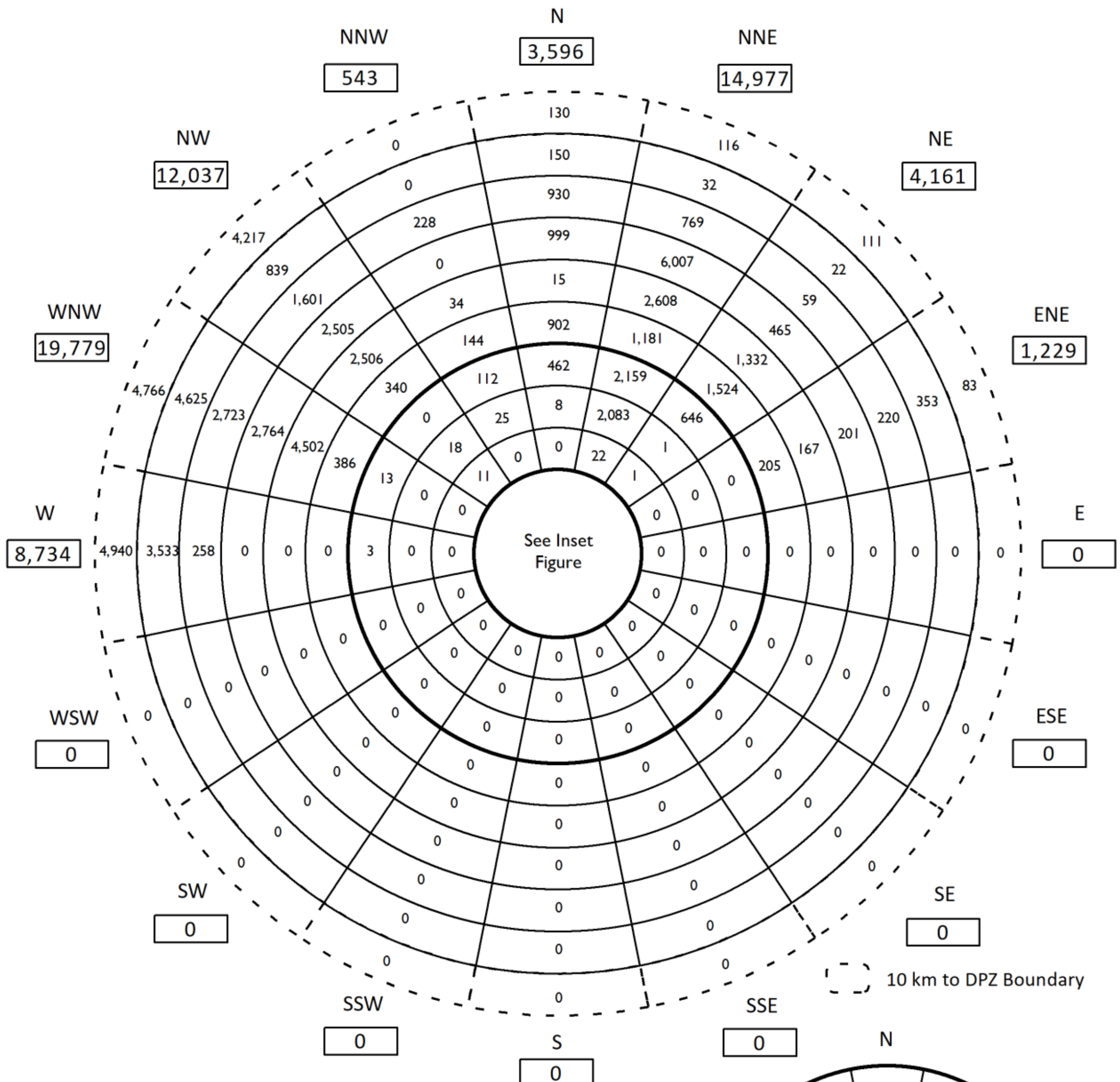



**Figure 3-4. Permanent Resident Population within the CPZ by Sector**




### Resident Vehicles (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 0 | 0 |
| 1 - 2 | 0 | 0 |
| 2 - 3 | 34 | 34 |
| 3 - 4 | 2,135 | 2,169 |
| 4 - 5 | 3,395 | 5,564 |
| 5 - 6 | 4,682 | 10,246 |
| 6 - 7 | 11,164 | 21,410 |
| 7 - 8 | 12,941 | 34,351 |
| 8 - 9 | 6,788 | 41,139 |
| 9 - 10 | 9,554 | 50,693 |
| 10 - DPZ | 14,363 | 65,056 |
| | Total: | 65,056 |

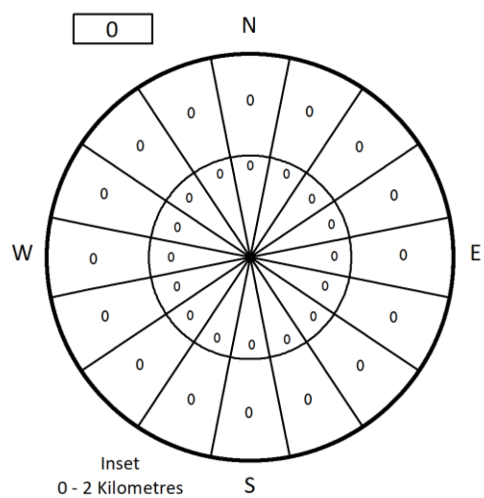
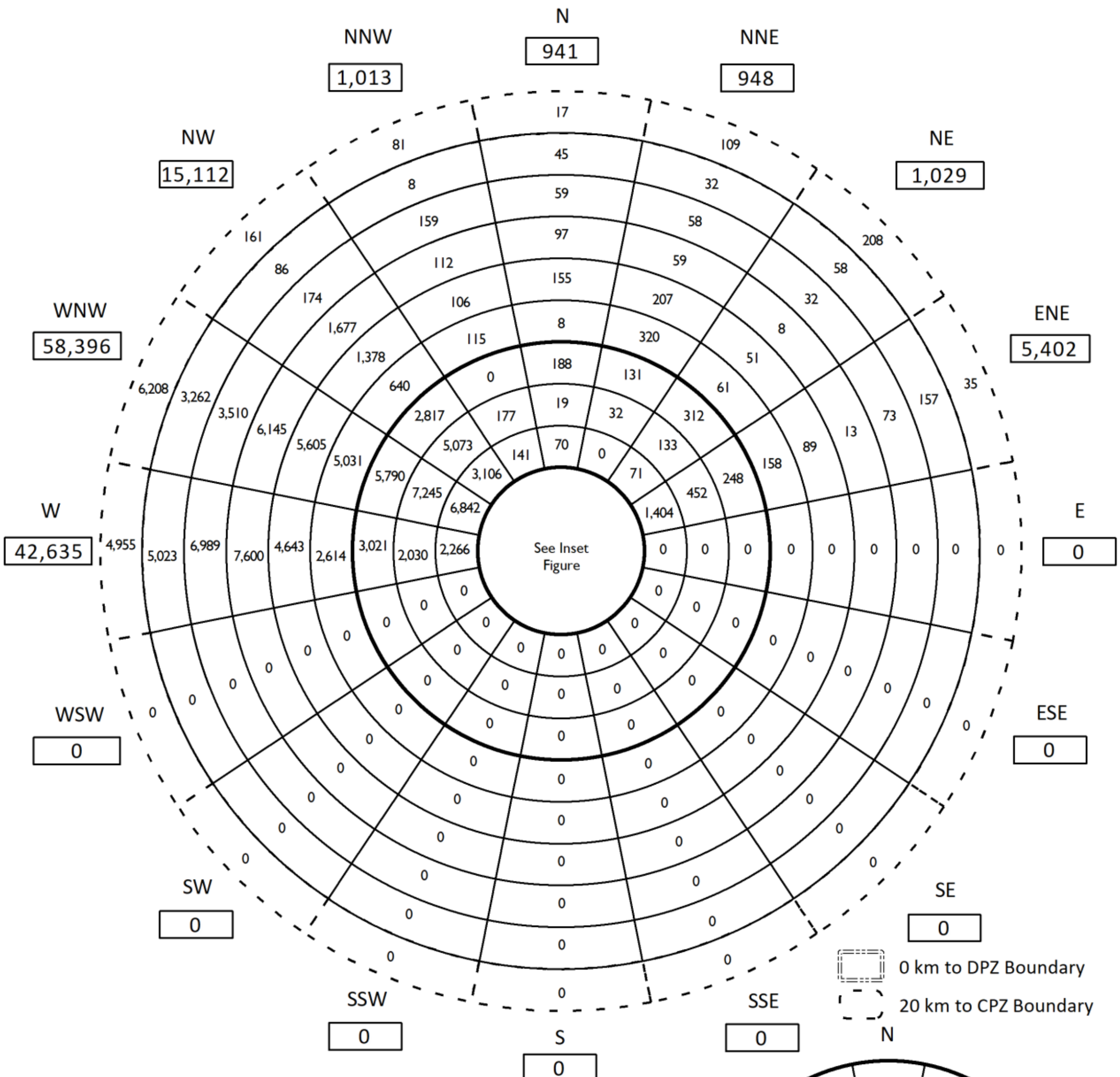
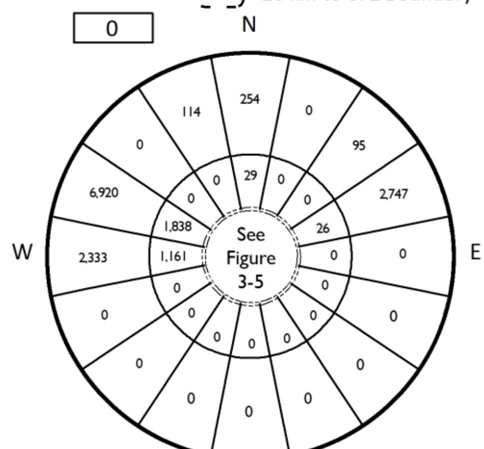



**Figure 3-5. Permanent Resident Vehicles within the DPZ by Sector**



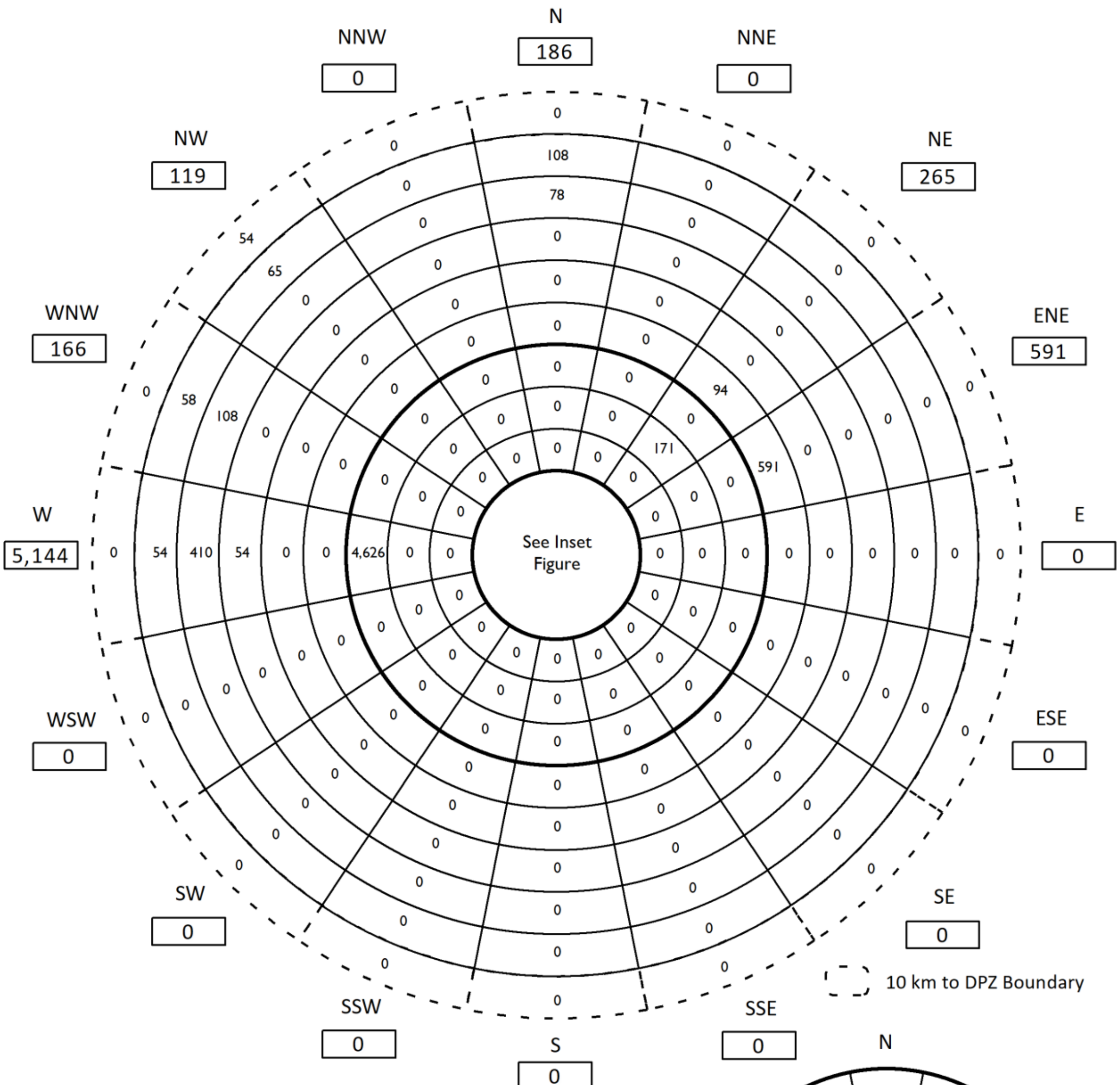

Resident Vehicles (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 3,054 | 3,054 |
| 11 - 12 | 12,463 | 15,517 |
| 12 - 13 | 13,900 | 29,417 |
| 13 - 14 | 15,161 | 44,578 |
| 14 - 15 | 12,507 | 57,085 |
| 15 -16 | 8,947 | 66,032 |
| 16 - 17 | 12,234 | 78,266 |
| 17 - 18 | 15,711 | 93,977 |
| 18 - 19 | 11,054 | 105,031 |
| 19 - 20 | 8,671 | 113,702 |
| 20 - CPZ | 11,774 | 125,476 |
| | Total: | 125,476 |




Inset
DPZ Boundary - 12 Kilometres

**Figure 3-6. Permanent Resident Vehicles within the CPZ by Sector**




Transients (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 0 | 0 |
| 1 - 2 | 0 | 0 |
| 2 - 3 | 0 | 0 |
| 3 - 4 | 171 | 171 |
| 4 - 5 | 4,626 | 4,797 |
| 5 - 6 | 685 | 5,482 |
| 6 - 7 | 0 | 5,482 |
| 7 - 8 | 54 | 5,536 |
| 8 - 9 | 596 | 6,132 |
| 9 - 10 | 285 | 6,417 |
| 10 - DPZ | 54 | 6,471 |
| | Total: | 6,471 |

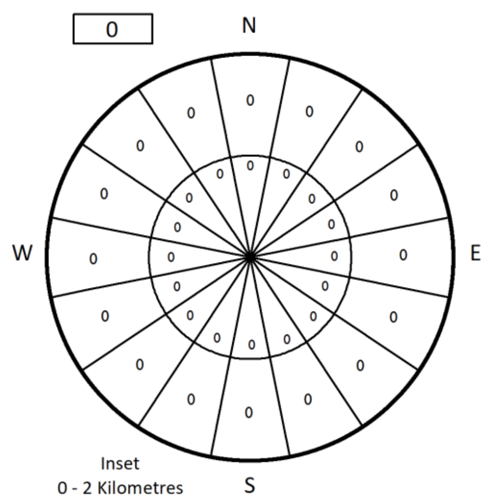
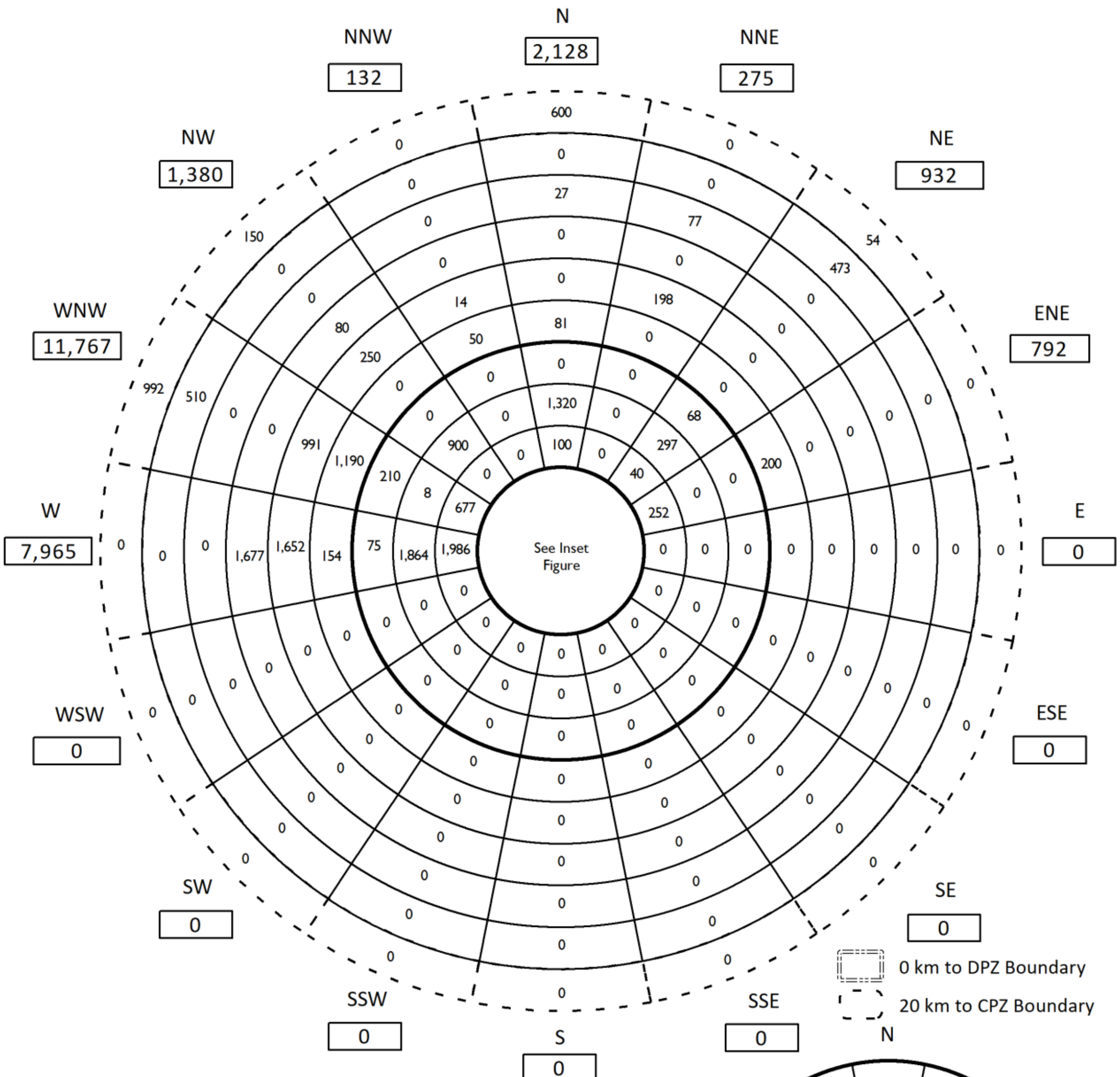



**Figure 3-7. Transient Population within the DPZ by Sector**




## Transients (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 625 | 625 |
| 11 - 12 | 7,529 | 8,154 |
| 12 - 13 | 3,055 | 11,209 |
| 13 - 14 | 4,389 | 15,598 |
| 14 - 15 | 353 | 15,951 |
| 15 -16 | 1,675 | 17,626 |
| 16 - 17 | 3,105 | 20,731 |
| 17 - 18 | 1,757 | 22,488 |
| 18 - 19 | 104 | 22,592 |
| 19 - 20 | 983 | 23,575 |
| 20 - CPZ | 1,796 | 25,371 |
| | Total: | 25,371 |

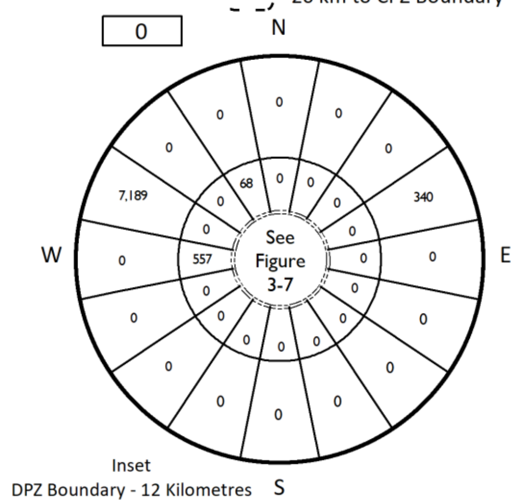
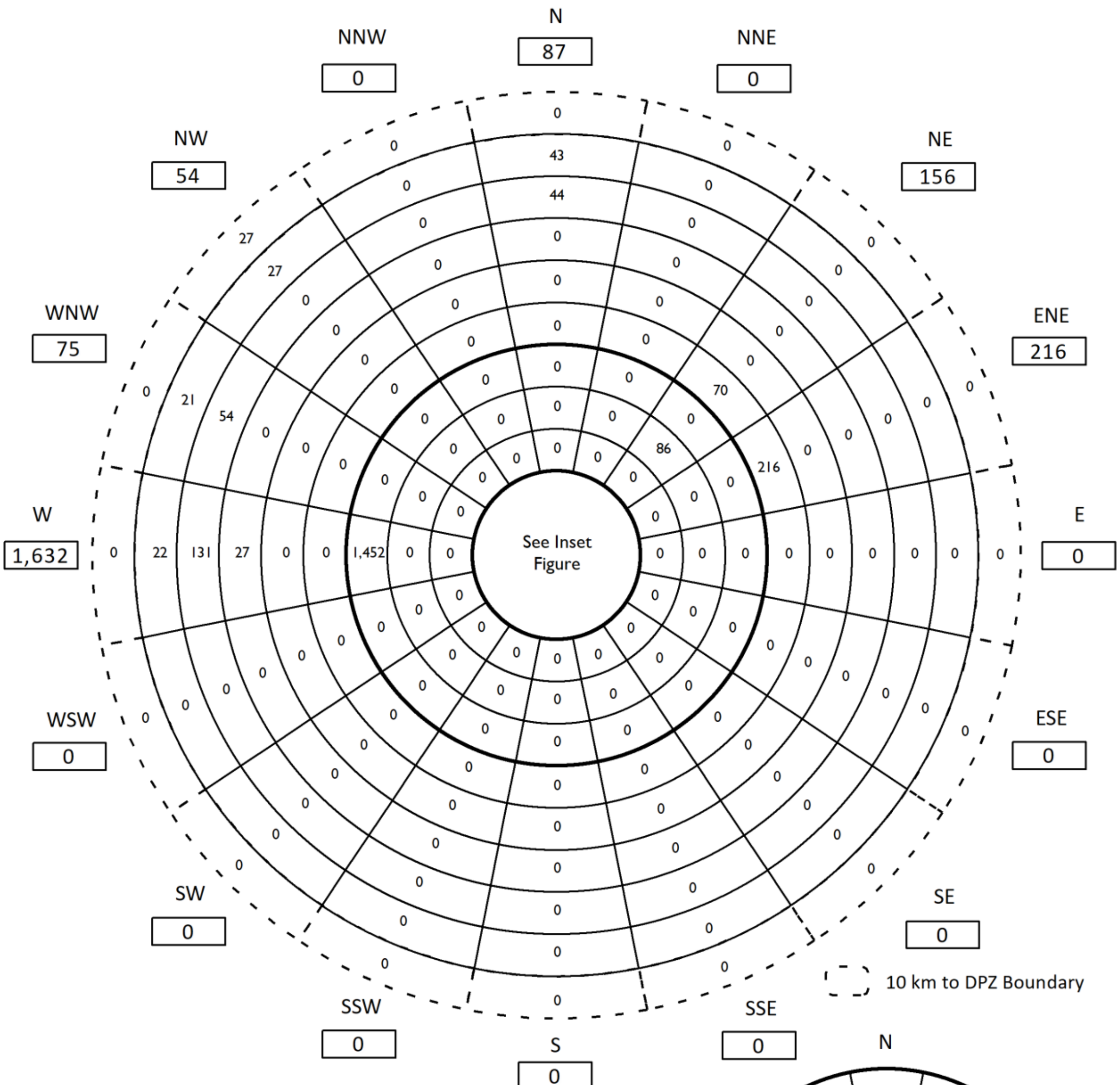



**Figure 3-8. Transient Population within the CPZ by Sector**




## Transient Vehicles (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 0 | 0 |
| 1 - 2 | 0 | 0 |
| 2 - 3 | 0 | 0 |
| 3 - 4 | 86 | 86 |
| 4 - 5 | 1,452 | 1,538 |
| 5 - 6 | 286 | 1,824 |
| 6 - 7 | 0 | 1,824 |
| 7 - 8 | 27 | 1,851 |
| 8 - 9 | 229 | 2,080 |
| 9 - 10 | 113 | 2,193 |
| 10 - DPZ | 27 | 2,220 |
| | Total: | 2,220 |

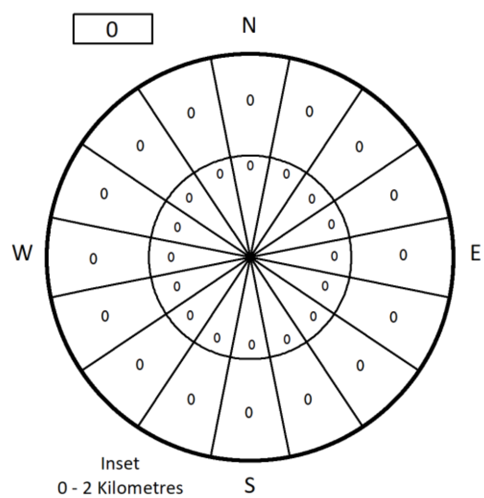
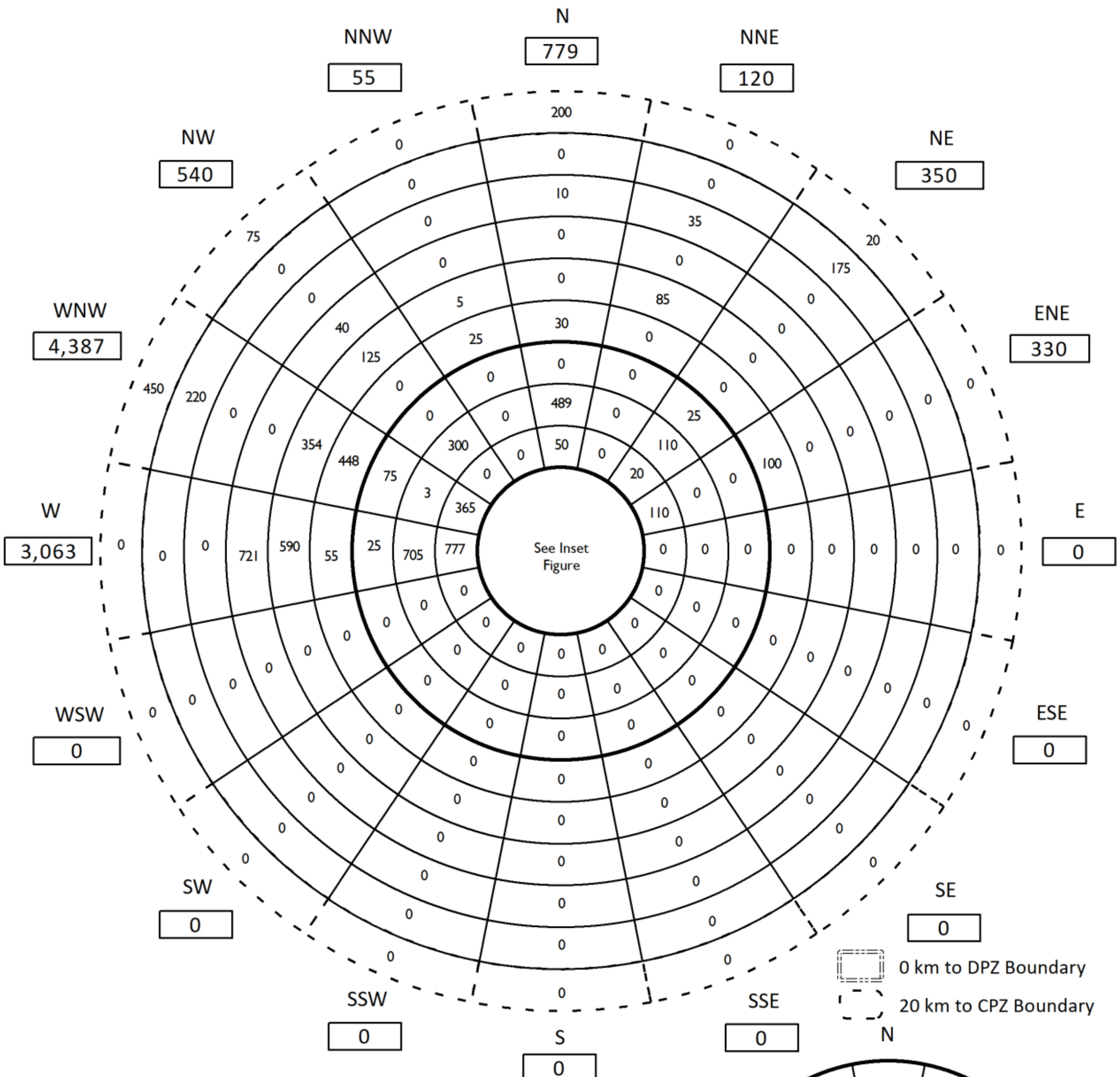



**Figure 3-9. Transient Vehicles within the DPZ by Sector**




Transient Vehicles (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 215 | 215 |
| 11 - 12 | 2,592 | 2,807 |
| 12 - 13 | 1,322 | 4,129 |
| 13 - 14 | 1,607 | 5,736 |
| 14 - 15 | 125 | 5,861 |
| 15 -16 | 658 | 6,519 |
| 16 - 17 | 1,159 | 7,678 |
| 17 - 18 | 761 | 8,439 |
| 18 - 19 | 45 | 8,484 |
| 19 - 20 | 395 | 8,879 |
| 20 - CPZ | 745 | 9,624 |
| | Total: | 9,624 |

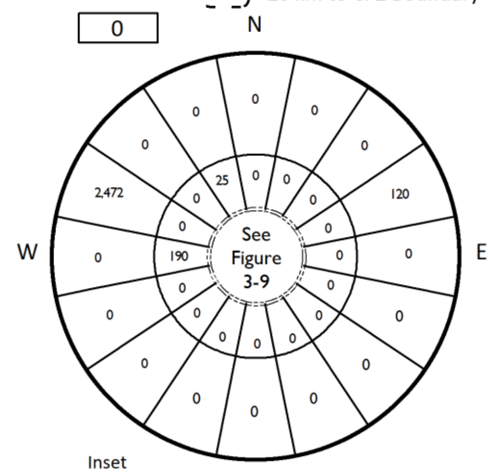
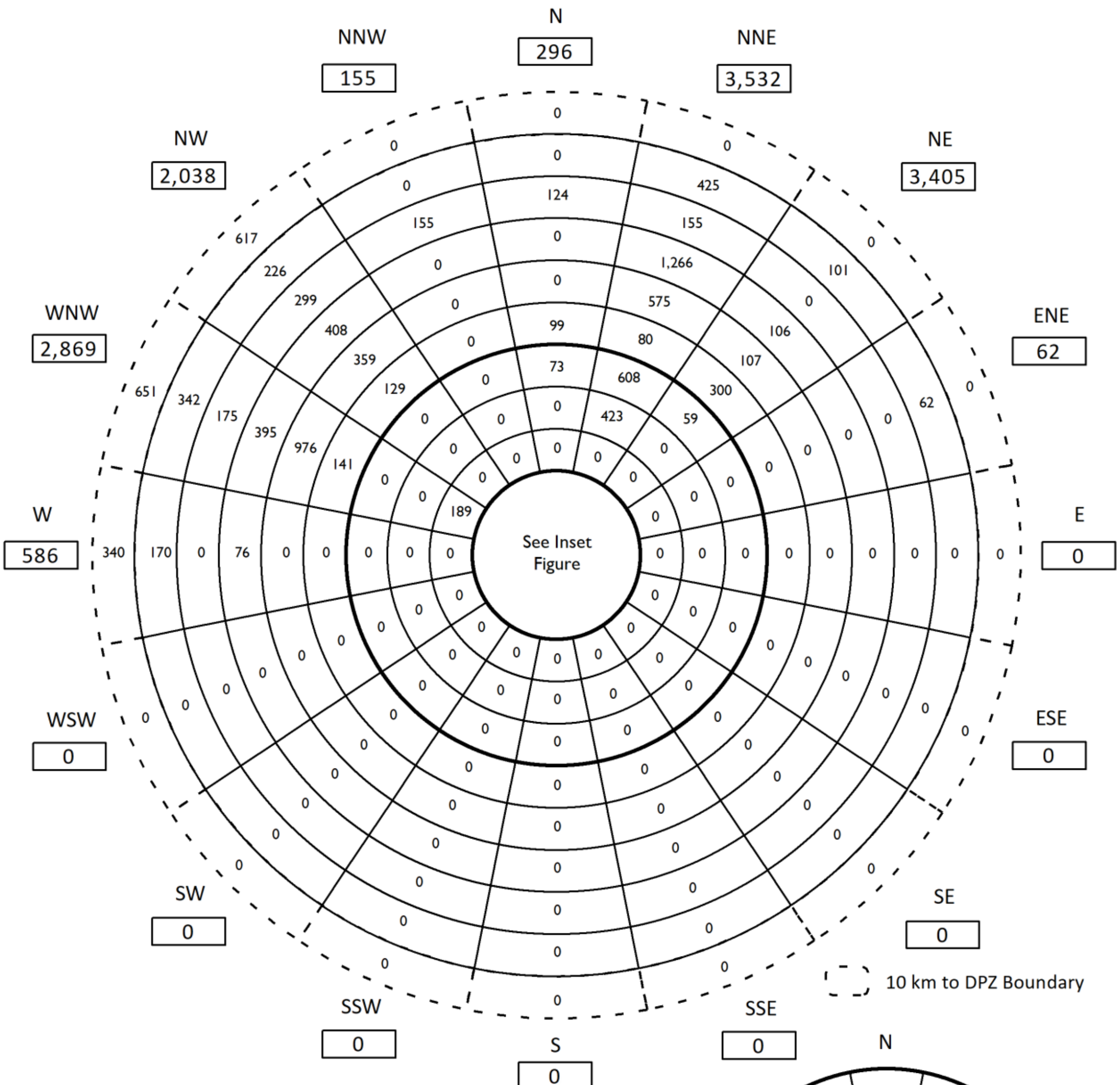



**Figure 3-10. Transient Vehicles within the CPZ by Sector**




Employees (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 2,732 | 2,732 |
| 1 - 2 | 0 | 2,732 |
| 2 - 3 | 189 | 2,921 |
| 3 - 4 | 423 | 3,344 |
| 4 - 5 | 740 | 4,084 |
| 5 - 6 | 749 | 4,833 |
| 6 - 7 | 2,017 | 6,850 |
| 7 - 8 | 2,251 | 9,101 |
| 8 - 9 | 908 | 10,009 |
| 9 - 10 | 1,326 | 11,335 |
| 10 - DPZ | 1,608 | 12,943 |
| | Total: | 12,943 |

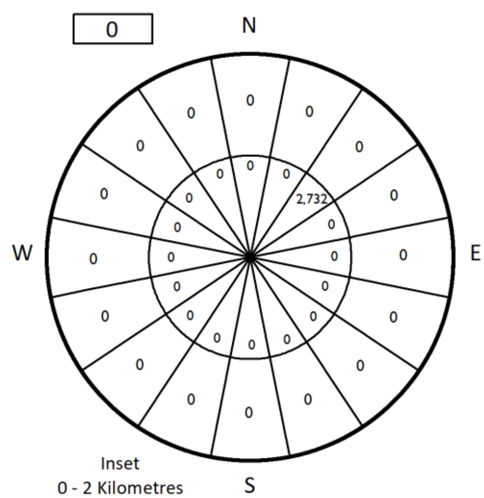
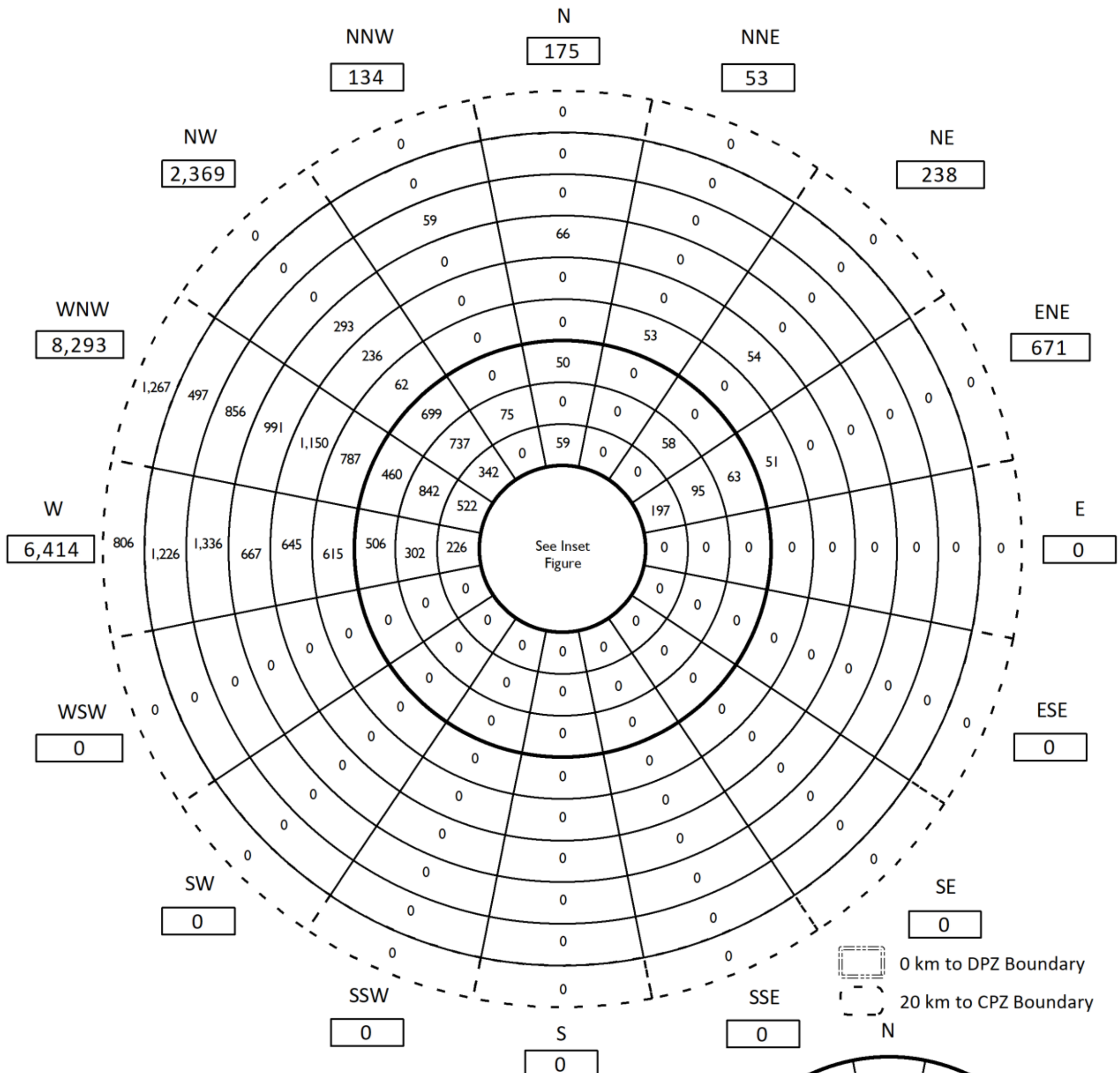
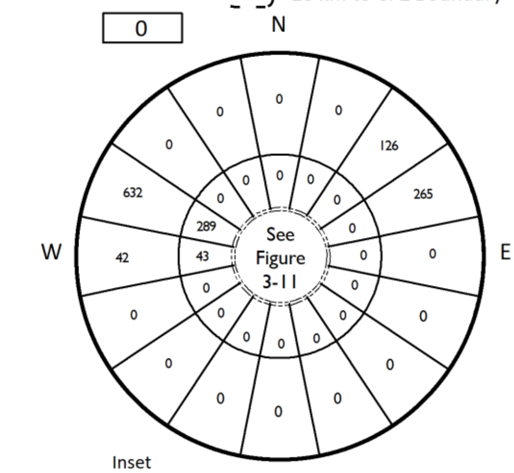



**Figure 3-11. Employee Population within the DPZ by Sector**



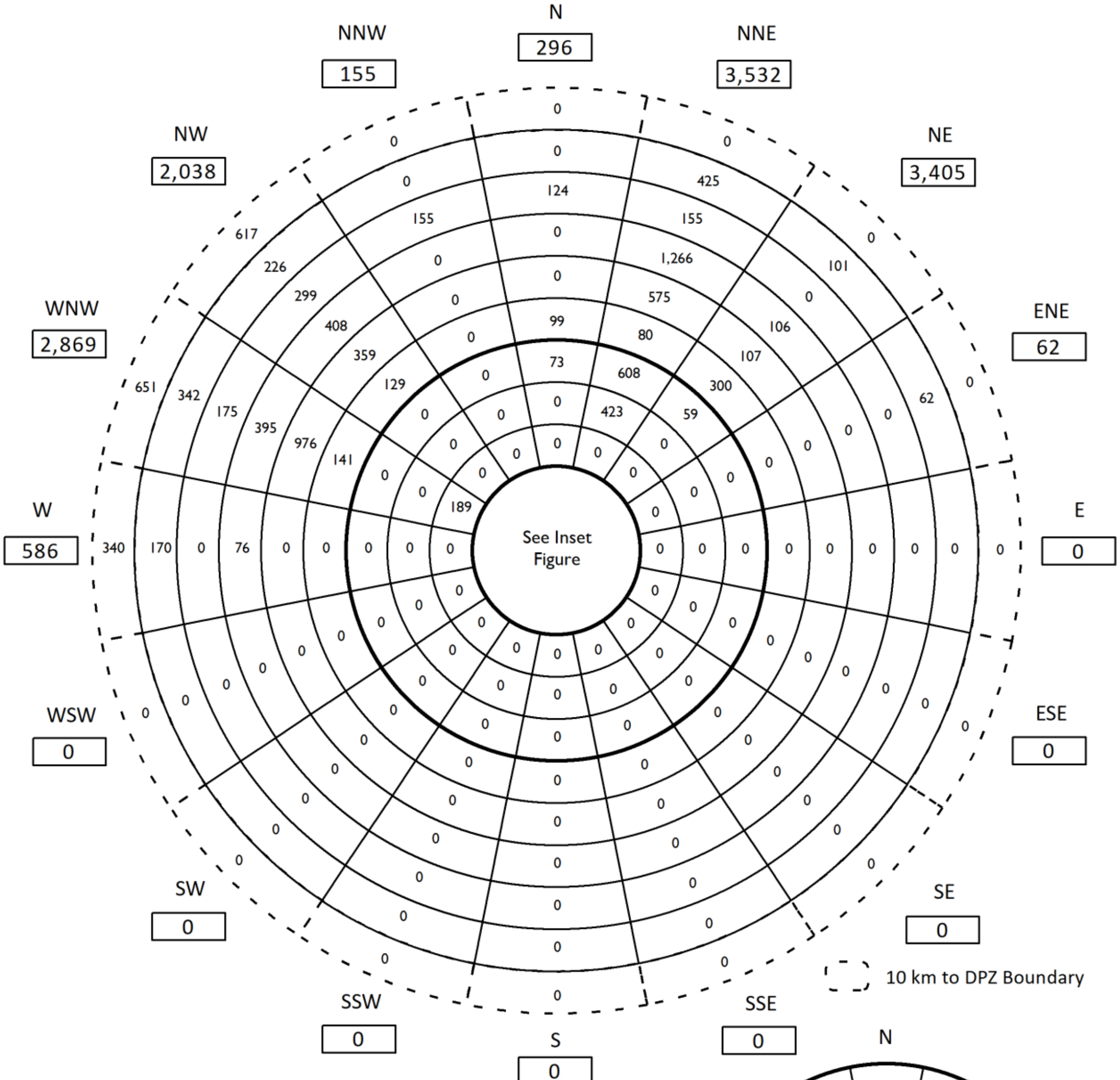

Employees (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 332 | 332 |
| 11 - 12 | 1,065 | 1,397 |
| 12 - 13 | 1,346 | 2,743 |
| 13 - 14 | 2,109 | 4,852 |
| 14 - 15 | 1,778 | 6,630 |
| 15 -16 | 1,568 | 8,198 |
| 16 - 17 | 2,085 | 10,283 |
| 17 - 18 | 2,017 | 12,300 |
| 18 - 19 | 2,251 | 14,551 |
| 19 - 20 | 1,723 | 16,274 |
| 20 - CPZ | 2,073 | 18,347 |
| | Total: | 18,347 |




Inset
DPZ Boundary - 12 Kilometres

**Figure 3-12. Employee Population within the CPZ by Sector**




Employee Vehicles (0 km-DPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| 0 - 1 | 2,732 | 2,732 |
| 1 - 2 | 0 | 2,732 |
| 2 - 3 | 189 | 2,921 |
| 3 - 4 | 423 | 3,344 |
| 4 - 5 | 740 | 4,084 |
| 5 - 6 | 749 | 4,833 |
| 6 - 7 | 2,017 | 6,850 |
| 7 - 8 | 2,251 | 9,101 |
| 8 - 9 | 908 | 10,009 |
| 9 - 10 | 1,326 | 11,335 |
| 10 - DPZ | 1,608 | 12,943 |
| | Total: | 12,943 |

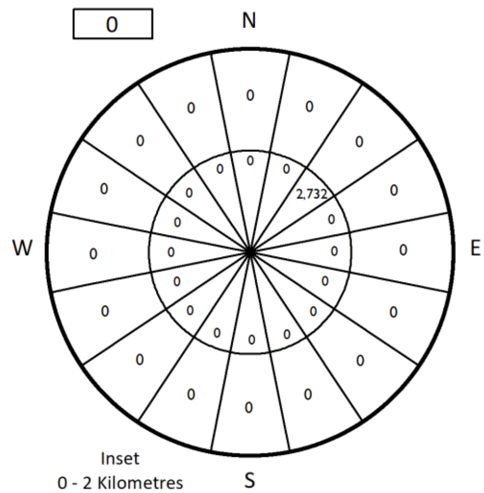
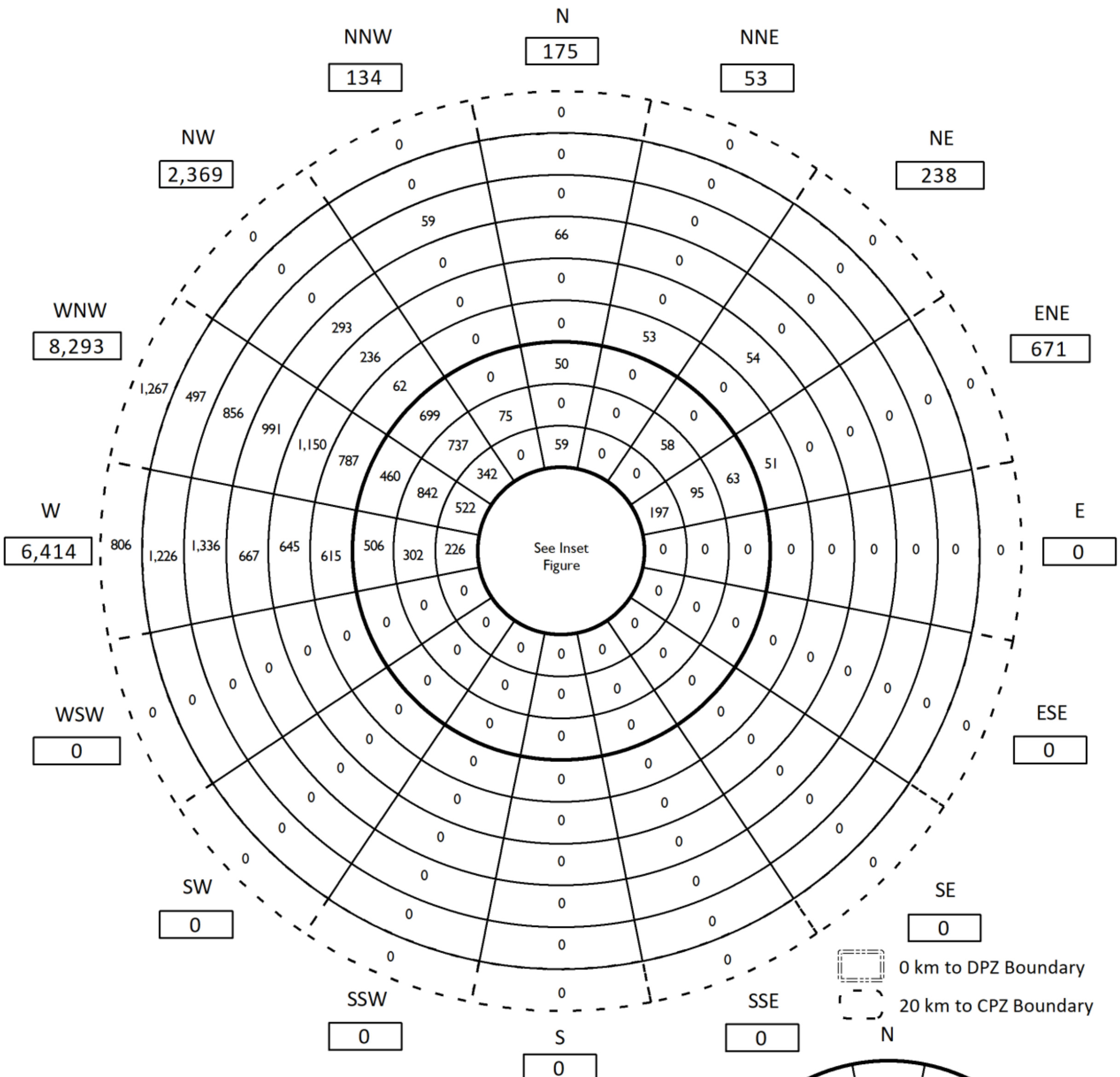



**Figure 3-13. Employee Vehicles within the DPZ by Sector**




Employee Vehicles (DPZ Boundary - CPZ Boundary)

| Kilometres | Subtotal by Ring | Cumulative Total |
|---|---|---|
| DPZ - 11 | 332 | 332 |
| 11 - 12 | 1,065 | 1,397 |
| 12 - 13 | 1,346 | 2,743 |
| 13 - 14 | 2,109 | 4,852 |
| 14 - 15 | 1,778 | 6,630 |
| 15 -16 | 1,568 | 8,198 |
| 16 - 17 | 2,085 | 10,283 |
| 17 - 18 | 2,017 | 12,300 |
| 18 - 19 | 2,251 | 14,551 |
| 19 - 20 | 1,723 | 16,274 |
| 20 - CPZ | 2,073 | 18,347 |
| | Total: | 18,347 |

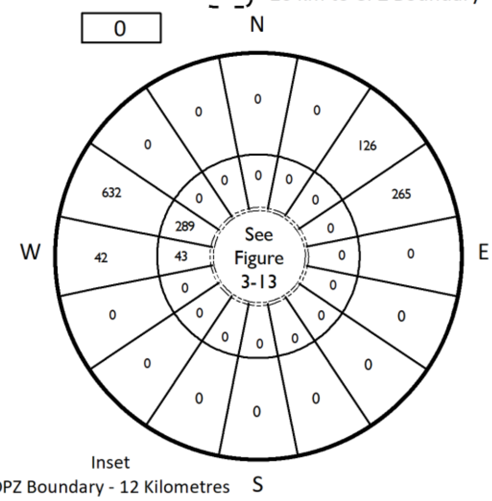



**Figure 3-14. Employee Vehicles within the CPZ by Sector**

# 4 ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum sustainable hourly flow rate at which vehicles reasonably can be expected to traverse a point or a uniform segment of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions, as stated in in the 2022 Highway Capacity Manual (HCM 2022)[1]. This section discusses how the capacity of the roadway network was estimated[2].

In discussing capacity, different operating conditions have been assigned alphabetical designations, A through F, to reflect the range of traffic operational characteristics. These designations have been termed "Levels of Service" (LOS). For example, LOS A connotes free-flow and high-speed operating conditions; LOS F represents a forced flow condition. LOS E describes traffic operating at or near capacity.

Another concept, closely associated with capacity, is "Service Volume". Service volume (SV) is defined as "The maximum hourly rate at which vehicles, bicycles or persons reasonably can be expected to traverse a point or uniform section of a roadway during an hour under specific assumed conditions while maintaining a designated level of service." This definition is similar to that for capacity. The major distinction is that values of SV vary from one LOS to another, while capacity is the SV at the upper bound of LOS E, only.

Thus, in simple terms, SV is the maximum traffic that can travel on a road and still maintain a certain perceived level of quality to a driver based on the A, B, C, rating system (LOS). Any additional vehicles above the SV would drop the rating to a lower letter grade.

This distinction is illustrated in Exhibit 12-37 of the HCM 2022. As indicated there, the SV varies with Free Flow Speed (FFS), and LOS. The SV is calculated by the DYNEV II simulation model, based on the specified link attributes, FFS, capacity, control device and traffic demand.

Other factors also influence capacity. These include, but are not limited to:

- Lane width
- Shoulder width
- Pavement condition
- Horizontal and vertical alignment (curvature and grade)
- Percent truck traffic
- Control device (and timing, if it is a signal)
- Weather conditions (good, rain, snow, fog, wind speed, ice)

[1] The Highway Capacity Manual for 2022 is authored by the Transportation Research Board (TRB) in the United States. The figures, equations and examples used in the HCM 2022 use English units (miles, miles per hour, etc.) by default. Some of these figures, equations and examples are used in this section and throughout this report with the English units maintained. The inputs and outputs to the DYNEV simulation model used for this study are also in English units. The free flow speeds in kilometres per hour observed during the road survey (See Section 1.3) were converted to miles per hour when input to DYNEV. Likewise, distances measured in kilometres were converted to miles. The model outputs (see Appendix J) were converted to metric units for this study. The critical element of this study, evacuation time, is the same in both the metric and English system of measure.

[2] The 2008 Canadian Capacity Guide was reviewed and considered for the estimation of capacity where applicable. However, the estimates for capacity in this study are based on the HCM 2022 as it is more up to date.

These factors are considered during the road survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on FFS and capacity based on the HCM 2022. Consequently, lane and shoulder widths at the narrowest points were observed during the road survey and these observations were recorded, but no detailed measurements of lane or shoulder width were taken. Horizontal and vertical alignment can influence both FFS and capacity. The estimated FFS were measured using the survey vehicle's speedometer and observing local traffic, under free flow conditions. The FFS ranged from 20 mph to 75 mph (32 kph to 121 kph) in the PZ. Capacity is estimated from the procedures of the HCM 2022. For example, HCM 2022 Exhibit 7-1(b) shows the sensitivity of SV at the upper bound of LOS D to grade (capacity is the SV at the upper bound of LOS E).

The amount of traffic that can flow on a roadway is effectively governed by vehicle speed and spacing. The faster that vehicles can travel when closely spaced, the higher the amount of flow. As discussed in Section 2.6, it is necessary to adjust capacity figures to represent the prevailing conditions. Adverse conditions like inclement weather, construction, and other incidents tend to slow traffic down and often, also increase vehicle-to-vehicles separation, thus decreasing the amount of traffic flow. Based on limited empirical data, weather conditions such as rain reduce the values of FFS and of highway capacity by approximately 10%. Over the last decade new studies have been made on the effects of rain on traffic capacity. These studies indicate a range of effects between 5% and 25% depending on wind speed and precipitation rates. As indicated in Section 2.6, we employ a reduction in free speed and in highway capacity of 10% for rain/light snow. During heavy snow conditions[3], the free speed and highway capacity reductions are 15% and 25%, respectively.

Since congestion arising from evacuation may be significant, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Rural highways generally consist of: (1) one or more uniform sections with limited access (driveways, parking areas) characterized by "uninterrupted" flow; and (2) approaches to at-grade intersections where flow can be "interrupted" by a control device or by turning or crossing traffic at the intersection. Due to these differences, separate estimates of capacity must be made for each section. Often, the approach to the intersection is widened by the addition of one or more lanes (turn pockets or turn bays), to compensate for the lower capacity of the approach due to the factors there that can interrupt the flow of traffic. These additional lanes are recorded during the field survey and later entered as input to the DYNEV II system.

[3] During heavy snow conditions, it is assumed that there is significant snowfall such that minor roadways have snow on them, and major roadways have been plowed but have a coating of snow such that it will reduce free flow speed and capacity. For these scenarios, residents take longer to mobilize (see Section 5) as they might choose to plow their driveway before beginning their evacuation trip. It is assumed that, during this time, roads are made passable by plow trucks and only speeds are capacities are affected. As such, this ETE study assumes all roadways are passible albeit at lower speeds and capacities for certain conditions. In cases wherein roadways are not passible, the ETE results from this study should be added to the time necessary to make the roadways passible and the sum of those times becomes the new ETE. For example, if it takes 24 hours for roadways to be plowed and this report estimates an evacuation time of 3 hours, the ETE under these conditions becomes 27 hours. Essentially, for purposes of this study time zero is from the moment the roadways are passible for heavy snow situations wherein roadways are not immediately traversable.

## 4.1 Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices.

The per-lane capacity of an approach to a signalized intersection can be expressed (simplistically) in the following form:

$$Q_{cap,m} = \left(\frac{3600}{h_m}\right) \times \left(\frac{G-L}{C}\right)_m = \left(\frac{3600}{h_m}\right) \times P_m$$

where:

| | | |
|---|---|---|
| $Q_{cap,m}$ | = | Capacity of a single lane of traffic on an approach, which executes movement, *m*, upon entering the intersection; vehicles per hour (vph) |
| $h_m$ | = | Mean queue discharge headway of vehicles on this lane that are executing movement, *m*; seconds per vehicle |
| *G* | = | Mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds |
| *L* | = | Mean "lost time" for each signal phase servicing movement, *m*; seconds |
| *C* | = | Duration of each signal cycle; seconds |
| $P_m$ | = | Proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified as part of the control treatment. |
| *m* | = | The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, and diagonal. |

The turn-movement-specific mean discharge headway $h_m$, depends in a complex way upon many factors: roadway geometrics, turn percentages, the extent of conflicting traffic streams, the control treatment, and others. A primary factor is the value of "saturation queue discharge headway", $h_{sat}$, which applies to through vehicles that are not impeded by other conflicting traffic streams. This value, itself, depends upon many factors including motorist behaviours. Formally, we can write,

$$h_m = f_m(h_{sat}, F_1, F_2, \ldots)$$

where:

| | | |
|---|---|---|
| $h_{sat}$ | = | Saturation discharge headway for through vehicles; seconds per vehicle |
| $F_1, F_2$ | = | The various known factors influencing $h_m$ |
| $f_m(\ )$ | = | Complex function relating $h_m$ to the known (or estimated) values of $h_{sa}$, $F_1$, $F_2$, … |

The estimation of $h_m$ for specified values of $h_{sat}$, $F_1$, $F_2$, ... is undertaken within the DYNEV II simulation model by a mathematical model[4]. The resulting values for $h_m$ always satisfy the condition:

$$h_m \geq h_{sat}$$

That is, the turn-movement-specific discharge headways are always greater than, or equal to the saturation discharge headway for through vehicles. These headways (or its inverse equivalent, "saturation flow rate"), may be determined by observation or using the procedures of the HCM 2022.

The above discussion is necessarily brief given the scope of this evacuation time estimate (ETE) report and the complexity of the subject of intersection capacity. In fact, Chapters 19, 20 and 21 in the HCM 2022 address this topic. The factors, $F_1$, $F_2$, …, influencing saturation flow rate are identified in equation (19-8) of the HCM 2022.

The traffic signals within the Planning Zone (PZ) are modelled using representative phasing plans and phase durations obtained as part of the field data collection. Traffic responsive signal installations allow the proportion of green time allocated ($P_m$) for each approach to each intersection to be determined by the expected traffic volumes on each approach during evacuation circumstances. The amount of green time (G) allocated is subject to maximum and minimum phase duration constraints; 2 seconds of yellow time are indicated for each signal phase and 1 second of all-red time is assigned between signal phases, typically. If a signal is pre-timed, the yellow and all-red times observed during the road survey are used. A lost time (L) of 2.0 seconds is used for each signal phase in the analysis.

## 4.2 Capacity Estimation along Sections of Highway

The capacity of highway sections -- as distinct from approaches to intersections -- is a function of roadway geometrics, traffic composition (e.g., percent heavy trucks and buses in the traffic stream) and, of course, motorist behaviour. There is a fundamental relationship which relates SV (i.e., the number of vehicles serviced within a uniform highway section in a given time period) to traffic density. The top curve in Figure 4-1 illustrates this relationship.

As indicated, there are two flow regimes: (1) Free Flow (left side of curve); and (2) Forced Flow (right side). In the Free Flow regime, the traffic demand is fully serviced; the SV increases as demand volume and density increase, until the SV attains its maximum value, which is the capacity of the highway section. As traffic demand and the resulting highway density increase beyond this "critical" value, the rate at which traffic can be serviced (i.e., the SV) can actually decline below capacity ("capacity drop"). Therefore, in order to realistically represent traffic performance during congested conditions (i.e., when demand exceeds capacity), it is necessary to estimate the service volume, $V_F$, under congested conditions.

[4] Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the Far Left Lane of an Approach". Both papers appear in Transportation Research Record 772, 1980. Lieberman, E., Xin, W., "Macroscopic Traffic Modeling for Large-Scale Evacuation Planning", presented at the TRB 2012 Annual Meeting, January 22-26, 2012.

The value of $V_F$ can be expressed as:

$$V_F = R \times Capacity$$

where:

| | | |
|---|---|---|
| *R* | = | Reduction factor which is less than unity |

We have employed a value of R=0.90. The advisability of such a capacity reduction factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at “bottlenecks” or “choke points” on a freeway system. Zhang and Levinson[5] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90.

Since the principal objective of ETE analyses is to develop a “realistic” estimate of evacuation times, use of the representative value for this capacity reduction factor (R=0.90) is justified. This factor is applied only when flow breaks down, as determined by the simulation model.

Rural roads, like freeways, are classified as “uninterrupted flow” facilities. (This is in contrast with urban street systems which have closely spaced signalized intersections and are classified as “interrupted flow” facilities.) As such, traffic flow along rural roads is subject to the same effects as freeways in the event traffic demand exceeds the nominal capacity, resulting in queuing and lower QDF rates. As a practical matter, rural roads rarely break down at locations away from intersections. Any breakdowns on rural roads are generally experienced at intersections where other model logic applies, or at lane drops which reduce capacity there. Therefore, the application of a factor of 0.90 is appropriate on rural roads, but rarely, if ever, activated.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction as is the case during an evacuation.

The procedure used here was to estimate "section" capacity, $V_E$, based on observations made traveling over each section of the evacuation network, based on the posted speed limits and travel behaviour of other motorists and by reference to the HCM 2022. The DYNEV II simulation model determines for each highway section, represented as a network link, whether its capacity

[5] Lei Zhang and David Levinson, “Some Properties of Flows at Freeway Bottlenecks,” Transportation Research Record 1883, 2004.

would be limited by the "section-specific" service volume, $V_E$, or by the intersection-specific capacity. For each link, the model selects the lower value of capacity.

## 4.3 Application to the DNGS Planning Zone

As part of the development of the link-node analysis network for the PZ, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

> 2022 Highway Capacity Manual (HCM 2022)
> Transportation Research Board
> National Research Council
> Washington, D.C.

The highway system in the PZ consists primarily of three categories of roads and, of course, intersections:

- Two-Lane roads: Municipal, Regional, Provincial
- Multilane Highways (at-grade)
- Freeways

Each of these classifications will be discussed below.

### 4.3.1 Two-Lane Roads

Ref: HCM 2022 Chapter 15

Two lane roads comprise the majority of highways within the PZ. The per-lane capacity of a two-lane highway is estimated at 1,700 passenger cars per hour (pc/h). This estimate is essentially independent of the directional distribution of traffic volume except that, for extended distances, the two-way capacity will not exceed 3,200 pc/h. The HCM 2022 procedures then estimate LOS and Average Travel Speed. The DYNEV II simulation model accepts the specified value of capacity as input and computes average speed based on the time-varying demand: capacity relations.

Based on the field survey and on expected traffic operations associated with evacuation scenarios:

- Most sections of two-lane roads within the PZ are classified as “Class I”, with “level terrain”; some are “rolling terrain”.
- “Class II” highways are mostly those within urban and suburban centres.

### 4.3.2 Multilane Highway

Ref: HCM 2022 Chapter 12

Exhibit 12-8 of the HCM 2022 presents a set of curves that indicate a per-lane capacity ranging from approximately 1,900 to 2,300 pc/h, for free-speeds of 45 mph to 70 mph (72 kph to 97 kph), respectively. Based on observation, the multilane highways outside of urban areas within the PZ, service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand and capacity relationship and the impact of control at intersections. A conservative estimate of per-lane capacity of 1,900 pc/h is adopted for this study for multilane highways outside of urban areas.

### 4.3.3 Freeways

Ref: HCM 2022 Chapters 10, 12, 13, 14

Chapter 10 of the HCM 2022 describes a procedure for integrating the results obtained in Chapters 12, 13 and 14, which compute capacity and LOS for freeway components. Chapter 10 also presents a discussion of simulation models. The DYNEV II simulation model automatically performs this integration process.

Chapter 12 of the HCM 2022 presents procedures for estimating capacity and LOS for “Basic Freeway Segments”. Exhibit 12-37 of the HCM 2022 presents capacity vs. free speed estimates, which are provided below.

| Free Speed mph (kph): | 55 (89) | 60 (97) | 65 (105) | 70+ (113+) |
|---|---|---|---|---|
| Per-Lane Capacity (pc/h): | 2,250 | 2,300 | 2,350 | 2,400 |

The inputs to the simulation model are highway geometrics, free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships. A conservative estimate of per-lane capacity of 2,250 pc/h is adopted for this study for freeways.

Chapter 13 of the HCM 2022 presents procedures for estimating capacity, speed, density and LOS for freeway weaving sections. The simulation model contains logic that relates speed to demand volume: capacity ratio. The value of capacity obtained from the computational procedures detailed in Chapter 13 depends on the “Type” and geometrics of the weaving segment and on the “Volume Ratio” (ratio of weaving volume to total volume).

Chapter 14 of the HCM 2022 presents procedures for estimating capacities of ramps and of “merge” areas. There are three significant factors to the determination of capacity of a ramp-freeway junction: The capacity of the freeway immediately downstream of an on-ramp or immediately upstream of an off-ramp; the capacity of the ramp roadway; and the maximum flow rate entering the ramp influence area. In most cases, the freeway capacity is the controlling factor. Values of this merge area capacity are presented in Exhibit 14-10 of the HCM 2022 and depend on the number of freeway lanes and on the freeway free speed. Ramp capacity is presented in Exhibit 14-12 and is a function of the ramp’s FFS. The DYNEV II simulation model logic simulates the merging operations of the ramp and freeway traffic in accord with the procedures in Chapter 14 of the HCM 2022. If congestion results from an excess of demand relative to capacity, then the model allocates service appropriately to the two entering traffic streams and produces LOS F conditions (The HCM 2022 does not address LOS F explicitly).

### 4.3.4 Intersections

Ref: HCM 2022 Chapters 19, 20, 21, 22

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapter 19 (signalized intersections), Chapters 20, 21 (un-signalized intersections) and Chapter 22 (roundabouts). The complexity of these computations is indicated by the aggregate length of these chapters. The DYNEV II simulation logic is likewise complex.

The simulation model explicitly models intersections: Stop/yield controlled intersections (both 2-way and all-way) and traffic signal controlled intersections. Where intersections are controlled by fixed time controllers, traffic signal timings are set to reflect average (non-evacuation) traffic conditions. Actuated traffic signal settings respond to the time-varying demands of evacuation traffic to adjust the relative capacities of the competing intersection approaches.

The model is also capable of modelling the presence of manned traffic control. At specific locations where it is advisable or where existing plans call for overriding existing traffic control to implement manned control, the model will use actuated signal timings that reflect the presence of traffic guides. At locations where a special traffic control strategy (continuous left-turns, contra-flow lanes) is used, the strategy is modelled explicitly. A list that includes the total number of intersections modelled that are unsignalized, signalized, or manned by response personnel is noted in Appendix K.

## 4.4 Simulation and Capacity Estimation

Chapter 6 of the HCM 2022 is entitled, "HCM and Alternative Analysis Tools." The chapter discusses the use of alternative tools such as simulation modelling to evaluate the operational performance of highway networks. Among the reasons cited in Chapter 6 to consider using simulation as an alternative analysis tool is:

> *"The system under study involves a group of different facilities or travel modes with mutual interactions involving several HCM chapters. Alternative tools are able to analyze these facilities as a single system."*

This statement succinctly describes the analyses required to determine traffic operations across an area encompassing a PZ operating under evacuation conditions. The model utilized for this study, DYNEV II is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM – they *replace* these procedures by describing the complex interactions of traffic flow and computing Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location. The DYNEV II simulation model includes some HCM 2022 procedures only for the purpose of estimating capacity.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of these are: (1) FFS; and (2) saturation headway, $h_{sat}$. The first of these is estimated by direct observation during the road survey; the second is estimated using the concepts of the HCM 2022, as described earlier.

It is important to note that simulation is a mathematical representation of an assumed set of conditions using the best available knowledge and understanding of traffic flow and available inputs. Simulation should not be assumed to be a prediction of what will happen under any event because a real evacuation can be impacted by an infinite number of things – many of which will differ from these test cases – and many others cannot be taken into account with the tools available.

## 4.5 Boundary Conditions

As illustrated in Figure 1-2 and in Appendix K, the link-node analysis network used for this study is finite. The analysis network extends well beyond the 15-mile (25-kilometre) radial PZ in some locations in order to model intersections with other major evacuation routes beyond the PZ. However, the network does have an end at the destination (exit) nodes as discussed in Appendix C. Beyond these destination nodes, there may be signalized intersections or merge points that impact the capacity of the evacuation routes leaving the PZ. Rather than neglect these "boundary conditions", this study assumes a 25% reduction in capacity on two-lane roads (Section 4.3.1 above) and multilane highways (Section 4.3.2 above). There is no reduction in capacity for freeways due to boundary conditions. The 25% reduction in capacity is based on the prevalence of actuated traffic signals outside the PZ and the fact that the evacuating traffic volume ("main street") will be more significant than the competing traffic volume ("side street") at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time.

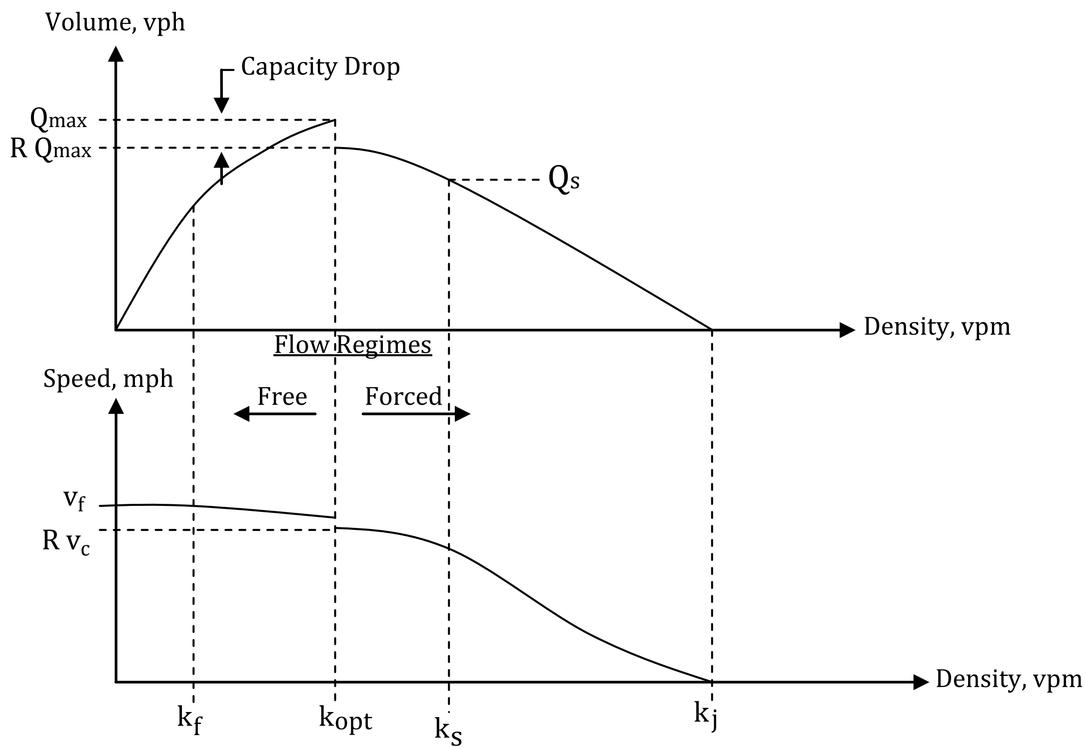



**Figure 4-1. Fundamental Diagrams**

# 5 ESTIMATION OF TRIP GENERATION/MOBILIZATION TIME

Federal guidance (NUREG/CR-7002, Rev. 1) specify that the planner estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the demographic survey. We define the sum of these distributions of elapsed times as the Trip Generation/Mobilization Time Distribution.

## 5.1 Background

In general, an accident at a nuclear power plant is characterized by the following Emergency Categorization Levels (Provincial Nuclear Emergency Response Plan, Implementing Plan for the DNGS, January 2019):

1. Reportable Event
2. Abnormal Incident
3. Onsite Emergency
4. General Emergency

At each level, the Provincial Plan specifies a set of Actions to be undertaken by Provincial and Municipal authorities. In addition, the Provincial Nuclear Emergency Response Plan (PNERP)-Implementing plan for the DNGS specifies default response actions at each level. As a Planning Basis, we will adopt a conservative posture, in accordance with Section 1.2 of NUREG/CR-7002 Rev. 1, that a rapidly progressing severe accident resulting in a Full Activation level of response (General or Onsite Emergency categorization, or emission in 36 hrs or less, or as required due to deteriorating conditions) will be considered in calculating the Trip Generation Time. We will assume:

1. The Emergency Bulletin to evacuate will be announced coincident with the activation of the notification.
2. Mobilization of the general population will commence within 15 minutes after notification.
3. The ETE are measured relative to the Emergency Bulletin to evacuate.

We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:

1. Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Section 2.13 of NUREG/CR-6863.
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is likely that a longer time will elapse between the various Emergency Categorization Levels. For example, suppose one-hour elapses from the siren alert to the Emergency Bulletin to evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the Planning Zone[1] (PZ) will be lower when the Emergency Bulletin to evacuate is announced, than at the time of the siren alert. In addition, many will engage in preparation activities to evacuate, in anticipation that an Emergency Bulletin to evacuate will be broadcasted. Thus, the time needed to complete the mobilization activities and the number of people remaining to evacuate the PZ after the Emergency Bulletin to evacuate, will both be somewhat less than the estimates presented in this report. Consequently, the ETE presented in this report are higher than the actual evacuation time, if this hypothetical situation were to take place.

The notification process consists of two events:

1. Transmitting information using the alert notification systems available within the PZs (e.g., sirens, automated phone calls, National Alert Aggregation & Dissemination System (NAADS), Alert Ready, media).
2. Receiving and correctly interpreting the information that is transmitted.

The population within the DPZ and CPZ is dispersed over a large area and is engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

The amount of elapsed time will vary from one individual to the next depending on where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the PZ at the time the emergency is declared. These people may be commuters, shoppers and other travellers who reside within the PZ and who will return to join the other household members upon receiving notification of an emergency.

As indicated in Section 2.13 of NUREG/CR-6863, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the PZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETE may be computed.

For example, people at home or at work within the PZ will be notified by siren, and other means listed above. Those well outside the PZs will be notified by telephone, radio, TV, and word-of-mouth, with potentially longer time lags. Furthermore, the spatial distribution of the population within the PZ will differ with time of day - families will be united in the evenings but dispersed during the day. In this respect, weekends will differ from weekdays.

As indicated in Section 4.3 of NUREG/CR-7002, Rev. 1, the information required to compute trip generation times is typically obtained from a demographic survey of residents within the PZs. Such a survey was conducted in support of this ETE study. Appendix F discusses the survey sampling plan, documents the survey instrument utilized and provides the survey results. The

[1] The Planning Zones include the Automatic Action Zone (AAZ), Detailed Planning Zone (Inner and Outer Rings) and the Contingency Planning Zone (CPZ).

remaining discussion will focus on the application of the trip generation data obtained from the demographic survey to the development of the ETE documented in this report.

## 5.2 Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips consists of a sequence of events and activities. Each event (other than the first) occurs at an instant in time and is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e., to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one another. The relevant events associated with the public's preparation for evacuation are:

| Event Number | Event Description |
|---|---|
| 1 | Notification |
| 2 | Awareness of Situation |
| 3 | Depart Work |
| 4 | Arrive Home |
| 5 | Depart on Evacuation Trip |

Associated with each sequence of events are one or more activities, as outlined below:

- An Event is a ‘state' that exists at a point in time (e.g., depart work, arrive home)
- An Activity is a ‘process' that takes place over some elapsed time (e.g., prepare to leave work, travel home)

These relationships are shown graphically in Table 5-1.

As such, a completed Activity changes the ‘state' of an individual (i.e., the activity, ‘travel home' changes the state from ‘depart work' to ‘arrive home'). Therefore, an Activity can be described as an ‘Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next and are described as statistical distributions on the following pages.

An employee who lives outside the PZ will follow sequence (c) of Figure 5-1. A household within the PZ that has one or more commuters at work and will await their return before beginning the evacuation trip will follow the first sequence of Figure 5-1(a). A household within the PZ that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day.

Households with no commuters on weekends or in the evening/night-time, will follow the applicable sequence in Figure 5-1(b). Transients will always follow one of the sequences of Figure 5-1(b). Some transients away from their residence (lodging facility or campground) could elect to evacuate immediately without returning to the residence, as indicated in the second sequence.

It is seen from Figure 5-1, that the Trip Generation time (i.e., the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities preceding that event. That is, to estimate the time distribution of Event 5, we must obtain estimates of the time distributions of all preceding events. For this study, we adopt the conservative posture that all activities will occur in sequence such that all preceding events must be completed before the current event can occur.

In some cases, assuming certain events occur strictly sequential (for instance, commuter returning home before beginning preparation to leave, or removing snow only after the preparation to leave) can result in rather *conservative* (that is, longer) estimates of mobilization times. It is reasonable to expect that at least some parts of these events will overlap for many households, but that assumption is not made in this study.

## 5.3 Estimated Time Distributions of Activities Preceding Event 5

The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since it is performed on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 → 2

Section 6.2.2 of the *Provincial Nuclear Emergency Response Plan (PNERP) Implementing Plan for the Darlington Nuclear Generating Station (DNGS) January 2019* states that, "The Regional Municipality of Durham, as the Designated Municipality in the DNGS Detailed Planning Zone shall make provisions, in their nuclear emergency plans, for a public alerting system which shall ensure that their Automatic Action Zone populations that may be required to undertake the default or immediate protective measures of (e.g., sheltering-in-place, evacuation, and ingestion of KI) can be alerted within 15 minutes of initiation". As discussed in item 1 of Section 2.3, an assumption of the time required to notify essentially 100% the population in the CPZ is necessary to produce ETEs. A value of 45 minutes has been assumed as reasonable and accepted by the Provincial emergency managers and OPG to extent possible, given the use of the sirens and land line telephone alerting in the DPZ together with NAAD[2] and wireless public alerting in the DPZ, CPZ, and Ingestion Planning Zone (IPZ) as required. The assumed distribution for notifying the population is provided in in Table 5-2.

Distribution No. 2, Prepare to Leave Work: Activity 2 → 3

It is reasonable to expect that the vast majority of business enterprises within the PZ will elect to shut down following notification and most employees would leave work quickly. Commuters, who work outside the PZ could, in all probability, also leave quickly since facilities outside the PZ would remain open and other personnel would remain. Personnel or farmers responsible for equipment/livestock would require additional time to secure their facility. The distribution of Activity 2 → 3 shown in Table 5-3 reflects data obtained by the demographic survey. This

[2] https://alerts.pelmorex.com/

distribution is also applicable for residents to leave stores, restaurants, parks, and other locations within the PZ. This distribution is plotted in Figure 5-2.

Distribution No. 3, Travel Home: Activity 3 $\rightarrow$ 4

These data are provided directly by those households which responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-4.

Distribution No. 4, Prepare to Leave Home: Activity 2, 4 $\rightarrow$ 5

These data are provided directly by those households which responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-5.

Distribution No. 5, Heavy Snow Clearance Time Distribution

Inclement weather scenarios involving snowfall must address the time lags associated with heavy snow clearance. It is assumed that snow equipment is mobilized and deployed during the snowfall to maintain passable roads. The general consensus is that the snow-ploughing efforts are generally successful for all but the most extreme blizzards when the rate of snow accumulation exceeds that of snow clearance over a period of many hours. (Note – evacuation may not be a prudent protective action under such blizzard conditions).

Consequently, it is reasonable to assume that the highway system will remain passable – albeit at a lower capacity – under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared to the extent needed to permit vehicles to gain access to the roadways. These clearance activities take time; this time must be incorporated into the trip generation time distributions. This distribution is plotted in Figure 5-2 and listed in Table 5-6.

## 5.4 Calculation of Trip Generation Time Distribution

The time distributions for each of the mobilization activities presented herein must be combined to form the appropriate Trip Generation Distributions. As discussed above, this study assumes that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 $\rightarrow$ 4) must precede Activity 4 $\rightarrow$ 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-7 presents the summing procedure to arrive at each designated distribution.

Table 5-8 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

### 5.4.1 Statistical Outliers

As already mentioned, some portion of the survey respondents answer "Decline to State" to some questions or choose to not respond to a question. The mobilization activity distributions are based upon actual responses. But, it is the nature of surveys that a few numeric responses are inconsistent with the overall pattern of results. An example would be a case in which for 500 responses, almost all of them estimate less than two hours for a given answer, but 3 say "four hours" and 4 say "six or more hours".

These "outliers" must be considered: are they valid responses, or so atypical that they should be dropped from the sample?

In assessing outliers, there are three alternatives to consider:

1. Some responses with very long times may be valid, but reflect the reality that the respondent really needs to be classified in a different population subgroup, based upon access and/or functional needs;
2. Other responses may be unrealistic (6 hours to return home from commuting distance, or 2 days to prepare the home for departure);
3. Some high values are representative and plausible, and one must not cut them as part of the consideration of outliers.

The issue of course is how to make the decision that a given response or set of responses are to be considered "outliers" for the component mobilization activities, using a method that objectively quantifies the process.

There is considerable statistical literature on the identification and treatment of outliers singly or in groups, much of which assumes the data is normally distributed and some of which uses non-parametric methods to avoid that assumption. The literature cites that limited work has been done directly on outliers in sample survey responses.

In establishing the overall mobilization time/trip generation distributions, the following principles are used:

1) It is recognized that the overall trip generation distributions are conservative estimates, because they assume a household will do the mobilization activities sequentially, with no overlap of activities;
2) The individual mobilization activities (prepare to leave work, travel home, prepare home, clear snow) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-7, and Table 5-8);
3) Outliers can be eliminated either because the response reflects a special population (e.g., access and/or functional needs, transit dependent) or lack of realism, because the purpose is to estimate trip generation patterns for personal vehicles;

4) To eliminate outliers,
   a) the mean and standard deviation of the specific activity are estimated from the responses,
   b) the median of the same data is estimated, with its position relative to the mean noted,
   c) the histogram of the data is inspected, and
   d) all values greater than 3.5 standard deviations are flagged for attention, taking special note of whether there are gaps (categories with zero entries) in the histogram display.

   In general, only flagged values more than 4.0 standard deviations from the mean are allowed to be considered outliers, with gaps in the histogram expected.

   When flagged values are classified as outliers and dropped, steps "a" to "d" are repeated.

5) As a practical matter, even with outliers eliminated by the above, the resultant histogram, viewed as a cumulative distribution, is not a normal distribution. A typical situation that results is shown below in Figure 5-3.

6) In particular, the cumulative distribution differs from the normal distribution in two key aspects, both very important in loading a network to estimate evacuation times:
   a) Most of the real data is to the left of the "normal" curve above, indicating that the network loads faster for the first 80-85% of the vehicles, potentially causing more (and earlier) congestion than otherwise modelled;
   b) The last 10-15% of the real data "tails off" slower than the comparable "normal" curve, indicating that there is significant traffic still loading at later times.

   Because these two features are important to preserve, it is the histogram of the data that is used to describe the mobilization activities, <u>not</u> a "normal" curve fit to the data. One could consider other distributions, but using the shape of the *actual* data curve is unambiguous and preserves these important features;

7) With the mobilization activities each modelled according to Steps 1-6, including preserving the features cited in Step 6, the overall (or total) mobilization times are constructed.

This is done by using the data sets and distributions under different scenarios (e.g., commuter returning, no commuter returning, no snow or heavy snow in each). In general, these are additive, using weighting based upon the probability distributions of each element; Figure 5-4 presents the combined trip generation distributions designated for each population group considered. These distributions are presented on the same time scale. (As discussed earlier, the use of strictly additive activities is a conservative approach, because it makes all activities <u>sequential</u> – preparation for departure follows the return of the commuter; snow clearance follows the preparation for departure, and so forth. In practice, it is reasonable that some of these activities are done in parallel, at least to some extent – for instance, preparation to depart begins by a household member at home while the commuter is still on the road.)

The mobilization distributions that result is used in their tabular/graphical form as direct inputs to later computations that lead to the ETE.

The DYNEV II simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, D, E and F, properly displaced with respect to one another, are tabulated in Table 5-9 (Distribution B, Arrive Home, omitted for clarity).

The final time period (15) is 600 minutes long. This time period is added to allow the analysis network to clear, in the event congestion persists beyond the trip generation period. Note that there are no trips generated during this final time period.

### 5.4.2 Staged Evacuation Trip Generation

NUREG/CR-7002, Rev.1, defines staged evacuation using English units (miles) and the typical planning radii (2, 5 and 10 miles) for U.S. nuclear plants. Adapting the guidance of NUREG/CR-7002, Rev. 1, to Canadian standards and planning radii, staged evacuation consists of the following:

1. Response Sectors comprising the AAZ are advised to evacuate immediately.
2. Response Sectors comprising regions extending beyond the AAZ downwind to the CPZ boundary are advised to shelter in-place while the AAZ region is cleared.
3. As vehicles evacuate the AAZ, sheltered people beyond the AAZ downwind to the CPZ boundary continue to prepare for an evacuation.
4. The population sheltering beyond the AAZ downwind to the CPZ boundary are advised to begin evacuating when approximately 90% of those originally within the AAZ evacuate across the AAZ boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow/voluntary evacuation percentage of 30%.

Assumptions

1. The population in Response Sectors not told to evacuate will shelter-in-place, with the exception of the 30% non-compliance.
2. The transient population will not be expected to stage their evacuation because of the limited sheltering options available to people who may be at parks, at campgrounds, on a beach, or at other venues. Also, notifying the transient population of a staged evacuation would prove difficult.
3. Employees will also be assumed to evacuate without first sheltering in place.

Procedure

1. Trip generation for population groups in the AAZ will be as computed based upon the results of the demographic survey and analysis.

2. Trip generation for the population subject to staged evacuation will be formulated as follows:
    a. Identify the 90th percentile evacuation time for the Response Sectors comprising the 3 km region. This value, $T_{Scen}^*$, obtained from simulation results, is scenario specific. It will become the time at which the region being sheltered will be told to evacuate for each scenario.
    b. The resultant trip generation curves for staging are then formed as follows:
        i. The non-shelter trip generation curve is followed until a maximum of 30% of the total trips are generated (to account for shelter non-compliance).
        ii. No additional trips are generated until time $T_{Scen}^*$
        iii. Following time $T_{Scen}^*$, the balance of trips are generated:
            1. by stepping up and then following the non-shelter trip generation curve (if $T_{Scen}^*$ is $\leq$ max trip generation time) or
            2. by stepping up to 100% (if $T_{Scen}^*$ is > max trip generation time)
    c. Note: This procedure implies that there may be different staged trip generation distributions for different scenarios. NUREG/CR-7002, Rev. 1, uses the statement "approximately 90th percentile" as the time to end staging and begin evacuating. The value of $T_{Scen}^*$ is 1:30 for non-snow scenarios and 2:00 for heavy snow scenarios (see Region R01 in Table 7-1).
3. Staged trip generation distributions are created for the following population groups:
    a. Residents with returning commuters
    b. Residents without returning commuters
    c. Residents with returning commuters and heavy snow conditions
    d. Residents without returning commuters and heavy snow conditions

Figure 5-5 presents the staged trip generation distributions for both residents with and without returning commuters; approximately, the 90th percentile evacuation time of the AAZ is approximately 90 minutes for non-snow scenarios and 120 minutes for heavy snow scenarios (see Region R01 in Table 7-1). At $T_{Scen}^*$, 30% of the permanent resident population (who normally would have completed their mobilization activities for an un-staged evacuation) advised to shelter has nevertheless departed the area. These people do not comply with the shelter advisory. Also included on the plot are the trip generation distributions for these groups as applied to the regions advised to evacuate immediately.

Since the 90th percentile evacuation time occurs before the end of the trip generation time, after the sheltered region is advised to evacuate, the shelter trip generation distribution rises to meet the balance of the non-staged trip generation distribution. Following time $T_{Scen}^*$, the balance of staged evacuation trips that are ready to depart are released within 30 minutes and after this time, the remainder of evacuation trips are generated in accordance with the un-staged trip generation distribution.

Figure 5-5 and Table 5-10 provides the trip generation histograms for staged evacuation.

### 5.4.3 Trip Generation for Waterways and Recreational Areas

Section 3.3.9 of Chapter 3 on page 13 of the Durham Region Nuclear Emergency Response Plan, indicates the Provincial Emergency Operations Centre (PEOC) will issue operational directives to clear boat traffic from Lake Ontario. The Canadian Coast Guard, assisted by the Durham Regional Police Services and Toronto Police marine units, will control entry into the lake during an evacuation.

As discussed in Section 2.2, this study assumes a rapidly progressing severe accident. As indicated in Table 5-2 and and discussed in Section 2.3, this study assumes essentially 100% notification in 45 minutes after the Emergency Bulletin to evacuate. Table 5-9 indicates that all transients will have mobilized within 1 hour and 15 minutes. It is assumed that this timeframe is sufficient time for boaters, campers and other transients to return to their vehicles and begin their evacuation trip. It is also assumed this is sufficient time for boaters who entered the PZ by boat to exit the PZ by boat.

**Table 5-1. Event Sequence for Evacuation Activities**

| Event Sequence | Activity | Distribution |
|---|---|---|
| 1 → 2 | Receive Notification | 1 |
| 2 → 3 | Prepare to Leave Work | 2 |
| 2,3 → 4 | Travel Home | 3 |
| 2,4 → 5 | Prepare to Leave to Evacuate | 4 |
| N/A | Snow Clearance | 5 |

**Table 5-2. Time Distribution for Notifying the Public**

| Elapsed Time (Minutes) | Percent of Population Notified |
|---|---|
| 0 | 0% |
| 5 | 7% |
| 10 | 13% |
| 15 | 27% |
| 20 | 47% |
| 25 | 66% |
| 30 | 87% |
| 35 | 92% |
| 40 | 97% |
| 45 | 100% |

**Table 5-3. Time Distribution for Employees to Prepare to Leave Work/College**

| Elapsed Time (Minutes) | Cumulative Percent Employees Leaving Work | Elapsed Time (Minutes) | Cumulative Percent Employees Leaving Work |
|---|---|---|---|
| 0 | 0% | 30 | 96.0% |
| 5 | 34.9% | 35 | 97.3% |
| 10 | 59.1% | 40 | 98.3% |
| 15 | 78.6% | 45 | 99.7% |
| 20 | 85.8% | 50 | 100.0% |
| 25 | 88.8% | | |

**NOTE:** The survey data was normalized to distribute the "Decline to State" response. That is, the sample was reduced in size to include only those households who responded to this question. The underlying assumption is that the distribution of this activity for the "Decline to State" responders, if the event takes place, would be the same as those responders who provided estimates.

**Table 5-4. Time Distribution for Commuters to Travel Home**

| Elapsed Time (Minutes) | Cumulative Percent Returning Home |
|---|---|
| 0 | 0% |
| 5 | 4.1% |
| 10 | 15.3% |
| 15 | 33.4% |
| 20 | 46.2% |
| 25 | 55.3% |
| 30 | 67.4% |
| 35 | 72.8% |
| 40 | 78.9% |
| 45 | 84.6% |
| 50 | 87.2% |
| 55 | 88.7% |
| 60 | 93.5% |
| 75 | 97.2% |
| 90 | 99.1% |
| 105 | 100.0% |

**NOTE:** The survey data was normalized to distribute the " Decline to State" response.

**Table 5-5. Time Distribution for Population to Prepare Home to Evacuate**

| Elapsed Time (Minutes) | Cumulative Percent Ready to Evacuate |
|---|---|
| 0 | 0% |
| 15 | 6.9% |
| 30 | 35.4% |
| 45 | 54.6% |
| 60 | 74.7% |
| 75 | 85.0% |
| 90 | 88.7% |
| 105 | 91.0% |
| 120 | 94.7% |
| 135 | 98.7% |
| 150 | 99.2% |
| 165 | 99.5% |
| 180 | 100.0% |

**NOTE:** The survey data was normalized to distribute the " Decline to State " response

**Table 5-6. Time Distribution for Population to Clear 15-20 cm of Snow**

| Elapsed Time (Minutes) | Cumulative Percent Ready to Evacuate |
|---|---|
| 0 | 21.9% |
| 15 | 48.5% |
| 30 | 75.0% |
| 45 | 89.1% |
| 60 | 96.3% |
| 75 | 98.4% |
| 90 | 99.2% |
| 105 | 100.0% |

**NOTE:** The survey data was normalized to distribute the " Decline to State " response

**Table 5-7. Mapping Distributions to Events**

| Apply "Summing" Algorithm To: | Distribution Obtained | Event Defined |
|---|---|---|
| Distributions 1 and 2 | Distribution A | Event 3 |
| Distributions A and 3 | Distribution B | Event 4 |
| Distributions B and 4 | Distribution C | Event 5 |
| Distributions 1 and 4 | Distribution D | Event 5 |
| Distributions C and 5 | Distribution E | Event 5 |
| Distributions D and 5 | Distribution F | Event 5 |

**Table 5-8. Description of the Distributions**

| Distribution | Description |
|---|---|
| **A** | Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the PZs who live outside, and to Transients within the PZs. |
| **B** | Time distribution of commuters arriving home (Event 4). |
| **C** | Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip (Event 5). |
| **D** | Time distribution of residents without commuters returning home, leaving home to begin the evacuation trip (Event 5). |
| **E** | Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip, after heavy snow clearance activities (Event 5). |
| **F** | Time distribution of residents with no commuters returning home, leaving to begin the evacuation trip, after heavy snow clearance activities (Event 5). |

**Table 5-9. Trip Generation Histograms for the PZ Population for Un-staged Evacuation[3]**

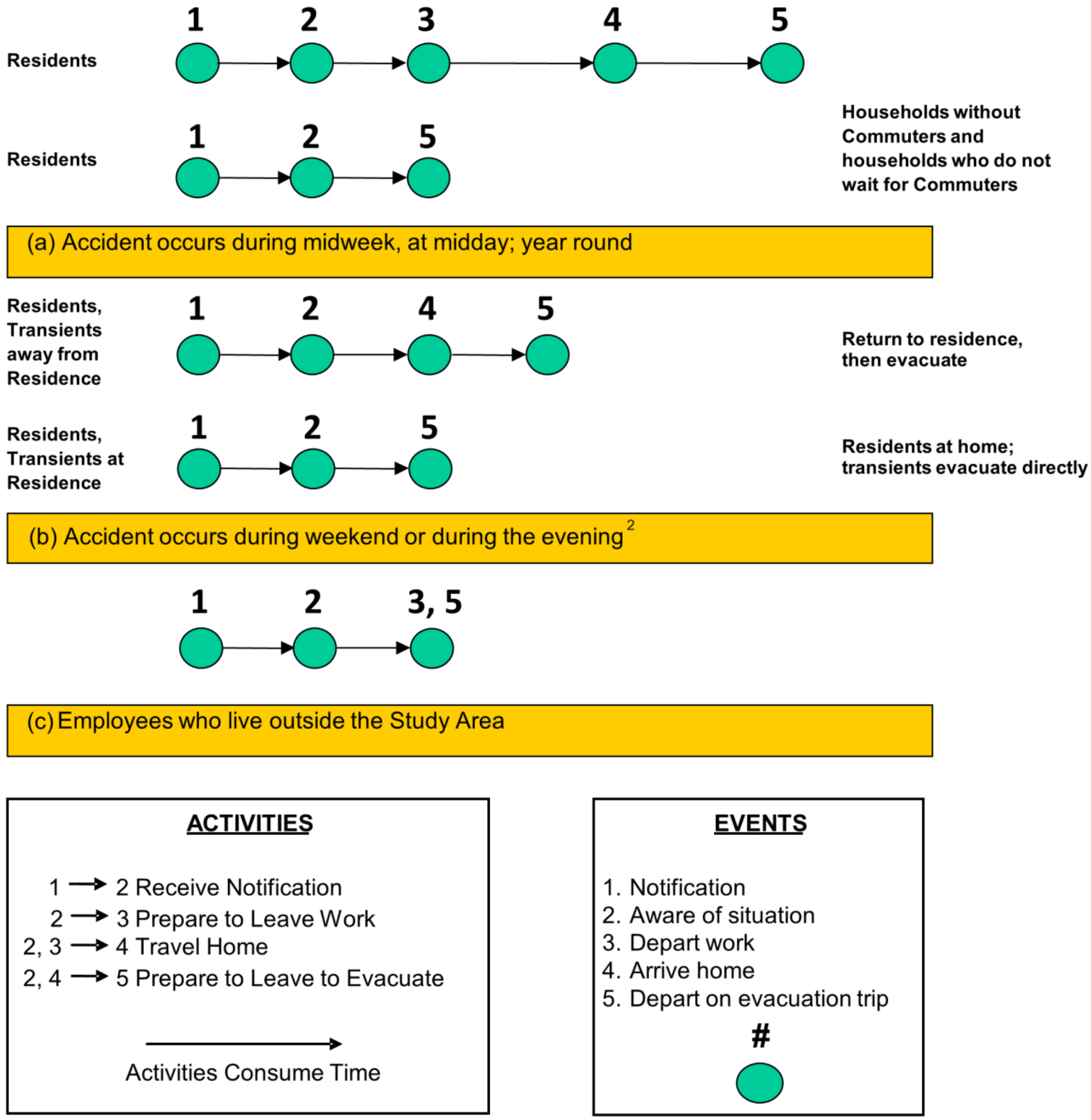
| Time Period | Duration (Min) | Percent of Total Trips Generated Within Indicated Time Period | | | | | |
|---|---|---|---|---|---|---|---|
| | | Employees (Distribution A) | Transients (Distribution A) | Residents with Commuters (Distribution C) | Residents without Commuters (Distribution D) | Residents with Commuters Heavy Snow (Distribution E) | Residents without Commuters Heavy Snow (Distribution F) |
| 1 | 15 | 6% | 6% | 0% | 0% | 0% | 0% |
| 2 | 15 | 35% | 35% | 0% | 5% | 0% | 2% |
| 3 | 15 | 40% | 40% | 1% | 16% | 0% | 5% |
| 4 | 15 | 15% | 15% | 4% | 22% | 2% | 13% |
| 5 | 15 | 4% | 4% | 10% | 20% | 4% | 16% |
| 6 | 15 | 0% | 0% | 15% | 15% | 8% | 17% |
| 7 | 30 | 0% | 0% | 33% | 12% | 27% | 25% |
| 8 | 30 | 0% | 0% | 20% | 6% | 26% | 12% |
| 9 | 30 | 0% | 0% | 10% | 3% | 17% | 7% |
| 10 | 15 | 0% | 0% | 3% | 1% | 5% | 1% |
| 11 | 30 | 0% | 0% | 3% | 0% | 7% | 2% |
| 12 | 15 | 0% | 0% | 0% | 0% | 2% | 0% |
| 13 | 15 | 0% | 0% | 1% | 0% | 1% | 0% |
| 14 | 30 | 0% | 0% | 0% | 0% | 1% | 0% |
| 15 | 600 | 0% | 0% | 0% | 0% | 0% | 0% |

[3] Shadow vehicles are loaded onto the analysis network (Figure 1-2) using Distributions C and E for good weather and heavy snow, respectively. Special event vehicles are loaded using Distribution A.

**Table 5-10. Trip Generation Histograms for the PZ Population for Staged Evacuation**

| Time Period | Duration (Min) | Percent of Total Trips Generated Within Indicated Time Period[4] | | | |
|---|---|---|---|---|---|
| | | Residents with Commuters (Distribution C) | Residents Without Commuters (Distribution D) | Residents with Commuters Heavy Snow (Distribution E) | Residents without Commuters Heavy Snow (Distribution F) |
| 1 | 15 | 0% | 0% | 0% | 0% |
| 2 | 15 | 0% | 1% | 0% | 0% |
| 3 | 15 | 0% | 3% | 0% | 1% |
| 4 | 15 | 1% | 5% | 0% | 3% |
| 5 | 15 | 2% | 4% | 1% | 3% |
| 6 | 15 | 3% | 3% | 2% | 4% |
| 7 | 30 | 57% | 74% | 5% | 5% |
| 8 | 30 | 20% | 6% | 59% | 74% |
| 9 | 30 | 10% | 3% | 17% | 7% |
| 10 | 15 | 3% | 1% | 5% | 1% |
| 11 | 30 | 3% | 0% | 7% | 2% |
| 12 | 15 | 0% | 0% | 2% | 0% |
| 13 | 15 | 1% | 0% | 1% | 0% |
| 14 | 30 | 0% | 0% | 1% | 0% |
| 15 | 600 | 0% | 0% | 0% | 0% |

[4] Trip Generation for Employees and Transients (see Table 5-9) is the same for Un-staged and Staged Evacuation.




[1] Applies for evening and weekends also if commuters are at work.
[2] Applies throughout the year for transients.

**Figure 5-1. Events and Activities Preceding the Evacuation Trip**

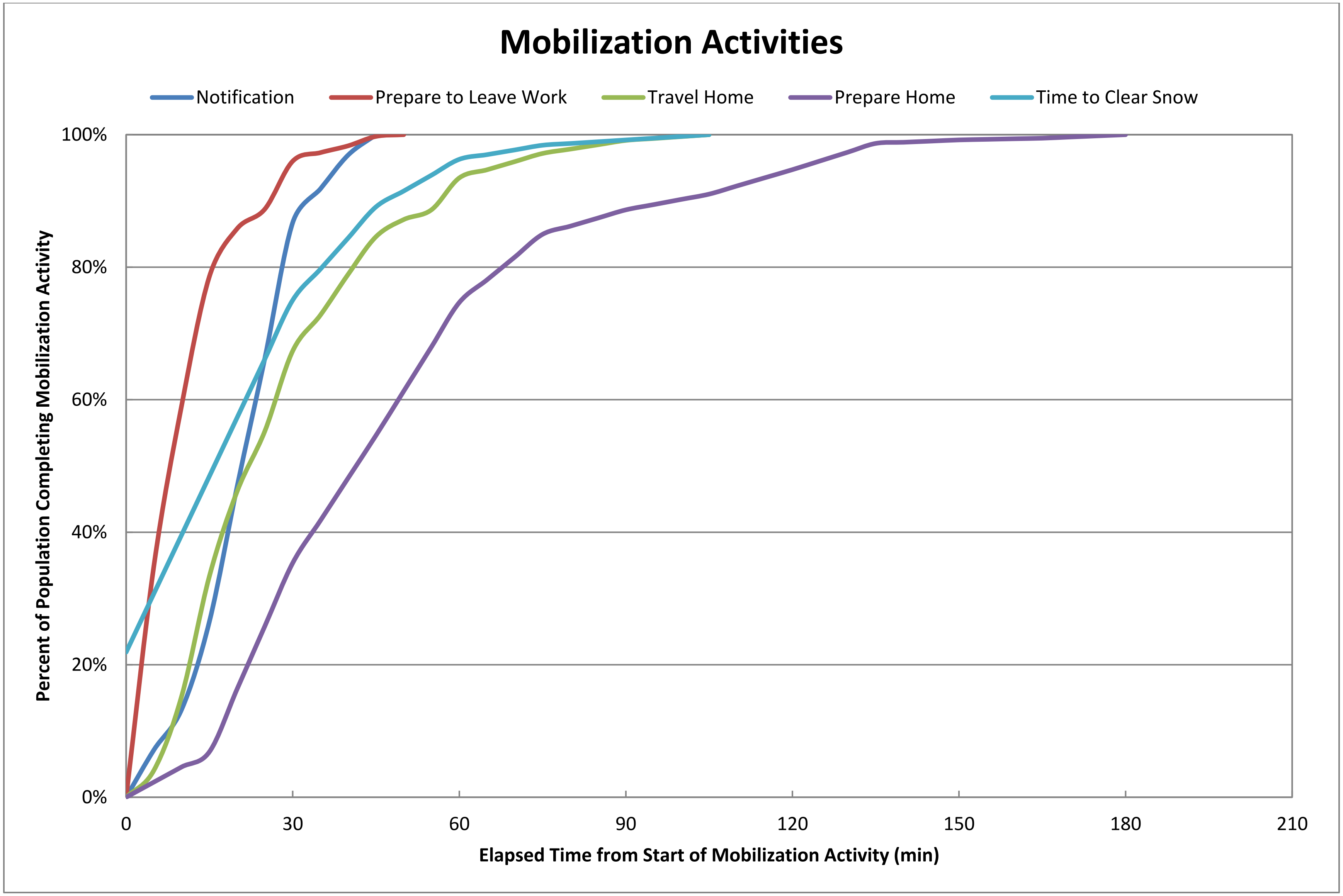



**Figure 5-2. Time Distributions for Evacuation Mobilization Activities**

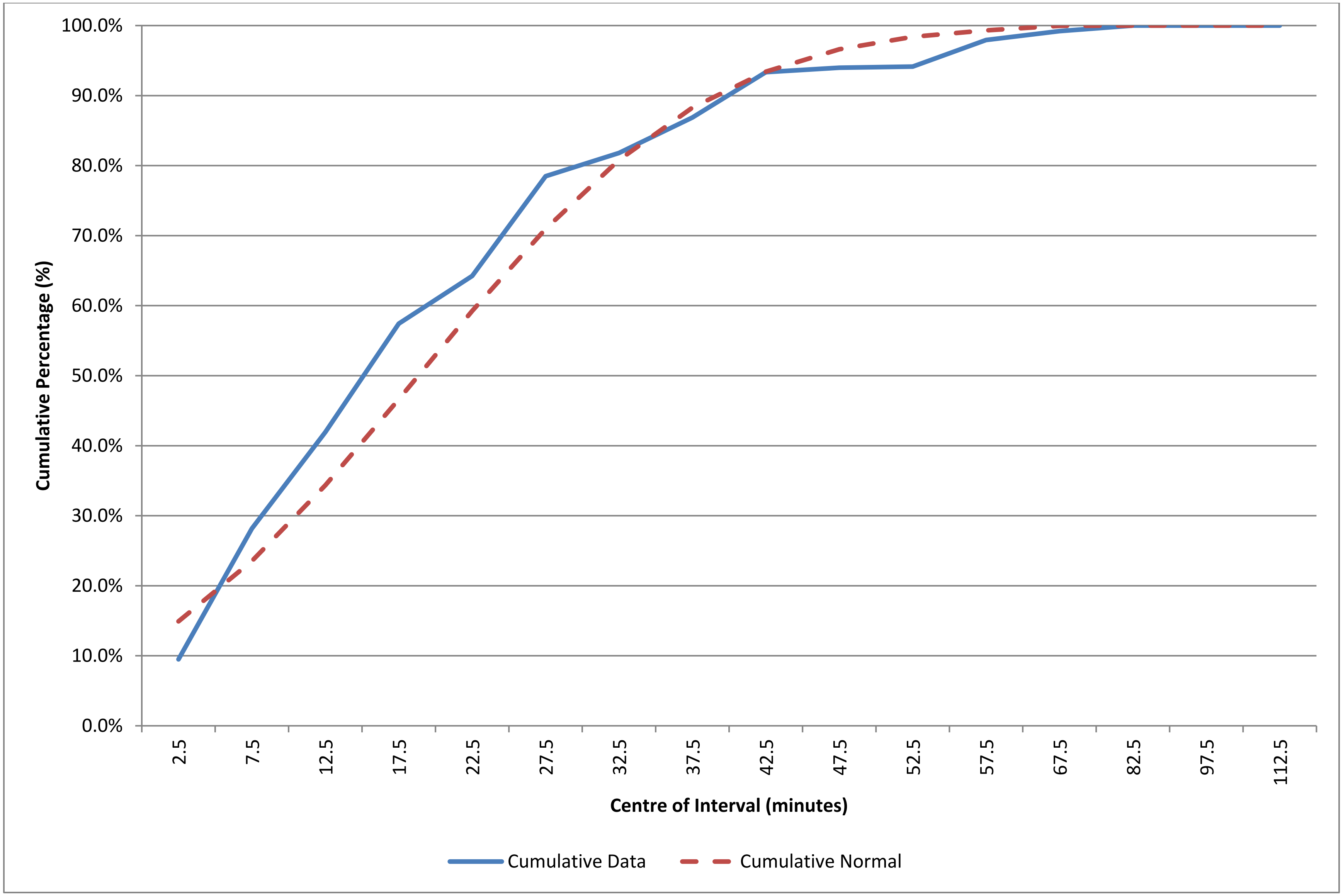



**Figure 5-3. Comparison of Data Distribution and Normal Distribution**

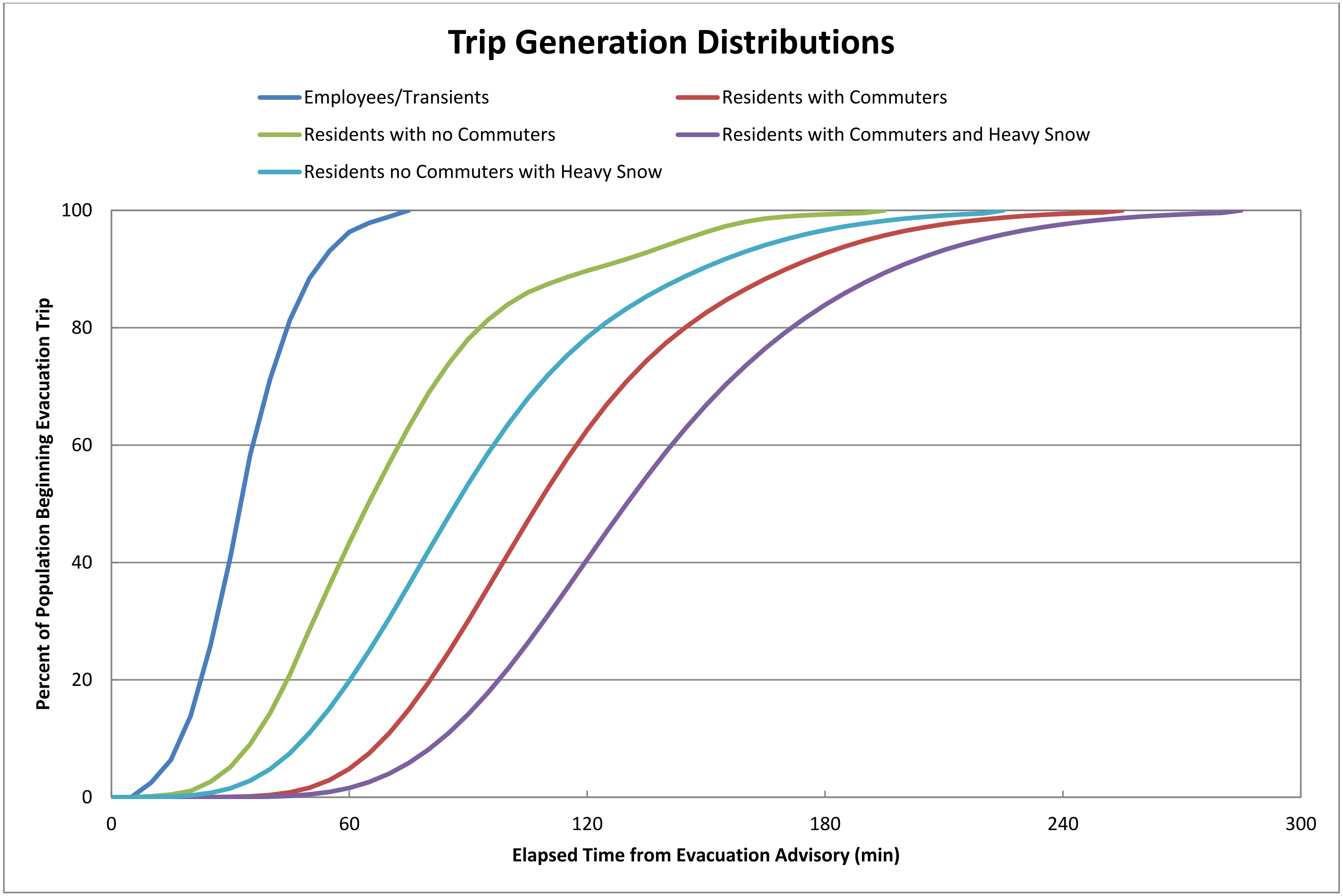



**Figure 5-4. Comparison of Trip Generation Distributions**

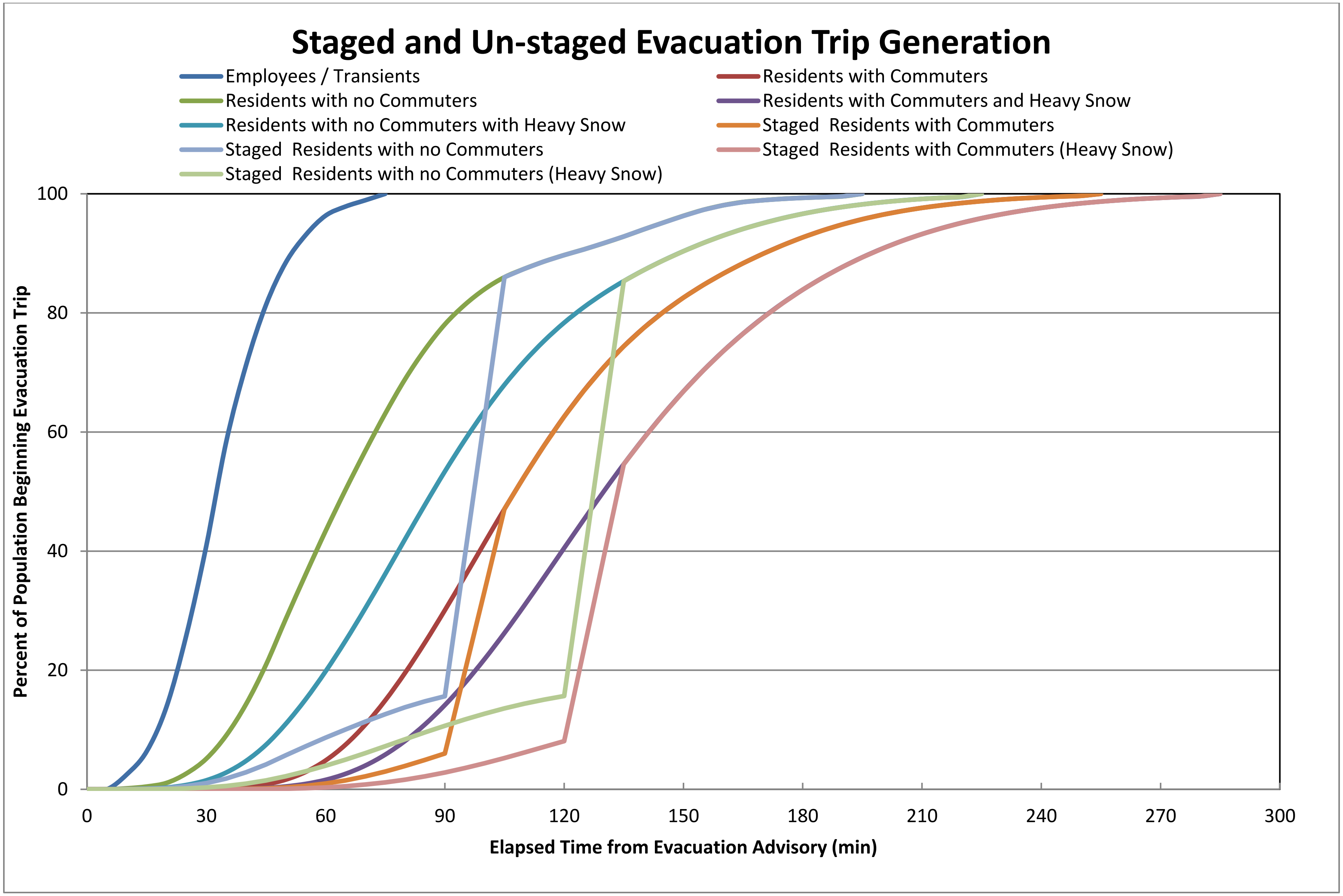



**Figure 5-5. Comparison of Staged and Un-staged Trip Generation Distributions in the 3 to 10 km Region**

## 6 EVACUATION CASES

An evacuation "case" defines a combination of Evacuation Region and Evacuation Scenario. The definitions of "Region" and "Scenario" are as follows:

**Region** A grouping of contiguous evacuating Response Sectors that forms either a "keyhole" sector-based area, or a circular area within the Planning Zones (PZs), that must be evacuated in response to a radiological emergency.

**Scenario** A combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions.

A total of 50 Regions were defined which encompass all the groupings of Response Sectors considered. These Regions are defined in Table 6-1 and Table 6-2. The Response Sector configurations are identified in Figure 6-1. Regions R01, R02, R03, and R04 represent evacuations of circular areas of the Automatic Action Zone (3km), the Detailed Planning Zone (DPZ) Inner Ring (6km), the DPZ Outer Ring (10km), and the Full Contingency Planning Zone (CPZ) (20km), respectively. Each keyhole sector-based area consists of a central circle centred at the power plant, and three adjoining sectors, each with a central angle of 22.5 degrees, as per NUREG/CR-7002, Rev. 1 guidance. The central sector coincides with the wind direction. These sectors extend to the CPZ boundary from the AAZ boundary (Regions R05 through R19) and from the outer DPZ boundary (Regions R20 through R34).

Regions R35 through R50 are identical to Regions R05 through R19 and R04, respectively; however, those Response Sectors between the AAZ and the CPZ are staged until 90% of the AAZ (Region R01) has evacuated. Regions R08, R15, R18, and R19 contain Response Sectors that are not within the keyhole but evacuate because they are surrounded by other Response Sectors that are evacuating.

Each Response Sector that intersects the keyhole is included in the Region; however, there are instances when a small portion (a "sliver") of a Response Sector is within the keyhole and the population within that small portion is low (500 people or 10% of the Response Sector population, whichever is less). Under those circumstances, the Response Sector would not be included in the Region so as to not evacuate large numbers of people outside of the keyhole for a small number of people that are actually in the keyhole.

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 50 x 14 = 700 evacuation cases. Table 6-3 provides a description of all Scenarios. Each combination of Region and Scenario implies a specific population to be evacuated.

The population and vehicle estimates presented in Section 3 and in Appendix E are peak values. These peak values are adjusted depending on the scenario and region being considered, using scenario and region-specific percentages, such that the population is considered for each evacuation case. The scenario percentages are presented in Table 6-4, while the regional percentages are provided in Table H-1 and Table H-2.

Table 6-5 and Table 6-6 provide the vehicle estimates by scenario for the DPZ Outer Ring and the entire PZ (including the CPZ), respectively. The percentages in Table 6-4 were determined as follows:

The percentage of residents with commuters during the week (when workforce is at its peak) is equal to 66%, which is the product of 91% (the number of households with at least one commuter – see Figure F-6) and 72% (the number of households with a commuter that would await the return of the commuter prior to evacuating – see Appendix F, Section F.3.2). See assumption 2 in Section 2.3. It is estimated for weekend and evening scenarios that 10% of households with returning commuters (72%) will have a commuter at work during those times, or 7% of households overall (10% x 72% = 7%).

It can be argued that the estimate of permanent residents overstates, somewhat, the number of evacuating vehicles, especially during the summer. It is certainly reasonable to assert that some portion of the population would be on vacation during the summer and would travel elsewhere. A rough estimate of this reduction can be obtained as follows:

- Assume 50% of all households vacation for a period over the summer.
- Assume these vacations, in aggregate, are uniformly dispersed over 10 weeks, i.e., 10% of the population is on vacation during each two-week interval.
- Assume half of these vacationers leave the area.

On this basis, the permanent resident population would be reduced by 5% in the summer and by a lesser amount in the off-season. Given the uncertainty in this estimate, we elected to apply no reductions in permanent resident population for the summer scenarios to account for residents who may be out of the area.

Employment is assumed to be at its peak (100%) during the winter, midweek, midday scenarios. Employment is reduced slightly (96%) for summer, midweek, midday scenarios. This is based on the estimation that 50% of the employees commuting into the PZs will be on vacation for a week during the approximate 12 weeks of summer. It is further estimated that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is further estimated that only 10% of the employees are working in the evenings and during the weekends.

As shown in Appendix E, there are some campgrounds (see Table E-6), recreational facilities (see Table E-8), and lodging facilities (see Table E-9) offering overnight accommodations in the PZ; thus, transient activity is estimated to be moderate (60%) during the evening for summer and less (45%) for winter evenings. Transient activity is estimated to be at its peak (90%) during summer weekends and less (65%) during the week. The recreational areas in the PZ (as shown in Table E-6 through Table E-8) are predominantly outdoors and will be frequented more often during the summer than the winter. As a result, transient activity during winter weekends is estimated to be 50%. It is assumed that weekend activity at transient attractions is higher than weekday activity during the winter and is 35% for winter weekdays.

As noted in the shadow footnote to Table 6-4, the shadow percentages beyond the DPZ Outer Ring are computed using a base of 30% (see assumption 8 in Section 2.2); to include the employees within the shadow region who may choose to evacuate, 30% is multiplied by a scenario-specific proportion of employees to permanent residents in the shadow region. This is only applicable for an evacuation of the AAZ (Region R01), DPZ Inner Ring (Region R02), and the DPZ Outer Ring (Region R03). For example, using the values provided in Table 6-5 for Scenario 1, the percentage is computed as follows:

$$30\% \times \left(1 + \frac{12{,}425}{42{,}817 + 22{,}239}\right) = 36\%$$

One special event – Apple Festival and Craft Sale in Bowmanville – was considered as Scenario 13, during the winter, weekend, midday with good weather. Thus, the special event traffic is 100% evacuated for Scenario 13, and 0% for all other scenarios.

As discussed in the footnote for Table 2-1 and in Section 7, schools are in session during the winter season, midweek, midday scenarios and 100% of buses will be needed under those circumstances. It is estimated that summer school enrollment is approximately 10% of enrollment during the regular school year for summer, midweek, midday scenarios. School is not in session during weekends and evening, thus no buses to evacuate schoolchildren are needed under those scenarios. These percentages are also used for the commuting college/university students using their own vehicles.

Similar to schools, on-campus students with their own vehicles are all present (100%) during the winter, midweek, midday scenarios. Since on-campus students live in campus housing, it is assumed they are also present on weekends and evenings during the winter scenarios. It is estimated that summer college/university enrollment is approximately 10% of the enrollment during the regular school year for the summer, midweek, midday scenarios. Similar to winter scenarios, on-campus students with their own vehicles are assumed to be present at the same rate (10%) during summer weekends and evenings.

Summer Day Camps are in session (100%) during the summer season, midweek, midday scenarios and are not in session (0%) for any other scenarios.

Buses, wheelchair vans and ambulances are set to 100% for all scenarios as it is assumed that the medical facility population (which includes retirement communities) are present in the PZ at all times. Transit buses for the transit-dependent population and those college/university students that do not evacuate with private vehicles are equal to 100% for all scenarios as it is assumed that the transit-dependent population is present in the PZs for all scenarios.

External traffic is estimated to be 100% for all midday scenarios, which is significantly less (40%) during the evening scenarios 5 and 12.

## Table 6-1. Description of Evacuation Regions (Regions R01-R34)

| Radial Regions | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Description | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R01 | AAZ | X | X | | | | | | | | | | | | | | | X | | | | | | | | | | |
| R02 | DPZ Inner Ring | X | X | X | X | X | X | | | | | | | | | | | X | X | | | | | | | | | |
| R03 | DPZ Outer Ring | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | |
| R04 | Full PZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Evacuate AAZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Wind Direction Towards: | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R05 | N | X | X | | X | X | X | | | | | | | | X | X | | X | | | X | | | | | | | X |
| R06 | NNE | X | X | | X | X | X | | | | | | | | X | X | X | X | | | X | X | | | | | | X |
| R07 | NE | X | X | | X | X | X | | | | | | | | | X | X | X | X | X | X | X | | | | | | |
| R08 | ENE | X | X | | | X | X | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| R09 | E | X | X | | | | X | | | | | | | | | | X | X | X | X | | X | X | | | | | |
| R10 | ESE, SE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | | | | |
| R11 | SSE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | X | | | |
| R12 | S | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | | | |
| R13 | SSW | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | X | | |
| R14 | SW | X | X | | | | | | | | | | | | | | | X | X | X | | | | | X | X | | |
| R15 | WSW | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | X | X | X | |
| R16 | W | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | | X | X | |
| R17 | WNW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | X | X | | | | | | X | X | X |
| R18 | NW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | | | | | | | | | X | X |
| R19 | NNW | X | X | X | X | | | X | X | X | X | X | X | X | X | X | | X | | | X | | | | | | X | X |
| Evacuate DPZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Wind Direction Towards: | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R20 | N | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | X |
| R21 | NNE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X |
| R22 | NE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | |
| R23 | ENE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | |
| R24 | E | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | X | | | | | |
| R25 | ESE, SE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | X | X | | | | |
| R26 | SSE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | X | X | X | | | |
| R27 | S | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | X | X | | | |
| R28 | SSW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | X | X | X | | |
| R29 | SW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | X | X | | |
| R30 | WSW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | X | X | X | |
| R31 | W | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X | |
| R32 | WNW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X | X |
| R33 | NW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | X | X |
| R34 | NNW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X |

Response Sector(s) Evacuate | Response Sector(s) Shelter-in-Place | Response Sector not within Plume, but Evacuates because it is surrounded by other Response Sectors which are Evacuating

## Table 6-2. Description of Staged Evacuation Regions (Regions R35-R50)

| Staged Evacuation - Evacuate AAZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Wind Direction Towards: | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R35 | N | X | X | | X | X | X | | | | | | | | X | X | | X | | | X | | | | | | | X |
| R36 | NNE | X | X | | X | X | X | | | | | | | | X | X | X | X | | | X | X | | | | | | X |
| R37 | NE | X | X | | X | X | X | | | | | | | | | X | X | X | X | X | X | X | | | | | | |
| R38 | ENE | X | X | | | X | X | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| R39 | E | X | X | | | | X | | | | | | | | | | X | X | X | X | | X | X | | | | | |
| R40 | ESE, SE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | | | | |
| R41 | SSE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | X | | | |
| R42 | S | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | | | |
| R43 | SSW | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | X | | |
| R44 | SW | X | X | | | | | | | | | | | | | | | X | X | X | | | | | X | X | | |
| R45 | WSW | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | X | X | X | |
| R46 | W | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | | X | X | |
| R47 | WNW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | X | X | | | | | | X | X | X |
| R48 | NW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | | | | | | | | | X | X |
| R49 | NNW | X | X | X | X | | | X | X | X | X | X | X | X | X | X | | X | | | X | | | | | | X | X |
| R50 | Full PZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Response Sector(s) Evacuate | | | | | | | | Response Sector(s) Shelter-in-Place | | | | | | | | | Response Sector (s) Shelter-in-Place until 90% ETE for R01, then Evacuate | | | | | | | | | | | |

**Table 6-3. Evacuation Scenario Definitions**

| Scenario | Season[1] | Day of Week | Time of Day[2] | Weather | Special |
|---|---|---|---|---|---|
| 1 | Summer | Midweek | Midday | Good | None |
| 2 | Summer | Midweek | Midday | Rain | None |
| 3 | Summer | Weekend | Midday | Good | None |
| 4 | Summer | Weekend | Midday | Rain | None |
| 5 | Summer | Midweek, Weekend | Evening | Good | None |
| 6 | Winter | Midweek | Midday | Good | None |
| 7 | Winter | Midweek | Midday | Rain/Light Snow | None |
| 8 | Winter | Midweek | Midday | Heavy Snow | None |
| 9 | Winter | Weekend | Midday | Good | None |
| 10 | Winter | Weekend | Midday | Rain/Light Snow | None |
| 11 | Winter | Weekend | Midday | Heavy Snow | None |
| 12 | Winter | Midweek, Weekend | Evening | Good | None |
| 13 | Winter | Weekend | Midday | Good | Special Event: Apple Festival and Craft Sale in Bowmanville |
| 14 | Summer | Midweek | Midday | Good | Roadway Impact: Single Lane Closure Highway 401 Westbound[3] |

[1] Winter means that school is in session at normal enrollment levels (also applies to spring and autumn). Summer means that school is not in session, at summer school enrollment levels (lower than normal enrollment).
[2] The terms midday and evening cover the full 24 hours of the day. Midday is the time during which children are typically at school and employees are at work – roughly from 8am to 5pm. Evening is the time when the family is united at home – roughly from 5pm to 8am.
[3] Closure of a single lane on Highway 401 westbound from interchange with Holt Road to the interchange with Thickson Road.

## Table 6-4. Percent of Population Groups Evacuating for Various Scenarios

| Scenario | Households With Returning Commuters | Households Without Returning Commuters | Employees | Transients | Shadow | Special Event | Summer Day Camps | College & University On-Campus Students | College & University Commuting Students | Medical Facilities | School Buses | Transit Buses | External Through Traffic |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 66% | 34% | 96% | 65% | 36% | 0% | 100% | 10% | 10% | 100% | 10% | 100% | 100% |
| 2 | 66% | 34% | 96% | 65% | 36% | 0% | 100% | 10% | 10% | 100% | 10% | 100% | 100% |
| 3 | 7% | 93% | 10% | 90% | 31% | 0% | 0% | 10% | 0% | 100% | 0% | 100% | 100% |
| 4 | 7% | 93% | 10% | 90% | 31% | 0% | 0% | 10% | 0% | 100% | 0% | 100% | 100% |
| 5 | 7% | 93% | 10% | 60% | 31% | 0% | 0% | 10% | 0% | 100% | 0% | 100% | 40% |
| 6 | 66% | 34% | 100% | 35% | 36% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% |
| 7 | 66% | 34% | 100% | 35% | 36% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% |
| 8 | 66% | 34% | 100% | 35% | 36% | 0% | 0% | 100% | 100% | 100% | 100% | 100% | 100% |
| 9 | 7% | 93% | 10% | 50% | 31% | 0% | 0% | 100% | 0% | 100% | 0% | 100% | 100% |
| 10 | 7% | 93% | 10% | 50% | 31% | 0% | 0% | 100% | 0% | 100% | 0% | 100% | 100% |
| 11 | 7% | 93% | 10% | 50% | 31% | 0% | 0% | 100% | 0% | 100% | 0% | 100% | 100% |
| 12 | 7% | 93% | 10% | 45% | 31% | 0% | 0% | 100% | 0% | 100% | 0% | 100% | 40% |
| 13 | 7% | 93% | 10% | 50% | 31% | 100% | 0% | 100% | 0% | 100% | 0% | 100% | 100% |
| 14 | 66% | 34% | 96% | 65% | 36% | 0% | 100% | 10% | 10% | 100% | 10% | 100% | 100% |

**Households with Returning Commuters**..................**Households of PZs residents who await the return of commuters prior to beginning the evacuation trip.**
**Households without Returning Commuters**.............**Households of PZs residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.**
**Employees** ............................................................**PZs employees who live outside the PZs**
**Transients** ............................................................**People who are in the PZs at the time of an accident for recreational or other (non-employment) purposes.**
**Shadow**......................................................................**Residents and employees in the shadow region (outside of the DPZ outer ring) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 30% relocation of shadow residents along with a proportional percentage of shadow employees. Percent of population for the shadow is only applicable for Regions R01, R02, and R03; for all other cases, the shadow population percentage is 0.**
**Special Event**.........................................................**Additional vehicles in the PZs due to the identified special event.**
**Summer Day Camps** ..............................................**Vehicle-equivalents present on the road during an evacuation of Summer Day Camps (1 bus is equivalent to 2 passenger vehicles).**
**On-Campus College/University Students** ................**College/University students that live on-campus and use private vehicles to evacuate.**
**College/University Commuting Students** ................**Students who commute to and from universities/colleges and Durham Continuing Education in private vehicles. All colleges/universities are located beyond the DPZ.**
**Medical, School and Transit Buses**..........................**Vehicle-equivalents present on the road during evacuation servicing medical facilities, schools, and transit-dependent people (including college/university students who evacuate using buses) - 1 bus is equivalent to 2 passenger vehicles.**
**External Through Traffic**..........................................**Traffic on freeways and major arterial roads at the start of the evacuation. This traffic is stopped by access control 4 hours after the evacuation begins.**

**Table 6-5. DPZ Outer Ring Vehicle Estimates by Scenario[4]**

| Scenario | Households With Returning Commuters | Households Without Returning Commuters | Employees | Transients | Shadow | Special Event | Summer Day Camps | College & University On-Campus Students | College & University Commuting Students | Medical Facilities[5] | School Buses | Transit Buses | External Through Traffic | Total Scenario Vehicles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 42,817 | 22,239 | 12,425 | 1,443 | 44,832 | 0 | 22 | 0 | 0 | 84 | 73 | 110 | 41,896 | 165,941 |
| 2 | 42,817 | 22,239 | 12,425 | 1,443 | 44,832 | 0 | 22 | 0 | 0 | 84 | 73 | 110 | 41,896 | 165,941 |
| 3 | 4,282 | 60,774 | 1,294 | 1,998 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 148,830 |
| 4 | 4,282 | 60,774 | 1,294 | 1,998 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 148,830 |
| 5 | 4,282 | 60,774 | 1,294 | 1,332 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 16,758 | 123,026 |
| 6 | 42,817 | 22,239 | 12,943 | 777 | 45,132 | 0 | 0 | 0 | 0 | 84 | 732 | 110 | 41,896 | 166,730 |
| 7 | 42,817 | 22,239 | 12,943 | 777 | 45,132 | 0 | 0 | 0 | 0 | 84 | 732 | 110 | 41,896 | 166,730 |
| 8 | 42,817 | 22,239 | 12,943 | 777 | 45,132 | 0 | 0 | 0 | 0 | 84 | 732 | 110 | 41,896 | 166,730 |
| 9 | 4,282 | 60,774 | 1,294 | 1,110 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 147,942 |
| 10 | 4,282 | 60,774 | 1,294 | 1,110 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 147,942 |
| 11 | 4,282 | 60,774 | 1,294 | 1,110 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 147,942 |
| 12 | 4,282 | 60,774 | 1,294 | 999 | 38,392 | 0 | 0 | 0 | 0 | 84 | 0 | 110 | 16,758 | 122,693 |
| 13 | 4,282 | 60,774 | 1,294 | 1,110 | 38,392 | 1,667 | 0 | 0 | 0 | 84 | 0 | 110 | 41,896 | 149,609 |
| 14 | 42,817 | 22,239 | 12,425 | 1,443 | 44,832 | 0 | 22 | 0 | 0 | 84 | 73 | 110 | 41,896 | 165,941 |

[4] Vehicle estimates are for an evacuation of the entire DPZ Outer Ring (Region R03)
[5] Medical Facilities include transport vehicles for the retirement communities within the DPZ.

**Table 6-6. Entire PZ Vehicle Estimates by Scenario[6]**

| Scenario | Households With Returning Commuters | Households Without Returning Commuters | Employees | Transients | Shadow[7] | Special Event | Summer Day Camps | College & University On-Campus Students | College & University Commuting Students[8] | Medical Facilities[9] | School Buses | Transit Buses[10] | External Through Traffic | Total Scenario Vehicles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 125,398 | 65,134 | 30,038 | 7,699 | 0 | 0 | 22 | 81 | 536 | 924 | 209 | 618 | 41,896 | 272,555 |
| 2 | 125,398 | 65,134 | 30,038 | 7,699 | 0 | 0 | 22 | 81 | 536 | 924 | 209 | 618 | 41,896 | 272,555 |
| 3 | 12,540 | 177,992 | 3,129 | 10,660 | 0 | 0 | 0 | 81 | 0 | 924 | 0 | 618 | 41,896 | 247,840 |
| 4 | 12,540 | 177,992 | 3,129 | 10,660 | 0 | 0 | 0 | 81 | 0 | 924 | 0 | 618 | 41,896 | 247,840 |
| 5 | 12,540 | 177,992 | 3,129 | 7,106 | 0 | 0 | 0 | 81 | 0 | 924 | 0 | 618 | 16,758 | 219,148 |
| 6 | 125,398 | 65,134 | 31,290 | 4,145 | 0 | 0 | 0 | 806 | 5,360 | 924 | 2,092 | 618 | 41,896 | 277,663 |
| 7 | 125,398 | 65,134 | 31,290 | 4,145 | 0 | 0 | 0 | 806 | 5,360 | 924 | 2,092 | 618 | 41,896 | 277,663 |
| 8 | 125,398 | 65,134 | 31,290 | 4,145 | 0 | 0 | 0 | 806 | 5,360 | 924 | 2,092 | 618 | 41,896 | 277,663 |
| 9 | 12,540 | 177,992 | 3,129 | 5,922 | 0 | 0 | 0 | 806 | 0 | 924 | 0 | 618 | 41,896 | 243,827 |
| 10 | 12,540 | 177,992 | 3,129 | 5,922 | 0 | 0 | 0 | 806 | 0 | 924 | 0 | 618 | 41,896 | 243,827 |
| 11 | 12,540 | 177,992 | 3,129 | 5,922 | 0 | 0 | 0 | 806 | 0 | 924 | 0 | 618 | 41,896 | 243,827 |
| 12 | 12,540 | 177,992 | 3,129 | 5,330 | 0 | 0 | 0 | 806 | 0 | 924 | 0 | 618 | 16,758 | 218,097 |
| 13 | 12,540 | 177,992 | 3,129 | 5,922 | 0 | 1,667 | 0 | 806 | 0 | 924 | 0 | 618 | 41,896 | 245,494 |
| 14 | 125,398 | 65,134 | 30,038 | 7,699 | 0 | 0 | 22 | 81 | 536 | 924 | 209 | 618 | 41,896 | 272,555 |

[6] Vehicle estimates are for an evacuation of the entire PZ (includes the CPZ) (Region R04).
[7] It is assumed that there are no shadow vehicles beyond the CPZ; hence there are no shadow vehicles when evacuating Region R04. See Section 2.2, assumption 7.
[8] College & University Commuting Students also includes 160 passenger vehicles used by Durham Continuing Education students.
[9] Medical Facilities include transport vehicles for the retirement communities within the PZ.
[10] Transit Buses includes 314 passenger car equivalent (157 buses) used for college/university students who do not have access to a private vehicle.

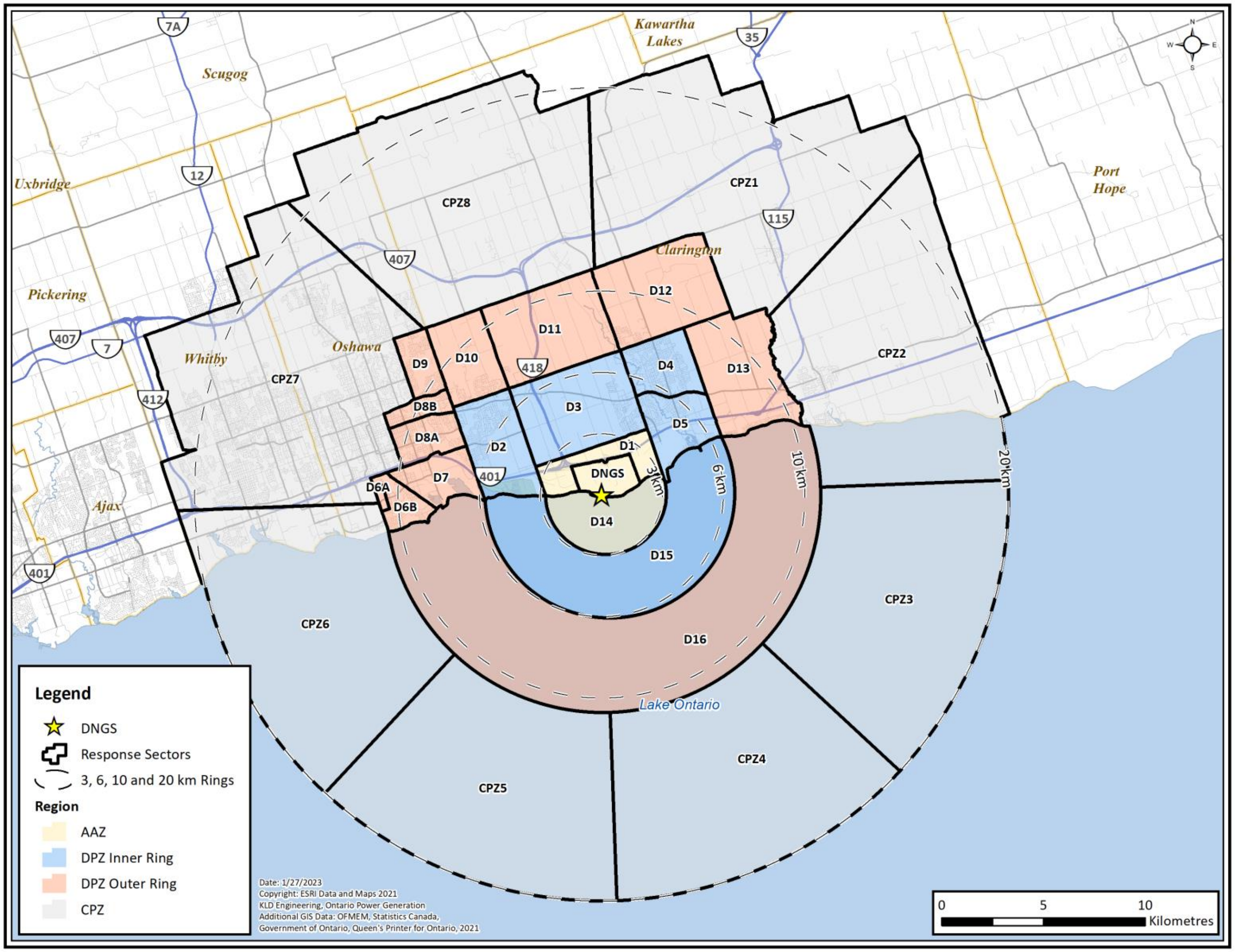



**Figure 6-1. Response Sectors Comprising the DNGS PZs**

# 7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 50 Regions within the DNGS Planning Zone (PZ) and the 14 Evacuation Scenarios discussed in Section 6. The ETE for all evacuation cases are presented in Table 7-1 and Table 7-2. These tables present the estimated times to clear the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios. The ETE of the Automatic Action Zone (AAZ) in both staged and un-staged regions are presented in Table 7-3 and Table 7-4. Table 7-5 and Table 7-6 define the Evacuation Regions considered. The tabulated values of ETE are obtained from the DYNEV II model outputs which are generated at 5-minute intervals. Currently, emergency plans are established for the Detailed Planning Zone (DPZ) Outer Ring and contingency plans are established for the Contingency Planning Zone (CPZ). As such, the results described in this section are divided into the DPZ Outer Ring and all PZs (DPZ Outer Ring plus CPZ).

## 7.1 Voluntary Evacuation and Shadow Evacuation

“Voluntary evacuees” are permanent residents within the PZs in Response Sectors for which an Emergency Bulletin to evacuate has not been issued, yet who elect to evacuate. “Shadow evacuation” is the voluntary outward movement of some permanent residents from the Shadow Region (outside the DPZ out to 20km) for whom no protective action recommendation has been issued. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for the DNGS PZs addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the PZs, 30% of permanent residents located in Response Sectors outside of the evacuation region (who are not advised to evacuate), are assumed to elect to evacuate. Similarly, it is assumed that 30% of the permanent residents in the Shadow Region will also choose to leave the area. Notice that shadow evacuation was only considered when evacuating Regions R01 (AAZ), R02 (DPZ Inner Ring) and R03 (DPZ Outer Ring). It is assumed no one evacuates beyond the CPZ boundary.

Figure 7-2 presents the area identified as the Shadow Region. This region extends radially from the plant to cover a region between the DPZ Outer Ring boundary and approximately 20 km. The population and number of evacuating vehicles in the Shadow Region were estimated using the same methodology that was used for permanent residents within the DPZ (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 270,207 permanent residents reside in the Shadow Region; 30% of them would evacuate. See Table 6-5 for the number of evacuating vehicles from the Shadow Region (including some employees) by scenario for evacuations of the AAZ, DPZ Inner Ring, and DPZ Outer Ring.

Traffic generated within this Shadow Region, traveling away from the plant location, has the potential for impeding evacuating vehicles from within the AAZ, DPZ Inner Ring, or DPZ Outer Ring. Regions R01, R02 and R03 ETE calculations include this shadow traffic movement. The remainder of the Regions include voluntary evacuation within Response Sectors not advised to evacuate only.

## 7.2 Staged Evacuation

As defined in NUREG/CR-7002, Rev. 1 staged evacuation using English units (miles) and the typical planning radii (2, 5 and 10 miles) for U.S. nuclear plants. Adapting the guidance of NUREG/CR-7002, Rev. 1 to Canadian standards and planning radii, staged evacuation consists of the following:

1. Response Sectors comprising the AAZ are advised to evacuate immediately.
2. Response Sectors downwind to the CPZ boundary are advised to shelter in-place while the AAZ is cleared.
3. As vehicles evacuate the AAZ, people downwind within the DPZ and CPZ continue to prepare for evacuation while they shelter.
4. The population sheltering in the DPZ and CPZ is advised to evacuate when approximately 90% of the AAZ evacuating traffic crosses the AAZ boundary.
5. Non-compliance with the shelter recommendation is 30%.

See Section 5.4.2 for additional information on staged evacuation.

## 7.3 Patterns of Traffic Congestion during Evacuation of the DPZ (R03)

Figure 7-3 through Figure 7-10 illustrate the patterns of traffic congestion that arise for the case when the entire DPZ Outer Ring (Region R03) is advised to evacuate during the winter, midweek, midday period under good weather conditions (Scenario 6).

Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (HCM 2022, page 5-5):

> The HCM uses LOS F to define operations that have either broken down (i.e., demand exceeds capacity) or have reached a point that most users would consider unsatisfactory, as described by a specified service measure value (or combination of service measure values). However, analysts may be interested in knowing just how bad the LOS F condition is, particularly for planning applications where different alternatives may be compared. Several measures are available for describing individually, or in combination, the severity of a LOS F condition:
>
> - *Demand-to-capacity ratios* describe the extent to which demand exceeds capacity during the analysis period (e.g., by 1%, 15%).
> - *Duration of LOS F* describes how long the condition persists (e.g., 15 min, 1 h, 3 h).
> - *Spatial extent measures* describe the areas affected by LOS F conditions. They include measures such as the back of queue, and the identification of the specific intersection approaches or system elements experiencing LOS F conditions.

All highway "links" which experience LOS F are delineated in these figures by a thick red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks.

At 30 minutes after the Emergency Bulletin to evacuate, Figure 7-3 displays the developing congestion within the population centres of Oshawa and Bowmanville. At this time, 41% of transients and employees, and only 8% of the permanent resident vehicles have begun their evacuation trips. Significant congestion (LOS F) can be seen within the AAZ (3km radius of the plant) as the employees located on site evacuate along Park Road and Megawatt Drive (within Response Sector DNGS) to gain access to Highway (Hwy) 401. At this time, external traffic on Hwy 401, Hwy 407 and Route (Rt) 115/35 has not been diverted. Hwy 401 and Regional Hwy 2 westbound are operating at LOS E and LOS F near Bowmanville. Hwy 401 and Regional Road 22 eastbound are operating at LOS C and LOS D. Portions of Taunton Road eastbound is operating at LOS E as evacuees from Oshawa and Whitby utilize this road to evacuate the PZ.

At 1 hour and 30 minutes after the Emergency Bulletin, Figure 7-4 displays more pronounced congestion throughout the study area with significant congestion (LOS F) visible along all major evacuation routes leaving Whitby, Brooklin, Oshawa, and Bowmanville. At this time, approximately 56% of permanent resident vehicles and 100% of the employees and transient vehicles have begun their evacuation trips and 34% of vehicles have successfully evacuated the DPZ. At this time, the congestion leaving the plant has dissipated. The roadways within Bowmanville are fully congested, as evacuees are trying to gain access northbound (towards Hwy 407/Rt 115/35) and southbound (Hwy 401). The roadways within the population centre of Oshawa are also displaying significant congestion as evacuees are utilizing these roads to gain access to Hwy 407 and Hwy 412. Evacuees south of Oshawa are also experiencing significant congestion (LOS F) to access Hwy 401 westbound which is also experiencing LOS F conditions. Baldwin Street is also experiencing congestions as evacuees in the area to gain access Hwy 407 and Hwy 401 westbound.

At 2 hours and 30 minutes after the Emergency Bulletin, as shown in Figure 7-5, congestion within the DPZ has worsened with all roads (within Whitby, Oshawa, Brooklin and Bowmanville) that provide access to the major evacuation routes on Hwy 401 and Hwy 407 which is also operating at LOS F. At this time, over 84% of vehicles have begun their evacuation trips, and about 62% of vehicles have successfully evacuated the DPZ. Significant congestion is visible on roadways that access the on-ramps to Hwy 401 and Hwy 407. The traffic congestion along Hwy 401 westbound is now extending into the AAZ (3km radius). Significant congestion continues within Windfields as more evacuees are using Liberty Street/Rt 14 to access Concession Road 8, Concession 7 and Durham Regional Road 20.

At 3 hours and 30 minutes after the emergency bulletin, as shown Figure 7-7, congestion has dissipated in Oshawa, Bowmanville and Whitby. At this time, more than 94% of the vehicles are mobilized and 85% vehicles have cleared the DPZ. Baldwin Street northbound, Thorton Road, Durham 2, Ritson Road, Harmony Road remain congested as evacuees use these arterials to gain access to the major roadways (to exit the study area) such as Hwy 407 westbound, Winchester Road, and Myrtle Road. In addition, significant congestion continues on Baldwin

Street southbound, Garden Street, Hopkin Street as vehicles are using these arterials to access the major roadways (to exit the study area) such as Hwy 401 westbound, Taunton Road, Rossland Road, Dundas Street and Regional Hwy 22. Portions of Hwy 418 northbound is operating at LOS F (from Hwy 401 to Regional Hwy 2). Rt 115/35 northbound (north of Concession Road), Newtonville Road, Regional Hwy 2 eastbound are operating at LOS F. Significant congestion (LOS F) is now visible throughout Hwy 401 and Hwy 407, as the external traffic (see Section 3.9) continues traversing the PZ reducing the roadway capacity from evacuees who have gained access and those who are trying to access Hwy 401 and Hwy 407. All on-ramps to Hwy 401, Hwy 407 and Rt 115/35 are also experiencing congestion as vehicles are trying to gain access to these roadways. Goodwood Road outside the PZ is experiencing congestion, as vehicles who have travelled north of Hwy 407 avoid accessing the significant congestion on Hwy 407.

At 4 hours and 30 minutes after the Emergency Bulletin, as shown in Figure 7-7, congestion is no longer visible in Oshawa, Bowmanville and other populated areas within the DPZ. At this time 100% of the vehicles are mobilized and 97% of the vehicles have cleared the DPZ boundary. Towards the western DPZ boundary, congestion persists on Hwy 401 westbound and Hwy 407 westbound, on Baldwin Street (in both north and south directions) which provides access to Hwy 407, Hwy 401 and Goodwood Road. Towards the eastern DPZ boundary, congestion continues on Hwy 407 east, as evacuees try to access Rt 115/35 northbound, and on Newtonville Road. External traffic was stopped by access control 30 minutes earlier (at 4 hours after the Emergency Bulletin). As such, the external traffic vehicles are still in the network due to the congestion along Hwy 407 and Hwy 401 westbound. The presence of these vehicles reduces the available roadway capacity for the evacuees within the DPZ Outer Ring. Goodwood Road continues to experience congestion.

At 5 hours after the Emergency Bulletin, as shown in Figure 7-8, congestion is now clear within the DPZ Inner Ring (6km radius) but persists on roadways where evacuees are accessing Hwy 401 and Hwy 407 within the DPZ Outer Ring. At this time, the majority (98%) of vehicles have cleared the DPZ Outer Ring. Congestion persists within the western portion of the DPZ boundary along Hwy 401 and Hwy 407. Within the eastern portion of the DPZ boundary (in the Shadow Region/CPZ) congestion remains on Hwy 407 eastbound, as evacuees gain access to Rt 115/35, Concession Road 6 and along Newtonville Road. Outside the PZ, significant congestion continues on Goodwood Road.

At 5 hours and 35 minutes after the Emergency Bulletin, as shown in Figure 7-9, the DPZ Outer Ring is now completely clear of congestion (which cleared 10 minutes earlier). Therefore, any evacuees who depart after this time encounters no traffic congestion or delays within the DPZ. The only congestion visible is along the western portion of the DPZ boundary (within the Shadow Region/CPZ) on Hwy 401 and Hwy 407. On the eastern boundary of the DPZ (within the Shadow Region/CPZ) significant congestion continues on Newtonville Road. Outside the PZ, Goodwood Road is no longer experiencing congestion.

At 6 hours after the Emergency Bulletin, as shown in Figure 7-10, the Shadow Region (CPZ) is now completely clear of congestion. The last of the congestion can be found on the eastern boundary of the CPZ (along Newtonville Road), which clears 25 minutes later at 6 hours and 25 minutes after the Emergency Bulletin.

## 7.4 Patterns of Traffic Congestion during Evacuation of all Planning Zones (R04)

Figure 7-11 through Figure 7-18 illustrate the patterns of traffic congestion that arise for the case when all PZs (Region R04) are advised to evacuate during the winter, midweek, midday period under good weather conditions (Scenario 6).

As discussed in Section 7.3, all highway "links" which experience LOS F are delineated in these figures by a thick red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks.

At 1 hour after the Emergency Bulletin to evacuate, Figure 7-11 displays the developing significant congestion within the population centres (i.e., Bowmanville, Windfields, Brooklin, Oshawa, and Whitby) and along Hwy 401, Hwy 407 westbound, Taunton Road, Dundas Street, and Rossland Road/Rt 28. The majority of the northbound/southbound roadways display congestion as evacuees utilize these roads to gain access to Hwy 401 and Hwy 407. Employees at DNGS experience congestion as employees try to gain access to Hwy 401. At this time, approximately 30% of the permanent resident vehicles, and the majority (96%) of employees and transient vehicles have begun their evacuation rip and approximately 10% of the vehicles have successfully evacuated the CPZ.

Figure 7-12 displays fully developed congestion at 2 hours after the Emergency Bulletin. Over 73% of the permanent resident vehicles and 100% of employees and transients have mobilized and begun their evacuation trip. As a result, the majority of the roads within the PZ are operating at LOS F causing gridlock conditions. At this time, only 23% of vehicles have successfully evacuated the area. Major population centres in the PZ including Bowmanville, Orono and Newcastle to the east and Oshawa and Whitby to the west of DNGS are fully congested. Significant congestion (LOS F) is now visible on many of the major evacuation routes as well. At this time, the roadways used by plant employees (within DNGS) are no longer experiencing congestion. Portions of Hwy 401 and Hwy 407 as external traffic has not been diverted yet, reduce the roadway capacity for evacuees within the PZ. It is important to note that even though, the majority of the study area is experiencing significant congestion, the traffic is moving; it is just moving slowly.

Figure 7-13 displays the extent of the congestion 3 hours and 45 minutes after the Emergency Bulletin. At this time, 99% of the vehicles have mobilized, and 47% of the vehicles have evacuated from the CPZ. Significant congestion in Bowmanville (Response Sectors D4, D5, and D13) no longer is visible, as evacuees have travelled north towards Kirby and east towards Starkville and Newtonville. The roadways within the population centres of Whitby, Oshawa, Brooklin, and Windfields remain significantly congested (LOS F), as more evacuees begin their evacuation trip. Hwy 401 and Hwy 407 are extremely congested in both directions (westbound and eastbound). Significant congestion (LOS F) is now also visible on Hwy 418, as more evacuees utilize Hwy 418 to travel towards Hwy 407.

At 5 hours after the Emergency Bulletin, congestion has significantly decreased within the eastern portion of the DNGS PZ, as shown in Figure 7-14. The remaining congestion within this portion, is located north of Orono as vehicles utilize Concession Road 4, Concession Road 6, Newtonville Road/Rt 18, Durham Regional Road 20 and Route 115/35 to evacuate towards Peterborough. Significant congestion (LOS F) continues within the western portion of the PZ (i.e., Oshawa, Whitby, Brooklin, Windfields, etc). The external traffic has been diverted (at 4 hours after the Emergency Bulletin) and is no longer entering the PZ. Hwy 401 and Hwy 407 westbound remain at LOS F conditions as vehicles continue to utilize these limited access highways throughout the evacuation. At this time, 100% of evacuees have begun their evacuation trip and approximately 62% of evacuees have successfully evacuated the CPZ.

At 6 hours and 30 minutes after the Emergency Bulletin, the eastern portion of the PZ, except along Newtonville Road, is no longer experiencing significant congestion, as shown in Figure 7-15. Congestion continues within the DPZ in Oshawa (Response Sectors D6A, D6B, D9 and D10) as evacuees travel towards Whitby and destinations to the west. Evacuation routes heading westbound within Whitby are still operating at LOS F (Hwy 401, Hwy 407, Hwy 7, Dundas Street, Rossland Road, and Taunton Road). Within this area of Whitby (CPZ 7), there are 57% of the permanent resident population (see Section 3.1 and Table 3-2). As such, significant congestion (LOS F) continues within this area. At this time, 100% of the evacuation population have begun their evacuation trip and about 77% have evacuated the PZ. The AAZ and Hwy 418 is no longer experiencing significant congestion, which cleared 20 minutes earlier at 6 hours and 10 minutes after the Emergency Bulletin.

Figure 7-16 displays the patterns of congestion at 7 hours 50 minutes after the Emergency Bulletin. At this time, about 88% of evacuees have successfully evacuated the CPZ. Congestion in Oshawa has dissipated and the DPZ is now completely clear of congestion. Significant congestion persists primarily in Response Sectors CPZ7 and CPZ8, along with the access roads (Baldwin Street northbound, Thorton Road, Thickson Street, Durham Road 2, Harmony Street) to gain access to Hwy 407, Winchester Road, Goodwood Road. In addition, congestion continues along Baldwin Street southbound, Garden Street, Hopkin Street, Hwy 412 southbound which provide access to alternate evacuation routes (i.e., Taunton Road, Rossland Road and Hwy 401).

At 8 hours and 40 minutes after the Emergency Bulletin, Figure 7-17 displays the remaining congestion on the western portion of the PZ, near Brooklin and Windfields (within CPZ7), along Baldwin Street, Hwy 407 westbound, Goodwood Road, Hwy 412, Hwy 12, and on Hwy 401 westbound (east of Ajax). At this time, 95% of vehicles have successfully evacuated the CPZ.

At 9 hours and 45 minutes after the Emergency Bulletin, the PZ is now clear of congestion, as shown in Figure 7-18. The last of the significant congestion is visible along Goodwood Road from evacuees traveling along Lake Ridge Road, which clears 30 minutes later at 10 hours and 15 minutes after the Emergency Bulletin.

## 7.5 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-19 through Figure 7-32. These figures display the rate at which traffic flows out of the indicated areas for the case of an evacuation of the DPZ (Region R03) and all PZs (Region R04 – labelled as CPZ in the figure) under the indicated conditions. One figure is presented for each scenario considered.

As indicated in Figure 7-19 through Figure 7-32, there is typically a long "tail" to these distributions due to congestion. Vehicles begin to evacuate an area slowly at first, as people respond to the Emergency Bulletin to evacuate at different rates. Then traffic demand builds rapidly (slopes of curves increase). When the system becomes congested, traffic exits the PZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the area being evacuated. Towards the end of the process, there are a few evacuation routes servicing the remaining demand.

This decline in aggregate flow rate, towards the end of the process, is characterized by these curves flattening and gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes equally so that all will service traffic near capacity levels, and all will clear at the same time. For this ideal situation, all curves would retain the same slope until the end of the mobilization time – thus minimizing evacuation time. In reality, this ideal is generally unattainable reflecting the spatial variation in population density, mobilization rates and in highway capacity over the PZ.

## 7.6 Evacuation Time Estimate (ETE) Results

Table 7-1 and Table 7-2 present the ETE values for all 50 Evacuation Regions and all 14 Evacuation Scenarios. Table 7-3 and Table 7-4 present the ETE values for the automatic action zone for both staged and un-staged keyhole regions downwind to the CPZ boundary. The tables are organized as follows:

| Table | Contents |
|---|---|
| 7-1 | The ETE represents the elapsed time required for 90% of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios. |
| 7-2 | The ETE represents the elapsed time required for 100% of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios. |
| 7-3 | The ETE represents the elapsed time required for 90% of the population within the automatic action zone, to evacuate from the automatic action zone with both Concurrent and Staged Evacuations of additional Response Sectors downwind in the keyhole Region. |
| 7-4 | The ETE represents the elapsed time required for 100% of the population within the automatic action zone, to evacuate from the automatic action zone with both Concurrent and Staged Evacuations of additional Response Sectors downwind in the keyhole Region. |

The animation snapshots described in Sections 7.3 and 7.4 reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in Figure 7-3 through Figure 7-10 for Region 03 (DPZ Outer Ring) and Figure 7-11 through Figure 7-18 for Region 04 (CPZ). Congestion exists throughout the DPZ and CPZ but migrates away from the DNGS during the course of the evacuation. This is reflected in the ETE statistics:

- The 90$^{th}$ percentile ETE for Region R01 (AAZ) are on average 1:50 (hr:mm) for all non-heavy snow and daytime scenarios, 2:00 for evening scenarios, and about 2:10 for heavy snow scenarios.
- The 90$^{th}$ percentile ETE for Region R02 (DPZ Inner Ring) are on average 1 hour and 45 minutes longer than the 90$^{th}$ percentile ETE for Region R01 and range between 3:00 and 4:20.
- The 90$^{th}$ percentile ETE for Region R03 (DPZ Outer Ring) are on average 5 minutes for non-heavy snow scenarios (15 minutes for heavy snow scenarios) longer than the 90$^{th}$ percentile ETE for Region R02 and generally range between 3:00 and 4:40.
- The 90$^{th}$ percentile ETE for Region R04 (CPZ) are on average 4 hours for non-heavy snow cases (5 hours for heavy snow cases) longer than the 90$^{th}$ percentile ETE for Region R03 and range between 6:45 and 10:10.

The 100$^{th}$ percentile ETE for the AAZ is 4:15 and 4:45 (same as trip generation time) for all non-heavy snow and with heavy snow scenarios respectively. The AAZ primarily is composed of employees located at the DNGS site (permanent residents are only 4.4.% of the AAZ evacuation population) who mobilize within 75 minutes after the Emergency Bulletin to evacuate. As shown in Figure 7-3 through Figure 7-18, the roadways significantly congested due to employees at the DNGS site and other evacuees within the AAZ (3km ring) are clear of congestion before the trip generation ends. As a result, the 100$^{th}$ percentile ETE for the AAZ for all scenarios is dictated by trip generation time rather than the congestion within the AAZ.

The 100$^{th}$ percentile ETE for the DPZ Inner Ring is on average 35 minutes when compared to the 100$^{th}$ percentile ETE for the AAZ (R01). The 100$^{th}$ percentile ETE for the DPZ Inner Ring range from 4:25 to 5:05 for non-heavy snow cases and are up to 6:30 for heavy snow cases.

The 100$^{th}$ percentile ETE for the DPZ Outer Ring is on average 50 minutes longer for all non-heavy snow scenarios and 5 minutes longer, on average, for evening scenarios and about 1 hour and 10 minutes longer for heavy snow scenarios when compared to the 100$^{th}$ percentile ETE for the DPZ Inner Ring (R02). The 100$^{th}$ percentile ETE for the DPZ Outer Ring range from 4:30 to 6:40 for non-heavy snow cases and are up to 7:35 for heavy snow cases.

The 100$^{th}$ percentile ETE for the CPZ, Region R04, range from 8:15 to 10:40 for non-heavy snow scenarios and to 12:30 for heavy snow scenarios. There are an additional 111,502 additional vehicles in Region R04 during Scenario 6 conditions compared to Region R03 during Scenario 6 conditions (see Section 6, Table 6-5 and Table 6-6). The additional demand exceeds the available capacity generating significant congestion (see Figure 7-11 through Figure 7-18) and significantly prolonging ETE.

Comparison of Scenario 9 in Table 7-1 and Table 7-2indicates that the Special Event – Apple Festival and Craft Sale in Bowmanville – has no significant impacts on the ETE for the 90$^{th}$ percentile (up to 15 minutes) and increases at most by 35 minutes at the 100$^{th}$ percentile ETE. Although the event attracts an additional 1,667 vehicles into the DPZ (Response Sectors D3 and D4), these vehicles comprise less than 2% of the total demand for Region 03 (less than 1% for an evacuation of the CPZ). There is more significant congestion and bottlenecks in other areas that dictate the 90$^{th}$ and 100$^{th}$ percentile ETE. In addition, there are ample evacuation routes in the area including Route 2, Hwy 401, Route 57, and Route 14/Liberty Road to service the additional vehicles. As discussed in Section 5, transients mobilize quickly, and many have already evacuated the area before significant traffic congestion develops. The only significant increase (35 minutes) in the 100$^{th}$ percentile ETE occurs only when DPZ Outer Ring Downwind to CPZ boundary evacuates towards the north (Region 20). This downwind direction includes CPZ1 and CPZ8, which have vehicles predominantly traveling northbound to head east or west to exit the PZ. Therefore, reducing the available capacity for the additional transient vehicles increases the 100$^{th}$ percentile ETE.

Comparison of Scenarios 1 and 14 in Table 7-1 indicates that the roadway closure – one lane westbound on Hwy 401 from the interchange with Hwy 418 to the interchange with Thickson Rd/Rt 26 – has no significant impacts on the ETE for the 90$^{th}$ percentile (up to 15 minutes). However, there is a significant impact on the 100$^{th}$ percentile ETE (up to 1 hour and 15 minutes) during the roadway closure. The 1 hour and 15 minutes maximum difference in the 100$^{th}$ percentile ETE occurs during the evacuation of the DPZ Outer Ring and Regions 25, 26, and 27 (all four regions have the same Response Sectors excluding the overwater zones of CPZ3, CPZ4, CPZ5). Hwy 401 westbound is a major evacuation route where external traffic traverses the DPZ Outer Ring and is not diverted until access control is established, which delays vehicles trying to access Hwy 401 westbound from the DPZ Outer Ring to reach destinations in and around Toronto. As such, Hwy 401 westbound is congested throughout the evacuation. The loss in capacity of Hwy 401 exacerbates an already overwhelmed roadway system causing worse congestion, longer delays, more queuing and longer ETE.

These results show that events such as adverse weather or traffic accidents which closes a single lane on a major evacuation route, could impact ETE. Regional and municipal police could consider traffic management tactics such as using the shoulder of the roadway as a travel lane or re-routing of traffic along other evacuation routes to avoid overwhelming major evacuation routes.

## 7.7 Staged Evacuation Results

Table 7-3 and Table 7-4 present a comparison of the ETE compiled for the concurrent (un-staged) and staged evacuation results. Note that Regions R35 through R50 are geographically identical to  Regions R05 through R19 and R04, respectively. The times shown in Table 7-3 and Table 7-4 are when the AAZ is 90% clear and 100% clear, respectively.

The objective of a staged evacuation strategy is to ensure the ETE for the AAZ is not significantly increased (30 minutes or 25%, whichever is less) when evacuating affecting the exposure of those beyond 3km. Additionally staged evacuation should not significantly increase the ETE for people evacuating beyond 3km. When evacuating all PZs (Region R04), the 90$^{th}$ percentile ETE for the AAZ is as much as 45 minutes longer than when evacuating just the AAZ (R01) by itself; compare R01 and R04 inTable 7-3.

In addition, when evacuating the AAZ and downwind to the CPZ boundary, (Regions 5 through 19), the 90$^{th}$ percentile ETE for the AAZ increases by at most by 50 minutes, except for those Regions wherein the AAZ evacuates concurrently with Response Sectors that are over mostly water (Regions R10 through R16). As such, the ETEs for Regions R10 through R16 remain the same. For all other cases, the evacuation of densely populated communities surrounding the AAZ (Whitby, Oshawa, Bowmanville) cause significant traffic congestion along Hwy 401 and Hwy 407. Those vehicles evacuating from Whitby, Oshawa and Bowmanville slow the egress of vehicles from Darlington, resulting in longer ETEs (up to 1 hour and 15 minutes) for the AAZ. As shown in Table 7-4, the 100$^{th}$ percentile ETE remains the same, as the trip generation dictates the ETE for the AAZ.

To determine the effect of staged evacuation on residents beyond the AAZ, the ETE for Regions R04 and R05 through R19 are compared to Regions R50 and R35 through R49, respectively, in Table 7-1 and Table 7-2. A comparison of ETE between these similar regions reveals that staging increases the 90th percentile ETE for most regions by up to 35 minutes (see Table 7-1) and increases the 100th percentile ETE by at most 1 hour and 50 minutes (see Table 7-2)The increase in the ETEs is due to the large number of evacuating vehicles, beyond the AAZ, sheltering and delaying the start of their evacuation. As shown in Figure 5-5, staging the evacuation causes a significant "spike" (sharp increase) in mobilization (trip-generation rate) of evacuating vehicles: nearly 80% of the evacuating vehicles between 3 and 20km who have sheltered in place while residents within 3 km evacuated, begin their evacuation trip over a 30-minute timeframe. This spike oversaturates evacuation routes, increases traffic congestion, rerouting of evacuees and prolongs ETE.

Therefore, staging evacuation provides no benefit to evacuees within the AAZ and adversely impacts many evacuees located beyond the AAZ. Based on this analysis, staged evacuation is not recommended for the DNGS PZ.

## 7.8 Guidance on Using ETE Tables

The user first determines the percentile of population for which the ETE is sought (The NRC guidance calls for the 90$^{th}$ percentile). The applicable value of ETE within the chosen Table may then be identified using the following procedure:

1. Identify the applicable **Scenario**:
   - Season
     - Summer
     - Winter (also Autumn and Spring)
   - Day of Week
     - Midweek
     - Weekend

- Time of Day
  - Midday
  - Evening
- Weather Condition
  - Good Weather
  - Rain/Light Snow
  - Heavy Snow
- Special Event
  - Apple Festival and Craft Sale in Bowmanville
  - Road Closure (One lane on Hwy 401 WB is closed)
- Evacuation Staging
  - No, Staged Evacuation is not considered.
  - Yes, Staged Evacuation is considered.

While these Scenarios are designed, in aggregate, to represent conditions throughout the year, some further clarification is warranted:

- The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (2) and (4) apply.
- The conditions of a winter evening (either midweek or weekend) and rain/light snow are not explicitly identified in the Tables. For these conditions, Scenarios (7) and (10) for rain/light snow apply.
- The conditions of a winter evening (either midweek or weekend) and heavy snow are not explicitly identified in the Tables. For these conditions, Scenarios (8) and (11) for heavy snow apply.
- The seasons are defined as follows:
  - Summer assumes that public schools are not in session.
  - Winter (includes Spring and Autumn) considers that public schools are in session.
- Time of Day: Midday implies the time over which most commuters are at work/college or are travelling to/from work/college.

2. With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region**:
   - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: towards N, NNE, NE…
   - Determine the distance that the Evacuation Region will extend from the nuclear power plant. The applicable distances and their associated candidate Regions are given below:
     - AAZ (Region R01)
     - DPZ Inner Ring (Region R02)
     - DPZ Outer Ring (Region R03)
     - To CPZ Boundary (R04 through R34)
   - Enter Table 7-5 through Table 7-6 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from the DNGS.

Select the Evacuation Region identifier in that row, based on the azimuth direction of the plume, from the first column of the Table.

3. Determine the **ETE Table** based on the **percentile** selected. Then, for the **Scenario** identified in Step 1 and the **Region** identified in Step 2, proceed as follows:
   - The columns of Table 7-1 through Table 7-4 are labelled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number defined in Step 1.
   - Identify the row in the table that provides ETE values for the Region identified in Step 2.
   - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

<u>Example</u>

It is desired to identify the ETE for the following conditions:

- Sunday, August 10$^{th}$ at 4:00 AM.
- It is raining.
- Wind direction is toward the northeast (NE).
- Wind speed is such that the distance to be evacuated is the full AAZ only.
- The desired ETE is that value needed to evacuate 90% of the population from within the impacted Region.
- A staged evacuation is not desired.

Table 7-1 is applicable because the 90$^{th}$ percentile ETE is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of circumstances to Scenario 4.
2. Enter Table 7-5 and locate the Region described as “AAZ” read Region R01
3. Enter Table 7-1 to locate the data cell containing the value of ETE for Scenario 4 and Region R01. This data cell is in column (4) and in the row for Region R01; it contains the ETE value of 2:00.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, Detailed Planning Zone Outer Ring and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R02** | 3:35 | 3:55 | 3:25 | 3:45 | 3:00 | 3:35 | 3:55 | 4:20 | 3:25 | 3:40 | 4:15 | 3:00 | 3:30 | 3:35 |
| **R03** | 3:45 | 4:00 | 3:35 | 3:45 | 3:00 | 3:45 | 4:05 | 4:40 | 3:35 | 3:45 | 4:25 | 3:00 | 3:30 | 3:55 |
| **R04** | 7:40 | 8:35 | 7:10 | 7:50 | 6:50 | 8:00 | 8:40 | 10:10 | 7:05 | 7:45 | 9:00 | 6:45 | 7:05 | 7:45 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 3:45 | 4:10 | 3:40 | 4:00 | 3:20 | 3:45 | 4:10 | 4:50 | 3:40 | 3:55 | 4:30 | 3:15 | 3:40 | 3:55 |
| **R06** | 4:05 | 4:30 | 3:55 | 4:20 | 3:35 | 4:05 | 4:30 | 5:20 | 4:00 | 4:15 | 5:00 | 3:35 | 3:55 | 4:10 |
| **R07** | 4:10 | 4:30 | 3:55 | 4:15 | 3:40 | 4:15 | 4:30 | 5:15 | 3:55 | 4:15 | 4:50 | 3:30 | 4:00 | 4:10 |
| **R08** | 4:00 | 4:15 | 3:55 | 4:05 | 3:40 | 4:05 | 4:15 | 4:55 | 3:55 | 4:00 | 4:35 | 3:35 | 3:55 | 4:05 |
| **R09** | 3:50 | 3:55 | 3:45 | 3:55 | 3:35 | 3:50 | 4:00 | 4:30 | 3:45 | 3:50 | 4:20 | 3:30 | 3:45 | 3:50 |
| **R10** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R11** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R12** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R13** | 3:20 | 3:40 | 3:00 | 3:05 | 2:45 | 3:25 | 3:40 | 4:15 | 3:00 | 3:15 | 3:55 | 2:40 | 2:50 | 3:20 |
| **R14** | 3:20 | 3:40 | 3:00 | 3:05 | 2:45 | 3:25 | 3:40 | 4:15 | 3:00 | 3:15 | 3:55 | 2:40 | 2:50 | 3:20 |
| **R15** | 7:30 | 8:05 | 6:55 | 7:35 | 6:30 | 7:40 | 8:20 | 9:40 | 6:55 | 7:35 | 8:35 | 6:30 | 6:55 | 7:20 |
| **R16** | 7:20 | 8:00 | 6:50 | 7:30 | 6:25 | 7:35 | 8:15 | 9:35 | 6:50 | 7:25 | 8:25 | 6:25 | 6:45 | 7:15 |
| **R17** | 7:40 | 8:20 | 7:05 | 7:45 | 6:45 | 7:50 | 8:30 | 10:00 | 7:00 | 7:40 | 8:55 | 6:45 | 7:00 | 7:30 |
| **R18** | 7:35 | 8:15 | 7:05 | 7:40 | 6:40 | 7:50 | 8:20 | 9:55 | 6:55 | 7:30 | 8:45 | 6:35 | 7:00 | 7:25 |
| **R19** | 7:40 | 8:15 | 6:55 | 7:40 | 6:40 | 7:45 | 8:30 | 9:50 | 7:00 | 7:35 | 9:00 | 6:45 | 6:55 | 7:30 |
| **Evacuate Detailed Planning Zone Outer Ring and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R20** | 4:30 | 4:50 | 4:10 | 4:35 | 3:30 | 4:25 | 4:55 | 5:45 | 4:10 | 4:40 | 5:25 | 3:30 | 4:05 | 4:25 |
| **R21** | 4:45 | 5:10 | 4:25 | 4:55 | 3:40 | 4:50 | 5:20 | 6:10 | 4:20 | 4:40 | 5:40 | 3:35 | 4:25 | 4:50 |
| **R22** | 4:25 | 4:55 | 4:10 | 4:30 | 3:25 | 4:20 | 4:45 | 5:40 | 4:10 | 4:30 | 5:20 | 3:30 | 4:15 | 4:25 |
| **R23** | 4:25 | 4:55 | 4:10 | 4:30 | 3:25 | 4:20 | 4:45 | 5:40 | 4:10 | 4:30 | 5:20 | 3:30 | 4:15 | 4:25 |
| **R24** | 4:00 | 4:20 | 3:45 | 4:00 | 3:15 | 3:55 | 4:15 | 4:50 | 3:40 | 3:55 | 4:25 | 3:20 | 3:55 | 3:55 |
| **R25** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **R26** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |
| **R27** | 3:45 | 4:05 | 3:30 | 4:10 | 3:10 | 4:05 | 4:20 | 4:50 | 3:35 | 3:50 | 4:30 | 3:10 | 3:35 | 3:55 |
| **R28** | 4:05 | 4:30 | 3:50 | 4:05 | 3:20 | 4:05 | 4:15 | 4:55 | 3:45 | 4:00 | 4:35 | 3:20 | 3:45 | 3:55 |
| **R29** | 4:05 | 4:30 | 3:50 | 4:05 | 3:20 | 4:05 | 4:15 | 4:55 | 3:45 | 4:00 | 4:35 | 3:20 | 3:45 | 3:55 |
| **R30** | 7:35 | 8:20 | 7:00 | 7:40 | 6:40 | 7:45 | 8:30 | 10:00 | 6:50 | 7:25 | 8:55 | 6:40 | 6:50 | 7:30 |
| **R31** | 7:35 | 8:20 | 7:00 | 7:40 | 6:40 | 7:45 | 8:30 | 10:00 | 6:50 | 7:25 | 8:55 | 6:40 | 6:50 | 7:30 |
| **R32** | 7:45 | 8:25 | 7:00 | 7:45 | 6:45 | 7:55 | 8:35 | 10:05 | 7:05 | 7:40 | 8:55 | 6:45 | 7:00 | 7:40 |
| **R33** | 7:30 | 8:15 | 6:55 | 7:35 | 6:40 | 7:45 | 8:25 | 9:50 | 7:00 | 7:35 | 8:50 | 6:45 | 6:55 | 7:30 |
| **R34** | 7:40 | 8:25 | 7:00 | 7:45 | 6:50 | 7:45 | 8:35 | 10:00 | 6:55 | 7:40 | 8:55 | 6:40 | 7:00 | 7:30 |
| **Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R35** | 4:00 | 4:10 | 3:55 | 4:15 | 3:40 | 4:00 | 4:15 | 5:00 | 3:50 | 4:20 | 4:50 | 3:35 | 3:55 | 4:05 |
| **R36** | 4:10 | 4:30 | 4:10 | 4:30 | 3:40 | 4:15 | 4:45 | 5:25 | 4:05 | 4:25 | 5:15 | 3:50 | 4:15 | 4:20 |
| **R37** | 4:10 | 4:35 | 4:05 | 4:20 | 3:50 | 4:15 | 4:40 | 5:30 | 4:05 | 4:15 | 5:10 | 3:50 | 4:05 | 4:10 |
| **R38** | 4:00 | 4:15 | 4:00 | 4:15 | 3:55 | 4:05 | 4:20 | 5:15 | 3:55 | 4:05 | 4:45 | 3:50 | 4:00 | 4:05 |
| **R39** | 3:50 | 3:55 | 3:45 | 3:55 | 3:35 | 3:55 | 4:05 | 4:30 | 3:45 | 3:55 | 4:20 | 3:35 | 3:50 | 3:55 |
| **R40** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R41** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R42** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R43** | 3:35 | 3:45 | 3:25 | 3:35 | 3:10 | 3:40 | 3:40 | 4:25 | 3:15 | 3:35 | 4:30 | 3:10 | 3:20 | 3:25 |
| **R44** | 3:35 | 3:45 | 3:25 | 3:35 | 3:10 | 3:40 | 3:40 | 4:25 | 3:15 | 3:35 | 4:30 | 3:10 | 3:20 | 3:25 |
| **R45** | 7:35 | 8:20 | 7:05 | 7:40 | 6:50 | 7:45 | 8:25 | 9:50 | 7:00 | 7:40 | 8:55 | 6:45 | 6:55 | 7:30 |
| **R46** | 7:25 | 8:10 | 7:00 | 7:35 | 6:45 | 7:35 | 8:20 | 9:40 | 6:50 | 7:30 | 8:45 | 6:40 | 6:50 | 7:20 |
| **R47** | 7:50 | 8:30 | 7:20 | 7:55 | 7:05 | 8:00 | 8:35 | 10:10 | 7:05 | 7:50 | 9:00 | 6:55 | 7:10 | 7:40 |
| **R48** | 7:35 | 8:25 | 7:10 | 7:50 | 7:00 | 8:00 | 8:30 | 9:55 | 7:10 | 7:40 | 9:05 | 6:55 | 7:05 | 7:35 |
| **R49** | 7:45 | 8:15 | 7:15 | 7:50 | 6:55 | 7:50 | 8:30 | 9:55 | 7:10 | 7:50 | 9:05 | 6:55 | 7:05 | 7:30 |
| **R50** | 7:45 | 8:45 | 7:25 | 7:55 | 7:00 | 8:00 | 8:50 | 10:10 | 7:10 | 7:50 | 9:20 | 7:00 | 7:15 | 8:00 |

**Table 7-2. Time to Clear the Indicated Area of 100 Percent of the Affected Population**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Inner Ring, Detailed Planning Zone and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 4:50 | 5:00 | 4:25 | 5:00 | 4:25 | 4:25 | 5:05 | 6:30 | 4:25 | 4:50 | 6:05 | 4:25 | 4:25 | 4:50 |
| **R03** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R04** | 9:30 | 10:40 | 8:50 | 9:40 | 8:25 | 10:10 | 10:30 | 12:30 | 8:40 | 9:25 | 11:00 | 8:15 | 8:40 | 9:35 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 5:05 | 5:20 | 4:50 | 5:30 | 4:30 | 5:20 | 5:35 | 6:40 | 4:55 | 4:55 | 6:05 | 4:30 | 4:55 | 5:10 |
| **R06** | 6:25 | 6:30 | 6:05 | 6:25 | 4:45 | 6:40 | 7:00 | 7:45 | 6:00 | 6:05 | 7:05 | 5:40 | 6:00 | 6:25 |
| **R07** | 6:25 | 6:30 | 5:40 | 5:40 | 4:45 | 6:35 | 6:35 | 7:45 | 5:45 | 6:00 | 6:55 | 5:35 | 6:00 | 6:25 |
| **R08** | 6:25 | 6:25 | 5:10 | 5:20 | 4:45 | 6:30 | 6:30 | 7:20 | 5:40 | 5:40 | 6:25 | 5:30 | 6:00 | 6:25 |
| **R09** | 4:35 | 4:55 | 4:35 | 4:35 | 4:30 | 4:55 | 5:05 | 5:55 | 4:35 | 4:35 | 5:15 | 4:30 | 4:35 | 4:55 |
| **R10** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R11** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R12** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R13** | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:25 | 4:30 | 4:30 | 5:10 | 4:30 | 4:30 | 4:30 |
| **R14** | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:25 | 4:30 | 4:30 | 5:10 | 4:30 | 4:30 | 4:30 |
| **R15** | 8:55 | 9:50 | 8:25 | 9:10 | 7:50 | 9:10 | 10:10 | 11:50 | 8:15 | 9:15 | 10:45 | 7:45 | 8:15 | 8:55 |
| **R16** | 8:55 | 9:50 | 8:25 | 9:10 | 7:50 | 9:10 | 10:10 | 11:50 | 8:15 | 9:15 | 10:45 | 7:45 | 8:15 | 8:55 |
| **R17** | 9:20 | 10:10 | 8:40 | 9:20 | 8:05 | 9:30 | 10:10 | 12:00 | 8:30 | 9:25 | 11:00 | 8:10 | 8:35 | 9:20 |
| **R18** | 9:10 | 9:55 | 8:25 | 9:20 | 8:05 | 9:30 | 10:10 | 12:00 | 8:30 | 9:10 | 10:30 | 8:00 | 8:35 | 9:10 |
| **R19** | 9:15 | 10:00 | 8:25 | 9:20 | 8:10 | 9:35 | 10:25 | 12:00 | 8:35 | 9:10 | 11:00 | 8:15 | 8:35 | 9:25 |
| **Evacuate Detailed Planning Zone Inner Ring and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R20** | 6:00 | 6:40 | 5:45 | 6:10 | 4:45 | 5:55 | 7:25 | 7:55 | 5:30 | 6:25 | 7:30 | 5:00 | 6:05 | 6:40 |
| **R21** | 6:55 | 7:40 | 6:35 | 7:25 | 6:00 | 7:05 | 7:55 | 8:25 | 6:50 | 6:55 | 8:05 | 5:45 | 6:50 | 6:55 |
| **R22** | 6:55 | 6:55 | 6:35 | 6:40 | 5:45 | 7:05 | 7:05 | 8:25 | 6:50 | 6:55 | 8:05 | 5:35 | 6:50 | 6:55 |
| **R23** | 6:55 | 6:55 | 6:35 | 6:40 | 5:45 | 7:05 | 7:05 | 8:25 | 6:50 | 6:55 | 8:05 | 5:35 | 6:50 | 6:55 |
| **R24** | 6:40 | 6:55 | 6:30 | 6:30 | 5:40 | 7:05 | 7:05 | 8:00 | 6:05 | 6:30 | 7:45 | 4:50 | 6:25 | 6:45 |
| **R25** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **R26** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R27** | 5:25 | 6:15 | 5:25 | 5:50 | 4:30 | 5:40 | 6:15 | 7:35 | 5:10 | 6:00 | 7:15 | 4:30 | 5:10 | 6:40 |
| **R28** | 6:15 | 7:30 | 5:40 | 6:00 | 4:55 | 6:05 | 6:20 | 7:35 | 5:25 | 6:00 | 7:15 | 4:50 | 5:40 | 6:40 |
| **R29** | 6:15 | 7:30 | 5:40 | 6:00 | 4:55 | 6:05 | 6:20 | 7:35 | 5:25 | 6:00 | 7:15 | 4:50 | 5:40 | 6:40 |
| **R30** | 9:15 | 10:15 | 8:35 | 9:30 | 8:10 | 9:40 | 10:30 | 12:30 | 8:30 | 9:15 | 11:00 | 8:15 | 8:30 | 9:15 |
| **R31** | 9:15 | 10:15 | 8:35 | 9:30 | 8:10 | 9:40 | 10:30 | 12:30 | 8:30 | 9:15 | 11:00 | 8:15 | 8:30 | 9:15 |
| **R32** | 9:30 | 10:20 | 8:45 | 9:30 | 8:15 | 9:45 | 10:30 | 12:30 | 8:40 | 9:20 | 11:00 | 8:15 | 8:40 | 9:35 |
| **R33** | 9:20 | 10:15 | 8:35 | 9:25 | 8:15 | 9:35 | 10:30 | 12:15 | 8:20 | 9:20 | 11:00 | 8:10 | 8:40 | 9:25 |
| **R34** | 9:20 | 10:15 | 8:35 | 9:30 | 8:15 | 9:35 | 10:30 | 12:15 | 8:20 | 9:25 | 11:00 | 8:10 | 8:40 | 9:35 |
| **Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R35** | 5:10 | 5:20 | 5:00 | 6:00 | 4:45 | 5:20 | 5:35 | 6:40 | 5:00 | 6:25 | 6:25 | 5:05 | 5:00 | 5:10 |
| **R36** | 6:25 | 6:30 | 6:10 | 6:45 | 4:45 | 6:45 | 7:05 | 9:00 | 6:25 | 6:25 | 8:55 | 5:40 | 6:30 | 6:35 |
| **R37** | 6:25 | 6:30 | 6:00 | 6:25 | 4:45 | 6:35 | 6:35 | 8:00 | 5:45 | 6:00 | 6:55 | 5:40 | 6:00 | 6:25 |
| **R38** | 6:25 | 6:25 | 5:10 | 5:50 | 4:45 | 6:30 | 6:30 | 8:00 | 5:45 | 5:55 | 6:25 | 5:40 | 6:00 | 6:25 |
| **R39** | 4:35 | 4:55 | 4:35 | 4:35 | 4:30 | 5:05 | 5:05 | 6:05 | 4:35 | 4:35 | 5:15 | 4:30 | 4:35 | 5:20 |
| **R40** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R41** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R42** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R43** | 4:35 | 4:35 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:35 | 4:30 | 4:30 | 5:30 | 4:30 | 4:30 | 4:35 |
| **R44** | 4:35 | 4:35 | 4:30 | 4:30 | 4:30 | 4:30 | 4:30 | 5:35 | 4:30 | 4:30 | 5:30 | 4:30 | 4:30 | 4:35 |
| **R45** | 9:25 | 10:00 | 8:25 | 9:25 | 8:20 | 9:10 | 10:15 | 12:10 | 8:35 | 9:15 | 11:05 | 8:10 | 8:35 | 9:25 |
| **R46** | 9:25 | 10:00 | 8:25 | 9:25 | 8:20 | 9:10 | 10:15 | 12:10 | 8:35 | 9:15 | 11:05 | 8:10 | 8:35 | 9:25 |
| **R47** | 9:30 | 10:10 | 8:50 | 9:40 | 8:20 | 9:45 | 10:25 | 12:25 | 8:40 | 9:25 | 11:05 | 8:25 | 8:40 | 9:30 |
| **R48** | 9:10 | 10:00 | 8:40 | 9:30 | 8:15 | 9:45 | 10:20 | 12:15 | 8:35 | 9:20 | 11:00 | 8:20 | 8:35 | 9:15 |
| **R49** | 9:25 | 10:00 | 8:50 | 9:30 | 8:15 | 9:50 | 10:25 | 12:15 | 8:35 | 9:35 | 11:00 | 8:25 | 8:40 | 9:25 |
| **R50** | 9:35 | 10:50 | 9:05 | 9:40 | 8:25 | 10:10 | 11:00 | 12:30 | 8:45 | 9:40 | 11:35 | 8:35 | 8:55 | 9:35 |

Table 7-3. Time to Clear ***90*** Percent of the Automatic Action Zone within the Indicated Region

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Inner Ring, Detailed Planning Zone and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R04** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:15 | 2:40 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:45 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **R06** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:45 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **R07** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:35 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **R08** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R09** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R10** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R11** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R12** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R13** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R14** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R15** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R16** | 1:35 | 1:35 | 2:00 | 2:00 | 2:00 | 1:35 | 1:35 | 1:55 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:35 |
| **R17** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **R18** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |
| **R19** | 2:10 | 2:10 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:10 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R35** | 2:15 | 2:15 | 2:15 | 2:25 | 2:15 | 2:15 | 2:15 | 2:55 | 2:15 | 2:25 | 2:55 | 2:15 | 2:15 | 2:15 |
| **R36** | 2:15 | 2:20 | 2:15 | 2:20 | 2:15 | 2:15 | 2:20 | 3:00 | 2:20 | 2:20 | 3:10 | 2:15 | 2:15 | 2:15 |
| **R37** | 2:15 | 2:15 | 2:20 | 2:20 | 2:20 | 2:15 | 2:20 | 3:10 | 2:15 | 2:20 | 3:15 | 2:15 | 2:20 | 2:15 |
| **R38** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R39** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R40** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R41** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R42** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R43** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R44** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R45** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R46** | 1:50 | 1:50 | 2:05 | 2:05 | 2:05 | 1:50 | 1:50 | 2:15 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 1:50 |
| **R47** | 2:15 | 2:15 | 2:15 | 2:20 | 2:15 | 2:15 | 2:15 | 2:45 | 2:15 | 2:20 | 3:00 | 2:15 | 2:15 | 2:15 |
| **R48** | 2:15 | 2:15 | 2:15 | 2:20 | 2:15 | 2:15 | 2:15 | 2:45 | 2:15 | 2:20 | 2:50 | 2:15 | 2:15 | 2:15 |
| **R49** | 2:15 | 2:15 | 2:15 | 2:20 | 2:20 | 2:15 | 2:15 | 2:45 | 2:15 | 2:20 | 2:50 | 2:15 | 2:15 | 2:15 |
| **R50** | 2:20 | 2:25 | 2:20 | 2:20 | 2:25 | 2:15 | 2:25 | 3:05 | 2:20 | 2:25 | 3:15 | 2:20 | 2:20 | 2:15 |

Table 7-4. Time to Clear *__100__* Percent of the Automatic Action Zone within the Indicated Region

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, Detailed Planning Zone Outer Ring and Contingency Planning Zone** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R04** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary** | | | | | | | | | | | | | | |
| **R05** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R06** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R07** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R08** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R09** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R10** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R11** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R12** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R13** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R14** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R15** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R16** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R17** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R18** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R19** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Staged Evacuation - Evacuate Automatic Action Zone and Downwind to Contingency Planning Zone Boundary | | | | | | | | | | | | | | |
| R35 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R36 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R37 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R38 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R39 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R40 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R41 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R42 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R43 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R44 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R45 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R46 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R47 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R48 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R49 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| R50 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |

## Table 7-5. Description of Evacuation Regions

| Region | Description | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Radial Regions** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | **Response Sectors** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **R01** | AAZ | X | X | | | | | | | | | | | | | | | X | | | | | | | | | | |
| **R02** | DPZ Inner Ring | X | X | X | X | X | X | | | | | | | | | | | X | X | | | | | | | | | |
| **R03** | DPZ Outer Ring | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | |
| **R04** | Full PZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Evacuate AAZ and Downwind to CPZ Boundary** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Region** | **Wind Direction Towards:** | **DNGS** | **D1** | **D2** | **D3** | **D4** | **D5** | **D6A** | **D6B** | **D7** | **D8A** | **D8B** | **D9** | **D10** | **D11** | **D12** | **D13** | **D14** | **D15** | **D16** | **CPZ1** | **CPZ2** | **CPZ3** | **CPZ4** | **CPZ5** | **CPZ6** | **CPZ7** | **CPZ8** |
| **R05** | N | X | X | | X | X | X | | | | | | | | X | X | | X | | | X | | | | | | | X |
| **R06** | NNE | X | X | | X | X | X | | | | | | | | X | X | X | X | | | X | X | | | | | | X |
| **R07** | NE | X | X | | X | X | X | | | | | | | | | X | X | X | X | X | X | X | | | | | | |
| **R08** | ENE | X | X | | | X | X | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| **R09** | E | X | X | | | | X | | | | | | | | | | X | X | X | X | | X | X | | | | | |
| **R10** | ESE, SE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | | | | |
| **R11** | SSE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | X | | | |
| **R12** | S | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | | | |
| **R13** | SSW | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | X | | |
| **R14** | SW | X | X | | | | | | | | | | | | | | | X | X | X | | | | | X | X | | |
| **R15** | WSW | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | X | X | X | |
| **R16** | W | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | | X | X | |
| **R17** | WNW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | X | X | | | | | | X | X | X |
| **R18** | NW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | | | | | | | | | X | X |
| **R19** | NNW | X | X | X | X | | | X | X | X | X | X | X | X | X | X | | X | | | X | | | | | | X | X |
| **Evacuate DPZ and Downwind to CPZ Boundary** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Region** | **Wind Direction Towards:** | **DNGS** | **D1** | **D2** | **D3** | **D4** | **D5** | **D6A** | **D6B** | **D7** | **D8A** | **D8B** | **D9** | **D10** | **D11** | **D12** | **D13** | **D14** | **D15** | **D16** | **CPZ1** | **CPZ2** | **CPZ3** | **CPZ4** | **CPZ5** | **CPZ6** | **CPZ7** | **CPZ8** |
| **R20** | N | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | X |
| **R21** | NNE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X |
| **R22** | NE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | |
| **R23** | ENE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | |
| **R24** | E | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | X | | | | | |
| **R25** | ESE, SE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | X | X | | | | |
| **R26** | SSE | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | X | X | X | | | |
| **R27** | S | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | X | X | | | |
| **R28** | SSW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | X | X | X | | |
| **R29** | SW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | X | X | | |
| **R30** | WSW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | X | X | X | |
| **R31** | W | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X | |
| **R32** | WNW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X | X |
| **R33** | NW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | X | X |
| **R34** | NNW | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | X | X |
| Response Sector(s) Evacuate | | | | Response Sector(s) Shelter-in-Place | | | | | | | Response Sector not within Plume, but Evacuates because it is surrounded by other Response Sectors which are Evacuating | | | | | | | | | | | | | | | | | |

## Table 7-6. Description of Staged Evacuation Regions

| Staged Evacuation - Evacuate AAZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Region | Wind Direction Towards: | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R35 | N | X | X | | X | X | X | | | | | | | | X | X | | X | | | X | | | | | | | X |
| R36 | NNE | X | X | | X | X | X | | | | | | | | X | X | X | X | | | X | X | | | | | | X |
| R37 | NE | X | X | | X | X | X | | | | | | | | | X | X | X | X | X | X | X | | | | | | |
| R38 | ENE | X | X | | | X | X | | | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| R39 | E | X | X | | | | X | | | | | | | | | | X | X | X | X | | X | X | | | | | |
| R40 | ESE, SE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | | | | |
| R41 | SSE | X | X | | | | | | | | | | | | | | | X | X | X | | | X | X | X | | | |
| R42 | S | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | | | |
| R43 | SSW | X | X | | | | | | | | | | | | | | | X | X | X | | | | X | X | X | | |
| R44 | SW | X | X | | | | | | | | | | | | | | | X | X | X | | | | | X | X | | |
| R45 | WSW | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | X | X | X | |
| R46 | W | X | X | X | | | | X | X | X | X | X | X | | | | | X | X | X | | | | | | X | X | |
| R47 | WNW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | X | X | | | | | | X | X | X |
| R48 | NW | X | X | X | X | | | X | X | X | X | X | X | X | X | | | X | | | | | | | | | X | X |
| R49 | NNW | X | X | X | X | | | X | X | X | X | X | X | X | X | X | | X | | | X | | | | | | X | X |
| R50 | Full PZ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

Response Sector(s) Evacuate | Response Sector(s) Shelter-in-Place | Response Sector (s) Shelter-in-Place until 90% ETE for R01, then Evacuate

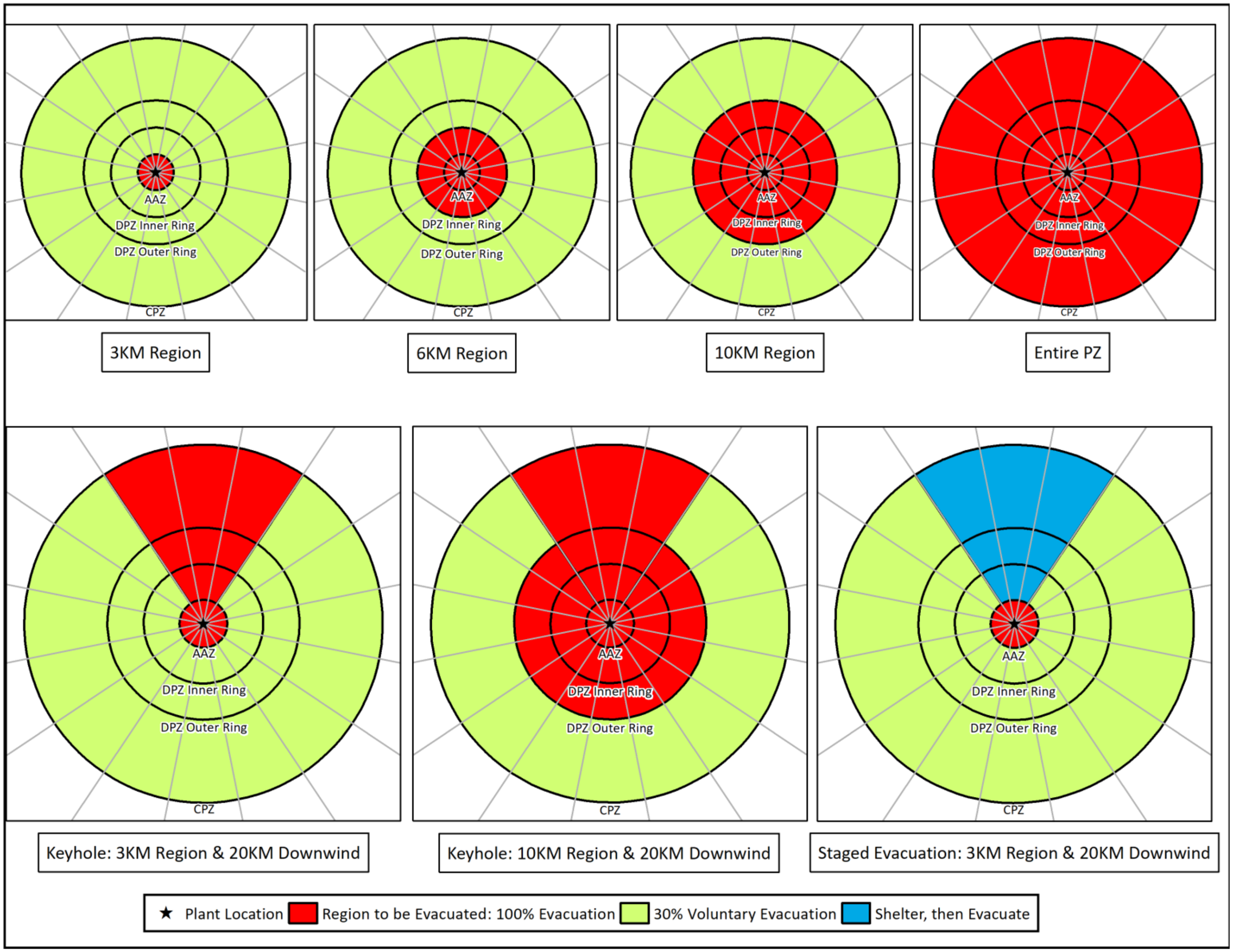



**Figure 7-1. Voluntary Evacuation Methodology**

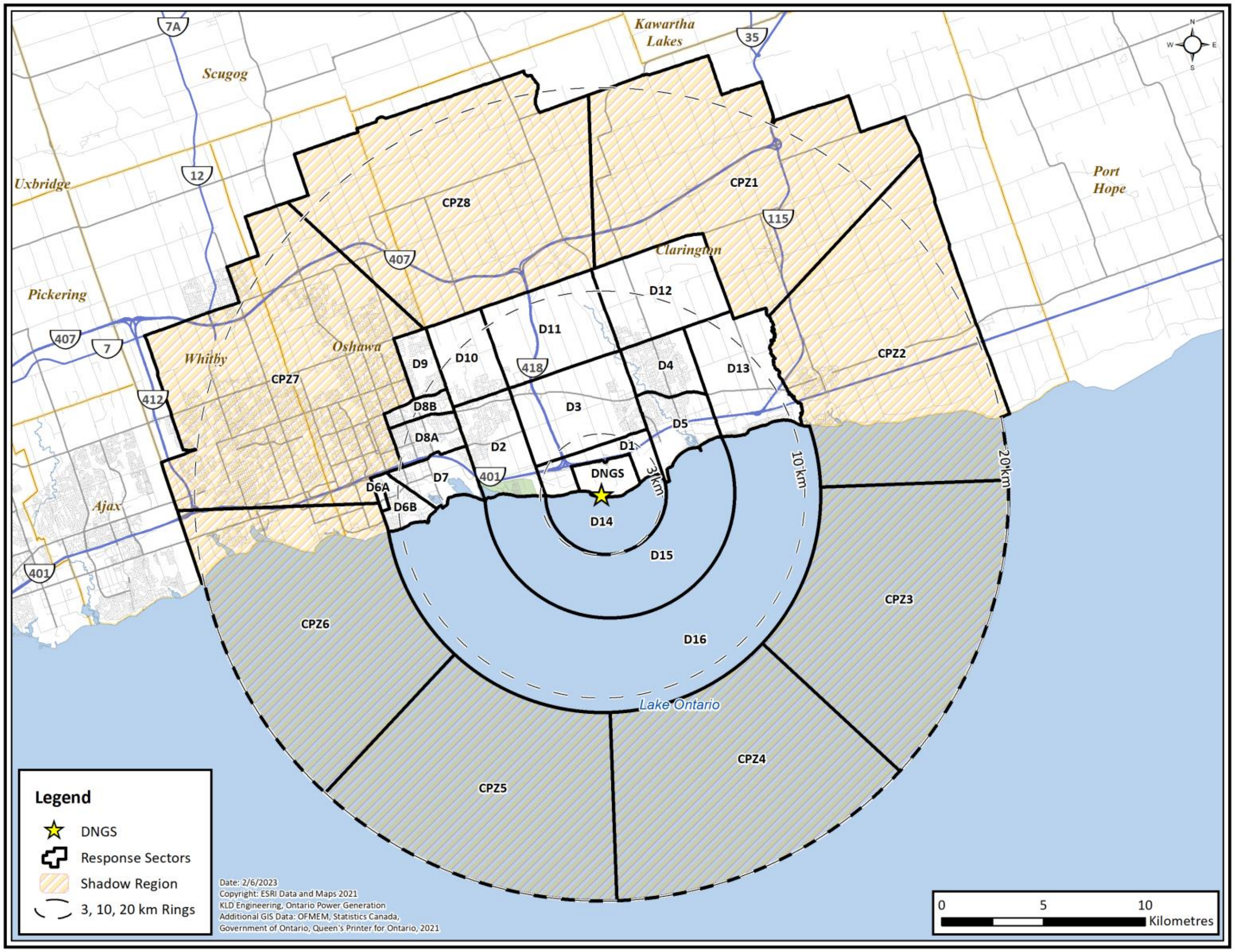



**Figure 7-2. DNGS Shadow Region**

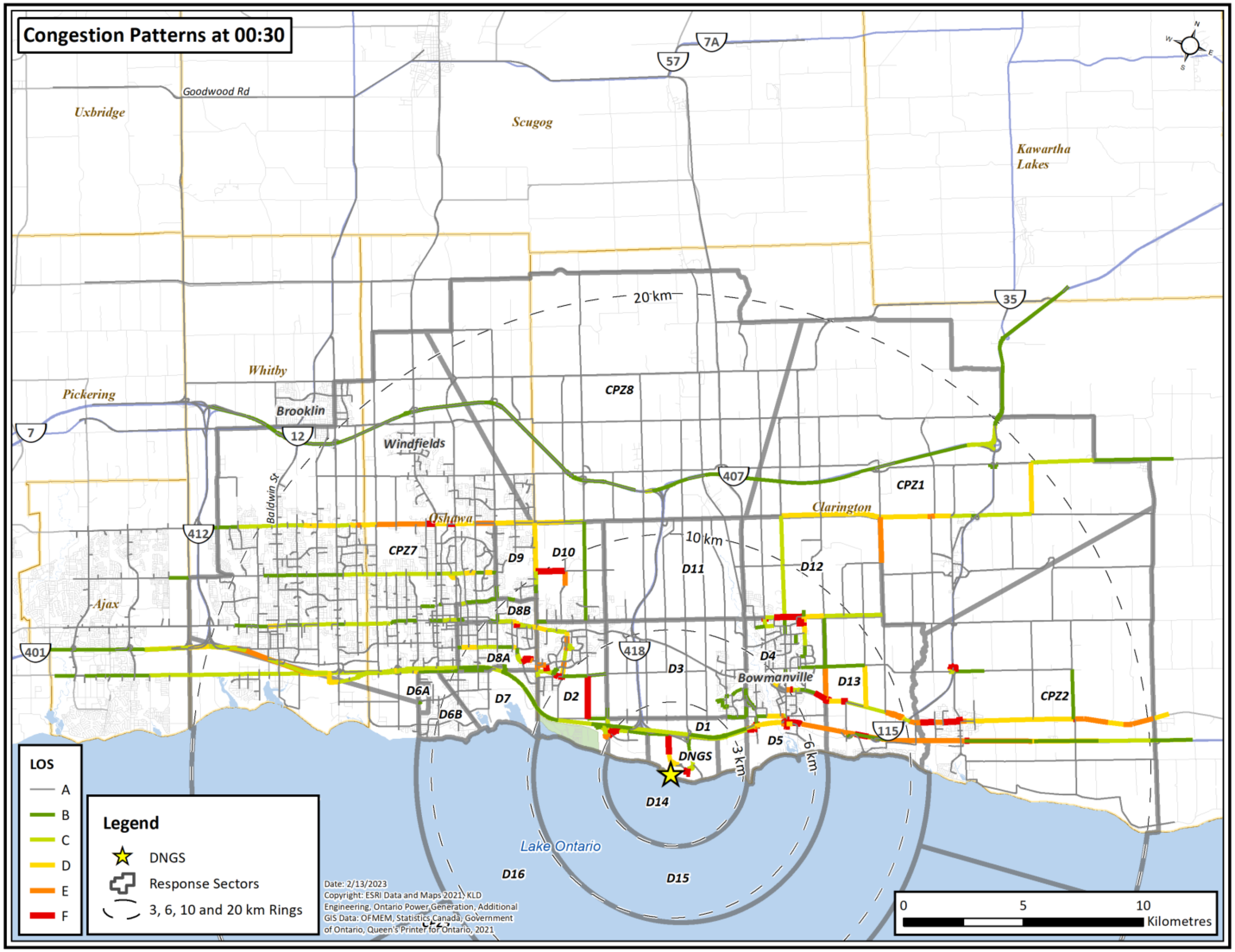



**Figure 7-3. Congestion Patterns at 30 Minutes after the Emergency Bulletin to Evacuate (R03)**

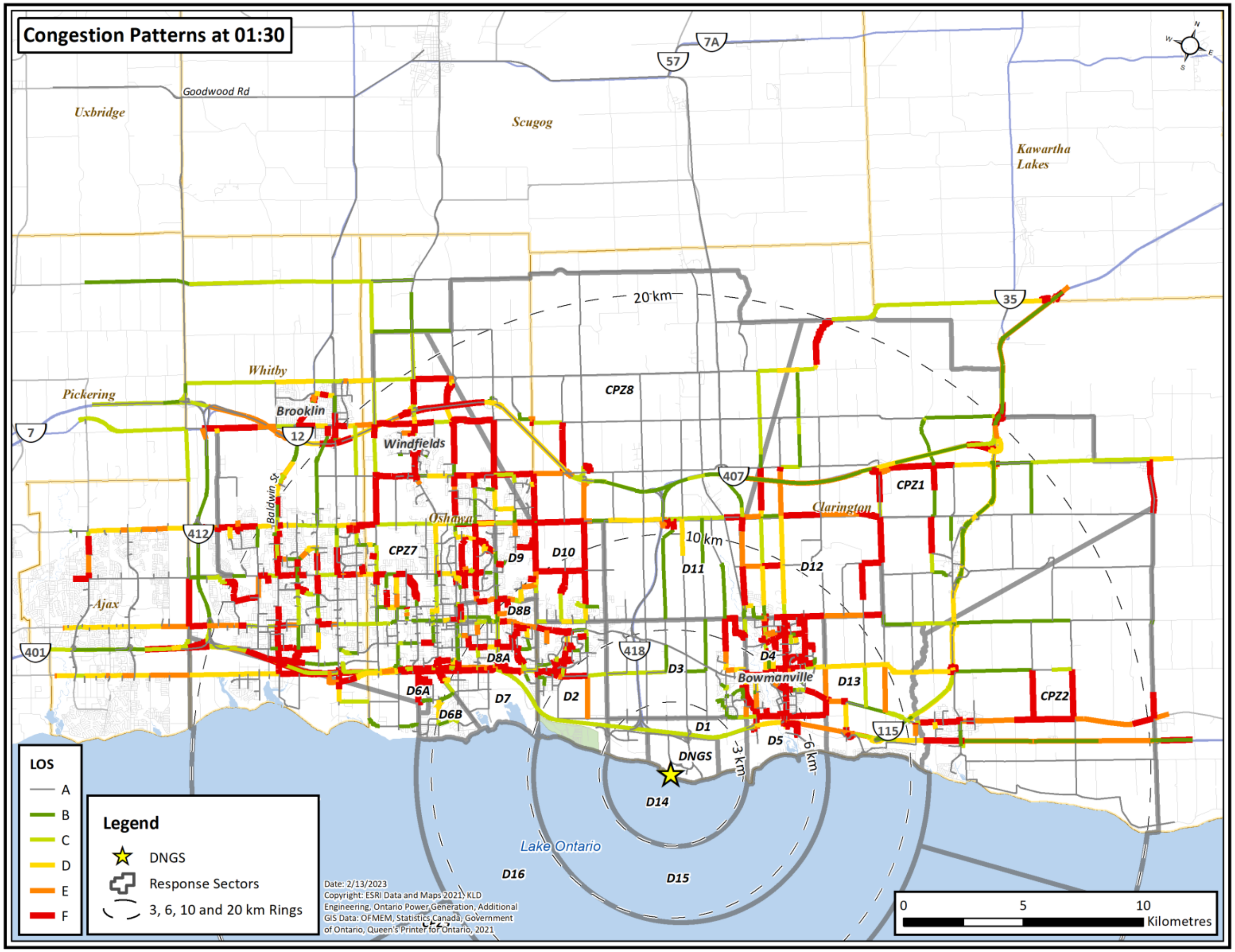



**Figure 7-4. Congestion Patterns at 1 Hour and 30 Minutes after the Emergency Bulletin to Evacuate (R03)**

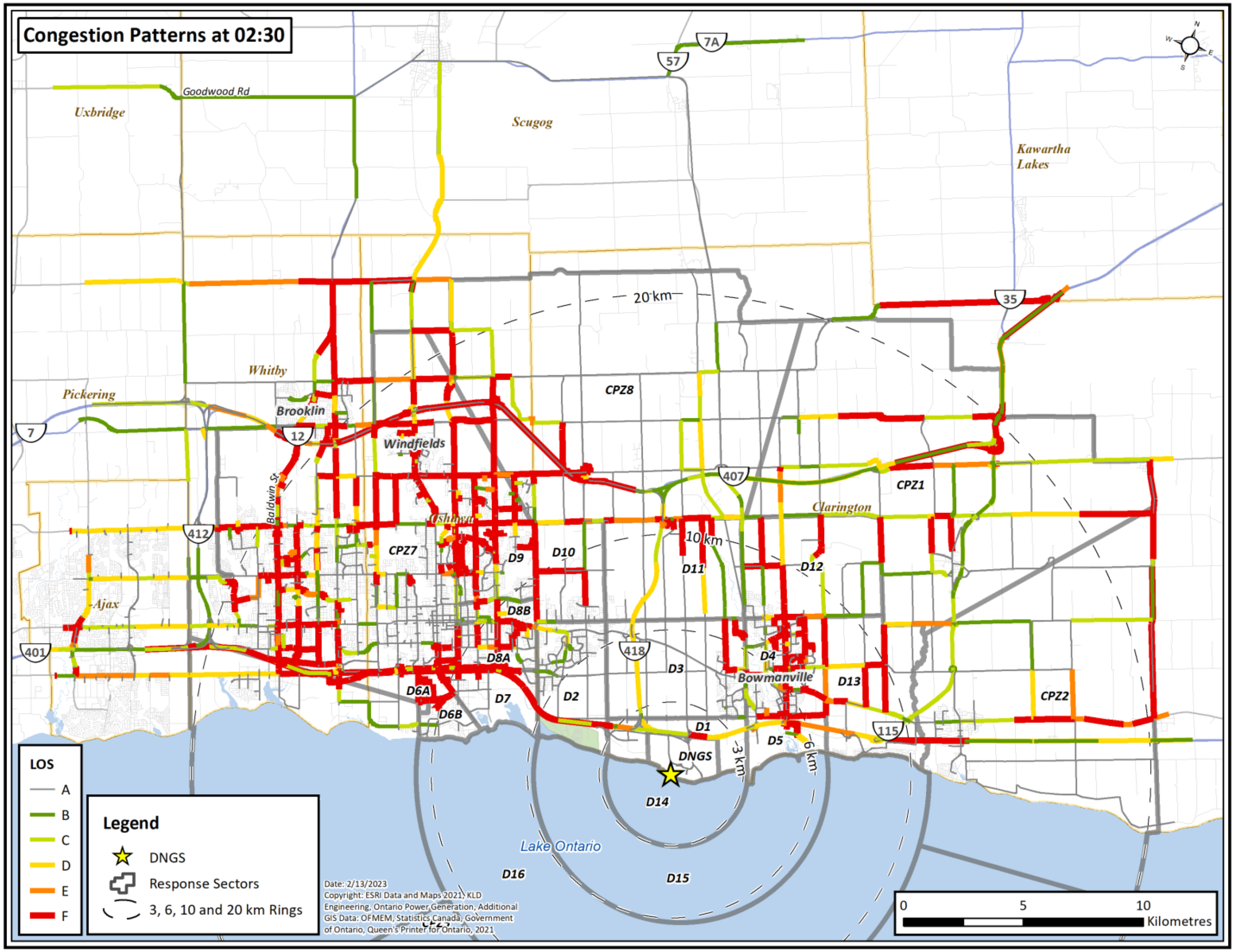



**Figure 7-5. Congestion Patterns at 2 Hours and 30 Minutes after the Emergency Bulletin to Evacuate (R03)**

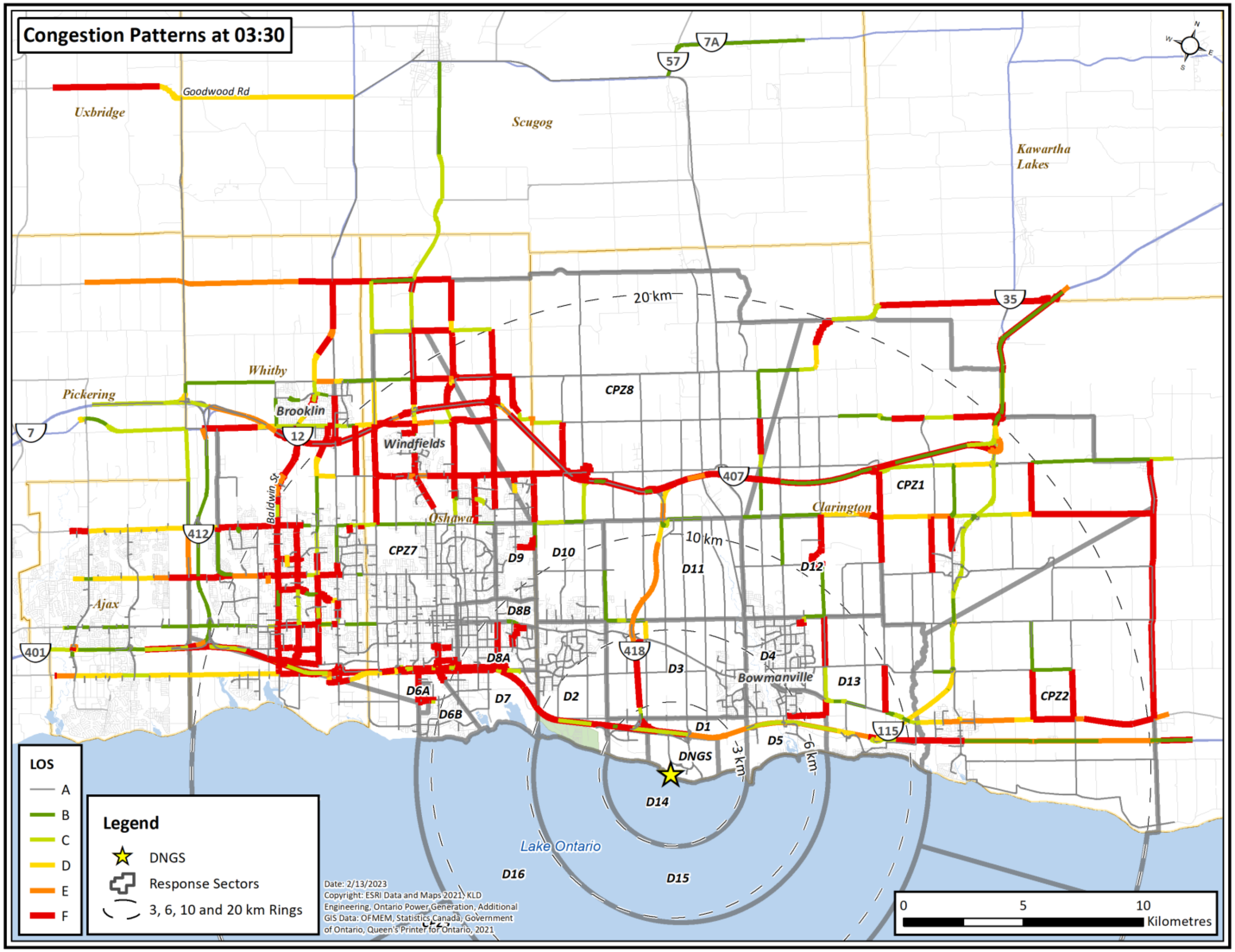



**Figure 7-6. Congestion Patterns at 3 Hours and 30 minutes after the Emergency Bulletin to Evacuate (R03)**

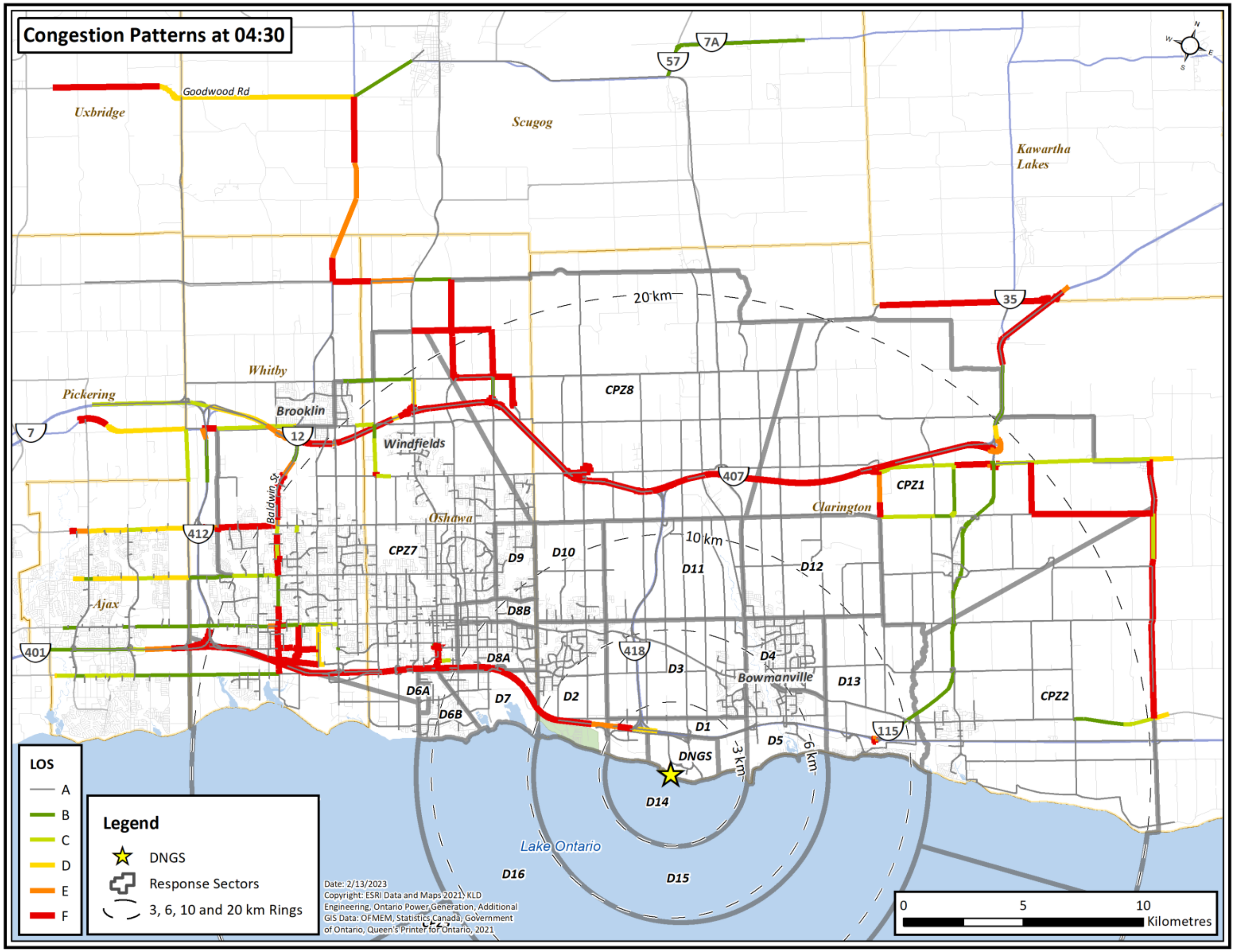



**Figure 7-7. Congestion Patterns at 4 Hours and 30 Minutes after the Emergency Bulletin to Evacuate (R03)**

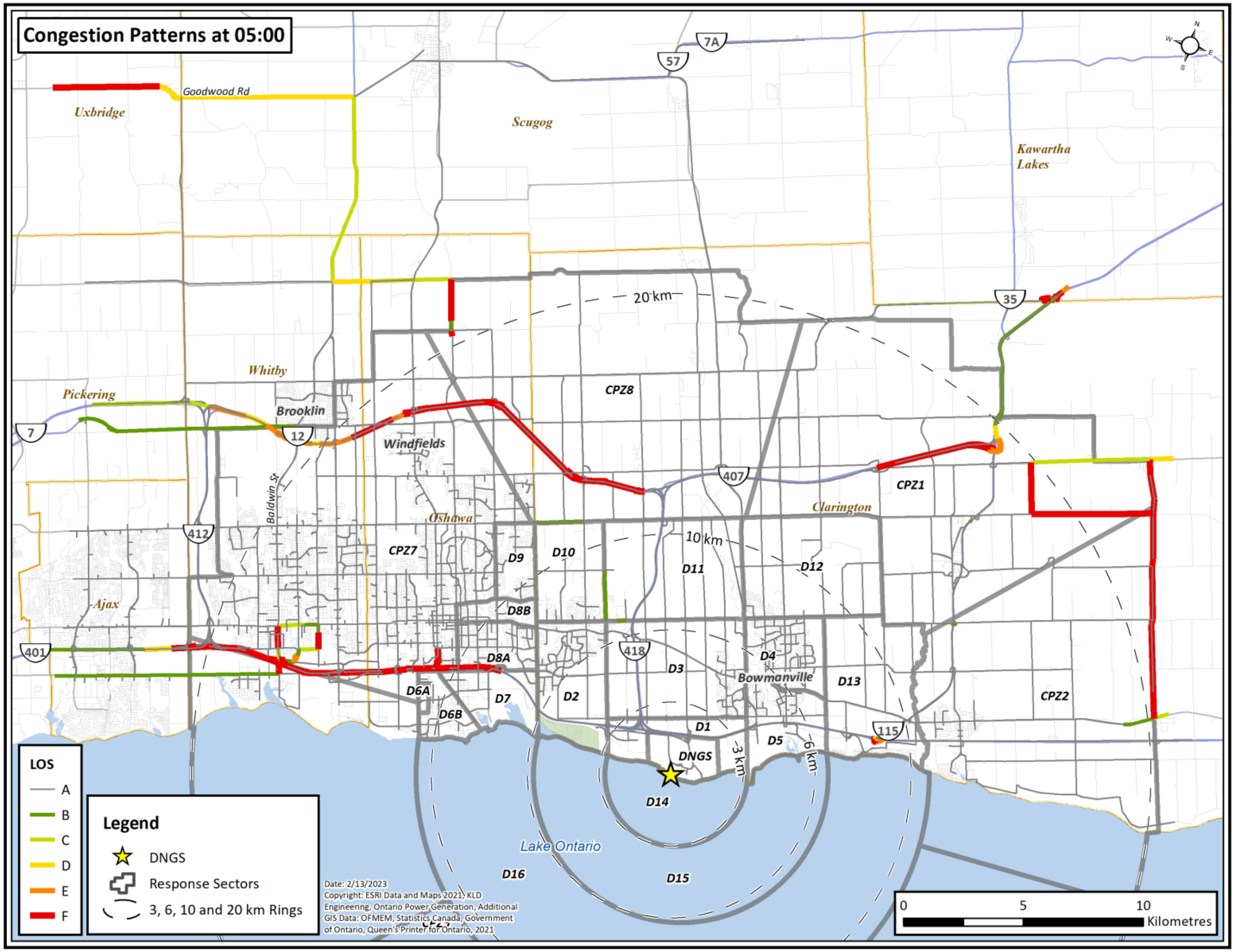



**Figure 7-8. Congestion Patterns at 5 Hours after the Emergency Bulletin to Evacuate (R03)**

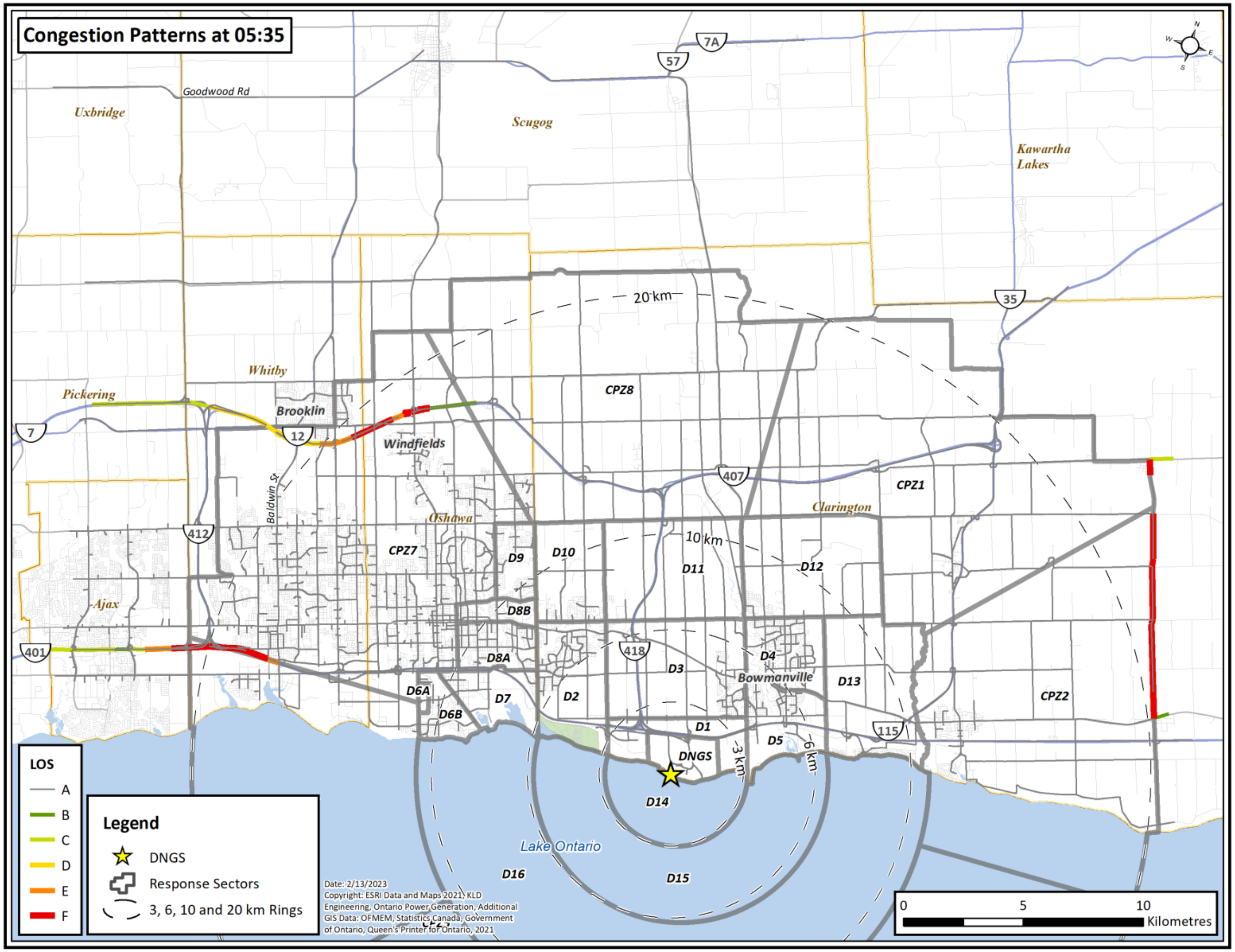



**Figure 7-9. Congestion Patterns at 5 Hours and 35 Minutes after the Emergency Bulletin to Evacuate (R03)**

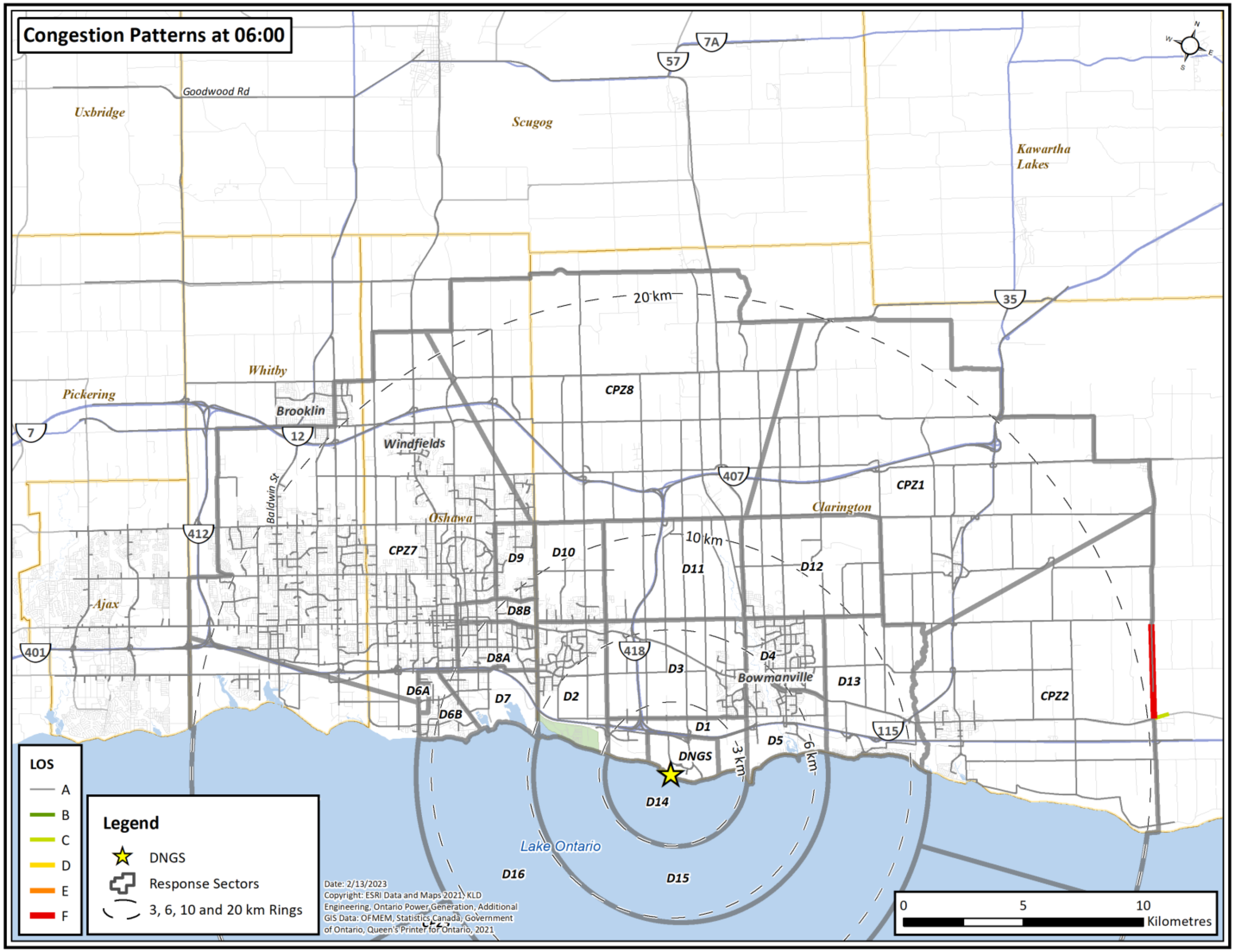



**Figure 7-10. Congestion Patterns at 6 Hours after the Emergency Bulletin to Evacuate (R03)**

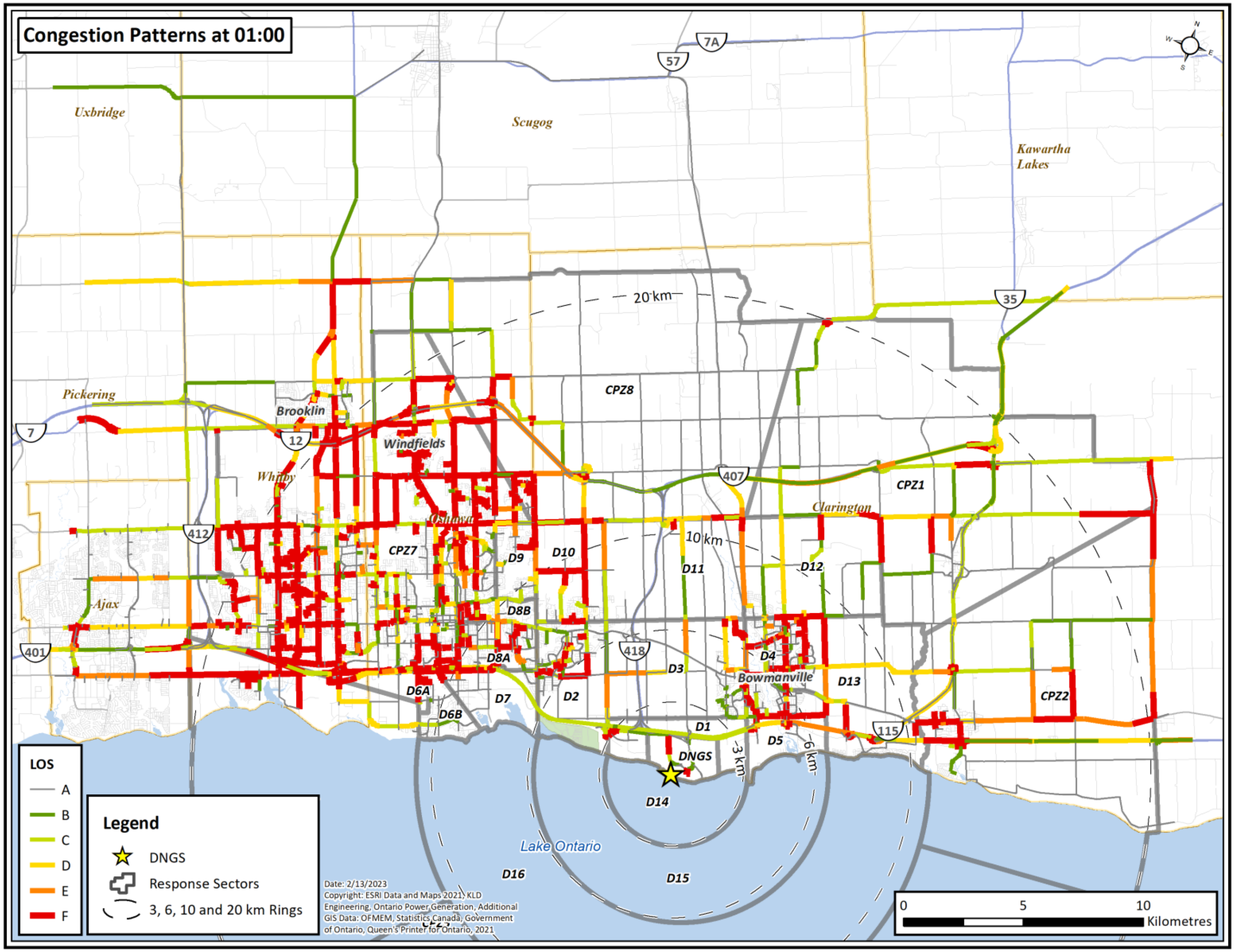



**Figure 7-11. Congestion Patterns at 1 Hour after the Emergency Bulletin to Evacuate (R04)**

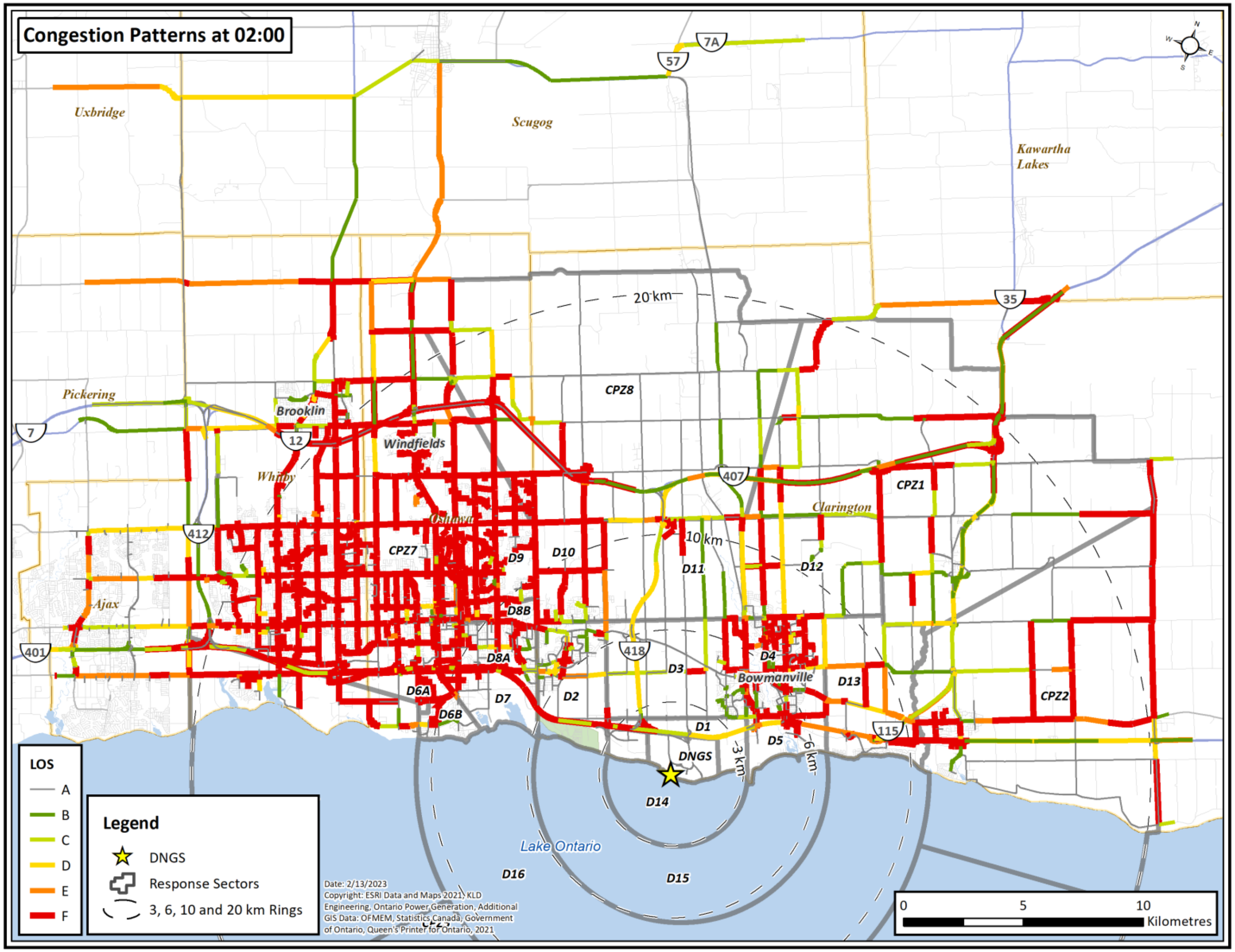



**Figure 7-12. Congestion Patterns at 2 Hours after the Emergency Bulletin to Evacuate (R04)**

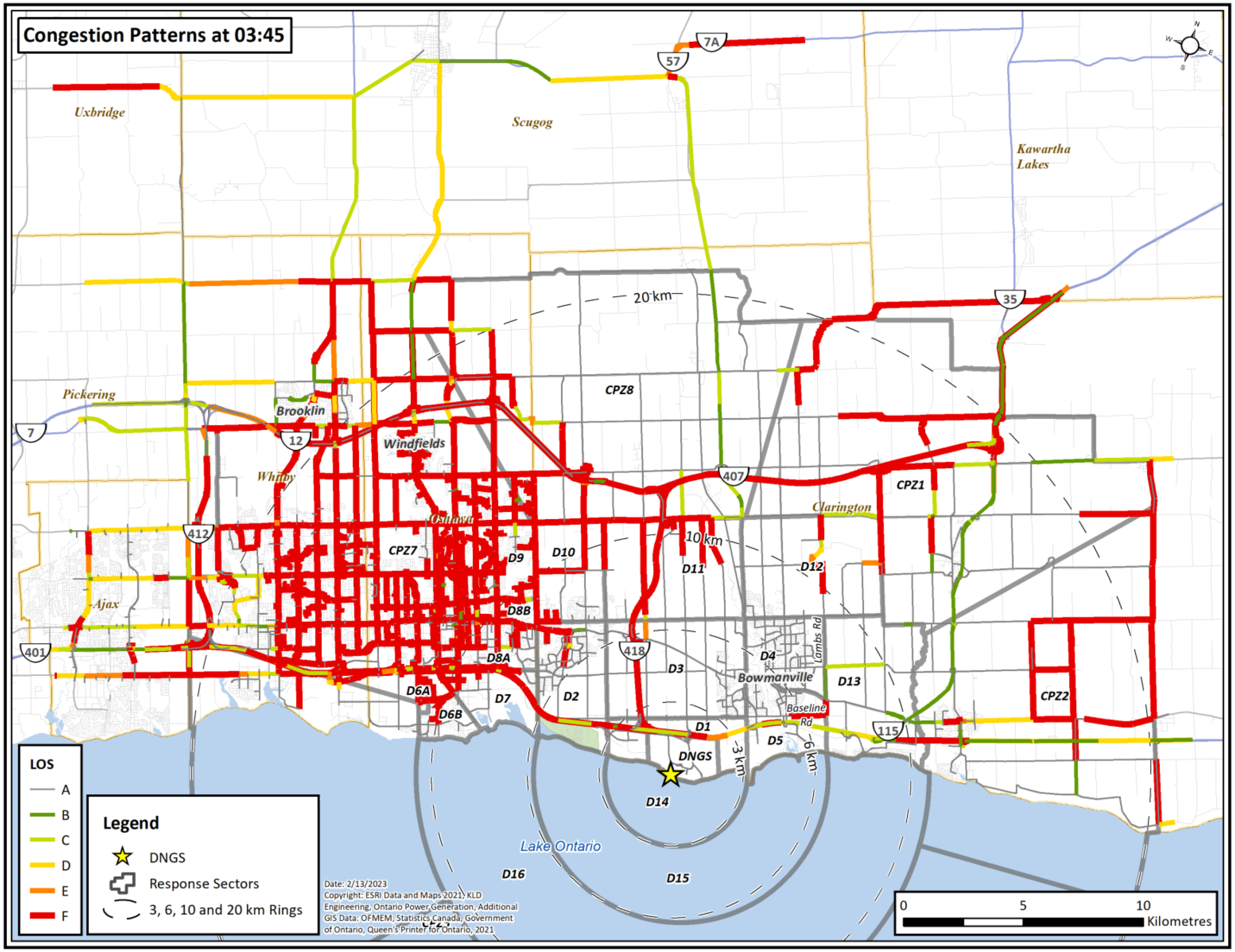



**Figure 7-13. Congestion Patterns at 3 Hours and 45 Minutes after the Emergency Bulletin to Evacuate (R04)**

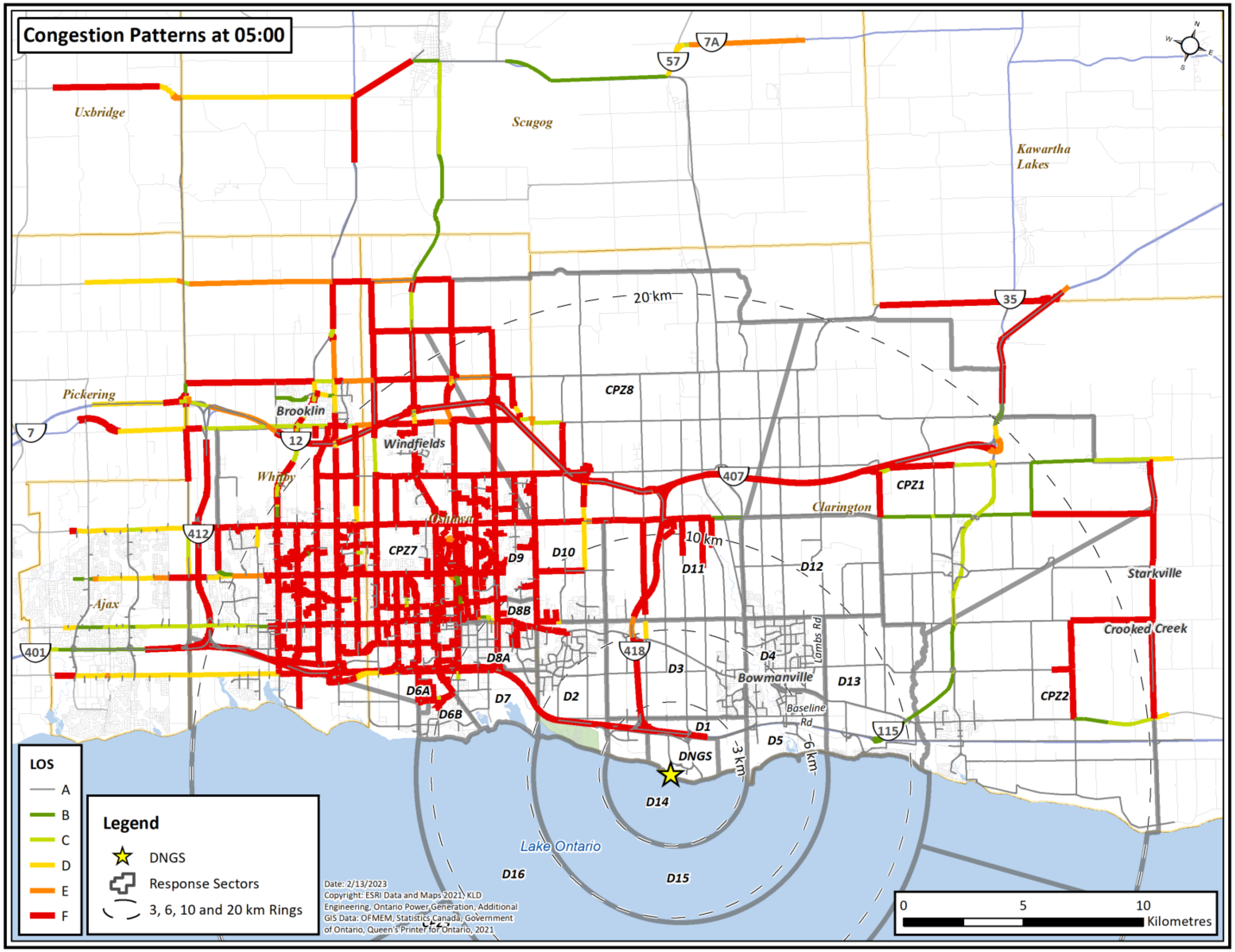



**Figure 7-14. Congestion Patterns at 5 Hours after the Emergency Bulletin to Evacuate (R04)**

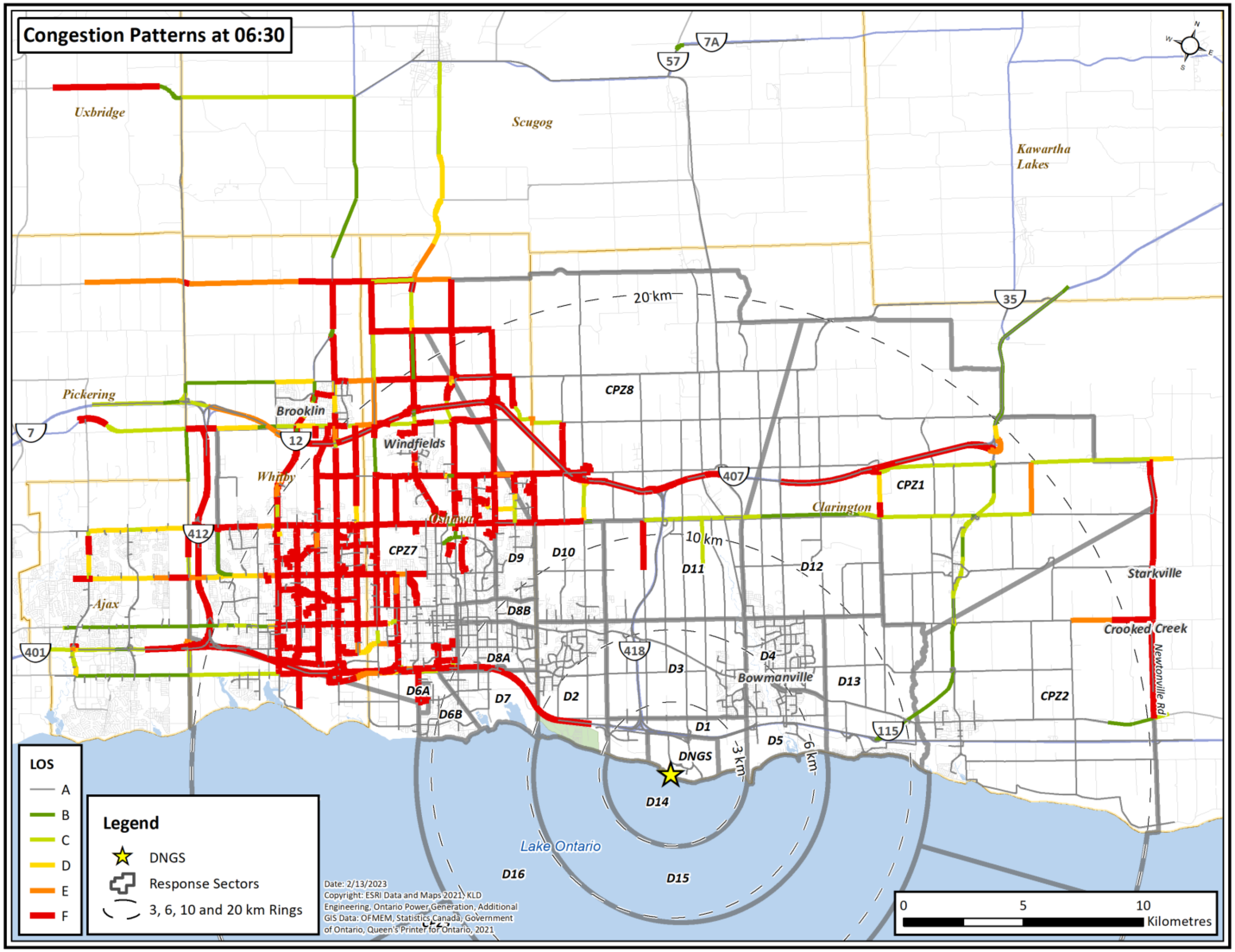



**Figure 7-15. Congestion Patterns at 6 Hours and 30 Minutes after the Emergency Bulletin to Evacuate (R04)**

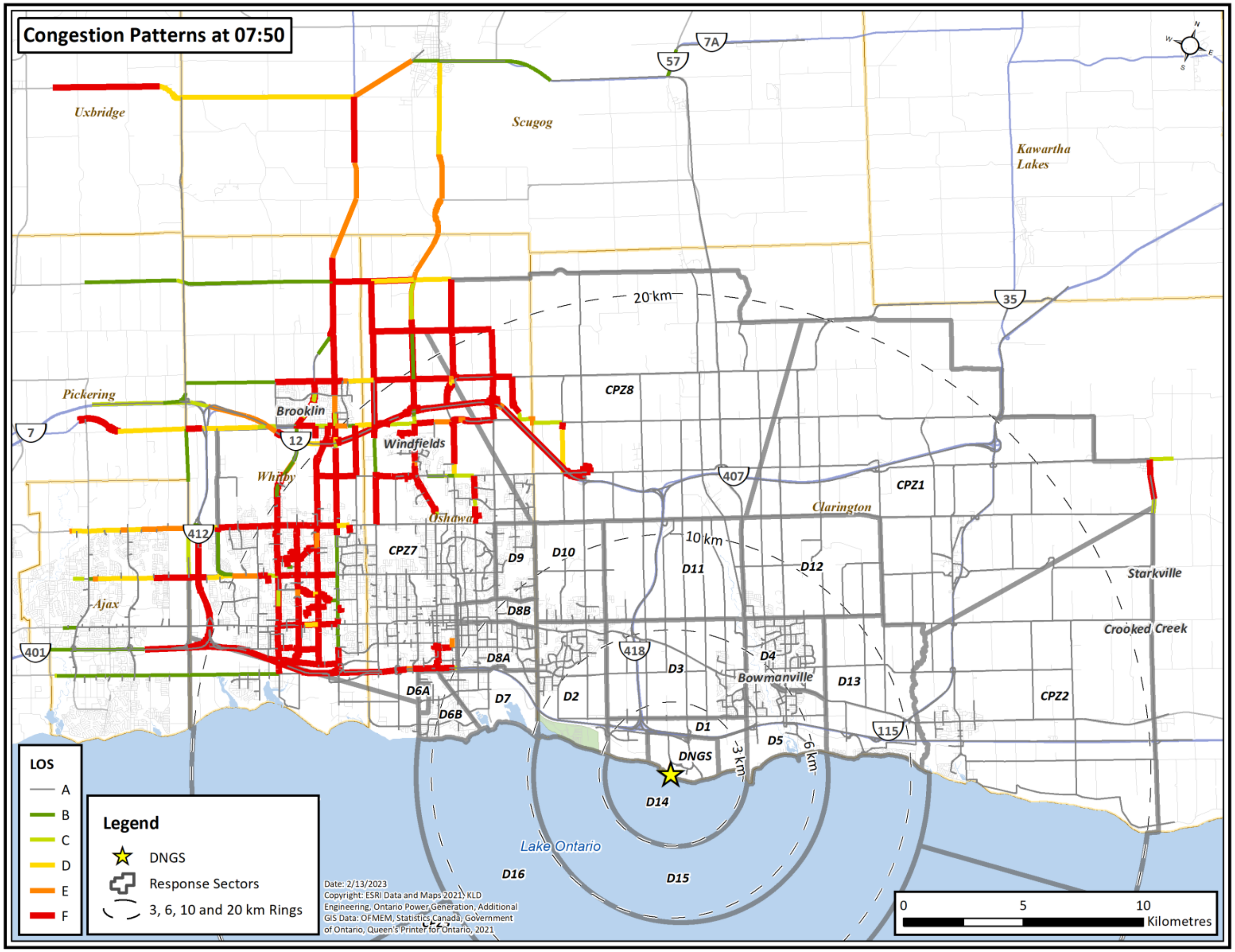



**Figure 7-16. Congestion Patterns at 7 Hours and 50 Minutes after the Emergency Bulletin to Evacuate (R04)**

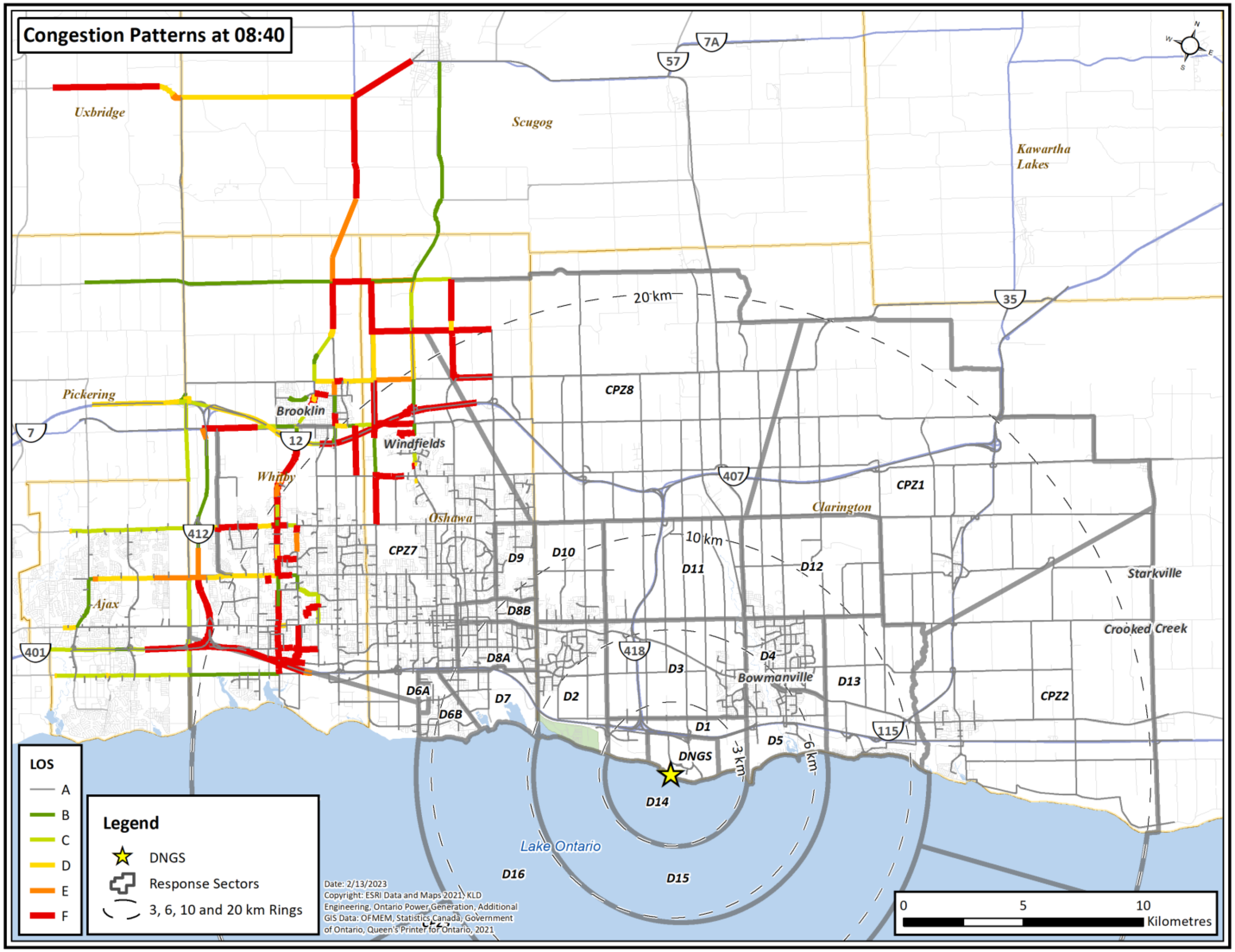



**Figure 7-17. Congestion Patterns at 8 Hours and 40 Minutes after the Emergency Bulletin to Evacuate (R04)**

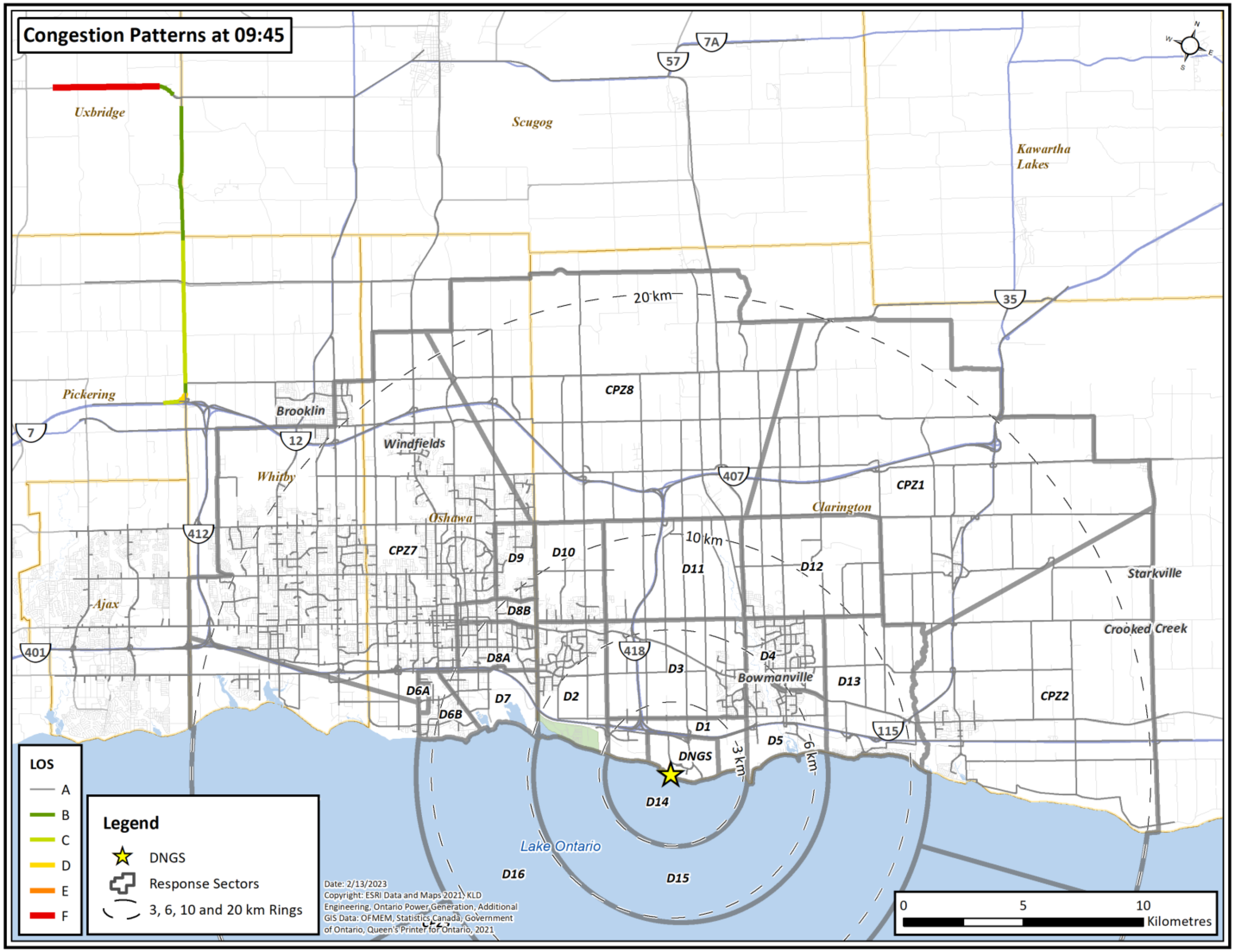



**Figure 7-18. Congestion Patterns at 9 Hours and 45 Minutes after the Emergency Bulletin to Evacuate (R04)**

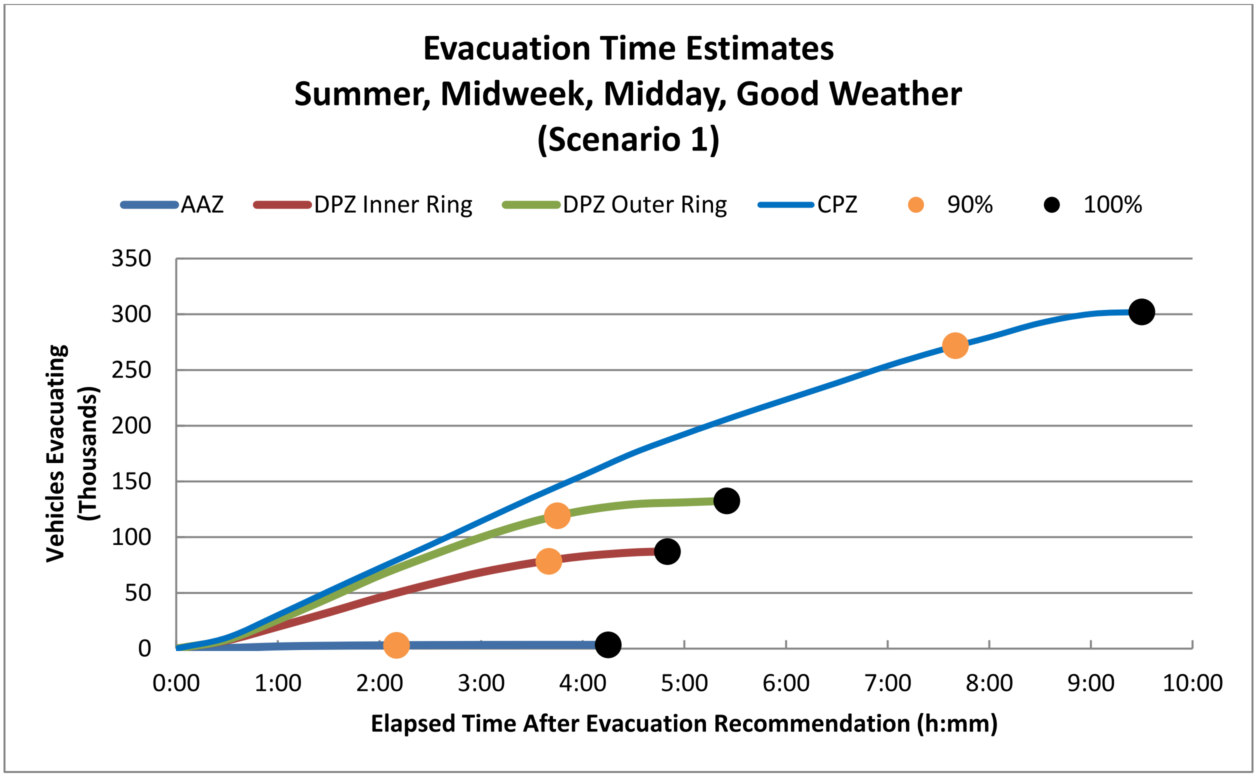



**Figure 7-19. Evacuation Time Estimates - Scenario 1 for Region R03 and R04**

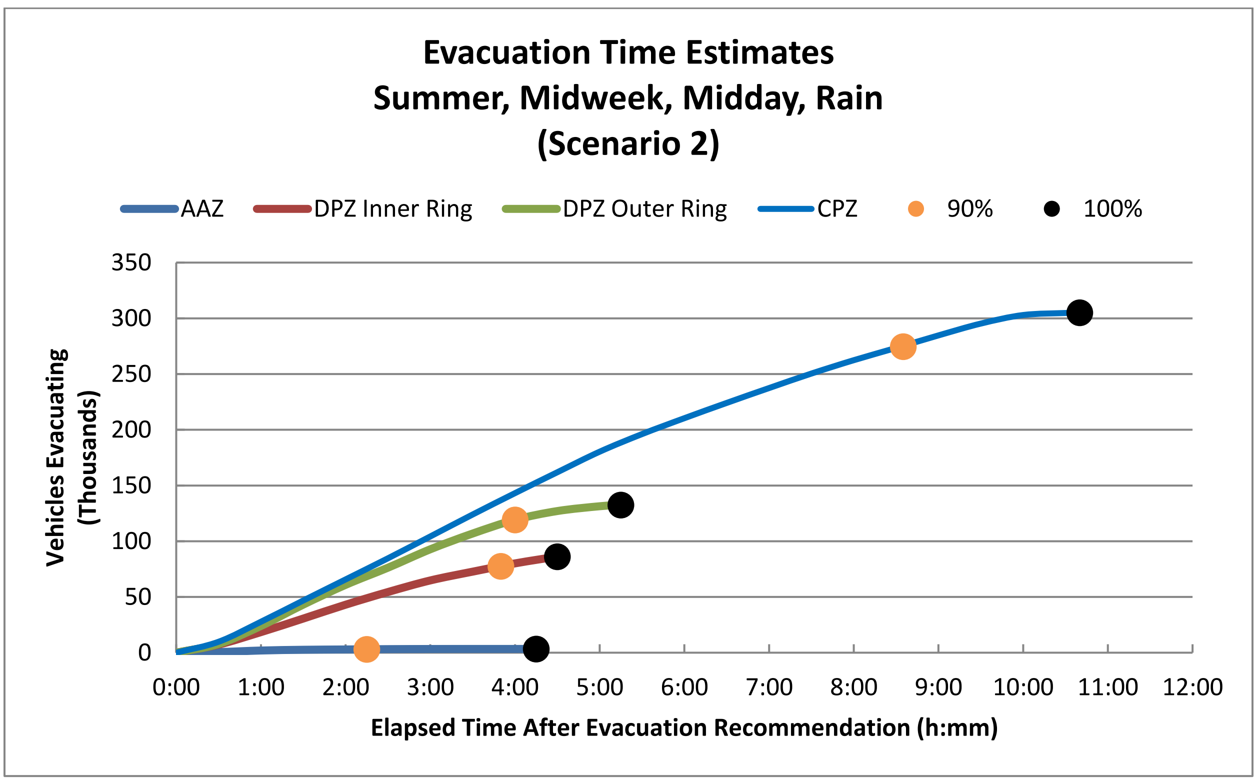



**Figure 7-20. Evacuation Time Estimates - Scenario 2 for Region R03 and R04**

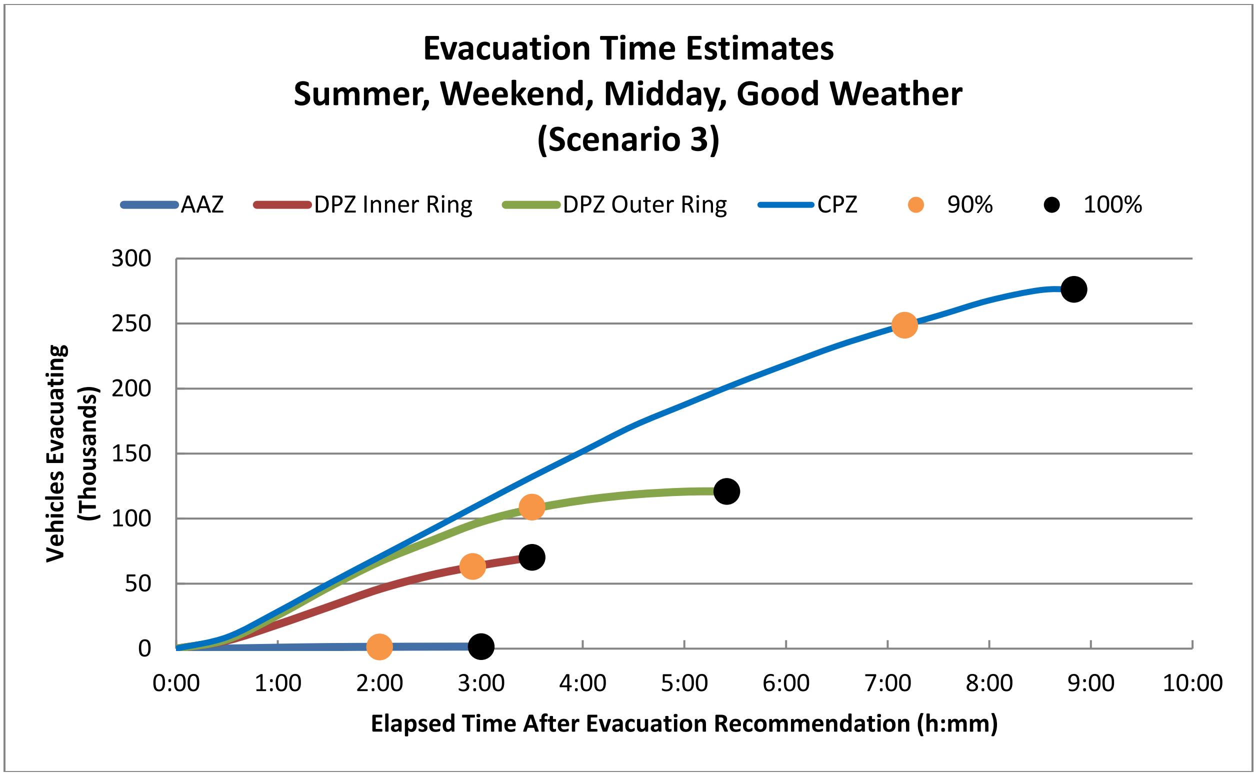



**Figure 7-21. Evacuation Time Estimates - Scenario 3 for Region R03 and R04**

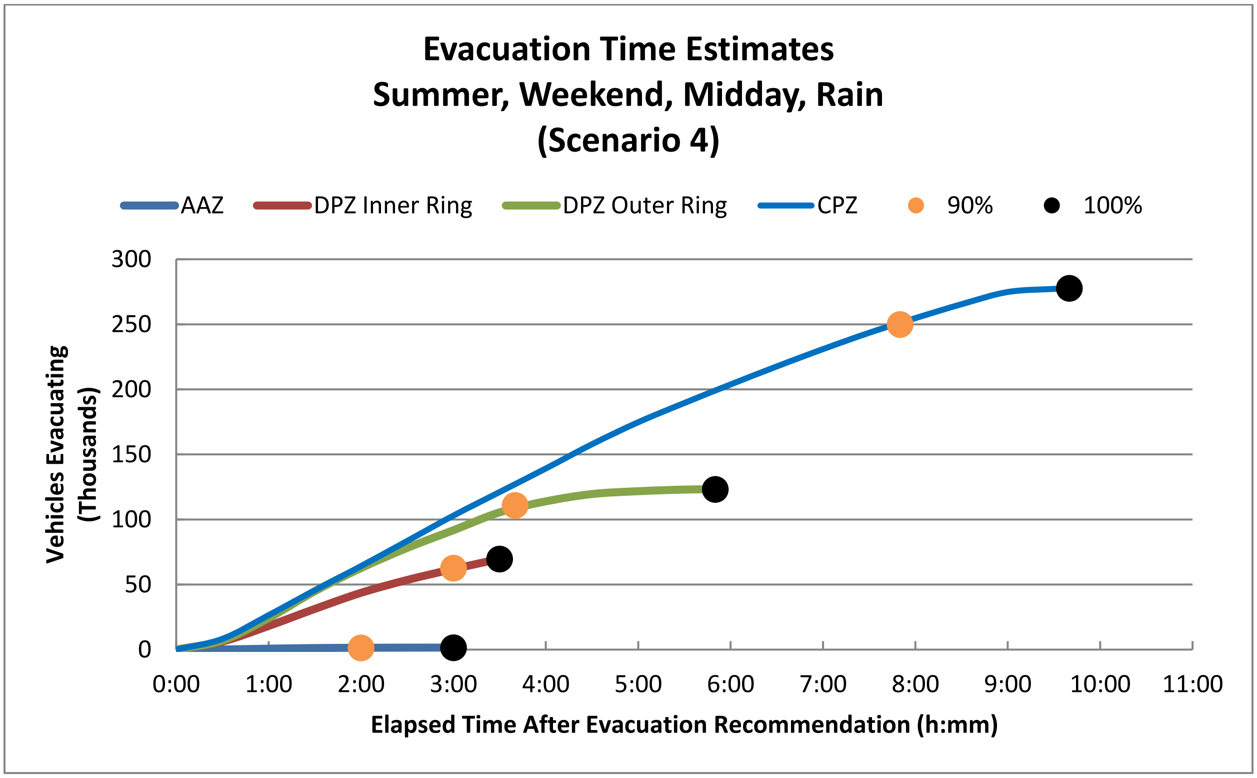



**Figure 7-22. Evacuation Time Estimates - Scenario 4 for Region R03 and R04**

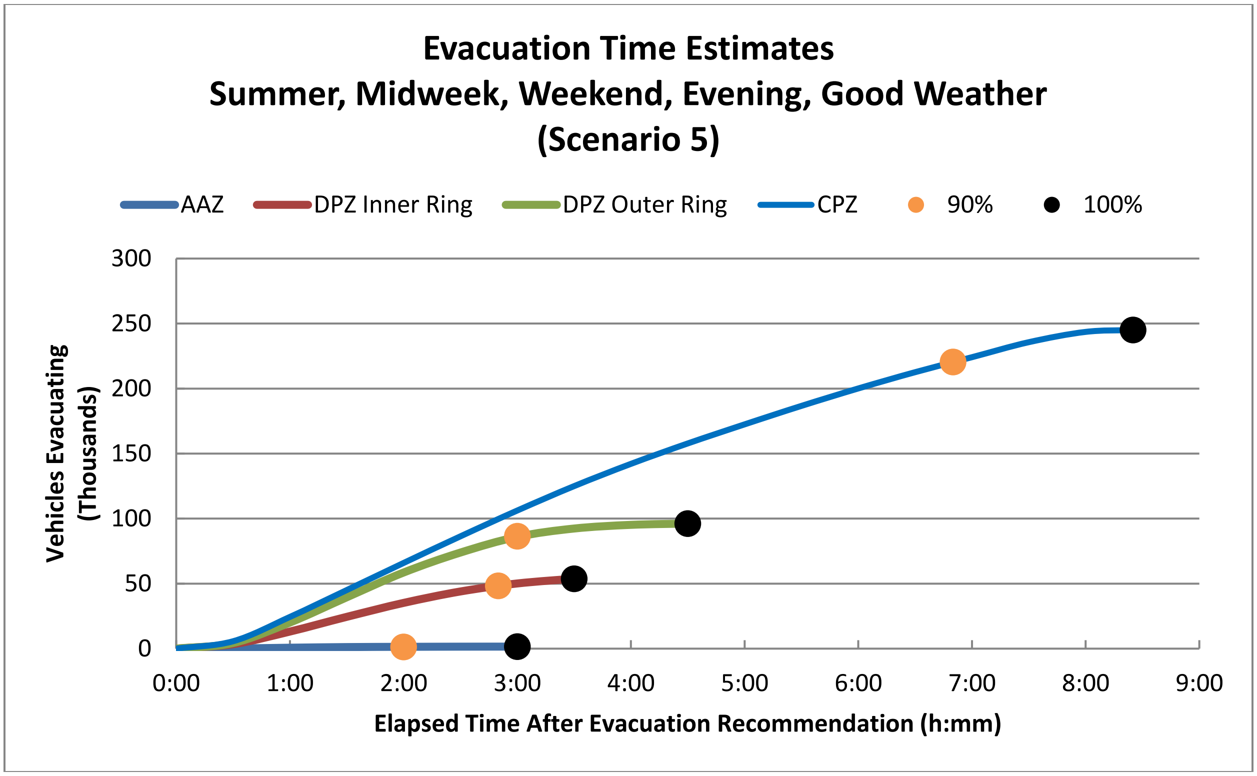



**Figure 7-23. Evacuation Time Estimates - Scenario 5 for Region R03 and R04**

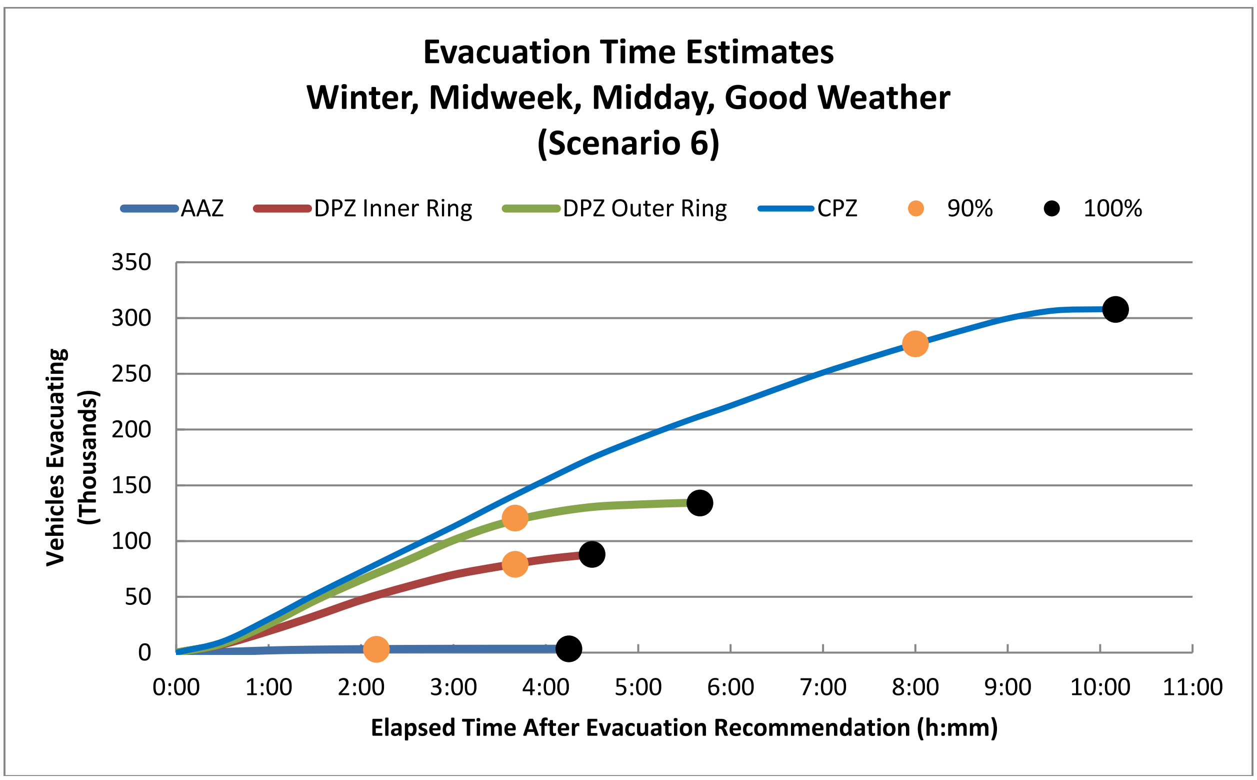



**Figure 7-24. Evacuation Time Estimates - Scenario 6 for Region R03 and R04**

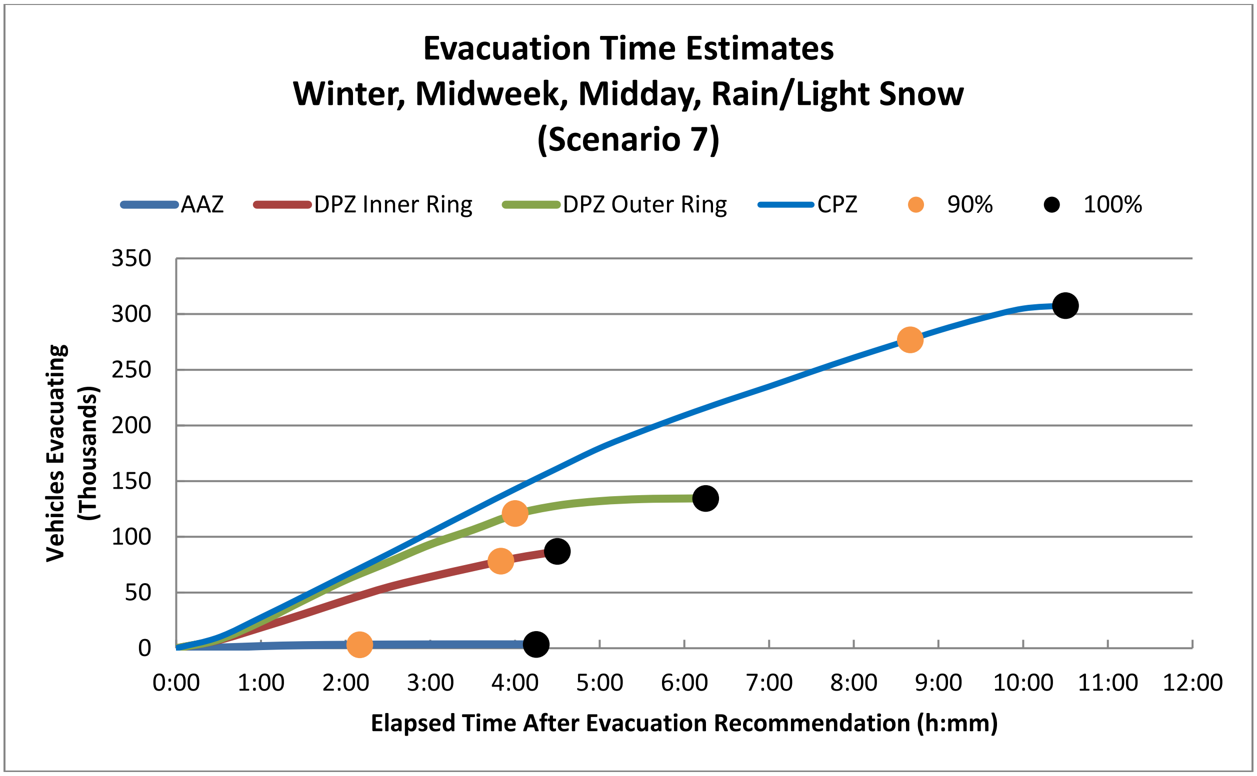



**Figure 7-25. Evacuation Time Estimates - Scenario 7 for Region R03 and R04**

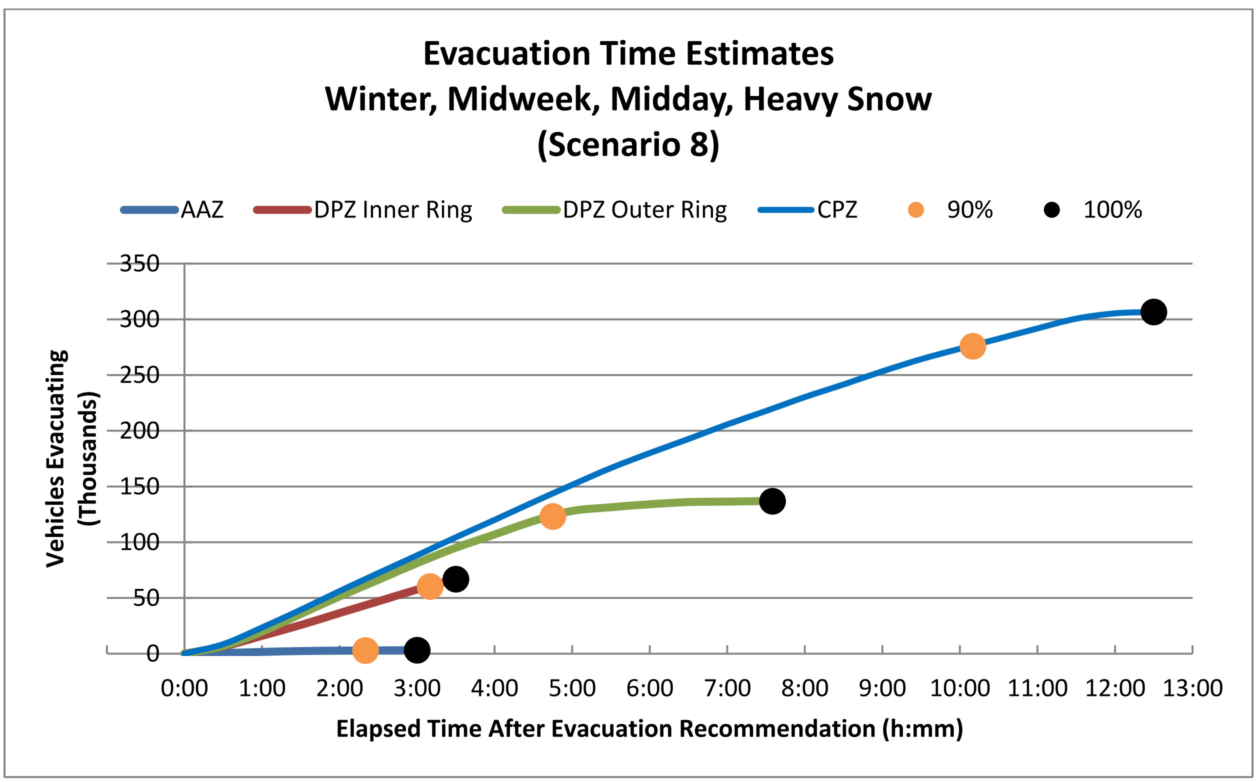



**Figure 7-26. Evacuation Time Estimates - Scenario 8 for Region R03 and R04**

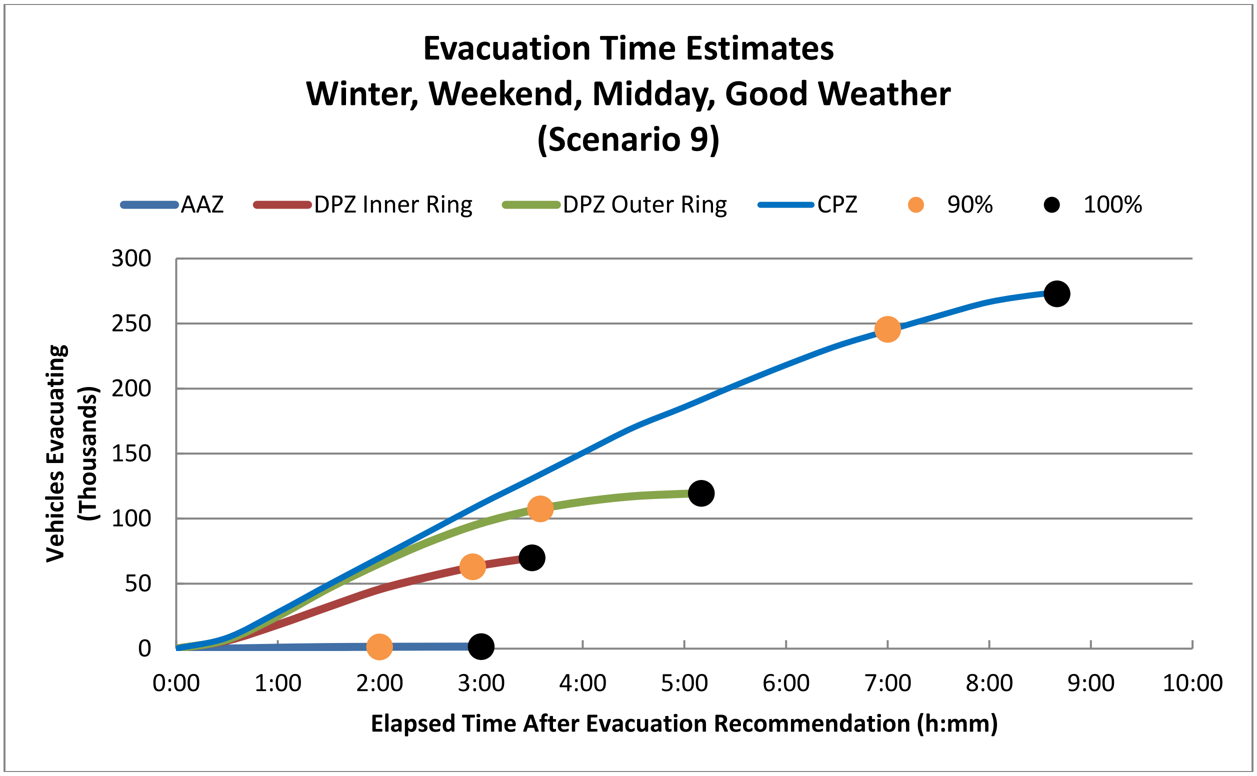



**Figure 7-27. Evacuation Time Estimates - Scenario 9 for Region R03 and R04**

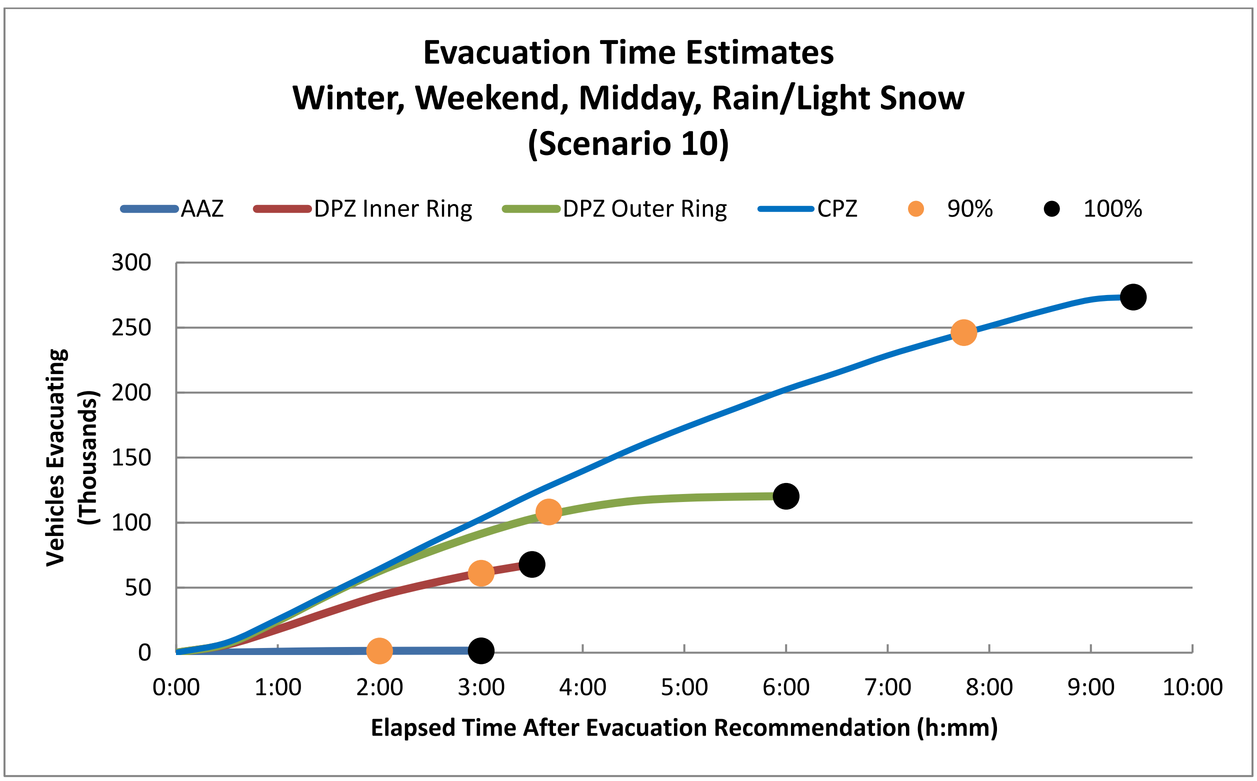



**Figure 7-28. Evacuation Time Estimates - Scenario 10 for Region R03 and R04**

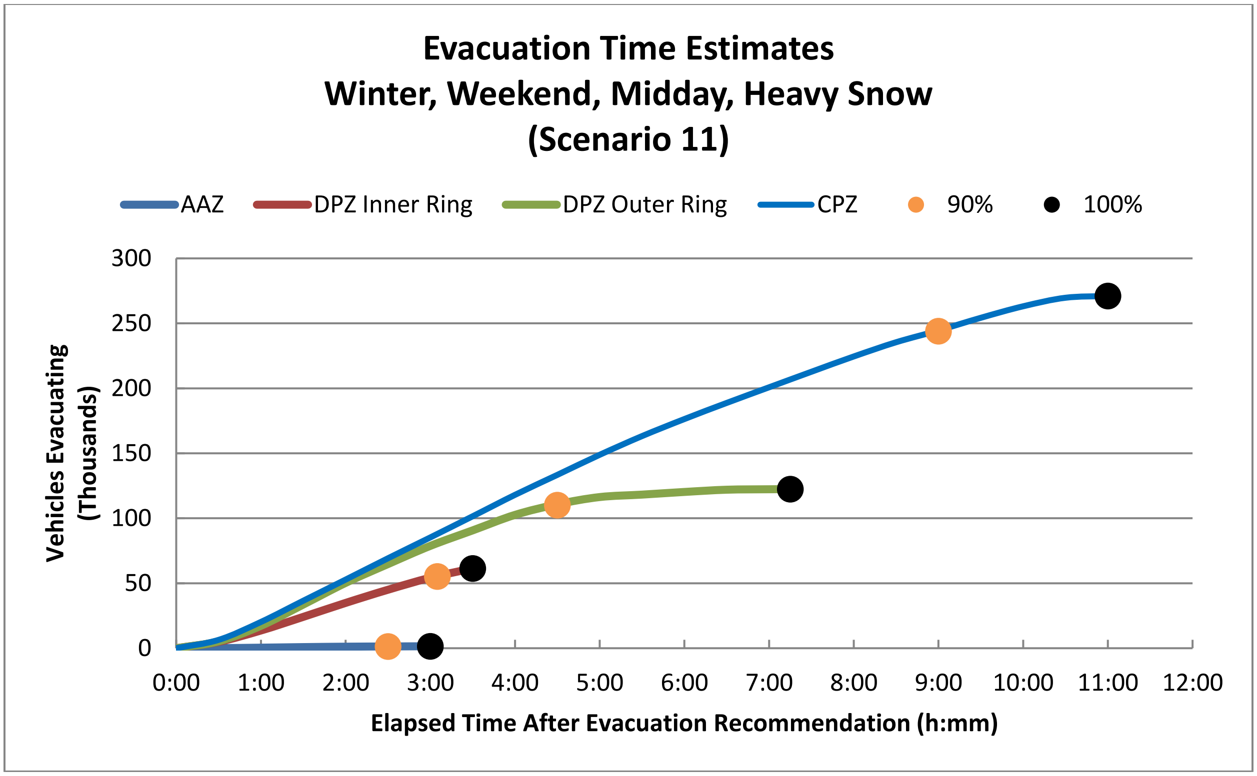



**Figure 7-29. Evacuation Time Estimates - Scenario 11 for Region R03 and R04**

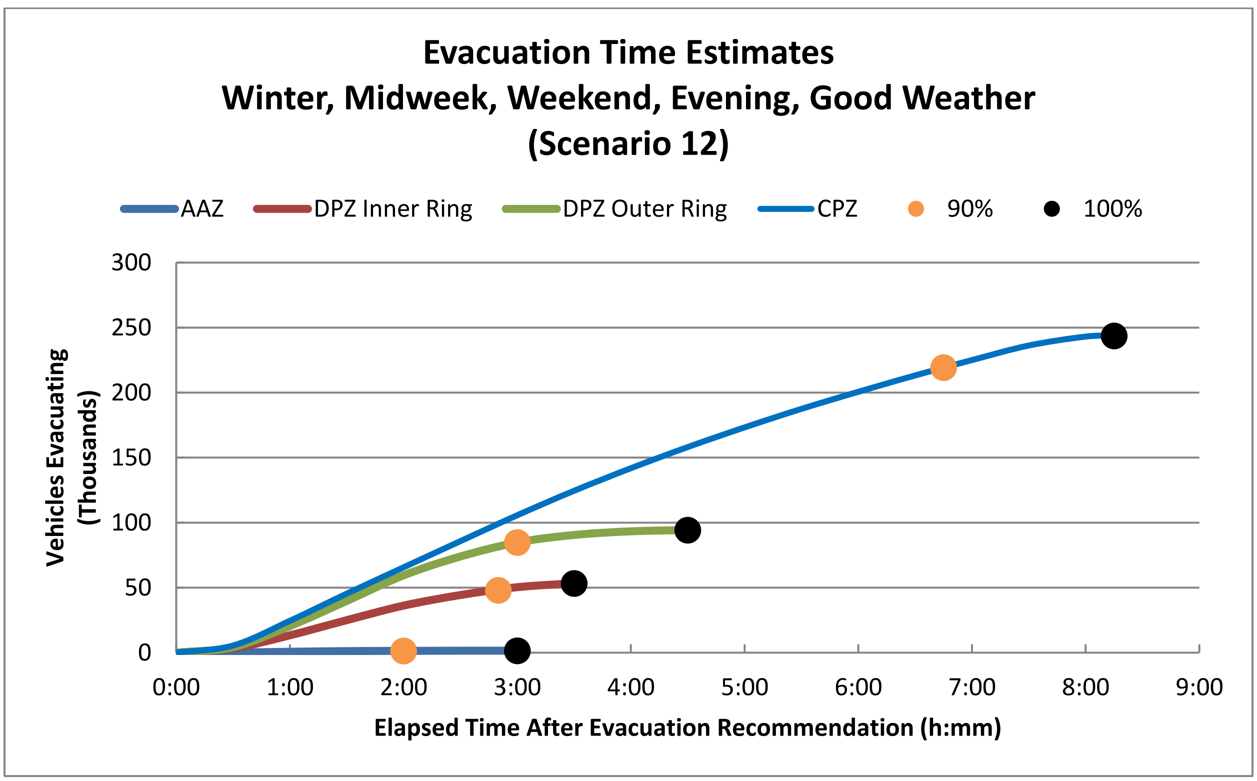



**Figure 7-30. Evacuation Time Estimates - Scenario 12 for Region R03 and R04**

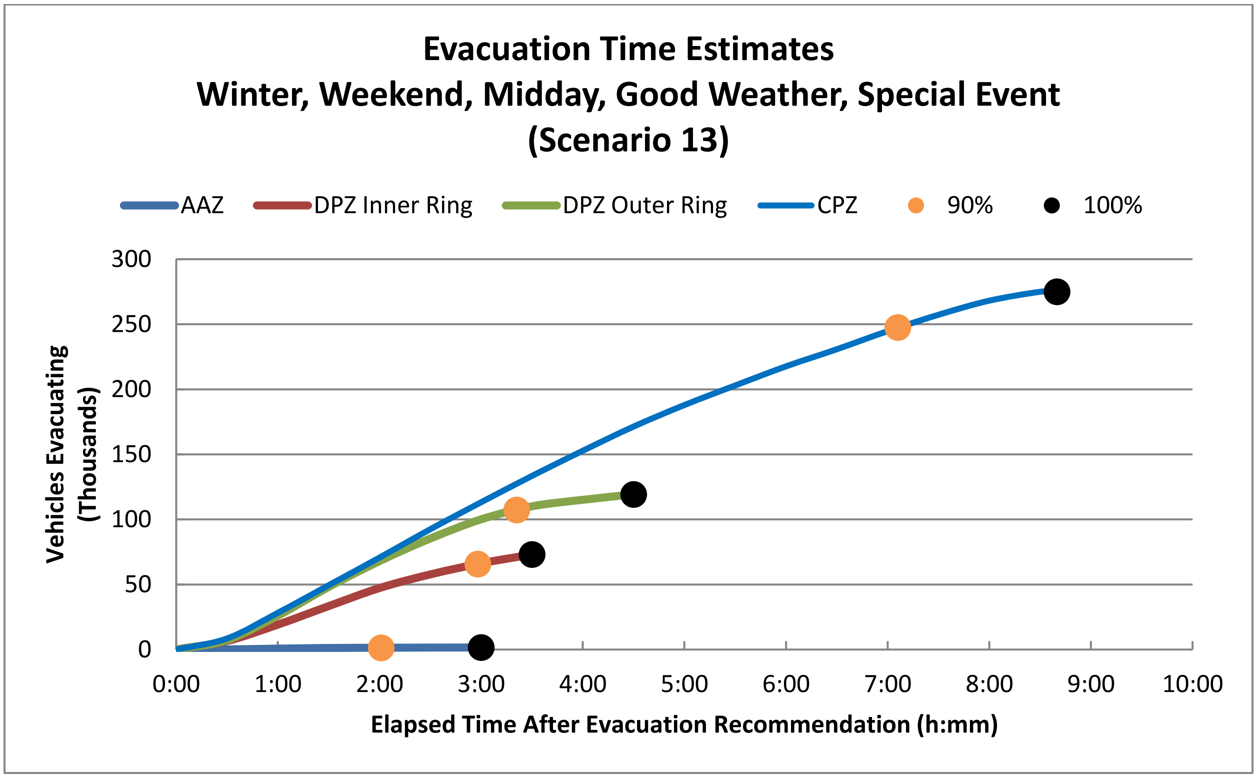



**Figure 7-31. Evacuation Time Estimates - Scenario 13 for Region R03 and R04**

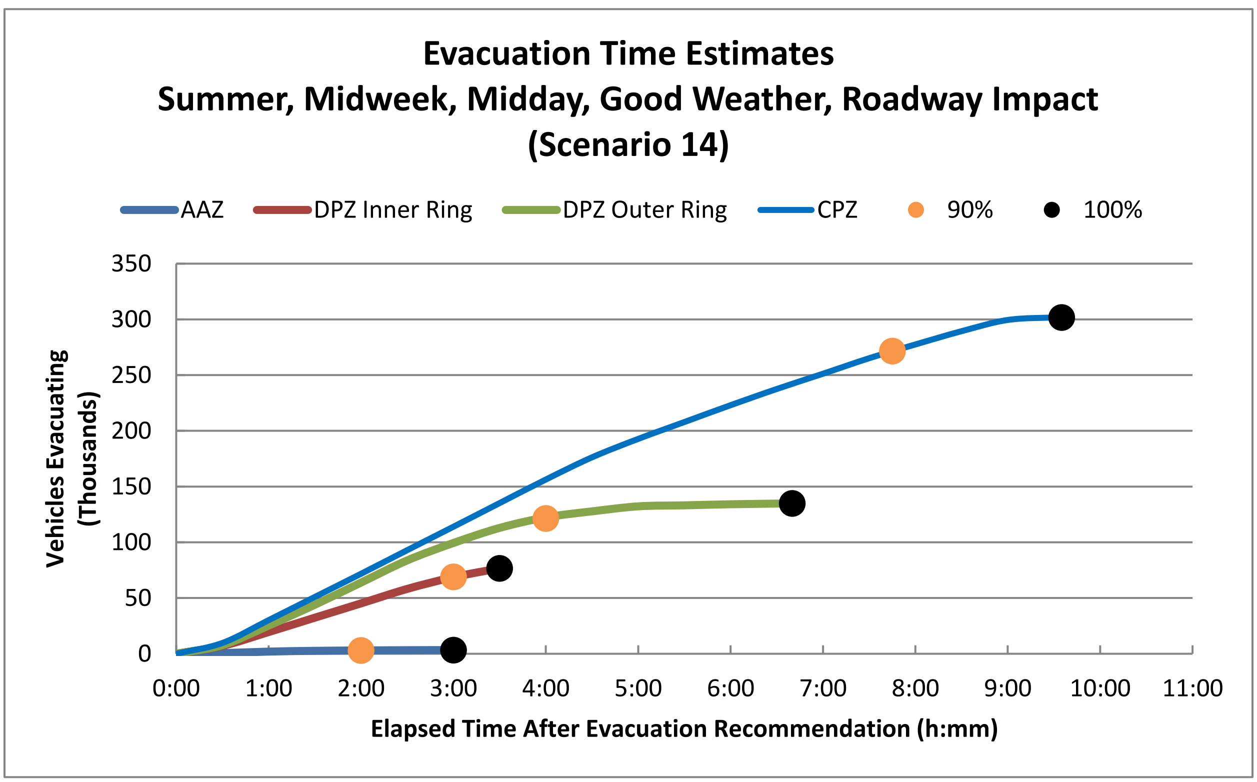



**Figure 7-32. Evacuation Time Estimates - Scenario 14 for Region R03 and R04**

# 8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES

This section details the analyses applied and the results obtained in the form of evacuation time estimates for transit vehicles, buses, ambulances and wheelchair transport vehicles. The demand for transit service reflects the needs of two population groups:

- residents with no vehicles available
- residents of special facilities such as schools and medical facilities.

These transit vehicles mix with the general evacuation traffic that is comprised mostly of "passenger cars" (pc's). The presence of each transit vehicle in the evacuating traffic stream is represented within the modelling paradigm described in Appendix D as equivalent to two pc's. This equivalence factor represents the longer size and more sluggish operating characteristics of a transit vehicle, relative to those of a pc. Table 8-1 summarizes the transportation resources necessary to evacuate the transit dependent population.

Transit vehicles must be mobilized in preparation for their respective evacuation missions. Specifically:

- Bus drivers must be alerted
- They must travel to the bus depot
- They must be briefed there and assigned to a route or facility

These activities consume time. Based on discussions with the bus providers within the PZs, it is estimated that bus mobilization time will average approximately 90 minutes for schools, medical facilities, and correctional facilities and 120 minutes for transit dependent bus mobilization extending from the Emergency Bulletin to evacuate to the time when buses first arrive at the facility to be evacuated.

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents, neighbours, relatives and friends to pick up children from school prior to the arrival of buses, so that they may join their families. Virtually all studies of evacuations have concluded that this "bonding" process of uniting families is universally prevalent during emergencies and should be anticipated in the planning process. The current Durham Nuclear Emergency Response Plan indicates that school boards have their own emergency and evacuation plans and will be evacuated to prearranged Temporary Holding Centres (THCs). The guide indicates local radio and television stations will announce when and where parents can pick up their children.

As discussed in Section 2, this study assumes a rapidly progressing severe accident that requires evacuation. Therefore, it is assumed children are evacuated directly to Temporary Holding Centres (THCs). Picking up children at school could add to traffic congestion at the schools, delaying the departure of the buses evacuating schoolchildren, which may have to return in a subsequent "wave" to the PZ to evacuate the transit-dependent population. This report provides estimates of buses under the assumption that no children (except for small day care centres) will be picked up by their parents (in accordance with NUREG/CR-7002 Rev.1), to present an upper bound estimate of buses required. This study assumes that public and private schools are evacuated to THCs where they will be picked up. It is further assumed that parents will pick up their children from small day cares within the PZs before evacuating and the time to do so is included in the time needed to mobilize based on the survey results (see Section 5).

The procedure for computing transit-dependent ETE is to:

- Estimate demand for transit service (discussed in Section 3)
- Estimate time to perform all transit functions
  Estimate route travel times to the PZ boundary and to the THCs and Reception Centres (RCs)

The ETE for transit trips were developed using both good weather and adverse weather conditions. Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

## 8.1 ETEs for Schools, Transit-Dependent People, and Special Facilities

Buses that conduct the daily operations at schools within the PZs are contracted by various bus companies in the area. These resources are assigned to evacuating schoolchildren (if school is in session at the time of the Emergency Bulletin to evacuate) as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities is somewhat “inefficient”, or if there is a shortfall of available drivers, then there may be a need for some buses to return to the PZs from the THCs after completing their first evacuation trip, to complete a “second wave” of providing transport service to evacuees. For this reason, a representative ETE for the school/summer day camp population and the ETE for the transit-dependent population will be calculated for both a single wave transit evacuation and for a second wave. Of course, if the impacted Evacuation Region is other than R03 (the entire DPZ Outer Ring) or R04 (all PZs), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

The number of available transportation resources was based on information provided by the offsite agencies. Table 8-1 lists the transportation resources and transportation needs to evacuate the transit dependent and special facility population in the area. As shown in the table, there are no sufficient resources to evacuate all children at schools/summer day camps, the transit dependent population[1], and patients at medical facilities in a single wave. A representative from Durham Region indicated that Durham Regional School Board manages their own buses, and that Durham Region does not have access to that information. Hence, there could be more resources available to the area, but that information was not provided to be part of this study.

When school evacuation needs are satisfied, subsequent assignments of buses to service the remaining transit-dependent population should be sensitive to their mobilization time. Clearly, the buses should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive at the bus stops.

[1] The transit dependent population also includes the college/university students who do not have access to a vehicle.

Evacuation of Schools and Summer Day Camps

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Emergency Bulletin to evacuate until the time the buses arrive at the facility to be evacuated. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, school bus drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities. Mobilization time is slightly longer in adverse weather – 100 minutes when raining, 110 minutes when snowing heavily.

Activity: Board Passengers (C→D)

A loading time of 15 minutes (20 minutes for rain/light snow and 25 minutes for heavy snow) for school buses is assumed. See Section 2.4 and Table 2-2.

Activity: Travel to DPZ or CPZ Boundary (D→E)

The buses servicing the schools or summer day camps are ready to begin their evacuation trips at 105 minutes after the Emergency Bulletin to evacuate – 90 minutes mobilization time plus 15 minutes loading time – in good weather. The UNITES software discussed in Section 1.3 was used to define bus routes along the most likely path from a school being evacuated to the DPZ or CPZ boundary, traveling toward the appropriate THC or Reception Centre, respectively. This is done in UNITES by interactively selecting the series of nodes from the school or day camp to the PZ boundaries. Each bus route is given an identification number and is written to the DYNEV II input stream. DYNEV computes the route length and outputs the average speed for each 5-minute interval, for each bus route. Due to the large number of schools and summer day camps within the PZ, a representative route was chosen for each response sector to obtain a representative ETE for all schools or day camps in that Response Sector. The specified bus routes are documented in Table 10-2 (refer to the maps of the link-node analysis network in Appendix K for node locations). Data provided by DYNEV during the appropriate timeframe depending on the mobilization and loading times (i.e., 100 to 105 minutes after the Emergency Bulletin to evacuate for good weather) were used to compute the average speed for each route, as follows:

$$Average\ Speed\ \left(\frac{km}{hr}\right) = \left[\frac{\sum_{i=1}^{n} length\ of\ link\ i\ (km)}{\sum_{i=1}^{n}\left\{Delay\ on\ link\ i\ (min.) + \frac{length\ of\ link\ i\ (km)}{current\ speed\ on\ link\ i\ \left(\frac{km}{hr.}\right)} \times \frac{60\ min.}{1\ hr.}\right\}}\right] \times \frac{60\ min.}{1\ hr.}$$

The average speed computed (using this methodology) for the buses servicing each of the schools in the DPZ and CPZ are shown in Table 8-2 through Table 8-4 for school evacuation, which also includes summer day camps within the DPZ. These tables provide ETE for an evacuation of the DPZ (Region R03) and CPZ (Region R04) for emergency planning and contingency planning, respectively, purposes. The travel time to the DPZ and CPZ boundaries were computed for each bus using the computed average speed and the distance to the DPZ or CPZ boundary along the most likely route out of the area being evacuated. The travel time from the DPZ or CPZ boundary to the THC or Reception Centre was computed assuming an average speed of 100 kph, 90 kph, and 85 kph for good weather, rain/light snow and heavy snow, respectively. Speeds were reduced in Table 8-2 through Table 8-4 to 100 kph (90 kph for rain/light snow and 85 kph for heavy snow) for those calculated bus speeds which exceed 100 kph, as the maximum school bus speed limit for highway routes in the Durham Region is 100 kph.

Table 8-2 (good weather), Table 8-3 (rain/light snow) and Table 8-4 (heavy snow) present the following evacuation time estimates (rounded up to the nearest 5 minutes) for schools in the study area and summer day camps in the DPZ:

- The elapsed time from the Emergency Bulletin to evacuate until the bus exits the DPZ or CPZ; and
- The elapsed time until the bus reaches the THC.

The evacuation time out of the DPZ can be computed as the sum of times associated with Activities A→B→C, C→D, and D→E (For example: 90 min. + 15 min. + 17 min. = 2:05 for Schools in D2, in good weather). The average single-wave ETE, for schools and summer day camps, is 2 hours and 10 minutes (3:45 – 2:10 = 1:35) less than the 90$^{th}$ percentile ETE for evacuation of the general population in the DPZ (Region R03) and 8 hours (8:00 – 4:20 = 3:40) less for Region R04 (CPZ) under winter, midweek, midday, good weather (Scenario 6) conditions.

The evacuation time to the THC is determined by adding the time associated with Activity E→F (discussed below), to this DPZ evacuation time.

Activity: Travel to Temporary Holding Centre (E→F)

The distances from the DPZ boundary to the THC are measured using GIS software along the most likely route from the DPZ exit point to the THC. The locations of the THC are not exactly known but are noted as being outside of the DPZ. A generalized distance to the nearest city centre was used to estimate an Estimated Time of Arrival (ETA) to the THC. For a single wave evacuation, this travel time outside the DPZ does not contribute to the ETE. Assumed bus speeds of 100 kph, 90 kph, and 85 kph for good weather, rain/light snow and heavy snow, respectively, are applied for this activity for the buses servicing the school population.

Activity: Passengers Leave Bus (F→G)

A bus can empty within 5 minutes. The driver takes a 10-minute break.

Activity: Bus Returns to Route for Second Wave Evacuation (G→C →D→E)

As shown in Table 8-1, there is a shortfall of buses for evacuation of children in a single wave, if all of the PZs are evacuated at once (a highly unlikely event). As such, a second wave evacuation may be needed for some schools and summer day camps. Due to the large number of schools and summer day camps in the PZs, second wave ETE were not computed for each school/summer day camp. Rather, the following representative ETE is provided to estimate the additional time needed for a second wave evacuation of schools. Page 84 of the PNERP Implementing Plan for the DNGS, dated January 2019, states that public reception centres should be beyond the DPZ. As such, there is a chance that THCs or RCs are within the CPZ and, therefore, a second wave evacuation of schools were only computed for the DPZ. The travel time from THC back to the DPZ boundary and then back to the school/summer day camp was computed assuming an average speed of 65 kph (good weather) as buses will be traveling counter to the evacuation traffic. Time and distance are based on averages for all schools in the DPZ for good weather:

- School buses arrive at the THC at 2:35.
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to DPZ and completes second route: 21 minutes (equal to average travel time to THC for good weather) + 4 minutes (4.8 km, average distance to DPZ boundary from Table 8-2 @ 65 kph) + 20 minutes (4.8 km, average distance to DPZ boundary from Table 8-2 @ 14.24 kph, average network speed at this time) = 45 minutes.
- Loading Time: 15 minutes.
- Bus exits DPZ at time 2:35 + 0:15 + 0:45 + 0:15 = 3:50 after the Emergency Bulletin.

Given the average single wave ETE for schools (also includes summer day camps) in the DPZ is 2:10, a second wave evacuation would require an additional 1 hour and 20 minutes, on average for good weather.

*Evacuation of Transit Dependent People (Residents and College/University Students without access to a vehicle)*

A detailed computation of transit dependent resident population was done and is discussed in Section 3.7. The total number of transit dependent people per Response Sector was determined using a weighted distribution based on population. See Table 3-13 for the distribution used. A detailed computation of transit dependent college/university students was done and discussed in Section 3.6.1 and shown in Table 3-10. Buses servicing the transit-dependent evacuees will first travel along their routes, then proceed out of the DPZ or CPZ. Figure 10-2 through Figure 10-4 show the existing DRT, TTC, YRT, and GO Transit bus routes that were used in this study. It is assumed that residents will walk to and congregate at bus stops along these routes.

Activity: Mobilize Drivers (A→B→C)

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As shown in Figure 5-4 (Residents with no Commuters), a large majority (90%) of evacuees will complete their mobilization when the buses begin their routes, approximately 120 minutes after the Emergency Bulletin to evacuate. Bus mobilization times for the transit-dependent population are therefore assumed to be 120 minutes for good weather, 130 minutes for rain/light snow, and 140 minutes for heavy snow conditions.

Activity: Board Passengers (C→D)

For multiple stops along a transit route estimation of travel time must allow for the delay associated with stopping and starting at each pick-up point. The time, t, required for a bus to decelerate at a rate, "a", expressed in m/sec/sec, from a speed, "v", expressed in m/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

Where B = Dwell time to service passengers. The total distance, "s" in metres, travelled during the deceleration and acceleration activities is: $s = v^2/a$. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s, would be: s/v = v/a. Then the total delay (i.e., pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

- B = 50 seconds: a generous value for a single passenger, carrying personal items, to board per stop
- v = 40 kph = 11 m/sec
- a = 1.22 m/sec/sec, a moderate average rate

Then, P ≈ 1 minute per stop. Allowing 30 minutes pick-up time per bus run implies 30 stops per run, for good weather. It is assumed that bus acceleration and speed will be less in adverse weather; total loading time is 35 minutes per bus in rain/light snow, 40 minutes in heavy snow.

Activity: Travel to PZ Boundary (D→E)

The travel distance along the respective pick-up routes within the PZs are estimated using the UNITES software. Bus travel times within the PZs are computed using average speeds computed by DYNEV, using the aforementioned methodology that was used for school evacuation.

Table 8-5 through Table 8-7 present the transit-dependent population evacuation time estimates for each bus route calculated using the above procedures for good weather, rain/light snow and heavy snow, respectively. The ETE is only presented for the case(s) (DPZ and/or CPZ) in which a given route would be used for evacuating the transit-dependent population. The ETE for the access and/or functional needs population is also included in the ETE estimates for the transit dependent population.

For example, the ETE for bus route DRT-902 servicing Response Sectors D2, D3, and D8A (also CPZ7 when evacuating the CPZ) is computed as 120 + 20 + 30 = 2:50 (rounded up to the nearest 5-minute interval) for an evacuation of the DPZ in good weather. Here, 20 minutes is the time to travel 7.2 kilometres at 21.2 kph, the average speed output by the model for this route starting at 120 minutes.

The average good weather DPZ ETE is 3:05, as shown in Table 8-5. As such, the single wave ETE for the transit-dependent population within the DPZ is 25 minutes shorter than the average 90$^{th}$ percentile ETE for the general population of the entire DPZ (R03) for good weather (3:30), as shown in Table 7-1.

The average good weather CPZ ETE, shown in Table 8-5, is 5:45. As such, the single wave ETE for the transit-dependent population within the CPZ is shorter (1 hour 30 minutes) than the average 90$^{th}$ percentile ETE for the general population of an evacuation of all the PZs (R04) for good weather (7:15), as shown in Table 7-1.

The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers, as previously discussed.

Activity: Travel to Reception Centre (E→F)

The distances from the PZ boundaries to the Reception Centres are measured using GIS software along the most likely route from the boundary of the area being evacuated to the Reception Centre. For a one-wave evacuation, this travel time outside the area being evacuated does not contribute to the ETE. The travel time outside of the area being evacuated is included in the two-wave evacuation. Due to the number of buses that are needed to evacuate the PZ population, a two-wave ETE for buses must be considered, since it could exceed the ETE for the general population. As previously mentioned, a second wave is only computed for the DPZ as some RCs may be located within the CPZ making it impossible to compute a second wave ETE for the CPZ. Assumed bus speeds of 65 kph, 60 kph, and 55 kph for good weather, rain/light snow, and heavy snow, respectively, will be applied for buses to return to the start of their routes since they are travelling against evacuating traffic.

Activity: Passengers Leave Bus (F→G)

A bus can empty within 5 minutes. The driver takes a 10-minute break.

Activity: Bus Returns to Route for Second Wave Evacuation (G→C→D→E)

The buses assigned to return to the DPZ to perform a "second wave" evacuation of transit-dependent evacuees will be those that have already evacuated transit-dependent people who mobilized more quickly. In reality, buses will continue to transport evacuees out of the area before the first wave of buses returns for a second wave. Nonetheless, a second wave computation is provided for informational purposes. The first wave of transit-dependent people departs the bus, and the bus then returns to the DPZ, travels to its route and proceeds to pick up more transit-dependent evacuees along the route. The travel time back to the DPZ is assumed to be equal to the travel time to the Reception Centre.

The second wave ETE for bus route DRT-902 servicing Response Sectors D2, D3, and D8A is computed as follows for good weather:

- Bus arrives at Reception Centre at 3:12 in good weather (2:50 to exit DPZ + 22-minute travel time to Reception Centre).
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to DPZ and completes second route: 22 minutes (equal to travel time to Reception Centre) + 7 minutes (7.2 km @ 65 kph – travel back to start of route) + 20 minutes (7.2 km @ 21.2 kph – complete route again) = 49 minutes
- Bus completes pick-ups along route: 30 minutes.
- Bus exits PZ at time 3:12 + 0:15 + 0:49 + 0:30 = 4:50 (rounded up to nearest 5 minutes) after the Emergency Bulletin.

The ETE for the completion of the second wave for all transit-dependent bus routes are provided in Table 8-5 through Table 8-7. The average second wave evacuation of transit-dependent people is 1 hour and 20 minutes longer than the average ETE (Region R03, good weather) for the general population at the 90$^{th}$ percentile (3:30).

*Evacuation of Medical Facilities*

Activity: Mobilize Drivers (A→B→C)

As discussed in Section 2.4, it is assumed that the mobilization time for medical facilities average 90 minutes in good weather, 100 minutes in rain/light snow and 110 minutes for heavy snow. Specially trained medical support staff (working their regular shift) will be on site to assist in the evacuation of patients. Additional staff (if needed) could be mobilized over this same 90-minute timeframe.

Activity: Board Passengers (C→D)

Item 5 of Section 2.4 discusses transit vehicle loading times for medical facilities. Loading times are assumed to be at least 1 minute per ambulatory passenger, 45 minutes to load wheelchair vans (assumed 12 minutes per wheelchair bound passenger), and 60 minutes to load ambulances. It is assumed loading times are used for all types of weather as the loading times of these patients are already considered conservative. Item 3 of Section 2.4 discusses transit vehicle capacities to cap loading times per vehicle type.

Activity: Travel to PZ Boundary (D→E)

Table 8-8 through Table 8-10 summarize the ETE for medical facilities within the PZs for good weather, rain/light snow, and heavy snow, respectfully. Average speeds output by the model for Scenario 6 (Scenario 7 for rain/light snow and Scenario 8 for heavy snow) Region R03, capped at 100 kph (90 kph for rain/light snow and 85 kph for heavy snow), are used to compute travel time to DPZ or CPZ boundary. The travel time to the DPZ or CPZ boundary is computed by dividing the distance to the DPZ or CPZ boundary by the average travel speed for an evacuation of the DPZ or CPZ, respectively. The ETE is the sum of the mobilization time, total passenger loading time, and travel time out of the area being evacuated. Concurrent loading on multiple buses, wheelchair vans, and ambulances at capacity is assumed such that the maximum loading times for buses, wheelchair vans and ambulances are 30, 48, and 60 minutes, respectively. All ETE are rounded up to the nearest 5 minutes. For example, the calculation of ETE for the Medical Faculties in D2 with 114 ambulatory residents during an evacuation of the DPZ in good weather is:

ETE: 90 + (30 x 1) + 25 = 145 min. or 2:25 (rounded up to the nearest 5 minutes)

It is assumed that medical facility population is directly evacuated to the appropriate medical Reception Centres outside of the area being evacuated. Relocation of this population to permanent facilities and/or passing through the Reception Centre before arriving at the host facility is not considered in this analysis.

The average single wave DPZ ETE for medical facilities within the DPZs is 50 minutes less than the general population ETE for Regions R03 (for all good weather), respectively, at the $90^{th}$ percentile (3:30), shown in Table 7-1.

The average single wave CPZ ETE for medical facilities within the DPZs is 3 hours and 15 minutes shorter (4:05) than the general population ETE for Regions R04 (for all good weather), respectively, at the $90^{th}$ percentile (7:15), shown in Table 7-1.

Due to uncertainty of host medical facilities, or medical facility reception centres, a second wave ETE was not considered or computed.

**Table 8-1. Summary of Transportation Resources**

| Transportation Resource | Buses | Wheelchair Vans | Ambulances |
|---|---|---|---|
| **Resources Available** | | | |
| **Durham Region Transit** | 160 | 20 | 0 |
| **Ambulances** | 0 | 0 | 31 |
| **TOTAL:** | **160** | **20** | **31** |
| **DPZ Resources Needed** | | | |
| **Schools and Summer Day Camps (Table 3-9, and Table 3-11):** | 377 | 0 | 0 |
| **Medical Facilities (Table 3-8):** | 24 | 21 | 15 |
| **Transit-Dependent Population (Table 10-1):** | 55 | 0 | 0 |
| **DPZ TRANSPORTATION NEEDS:** | **456** | **21** | **15** |
| **CPZ Resources Needed** | | | |
| **Schools[2] (Table 3-9, Section 3.6.2):** | 680 | 0 | 0 |
| **Medical Facilities (Table 3-8):** | 82 | 333 | 343 |
| **Transit-Dependent Population[3] (Table 3-10 and Table 10-1):** | 254 | 0 | 0 |
| **CPZ TRANSPORTATION NEEDS:** | **1,016** | **333** | **343** |
| **TOTAL TRANSPORTATION NEEDS:** | **1,472** | **354** | **358** |

[2] It is assumed that parents will pick up children at summer day camps within the CPZ prior to evacuation. As such, no transit vehicles are considered.

[3] Transit Dependent Population also includes the students at colleges/universities who do not have access to a passenger vehicle in CPZ7.

**Table 8-2. School and Summer Day Camp[4] Evacuation Time Estimates - Good Weather**

| Response Sector | Representative School by Response Sector | Driver Mobilization Time (min) | Loading Time (min) | Dist. To DPZ Bdry (km) | Dist. To CPZ Bdry (km) | Average Speed (DPZ Evac) (kph) | Average Speed (CPZ Evac) (kph) | Travel Time to DPZ Bdry (min) | Travel Time to CPZ Bdry (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Dist. DPZ Bdry to THC (km) | Dist. CPZ Bdry to THC (km) | Travel Time from DPZ Bdry to THC (min) | Travel Time from CPZ Bdry to THC (min) | DPZ ETE to THC (hr:min) | CPZ ETE to THC (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Schools in D2 | 90 | 15 | 7.1 | 18.2 | 24.4 | 4.3 | 17 | 253 | **2:05** | **6:00** | 23.7 | 11.6 | 14 | 7 | **2:20** | **6:10** |
| D3 | Schools in D3 | 90 | 15 | 8.5 | 18.1 | 22.1 | 32.9 | 23 | 33 | **2:10** | **2:20** | 62.1 | 71.1 | 37 | 43 | **2:50** | **3:05** |
| D4 | Schools in D4 | 90 | 15 | 5.8 | 17.4 | 14.5 | 14.1 | 24 | 74 | **2:10** | **3:00** | 51.8 | 51.3 | 31 | 31 | **2:45** | **3:35** |
| D5 | Schools in D5 | 90 | 15 | 7.9 | 17.5 | 21.2 | 34.0 | 22 | 31 | **2:10** | **2:20** | 62.1 | 71.1 | 37 | 43 | **2:50** | **3:05** |
| D6B | Schools in D6B | 90 | 15 | 3.8 | 13.6 | 4.8 | 5.3 | 47 | 153 | **2:35** | **4:20** | 20.2 | 19.3 | 12 | 12 | **2:50** | **4:35** |
| D7 | Schools in D7 | 90 | 15 | 0.8 | 12.1 | 10.6 | 5.2 | 5 | 140 | **1:50** | **4:05** | 21.5 | 19.3 | 13 | 12 | **2:05** | **4:20** |
| D8A | Schools in D8A | 90 | 15 | 3.3 | 14.6 | 5.9 | 5.2 | 33 | 168 | **2:20** | **4:35** | 25.1 | 19.3 | 15 | 12 | **2:35** | **4:50** |
| D8B | Schools in D8B | 90 | 15 | 3.4 | 14.6 | 39.0 | 3.6 | 5 | 244 | **1:50** | **5:50** | 23.7 | 13.6 | 14 | 8 | **2:05** | **6:00** |
| D10 | Schools in D10 | 90 | 15 | 2.5 | 13.7 | 9.3 | 3.3 | 16 | 253 | **2:05** | **6:00** | 29.9 | 16.4 | 18 | 10 | **2:25** | **6:10** |
| | | | | | | | | | **Maximum for DPZ:** | **2:35** | **6:00** | | | | **Maximum:** | **2:50** | **6:10** |
| | | | | | | | | | **Average for DPZ:** | **2:10** | **4:20** | | | | **Average:** | **2:35** | **4:40** |
| CPZ1 | Schools in CPZ1 | 90 | 15 | | 6.2 | | 21.9 | | 17 | | **2:05** | | 48.0 | | 29.0 | | **2:35** |
| CPZ2 | Schools in CPZ2 | 90 | 15 | | 7.7 | | 15.5 | | 30 | | **2:15** | | 51.3 | | 31.0 | | **2:50** |
| CPZ6 | Schools in CPZ6 | 90 | 15 | N/A | 2.7 | N/A | 25.5 | N/A | 6 | **N/A** | **1:55** | N/A | 10.7 | N/A | 6.0 | **N/A** | **2:05** |
| CPZ7 | Schools in CPZ7 | 90 | 15 | | 10.9 | | 3.4 | | 191 | | **5:00** | | 11.6 | | 7.0 | | **5:10** |
| CPZ8 | Schools in CPZ8 | 90 | 15 | | 9.6 | | 4.9 | | 117 | | **3:45** | | 23.3 | | 14.0 | | **4:00** |
| | | | | | | | | | **Maximum for PZ:** | **N/A** | **6:00** | | | | **Maximum:** | **N/A** | **6:10** |
| | | | | | | | | | **Average for PZ:** | | **3:50** | | | | **Average:** | | **4:10** |

[4] Schools in this table also includes students at summer day camps within the DPZ portion of the PZ.

**Table 8-3. School and Summer Day Camp[5] Evacuation Time Estimates – Rain/Light Snow**

| Response Sector | Representative School by Response Sector | Driver Mobilization Time (min) | Loading Time (min) | Dist. To DPZ Bdry (km) | Dist. To CPZ Bdry (km) | Average Speed (DPZ Evac) (kph) | Average Speed (CPZ Evac) (kph) | Travel Time to DPZ Bdry (min) | Travel Time to CPZ Bdry (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Dist. DPZ Bdry to THC (km) | Dist. CPZ Bdry to THC (km) | Travel Time from DPZ Bdry to THC (min) | Travel Time from CPZ Bdry to THC (min) | DPZ ETE to THC (hr:min) | CPZ ETE to THC (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Schools in D2 | 100 | 20 | 7.1 | 18.2 | 15.7 | 3.9 | 27 | 282 | **2:30** | **6:45** | 4.2 | 11.6 | 3 | 8 | **2:35** | **6:55** |
| D3 | Schools in D3 | 100 | 20 | 8.5 | 18.1 | 12.5 | 12.8 | 41 | 85 | **2:45** | **3:25** | 41.3 | 71.1 | 28 | 47 | **3:15** | **4:15** |
| D4 | Schools in D4 | 100 | 20 | 5.8 | 17.4 | 14.0 | 11.8 | 25 | 89 | **2:25** | **3:30** | 40.6 | 51.3 | 27 | 34 | **2:55** | **4:05** |
| D5 | Schools in D5 | 100 | 20 | 7.9 | 17.5 | 20.4 | 17.7 | 23 | 59 | **2:25** | **3:00** | 41.5 | 71.1 | 28 | 47 | **2:55** | **3:50** |
| D6B | Schools in D6B | 100 | 20 | 3.8 | 13.6 | 6.8 | 4.7 | 33 | 175 | **2:35** | **4:55** | 4.7 | 19.3 | 3 | 13 | **2:40** | **5:10** |
| D7 | Schools in D7 | 100 | 20 | 0.8 | 12.1 | 6.6 | 4.8 | 7 | 151 | **2:10** | **4:35** | 5.5 | 19.3 | 4 | 13 | **2:15** | **4:50** |
| D8A | Schools in D8A | 100 | 20 | 3.3 | 14.6 | 6.0 | 4.7 | 33 | 186 | **2:35** | **5:10** | 4.5 | 19.3 | 3 | 13 | **2:40** | **5:25** |
| D8B | Schools in D8B | 100 | 20 | 3.4 | 14.6 | 17.4 | 3.3 | 12 | 269 | **2:15** | **6:30** | 4.4 | 13.6 | 3 | 9 | **2:20** | **6:40** |
| D10 | Schools in D10 | 100 | 20 | 2.5 | 13.7 | 8.5 | 3.2 | 18 | 260 | **2:20** | **6:20** | 4.1 | 16.4 | 3 | 11 | **2:25** | **6:35** |
| **Maximum for DPZ:** | | | | | | | | | | **2:45** | **6:45** | **Maximum:** | | | | **3:15** | **6:55** |
| **Average for DPZ:** | | | | | | | | | | **2:30** | **4:55** | **Average:** | | | | **2:40** | **5:20** |
| CPZ1 | Schools in CPZ1 | 100 | 20 | | 6.2 | | 30.7 | | 12 | | **2:15** | | 48.0 | | 32.0 | | **2:50** |
| CPZ2 | Schools in CPZ2 | 100 | 20 | | 7.7 | | 12.6 | | 37 | | **2:40** | | 51.3 | | 34.0 | | **3:15** |
| CPZ6 | Schools in CPZ6 | 100 | 20 | N/A | 2.7 | N/A | 16.9 | N/A | 10 | **N/A** | **2:10** | N/A | 10.7 | N/A | 7.0 | **N/A** | **2:20** |
| CPZ7 | Schools in CPZ7 | 100 | 20 | | 10.9 | | 3.2 | | 207 | | **5:30** | | 11.6 | | 8.0 | | **5:40** |
| CPZ8 | Schools in CPZ8 | 100 | 20 | | 9.6 | | 4.4 | | 132 | | **4:15** | | 23.3 | | 16.0 | | **4:35** |
| **Maximum for PZ:** | | | | | | | | | | **2:45** | **6:45** | **Maximum:** | | | | **N/A** | **6:55** |
| **Average for PZ:** | | | | | | | | | | **2:30** | **4:25** | **Average:** | | | | | **4:45** |

[5] Schools in this table also includes students at summer day camps within the DPZ portion of the PZ.

**Table 8-4. School and Summer Day Camps[6] Evacuation Time Estimates – Heavy Snow**

| Response Sector | Representative School by Response Sector | Driver Mobilization Time (min) | Loading Time (min) | Dist. To DPZ Bdry (km) | Dist. To CPZ Bdry (km) | Average Speed (DPZ Evac) (kph) | Average Speed (CPZ Evac) (kph) | Travel Time to DPZ Bdry (min) | Travel Time to CPZ Bdry (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Dist. DPZ Bdry to THC (km) | Dist. CPZ Bdry to THC (km) | Travel Time from DPZ Bdry to THC (min) | Travel Time from CPZ Bdry to THC (min) | DPZ ETE to THC (hr:min) | CPZ ETE to THC (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Schools in D2 | 110 | 25 | 7.1 | 18.2 | 22.2 | 3.4 | 19 | 323 | **2:35** | **7:40** | 4.2 | 11.6 | 3 | 9 | **2:40** | **7:50** |
| D3 | Schools in D3 | 110 | 25 | 8.5 | 18.1 | 9.9 | 10.7 | 51 | 102 | **3:10** | **4:00** | 41.3 | 71.1 | 31 | 53 | **3:45** | **4:55** |
| D4 | Schools in D4 | 110 | 25 | 5.8 | 17.4 | 10.5 | 9.0 | 33 | 116 | **2:50** | **4:15** | 40.6 | 51.3 | 30 | 38 | **3:20** | **4:55** |
| D5 | Schools in D5 | 110 | 25 | 7.9 | 17.5 | 17.3 | 15.7 | 27 | 67 | **2:45** | **3:25** | 41.5 | 71.1 | 31 | 53 | **3:20** | **4:20** |
| D6B | Schools in D6B | 110 | 25 | 3.8 | 13.6 | 6.5 | 4.2 | 35 | 196 | **2:50** | **5:35** | 4.7 | 19.3 | 4 | 14 | **2:55** | **5:50** |
| D7 | Schools in D7 | 110 | 25 | 0.8 | 12.1 | 6.0 | 4.2 | 8 | 173 | **2:25** | **5:10** | 5.5 | 19.3 | 4 | 14 | **2:30** | **5:25** |
| D8A | Schools in D8A | 110 | 25 | 3.3 | 14.6 | 5.3 | 4.2 | 37 | 209 | **2:55** | **5:45** | 4.5 | 19.3 | 3 | 14 | **3:00** | **6:00** |
| D8B | Schools in D8B | 110 | 25 | 3.4 | 14.6 | 17.4 | 2.8 | 12 | 308 | **2:30** | **7:25** | 4.4 | 13.6 | 3 | 10 | **2:35** | **7:35** |
| D10 | Schools in D10 | 110 | 25 | 2.5 | 13.7 | 7.8 | 2.5 | 19 | 327 | **2:35** | **7:45** | 4.1 | 16.4 | 3 | 12 | **2:40** | **8:00** |
| | | | | | | | | | **Maximum for DPZ:** | **3:10** | **7:45** | | | | **Maximum:** | **3:45** | **8:00** |
| | | | | | | | | | **Average for DPZ:** | **2:45** | **5:40** | | | | **Average:** | **3:00** | **6:05** |
| CPZ1 | Schools in CPZ1 | 110 | 25 | | 6.2 | | 18.7 | | 20 | | **2:35** | | 48.0 | | 36.0 | | **3:15** |
| CPZ2 | Schools in CPZ2 | 110 | 25 | | 7.7 | | 9.6 | | 48 | | **3:05** | | 51.3 | | 38.0 | | **3:45** |
| CPZ6 | Schools in CPZ6 | 110 | 25 | N/A | 2.7 | N/A | 23.0 | N/A | 7 | **N/A** | **2:25** | N/A | 10.7 | N/A | 8.0 | **N/A** | **2:35** |
| CPZ7 | Schools in CPZ7 | 110 | 25 | | 10.9 | | 2.9 | | 224 | | **6:00** | | 11.6 | | 9.0 | | **6:10** |
| CPZ8 | Schools in CPZ8 | 110 | 25 | | 9.6 | | 3.9 | | 149 | | **4:45** | | 23.3 | | 17.0 | | **5:05** |
| | | | | | | | | | **Maximum for PZ:** | **N/A** | **7:45** | | | | **Maximum:** | **N/A** | **8:00** |
| | | | | | | | | | **Average for PZ:** | | **5:00** | | | | **Average:** | | **5:25** |

[6] Schools in this table also includes students at summer day camps within the DPZ portion of the PZ.

**Table 8-5. Transit-Dependent Evacuation Time Estimates - Good Weather**

| | Single Wave | | | | | | | | | | Second Wave for DPZ Evacuation Only | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Route Number | Mobilization (min) | Route Length DPZ (km) | Route Length CPZ (km) | Speed DPZ Evac (kph) | Speed CPZ Evac (kph) | DPZ Route Travel Time (min) | CPZ Route Travel Time (min) | Pickup Time (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Distance to R. C. (km) | Travel Time to R. C. (min) | Unload (min) | Driver Rest (min) | Route Travel Time (min) | Pickup Time (min) | ETE (hr:min) |
| **DRT-902** | 120 | 7.2 | 18.9 | 21.2 | 4.7 | 20 | 240 | 30 | **2:50** | **6:30** | 23.7 | 22 | 5 | 10 | 49 | 30 | **4:50** |
| **DRT-502** | 120 | 7.0 | 19.8 | 14.2 | 22.8 | 30 | 52 | 30 | **3:00** | **3:25** | 47.8 | 44 | 5 | 10 | 80 | 30 | **5:50** |
| **DRT-901** | 120 | 4.6 | 15.7 | 5.4 | 5.0 | 51 | 187 | 30 | **3:25** | **5:40** | 20.7 | 19 | 5 | 10 | 75 | 30 | **5:45** |
| **DRT-407** | 120 | 3.9 | 16.2 | 7.7 | 5.9 | 30 | 165 | 30 | **3:00** | **5:15** | 21.4 | 20 | 5 | 10 | 54 | 30 | **5:00** |
| **DRT-410** | 120 | 4.6 | 18.1 | 16.5 | 4.1 | 17 | 265 | 30 | **2:50** | **6:55** | 38.0 | 35 | 5 | 10 | 56 | 30 | **5:10** |
| **DRT-411** | 120 | 4.5 | 17.7 | 3.0 | 4.4 | 90 | 226 | 30 | **4:00** | **6:20** | 25.3 | 23 | 5 | 10 | 117 | 30 | **7:05** |
| **DRT-423** | 120 | 6.9 | 21.5 | 29.6 | 5.8 | 14 | 134 | 30 | **2:45** | **4:45** | 19.1 | 18 | 5 | 10 | 38 | 30 | **4:30** |
| **DRT-916** | 120 | 2.5 | 16.6 | 15.4 | 4.5 | 10 | 236 | 30 | **2:40** | **6:30** | 38.0 | 35 | 5 | 10 | 47 | 30 | **4:50** |
| **DRT-403** | 120 | | 13.0 | | 8.1 | | 159 | 30 | | **5:10** | | | | | | | |
| **DRT-900** | 120 | | 11.1 | | 3.6 | | 187 | 30 | | **5:40** | | | | | | | |
| **DRT-915** | 120 | | 11.7 | | 2.5 | | 233 | 30 | | **6:25** | | | | | | | |
| **DRT-920** | 120 | | 14.7 | | 4.3 | | 174 | 30 | | **5:25** | | | | | | | |
| **DRT-409** | 120 | N/A | 12.4 | N/A | 3.0 | N/A | 254 | 30 | **N/A** | **6:45** | N/A | | | | | | |
| **DRT-319** | 120 | | 10.1 | | 2.5 | | 247 | 30 | | **6:40** | | | | | | | |
| **DRT-302A, B** | 120 | | 10.8 | | 4.3 | | 149 | 30 | | **5:00** | | | | | | | |
| **DRT-905A, B** | 120 | | 10.9 | | 3.0 | | 219 | 30 | | **6:10** | | | | | | | |
| **DRT-392** | 120 | | 10.4 | | 5.5 | | 114 | 30 | | **4:25** | | | | | | | |
| | | | | | | | | **Maximum ETE:** | **4:00** | **6:55** | | | | | | **Maximum ETE:** | **7:05** |
| | | | | | | | | **Average ETE:** | **3:05** | **5:45** | | | | | | **Average ETE:** | **5:25** |

### Table 8-6. Transit-Dependent Evacuation Time Estimates – Rain/Light Snow

| | Single Wave | | | | | | | | | | Second Wave for DPZ Evacuation Only | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Route Number | Mobilization (min) | Route Length DPZ (km) | Route Length CPZ (km) | Speed DPZ Evac (kph) | Speed CPZ Evac (kph) | DPZ Route Travel Time (min) | CPZ Route Travel Time (min) | Pickup Time (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Distance to R. C. (km) | Travel Time to R. C. (min) | Unload (min) | Driver Rest (min) | Route Travel Time (min) | Pickup Time (min) | ETE (hr:min) |
| **DRT-902** | 130 | 7.2 | 18.9 | 24.4 | 4.1 | 18 | 279 | 40 | **3:10** | **7:30** | 23.7 | 24 | 5 | 10 | 48 | 40 | **5:20** |
| **DRT-502** | 130 | 7.0 | 19.8 | 11.0 | 19.2 | 38 | 62 | 40 | **3:30** | **3:55** | 47.8 | 48 | 5 | 10 | 93 | 40 | **6:50** |
| **DRT-901** | 130 | 4.6 | 15.7 | 4.5 | 4.7 | 61 | 202 | 40 | **3:55** | **6:15** | 20.7 | 21 | 5 | 10 | 87 | 40 | **6:40** |
| **DRT-407** | 130 | 3.9 | 16.2 | 7.3 | 5.3 | 32 | 183 | 40 | **3:25** | **5:55** | 21.4 | 21 | 5 | 10 | 57 | 40 | **5:40** |
| **DRT-410** | 130 | 4.6 | 18.1 | 9.4 | 3.8 | 29 | 284 | 40 | **3:20** | **7:35** | 38.0 | 38 | 5 | 10 | 72 | 40 | **6:05** |
| **DRT-411** | 130 | 4.5 | 17.7 | 3.2 | 3.6 | 85 | 280 | 40 | **4:15** | **7:30** | 25.3 | 25 | 5 | 10 | 115 | 40 | **7:30** |
| **DRT-423** | 130 | 6.9 | 21.5 | 12.2 | 5.3 | 34 | 148 | 40 | **3:25** | **5:20** | 19.1 | 19 | 5 | 10 | 59 | 40 | **5:40** |
| **DRT-916** | 130 | 2.5 | 16.6 | 6.1 | 4.3 | 25 | 247 | 40 | **3:15** | **7:00** | 38.0 | 38 | 5 | 10 | 65 | 40 | **5:55** |
| **DRT-403** | 130 | | 13.0 | | 7.2 | | 178 | 40 | | **5:50** | | | | | | | |
| **DRT-900** | 130 | | 11.1 | | 3.3 | | 202 | 40 | | **6:15** | | | | | | | |
| **DRT-915** | 130 | | 11.7 | | 3.0 | | 237 | 40 | | **6:50** | | | | | | | |
| **DRT-920** | 130 | | 14.7 | | 4.7 | | 189 | 40 | | **6:00** | | | | | | | |
| **DRT-409** | 130 | N/A | 12.4 | N/A | 3.1 | N/A | 243 | 40 | **N/A** | **6:55** | N/A | | | | | | |
| **DRT-319** | 130 | | 10.1 | | 2.5 | | 238 | 40 | | **6:50** | | | | | | | |
| **DRT-302A, B** | 130 | | 10.8 | | 4.2 | | 153 | 40 | | **5:25** | | | | | | | |
| **DRT-905A, B** | 130 | | 10.9 | | 3.3 | | 199 | 40 | | **6:10** | | | | | | | |
| **DRT-392** | 130 | | 10.4 | | 4.7 | | 132 | 40 | | **5:05** | | | | | | | |
| | | | | | | | | **Maximum ETE:** | **4:15** | **7:35** | | | | | | **Maximum ETE:** | **7:30** |
| | | | | | | | | **Average ETE:** | **3:35** | **6:15** | | | | | | **Average ETE:** | **6:15** |

## Table 8-7. Transit Dependent Evacuation Time Estimates – Heavy Snow

| Route Number | Single Wave | | | | | | | | | | Second Wave for DPZ Evacuation Only | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mobilization (min) | Route Length DPZ (km) | Route Length CPZ (km) | Speed DPZ Evac (kph) | Speed CPZ Evac (kph) | DPZ Route Travel Time (min) | CPZ Route Travel Time (min) | Pickup Time (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) | Distance to R. C. (km) | Travel Time to R. C. (min) | Unload (min) | Driver Rest (min) | Route Travel Time (min) | Pickup Time (min) | ETE (hr:min) |
| **DRT-902** | 140 | 7.2 | 18.9 | 15.7 | 3.5 | 27 | 321 | 50 | **3:40** | **8:35** | 23.7 | 26 | 5 | 10 | 41 | 50 | **5:55** |
| **DRT-502** | 140 | 7.0 | 19.8 | 7.9 | 15.1 | 53 | 79 | 50 | **4:05** | **4:30** | 47.8 | 52 | 5 | 10 | 65 | 50 | **7:10** |
| **DRT-901** | 140 | 4.6 | 15.7 | 3.9 | 4.2 | 71 | 225 | 50 | **4:25** | **6:55** | 20.7 | 23 | 5 | 10 | 33 | 50 | **6:30** |
| **DRT-407** | 140 | 3.9 | 16.2 | 17.8 | 4.9 | 13 | 200 | 50 | **3:25** | **6:30** | 21.4 | 23 | 5 | 10 | 54 | 50 | **5:50** |
| **DRT-410** | 140 | 4.6 | 18.1 | 20.8 | 3.3 | 13 | 333 | 50 | **3:25** | **8:45** | 38.0 | 41 | 5 | 10 | 50 | 50 | **6:05** |
| **DRT-411** | 140 | 4.5 | 17.7 | 2.5 | 2.9 | 108 | 338 | 50 | **5:00** | **8:50** | 25.3 | 28 | 5 | 10 | 37 | 50 | **7:10** |
| **DRT-423** | 140 | 6.9 | 21.5 | 30.9 | 4.9 | 13 | 158 | 50 | **3:25** | **5:50** | 19.1 | 21 | 5 | 10 | 35 | 50 | **5:30** |
| **DRT-916** | 140 | 2.5 | 16.6 | 14.0 | 3.7 | 11 | 290 | 50 | **3:25** | **8:00** | 38.0 | 41 | 5 | 10 | 46 | 50 | **6:00** |
| **DRT-403** | 140 | | 13.0 | | 6.3 | | 204 | 50 | | **6:35** | | | | | | | |
| **DRT-900** | 140 | | 11.1 | | 3.0 | | 224 | 50 | | **6:55** | | | | | | | |
| **DRT-915** | 140 | | 11.7 | | 2.4 | | 290 | 50 | | **8:00** | | | | | | | |
| **DRT-920** | 140 | | 14.7 | | 4.0 | | 220 | 50 | | **6:50** | | | | | | | |
| **DRT-409** | 140 | N/A | 12.4 | N/A | 2.5 | N/A | 300 | 50 | **N/A** | **8:10** | N/A | | | | | | |
| **DRT-319** | 140 | | 10.1 | | 2.2 | | 279 | 50 | | **7:50** | | | | | | | |
| **DRT-302A, B** | 140 | | 10.8 | | 3.3 | | 197 | 50 | | **6:30** | | | | | | | |
| **DRT-905A, B** | 140 | | 10.9 | | 2.9 | | 229 | 50 | | **7:00** | | | | | | | |
| **DRT-392** | 140 | | 10.4 | | 4.0 | | 156 | 50 | | **5:50** | | | | | | | |
| | | | | | | | | **Maximum ETE:** | **5:00** | **8:50** | | | | | | **Maximum ETE:** | **7:10** |
| | | | | | | | | **Average ETE:** | **3:55** | **7:10** | | | | | | **Average ETE:** | **6:20** |

Table 8-8. Medical Facility Evacuation Time Estimates - Good Weather

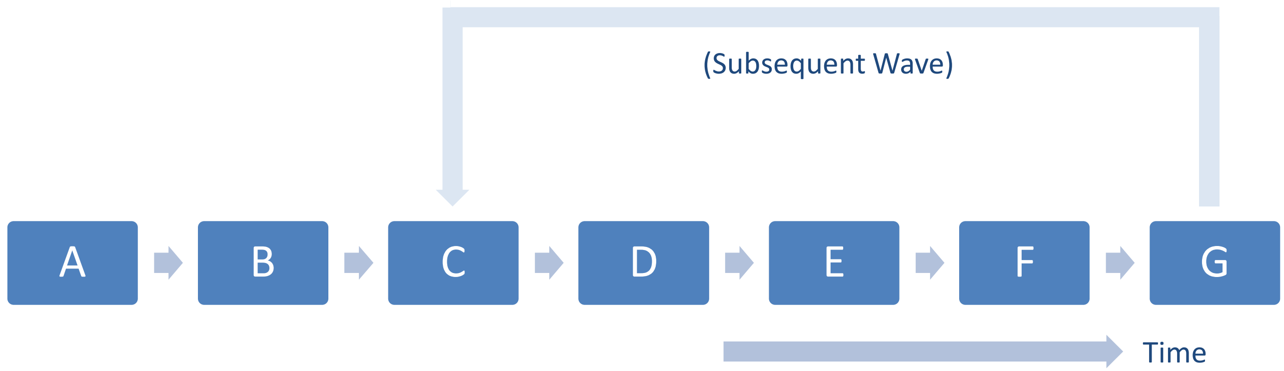
| Response Sector | Medical Facility | Patient | Mobilization (min) | Loading Rate (min per person) | People | Total Loading Time (min) | Dist. To DPZ Bdry (mi) | Dist. To CPZ Bdry (mi) | Travel Time to DPZ Boundary (min) | Travel Time to CPZ Boundary (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Medical Facilities in D2 | Ambulatory | 90 | 1 | 114 | 30 | 7.1 | 18.2 | 25 | 249 | **2:25** | **6:10** |
| D3 | Medical Facilities in D3 | Ambulatory | 90 | 1 | 84 | 30 | 8.5 | 18.1 | 22 | 29 | **2:25** | **2:30** |
| | | Wheelchair bound | 90 | 12 | 28 | 48 | 8.5 | 18.1 | 17 | 26 | **2:35** | **2:45** |
| D4 | Medical Facilities in D4 | Ambulatory | 90 | 1 | 158 | 30 | 5.8 | 17.4 | 20 | 71 | **2:20** | **3:15** |
| | | Wheelchair bound | 90 | 12 | 40 | 48 | 5.8 | 17.4 | 16 | 52 | **2:35** | **3:10** |
| | | Bedridden | 90 | 60 | 1 | 60 | 5.8 | 17.4 | 13 | 77 | **2:45** | **3:50** |
| D5 | Medical Facilities in D5 | Ambulatory | 90 | 1 | 40 | 30 | 7.9 | 17.5 | 22 | 28 | **2:25** | **2:30** |
| | | Wheelchair bound | 90 | 12 | 7 | 48 | 7.9 | 17.5 | 17 | 27 | **2:35** | **2:45** |
| | | Bedridden | 90 | 60 | 13 | 60 | 7.9 | 17.5 | 17 | 31 | **2:50** | **3:05** |
| D7 | Medical Facilities in D7 | Ambulatory | 90 | 1 | 131 | 30 | 0.8 | 12.1 | 9 | 145 | **2:10** | **4:25** |
| | | Wheelchair bound | 90 | 12 | 1 | 12 | 0.8 | 12.1 | 5 | 135 | **1:50** | **4:00** |
| D8A | Medical Facilities in D8A | Ambulatory | 90 | 1 | 69 | 30 | 3.3 | 14.6 | 72 | 172 | **3:15** | **4:55** |
| | | Wheelchair bound | 90 | 12 | 3 | 36 | 3.3 | 14.6 | 70 | 168 | **3:20** | **4:55** |
| | | Bedridden | 90 | 60 | 1 | 60 | 3.3 | 14.6 | 62 | 167 | **3:35** | **5:20** |
| D10 | Medical Facilities in D10 | Ambulatory | 90 | 1 | 9 | 9 | 2.5 | 13.7 | 16 | 265 | **1:55** | **6:05** |
| | | | | | | | | | | **Maximum ETE:** | **3:35** | **6:10** |
| | | | | | | | | | | **Average ETE:** | **2:40** | **4:00** |
| CPZ2 | Medical Facilities in CPZ2 | Ambulatory | 90 | 1 | 38 | 30 | N/A | 7.7 | N/A | 30 | **N/A** | **2:30** |
| | | Wheelchair bound | 90 | 12 | 28 | 48 | | 7.7 | | 29 | | **2:50** |
| | | Bedridden | 90 | 60 | 7 | 60 | | 7.7 | | 30 | | **3:00** |
| CPZ7 | Medical Facilities in CPZ7 | Ambulatory | 90 | 1 | 1,973 | 30 | | 10.9 | | 190 | | **5:10** |
| | | Wheelchair bound | 90 | 12 | 1,263 | 48 | | 10.9 | | 175 | | **5:15** |
| | | Bedridden | 90 | 60 | 336 | 60 | | 10.9 | | 190 | | **5:40** |
| | | | | | | | | | | **Maximum ETE:** | **N/A** | **5:40** |
| | | | | | | | | | | **Average ETE:** | | **4:05** |
| | | | | | | | | | | **Maximum ETE:** | **3:35** | **6:10** |
| | | | | | | | | | | **Average ETE:** | **2:40** | **4:05** |

**Table 8-9. Medical Facility Evacuation Time Estimates – Rain/Light Snow**

| Response Sector | Medical Facility | Patient | Mobilization (min) | Loading Rate (min per person) | People | Total Loading Time (min) | Dist. To DPZ Bdry (mi) | Dist. To CPZ Bdry (mi) | Travel Time to DPZ Boundary (min) | Travel Time to CPZ Boundary (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Medical Facilities in D2 | Ambulatory | 100 | 1 | 114 | 30 | 7.1 | 18.2 | 18 | 275 | **2:30** | **6:45** |
| D3 | Medical Facilities in D3 | Ambulatory | 100 | 1 | 84 | 30 | 8.5 | 18.1 | 63 | 85 | **3:15** | **3:35** |
| | | Wheelchair bound | 100 | 12 | 28 | 48 | 8.5 | 18.1 | 58 | 61 | **3:30** | **3:30** |
| D4 | Medical Facilities in D4 | Ambulatory | 100 | 1 | 158 | 30 | 5.8 | 17.4 | 16 | 83 | **2:30** | **3:35** |
| | | Wheelchair bound | 100 | 12 | 40 | 48 | 5.8 | 17.4 | 12 | 59 | **2:40** | **3:30** |
| | | Bedridden | 100 | 60 | 1 | 60 | 5.8 | 17.4 | 10 | 93 | **2:50** | **4:15** |
| D5 | Medical Facilities in D5 | Ambulatory | 100 | 1 | 40 | 30 | 7.9 | 17.5 | 39 | 59 | **2:50** | **3:10** |
| | | Wheelchair bound | 100 | 12 | 7 | 48 | 7.9 | 17.5 | 37 | 57 | **3:05** | **3:25** |
| | | Bedridden | 100 | 60 | 13 | 60 | 7.9 | 17.5 | 37 | 59 | **3:20** | **3:40** |
| D7 | Medical Facilities in D7 | Ambulatory | 100 | 1 | 131 | 30 | 0.8 | 12.1 | 14 | 150 | **2:25** | **4:40** |
| | | Wheelchair bound | 100 | 12 | 1 | 12 | 0.8 | 12.1 | 16 | 153 | **2:10** | **4:25** |
| D8A | Medical Facilities in D8A | Ambulatory | 100 | 1 | 69 | 30 | 3.3 | 14.6 | 69 | 185 | **3:20** | **5:15** |
| | | Wheelchair bound | 100 | 12 | 3 | 36 | 3.3 | 14.6 | 72 | 187 | **3:30** | **5:25** |
| | | Bedridden | 100 | 60 | 1 | 60 | 3.3 | 14.6 | 66 | 188 | **3:50** | **5:50** |
| D10 | Medical Facilities in D10 | Ambulatory | 100 | 1 | 9 | 9 | 2.5 | 13.7 | 26 | 269 | **2:15** | **6:20** |
| | | | | | | | | | | **Maximum ETE:** | **3:50** | **6:45** |
| | | | | | | | | | | **Average ETE:** | **3:00** | **4:30** |
| CPZ2 | Medical Facilities in CPZ2 | Ambulatory | 100 | 1 | 38 | 30 | N/A | 7.7 | N/A | 38 | **N/A** | **2:50** |
| | | Wheelchair bound | 100 | 12 | 28 | 48 | | 7.7 | | 40 | | **3:10** |
| | | Bedridden | 100 | 60 | 7 | 60 | | 7.7 | | 35 | | **3:15** |
| CPZ7 | Medical Facilities in CPZ7 | Ambulatory | 100 | 1 | 1,973 | 30 | | 10.9 | | 204 | | **5:35** |
| | | Wheelchair bound | 100 | 12 | 1,263 | 48 | | 10.9 | | 193 | | **5:45** |
| | | Bedridden | 100 | 60 | 336 | 60 | | 10.9 | | 207 | | **6:10** |
| | | | | | | | | | | **Maximum ETE:** | **N/A** | **6:10** |
| | | | | | | | | | | **Average ETE:** | | **4:30** |
| | | | | | | | | | | **Maximum ETE:** | **3:50** | **6:45** |
| | | | | | | | | | | **Average ETE:** | **3:00** | **4:30** |

**Table 8-10. Medical Facility Evacuation Time Estimates – Heavy Snow**

| Response Sector | Medical Facility | Patient | Mobilization (min) | Loading Rate (min per person) | People | Total Loading Time (min) | Dist. To DPZ Bdry (mi) | Dist. To CPZ Bdry (mi) | Travel Time to DPZ Boundary (min) | Travel Time to CPZ Boundary (min) | DPZ ETE (hr:min) | CPZ ETE (hr:min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | Medical Facilities in D2 | Ambulatory | 110 | 1 | 114 | 30 | 7.1 | 18.2 | 23 | 317 | 2:45 | 7:40 |
| D3 | Medical Facilities in D3 | Ambulatory | 110 | 1 | 84 | 30 | 8.5 | 18.1 | 78 | 99 | 3:40 | 4:00 |
| | | Wheelchair bound | 110 | 12 | 28 | 48 | 8.5 | 18.1 | 72 | 79 | 3:50 | 4:00 |
| D4 | Medical Facilities in D4 | Ambulatory | 110 | 1 | 158 | 30 | 5.8 | 17.4 | 19 | 115 | 2:40 | 4:15 |
| | | Wheelchair bound | 110 | 12 | 40 | 48 | 5.8 | 17.4 | 23 | 94 | 3:05 | 4:15 |
| | | Bedridden | 110 | 60 | 1 | 60 | 5.8 | 17.4 | 25 | 126 | 3:15 | 5:00 |
| D5 | Medical Facilities in D5 | Ambulatory | 110 | 1 | 40 | 30 | 7.9 | 17.5 | 46 | 67 | 3:10 | 3:30 |
| | | Wheelchair bound | 110 | 12 | 7 | 48 | 7.9 | 17.5 | 49 | 66 | 3:30 | 3:45 |
| | | Bedridden | 110 | 60 | 13 | 60 | 7.9 | 17.5 | 48 | 66 | 3:40 | 4:00 |
| D7 | Medical Facilities in D7 | Ambulatory | 110 | 1 | 131 | 30 | 0.8 | 12.1 | 14 | 173 | 2:35 | 5:15 |
| | | Wheelchair bound | 110 | 12 | 1 | 12 | 0.8 | 12.1 | 7 | 172 | 2:10 | 4:55 |
| D8A | Medical Facilities in D8A | Ambulatory | 110 | 1 | 69 | 30 | 3.3 | 14.6 | 73 | 209 | 3:35 | 5:50 |
| | | Wheelchair bound | 110 | 12 | 3 | 36 | 3.3 | 14.6 | 79 | 208 | 3:45 | 5:55 |
| | | Bedridden | 110 | 60 | 1 | 60 | 3.3 | 14.6 | 78 | 208 | 4:10 | 6:20 |
| D10 | Medical Facilities in D10 | Ambulatory | 110 | 1 | 9 | 9 | 2.5 | 13.7 | 28 | 332 | 2:30 | 7:35 |
| | | | | | | | | | | **Maximum ETE:** | **4:10** | **7:40** |
| | | | | | | | | | | **Average ETE:** | **3:15** | **5:05** |
| CPZ2 | Medical Facilities in CPZ2 | Ambulatory | 110 | 1 | 38 | 30 | N/A | 7.7 | N/A | 49 | N/A | 3:10 |
| | | Wheelchair bound | 110 | 12 | 28 | 48 | | 7.7 | | 51 | | 3:30 |
| | | Bedridden | 110 | 60 | 7 | 60 | | 7.7 | | 47 | | 3:40 |
| CPZ7 | Medical Facilities in CPZ7 | Ambulatory | 110 | 1 | 1,973 | 30 | | 10.9 | | 224 | | 6:05 |
| | | Wheelchair bound | 110 | 12 | 1,263 | 48 | | 10.9 | | 217 | | 6:15 |
| | | Bedridden | 110 | 60 | 336 | 60 | | 10.9 | | 224 | | 6:35 |
| | | | | | | | | | | **Maximum ETE:** | **N/A** | **6:35** |
| | | | | | | | | | | **Average ETE:** | | **4:55** |
| | | | | | | | | | | **Maximum ETE:** | **4:10** | **7:40** |
| | | | | | | | | | | **Average ETE:** | **3:15** | **5:00** |




| Event | |
|---|---|
| A | Emergency Bulletin to Evacuate |
| B | Bus Dispatched from Depot |
| C | Bus Arrives at Facility/Transit Route |
| D | Bus Departs for Reception Centre |
| E | Bus Exits PZ |
| F | Bus Arrives at Reception Centre/Temporary Holding Centre |
| G | Bus Available for "Second Wave" Evacuation Service |
| **Activity** | |
| A→B | Driver Mobilization |
| B→C | Travel to Facility or to Transit Route |
| C→D | Passengers Board the Bus |
| D→E | Bus Travels Towards PZ Boundary |
| E→F | Bus Travels Towards Reception Centre/Temporary Holding Centre Outside the PZ |
| F→G | Passengers Leave Bus; Driver Takes a Break |

**Figure 8-1. Chronology of Transit Evacuation Operations**

# 9 TRAFFIC MANAGEMENT STRATEGY

This section discusses the suggested traffic control and management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy include:

- Personnel with the capabilities of performing the planned control functions of traffic guides (preferably, not necessarily, law enforcement officers).
- Traffic Control Devices to assist these personnel in the performance of their tasks. These devices should comply with the guidance of the Ontario Traffic Manual and/or the U.S. Manual on Uniform Traffic Control Devices (U.S. MUTCD) published by the U.S. Federal Highway Administration (FHWA) of the U.S.D.O.T. All international transportation agencies have access to the U.S. MUTCD, which is available on-line: http://mutcd.fhwa.dot.gov provides access to the official PDF version.
- A plan that defines all locations, provides necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that safely expedite travel out of the PZs.
2. Discourage traffic movements that move evacuating vehicles in a direction which takes them significantly closer to the power plant, or which interferes with the efficient flow of other evacuees.

We employ the terms "facilitate" and "discourage" rather than "enforce" and "prohibit" to indicate the need for flexibility in performing the traffic control function. There are always legitimate reasons for a driver to prefer a direction other than that indicated. For example:

- A driver may be traveling home from work or from another location, to join other family members prior to evacuating.
- An evacuating driver may be travelling to pick up a relative, or other evacuees.
- The driver may be an emergency worker entering the area being evacuated to perform an important emergency service.

The implementation of a plan must also be flexible enough for the application of sound judgment by the traffic guide.

The traffic management plan is the outcome of the following process:

1. The existing Evacuation Traffic Points (TCPs) and Diversion Traffic Control Points (ACPs) identified by the offsite agencies in their emergency plans serve as the basis of the traffic management plan, as per NUREG/CR-7002 Rev 1. All TCPs listed at stop and yield signs inside Nuclear Emergency Darlington Guidebook Annex B1 Traffic Control/Sector Book were not modelled as TCPs based on discussions with emergency management personnel from Durham Region. Almost all traffic signals in Durham Region are already wired to the Traffic Management Centre (TMC). As a result, manual traffic control may not be necessary as the signals can be changed/controlled from the TMC as needed.

2. Evacuation simulations were run using DYNEV II to predict traffic congestion during evacuation (see Figures 7-3 through 7-10 for the DPZ Outer Ring [Region R03] and Figure 7-11 through 7-18 for all PZs [Region R04]).These simulations help to identify the best routing and critical intersections that experience pronounced congestion during evacuation. Any critical intersections that would benefit from TCPs or ACPs which are not already identified in the existing offsite agency plans are examined. No additional TCP or ACP locations were identified which would benefit the evacuation time estimate (ETE), as part of this study.

## 9.1 Assumptions

The following assumptions made for this study:

- The ETE calculations documented in Sections 7 and 8 assume that the TCPs (at traffic signals) and ACPs (to stop external traffic) are implemented during evacuation.
- The ETE calculations reflect the assumption that all "external-external" trips are interdicted and diverted after 4 hours have elapsed from the emergency bulletin to evacuate along the major highways traversing the PZ, as per the Ministry of Transportation of Ontario (MTO).
- All transit vehicles and other responders entering the PZs to support the evacuation are assumed to be unhindered by personnel manning ACPs. All ACPs will be manned within 4 hours, after the emergency bulletin to evacuate.
- Study assumptions 1 and 2 in Section 2.5 discuss TCP and ACP staffing schedules and operations.

## 9.2 Additional Considerations

The use of Intelligent Transportation Systems (ITS) technologies can reduce manpower and equipment needs, while still facilitating the evacuation process. Dynamic message signs (DMS) can be placed within the PZs to provide information to travelers regarding traffic conditions, route selection, and reception centre information. DMS placed outside of the PZs will warn motorists to avoid using routes that may conflict with the flow of evacuees away from the power plant. Highway Advisory Radio (HAR) can be used to broadcast information to evacuees during egress through their vehicle stereo systems. Automated Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins their trip, while the on-board navigation systems (GPS units) and smartphones can be used to provide information during the evacuation trip.

These are only several examples of how ITS technologies can benefit the evacuation process. Consideration should be given that ITS technologies be used to facilitate the evacuation process, and any additional signage placed should consider evacuation needs.

# 10 EVACUATION ROUTES AND RECEPTION CENTRES/TEMPORARY HOLDING CENTRES

Evacuation routes are comprised of two distinct components:

- Routing from a Response Sector being evacuated to the boundary of the Evacuation Region and thence out of the PZ (DPZ or CPZ).
- Routing of transit-dependent evacuees (schools, colleges/universities, summer day camps, medical facilities, employees, transients, or permanent resident who do not own or have access to private vehicles) from the PZ boundary to appropriate Reception Centres - RCs (general public) or Temporary Holding Centres - THCs (school/summer day camp population).

Evacuees will select routes within the PZ in such a way as to minimize their exposure to risk. This expectation is met by the DYNEV II model routing traffic away from the location of the plant to the extent practicable. The DTRAD model satisfies this behaviour by routing traffic so as to balance traffic demand relative to the available highway capacity to the extent possible. See Appendices B through D for further discussion.

The major evacuation routes for the PZs are presented in Figure 10-1. These routes will be used by the general population evacuating in private vehicles, and by the transit-dependent population evacuating in buses. General population may evacuate to either a Reception Centre or some alternate destination (i.e., lodging facility, relative's home, campground) outside the PZs.

It is assumed that buses will be available during an emergency at DNGS. Based on discussions with the OROs, DRT operators will dispatch buses along pre-established routes within the PZs to collect the transit-dependent population at the predesignated stops along each route. Service along these routes will be increased to accommodate the increase in demand and to facilitate the evacuation. The existing DRT bus routes that were used in this study are shown in Figure 10-2 through Figure 10-4 as well as summarized in Table 10-1. The corresponding nodes (see Appendix K) that each route traverses within the model are listed in Table 10-2.

Buses servicing the transit-dependent evacuees will first travel along their routes, then proceed out of the PZs. Transit-dependent evacuees who require monitoring and decontamination are transported to the nearest reception centre. The routing of transit-dependent evacuees from the PZ boundaries to Reception Centres utilized existing transit routes. It is assumed that residents will walk to and congregate at bus stops along these routes, and that they can arrive at these routes within the 120-minute bus mobilization time (for good weather).

Schools and summer day camps within the DPZ will be routed to THCs. Schools within the CPZ will be routed along the shortest route out of the CPZ. The routing, of the school[1], summer day camp[2] evacuees from the PZ boundaries to THCs, was designed to minimize the amount of travel outside the PZs, from the points where these routes cross the PZ boundaries.

[1] This also includes the college/university students who do not have access to a private vehicle.
[2] The students at summer day camps within the CPZ will be directly picked up by parents/guardians as such no routes were created for those facilities.

Representative routes were developed for schools, summer day camps (in the DPZ) and medical facilities within each respective Response Sector, rather than developing specific routes for each individual facility. The THC and RC locations are not specifically provided/listed, but the evacuation routes selected produce representative ETE to be used generally. It is assumed that all school and summer day camp evacuees will be taken to the appropriate THC and subsequently picked up by parents or guardians. Patients at medical facilities will be taken to the appropriate host facility.

The specified bus routes for all the transit-dependent population are documented in Table 10-2 (refer to the maps of the link-node analysis network in Appendix K for node locations). This study does not consider the transport of evacuees from reception centres to congregate care centres, if the municipalities do make the decision to relocate evacuees.

**Table 10-1. Summary of Transit-Dependent Bus Routes**

| Route | No. of Buses for DPZ | No. of Buses for CPZ | Total No. of Buses | Route Description | Services Response Sector(s) | Length to DPZ Outer Ring Boundary (km) | Length to CPZ Boundary (km) | Length to DPZ Outer Ring Boundary to R.C. (km) [3] |
|---|---|---|---|---|---|---|---|---|
| **DRT-902** | 12 | 0 | 12 | Traverses the major evacuation routes of Response Sectors D2, D3, D8A, D8B and CPZ7 | D2 | 7.2 | 18.9 | 23.7 |
| **DRT-502** | 16 | 7 | 23 | Traverses the major evacuation routes of Response Sectors D4, D12, D13, CPZ1 and CPZ2 | D4 | 7.0 | 19.8 | 47.8 |
| **DRT-901** | 6 | 0 | 6 | Traverses the major evacuation routes of Response Sectors D6A, D6B, CPZ6 and CPZ7 | D6B | 4.6 | 15.7 | 20.7 |
| **DRT-407** | 2 | 0 | 2 | Traverses the major evacuation routes of Response Sectors D7, D8A, CPZ6 and CPZ7 | D8A | 3.9 | 16.2 | 21.4 |
| **DRT-410** | 3 | 0 | 3 | Traverses the major evacuation routes of Response Sectors D8A, D8B, D9 and CPZ7 | D8B | 4.6 | 18.1 | 38.0 |
| **DRT-916** | 5 | 4 | 9 | Traverses the major evacuation routes of Response Sectors D9 and CPZ7 | D9 | 2.5 | 16.6 | 38.0 |
| **DRT-403** | 0 | 3 | 3 | Traverses the major evacuation routes of Response Sectors D6A and CPZ6 | CPZ6 | N/A | 13.0 | N/A |
| **DRT-411** | 4 | 0 | 4 | Traverses the major evacuation routes of Response Sectors D2, D8A, CPZ6, and CPZ7 | D2 | 4.5 | 17.7 | 25.3 |
| **DRT-423** | 7 | 0 | 7 | Traverses the major evacuation routes of Response Sectors D2, D8A, D8B, D9, and CPZ7 | D2/D8A | 6.9 | 21.5 | 19.1 |
| **DRT-900** | 0 | 11 | 11 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 11.1 | N/A |
| **DRT-915** | 0 | 11 | 11 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 11.7 | N/A |
| **DRT-920** | 0 | 11 | 11 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 14.7 | N/A |
| **DRT-409** | 0 | 10 | 10 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 12.4 | N/A |
| **DRT-319** | 0 | 10 | 10 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 10.1 | N/A |
| **DRT-302A, B** | 0 | 10 | 10 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 10.8 | N/A |
| **DRT-905A, B** | 0 | 10 | 10 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 10.9 | N/A |
| **DRT-392** | 0 | 10 | 10 | Traverses the major evacuation routes of Response Sector CPZ7 | CPZ7 | N/A | 10.4 | N/A |
| **Total:** | **55** | **97** | **152** | | | | | |

[3] The distance to the R.C. is measured from the DPZ boundary for routes that evacuate during an evacuation of the DPZ Outer Ring (Region R03). Since reception centers can be within in the CPZ, distances are not provided when all PZs (Region R04) evacuate.

**Table 10-2. Bus Route Descriptions**

| Bus Route Number | Description | Nodes Traversed from Route Start to PZ Boundary |
|---|---|---|
| 36 | Schools, Summer Day Camps and Medical Facilities in D2 | 1092, 1090, 3196, 366, 548, 367, 168, 167, 545, 163, 543, 393, 394, 395, 396, 503, 536, 518, 519, 520, 521, 522, 535, 523, 524, 525, 526, 19, 1158, 527, 646, 528, 1153, 534, 529, 530, 533, 531, 532, 3438, 388, 644, 888, 389, 1269, 666, 3586, 770, 1271, 1272, 1456, 1667, 1461, 1662, 3545, 1633, 1659, 1906, 3551, 1495, 1496, 1523, 1952 |
| 45 | Schools and Medical Facilities in D3 CPZ | 1204, 1203, 1202, 1075, 1074, 89, 90, 91, 92, 93, 94, 97, 303, 307, 306, 258, 257, 256, 255, 254, 184, 183, 252, 253, 473, 316, 315, 202, 475, 915, 1910, 1521, 1555 |
| 71 | Schools, Summer Day Camps and Medical Facilities in D4 CPZ | 103, 378, 562, 379, 125, 565, 568, 566, 569, 380, 381, 135, 312, 313, 314, 185, 187, 188, 382, 383, 384, 192, 1071, 195, 196, 3419, 197, 574, 576, 1220, 205, 913, 573, 1285, 1306, 1296, 1286, 1287, 1288, 1289, 1290 |
| 82 | Schools and Medical Facilities in D5 | 598, 92, 93, 94, 97, 303, 307, 306, 258, 257, 256, 255, 254, 184, 183, 252, 253, 473, 316, 315, 202, 475, 915, 1910, 1521, 1555 |
| 84 | Schools and Summer Day Camps in D6B | 1773, 705, 970, 408, 355, 405, 1017, 354, 1019, 353, 435, 428, 434, 427, 422, 423, 424, 285, 1848, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 86 | Schools and Medical Facilities in D7 | 878, 358, 980, 359, 13, 9, 7, 6, 447, 287, 443, 286, 516, 285, 1848, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 88 | Schools, Summer Day Camps, and Medical Facilities in D8A | 461, 517, 462, 460, 459, 458, 453, 454, 456, 455, 288, 3, 322, 447, 287, 443, 286, 516, 285, 1848, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 90 | Schools and Summer Day Camps in D8B | 161, 583, 584, 609, 610, 611, 608, 612, 613, 607, 614, 615, 616, 22, 617, 618, 1105, 1106, 1109, 1110, 399, 1113, 398, 1116, 397, 1119, 400, 889, 401, 1148, 766, 813, 1674, 1527, 1793, 1434, 3571, 1688, 1487, 1663, 1589, 1590, 1591, 1588, 1974 |
| 92 | Schools, Summer Day Camps and Medical Facilities in D10 | 51, 497, 753, 160, 3390, 159, 698, 357, 502, 29, 691, 361, 1023, 891, 664, 761, 3378, 762, 3375, 767, 814, 1678, 1630, 1528, 1626, 1463, 1681, 1526, 1623, 1790, 1682, 1504 |
| 93 | Schools in CPZ1 | 731, 732, 733, 238, 338, 337, 578, 1744, 1291, 1888, 1889, 1544 |
| 94 | Schools, Summer Day Camps and Medical Facilities in CPZ2 | 950, 952, 197, 574, 576, 1220, 205, 913, 573, 1285, 1306, 1296, 1286, 1287, 1288, 1289, 1290 |
| 95 | Schools and Medical Facilities in CPZ6 | 1645, 1640, 1641, 1593, 1934 |
| 96 | Schools[4], Summer Day Camps, and Medical Facilities in CPZ7 | 19, 1158, 527, 646, 528, 1153, 534, 529, 530, 533, 531, 532, 3438, 388, 644, 888, 389, 1269, 666, 3586, 770, 1271, 1272, 1456, 1667, 1461, 1662, 3545, 1633, 1659, 1906, 3551, 1495, 1496, 1523, 1952 |
| 97 | Schools and Summer Day Camps in CPZ8 | 1048, 1046, 3516, 3519, 3443, 652, 643, 3512, 1034, 894, 34, 3490, 3489, 663, 3065, 763, 1782, 3553, 765, 3499, 1390, 1771, 1732, 1565, 1566, 1414, 3454, 1563, 1415, 1416, 1417, 3453, 1418, 1847, 1567, 1844, 1420, 1513, 1846, 1421, 1845, 1422 |
| 99 | DRT 902A/902B | 53, 1855, 52, 3464, 3466, 498, 1221, 170, 169, 1093, 162, 1235, 163, 543, 393, 394, 395, 396, 503, 536, 518, 519, 520, 521, 522, 535, 523, 524, 525, 526, 19, 1158, 527, 646, 528, 1153, 534, 529, 530, 533, 531, 532, 3438, 388, 644, 888, 389, 1269, 666, 3586, 770, 1271, 1272, 1456, 1667, 1461, 1662, 3545, 1633, 1659, 1906, 3551, 1495, 1496, 1523, 1952 |
| 104 | DRT 502 | 1080, 1227, 1228, 3283, 1229, 3318, 1218, 137, 587, 247, 248, 249, 250, 736, 734, 727, 725, 251, 224, 225, 226, 1165, 477, 334, 227, 228, 229, 230, 231, 1164, 232, 233, 234, 235, 236, 2, 921, 953, 954, 955, 956, 1259, 1260, 1261, 1262, 3056, 3057 |

[4] This also includes transit-dependent college/university students.

| Bus Route Number | Description | Nodes Traversed from Route Start to PZ Boundary |
|---|---|---|
| 105 | DRT 901A/901B | 704, 445, 708, 707, 1772, 706, 1773, 705, 1226, 943, 403, 1234, 402, 444, 352, 440, 441, 3187, 442, 443, 286, 516, 285, 1848, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 107 | DRT 407 | 879, 699, 451, 1781, 452, 918, 983, 1882, 373, 685, 683, 14, 3344, 1890, 647, 1096, 450, 440, 441, 3187, 442, 443, 286, 516, 285, 1848, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 108 | DRT 410 | 372, 985, 503, 869, 608, 988, 623, 886, 934, 938, 357, 990, 853, 3067, 643, 3512, 1034, 894, 34, 3490, 3489, 663, 3065, 763, 1027, 764, 1425, 1778, 1541, 1538, 1697, 1424, 1427, 1710, 1568, 1569, 1567, 1844, 1420, 1513, 1846, 1421, 1845, 1422 |
| 109 | DRT 916 | 623, 886, 934, 938, 357, 990, 853, 3067, 643, 3512, 1034, 894, 34, 3490, 3489, 663, 3065, 763, 1782, 3553, 765, 3499, 1390, 1771, 1732, 1565, 1566, 1414, 3454, 1563, 1415, 1416, 1417, 3453, 1418, 1847, 1567, 1844, 1420, 1513, 1846, 1421, 1845, 1422 |
| 113 | DRT 403 | 408, 407, 406, 409, 410, 411, 412, 828, 800, 416, 413, 417, 418, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 117 | DRT 411 | 3203, 3165, 1860, 635, 165, 461, 517, 462, 460, 459, 458, 453, 605, 451, 1781, 452, 1737, 359, 446 |
| 118 | DRT 411 | 3203, 3165, 1860, 635, 165, 461, 517, 462, 460, 459, 458, 453, 605, 451, 1781, 452, 1737, 359, 446, 352, 353, 435, 428, 434, 427, 422, 425, 787, 788, 430, 284, 1, 421, 922, 1447, 1448, 1449, 1457, 1450, 1451, 1718, 1492, 1598 |
| 119 | DRT 423 | 164, 163, 162, 161, 583, 584, 609, 610, 611, 608, 988, 623, 886, 934, 938, 357 |
| 120 | DRT 423 | 164, 163, 162, 161, 583, 584, 609, 610, 611, 608, 988, 623, 886, 934, 938, 357, 502, 29, 691, 361, 500, 501, 892, 1712, 1021, 1030, 3507, 3066, 763, 1782, 3553, 765, 3499, 1390, 1771, 1732, 1565, 1566, 1414, 3454, 1563, 1415, 1416, 1417, 3453, 1418, 1847, 1567, 1844, 1420, 1513, 1846, 1421, 1845, 1422 |
| 121 | DRT 900 | 646, 528, 1153, 534, 529, 530, 533, 531, 532, 3438, 388, 644, 888, 389, 1269, 666, 3586, 770, 1271, 1272, 1456, 1667, 1461, 1662, 3545, 1633, 1659, 1906, 3551, 1495, 1496, 1523, 1952 |
| 122 | DRT 915 | 357, 502, 29, 691, 361, 1023, 891, 664, 761, 3378, 762, 3375, 767, 814, 1678, 1630, 1528, 1626, 1463, 1681, 1526, 1623, 1790, 1682, 1504 |
| 123 | DRT 920 | 357, 990, 853, 3067, 643, 3512, 1034, 894, 34, 3490, 3489, 663, 3065, 763, 1782, 3553, 765, 3499, 1390, 1771, 1732, 1565, 1566, 1414, 3454, 1563, 1415, 1416, 1417, 3453, 1418, 1847, 1567, 1844, 1420, 1513, 1846, 1421, 1845, 1422 |
| 124 | DRT 409 | 484, 485, 486, 487, 3568, 1169, 644, 645, 401, 3365, 3366, 928, 3582, 762, 3375, 767, 814, 1678, 1630, 1528, 1626, 1463, 1681, 1526, 1623, 1790, 1682, 1504 |
| 133 | DRT 319 | 768, 769, 1483, 666, 1725, 3478, 1439, 1437, 1436, 1441, 3578, 1527, 1622, 1532, 3560, 1833, 1528, 1626, 1463, 1681, 1526, 1623, 1790, 1682, 1504 |
| 134 | DRT 302 | 1446, 1443, 1671, 1460, 1456, 1462, 1609, 1435, 1434, 1533, 1464, 3528, 1463, 1465, 1684, 1466, 1467, 1468, 1469, 1470, 1515, 1514, 1513, 1846, 1421, 1845, 1422 |

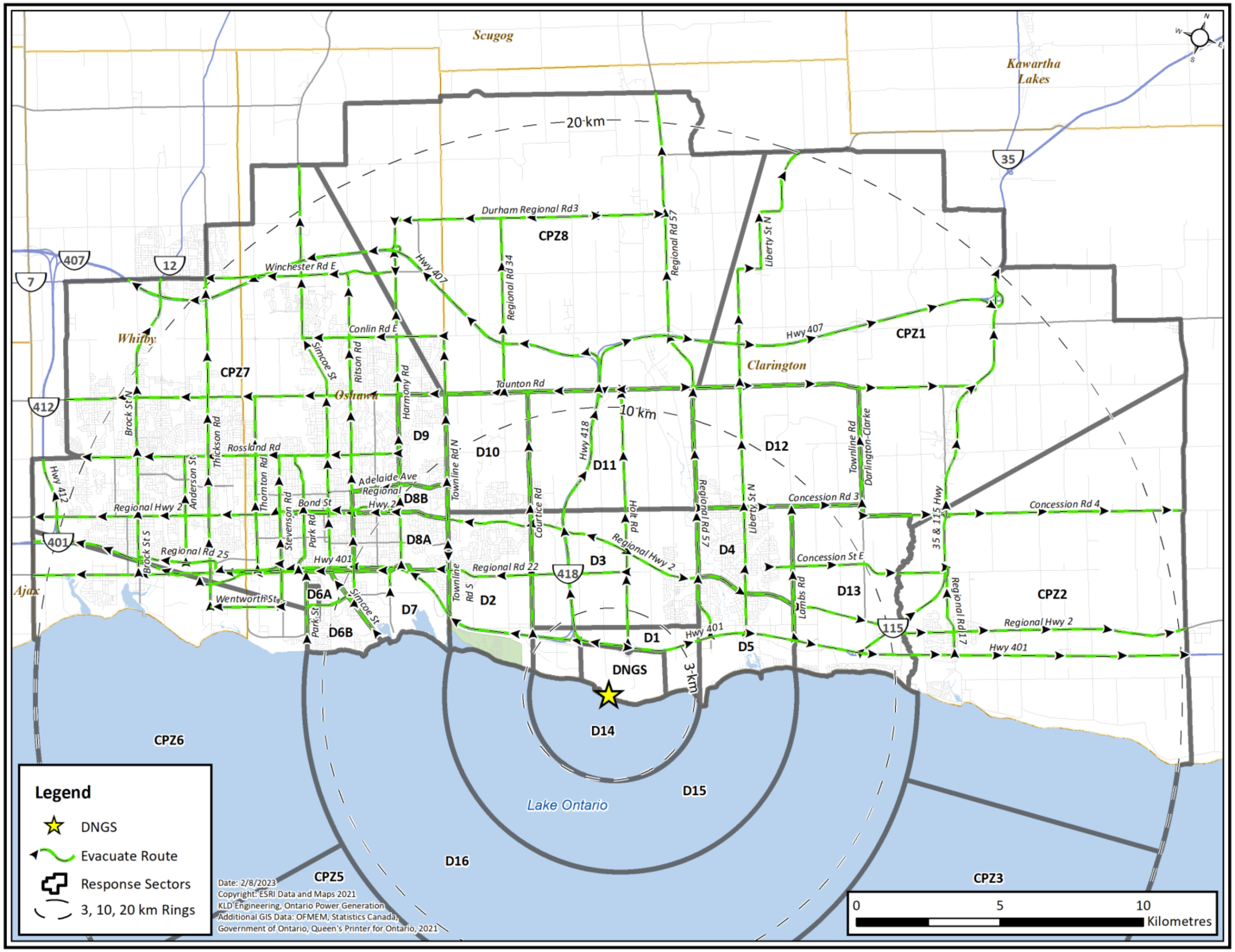



**Figure 10-1. Major Evacuation Routes**

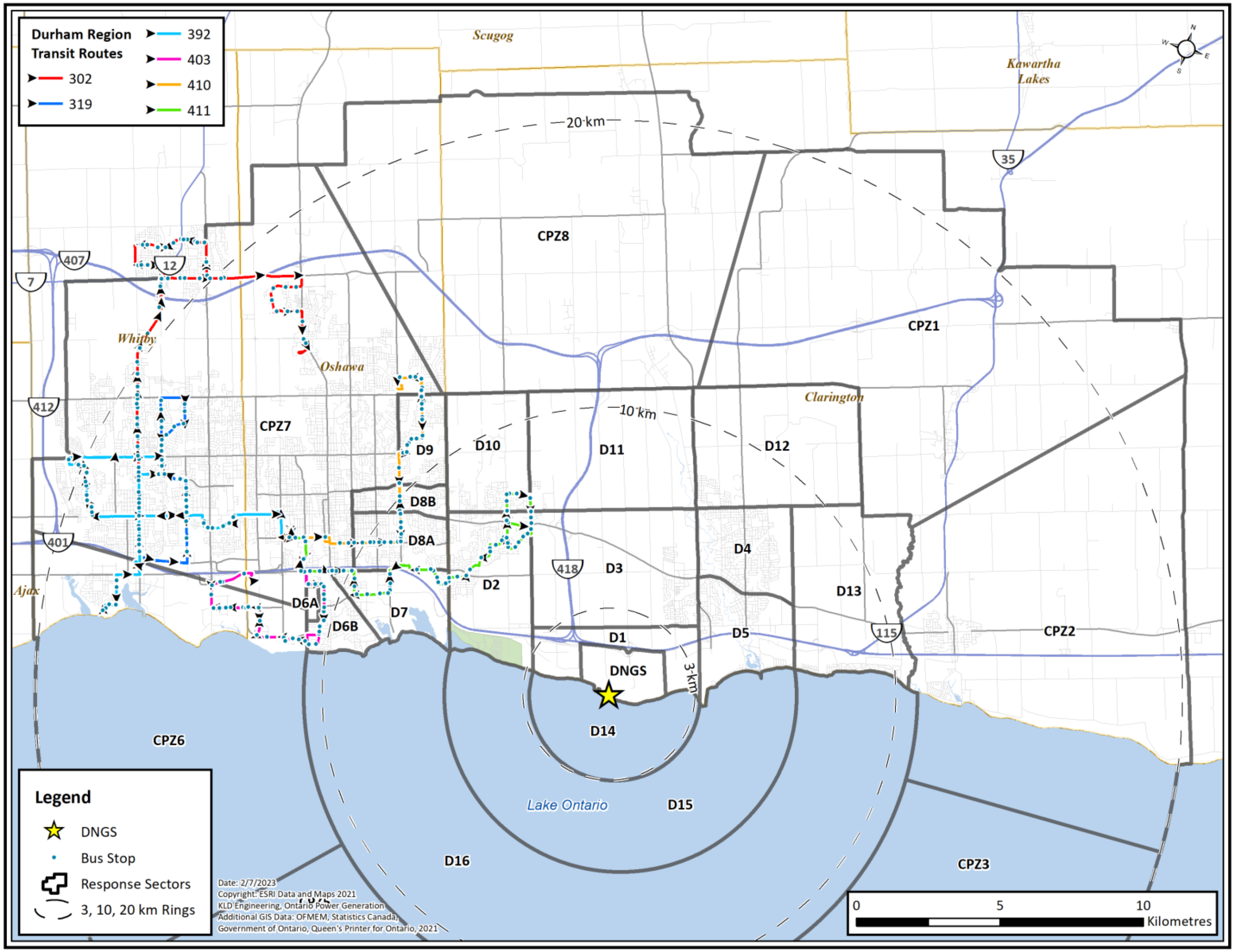



**Figure 10-2. Durham Region Transit Transit-Dependent Routes**

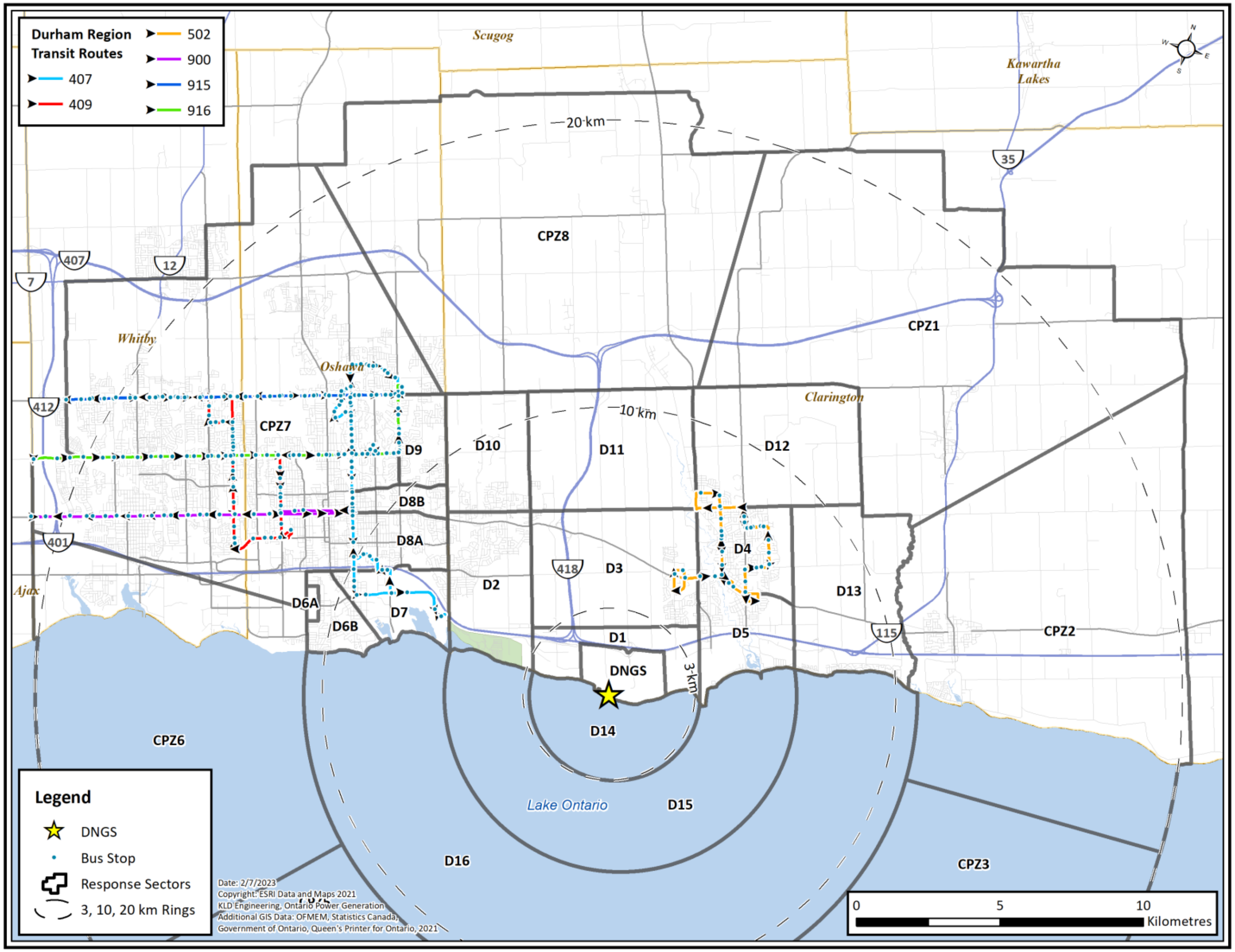



**Figure 10-3. Continued - Durham Region Transit Transit-Dependent Routes**

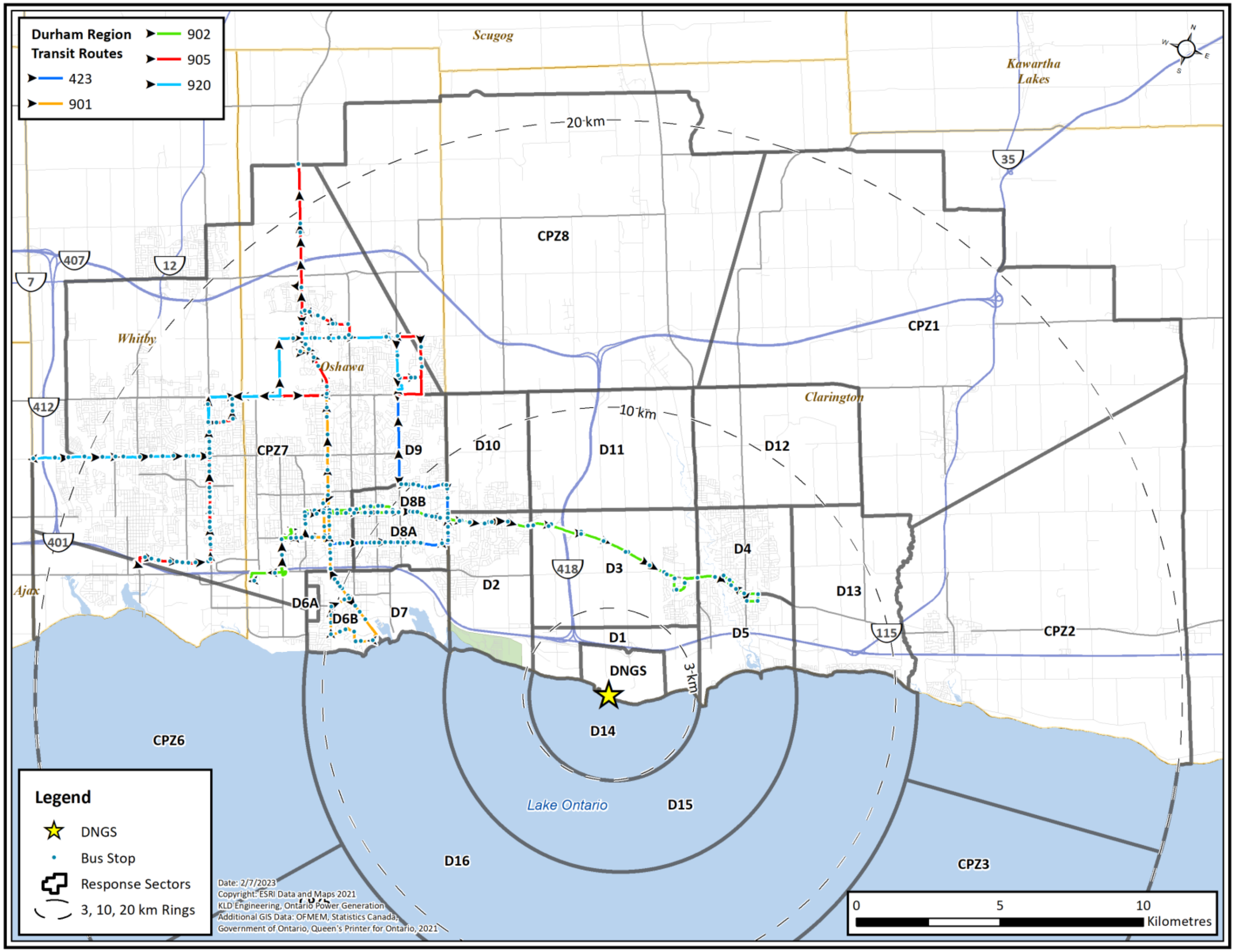



**Figure 10-4. Continued - Durham Region Transit Transit-Dependent Routes**

# APPENDIX A

Glossary of Traffic Engineering Terms

## A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

**Table A-1. Glossary of Traffic Engineering Terms**

| Term | Definition |
|---|---|
| Analysis Network | A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes. |
| Link | A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics. |
| Measures of Effectiveness | Statistics describing traffic operations on a roadway network. |
| Node | A network node generally represents an intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link. |
| Origin | A location attached to a network link, within the PZ or Shadow Region, where trips are generated at a specified rate in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations. |
| Prevailing Roadway and Traffic Conditions | Relates to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.). |
| Service Rate | Maximum rate at which vehicles, executing a specific turn manoeuvre, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps) or vph. |
| Service Volume | Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service (The Service Volume at the upper bound of Level of Service, E, equals Capacity). Service Volume is usually expressed as vph. |
| Signal Cycle Length | The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds. |
| Signal Interval | A single combination of signal indications. The interval duration is expressed in seconds. A signal phase is comprised of a sequence of signal intervals, usually green, yellow, red. |

| Term | Definition |
|---|---|
| Signal Phase | A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds. |
| Traffic (Trip) Assignment | A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time. |
| Traffic Density | The number of vehicles that occupy one lane of a roadway section of specified length at a point in time, expressed as vehicles per mile (vpm). |
| Traffic (Trip) Distribution | A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes. |
| Traffic Simulation | A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness. |
| Traffic Volume | The number of vehicles that pass over a section of roadway in one direction, expressed in vph. Where applicable, traffic volume may be stratified by turn movement. |
| Travel Mode | Distinguishes between private auto, bus, rail, pedestrian and air travel modes. |
| Trip Table or Origin-Destination Matrix | A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vph or in vehicles. |
| Turning Capacity | The capacity associated with that component of the traffic stream which executes a specified turn manoeuvre from an approach at an intersection. |

# APPENDIX B

DTRAD: Dynamic Traffic Assignment and Distribution Model

# B. DYNAMIC TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

This appendix describes the integrated dynamic trip assignment and distribution model named DTRAD (Dynamic TRaffic Assignment and Distribution) that is expressly designed for use in analyzing evacuation scenarios. DTRAD employs logit-based path-choice principles and is one of the models of the DYNEV II System. The DTRAD module implements path-based *Dynamic Traffic Assignment* (DTA) so that time dependent Origin-Destination (O-D) trips are "assigned" to routes over the network based on prevailing traffic conditions.

To apply the DYNEV II System, the analyst must specify the highway network, link capacity information, the time-varying volume of traffic generated at all origin centroids and, optionally, a set of accessible candidate destination nodes on the periphery of the Planning Zone (PZ) for selected origins. DTRAD calculates the optimal dynamic trip distribution (i.e., trip destinations) and the optimal dynamic trip assignment (i.e., trip routing) of the traffic generated at each origin node traveling to its set of candidate destination nodes, so as to minimize evacuee travel "cost."

## B.1 Overview of Integrated Distribution and Assignment Model

The underlying premise is that the selection of destinations and routes is intrinsically coupled in an evacuation scenario. That is, people in vehicles seek to travel out of an area of potential risk as rapidly as possible by selecting the "best" routes. The model is designed to identify these "best" routes in a manner that realistically distributes vehicles from origins to destinations and routes them over the highway network, in a consistent and optimal manner, reflecting evacuee behaviour.

For each origin, a set of "candidate destination nodes" is selected by the software logic and by the analyst to reflect the desire by evacuees to travel away from the power plant and to access major highways. The specific destination nodes within this set that are selected by travelers and the selection of the connecting paths of travel, are both determined by DTRAD. This determination is made by a logit-based path choice model in DTRAD, so as to minimize the trip "cost", as discussed later.

The traffic loading on the network and the consequent operational traffic environment of the network (density, speed, throughput on each link) vary over time as the evacuation takes place. The DTRAD model, which is interfaced with the DYNEV simulation model, executes a succession of "sessions" wherein it computes the optimal routing and selection of destination nodes for the conditions that exist at that time.

## B.2 Interfacing the DYNEV Simulation Model with DTRAD

The DYNEV II system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. An algorithm was developed to support the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next. Another algorithm executes a "mapping" from the specified "geometric" network (link-node analysis network) that represents the physical highway system, to a "path" network that represents the vehicle [turn] movements. DTRAD computations are performed on the "path" network: DYNEV simulation model, on the "geometric" network.

### B.2.1 DTRAD Description

DTRAD is the DTA module for the DYNEV II System.

When the road network under study is large, multiple routing options are usually available between trip origins and destinations. The problem of loading traffic demands and propagating them over the network links is called Network Loading and is addressed by DYNEV II using macroscopic traffic simulation modelling. Traffic assignment deals with computing the distribution of the traffic over the road network for given O-D demands and is a model of the route choice of the drivers. Travel demand changes significantly over time, and the road network may have time dependent characteristics, e.g., time-varying signal timing or reduced road capacity because of lane closure, or traffic congestion. To consider these time dependencies, DTA procedures are required.

The DTRAD DTA module represents the dynamic route choice behaviour of drivers, using the specification of dynamic origin-destination matrices as flow input. Drivers choose their routes through the network based on the travel cost they experience (as determined by the simulation model). This allows traffic to be distributed over the network according to the time-dependent conditions. The modelling principles of DTRAD include:

- It is assumed that drivers not only select the best route (i.e., lowest cost path) but some also select less attractive routes. The algorithm implemented by DTRAD archives several "efficient" routes for each O-D pair from which the drivers choose.
- The choice of one route out of a set of possible routes is an outcome of "discrete choice modelling". Given a set of routes and their generalized costs, the percentages of drivers that choose each route is computed. The most prevalent model for discrete choice modelling is the logit model. DTRAD uses a variant of Path-Size-Logit model (PSL). PSL overcomes the drawback of the traditional multinomial logit model by incorporating an additional deterministic path size correction term to address path overlapping in the random utility expression.

- DTRAD executes the traffic assignment (TA) algorithm on an abstract network representation called "the path network" which is built from the actual physical link-node analysis network. This execution continues until a stable situation is reached: the volumes and travel times on the edges of the path network do not change significantly from one iteration to the next. The criteria for this convergence are defined by the user.
- Travel “cost” plays a crucial role in route choice. In DTRAD, path cost is a linear summation of the generalized cost of each link that comprises the path. The generalized cost for a link, a, is expressed as

$$c_a = \alpha t_a + \beta l_a + \gamma s_{a,}$$

  where $c_a$is the generalized cost for link $a$ and $\alpha$, $\beta$, and, $\gamma$ are cost coefficients for link travel time, distance, and supplemental cost, respectively. Distance and supplemental costs are defined as invariant properties of the network model, while travel time is a dynamic property dictated by prevailing traffic conditions. The DYNEV simulation model computes travel times on all edges in the network and DTRAD uses that information to constantly update the costs of paths. The route choice decision model in the next simulation iteration uses these updated values to adjust the route choice behaviour. This way, traffic demands are dynamically re-assigned based on time dependent conditions. The interaction between the DTRAD traffic assignment and DYNEV II simulation models is depicted in Figure B-1. Each round of interaction is called a Traffic Assignment Session (TA session). A TA session is composed of multiple iterations, marked as loop B in the figure.
- The supplemental cost is based on the “survival distribution” (a variation of the exponential distribution).The Inverse Survival Function is a “cost” term in DTRAD to represent the potential risk of travel toward the plant:

  $s_a = - \beta \ln (p), 0 \leq p \leq l ; \beta > 0$

  $p = \frac{d_n}{d_0}$

  $d_n$ = Distance of node, n, from the plant
  $d_0$ =Distance from the plant where there is zero risk
  β = Scaling factor

  The value of $d_o$ = 20 kilometres, the outer distance of the Contingency Planning Zone (CPZ). Note that the supplemental cost, $s_{a,}$ of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

### B.2.2 Network Equilibrium

In 1952, John Wardrop wrote:

> *Under equilibrium conditions traffic arranges itself in congested networks in such a way that no individual trip-maker can reduce his path costs by switching routes.*

The above statement describes the "User Equilibrium" definition, also called the "Selfish Driver Equilibrium". It is a hypothesis that represents a [hopeful] condition that evolves over time as drivers search out alternative routes to identify those routes that minimize their respective "costs". It has been found that this "equilibrium" objective to minimize costs is largely realized by most drivers who routinely take the same trip over the same network at the same time (i.e., commuters). Effectively, such drivers "learn" which routes are best for them over time. Thus, the traffic environment "settles down" to a near-equilibrium state.

Clearly, since an emergency evacuation is a sudden, unique event, it does not constitute a long-term learning experience which can achieve an equilibrium state. Consequently, DTRAD was not designed as an equilibrium solution, but to represent drivers in a new and unfamiliar situation, who respond in a flexible manner to real-time information (either broadcast or observed) in such a way as to minimize their respective costs of travel.

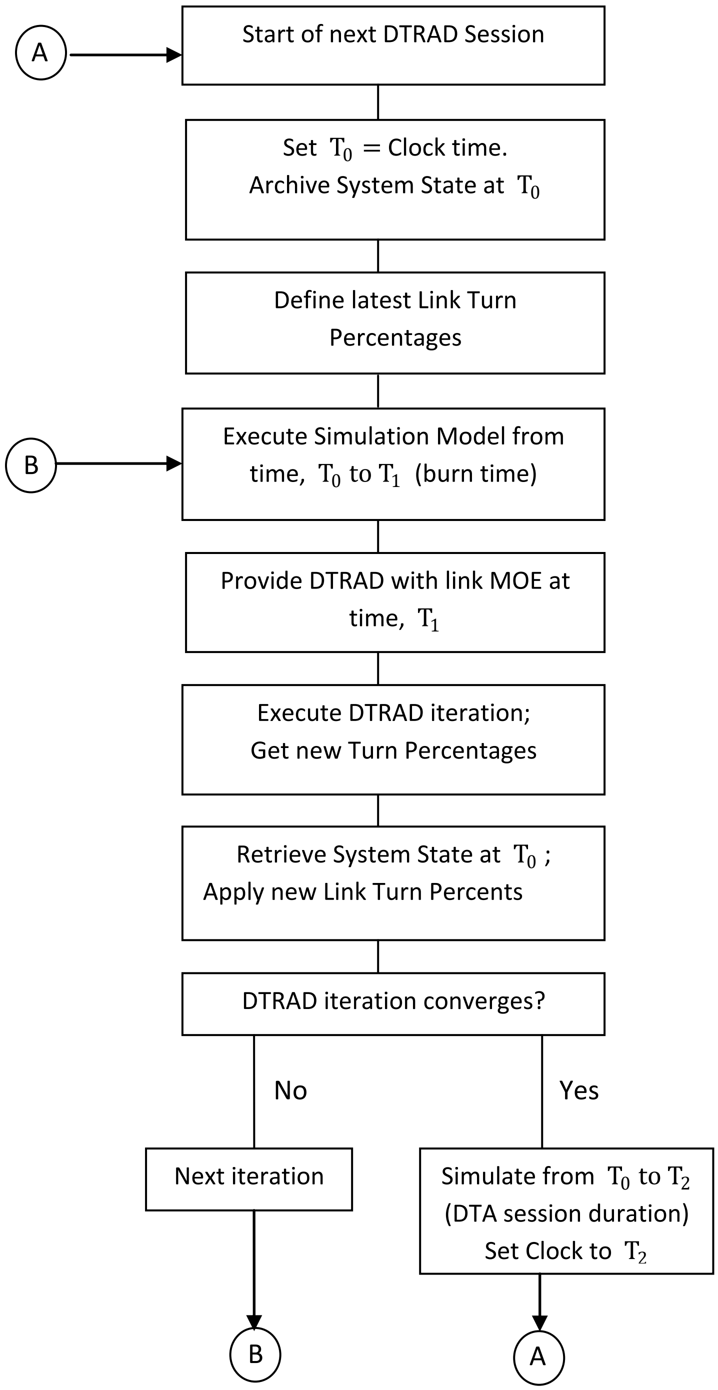



**Figure B-1. Flow Diagram of Simulation-DTRAD Interface**

# APPENDIX C

DYNEV Traffic Simulation Model

# C. DYNEV TRAFFIC SIMULATION MODEL

This appendix describes the DYNEV traffic simulation model. The DYNEV traffic simulation model is a *macroscopic* model that describes the operations of traffic flow in terms of aggregate variables: vehicles, flow rate, mean speed, volume, density, and queue length, *on each link*, for each turn movement, during each Time Interval (simulation time step). The model generates trips from "sources" and from Entry Links and introduces them onto the analysis network at rates specified by the analyst based on the mobilization time distributions. The model simulates the movements of all vehicles on all network links over time until the network is empty. At intervals, the model outputs Measures of Effectiveness (MOE) such as those listed in Table C-1.

Model Features Include:

- Explicit consideration is taken of the variation in density over the time step; an iterative procedure is employed to calculate an average density over the simulation time step for the purpose of computing a mean speed for moving vehicles.
- Multiple turn movements can be serviced on one link; a separate algorithm is used to estimate the number of (fractional) lanes assigned to the vehicles performing each turn movement, based, in part, on the turn percentages provided by the Dynamic TRaffic Assignment and Distribution (DTRAD) model.
- At any point in time, traffic flow on a link is subdivided into two classifications: queued and moving vehicles. The number of vehicles in each classification is computed. Vehicle spillback, stratified by turn movement for each network link, is explicitly considered and quantified. The propagation of stopping waves from link to link is computed within each time step of the simulation. There is no "vertical stacking" of queues on a link.
- Any link can accommodate "source flow" from zones via side streets and parking facilities that are not explicitly represented. This flow represents the evacuating trips that are generated at the source.
- The relation between the number of vehicles occupying the link and its storage capacity is monitored every time step for every link and for every turn movement. If the available storage capacity on a link is exceeded by the demand for service, then the simulator applies a "metering" rate to the entering traffic from both the upstream feeders and source node to ensure that the available storage capacity is not exceeded.
- A "path network" that represents the specified traffic movements from each network link is constructed by the model; this path network is utilized by the DTRAD model.
- A two-way interface with DTRAD: (1) provides link travel times; (2) receives data that translates into link turn percentages.
- Provides MOE to animation software, EVacuation Animator (EVAN).
- Calculates Evacuation Time Estimates (ETE) statistics.

All traffic simulation models are data intensive. Table C-2 outlines the necessary input data elements.

Please note the model uses US customary units so all data was converted from metric to US customary units for input to the model. All model outputs were then converted from US customary units to metric for analysis and reporting in this document.

To provide an efficient framework for defining these specifications, the physical highway environment is represented as a network. The unidirectional links of the network represent roadway sections: rural, multi-lane, urban streets or freeways. The nodes of the network generally represent intersections or points along a section where a geometric property changes (e.g., a lane drop, change in grade or free flow speed).

Figure C-1 is an example of a small network representation. The freeway is defined by the sequence of links, (20, 21), (21, 22), and (22, 23). Links (8001, 19) and (3, 8011) are Entry and Exit links, respectively. An arterial extends from node 3 to node 19 and is partially subsumed within a grid network. Note that links (21, 22) and (17, 19) are grade-separated.

## C.1 Methodology

### C.1.1 The Fundamental Diagram

It is necessary to define the fundamental diagram describing flow-density and speed-density relationships. Rather than "settling for" a triangular representation, a more realistic representation that includes a "capacity drop", (I-R)$Q_{max}$, at the critical density when flow conditions enter the forced flow regime, is developed and calibrated for each link. This representation, shown in Figure C-2, asserts a constant free speed up to a density, $k_f$, and then a linear reduction in speed in the range, $k_f \leq k \leq k_c = 45$ vpm, the density at capacity. In the flow-density plane, a quadratic relationship is prescribed in the range, $k_c < k \leq k_s = 95$ vpm which roughly represents the "stop-and-go" condition of severe congestion. The value of flow rate, $Q_s$, corresponding to $k_s$, is approximated at $0.7\, RQ_{max}$. A linear relationship between $k_s$ and $k_j$ completes the diagram shown in Figure C-2. Table C-3 is a glossary of terms.

The fundamental diagram is applied to <u>moving</u> traffic on every link. The specified calibration values for each link are: (1) Free speed, $v_f$ ; (2) Capacity, $Q_{max}$ ; (3) Critical density, $k_c = 45$ vpm ; (4) Capacity Drop Factor, R = 0.9 ; (5) Jam density, $k_j$ .

Then, $v_c = \frac{Q_{max}}{k_c}$ , $k_f = k_c - \frac{(V_f - V_c)\, k_c^2}{Q_{max}}$. Setting $\bar{k} = k - k_c$ , then $Q = RQ_{max} - \frac{RQ_{max}}{8333}\, \bar{k}^2$ for $0 \leq \bar{k} \leq \bar{k}_s = 50$ . It can be shown that $Q = \left(0.98 - 0.0056\, \bar{k}\right) RQ_{max}$ for $\bar{k}_s \leq \bar{k} \leq \bar{k}_j$, where $\bar{k}_s = 50$ and $\bar{k}_j = 175$.

### C.1.2 The Simulation Model

The simulation model solves a sequence of "unit problems". Each unit problem computes the movement of traffic on a link, for each specified turn movement, over a specified time interval (TI) which serves as the simulation time step for all links. Figure C-3 is a representation of the unit problem in the time-distance plane. Table C-3 is a glossary of terms that are referenced in the following description of the unit problem procedure.

The formulation and the associated logic presented below are designed to solve the unit problem for each sweep over the network (discussed below), for each turn movement serviced on each link that comprises the evacuation network, and for each TI over the duration of the evacuation.

Given= $Q_b$ , $M_b$ , L , TI , $E_0$ , LN , $G/C$ , h , $L_v$ , $R_0$ , $L_c$ , E , M

Compute=O , $Q_e$ , $M_e$

Define $O=O_Q+O_M+O_E$ ; $E=E_1+E_2$

1. For the first sweep, s = 1, of this TI, get initial estimates of mean density, $k_0$ , the R – factor, $R_0$ and entering traffic, $E_0$ , using the values computed for the final sweep of the prior TI. For each subsequent sweep, $s>1$ , calculate $E=\sum_i P_i\ O_i+S$ where $P_i$ , $O_i$ are the relevant turn percentages from feeder link, i, and its total outflow (possibly metered) over this TI; S is the total source flow (possibly metered) during the current TI.
   Set iteration counter, n = 0, $k=k_0$ , and $E=E_0$ .

2. Calculate $v(k)$ such that $k \le 130$ using the analytical representations of the fundamental diagram.
   Calculate $Cap=\frac{Q_{max}(TI)}{3600}\left(G/C\right) LN$ , in vehicles, this value may be reduced due to metering
   Set R=1.0 if $G/C<1$ or if $k \le k_c$ ; Set R=0.9 only if $G/C=1$ and $k>k_c$
   Calculate queue length, $L_b=Q_b\ \frac{L_v}{LN}$

3. Calculate $t_1=TI-\frac{L}{V}$ . If $t_1<0$ , set $t_1=E_1=O_E=0$ ; Else, $E_1=E\ \frac{t_1}{TI}$ .

4. Then $E_2=E-E_1$ ; $t_2=TI-t_1$

5. If $Q_b \ge Cap$ , then
   $O_Q=Cap$ , $O_M=O_E=0$
   If $t_1>0$ , then
   $Q_e'=Q_b+M_b+E_1-Cap$
   Else
   $Q_e'=Q_b-Cap$
   End if
   Calculate $Q_e$ and $M_e$ using Algorithm A (below)

6. Else $(Q_b<Cap)$
   $O_Q=Q_b$ , $RCap=Cap-O_Q$

7. If $M_b \le RCap$ , then

8. If $t_1 > 0$ , $O_M = M_b$ , $O_E = \min\left(RCap - M_b, \frac{t_1\ Cap}{TI}\right) \ge 0$

$Q_e^{'} = E_1 - O_E$

If $Q_e^{'} > 0$ , then

Calculate $Q_e$ , $M_e$ with Algorithm A

Else

$Q_e = 0$ , $M_e = E_2$

End if

Else $(t_1 = 0)$

$O_M = \left(\frac{v(TI) - L_b}{L - L_b}\right) M_b$ and $O_E = 0$

$M_e = M_b - O_M + E$ ; $Q_e = 0$

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$ , then

$O_M = RCap$ , $Q_e^{'} = M_b - O_M + E_1$

Calculate $Q_e$ and $M_e$ using Algorithm A

10. Else $(t_1 = 0)$

$M_d = \left[\left(\frac{v(TI) - L_b}{L - L_b}\right) M_b\right]$

If $M_d > RCap$ , then

$O_M = RCap$

$Q_e^{'} = M_d - O_M$

Apply Algorithm A to calculate $Q_e$ and $M_e$

Else

$O_M = M_d$

$M_e = M_b - O_M + E$ and $Q_e = 0$

End if

End if

End if

End if

11. Calculate a new estimate of average density, $\bar{k}_n = \frac{1}{4}[k_b + 2\ k_m + k_e]$ ,

where $k_b$ = density at the beginning of the TI

$k_e$ = density at the end of the TI

$k_m$ = density at the mid-point of the TI

All values of density apply only to the <u>moving</u> vehicles.

If $\left|\bar{k}_n - \bar{k}_{n-1}\right| > \epsilon$ and $n<N$

where N= max number of iterations, and $\epsilon$ is a convergence criterion, then

12. set n=n+1 , and return to step 2 to perform iteration, n, using $k = \bar{k}_n$ .

End if

**Computation of unit problem is now complete.** Check for excessive inflow causing spillback.

13. If $Q_e + M_e > \frac{(L-W)\,LN}{L_v}$ , then

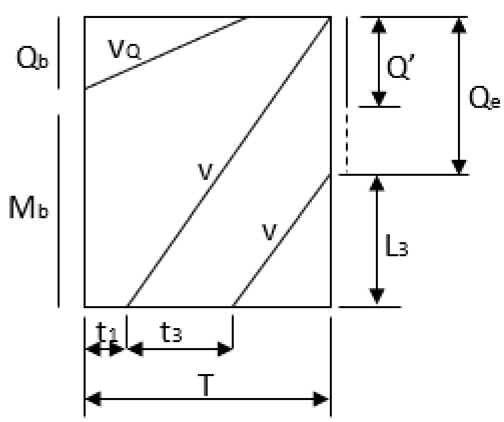
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W) \cdot LN}{L_v}$ , where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and the source flow, S, during the TI, by the amount, SB. That is, set

$$M = 1 - \frac{SB}{(E+S)} \geq 0 \text{, where M is the metering factor (over all movements).}$$

This metering factor is assigned appropriately to all feeder links and to the source flow, to be applied during the next network sweep, discussed later.

*Algorithm A*

This analysis addresses the flow environment over a TI during which moving vehicles can join a standing or discharging queue. For the case shown, $Q_b \leq Cap$, with $t_1 > 0$ and a queue of length, $Q'_e$ , formed by that portion of $M_b$ and $E$ that reaches the stop-bar within the TI, but could not discharge due to inadequate capacity. That is, $Q_b + M_b + E_1 > Cap$. This queue length, $Q'_e = Q_b + M_b + E_1 - Cap$ can be extended to $Q_e$ by traffic entering the approach during the current TI, traveling at speed, v, and reaching the rear of the queue within the TI. A portion of the entering vehicles, $E_3 = E \frac{t_3}{TI}$ , will likely join the queue. This analysis calculates $t_3$ , $Q_e$ and $M_e$ for the input values of L, TI, v, E, t, $L_v$, LN, $Q'_e$ .




When $t_1 > 0$ and $Q_b \leq Cap$:

$$\text{Define: } L'_e = Q'_e \frac{L_v}{LN} \text{ . From the sketch, } L_3 = v(TI - t_1 - t_3) = L - (Q'_e + E_3)\frac{L_v}{LN} \text{ .}$$

Substituting $E_3=\frac{t_3}{TI}\ E$ yields: $-vt_3+\frac{t_3}{TI}\ E\ \frac{L_v}{LN}=L-v(TI-t_1)-L_e^{'}$. Recognizing that the first two terms on the right hand side cancel, solve for $t_3$ to obtain:

$$t_3=\frac{L_e^{'}}{\left[v-\frac{E}{TI}\ \frac{L_v}{LN}\right]} \qquad \text{such that} \quad 0\le t_3\le TI-t_1$$

If the denominator, $\left[v-\frac{E}{TI}\ \frac{L_v}{LN}\right]\le 0$, set $t_3=TI-t_1$.

$$\text{Then, } Q_e=Q_e^{'}+E\ \frac{t_3}{TI}\ ,\ M_e=E\ \left(1-\frac{t_1+t_3}{TI}\right)$$

The complete Algorithm A considers all flow scenarios; space limitation precludes its inclusion, here.

### C.1.3 Lane Assignment

The "unit problem" is solved for each turn movement on each link. Therefore it is necessary to calculate a value, $LN_x$, of allocated lanes for each movement, x. If in fact all lanes are specified by, say, arrows painted on the pavement, either as full lanes or as lanes within a turn bay, then the problem is fully defined. If however there remain un-channelized lanes on a link, then an analysis is undertaken to subdivide the number of these physical lanes into turn movement specific virtual lanes, $LN_x$.

## C.2 Implementation

### C.2.1 Computational Procedure

The computational procedure for this model is shown in the form of a flow diagram as Figure C-4. As discussed earlier, the simulation model processes traffic flow for each link independently over TI that the analyst specifies; it is usually 60 seconds or longer. The first step is to execute an algorithm to define the sequence in which the network links are processed so that as many links as possible are processed after their feeder links are processed, within the same network sweep. Since a general network will have many closed loops, it is not possible to guarantee that every link processed will have all of its feeder links processed earlier.

The processing then continues as a succession of time steps of duration, TI, until the simulation is completed. Within each time step, the processing performs a series of "sweeps" over all network links; this is necessary to ensure that the traffic flow is synchronous over the entire network. Specifically, the sweep ensures continuity of flow among all the network links; in the context of this model, this means that the values of E, M, and S are all defined for each link such that they represent the synchronous movement of traffic from each link to all of its outbound links. These sweeps also serve to compute the metering rates that control spillback.

Within each sweep, processing solves the "unit problem" for each turn movement on each link. With the turn movement percentages for each link provided by the DTRAD model, an algorithm allocates the number of lanes to each movement serviced on each link. The timing at a signal, if any, applied at the downstream end of the link, is expressed as a G/C ratio, the signal timing needed to define this ratio is an input requirement for the model. The model also has the capability of representing, with macroscopic fidelity, the actions of actuated signals responding to the time-varying competing demands on the approaches to the intersection.

The solution of the unit problem yields the values of the number of vehicles, O, that discharge from the link over the time interval and the number of vehicles that remain on the link at the end of the time interval as stratified by queued and moving vehicles: $Q_e$ and $M_e$. The procedure considers each movement separately (multi-piping). After all network links are processed for a given network sweep, the updated consistent values of entering flows, E; metering rates, M; and source flows, S are defined so as to satisfy the "no spillback" condition. The procedure then performs the unit problem solutions for all network links during the following sweep.

Experience has shown that the system converges (i.e., the values of E, M and S "settle down" for all network links) in just two sweeps if the network is entirely under-saturated or in four sweeps in the presence of extensive congestion with link spillback. (The initial sweep over each link uses the final values of E and M, of the prior TI). At the completion of the final sweep for a TI, the procedure computes and stores all MOEs for each link and turn movement for output purposes. It then prepares for the following time interval by defining the values of $Q_b$ and $M_b$ for the start of the next TI as being those values of $Q_e$ and $M_e$ at the end of the prior TI. In this manner, the simulation model processes the traffic flow over time until the end of the run. Note that there is no space-discretization other than the specification of network links.

### C.2.2 Interfacing with Dynamic Traffic Assignment (DTRAD)

The **DYNEV II** system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. Thus, an algorithm was developed to identify an appropriate set of destination nodes for each origin based on its location and on the expected direction of travel. This algorithm also supports the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next.

Figure B-1 depicts the interaction of the simulation model with the DTRAD model in the **DYNEV II** system. As indicated, **DYNEV II** performs a succession of DTRAD "sessions"; each such session computes the turn link percentages for each link that remain constant for the session duration, $[T_0, T_2]$, specified by the analyst. The end product is the assignment of traffic volumes from each origin to paths connecting it with its destinations in such a way as to minimize the network-wide cost function. The output of the DTRAD model is a set of updated link turn percentages which represent this assignment of traffic.
As indicated in Figure B-1, the simulation model supports the DTRAD session by providing it with operational link MOE that are needed by the path choice model and included in the DTRAD cost function. These MOE represent the operational state of the network at a time,

$T_1 \leq T_2$ , which lies within the session duration, $[T_0, T_2]$. This "burn time", $T_1 - T_0$ , is selected by the analyst. For each DTRAD iteration, the simulation model computes the change in network operations over this burn time using the latest set of link turn percentages computed by the DTRAD model. Upon convergence of the DTRAD iterative procedure, the simulation model accepts the latest turn percentages provided by the Dynamic Traffic Assignment (DTA) model, returns to the origin time, $T_0$ , and executes until it arrives at the end of the DTRAD session duration at time, $T_2$ . At this time the next DTA session is launched and the whole process repeats until the end of the **DYNEV II** run.

Additional details are presented in Appendix B.

**Table C-1. Selected Measures of Effectiveness Output by DYNEV II**

| Measure | Units | Applies To |
|---|---|---|
| Vehicles Discharged | Vehicles | Link, Network, Exit Link |
| Speed | Miles/Hours (mph) | Link, Network |
| Density | Vehicles/Mile/Lane | Link |
| Level of Service | LOS | Link |
| Content | Vehicles | Network |
| Travel Time | Vehicle-hours | Network |
| Evacuated Vehicles | Vehicles | Network, Exit Link |
| Trip Travel Time | Vehicle-minutes/trip | Network |
| Capacity Utilization | Percent | Exit Link |
| Attraction | Percent of total evacuating vehicles | Exit Link |
| Max Queue | Vehicles | Node, Approach |
| Time of Max Queue | Hours:minutes | Node, Approach |
| Route Statistics | Length (mi); Mean Speed (mph); Travel Time (min) | Route |
| Mean Travel Time | Minutes | Evacuation Trips; Network |

**Table C-2. Input Requirements for the DYNEV II Model**

HIGHWAY NETWORK

- Links defined by upstream and downstream node numbers
- Link lengths
- Number of lanes (up to 9) and channelization
- Turn bays (1 to 3 lanes)
- Destination (exit) nodes
- Network topology defined in terms of downstream nodes for each receiving link
- Node Coordinates (X,Y)
- Nuclear Power Plant Coordinates (X,Y)

GENERATED TRAFFIC VOLUMES

- On all entry links and source nodes (origins), by Time Period

TRAFFIC CONTROL SPECIFICATIONS

- Traffic signals: link-specific, turn movement specific
- Signal control treated as fixed time or actuated
- Location of traffic control points (these are represented as actuated signals)
- Stop and Yield signs
- Right-turn-on-red (RTOR)
- Route diversion specifications
- Turn restrictions
- Lane control (e.g., lane closure, movement-specific)

DRIVER'S AND OPERATIONAL CHARACTERISTICS

- Driver's (vehicle-specific) response mechanisms: free-flow speed, discharge headway
- Bus route designation.

DYNAMIC TRAFFIC ASSIGNMENT

- Candidate destination nodes for each origin (optional)
- Duration of DTA sessions
- Duration of simulation "burn time"
- Desired number of destination nodes per origin

INCIDENTS

- Identify and Schedule of closed lanes
- Identify and Schedule of closed links

**Table C-3. Glossary**

| | |
|---|---|
| Cap | The maximum number of vehicles, of a particular movement, that can discharge from a link within a time interval. |
| E | The number of vehicles, of a particular movement, that enter the link over the time interval. The portion, $E_{TI}$, can reach the stop-bar within the TI. |
| G/C | The green time: cycle time ratio that services the vehicles of a particular turn movement on a link. |
| h | The mean queue discharge headway, seconds. |
| k | Density in vehicles per lane per mile. |
| $\bar{k}$ | The average density of moving vehicles of a particular movement over a TI, on a link. |
| L | The length of the link in feet. |
| $L_b$ , $L_e$ | The queue length in feet of a particular movement, at the [beginning, end] of a time interval. |
| LN | The number of lanes, expressed as a floating point number, allocated to service a particular movement on a link. |
| $L_v$ | The mean effective length of a queued vehicle including the vehicle spacing, feet. |
| M | Metering factor (Multiplier): 1. |
| $M_b$ , $M_e$ | The number of moving vehicles on the link, of a particular movement, that are moving at the [beginning, end] of the time interval. These vehicles are assumed to be of equal spacing, over the length of link upstream of the queue. |
| O | The total number of vehicles of a particular movement that are discharged from a link over a time interval. |
| $O_Q$ , $O_M$ , $O_E$ | The components of the vehicles of a particular movement that are discharged from a link within a time interval: vehicles that were Queued at the beginning of the TI; vehicles that were Moving within the link at the beginning of the TI; vehicles that Entered the link during the TI. |
| $P_x$ | The percentage, expressed as a fraction, of the total flow on the link that executes a particular turn movement, x. |

| | |
|---|---|
| $Q_b$ , $Q_e$ | The number of queued vehicles on the link, of a particular turn movement, at the [beginning, end] of the time interval. |
| $Q_{max}$ | The maximum flow rate that can be serviced by a link for a particular movement in the absence of a control device. It is specified by the analyst as an estimate of link capacity, based upon a field survey, with reference to the Highway Capacity Manual (HCM 2022). |
| R | The factor that is applied to the capacity of a link to represent the “capacity drop” when the flow condition moves into the forced flow regime. The lower capacity at that point is equal to $RQ_{max}$ . |
| RCap | The remaining capacity available to service vehicles of a particular movement after that queue has been completely serviced, within a time interval, expressed as vehicles. |
| $S_x$ | Service rate for movement x, vehicles per hour (vph). |
| $t_1$ | Vehicles of a particular turn movement that enter a link over the first $t_1$ seconds of a time interval, can reach the stop-bar (in the absence of a queue down-stream) within the same time interval. |
| TI | The time interval, in seconds, which is used as the simulation time step. |
| v | The mean speed of travel, in feet per second (fps) or miles per hour (mph), of moving vehicles on the link. |
| $v_Q$ | The mean speed of the last vehicle in a queue that discharges from the link within the TI. This speed differs from the mean speed of moving vehicles, v. |
| W | The width of the intersection in feet. This is the difference between the link length which extends from stop-bar to stop-bar and the block length. |

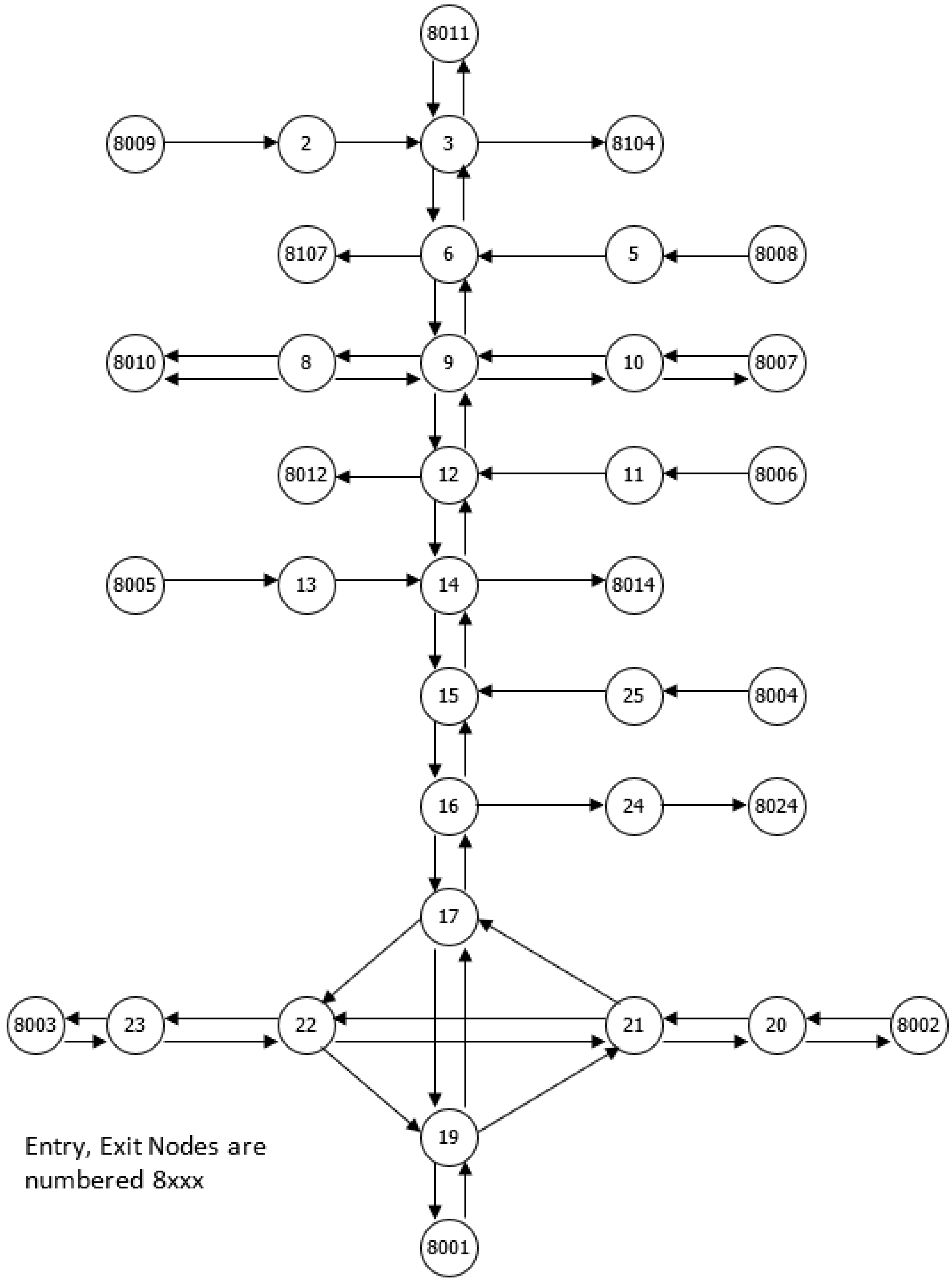



**Figure C-1. Representative Analysis Network**

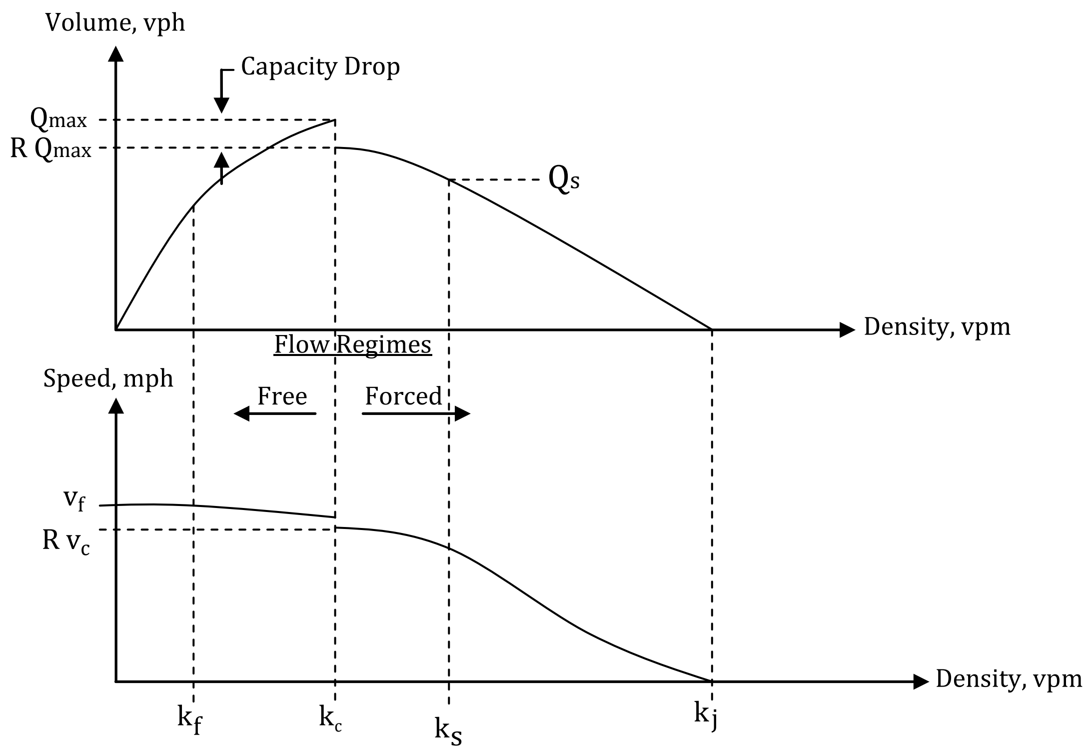



**Figure C-2. Fundamental Diagrams**

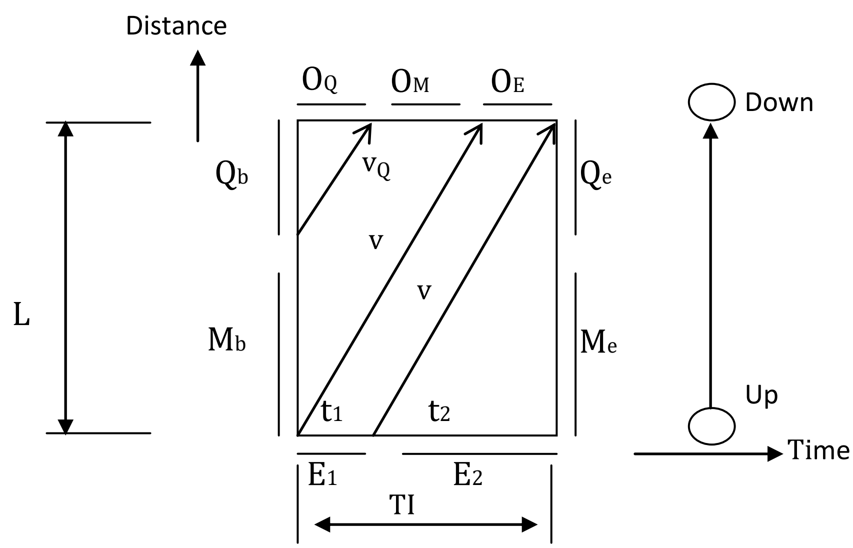



**Figure C-3. A UNIT Problem Configuration with $t_1 > 0$**

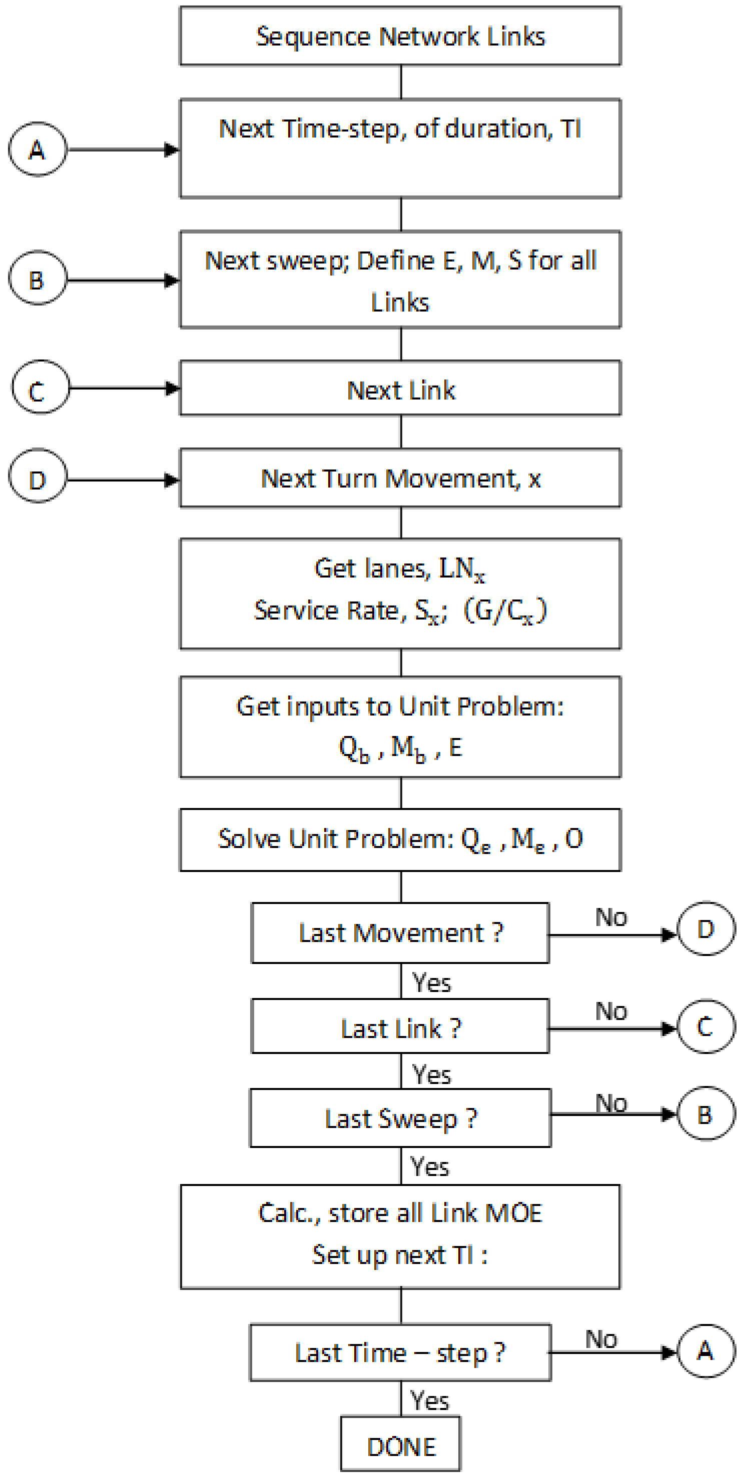



**Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)**

# APPENDIX D

Detailed Description of Study Procedure

## D. DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute Evacuation Time Estimates (ETE). The individual steps of this effort are represented as a flow diagram in Figure D-1. Each numbered step in the description that follows corresponds to the numbered element in the flow diagram.

Step 1

The first activity was to obtain the Planning Zone (PZ)[1] boundary information and create a geographic information system (GIS) base map. The base map extends beyond the Contingency Planning Zone (CPZ) which extends approximately 20 kilometres (radially) from the power plant. The base map incorporates the local roadway topology, a suitable topographic background and the PZ boundaries.

Step 2

The 2021 Statistics Canada population information[2] was obtained in GIS format. This information was used to extrapolate and estimate the permanent resident population within the PZ to the year 2023 as the base year of analysis and to define the spatial distribution and demographic characteristics of the population within the PZ. Data for employees, transients, schools, colleges/universities, summer day camps, and medical facilities (which includes retirement facilities) were obtained from Statistics Canada, Ontario Power Generation (OPG)[3], Durham Region, municipalities within the PZ, the 2019 ETE study, supplemented by internet searches and aerial imagery for parking spaces where data is missing. When aerial imagery is used, it is assumed that parking lots are full during peak times. In addition, transportation resources available during an emergency were provided by the Durham Region.

Step 3

A kickoff meeting was conducted with major stakeholders (municipal, regional, and provincial emergency officials, local police, and OPG personnel). The purpose of the kick-off meeting was to present an overview of the work effort, identify key agency personnel, and indicate the data requirements for the study. Specific requests for information were presented to the municipality and provincial emergency agency personnel and OPG utility managers. Unique features of the study area were discussed to identify the local concerns that should be addressed by the ETE study.

[1] The Planning Zone represents the entire study area which includes the Automatic Action Zone, Detailed Planning Zone (Inner and Outer Rings) and the Contingency Planning Zone.
[2] https://www.statcan.gc.ca/eng/start
[3] Some OPG employees can work from home (WFH) 2 days a week. However, the current WFH agreement might change during the next Collective Agreement and there could be more or less employees who WFH. In addition, there are a number of contractors that are on site that are present at the site every day. The number of contractors fluctuates daily. As such, the percentage of employees who WFH was disregarded and it is conservatively assumed that during the peak time, the maximum shift is present at the site on average. Essentially, it is assumed the WFH employees are offset by the additional contractors that are present on site each day.

Step 4

Next, a physical survey of the roadway system in the study area was conducted to determine the geometric properties of the highway sections, the channelization of lanes on each section of roadway, whether there are any turn restrictions or special treatment of traffic at intersections, the type and functioning of traffic control devices, the type and functioning of traffic control devices, and to make the necessary observations needed to estimate realistic values of roadway capacity. Roadway characteristics were also verified using aerial imagery.

Step 5

An online demographic survey of the households within the PZ was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the PZ population for this study. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the most recent UNITES software (see Section 1.3) developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4) and information obtained from aerial imagery. Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. The 2023 extrapolated permanent resident population estimates (Step 2) were overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 7

The Detailed Planning Zone (DPZ) is subdivided into 19 Response Sectors (DNGS and D1 through D18). The CPZ is subdivided into 8 Response Sectors (CPZ1 through CPZ8). Based on wind direction and speed, Regions (groupings of Response Sectors) that may be advised to evacuate, were developed.

The need for evacuation can occur over a range of time-of-day, day-of-week, seasonal and weather-related conditions. Scenarios were developed to capture the variation in evacuation demand, highway capacity and mobilization time, for different time of day, day of the week, time of year, and weather conditions.

Step 8

The input stream for the DYNEV II System, which integrates the dynamic traffic assignment and distribution model, DTRAD, with the evacuation simulation model, was created for two prototype evacuation cases – the evacuation of the entire DPZ and the CPZ for representative scenarios.

Step 9

After creating this input stream, the DYNEV II model was executed on the prototype evacuation case to compute evacuating traffic routing patterns consistent with the appropriate NRC guidelines. DYNEV II contains an extensive suite of data diagnostics which check the completeness and consistency of the input data specified. The analyst reviews all warning and error messages produced by the model and then corrects the database to create an input stream that properly executes to completion.

The model assigns destinations to all origin centroids consistent with a (general) radial evacuation of the study area. The analyst may optionally supplement and/or replace these model-assigned destinations, based on professional judgment, after studying the topology of the analysis highway network. The model produces link and network-wide measures of effectiveness as well as estimates of evacuation time.

Step 10

The results generated by the prototype evacuation case are critically examined. The examination includes observing the animated graphics (using the EVAN software - see Section 1.3) produced by DYNEV II and reviewing the statistics output by the model. This is a labour-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the results.

Essentially, the approach is to identify those bottlenecks in the network that represent locations where congested conditions are pronounced and to identify the cause of this congestion. This cause can take many forms, either as excess demand due to high rates of trip generation, improper routing, a shortfall of capacity, or as a quantitative flaw in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are satisfactory; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment and experience based upon the results obtained in previous applications of the model and a comparison of the results of the latest prototype evacuation case iteration with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 13. Otherwise, proceed to Step 11.

Step 11

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, adding minor routes (which are paved and traversable) that were not previously modelled but may assist in an evacuation and increase the available roadway network capacity, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems.

Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behaviour.

Step 12

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 11. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 13

Evacuation of transit-dependent evacuees and special facilities are included in the evacuation analysis. Fixed routing for Durham Regional Transit (DRT) buses, specialized wheelchair vans, school board buses, and ambulances are introduced into the final prototype evacuation case data set. DYNEV II generates route-specific speeds over time for use in the estimation of evacuation times for the transit dependent and special facility population groups.

Step 14

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the highway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 15

All evacuation cases were executed using the DYNEV II System to compute ETE. Once results are available, quality control procedures were used to assure the results were consistent, dynamic routing was reasonable, and traffic congestion/bottlenecks were addressed properly. Traffic management plans are analyzed, and traffic control points are prioritized, if applicable. Additional analysis is conducted to identify the sensitivity of the ETE to change in some base evacuation conditions and model assumptions.

Step 16

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes are used to compute ETE for transit-dependent permanent residents, schools, colleges/universities, summer day camps, and medical facilities (also includes retirement facilities).

Step 17

The simulation results are analyzed, tabulated, and graphed. The results are then documented, as required by U.S. NUREG/CR-7002, Rev. 1.

Step 18

Following the completion of documentation activities, the ETE criteria checklist (see Appendix N) is completed. An appropriate report reference is provided for each criterion provided in the checklist.

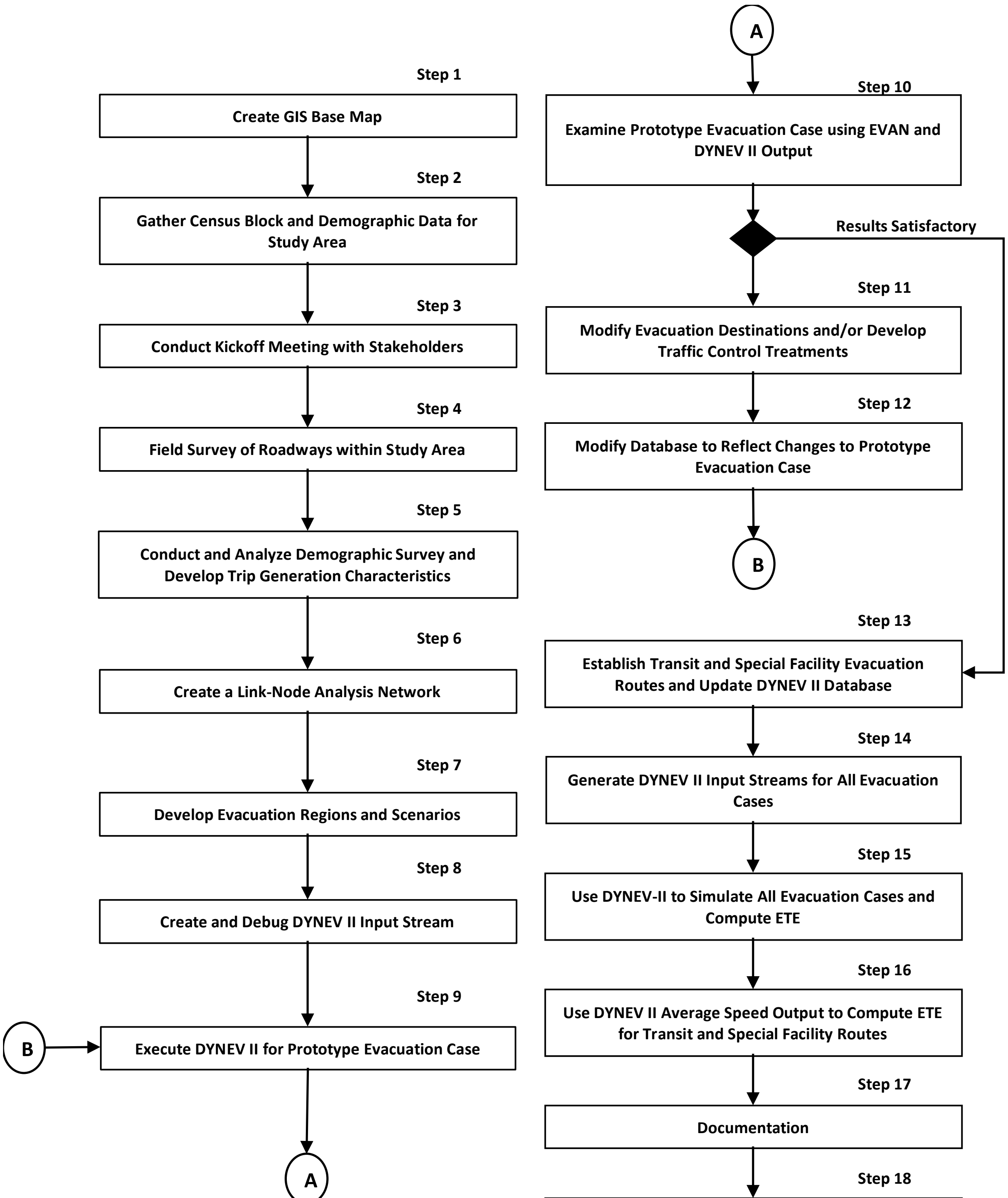



**Figure D-1. Flow Diagram of Activities**

# APPENDIX E

Special Facility Data

## E. SPECIAL FACILITY DATA

The following tables list population information, as of November 2022, for special facilities, recreational areas and major employers that are located within the DNGS PZs. Special facilities are defined as schools, colleges/universities, summer day camps, and medical facilities. Transient population data is included in the tables for recreational areas and lodging facilities. Employment data is included in the table for major employers. Each table is grouped by municipality. The location of the facility is defined by its straight-line distance (kilometres) and direction (magnetic bearing) from the centre point of the plant. Maps of each school, college/university, summer day camp, medical facility, recreational area, lodging facility, and major employer are also provided.

**Table E-1. Schools within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment |
|---|---|---|---|---|---|---|
| CLARINGTON, ONTARIO | | | | | | |
| D2 | 5.7 | NW | Holy Trinity Catholic Secondary School | 2260 Courtice Rd | Courtice | 770 |
| D2 | 5.9 | NW | Good Shepherd Catholic Elementary School | 20 Farmington Dr | Courtice | 438 |
| D2 | 6.2 | NW | Lydia Trull Public School | 80 Avondale Dr | Courtice | 331 |
| D2 | 6.5 | WNW | Dr. G.J. MacGillivray Public School | 75 Meadowglade Rd | Courtice | 850 |
| D2 | 6.8 | NW | Dr. Emily Stowe School | 71 Sandringham Dr | Courtice | 326 |
| D2 | 6.9 | WNW | Mother Teresa Catholic Elementary School | 78 Glenabbey Dr | Courtice | 420 |
| D2 | 7.0 | NW | Courtice Secondary School | 1717 Nash Rd | Courtice | 694 |
| D2 | 7.1 | NW | Courtice North Public School | 1675 Nash Rd | Courtice | 448 |
| D2 | 8.3 | WNW | Oxford Learning Academy | 1414 King St E, Unit #6 | Courtice | 50 |
| D3 | 3.9 | NNE | Dr. Ross Tilley Public School | 45 Westside Dr | Bowmanville | 497 |
| D3 | 4.0 | NNE | Holy Family Catholic Elementary School | 125 Aspen Springs Dr | Bowmanville | 659 |
| D3 | 5.1 | NNE | Clarington Central Secondary School | 200 Clarington Blvd | Bowmanville | 850 |
| D4 | 5.8 | NNE | Four Winds Montessori School | 116 Church St | Bowmanville | 20 |
| D4 | 5.9 | NNE | Central Public School | 120 Wellington St | Bowmanville | 161 |
| D4 | 6.2 | NE | Duke of Cambridge Public School | 47 Liberty St N | Bowmanville | 890 |
| D4 | 6.4 | NNE | Bowmanville High School | 49 Liberty St N | Bowmanville | 970 |
| D4 | 6.9 | NNE | Durham Christian High School | 340 W Scugog Ln | Bowmanville | 155 |
| D4 | 6.9 | NNE | St. Stephen Catholic Secondary School | 300 Scugog St | Bowmanville | 995 |
| D4 | 7.0 | N | Knox Christian School | 410 N Scugog Ct | Haydon | 291 |
| D4 | 7.3 | NNE | Saint Elizabeth Catholic Elementary School | 610 Longworth Ave | Bowmanville | 462 |
| D4 | 7.4 | NNE | Charles Bowman Public School | 195 Bons Ave | Bowmanville | 715 |
| D4 | 7.4 | NNE | John M. James School | 175 Mearns Ave | Bowmanville | 414 |
| D4 | 7.8 | NNE | Harold Longworth Public School | 350 Longworth Ave | Bowmanville | 492 |
| D5 | 4.6 | NE | Waverley Public School | 168 Waverley Rd | Bowmanville | 365 |
| D5 | 4.7 | NNE | Blaisdale Montessori | 80 Rhonda Blvd | Bowmanville | 1,094 |
| D5 | 5.5 | NE | St. Joseph Catholic Elementary School | 90 Parkway Cres | Bowmanville | 496 |
| D10 | 8.2 | WNW | S.T. Worden Public School | 1462 Nash Rd | Courtice | 210 |
| D10 | 8.8 | NW | Monsignor Leo Cleary Catholic Elementary School | 3820 Courtice Rd | Courtice | 188 |
| CPZ1 | 14.9 | NE | Ummati School | 111 Church St N | Orono | 70 |
| CPZ1 | 15.2 | NNE | Orono Public School | 171 Church St | Orono | 131 |
| CPZ1 | 18.4 | NNE | Kirby Centennial Public School | 3675 Concession Rd 7 | Clarington | 92 |

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment |
|---|---|---|---|---|---|---|
| CPZ2 | 12.4 | ENE | Newcastle Public School | 50 Glass Ct | Newcastle | 579 |
| CPZ2 | 12.9 | NE | The Pines Senior Public School | 3421 Hwy 35&115, RR | Newcastle | 193 |
| CPZ2 | 12.9 | NE | Clarke High School | 3425 Highway 35 115 | Newcastle | 313 |
| CPZ8 | 10.8 | N | M J Hobbs Senior Public School | 2296 Taunton Road R.R. #1 | Clarington | 223 |
| CPZ8 | 11.7 | N | Hampton Junior Public School | 43 Ormiston St | Clarington | 174 |
| CPZ8 | 17.1 | NNW | Enniskillen Public School | 8145 Old Scugog Rd | Clarington | 191 |
| | | | | | *Clarington DPZ Total:* | *14,251* |
| | | | | | *Clarington CPZ Total:* | *1,966* |
| | | | | | *Clarington Total:* | *16,217* |
| | | | **OSHAWA, ONTARIO** | | | |
| D6B | 9.6 | W | Lakewoods Public School | 323 Chaleur Av | Oshawa | 333 |
| D6B | 9.7 | W | G L Roberts Collegiate and Vocational Institute | 399 Chaleur Av | Oshawa | 481 |
| D6B | 10.1 | W | Dr C F Cannon Public School | 1196 Cedar St | Oshawa | 415 |
| D6B | 10.4 | W | Monsignor Philip Coffey Catholic School | 1324 Oxford St | Oshawa | 247 |
| D6B | 10.5 | W | Glen Street Public School | 929 Glen St | Oshawa | 395 |
| D7 | 9.3 | W | Bobby Orr Public School | 7 Waterloo St | Oshawa | 262 |
| D7 | 9.6 | W | Monsignor John Pereyma Catholic Secondary School | 316 Conant St | Oshawa | 489 |
| D8A | 7.2 | WNW | Campbell School | 600 Townline Rd S | Oshawa | 250 |
| D8A | 8.2 | WNW | John XXIII Catholic School | 195 Athabasca St | Oshawa | 205 |
| D8A | 8.3 | WNW | Forest View Public School | 285 Grandview St S | Oshawa | 430 |
| D8A | 9.1 | WNW | Clara Hughes Public School | 610 Taylor Ave | Oshawa | 565 |
| D8A | 9.5 | WNW | David Bouchard Public School | 460 Wilson Rd S | Oshawa | 576 |
| D8A | 9.9 | WNW | St. Hedwig Catholic School | 421 Olive Av | Oshawa | 113 |
| D8B | 8.9 | WNW | College Park Elementary School | 220 Townline Rd N | Oshawa | 196 |
| D8B | 9.0 | WNW | Kingsway College Private High School | 1200 Leland Rd | Oshawa | 182 |
| D8B | 10.1 | WNW | Vincent Massey Public School | 211 Harmony Rd N | Oshawa | 427 |
| D8B | 10.1 | WNW | Eastdale Collegiate & Vocational Institute | 265 Harmony Rd N | Oshawa | 1,124 |
| D8B | 10.9 | WNW | Great Beginnings Montessori School | 505 Adelaide St E | Oshawa | 72 |
| D8B | 11.0 | WNW | Coronation Public School | 441 Adelaide Av E | Oshawa | 458 |
| CPZ7 | 11.0 | WNW | Harmony Heights Public School | 590 Galahad Dr | Oshawa | 346 |
| CPZ7 | 11.0 | WNW | Sir Albert Love Catholic School | 425 Wilson Rd N | Oshawa | 244 |
| CPZ7 | 11.3 | WNW | Village Union Public School | 155 Gibb St | Oshawa | 337 |

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment |
|---|---|---|---|---|---|---|
| CPZ7 | 11.6 | WNW | Durham Continuing Education[1] | 120 Centre St S | Oshawa | 184 |
| CPZ7 | 11.6 | WNW | Walter E Harris Public School | 495 Central Park Blvd N | Oshawa | 565 |
| CPZ7 | 11.6 | WNW | Mary Street Community School | 110 Mary St N | Oshawa | 145 |
| CPZ7 | 11.9 | W | Elementary School Catholic Corpus-Christi | 362 Hillside Ave | Oshawa | 282 |
| CPZ7 | 11.9 | W | St. Thomas Aquinas Catholic School | 400 Pacific Ave | Oshawa | 288 |
| CPZ7 | 12.0 | WNW | Hillsdale Public School | 525 Oshawa Blvd N | Oshawa | 149 |
| CPZ7 | 12.0 | WNW | Gordon B Attersley Public School | 1110 Attersley Dr | Oshawa | 382 |
| CPZ7 | 12.0 | W | College Hill Public School | 530 Laval St | Oshawa | 243 |
| CPZ7 | 12.0 | WNW | O'Neill Collegiate and Vocational Institute | 301 Simcoe St N | Oshawa | 1,187 |
| CPZ7 | 12.5 | NW | St. Joseph Catholic School | 1200 Summerwood Heights | Oshawa | 470 |
| CPZ7 | 12.6 | W | Durham Alternative Secondary School | 240 Simcoe St S | Oshawa | 250 |
| CPZ7 | 12.7 | NW | St. Kateri Tekakwitha Catholic School | 1425 Coldstream Dr | Oshawa | 329 |
| CPZ7 | 12.8 | WNW | DR S J Phillips Public School | 625 Simcoe St N | Oshawa | 710 |
| CPZ7 | 12.9 | WNW | Beau Valley Public School | 230 Marigold Ave | Oshawa | 279 |
| CPZ7 | 13.2 | W | Waverly Public School | 100 Waverly St S | Oshawa | 380 |
| CPZ7 | 13.3 | NW | Maxwell Heights Secondary School | 1100 Coldstream Dr | Oshawa | 1,573 |
| CPZ7 | 13.4 | WNW | St. Christopher Catholic School | 431 Annapolis Ave | Oshawa | 407 |
| CPZ7 | 13.4 | WNW | Woodcrest Public School | 506 Woodcrest Ave | Oshawa | 300 |
| CPZ7 | 13.6 | WNW | Blaisdale Montessori Oshawa Campus | 1037 Simcoe St N | Oshawa | 60 |
| CPZ7 | 13.6 | NW | Jeanne Sauvé Public School | 950 Coldstream Dr | Oshawa | 720 |
| CPZ7 | 13.7 | WNW | Elementary School Antonine-Maillet | 615 Ridgeway Ave | Oshawa | 193 |
| CPZ7 | 13.7 | NW | St. John Bosco Catholic School | 1600 Clearbrook Dr | Oshawa | 515 |
| CPZ7 | 13.9 | NW | Sherwood Public School | 633 Ormond Dr | Oshawa | 780 |
| CPZ7 | 14.0 | WNW | Queen Elizabeth Public School | 1205 Simcoe St N | Oshawa | 450 |
| CPZ7 | 14.0 | WNW | R.S. McLaughlin CVI | 570 Stevenson Rd N | Oshawa | 1,000 |
| CPZ7 | 14.1 | WNW | Adelaide McLaughlin Public School | 630 Stevenson Rd N | Oshawa | 323 |
| CPZ7 | 14.2 | WNW | Monsignor Paul Dwyer Catholic High School | 700 Stevenson Rd N | Oshawa | 854 |
| CPZ7 | 14.3 | WNW | Sunset Heights Public School | 1130 Mohawk St | Oshawa | 315 |
| CPZ7 | 14.4 | WNW | Father Joseph Venini Catholic School | 120 Glovers Rd | Oshawa | 269 |
| CPZ7 | 14.6 | WNW | Stephen G. Saywell Public School | 855 Roundelay Dr | Oshawa | 400 |
| CPZ7 | 15.2 | WNW | Immanuel Christian School | 416 Taunton Rd W Unit A | Oshawa | 126 |

[1] Durham Continuing Education is an adult education facility where students will be evacuated in private vehicles in the event of emergency. Thus, no buses were assigned to these two schools. See Section 3 for additional information.

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment |
|---|---|---|---|---|---|---|
| CPZ7 | 15.2 | NW | Kedron Public School | 1935 Ritson Rd N | Oshawa | 436 |
| CPZ7 | 19.5 | NW | Columbus Private School | 3285 Simcoe St N | Oshawa | 29 |
| CPZ8 | 12.6 | NW | Norman G. Powers Public School | 1555 Coldstream Dr | Oshawa | 789 |
| CPZ8 | 13.7 | NW | Seneca Trail Public School | 1915 Queensbury Dr | Oshawa | 706 |
| | | | | | *Oshawa DPZ Total:* | *7,220* |
| | | | | | *Oshawa CPZ Total:* | *17,015* |
| | | | | | *Oshawa Total:* | *24,235* |
| **WHITBY, ONTARIO** | | | | | | |
| CPZ6 | 18.1 | W | Whitby Shores Public School | 485 Shores Greenway | Whitby | 674 |
| CPZ7 | 14.6 | W | Bellwood Public School | 30 Bellwood Dr | Whitby | 470 |
| CPZ7 | 15.1 | W | Dr. Robert Thornton Public School | 101 Hazelwood Dr | Whitby | 305 |
| CPZ7 | 15.3 | WNW | St. Paul Catholic School | 200 Garrard Rd | Whitby | 297 |
| CPZ7 | 15.6 | W | Kendalwood Montessori & Elementary School | 104 Consumers Dr | Whitby | 107 |
| CPZ7 | 16.0 | W | St. Theresa Catholic School | 173 Crawforth St | Whitby | 236 |
| CPZ7 | 16.2 | W | Jean-Paul II Catholic Elementary School | 1001 Hutchison Ave | Whitby | 305 |
| CPZ7 | 16.2 | W | Anderson Collegiate and Vocational Institute | 400 Anderson St | Whitby | 900 |
| CPZ7 | 16.3 | WNW | John Dryden Public School | 40 Rolling Acres Dr | Whitby | 715 |
| CPZ7 | 16.4 | W | C E Broughton Public School | 80 Crawforth St | Whitby | 320 |
| CPZ7 | 16.5 | WNW | St. Mark the Evangelist Catholic Elementary School | 95 Waller St | Whitby | 304 |
| CPZ7 | 16.6 | WNW | Sir Samuel Steele Public School | 55 Bakerville St | Whitby | 500 |
| CPZ7 | 16.7 | W | Pringle Creek Public School | 80 Ribblesdale Dr | Whitby | 720 |
| CPZ7 | 16.8 | W | Trafalgar Castle School | 401 Reynolds St | Whitby | 205 |
| CPZ7 | 16.8 | W | Sir William Stephenson Public School | 1125 Athol St | Whitby | 425 |
| CPZ7 | 17.0 | W | Julie Payette Public School | 300 Garden St | Whitby | 953 |
| CPZ7 | 17.3 | WNW | Glen Dhu Public School | 29 Fallingbrook St | Whitby | 466 |
| CPZ7 | 17.4 | W | Blyth Academy - Whitby Campus | 209 Dundas St E, Suite 105 | Whitby | 60 |
| CPZ7 | 17.5 | W | Hatch House Montessori School | 301 Byron St S | Whitby | 61 |
| CPZ7 | 17.7 | W | Henry Street High School | 600 Henry St | Whitby | 1,000 |
| CPZ7 | 17.8 | WNW | Father Leo J Austin Catholic Secondary School | 1020 Dryden Blvd | Whitby | 817 |
| CPZ7 | 17.9 | WNW | St. Bernard's Catholic Elementary School | 1000 Dryden Blvd | Whitby | 335 |
| CPZ7 | 18.2 | WNW | Fallingbrook Public School | 155 Fallingbrook St | Whitby | 411 |
| CPZ7 | 18.3 | W | St. Marguerite d'Youville Catholic School | 250 Michael Blvd | Whitby | 415 |
| CPZ7 | 18.3 | W | West Lynde Public School | 270 Michael Blvd | Whitby | 450 |

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment |
|---|---|---|---|---|---|---|
| CPZ7 | 18.3 | W | E A Fairman Public School | 620 Walnut St W | Whitby | 240 |
| CPZ7 | 18.4 | WNW | Sinclair Secondary School | 380 Taunton Rd E | Whitby | 1,600 |
| CPZ7 | 18.4 | WNW | Ormiston Public School | 20 Forest Heights St | Whitby | 400 |
| CPZ7 | 18.5 | W | Immanuel Christian School | 100-A Rossland Rd W | Whitby | 58 |
| CPZ7 | 18.5 | WNW | St. Matthew the Evangelist Catholic School | 60 Willowbrook Dr | Whitby | 457 |
| CPZ7 | 18.6 | W | St. John the Evangelist Catholic School | 1103 Giffard St | Whitby | 220 |
| CPZ7 | 19.1 | WNW | Whitby Montessori and Elementary School | 95 Taunton Rd E | Whitby | 112 |
| CPZ7 | 19.4 | WNW | Jack Miner Public School | 144 Whitburn St | Whitby | 530 |
| CPZ7 | 19.4 | W | Donald A. Wilson Secondary School | 681 Rossland Rd W | Whitby | 1,520 |
| CPZ7 | 19.5 | WNW | École Secondaire Catholique Saint-Charles-Garnier | 4101 Baldwin St S | Whitby | 100 |
| CPZ7 | 19.6 | W | All Saints Catholic Secondary School | 3001 Country Ln | Whitby | 817 |
| CPZ7 | 19.8 | W | Colonel J E Farewell Public School | 810 McQuay Blvd | Whitby | 450 |
| CPZ7 | 20.0 | W | Captain Michael Vandenbos Public School | 3121 Country Ln | Whitby | 650 |
| CPZ7 | 20.0 | W | St. Luke the Evangelist Catholic School | 55 Twin Streams Rd | Whitby | 65 |
| CPZ7 | 20.1 | WNW | Robert Munsch Public School | 20 Norista St | Whitby | 635 |
| CPZ7 | 20.3 | WNW | Blair Ridge Public School | 100 Blackfriar Ave | Whitby | 740 |
| CPZ7 | 20.7 | W | Williamsburg Public School | 20 Kirkland Pl | Whitby | 711 |
| CPZ7 | 20.7 | WNW | St. John Paul II Catholic School | 160 Cachet Blvd | Brooklin | 130 |
| | | | | | *Whitby DPZ Total:* | *0* |
| | | | | | *Whitby CPZ Total:* | *20,886* |
| | | | | | *Whitby Total:* | *20,886* |
| | | | | | **DPZ TOTAL:** | **21,471** |
| | | | | | **CPZ TOTAL:** | **39,867** |
| | | | | | **TOTAL:** | **61,338** |

**Table E-2. Colleges and Universities within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Total Enrolment | Commuter/ Ridesharing Students | Student Vehicles |
|---|---|---|---|---|---|---|---|---|
| **OSHAWA, ONTARIO** | | | | | | | | |
| CPZ7 | 13.6 | W | Trent University - Durham GTA Campus | 55 Thornton Rd S | Oshawa | 1,960 | 1,496 | 360 |
| CPZ7 | 16.1 | WNW | Durham College - Oshawa Campus | 2000 Simcoe St N | Oshawa | 8,539 | 6,933 | 3,000 |
| CPZ7 | 16.1 | WNW | Ontario Tech University | 2000 Simcoe St N | Oshawa | 9,732 | 7,490 | 2,000 |
| | | | | | *Oshawa DPZ Total:* | *0* | *0* | *0* |
| | | | | | *Oshawa CPZ Total:* | *20,231* | *15,919* | *5,360* |
| | | | | | *Oshawa Total:* | *20,231* | *15,919* | *5,360* |
| **WHITBY, ONTARIO** | | | | | | | | |
| CPZ7 | 11.2 | W | Durham College - Whitby Campus | 1610 Champlain Ave | Whitby | 1,839 | 1,493 | 646 |
| | | | | | *Whitby DPZ Total:* | *0* | *0* | *0* |
| | | | | | *Whitby CPZ Total:* | *1,839* | *1,493* | *646* |
| | | | | | *Whitby Total:* | *1,839* | *1,493* | *646* |
| | | | | | **DPZ TOTAL:** | **0** | **0** | **0** |
| | | | | | **CPZ TOTAL:** | **22,070** | **17,412** | **6,006** |
| | | | | | **TOTAL:** | **22,070** | **17,412** | **6,006** |

**Table E-3. Day Camps within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment[2] |
|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | |
| D2 | 5.9 | NW | Good Shepherd Catholic Elementary School | 20 Farmington Dr | Courtice | 50 |
| D2 | 6.2 | NW | Lydia Trull Public School | 80 Avondale Dr | Courtice | 50 |
| D2 | 6.8 | NW | Dr. Emily Stowe School | 71 Sandringham Dr | Courtice | 50 |
| D2 | 7.1 | NW | Courtice North Public School | 1675 Nash Rd | Courtice | 50 |
| D4 | 7.4 | NNE | Charles Bowman Public School | 195 Bons Ave | Bowmanville | 50 |
| D4 | 7.8 | NNE | Harold Longworth Public School | 350 Longworth Ave | Bowmanville | 50 |
| D10 | 8.2 | WNW | S.T. Worden Public School | 1462 Nash Rd | Courtice | 50 |
| CPZ2 | 11.1 | ENE | Pryde At St Francis Of Assisi | 1774 Rudell Rd | Newcastle | - |
| CPZ2 | 12.4 | ENE | Newcastle Glass Court YMCA Child Care Centre | 50 Glass Ct | Newcastle | - |
| CPZ8 | 11.7 | N | Hampton Hampton YMCA Centre | 43 Ormiston St | Hampton | - |
| CPZ8 | 17.1 | NNW | Enniskillen YMCA Centre | 8145 Old Scugog Rd | Hampton | - |
| | | | | | *Clarington DPZ Total:* | *350* |
| | | | | | *Clarington CPZ Total:* | *-* |
| | | | | | *Clarington Total:* | *350* |
| **OSHAWA, ONTARIO** | | | | | | |
| D6B | 10.1 | W | Dr. C.F. Cannon Public School | 1196 Cedar St | Oshawa | 50 |
| D8A | 8.2 | WNW | John XXIII Catholic School | 195 Athabasca St | Oshawa | 50 |
| D8A | 9.1 | WNW | Clara Hughes Public School | 610 Taylor Ave | Oshawa | 50 |
| D8B | 11.0 | WNW | Oshawa Coronation YMCA Centre | 445 Adelaide Ave E | Oshawa | 50 |
| CPZ7 | 11.5 | WNW | Oshawa Mary St. YMCA | 99 Mary St N | Oshawa | - |
| CPZ7 | 12.7 | NW | Oshawa St. Kateri Tekakwitha YMCA Centre | 1425 Coldstream Dr | Oshawa | - |
| CPZ7 | 12.8 | WNW | Oshawa Dr. SJ Phillips YMCA Centre | 625 Simcoe St N | Oshawa | - |
| CPZ7 | 13.3 | W | Oshawa Waverly YMCA Centre | 100 Waverly St S | Oshawa | - |
| CPZ7 | 13.4 | WNW | Oshawa St. Christopher YMCA Centre | 431 Annapolis Ave | Oshawa | - |
| CPZ7 | 13.7 | NW | Oshawa St. John Bosco YMCA Centre | 1600 Clearbrook Dr | Oshawa | - |
| CPZ7 | 14.4 | WNW | Oshawa Father Joseph Venini YMCA Centre | 120 Glovers Rd | Oshawa | - |
| CPZ7 | 15.2 | NW | Oshawa Kedron YMCA Child Care Centre | 1935 Ritson Rd N | Oshawa | - |

[2] The number of students at each day camp, within the DPZ, is estimated at approximately 50 during the summer months. Students from these day camps will be transported to designated Temporary Holding Centres during an evacuation. For day camps within the CPZ, it is assumed that parents will pick up their children prior to evacuation. No transient vehicles are considered for those day camps. See Section 3.8 for additional discussion.

| Response Sector | Distance (km) | Direc-tion | School Name | Street Address | Municipality | Enrol-ment[2] |
|---|---|---|---|---|---|---|
| CPZ8 | 12.6 | NW | Oshawa Norman G. Powers YMCA Centre | 1555 Coldstream Dr | Oshawa | - |
| | | | | | *Oshawa DPZ Total:* | *200* |
| | | | | | *Oshawa CPZ Total:* | *-* |
| | | | | | *Oshawa Total:* | *200* |
| **WHITBY, ONTARIO** | | | | | | |
| CPZ7 | 15.3 | WNW | Whitby St. Paul YMCA Centre | 200 Garrard Rd | Whitby | - |
| CPZ7 | 18.5 | WNW | Whitby St. Matthew YMCA Child Care Centre | 60 Willowbrook Dr | Whitby | - |
| CPZ7 | 19.9 | W | Whitby Colonel JE Farewell YMCA Centre | 810 McQuay Blvd | Whitby | - |
| CPZ7 | 20.7 | WNW | Brooklin St. John Paul II YMCA Centre | 160 Cachet Blvd | Whitby | - |
| | | | | | *Whitby DPZ Total:* | *-* |
| | | | | | *Whitby CPZ Total:* | *-* |
| | | | | | *Whitby Total:* | *-* |
| | | | | | **DPZ TOTAL:** | **550** |
| | | | | | **CPZ TOTAL:** | **-** |
| | | | | | **TOTAL:** | **550** |

**Table E-4. Medical Facilities within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Capacity | Current Census | Ambula-tory Patients | Wheel-chair Patients | Bed-ridden Patients |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | | | |
| D2 | 7.7 | WNW | White Cliffe Terrace Retirement Residence | 1460 Durham Regional Hwy 2 | Courtice | 114 | 114 | 114 | 0 | 0 |
| D3 | 4.5 | NNE | Seasons Clarington | 65 Clarington Blvd | Bowmanville | 120 | 112 | 84 | 28 | 0 |
| D4 | 6.4 | NE | Glen Hill - Strathaven Retirement Residence | 264 King St E | Bowmanville | 199 | 199 | 158 | 40 | 1 |
| D5 | 5.8 | NE | Lakeridge Health | 47 Liberty St S | Bowmanville | 77 | 60 | 40 | 7 | 13 |
| D10 | 8.9 | NW | Harmony Estate Senior Residence Inc. | 3589 Tooley Rd | Courtice | 10 | 9 | 9 | 0 | 0 |
| CPZ2 | 11.7 | ENE | Fosterbrooke Long Term Care | 330 King Ave W | Newcastle | 88 | 88 | 76 | 10 | 2 |
| | | | | | *Clarington DPZ Total:* | *520* | *494* | *405* | *75* | *14* |
| | | | | | *Clarington CPZ Total:* | *88* | *88* | *76* | *10* | *2* |
| | | | | | *Clarington Total:* | *608* | *582* | *481* | *85* | *16* |
| **OSHAWA, ONTARIO** | | | | | | | | | | |
| D7 | 7.3 | WNW | Traditions of Durham Retirement Community | 1255 Bloor St E | Oshawa | 140 | 132 | 131 | 1 | 0 |
| D8A | 10.0 | WNW | Cedarcroft Place Retirement Residence | 649 King St E | Oshawa | 77 | 73 | 69 | 3 | 1 |
| CPZ7 | 11.5 | WNW | Park View Place | 25 John St W | Oshawa | 60 | 60 | 30 | 24 | 6 |
| CPZ7 | 11.5 | WNW | The Carriage House | 60 Bond St E | Oshawa | 30 | 30 | 15 | 12 | 3 |
| CPZ7 | 11.9 | WNW | Livita Centennial Retirement Residence | 259 Hillcroft St | Oshawa | 20 | 20 | 10 | 8 | 2 |
| CPZ7 | 11.9 | WNW | Faith Place | 44 William St W | Oshawa | 180 | 180 | 91 | 70 | 19 |
| CPZ7 | 12.2 | WNW | Hillsdale Estates | 590 Oshawa Blvd N | Oshawa | 300 | 300 | 152 | 117 | 31 |
| CPZ7 | 12.3 | WNW | Lakeridge Health Oshawa | 1 Hospital Ct | Oshawa | 363 | 363 | 184 | 141 | 38 |
| CPZ7 | 12.4 | WNW | Hillsdale Terrace | 600 Oshawa Blvd N | Oshawa | 200 | 200 | 101 | 78 | 21 |
| CPZ7 | 12.5 | WNW | Extendicare Oshawa | 82 Park Rd N | Oshawa | 175 | 175 | 89 | 68 | 18 |
| CPZ7 | 13.6 | W | Revera ThorntonView Long Term Care Home | 186 Thornton Rd S | Oshawa | 154 | 154 | 78 | 60 | 16 |
| CPZ7 | 14.7 | NW | Chartwell Wynfield Long Term Care Residence | 431 Woodmount Dr | Oshawa | 252 | 172 | 172 | 0 | 0 |
| CPZ7 | 14.8 | NW | Chartwell Wynfield Retirement Residence | 431 Woodmount Dr | Oshawa | 107 | 102 | 102 | 0 | 0 |
| | | | | | *Oshawa DPZ Total:* | *217* | *205* | *200* | *4* | *1* |
| | | | | | *Oshawa CPZ Total:* | *1,841* | *1,756* | *1,024* | *578* | *154* |
| | | | | | *Oshawa Total:* | *2,058* | *1,961* | *1,224* | *582* | *155* |
| **WHITBY, ONTARIO** | | | | | | | | | | |
| CPZ6 | 17.6 | W | Lakeridge Health | 300 Gordon St | Whitby | 74 | 73 | 38 | 28 | 7 |
| CPZ7 | 15.0 | W | Sunnycrest Nursing Homes Ltd | 1635 Dundas St E | Whitby | 136 | 136 | 69 | 53 | 14 |

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Capacity | Current Census | Ambula-tory Patients | Wheel-chair Patients | Bed-ridden Patients |
|---|---|---|---|---|---|---|---|---|---|---|
| CPZ7 | 15.4 | W | Tekoa Manor | 200 Glen Hill Dr S | Whitby | 125 | 125 | 63 | 49 | 13 |
| CPZ7 | 15.4 | W | Glen Hill Terrace | 100 Glen Hill Drive S | Whitby | 174 | 174 | 88 | 68 | 18 |
| CPZ7 | 16.7 | W | Bloomsdale Seniors Home | 737 Anderson St | Whitby | 20 | 20 | 10 | 8 | 2 |
| CPZ7 | 17.1 | W | Bowling Green Towers | 850 Green St | Whitby | 80 | 80 | 41 | 31 | 8 |
| CPZ7 | 17.5 | W | Centre - DRLHC | 409 Centre Street S | Whitby | 16 | 16 | 8 | 6 | 2 |
| CPZ7 | 17.7 | W | Windsor Place | 315 Colborne St W | Whitby | 104 | 104 | 52 | 41 | 11 |
| CPZ7 | 17.9 | WNW | The Court At Pringle Creek | 3975 Anderson St | Whitby | 119 | 119 | 60 | 47 | 12 |
| CPZ7 | 17.9 | W | Amica at Whitby | 200 Kenneth Hobbs Ave | Whitby | 139 | 139 | 70 | 54 | 15 |
| CPZ7 | 18.0 | W | Chartwell Colonial Retirement Residence | 101 Manning Rd | Whitby | 96 | 96 | 49 | 37 | 10 |
| CPZ7 | 18.2 | W | Fairview Lodge | 632 Dundas St W | Whitby | 198 | 198 | 100 | 77 | 21 |
| CPZ7 | 19.3 | WNW | Village of Taunton Mills | 3800 Brock St N | Whitby | 184 | 184 | 93 | 72 | 19 |
| CPZ7 | 19.4 | WNW | Oakwood Retirement Communities | 3800 Brock St N | Whitby | 125 | 125 | 63 | 49 | 13 |
| CPZ7 | 19.7 | WNW | Aspira Lynde Creek Gardens Retirement Living | 50 Paul Burns Way | Whitby | 94 | 94 | 47 | 37 | 10 |
| CPZ7 | 20.2 | WNW | The Court at Brooklin | 5909 Anderson St | Whitby | 118 | 118 | 60 | 46 | 12 |
| | | | | | *Whitby DPZ Total:* | *0* | *0* | *0* | *0* | *0* |
| | | | | | *Whitby CPZ Total:* | *1,802* | *1,801* | *911* | *703* | *187* |
| | | | | | *Whitby Total:* | *1,802* | *1,801* | *911* | *703* | *187* |
| | | | | | **DPZ TOTAL:** | **737** | **699** | **605** | **79** | **15** |
| | | | | | **CPZ TOTAL:** | **3,731** | **3,645** | **2,011** | **1,291** | **343** |
| | | | | | **TOTAL:** | **4,468** | **4,344** | **2,616** | **1,370** | **358** |

**Table E-5. Major Employers[3] within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Employees (Max Shift)[4] | % Employees Commuting into the PZ[5] | Employees Commuting into the PZ | Employee Vehicles Commuting into the PZ |
|---|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | | |
| DNGS | - | - | Darlington Nuclear Generating Station | 1 Holt Rd S | Bowmanville | 3,042 | 52.0% | 1,582 | 1,582 |
| DNGS | - | - | DNGS Refurbishment and DNNP Site Preparation | 1 Holt Rd S | Bowmanville | 1,150 | 100.0% | 1,150 | 1,150 |
| Various locations throughout the DPZ | | | | | | 30,299 | 24.5% | 7,559 | 7,559 |
| Various locations throughout the CPZ | | | | | | 5,437 | 24.5% | 1,341 | 1,341 |
| *Clarington DPZ Total:* | | | | | | *34,491* | *58.8%* | *10,291* | *10,291* |
| *Clarington CPZ Total:* | | | | | | *5,437* | *24.5%* | *1,341* | *1,341* |
| *Clarington Total:* | | | | | | *39,928* | *41.7%* | *11,632* | *11,632* |
| **OSHAWA, ONTARIO** | | | | | | | | | |
| CPZ7 | 13.0 | W | GO Station - Oshawa | 915 Bloor St W | Oshawa | 2,390 | 5.0% | 120 | 120 |
| Various locations throughout the DPZ | | | | | | 13,958 | 18.8% | 2,652 | 2,652 |
| Various locations throughout the CPZ | | | | | | 34,355 | 18.8% | 6,521 | 6,521 |
| *Oshawa DPZ Total:* | | | | | | *13,958* | *18.8%* | *2,652* | *2,652* |
| *Oshawa CPZ Total:* | | | | | | *36,745* | *18.8%* | *6,641* | *6,641* |
| *Oshawa Total:* | | | | | | *50,703* | *18.8%* | *9,293* | *9,293* |
| **WHITBY, ONTARIO** | | | | | | | | | |
| CPZ6 | 17.1 | W | GO Station - Whitby | 1350 Brock St S | Whitby | 4,230 | 5.0% | 212 | 212 |
| Various locations throughout the DPZ | | | | | | 0 | - | 0 | 0 |

[3] The major employer locations shown in Figure E-9 are represented by circles which increase in size proportional to the number of employees commuting into the PZs in each Dissemination Area.
[4] The data for the DNGS, DNGS Refurbishment and DNNP Site Preparation were provided by the OPG. The number of employees who work outside of the PZs but evacuate from GO Transit stations within the PZs, is estimated based on the rail station parking capacity. See Section 3.4 for additional discussion.
[5] The 2021 Commuting Flow survey from Statistics Canada was used to calculate the percent of employees commuting into the PZs for each municipality (see Section 3.4). These values were applied to employment data provided by Statistics Canada and by the OPG. The 2022 telephone survey provides the percent of commuters (5.0%, see Appendix F, Section F.3.1) who work outside of the PZs but evacuate from rail stations within the PZs. This value was applied to the employees evacuating from GO Transit stations within the PZs.

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Employees (Max Shift)[4] | % Employees Commuting into the PZ[5] | Employees Commuting into the PZ | Employee Vehicles Commuting into the PZ |
|---|---|---|---|---|---|---|---|---|---|
| Various locations throughout the CPZ | | | | | | 42,140 | 24.0% | 10,153 | 10,153 |
| | | | | | *Whitby DPZ Total:* | *0* | *-* | *0* | *0* |
| | | | | | *Whitby CPZ Total:* | *46,370* | *24.0%* | *10,365* | *10,365* |
| | | | | | *Whitby Total:* | *46,370* | *24.0%* | *10,365* | *10,365* |
| | | | | | **DPZ TOTAL:** | **48,449** | **-** | **12,943** | **12,943** |
| | | | | | **CPZ TOTAL:** | **88,552** | **-** | **18,347** | **18,347** |
| | | | | | **TOTAL:** | **137,001** | **-** | **31,290** | **31,290** |

**Table E-6. Beaches, Campgrounds and Parks within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | |
| D2 | 4.4 | W | Darlington Provincial Park | 1600 Darlington Park Rd | Bowmanville | Park | 2,700 | 810 |
| D2 | 4.8 | W | Darlington Provincial Park | 1600 Darlington Park Rd | Bowmanville | Campground | 1,926 | 642 |
| D5 | 5.3 | ENE | Port Darlington West Beach Park | W Beach Rd | Bowmanville | Beach | 81 | 27 |
| D5 | 5.4 | ENE | Bowmanville Harbour Conservation Area | W Beach Rd | Bowmanville | Park | 54 | 27 |
| D5 | 5.4 | ENE | Port Darlington East Beach Park | E Beach Rd | Bowmanville | Beach | 81 | 27 |
| CPZ1 | 12.1 | NE | Thurne Park Valley Conservation Area | 3315-3341 Concession Rd 4 | Newcastle | Park | 40 | 20 |
| CPZ1 | 16.8 | NNE | Jungle Cat World Wildlife Park | 3667 Concession Rd 6 | Orono | Park | 90 | 45 |
| CPZ1 | 18.6 | NNE | Leskard Conservation Area | Leskard Rd | Leskard | Park | 50 | 25 |
| CPZ2 | 11.0 | ENE | Samuel Wilmot Nature Area | Waterfront Trail | Newcastle | Park | 40 | 20 |
| CPZ2 | 12.7 | ENE | Beautiful Beach Relaxation | 3650 Lakeshore Rd | Newcastle | Beach | 122 | 45 |
| CPZ2 | 19.9 | NE | Cedar Valley Resort | 4739 Cedar Valley Rd | Orono | Campground | 473 | 175 |
| CPZ8 | 13.7 | N | Cedar Park Resort | 6296 Cedar Park Rd | Bowmanville | Campground | 1,320 | 489 |
| CPZ8 | 15.6 | NNW | Enniskillen Conservation Area | Holt Rd | Hampton | Park | 50 | 25 |
| | | | | | | *Clarington DPZ Total:* | *4,842* | *1,533* |
| | | | | | | *Clarington CPZ Total:* | *2,185* | *844* |
| | | | | | | *Clarington Total:* | *7,027* | *2,377* |
| **OSHAWA, ONTARIO** | | | | | | | | |
| D6B | 9.6 | W | Oshawa Valleylands Conservation Area | Thomas St | Oshawa | Park | 54 | 22 |

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| D7 | 7.0 | W | McLaughlin Bay Wildlife Reserve | Colonel Sam Dr | Oshawa | Park | 54 | 27 |
| D7 | 8.1 | W | Lakeview Park Beach | Lakeview Park | Oshawa | Beach | 270 | 81 |
| D9 | 10.9 | NW | Harmony Valley Conservation Area | Rathburn St & Grandview St N | Oshawa | Park | 54 | 27 |
| CPZ6 | 12.1 | W | Lakefront Park West | 1221 Phillip Murray Ave | Oshawa | Park | 600 | 300 |
| CPZ7 | 13.4 | W | Civic Auditorium Complex | 99 Thornton Rd S | Oshawa | Park | 400 | 200 |
| CPZ7 | 15.1 | WNW | Cedar Valley Conservation Area | 1510 Simcoe St N | Oshawa | Park | 50 | 25 |
| CPZ7 | 15.8 | WNW | Camp Samac - Scouts Canada | 275 Conlin Rd E | Oshawa | Campground | 405 | 150 |
| | | | | | | *Oshawa DPZ Total:* | *432* | *157* |
| | | | | | | *Oshawa CPZ Total:* | *1,455* | *675* |
| | | | | | | *Oshawa Total:* | *1,887* | *832* |
| **WHITBY, ONTARIO** | | | | | | | | |
| CPZ2 | 14.0 | W | Thickson's Woods Nature Reserve | Waterfront Trl | Whitby | Park | 75 | 25 |
| CPZ6 | 14.0 | W | Crystal Beach | 112 Crystal Beach Blvd | Whitby | Beach | 56 | 20 |
| CPZ6 | 15.9 | W | Kiwanis Heydenshore Park | 589 Water St | Whitby | Beach | 154 | 55 |
| CPZ6 | 17.3 | W | Iroquois Beach | 731 Gordon St | Whitby | Beach | 196 | 70 |
| CPZ6 | 17.5 | W | Iroquois Park Sports Centre | 500 Victoria St W | Whitby | Park | 430 | 215 |
| CPZ7 | 20.2 | WNW | Cullen Central Park | 300 Taunton Rd E | Whitby | Park | 500 | 250 |
| CPZ7 | 21.9 | WNW | Heber Down Conservation Area | 5000 Cochrane St | Whitby | Park | 90 | 30 |
| | | | | | | *Whitby DPZ Total:* | *0* | *0* |
| | | | | | | *Whitby CPZ Total:* | *1,501* | *665* |
| | | | | | | *Whitby Total:* | *1,501* | *665* |
| | | | | | | **DPZ TOTAL:** | **5,274** | **1,690** |
| | | | | | | **CPZ TOTAL:** | **5,141** | **2,184** |
| | | | | | | **TOTAL:** | **10,415** | **3,874** |

**Table E-7. Golf Courses and Marinas within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | |
| D5 | 5.4 | ENE | Port Darlington Marina | 70 Port Darlington Rd | Bowmanville | Marina | 375 | 135 |
| D10 | 9.9 | NW | Pebblestone Golf Course | 1550 Pebblestone Rd | Courtice | Golf Course | 65 | 27 |
| D12 | 8.7 | N | Quarry Lion Golf Resort | 3705 Durham Rd 57 | Bowmanville | Golf Course | 78 | 44 |

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| D12 | 9.4 | N | Bowmanville Golf & Country Club | 3845 Middle Rd N | Bowmanville | Golf Course | 108 | 43 |
| CPZ1 | 12.8 | N | Ayren Links Golf & Country Club | 5210 Bethesda Rd | Bowmanville | Golf Course | 100 | 50 |
| CPZ2 | 12.2 | ENE | Newcastle Marina | 377 Baldwin St | Newcastle | Marina | 130 | 65 |
| CPZ2 | 15.8 | ENE | Newcastle Golf Course | 2429 Golf Course Rd | Newcastle | Golf Course | 200 | 100 |
| | | | | | | *Clarington DPZ Total:* | *626* | *249* |
| | | | | | | *Clarington CPZ Total:* | *430* | *215* |
| | | | | | | *Clarington Total:* | *1,056* | *464* |
| **OSHAWA, ONTARIO** | | | | | | | | |
| D8A | 8.2 | WNW | Harmony Creek Golf Centre Ltd. | 1000 Bloor St E | Oshawa | Golf Course | 108 | 54 |
| CPZ7 | 12.7 | WNW | Oshawa Golf and Curling Club | 160 Alexandra St | Oshawa | Golf Course | 200 | 200 |
| CPZ7 | 15.5 | WNW | Oshawa Airport Golf Club | 1145 Thornton Rd N | Oshawa | Golf Course | 170 | 85 |
| CPZ7 | 16.4 | NW | Kedron Dells Golf Club | 2400 Ritson Rd N RR 5 | Oshawa | Golf Course | 250 | 125 |
| CPZ7 | 20.4 | NW | Columbus Golf & Country Club | 3622 Simcoe St N | Oshawa | Golf Course | 150 | 75 |
| | | | | | | *Oshawa DPZ Total:* | *108* | *54* |
| | | | | | | *Oshawa CPZ Total:* | *770* | *485* |
| | | | | | | *Oshawa Total:* | *878* | *539* |
| **WHITBY, ONTARIO** | | | | | | | | |
| CPZ6 | 17.1 | W | Port Whitby Marina | 301 Watson St W | Whitby | Marina | 320 | 160 |
| CPZ6 | 17.1 | W | The Whitby Yacht Club Sailing School | 701 Gordon St | Whitby | Marina | 150 | 70 |
| CPZ7 | 19.4 | WNW | Winchester Golf Club | 750 Winchester Rd E | Whitby | Golf Course | 150 | 75 |
| CPZ7 | 19.7 | WNW | Eldorado Golf Club | 615 Winchester Rd E | Whitby | Golf Course | 60 | 45 |
| CPZ7 | 20.4 | WNW | Lyndebrook Golf Course | 5055 Baldwin St S | Whitby | Golf Course | 90 | 45 |
| CPZ7 | 23.3 | WNW | Devil's Den Golf & Beach Volleyball Centre | 745 Winchester Rd W | Whitby | Golf Course | 120 | 60 |
| | | | | | | *Whitby DPZ Total:* | *0* | *0* |
| | | | | | | *Whitby CPZ Total:* | *890* | *455* |
| | | | | | | *Whitby Total:* | *890* | *455* |
| | | | | | | **DPZ TOTAL:** | **734** | **303** |
| | | | | | | **CPZ TOTAL:** | **2,090** | **1,155** |
| | | | | | | **TOTAL:** | **2,824** | **1,458** |

**Table E-8. Historic Sites, Museums and Other Recreational Areas within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | | |
| CPZ1 | 13.8 | NE | David Trotter Leather Design at the Cow Palace | 3305 Concession Rd 5 | Orono | Museum | 54 | 20 |
| CPZ1 | 14.9 | NE | Orono Town Hall | 5315 Main St | Orono | Historic Site | 54 | 20 |
| CPZ1 | 21.1 | N | Canadian Tire Motorsport Park | 3233 Concession Rd 10 | Bowmanville | Other, Not Listed | 600 | 200 |
| CPZ1 | 21.1 | NE | Brimacombe | 4098 Regional Rd 9 | Orono | Other, Not Listed | 54 | 20 |
| CPZ2 | 12.0 | ENE | Newcastle Memorial Arena | 103 Caroline St W | Newcastle | Other, Not Listed | 300 | 100 |
| CPZ8 | 10.8 | NNW | The Marksmen Club | 5070 Holt Rd | Hampton | Other, Not Listed | 68 | 25 |
| CPZ8 | 15.3 | N | Robert McLaughlin Homestead | 2574 Concession Rd 7 | Hampton | Museum | 81 | 30 |
| | | | | | | *Clarington DPZ Total:* | *0* | *0* |
| | | | | | | *Clarington CPZ Total:* | *1,211* | *415* |
| | | | | | | *Clarington Total:* | *1,211* | *415* |
| **OSHAWA, ONTARIO** | | | | | | | | |
| D6B | 8.2 | W | Oshawa Community Museum & Archives | 1450 Simcoe St S | Oshawa | Museum | 140 | 50 |
| CPZ2 | 12.5 | W | Canlan Sports | 1401 Phillip Murray Ave | Oshawa | Other, Not Listed | 750 | 250 |
| CPZ7 | 10.6 | W | LVIV Hall | 38 Lviv Blvd | Oshawa | Other, Not Listed | 375 | 125 |
| CPZ7 | 11.1 | WNW | Oshawa Curling Club | 226 Bond St E | Oshawa | Other, Not Listed | 250 | 125 |
| CPZ7 | 11.2 | WNW | Tribute Communities Centre | 99 Athol St E | Oshawa | Other, Not Listed | 5,500 | 1,833 |
| CPZ7 | 11.4 | WNW | Canadian Automotive Museum | 99 Simcoe St S | Oshawa | Museum | 420 | 150 |
| CPZ7 | 11.7 | WNW | The Robert McLaughlin Gallery | 72 Queen St | Oshawa | Museum | 756 | 270 |
| CPZ7 | 12.2 | WNW | Parkwood Estate | 270 Simcoe St N | Oshawa | Museum | 238 | 85 |
| CPZ7 | 12.2 | WNW | Kinsmen Civic Memorial Stadium | 89 Arena St | Oshawa | Other, Not Listed | 225 | 75 |
| CPZ7 | 13.0 | W | Tosca Banquet Hall | 800 Champlain Ave | Oshawa | Other, Not Listed | 750 | 250 |
| CPZ7 | 13.4 | NW | Delpark Homes Centre | 1661 Harmony Rd N | Oshawa | Other, Not Listed | 900 | 300 |
| CPZ7 | 14.7 | WNW | Ontario Regiment Museum | 1000 Stevenson Rd N | Oshawa | Museum | 210 | 75 |
| CPZ7 | 15.8 | WNW | Polish Veteran's - Sikorski Hall | 1551 Stevenson Rd N | Oshawa | Other, Not Listed | 565 | 188 |
| CPZ8 | 17.8 | NW | Oshawa Zoo | 3377 Grandview St N | Oshawa | Other, Not Listed | 80 | 40 |
| | | | | | | *Oshawa DPZ Total:* | *140* | *50* |
| | | | | | | *Oshawa CPZ Total:* | *11,019* | *3,766* |
| | | | | | | *Oshawa Total:* | *11,159* | *3,816* |
| **WHITBY, ONTARIO** | | | | | | | | |
| CPZ7 | 16.0 | W | Thomas House of Music | 1001 Burns St E | Whitby | Museum | 420 | 150 |
| CPZ7 | 17.2 | W | Lynde House Museum | 900 Brock St S | Whitby | Museum | 210 | 75 |

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Category | Transients | Vehicles |
|---|---|---|---|---|---|---|---|---|
| CPZ7 | 17.4 | W | Whitby Cenotaph | 109 Dundas St E | Whitby | Museum | 168 | 60 |
| CPZ7 | 17.6 | W | The Centennial Building | 416 Centre St S | Whitby | Other, Not Listed | 63 | 21 |
| CPZ7 | 19.4 | WNW | McKinney Centre | 222 McKinney Dr | Whitby | Other, Not Listed | 300 | 100 |
| CPZ7 | 20.4 | WNW | Kent Mills Heritage Site | - | Whitby | Historic Site | 42 | 15 |
| CPZ7 | 20.8 | WNW | Luther Vipond Brooklin Memorial Arena | 67 Winchester Rd | Whitby | Other, Not Listed | 150 | 50 |
| | | | | | | *Whitby DPZ Total:* | *0* | *0* |
| | | | | | | *Whitby CPZ Total:* | *1,353* | *471* |
| | | | | | | *Whitby Total:* | *1,353* | *471* |
| | | | | | | **DPZ TOTAL:** | **140** | **50** |
| | | | | | | **CPZ TOTAL:** | **13,583** | **4,652** |
| | | | | | | **TOTAL:** | **13,723** | **4,702** |

**Table E-9. Lodging Facilities within the DNGS PZs**

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Transients | Vehicles |
|---|---|---|---|---|---|---|---|
| **CLARINGTON, ONTARIO** | | | | | | | |
| D5 | 3.9 | NE | Holiday Inn Express & Suites | 37 Spicer Square | Bowmanville | 171 | 86 |
| D5 | 5.3 | NE | Howard Johnson Hotel (Best Western Plus) | 160 Liberty St S | Bowmanville | 94 | 70 |
| CPZ1 | 13.4 | NE | Bon Voyage Motel | 7645 Baldwin St N | Whitby | 162 | 60 |
| CPZ1 | 14.4 | NE | Susan's Sanctuary Bed & Breakfast | 5016 Main St | Orono | 14 | 5 |
| CPZ1 | 16.8 | NNE | Safari Lodge & Lion's Den | 3667 Concession Rd 6 | Orono | 108 | 40 |
| CPZ1 | 18.3 | N | Joe Lin Station Bed & Breakfast | 2969 Concession Rd 8 | Bowmanville | 27 | 10 |
| CPZ1 | 18.4 | NNE | The Hive Centre and Bee & Bee | 3392 Concession Rd 8 | Leskard | 27 | 10 |
| CPZ2 | 13.3 | NE | Twin Oaks Motel | 3511 Rd 4 Conc | Clarington | 81 | 30 |
| CPZ8 | 17.0 | NNW | Our Valley View Bed & Breakfast | 50 Barton Rd | Hampton | 14 | 5 |
| | | | | | *Clarington DPZ Total:* | *265* | *156* |
| | | | | | *Clarington CPZ Total:* | *433* | *160* |
| | | | | | *Clarington Total:* | *698* | *316* |
| **OSHAWA, ONTARIO** | | | | | | | |
| D8A | 9.9 | WNW | Knights Inn Oshawa | 659 King St E | Oshawa | 58 | 21 |
| CPZ7 | 10.1 | W | A Cloverleaf Motel | 214 Toronto Ave | Oshawa | 70 | 25 |
| CPZ7 | 11.0 | W | Street Side Inn | 394 Simcoe St S | Oshawa | 112 | 40 |
| CPZ7 | 11.4 | WNW | La Quinta Inn & Suites Oshawa | 63 King St E | Oshawa | 165 | 59 |
| CPZ7 | 11.7 | WNW | Holiday Inn Express & Suites Oshawa Downtown - Toronto Area | 67 Simcoe St N | Oshawa | 98 | 35 |
| CPZ7 | 12.2 | WNW | Strawberry Suite Bed & Breakfast | 763 Greystone Ct | Oshawa | 14 | 5 |
| CPZ7 | 12.3 | W | Best Western Plus Durham Hotel & Conference Centre | 559 Bloor St W | Oshawa | 420 | 150 |
| CPZ7 | 12.3 | W | Comfort Inn | 605 Bloor St W | Oshawa | 216 | 77 |
| CPZ7 | 13.3 | WNW | Emerson Manor | 132 Stevenson Rd N | Oshawa | 8 | 3 |
| CPZ7 | 13.3 | W | Travelodge by Wyndham Oshawa Whitby | 940 Champlain Ave | Oshawa | 280 | 100 |
| CPZ7 | 16.1 | WNW | Residence & Conference Centre - Oshawa | 32 Commencement Dr | Oshawa | 991 | 354 |
| | | | | | *Oshawa DPZ Total:* | *58* | *21* |
| | | | | | *Oshawa CPZ Total:* | *2,374* | *848* |
| | | | | | *Oshawa Total:* | *2,432* | *869* |
| **WHITBY, ONTARIO** | | | | | | | |
| CPZ7 | 13.8 | W | Quality Suites | 1700 Champlain Ave | Whitby | 378 | 135 |
| CPZ7 | 16.5 | W | Residence Inn by Marriott Whitby | 160 Consumers Dr | Whitby | 490 | 175 |
| CPZ7 | 16.6 | W | Motel 6 Toronto East - Whitby | 165 Consumers Dr | Whitby | 420 | 150 |

| Response Sector | Distance (km) | Direc-tion | Facility Name | Street Address | Municipality | Transients | Vehicles |
|---|---|---|---|---|---|---|---|
| CPZ7 | 16.7 | W | Holiday Inn Express Whitby Oshawa | 180 Consumers Dr | Whitby | 322 | 115 |
| CPZ7 | 17.7 | W | Lucien Motel | 134 Byron St N | Whitby | 140 | 50 |
| | | | | | *Whitby DPZ Total:* | *0* | *0* |
| | | | | | *Whitby CPZ Total:* | *1,750* | *625* |
| | | | | | *Whitby Total:* | *1,750* | *625* |
| | | | | | **DPZ TOTAL:** | **323** | **177** |
| | | | | | **CPZ TOTAL:** | **4,557** | **1,633** |
| | | | | | **TOTAL:** | **4,880** | **1,810** |

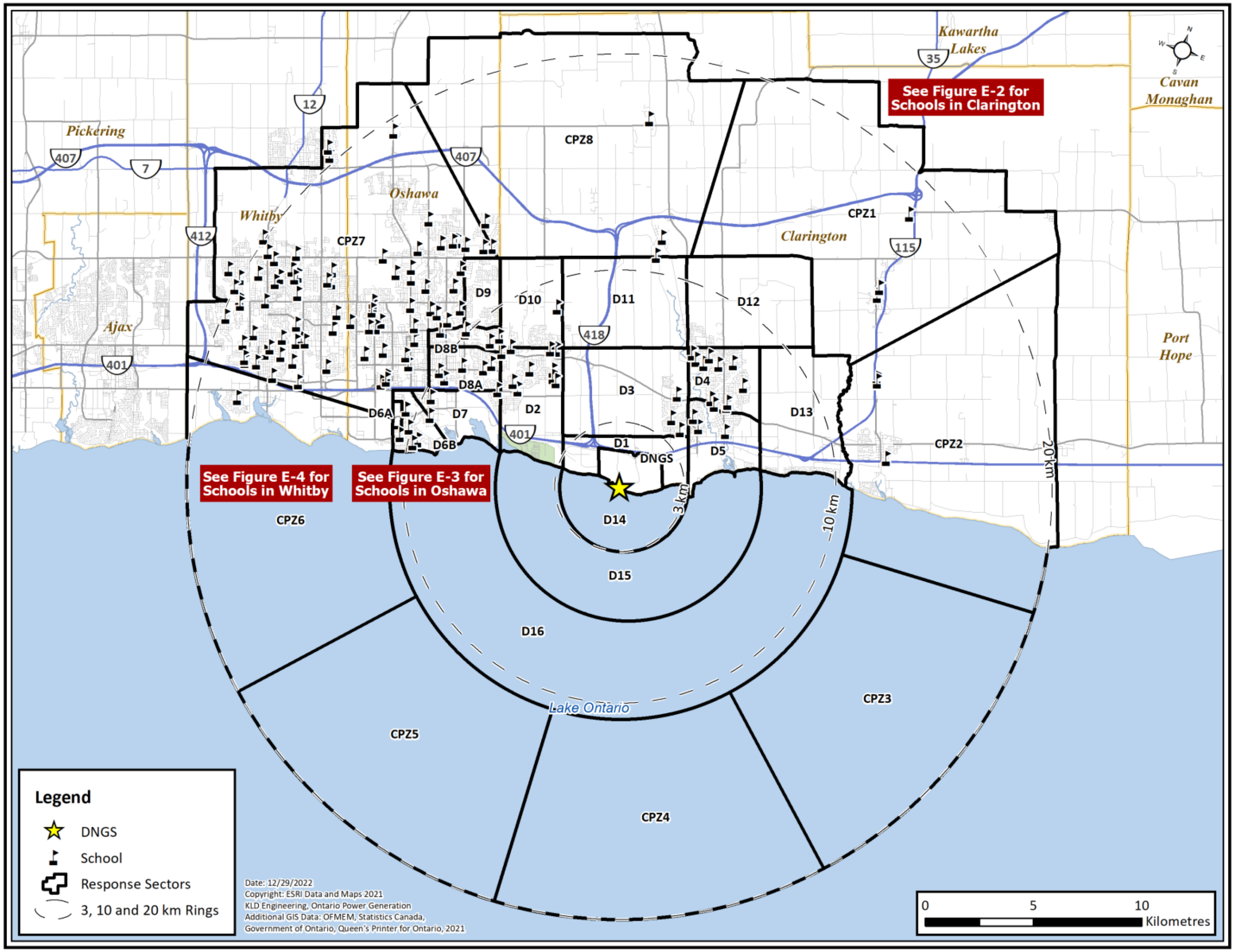
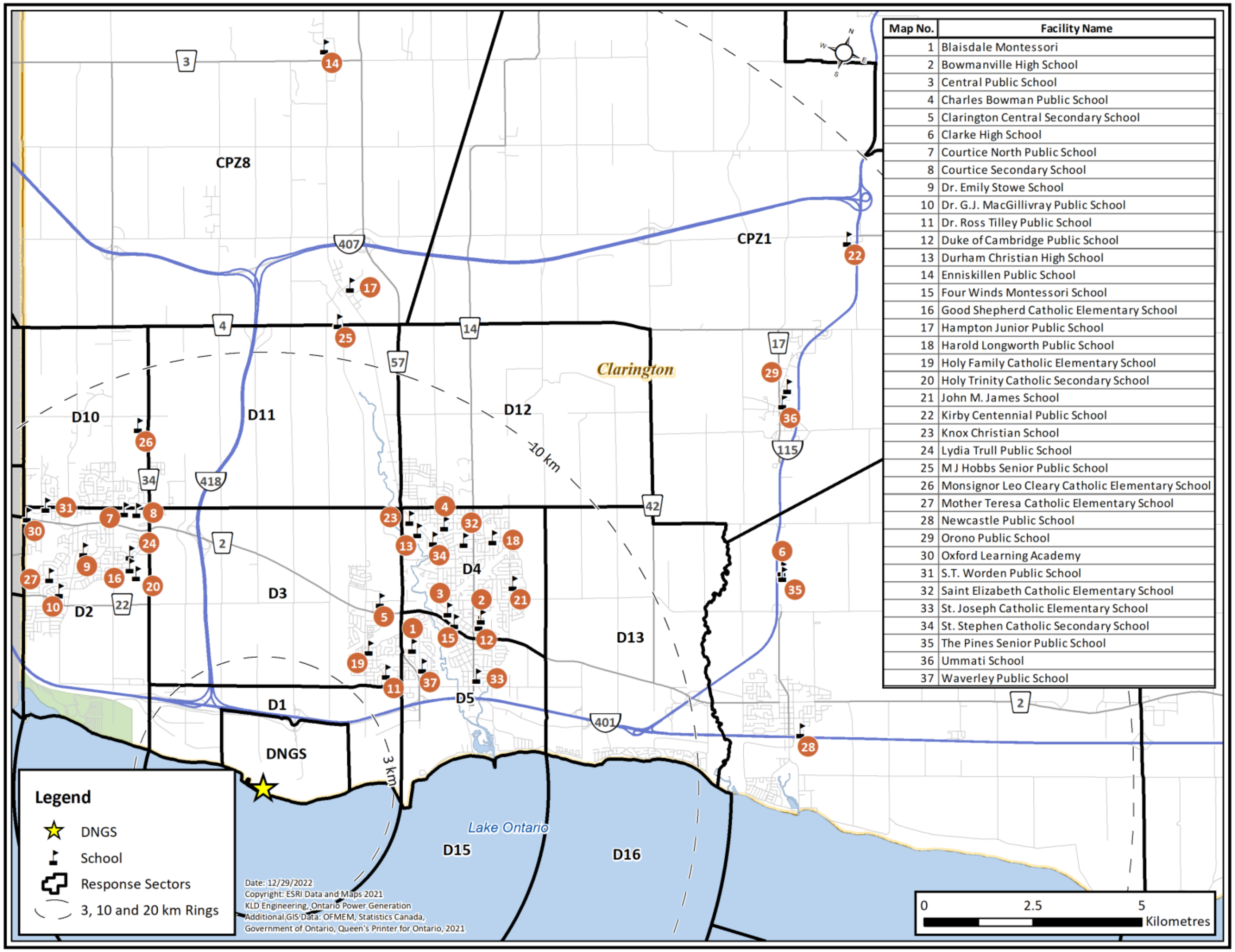
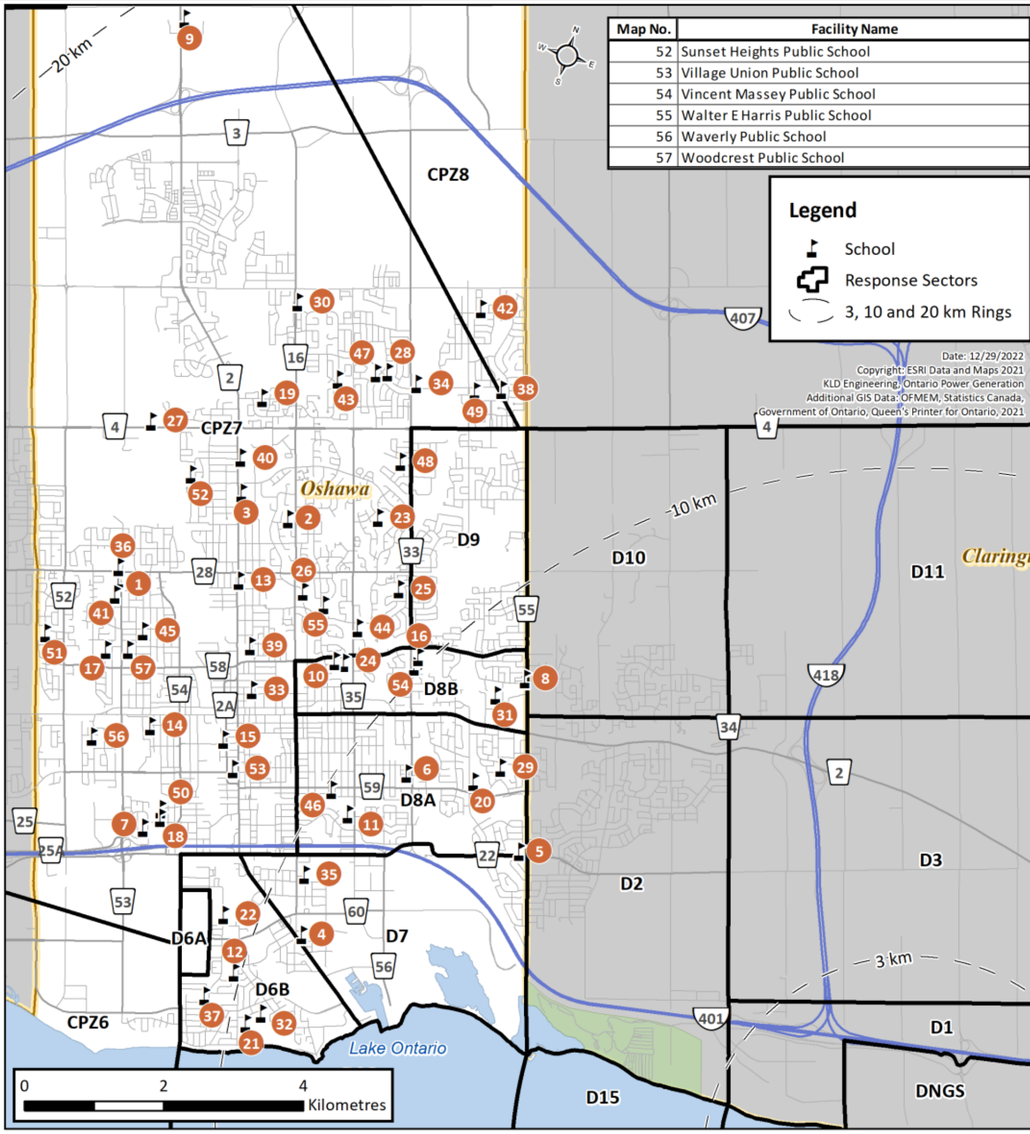



**Figure E-1. Schools within the DNGS PZs – Overview**



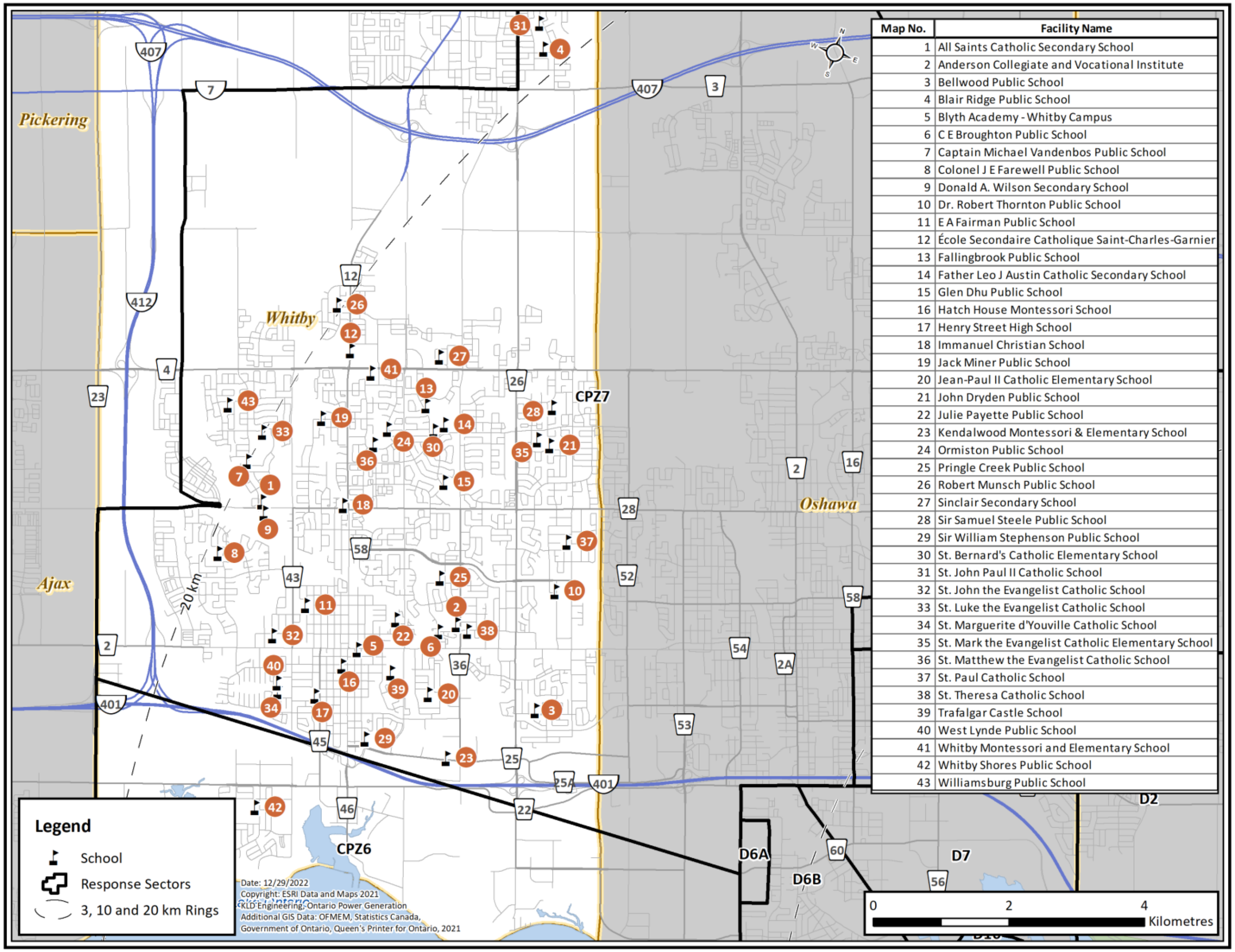

| Map No. | Facility Name |
|---|---|
| 1 | Blaisdale Montessori |
| 2 | Bowmanville High School |
| 3 | Central Public School |
| 4 | Charles Bowman Public School |
| 5 | Clarington Central Secondary School |
| 6 | Clarke High School |
| 7 | Courtice North Public School |
| 8 | Courtice Secondary School |
| 9 | Dr. Emily Stowe School |
| 10 | Dr. G.J. MacGillivray Public School |
| 11 | Dr. Ross Tilley Public School |
| 12 | Duke of Cambridge Public School |
| 13 | Durham Christian High School |
| 14 | Enniskillen Public School |
| 15 | Four Winds Montessori School |
| 16 | Good Shepherd Catholic Elementary School |
| 17 | Hampton Junior Public School |
| 18 | Harold Longworth Public School |
| 19 | Holy Family Catholic Elementary School |
| 20 | Holy Trinity Catholic Secondary School |
| 21 | John M. James School |
| 22 | Kirby Centennial Public School |
| 23 | Knox Christian School |
| 24 | Lydia Trull Public School |
| 25 | M J Hobbs Senior Public School |
| 26 | Monsignor Leo Cleary Catholic Elementary School |
| 27 | Mother Teresa Catholic Elementary School |
| 28 | Newcastle Public School |
| 29 | Orono Public School |
| 30 | Oxford Learning Academy |
| 31 | S.T. Worden Public School |
| 32 | Saint Elizabeth Catholic Elementary School |
| 33 | St. Joseph Catholic Elementary School |
| 34 | St. Stephen Catholic Secondary School |
| 35 | The Pines Senior Public School |
| 36 | Ummati School |
| 37 | Waverley Public School |

**Figure E-2. Schools within the Clarington Portion of the DNGS PZs**




| Map No. | Facility Name |
|---|---|
| 1 | Adelaide McLaughlin Public School |
| 2 | Beau Valley Public School |
| 3 | Blaisdale Montessori Oshawa Campus |
| 4 | Bobby Orr Public School |
| 5 | Campbell School |
| 6 | Clara Hughes Public School |
| 7 | College Hill Public School |
| 8 | College Park Elementary School |
| 9 | Columbus Private School |
| 10 | Coronation Public School |
| 11 | David Bouchard Public School |
| 12 | Dr C F Cannon Public School |
| 13 | DR S J Phillips Public School |
| 14 | Durham Alternative Secondary School |
| 15 | Durham Continuing Education |
| 16 | Eastdale Collegiate & Vocational Institute |
| 17 | Elementary School Antonine-Maillet |
| 18 | Elementary School Catholic Corpus-Christi |
| 19 | Father Joseph Venini Catholic School |
| 20 | Forest View Public School |
| 21 | G L Roberts Collegiate and Vocational Institute |
| 22 | Glen Street Public School |
| 23 | Gordon B Attersley Public School |
| 24 | Great Beginnings Montessori School |
| 25 | Harmony Heights Public School |
| 26 | Hillsdale Public School |
| 27 | Immanuel Christian School |
| 28 | Jeanne Sauvé Public School |
| 29 | John XXIII Catholic School |
| 30 | Kedron Public School |
| 31 | Kingsway College Private High School |
| 32 | Lakewoods Public School |
| 33 | Mary Street Community School |
| 34 | Maxwell Heights Secondary School |
| 35 | Monsignor John Pereyma Catholic Secondary School |
| 36 | Monsignor Paul Dwyer Catholic High School |
| 37 | Monsignor Philip Coffey Catholic School |
| 38 | Norman G. Powers Public School |
| 39 | O'Neill Collegiate and Vocational Institute |
| 40 | Queen Elizabeth Public School |
| 41 | R.S. McLaughlin CVI |
| 42 | Seneca Trail Public School |
| 43 | Sherwood Public School |
| 44 | Sir Albert Love Catholic School |
| 45 | St. Christopher Catholic School |
| 46 | St. Hedwig Catholic School |
| 47 | St. John Bosco Catholic School |
| 48 | St. Joseph Catholic School |
| 49 | St. Kateri Tekakwitha Catholic School |
| 50 | St. Thomas Aquinas Catholic School |
| 51 | Stephen G. Saywell Public School |
| 52 | Sunset Heights Public School |
| 53 | Village Union Public School |
| 54 | Vincent Massey Public School |
| 55 | Walter E Harris Public School |
| 56 | Waverly Public School |
| 57 | Woodcrest Public School |

**Figure E-3. Schools within the Oshawa Portion of the DNGS PZs**




| Map No. | Facility Name |
|---|---|
| 1 | All Saints Catholic Secondary School |
| 2 | Anderson Collegiate and Vocational Institute |
| 3 | Bellwood Public School |
| 4 | Blair Ridge Public School |
| 5 | Blyth Academy - Whitby Campus |
| 6 | C E Broughton Public School |
| 7 | Captain Michael Vandenbos Public School |
| 8 | Colonel J E Farewell Public School |
| 9 | Donald A. Wilson Secondary School |
| 10 | Dr. Robert Thornton Public School |
| 11 | E A Fairman Public School |
| 12 | École Secondaire Catholique Saint-Charles-Garnier |
| 13 | Fallingbrook Public School |
| 14 | Father Leo J Austin Catholic Secondary School |
| 15 | Glen Dhu Public School |
| 16 | Hatch House Montessori School |
| 17 | Henry Street High School |
| 18 | Immanuel Christian School |
| 19 | Jack Miner Public School |
| 20 | Jean-Paul II Catholic Elementary School |
| 21 | John Dryden Public School |
| 22 | Julie Payette Public School |
| 23 | Kendalwood Montessori & Elementary School |
| 24 | Ormiston Public School |
| 25 | Pringle Creek Public School |
| 26 | Robert Munsch Public School |
| 27 | Sinclair Secondary School |
| 28 | Sir Samuel Steele Public School |
| 29 | Sir William Stephenson Public School |
| 30 | St. Bernard's Catholic Elementary School |
| 31 | St. John Paul II Catholic School |
| 32 | St. John the Evangelist Catholic School |
| 33 | St. Luke the Evangelist Catholic School |
| 34 | St. Marguerite d'Youville Catholic School |
| 35 | St. Mark the Evangelist Catholic Elementary School |
| 36 | St. Matthew the Evangelist Catholic School |
| 37 | St. Paul Catholic School |
| 38 | St. Theresa Catholic School |
| 39 | Trafalgar Castle School |
| 40 | West Lynde Public School |
| 41 | Whitby Montessori and Elementary School |
| 42 | Whitby Shores Public School |
| 43 | Williamsburg Public School |

**Figure E-4. Schools within the Whitby Portion of the DNGS PZs**

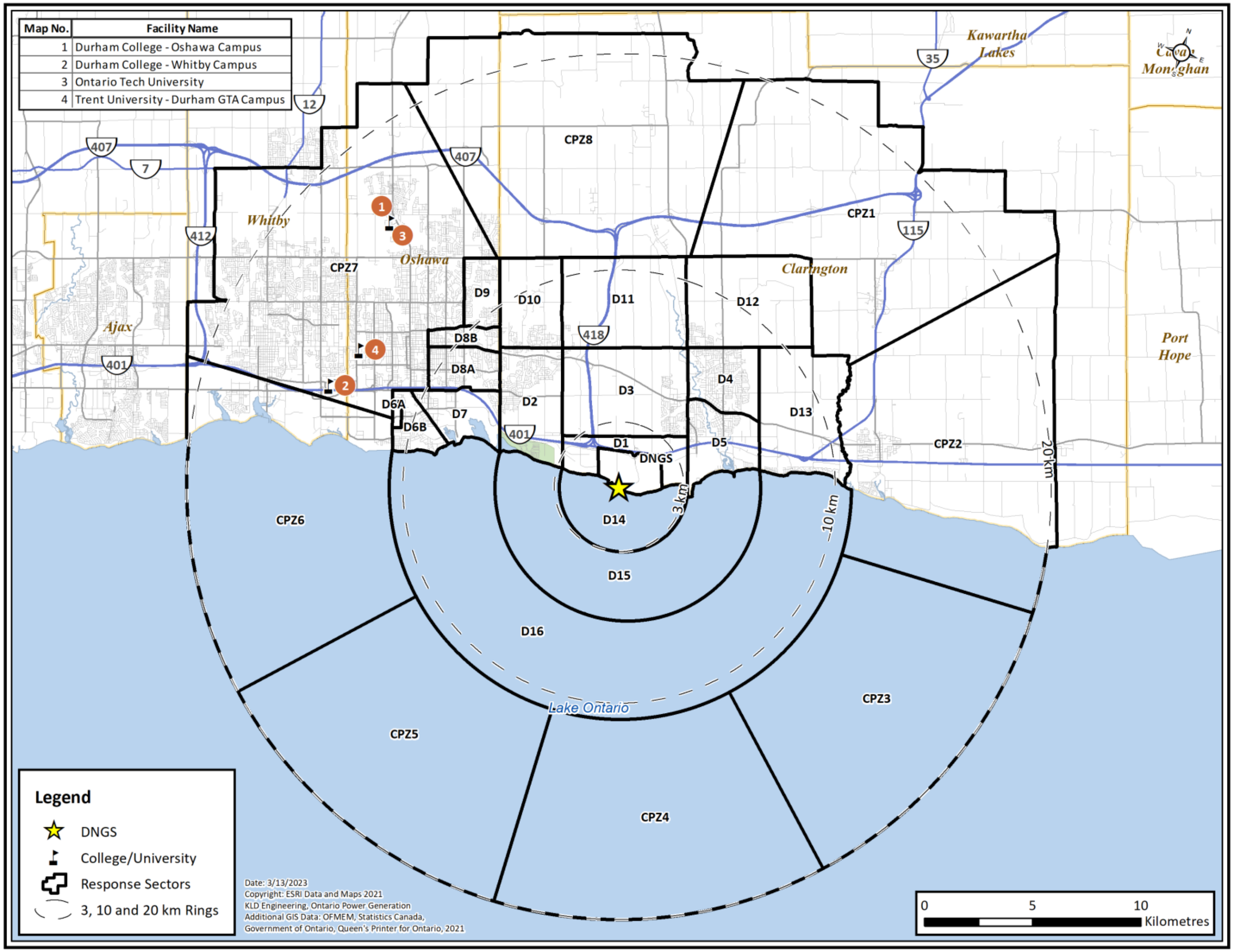
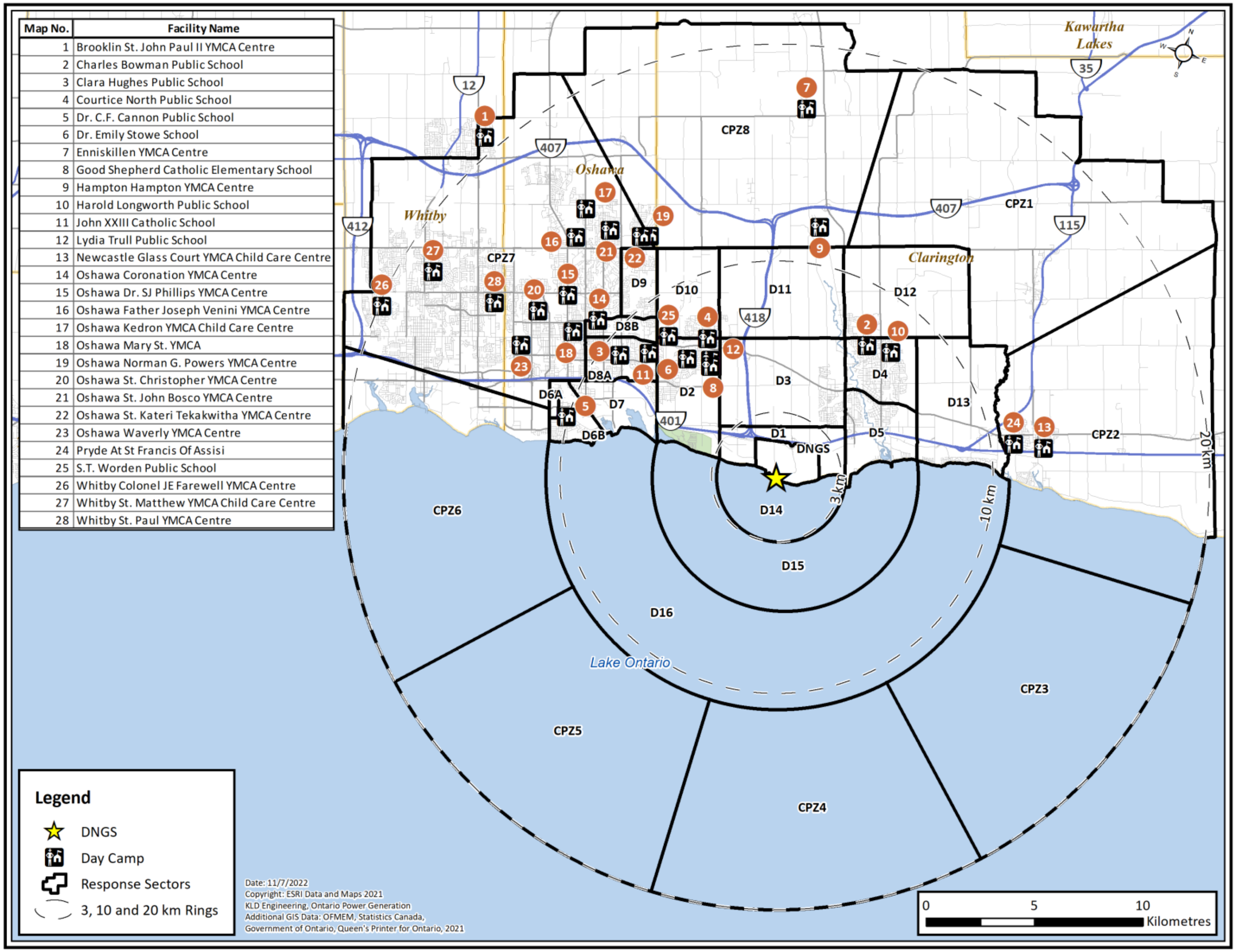



**Figure E-5. Colleges and Universities within the DNGS PZs**




| Map No. | Facility Name |
|---|---|
| 1 | Brooklin St. John Paul II YMCA Centre |
| 2 | Charles Bowman Public School |
| 3 | Clara Hughes Public School |
| 4 | Courtice North Public School |
| 5 | Dr. C.F. Cannon Public School |
| 6 | Dr. Emily Stowe School |
| 7 | Enniskillen YMCA Centre |
| 8 | Good Shepherd Catholic Elementary School |
| 9 | Hampton Hampton YMCA Centre |
| 10 | Harold Longworth Public School |
| 11 | John XXIII Catholic School |
| 12 | Lydia Trull Public School |
| 13 | Newcastle Glass Court YMCA Child Care Centre |
| 14 | Oshawa Coronation YMCA Centre |
| 15 | Oshawa Dr. SJ Phillips YMCA Centre |
| 16 | Oshawa Father Joseph Venini YMCA Centre |
| 17 | Oshawa Kedron YMCA Child Care Centre |
| 18 | Oshawa Mary St. YMCA |
| 19 | Oshawa Norman G. Powers YMCA Centre |
| 20 | Oshawa St. Christopher YMCA Centre |
| 21 | Oshawa St. John Bosco YMCA Centre |
| 22 | Oshawa St. Kateri Tekakwitha YMCA Centre |
| 23 | Oshawa Waverly YMCA Centre |
| 24 | Pryde At St Francis Of Assisi |
| 25 | S.T. Worden Public School |
| 26 | Whitby Colonel JE Farewell YMCA Centre |
| 27 | Whitby St. Matthew YMCA Child Care Centre |
| 28 | Whitby St. Paul YMCA Centre |

**Figure E-6. Day Camps within the DNGS PZs**

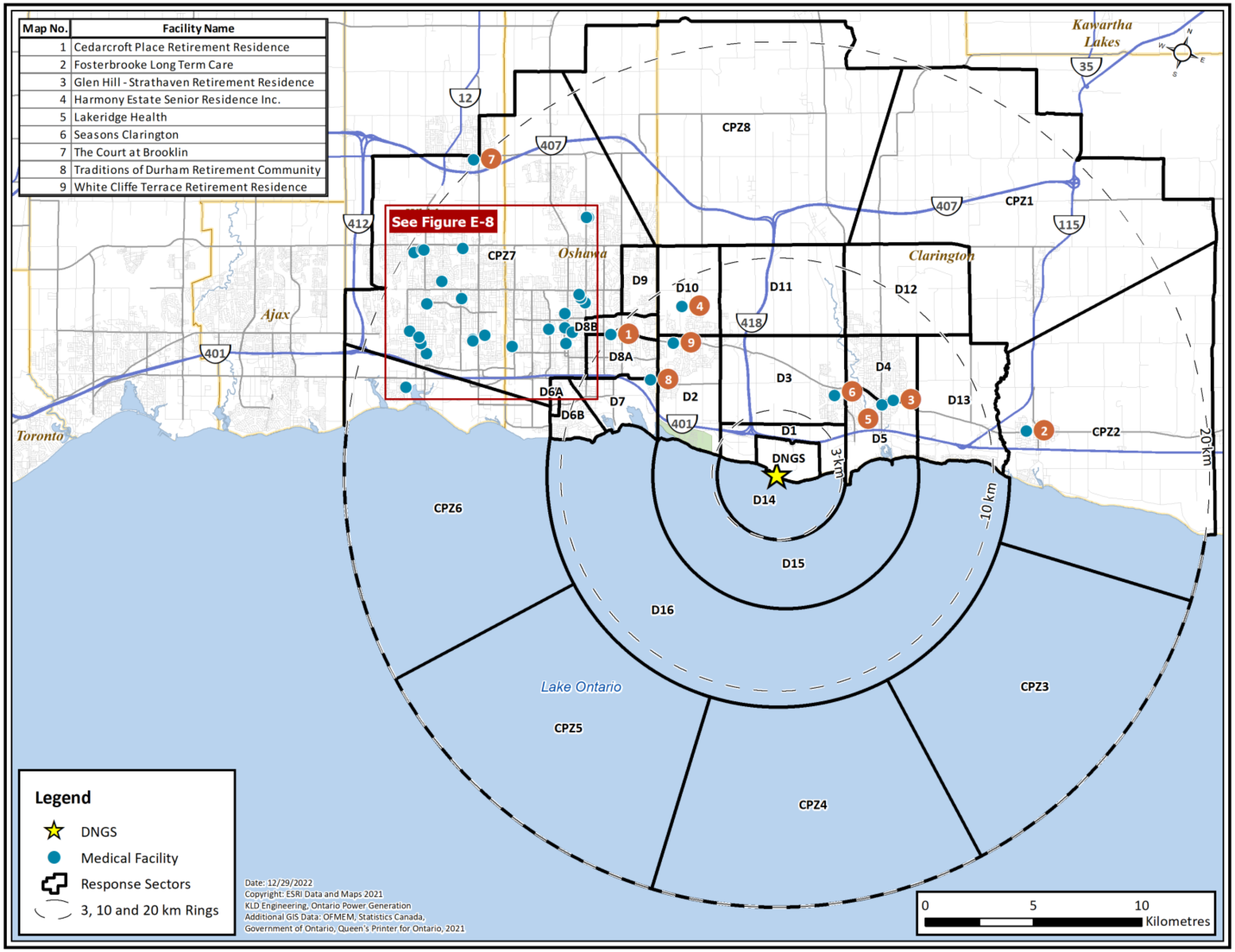



**Figure E-7. Medical Facilities within the DNGS PZs (1 of 2)**

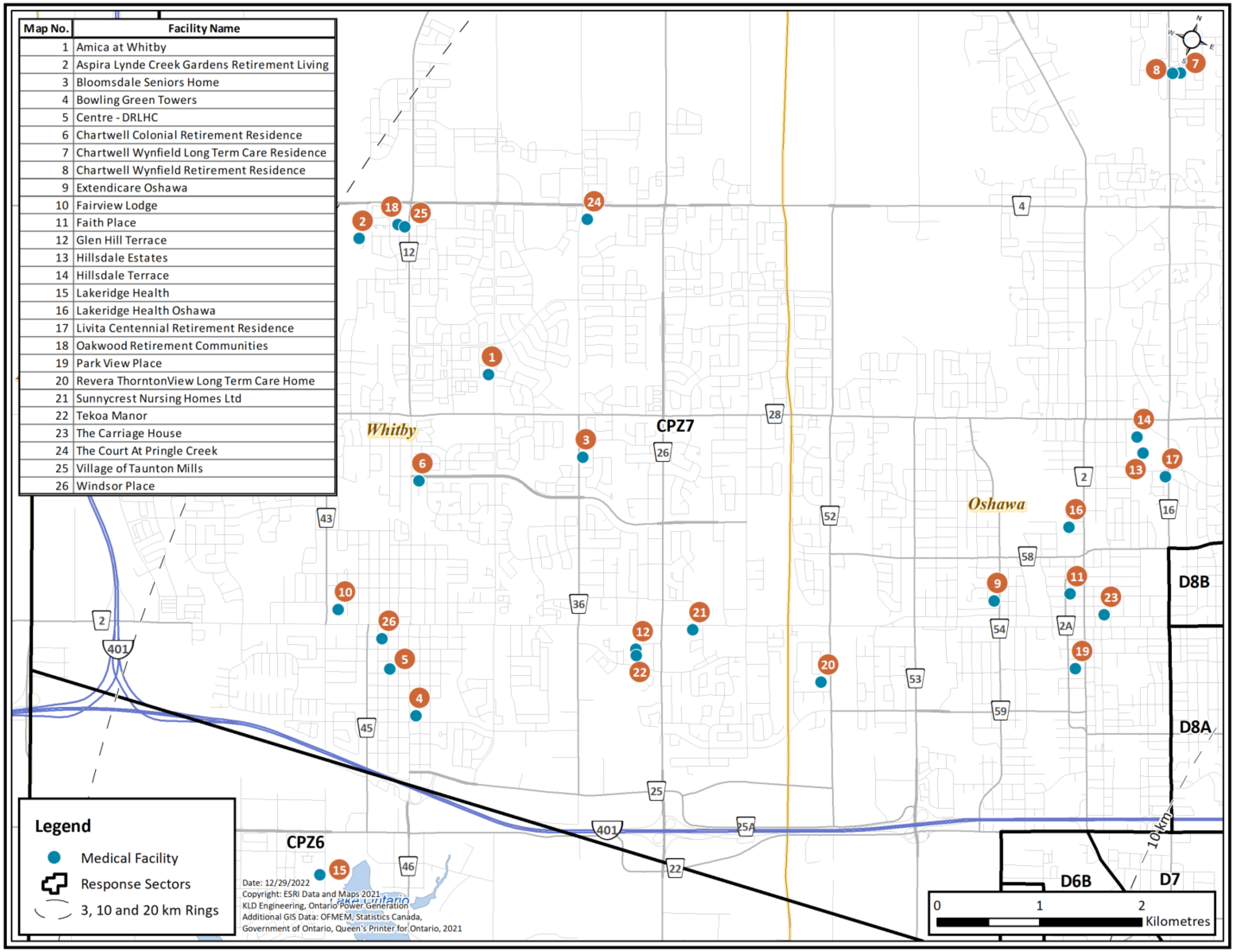



**Figure E-8. Medical Facilities within the DNGS PZs (2 of 2)**

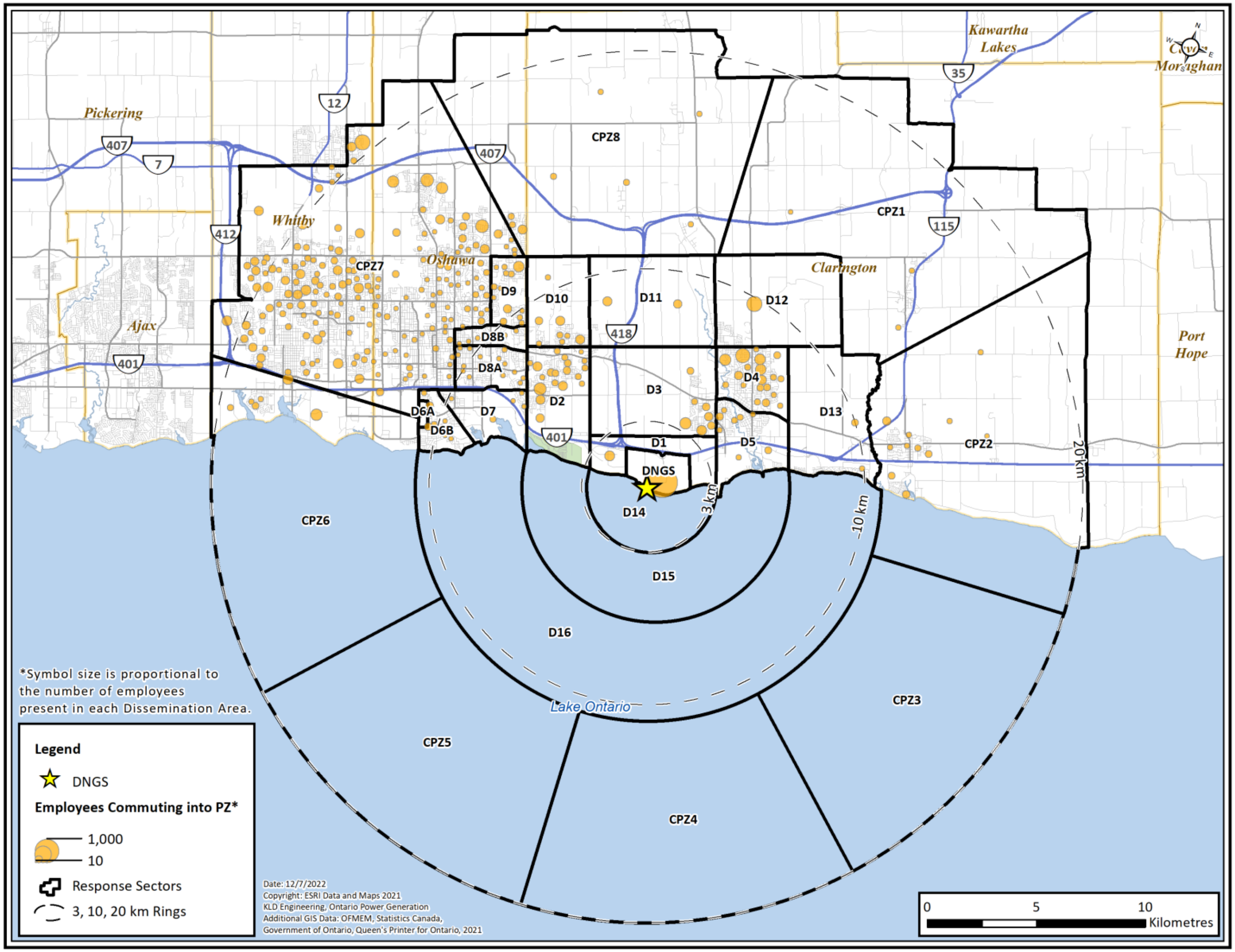



**Figure E-9. Major Employers within the DNGS PZs**

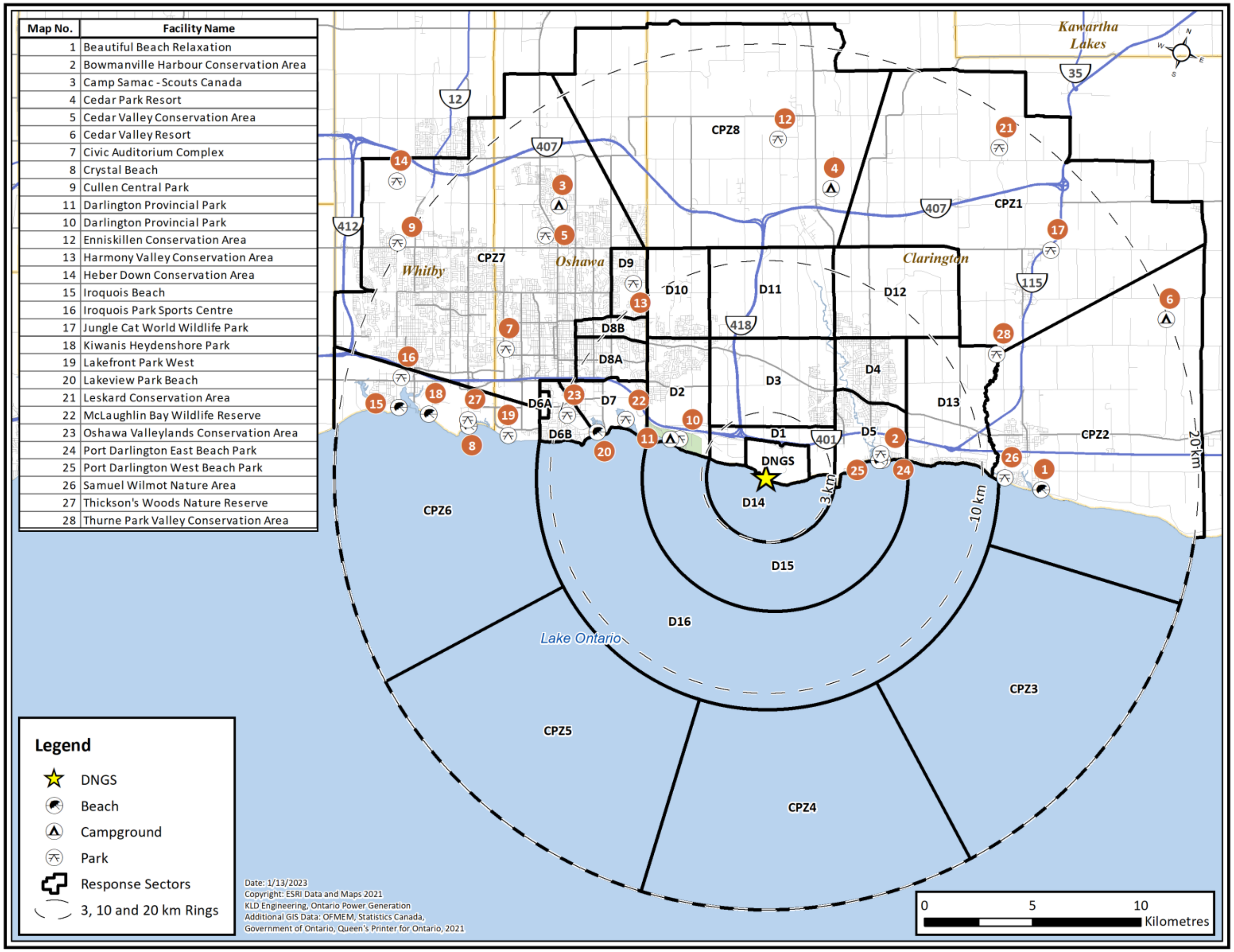



**Figure E-10. Beaches, Campgrounds and Parks within the DNGS PZs**

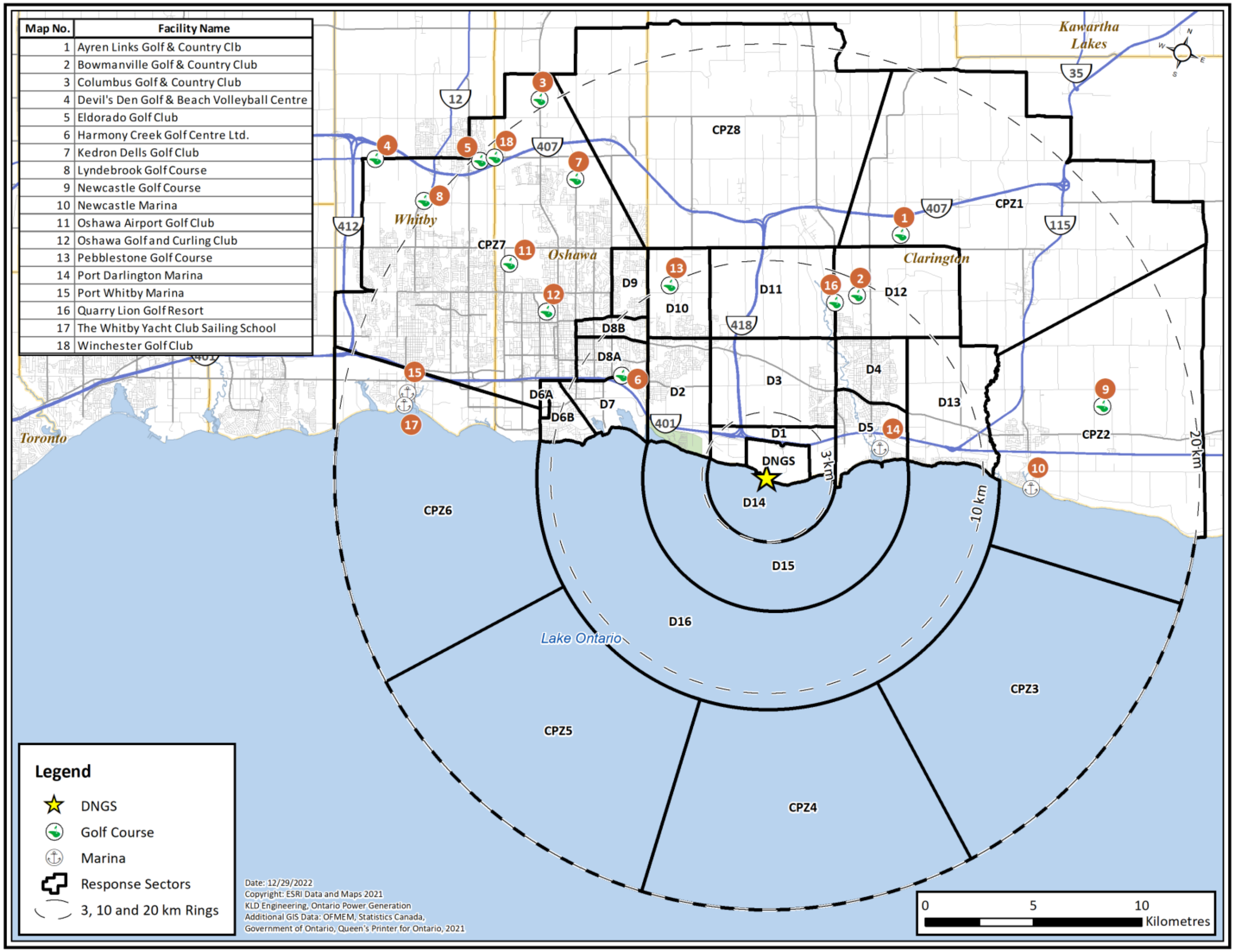
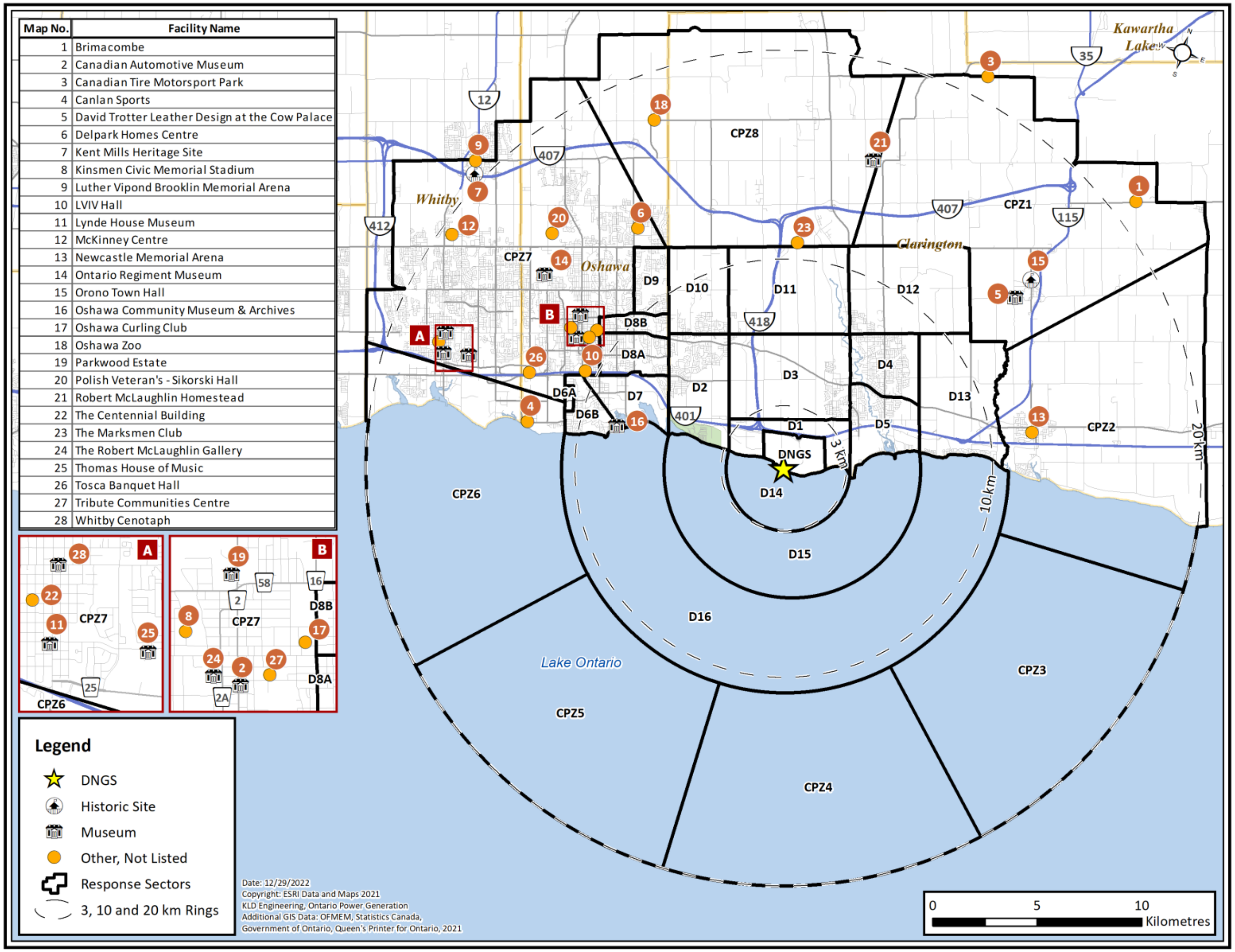



**Figure E-11. Golf Courses and Marinas within the DNGS PZs**




| Map No. | Facility Name |
|---|---|
| 1 | Brimacombe |
| 2 | Canadian Automotive Museum |
| 3 | Canadian Tire Motorsport Park |
| 4 | Canlan Sports |
| 5 | David Trotter Leather Design at the Cow Palace |
| 6 | Delpark Homes Centre |
| 7 | Kent Mills Heritage Site |
| 8 | Kinsmen Civic Memorial Stadium |
| 9 | Luther Vipond Brooklin Memorial Arena |
| 10 | LVIV Hall |
| 11 | Lynde House Museum |
| 12 | McKinney Centre |
| 13 | Newcastle Memorial Arena |
| 14 | Ontario Regiment Museum |
| 15 | Orono Town Hall |
| 16 | Oshawa Community Museum & Archives |
| 17 | Oshawa Curling Club |
| 18 | Oshawa Zoo |
| 19 | Parkwood Estate |
| 20 | Polish Veteran's - Sikorski Hall |
| 21 | Robert McLaughlin Homestead |
| 22 | The Centennial Building |
| 23 | The Marksmen Club |
| 24 | The Robert McLaughlin Gallery |
| 25 | Thomas House of Music |
| 26 | Tosca Banquet Hall |
| 27 | Tribute Communities Centre |
| 28 | Whitby Cenotaph |

**Figure E-12. Historic Sites, Museums and Other Recreational Areas within the DNGS PZs**

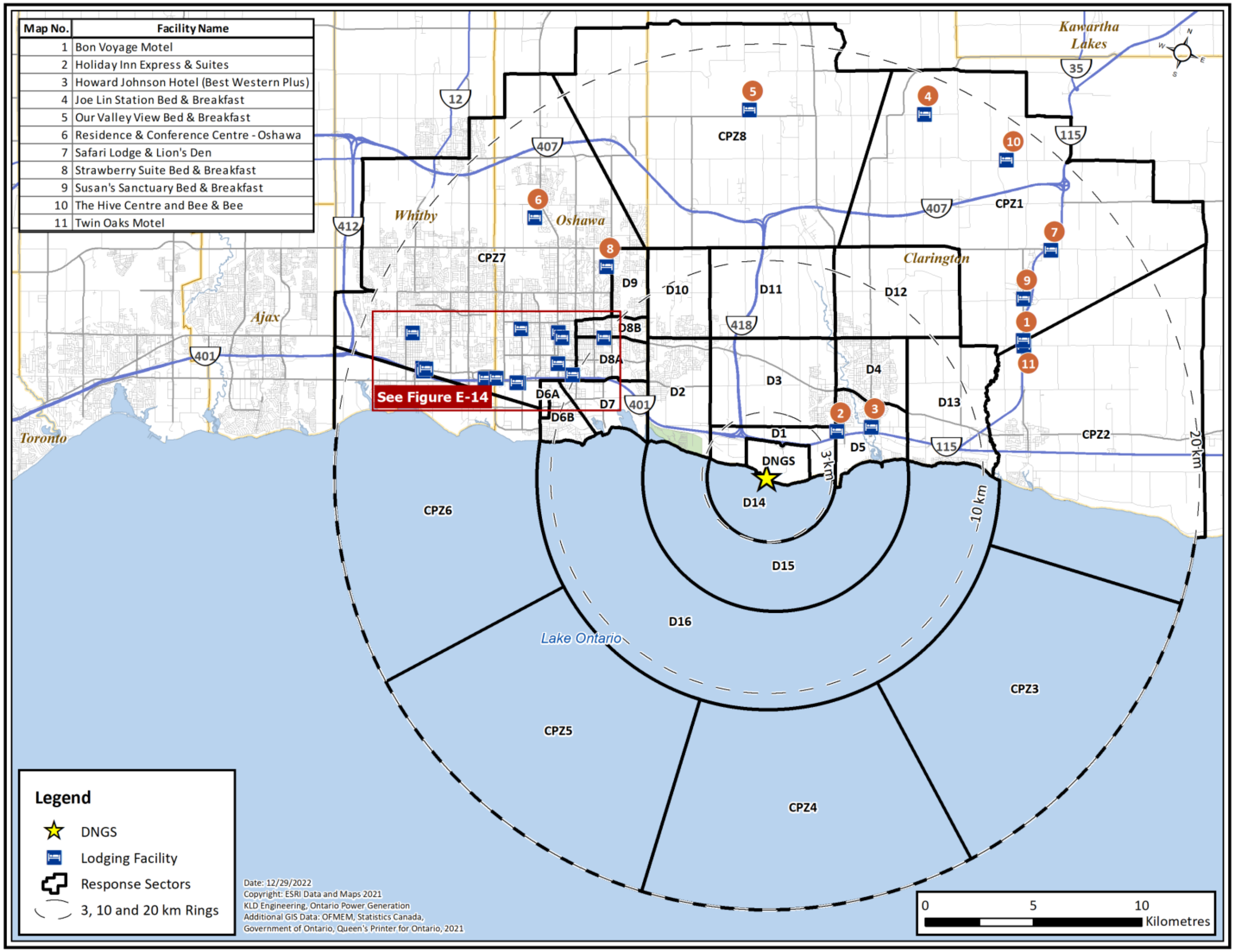
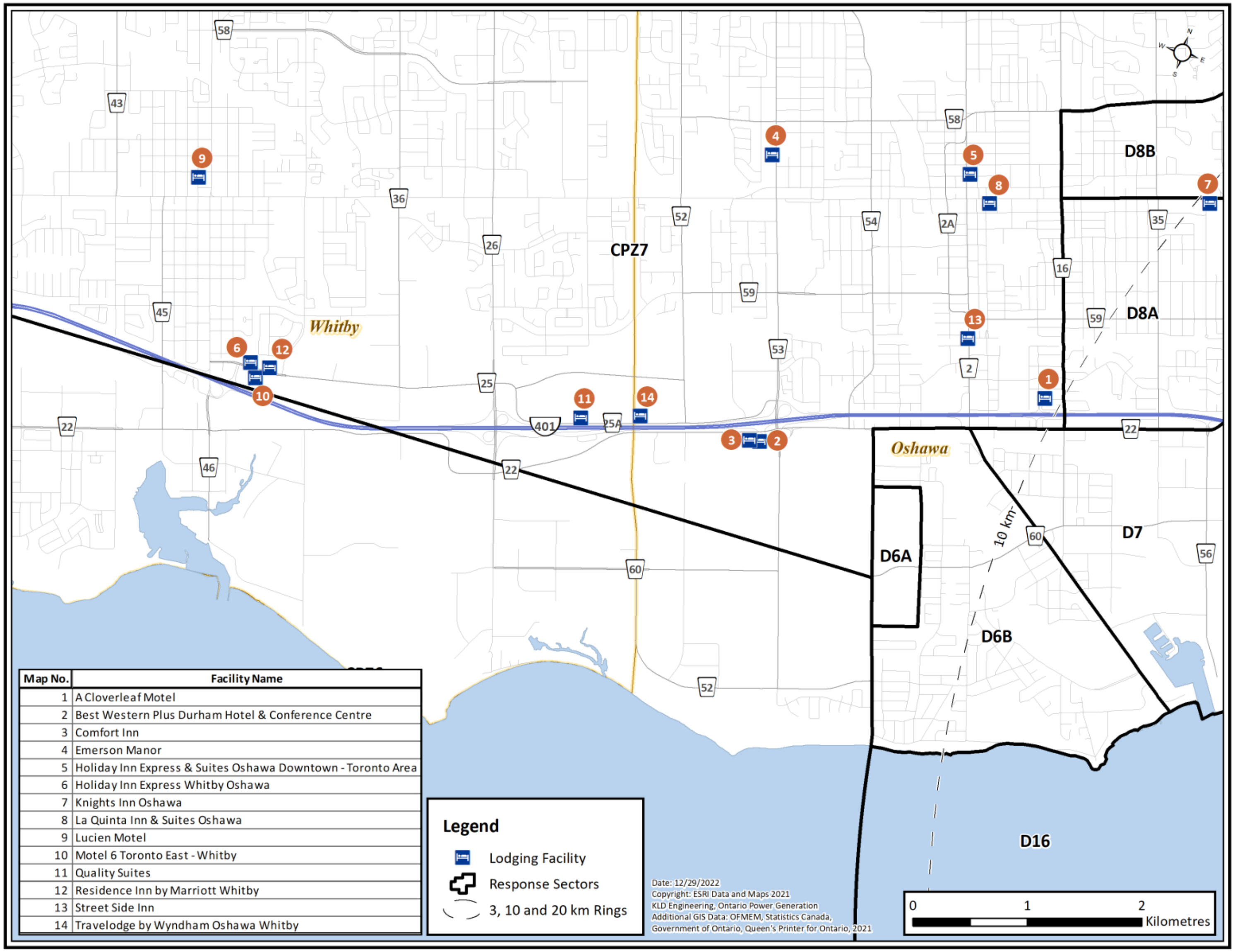



**Figure E-13. Lodging Facilities within the DNGS PZs (1 of 2)**




| Map No. | Facility Name |
|---|---|
| 1 | A Cloverleaf Motel |
| 2 | Best Western Plus Durham Hotel & Conference Centre |
| 3 | Comfort Inn |
| 4 | Emerson Manor |
| 5 | Holiday Inn Express & Suites Oshawa Downtown - Toronto Area |
| 6 | Holiday Inn Express Whitby Oshawa |
| 7 | Knights Inn Oshawa |
| 8 | La Quinta Inn & Suites Oshawa |
| 9 | Lucien Motel |
| 10 | Motel 6 Toronto East - Whitby |
| 11 | Quality Suites |
| 12 | Residence Inn by Marriott Whitby |
| 13 | Street Side Inn |
| 14 | Travelodge by Wyndham Oshawa Whitby |

**Figure E-14. Lodging Facilities within the DNGS PZs (2 of 2)**

# APPENDIX F

Demographic Survey

# F. DEMOGRAPHIC SURVEY

## F.1 Introduction

The development of evacuation time estimates for the Darlington Nuclear Generating Station (DNGS) study area requires the identification of travel patterns, car ownership and household size of the population within the Planning Zones[1]. Demographic information can be obtained from 2021 Statistics Canada Census data. The use of this data has several limitations when applied to emergency planning. First, the Census data does not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data does not contain attitudinal responses needed from the population of the planning zones (PZs) and consequently may not accurately represent the anticipated behavioural characteristics of the evacuating populace.

These concerns are addressed by conducting a demographic survey of a representative sample of the population within the PZ. The survey is designed to elicit information from the public concerning family demographics and estimates of response times to well defined events. The design of the survey includes a limited number of questions of the form "What would you do if …?" and other questions regarding activities with which the respondent is familiar ("How long does it take you to …?")

## F.2 Survey Instrument and Sampling Plan

Attachment A presents the final survey instrument used in this study. A draft of the instrument was submitted to stakeholders for comment. Comments were received and the survey instrument was modified accordingly, prior to conducting the survey. Following the completion of the instrument, a sampling plan was developed using the 2021 Statistic Canada data.

A sample size of approximately 380 **completed** survey forms yields results with a sampling error of ±5% at the 95% confidence level. The sample must be drawn from the PZ population. Consequently, a list of Forward Sortation Areas[2] (FSA) in the PZ was developed using GIS software. This list is shown in Table F-1. Along with each FSA, an estimate of the population and number of households in each area was determined by overlaying Census data and the PZ boundary, again using GIS software. The proportional number of desired completed survey interviews for each area was identified, as shown in Table F-1. Note that the average household size computed in Table F-1 was an estimate for sampling purposes and was not used in the ETE study.

[1] The Planning Zone represents the entire study area which includes the Automatic Action Zone, Detailed Planning Zone (Inner and Outer Rings) and the Contingency Planning Zones.

[2] Given the close proximity and similar demographics between the Pickering Nuclear Generating Station (PNGS) and the DNGS PZs, one demographic survey conducted which was used for both sites. The FSA used include FSA from both PZs.

The results of the survey exceeded the sampling plan. A total of 398 completed samples were obtained within the Contingency Planning Zones (CPZs)[3] of DNGS and PNGS, which corresponds to a sampling error of ±4.91% at the 95% confidence level. Table F-1 also shows the number of samples obtained within each FSA.

## F.3 Survey Results

The results of the survey fall into two categories. First, the household demographics of the area can be identified. Demographic information includes such factors as household size, automobile ownership, and automobile availability. The distributions of the time to perform certain pre-evacuation activities are the second category of survey results. These data are processed to develop the trip generation distributions used in the evacuation modelling effort, as discussed in Section 5.

A review of the survey instrument reveals that several questions have a "decline to state" entry for a response. It is an accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a decline to state response for a few questions or who refuses to answer a few questions. To address the issue of occasional decline to state responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the "decline to state" responses are ignored, and the distributions are based upon the positive data that is acquired.

### F.3.1 Household Demographic Results

<u>Household Size</u>

Figure F-1 presents the distribution of household size within the PZ based on the responses to the 2022 demographic survey. According to the responses, the average household contains 3.20 people. The estimated average household size of the PZ from the 2021 Statistics Canada Census data is 2.95 people. The percent difference between the 2021 Census data and survey data is 8.5%, which exceeds the sampling error of ±4.91%, as discussed in Section F.2. It was decided that the Canadian Census estimate of 2.95 people per household should be used for this study, as it will result in a more conservative number of evacuating vehicles (see Section 3.1 – the number of evacuating vehicles is determined by dividing population by average household size and then multiplying by the number of vehicles per household. Using a smaller average household size will result in a larger number of evacuating vehicles.)

<u>Automobile Ownership</u>

The average number of automobiles available per household in the PZ is 2.13. It should be noted that two households (0.50% of households) stated they do not have access to an automobile. The distribution of automobile ownership is presented in Figure F-2. Figure F-3 and Figure F-4 present the automobile availability by household size. As expected, a majority of households with 2 or more people have access to at least one vehicle.

[3] CPZ represents 0 to 20 km from the plants.

Ridesharing

Approximately 71% of households responded that they would share a ride with a neighbour, relative, or a friend, if a car was not available to them when advised to evacuate in the event of an emergency, as shown in Figure F-5.

Commuters

Figure F-6 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data shows an average of 2.10 commuters in each household, and about 91% of households have at least one commuter.

Commuter Travel Modes

Figure F-7 presents the mode of travel that commuters use on a daily basis. The vast majority (68%) of commuters use their private automobiles to travel to work/college, 4% use rail, 8% use a bus, 8% walk or bike and 12% carpool. The data shows an average of 1.15 commuters per vehicle, assuming 2 people per vehicle – on average – for carpools. Based on discussions with Durham Emergency Management, employee occupancy rate of 1 employee per vehicle will be used for major employers in the Durham Region (which encompasses the entire PZ) and 1.15 commuters per vehicle (as per demographic survey results) outside of the Durham Region.

For those that responded they commute using rail (4%), 68% stated they would return to their vehicle parked at the rail station and of those who would return to their vehicle, 95% stated they would return home before evacuating.

Impact of Coronavirus Disease 2019 (COVID-19) on Commuters

Figure F-8 presents the distribution of the number of commuters in each household that were temporarily impacted by the COVID-19 pandemic. Approximately 60% of households indicated someone in their household had a work and/or school commute that was temporarily impacted by the COVID-19 pandemic. The data shows an average of 1.21 commuters per household were affected by the COVID-19 pandemic. As the majority of people responded they had someone's commute impacted by COVID-19 pandemic, the commuter patterns were compared to the telephone survey conducted for the previous ETE study (2019) for DNGS and PNGS. As discussed below, the commuter travel patterns are very similar between the telephone survey and the demographic survey.

Functional or Transportation Needs

Figure F-9 presents the distribution of the number of individuals with functional or transportation needs. Approximately 4% of households (17 households out of 398 households total) responded to the survey as having functional or transportation needs. A total of 28 people were identified as having functional and/or transportation needs in those 17 households: 16 require a bus, seven require a medical bus/van, two require a wheelchair accessible van, and 3 require an ambulance. Of the 17 households that responded having an individual with functional or transportation need, 14 households stated they have not registered with local/provincial agencies for assistance (in the event there is a need for emergency evacuation) and three households declined to respond.

Seasonal Residents

Approximately 6% of the surveyed households (25 households) that they stated they have seasonal residents. As shown in Figure F-10, 68% stated that 1 household member is considered a seasonal resident; 20% have 2 seasonal residents; and remaining 12% have 4 seasonal residents. Approximately 63% of the seasonal residents stay away from home during the Summer and the remaining 37% stay away during the Fall, Winter, and/or Spring seasons.

Evacuation Method

Approximately 99% (392 households) of the surveyed households stated they would use a personal vehicle for an emergency evacuation. Only one household (0.25%) would rideshare with a neighbour or friend, one household (0.25% of households) would use a train and two households (0.5% households) would choose not to evacuate. The one household who responded they would evacuate by train during an emergency evacuation responded that they would evacuate by bus if the train was unavailable.

### F.3.2 Evacuation Response

Several questions were asked to gauge the population's response to an emergency. These are now discussed:

***"How many of the vehicles would your household use during an evacuation?"*** The response is shown in Figure F-11. On average, evacuating households would use 1.37 vehicles.

***"Would your family await the return of other family members prior to evacuating the area?"*** Of the survey participants who responded, about 72% said they would await the return of other family members before evacuating and nearly 28% indicated that they would not await the return of other family members, as shown in Figure F-12.

***"Emergency officials advise you to take shelter at home in an emergency. Would you?"*** This question is designed to elicit information regarding compliance with instructions to shelter in place. The results indicate that about 83% of households who are advised to shelter in place would do so; the remaining 17% would choose to evacuate the area.

Note the baseline ETE study assumes 30% of households will not comply with the shelter advisory, as per discussions with OPG and the OROs. The data obtained above is about 43% less than the baseline assumption of 30%. A sensitivity study was conducted to estimate the impact of shadow evacuation non-compliance of shelter advisory on ETE – see Table M-2 in Appendix M.

***"Emergency officials advise you to take shelter at home now in an emergency and possibly evacuate later while people in other areas are advised to evacuate now. Would you?"*** This question is designed to elicit information specifically related to the possibility of a staged evacuation. That is, asking a population to shelter in place now and to evacuate after a specified period of time.

As shown in Figure F-13, results indicate that nearly 66% of households would follow instructions and delay the start of evacuation until so advised, while the remaining 34% would choose to begin evacuating immediately.

***"Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?"*** This question is designed to elicit information regarding the destination of evacuees in case of an evacuation. Approximately 46% of households indicated that they would evacuate to a friend or relative's home, 5% to a reception/evacuation centre, 9% to a hotel, motel or campground, 17% to a second or seasonal home, and the remaining 23% answered other/don't know to this question, as shown in Figure F-14.

***"In the event of an emergency evacuation, would you use a toll road at any point along your route?"*** Based on the responses to the survey, over half (56%) of the households would use a toll road during an emergency evacuation, 19% of households would use the toll road, if tolls are waived, and the remaining 25% would not use any toll road at any point of their evacuation route.

***"If you had a household pet, would you take your pet with you if you were asked to evacuate the area?"*** Based on the responses to the survey, about 98% of households have a family pet. Of the households with pets, nearly 36% indicated that they would take their pets with them to a shelter, about 61% indicated that they would take their pets somewhere else and only 3% would leave their pet at home, as shown Figure F-15. Of the households that would evacuate with their pets, 98% indicated that they have sufficient room in their vehicle to evacuate with their pet(s)/animal(s), 1% said they did not, and 1% would use a trailer.

***"What type of pet(s) and/or animal(s) do you have?"*** Based on the responses to the survey, 93.3% of households with a pet have a household pet (dog, cat, bird, reptile, fish, guinea pig, or hamster) and 2.4% have farm animals (horse, chicken, or cow) and the remaining 4.4% have other large or small pets/animals.

### F.3.3 Time Distribution Results

The survey asked several questions about the amount of time it takes to perform certain pre-evacuation activities. These activities involve actions taken by residents during the course of their day-to-day lives. Thus, the answers fall within the realm of the responder's experience.

As discussed in Section F.3.1 and shown in Figure F-8, the COVID-19 pandemic impacted about 60% of the commuters in the PZ. To minimize uncertainty in the commuting patterns obtained and resulting estimated trip generation times, data from the previous survey [2012 (PNGS) and 2018 (DNGS)] were compared to the results of this survey for the distributions involving commuters (time to prepare to leave work/college and time to travel home from work/college).

For this reason, both the results of this survey, and the results of the previous surveys for these questions are discussed herein. Due to the similar patterns between the two survey results [2022 (both) and 2018 (DNGS)] and the close endpoints to the graphs (within 10 to 15 minutes), the results from this survey [labeled as "2022 (both)" in the graphs] are deemed acceptable for use in this study.

The mobilization distributions provided below are the result of having applied the analysis described in Section 5.4.1 on the component activities of the mobilization.

***"How long does it take the commuter to complete preparation for leaving work or college?"*** Figure F-16 presents the cumulative distribution; in all cases, the activity is completed within 50 minutes. Approximately 96% can leave within 30 minutes. In the previous study [i.e., 2019 (DNGS)], the activity was completed by 60 minutes and 92% could leave within 30 minutes.

***"How long would it take the commuter to travel home?"*** Figure F-17 presents the time to travel home for those who commute to work or college. About 94% (91% in the previous study) of commuters can arrive home within 60 minutes of leaving work/college; all within 105 minutes (120 minutes in the previous study). In comparison, the 2022 distribution curve is shifted to the left resulting in a little less conservative estimate for the time needed to travel home.

***"How long would it take the family to pack clothing, secure the house, and load the car?"*** Figure F-18 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities.

The distribution shown in Figure F-18 has a long "tail." About 89% of households can be ready to leave home within 90 minutes; the remaining households require up to an additional 1 hour and 30 minutes.

***"How long would it take you to clear 15 to 20 centimetres of snow from your driveway?"*** During adverse, snowy weather conditions, an additional activity must be performed before residents can depart on the evacuation trip. Although snow scenarios assume that the roads and highways have been ploughed and are passable (albeit at lower speeds and capacities), it may be necessary to clear a private driveway prior to leaving the home so that the vehicle can access the street.

Approximately 89% of households can have their car cleared and the driveway passable within 45 minutes; the remaining households would require up to an additional hour to begin their evacuation trip, as shown in Figure F-19. As shown in the graph, only 22% of households would not shovel out and would just begin their evacuation trip (having a zero-shovel time).

### F.3.4 Emergency Communications

***"At your place of residence, how reliable is your cell phone signal?"*** This question is designed to elicit information regarding the ability to be notified in case of an evacuation.

Majority (92.9%) of households indicated that they have very reliable signal to receive texts and phone calls, 3.3% indicated that their signal is reliable for text messages only and remaining 3.8% indicated that they either do not always receive cell communications at their residence or do not have cell service at their residence, as shown in Figure F-20.

***"Emergency management officials in your region/province may send text messages, similar to AMBER Alerts, with emergency directions for the public during an emergency. How likely would you be to take action on these directions, if you received the message?"*** This question is designed to elicit information regarding the likelihood of an individual to take action based on emergency management officials' guidelines.

The majority (64.3%) of households indicated that they are highly likely to take action on these directions, 29.4% indicated likely, 3.8% indicated neither likely nor unlikely (neutral), and the remaining 2.5% (10 households) stated unlikely or strongly unlikely to take action on emergency management officials' directions, as shown in Figure F-21.

***"Which of the following emergency communication methods do you think is most likely to alert you at your residence?"*** This question is designed to elicit information regarding the most efficient way to alert residents within the PZ.

Majority (73.7%) of households indicated that a emergency alert text message from emergency officials would be most likely to alert them at their residence, 16.9% indicated that a siren sounding near their home, 2.8% indicated an alert broadcast on the radio, 4% indicated an alert broadcast on the television, 2% indicated that a phone call/text message from a family member, friend or neighbour, 0.3% (one household) indicated that information on Facebook/Twitter, and remaining 0.3% (one household) indicated other communication methods would be the most likely way to alert them at their residence, as shown in Figure F-22.

**Table F-1. Demographic Survey Sampling Plan**

| FSA | CPZ Pop in FSA | CPZ HH in FSA | Desired Sample | Sample Obtained |
|---|---|---|---|---|
| L0A | 1,021 | 368 | 0 | 10 |
| L0B | 7,920 | 2,854 | 2 | 18 |
| L0H | 1,055 | 353 | 0 | 0 |
| L1B | 12,996 | 5,059 | 4 | 18 |
| L1C | 50,223 | 17,713 | 14 | 63 |
| L1E | 27,831 | 9,459 | 7 | 36 |
| L1G | 44,502 | 19,104 | 15 | 19 |
| L1H | 31,206 | 13,094 | 10 | 7 |
| L1J | 42,687 | 16,991 | 13 | 8 |
| L1K | 43,397 | 13,475 | 11 | 15 |
| L1L | 12,845 | 3,716 | 3 | 3 |
| L1M | 23,978 | 7,228 | 6 | 8 |
| L1N | 48,825 | 18,771 | 15 | 27 |
| L1P | 21,910 | 6,772 | 5 | 9 |
| L1R | 42,416 | 13,214 | 10 | 19 |
| L1S | 41,434 | 15,449 | 12 | 24 |
| L1T | 52,752 | 15,039 | 12 | 20 |
| L1V | 56,032 | 18,771 | 15 | 25 |
| L1W | 18,428 | 7,088 | 6 | 15 |
| L1X | 21,280 | 6,365 | 5 | 9 |
| L1Y | 1,922 | 687 | 1 | 0 |
| L1Z | 32,482 | 9,000 | 7 | 14 |
| L3P | 37,660 | 12,802 | 10 | 2 |
| L3R | 32,875 | 10,636 | 8 | 2 |
| L3S | 55,585 | 15,021 | 12 | 0 |
| L6B | 34,556 | 10,065 | 8 | 3 |
| L6C | 23,079 | 6,872 | 5 | 1 |
| L6E | 38,557 | 11,703 | 9 | 1 |
| L6G | 8,102 | 4,281 | 3 | 1 |
| M1B | 65,818 | 20,599 | 16 | 3 |
| M1C | 34,874 | 11,144 | 9 | 5 |
| M1E | 48,669 | 17,552 | 14 | 3 |
| M1G | 31,064 | 10,373 | 8 | 1 |
| M1H | 23,538 | 8,470 | 7 | 1 |
| M1J | 37,725 | 12,956 | 10 | 0 |
| M1K | 47,857 | 17,615 | 13 | 1 |
| M1L | 13,458 | 4,275 | 3 | 0 |
| M1M | 22,351 | 8,285 | 6 | 2 |
| M1N | 14,641 | 5,865 | 5 | 1 |
| M1P | 46,008 | 16,735 | 13 | 0 |
| M1R | 16,947 | 5,878 | 5 | 1 |
| M1S | 37,822 | 13,368 | 10 | 2 |
| M1T | 29,471 | 11,062 | 9 | 0 |

| FSA | CPZ Pop in FSA | CPZ HH in FSA | Desired Sample | Sample Obtained |
|---|---|---|---|---|
| M1V | 50,845 | 15,972 | 12 | 0 |
| M1W | 32,295 | 11,405 | 9 | 1 |
| M1X | 14,806 | 3,711 | 3 | 0 |
| **Total** | **1,435,745** | **487,215** | **380** | **398** |
| **Average Household Size** | **2.95** | | | |

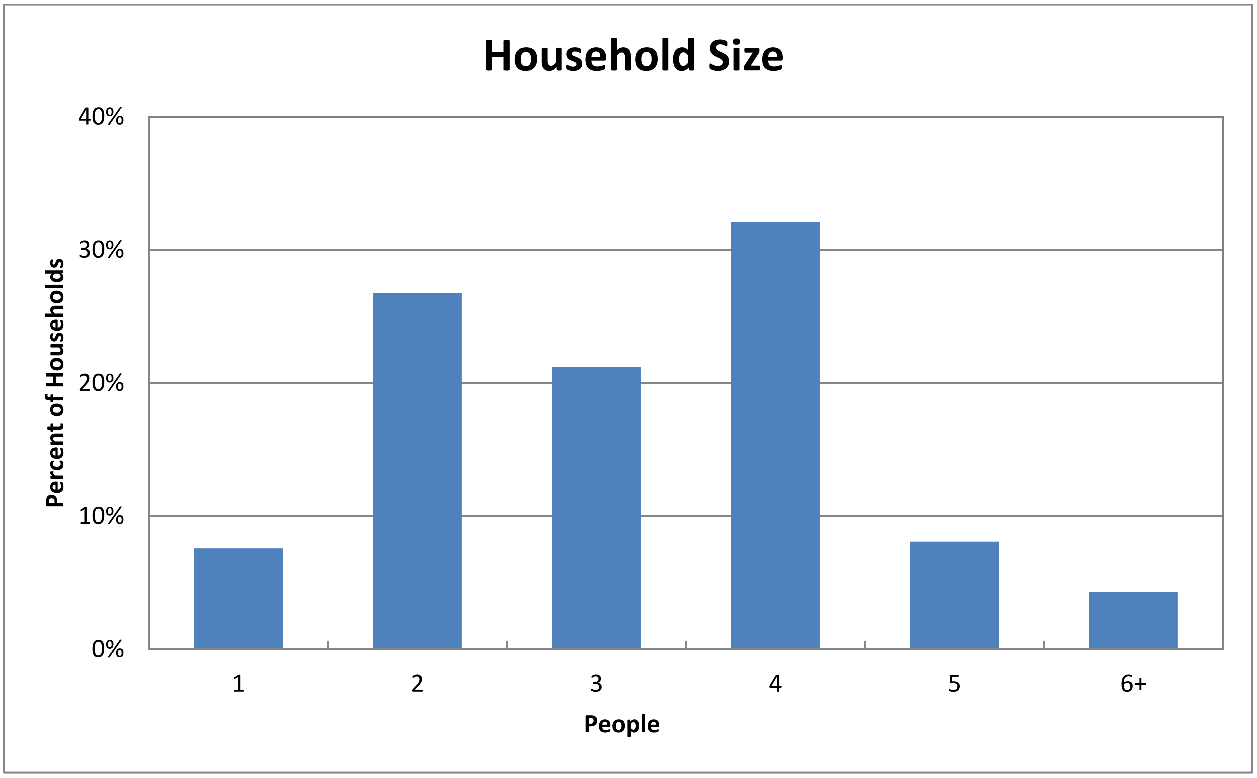



**Figure F-1. Household Size in the Planning Zone**

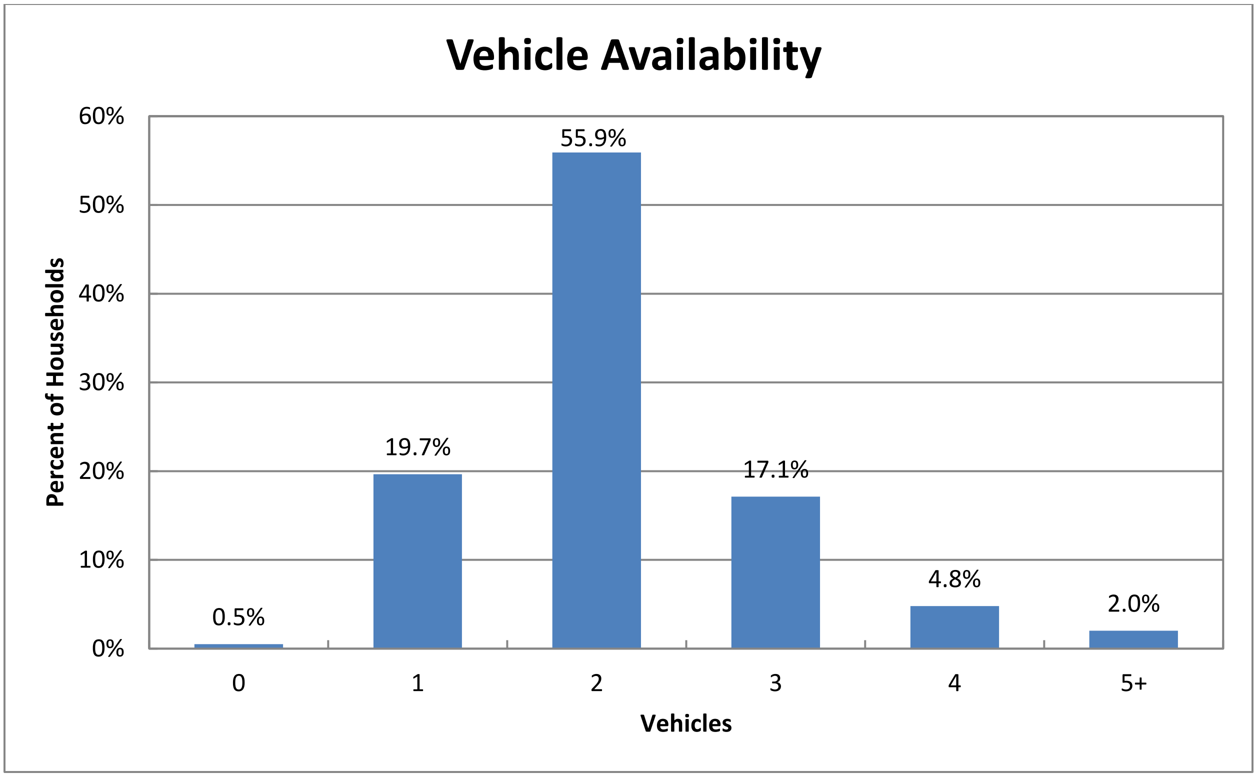



**Figure F-2. Household Vehicle Availability**

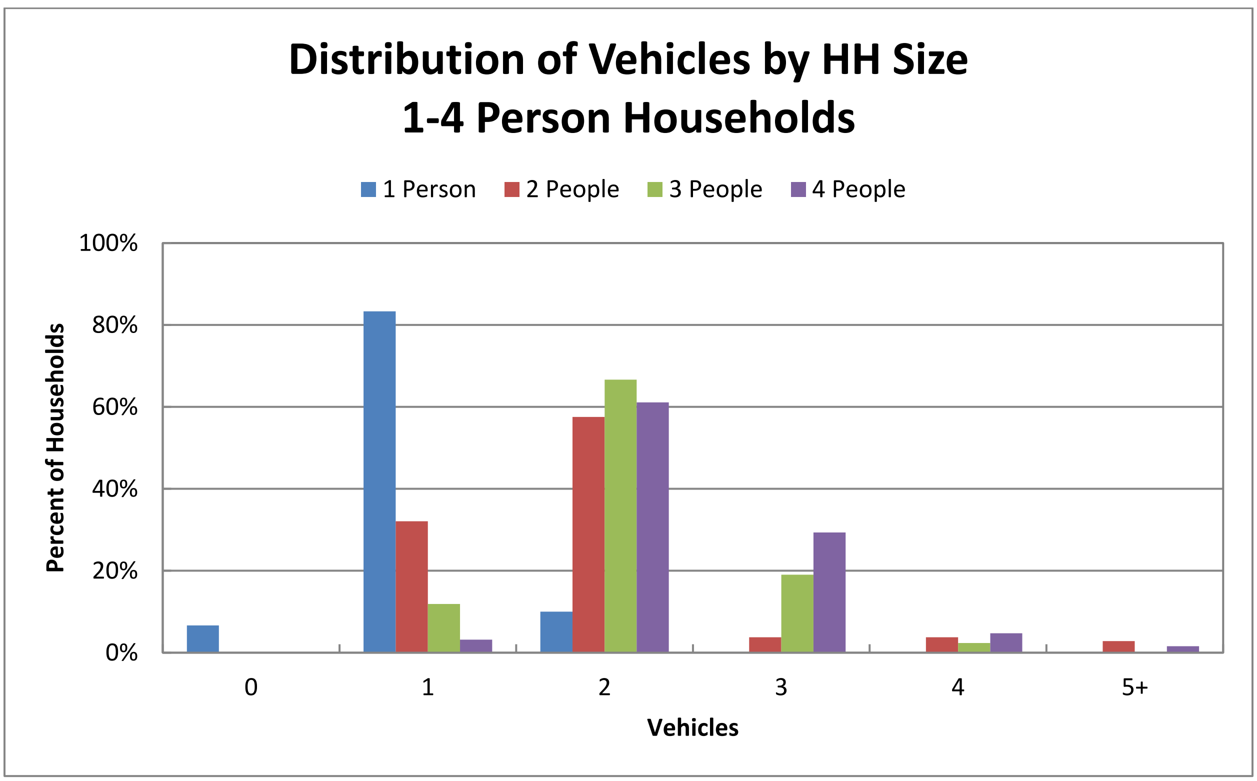



**Figure F-3. Vehicle Availability - 1 to 4 Person Households**

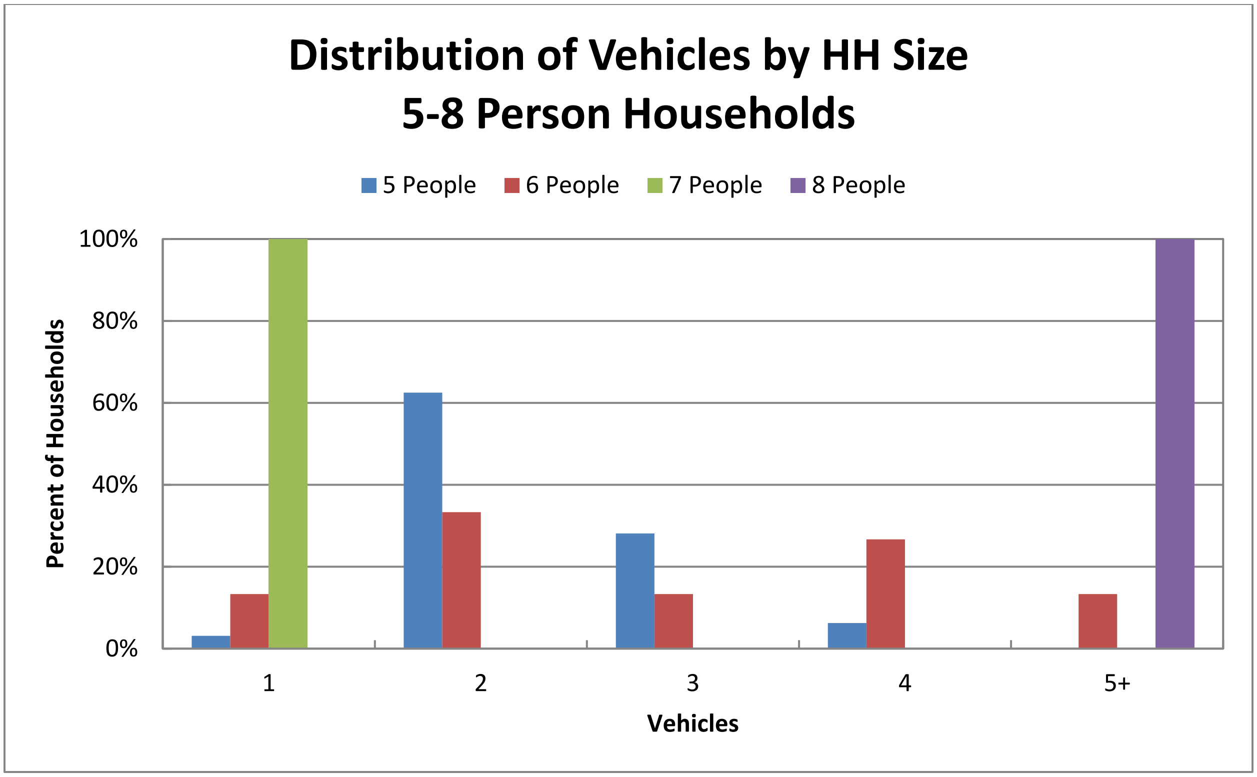



**Figure F-4. Vehicle Availability - 5 to 8 Person Households**

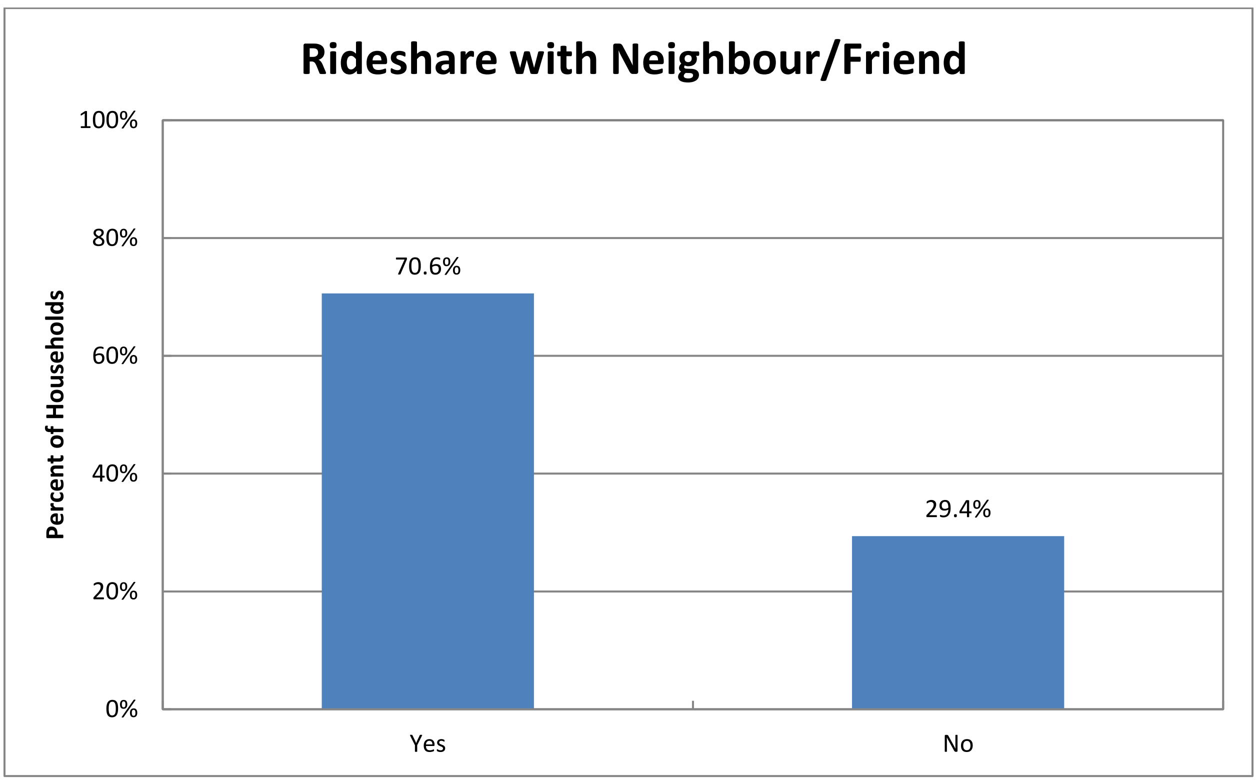



**Figure F-5. Household Ridesharing Preference**

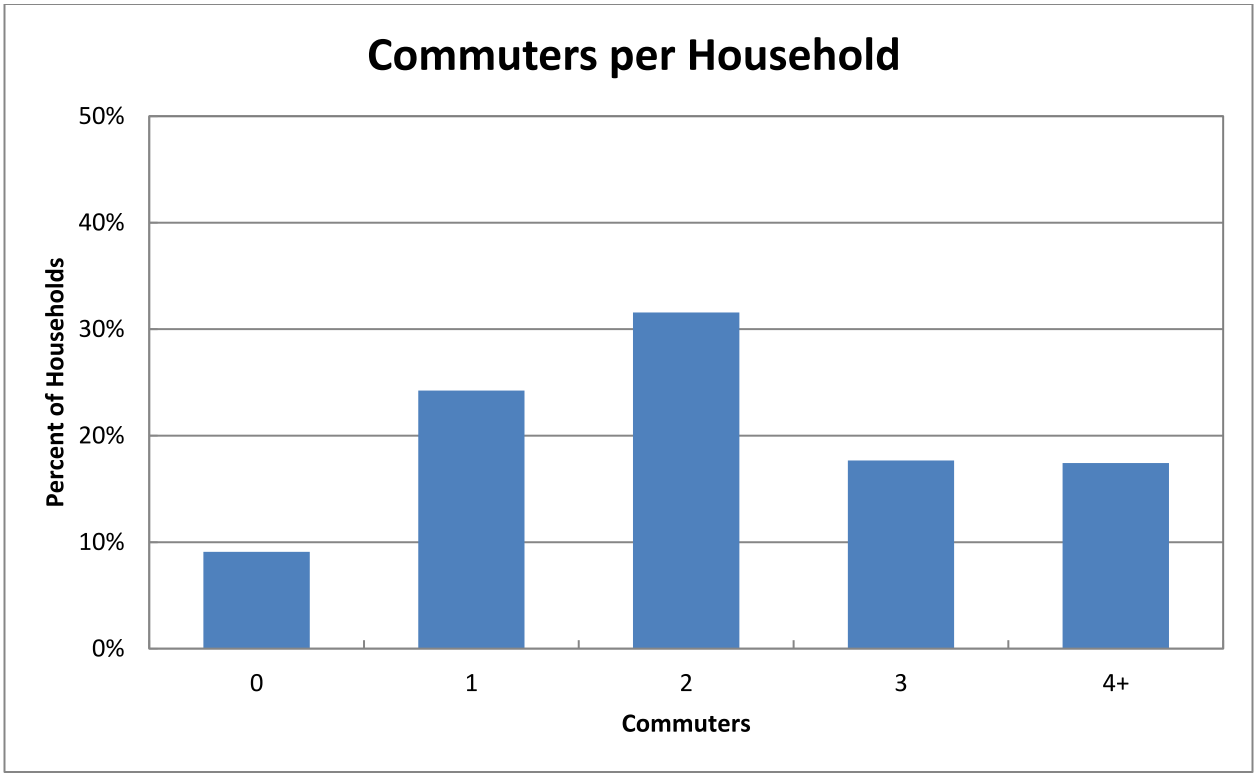



**Figure F-6. Commuters in Households in the Planning Zone**

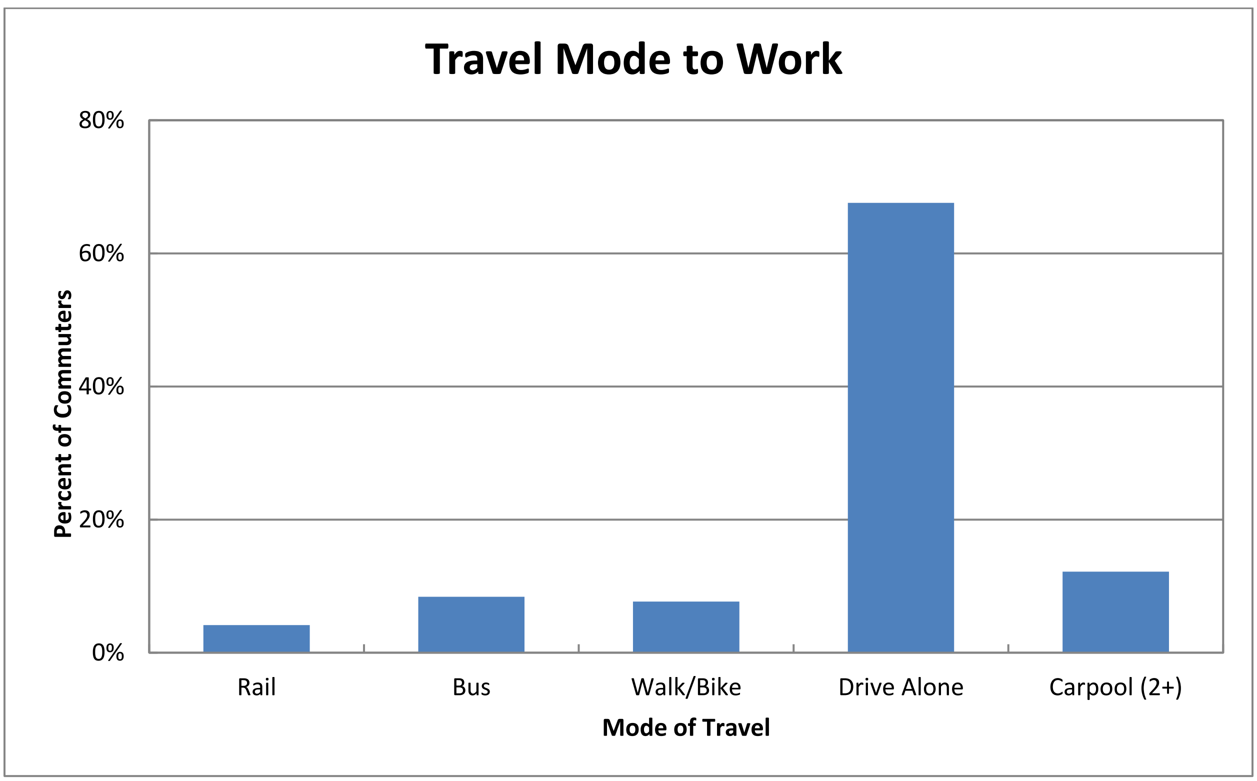



**Figure F-7. Modes of Travel in the Planning Zone**

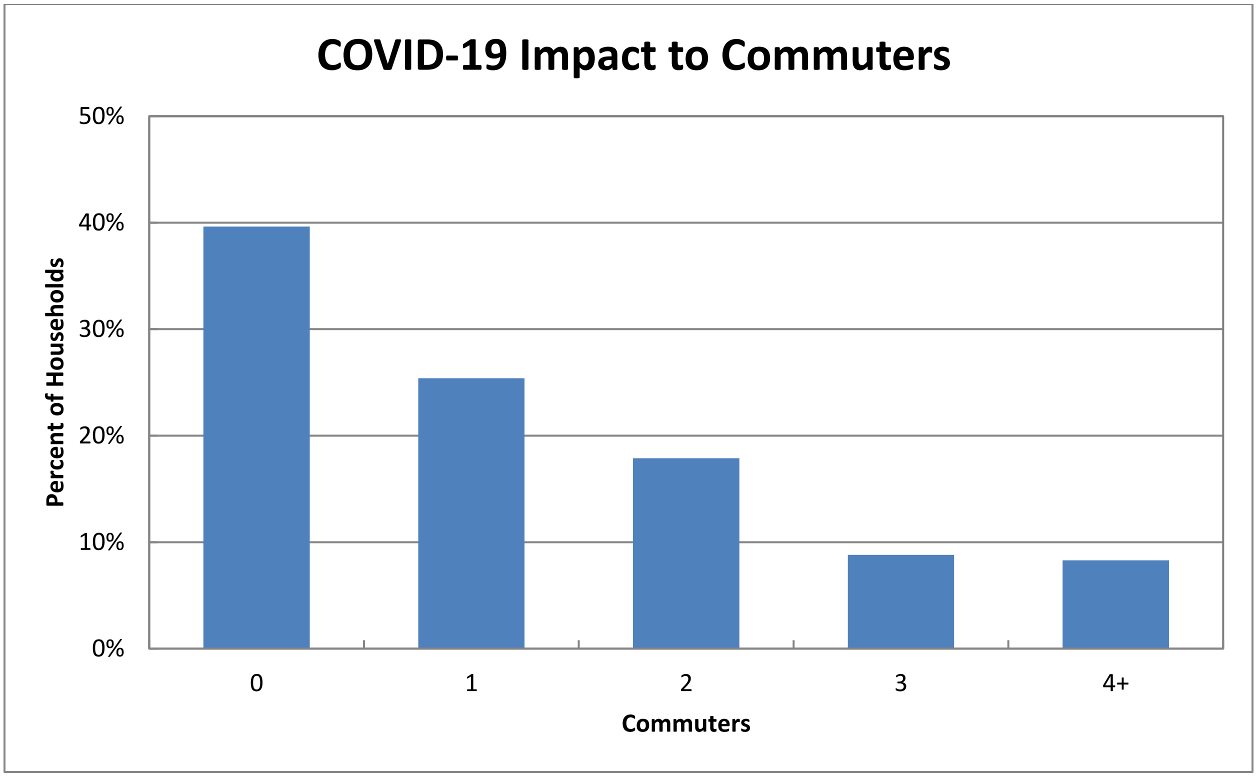



**Figure F-8. Impact to Commuters due to the COVID-19 Pandemic**

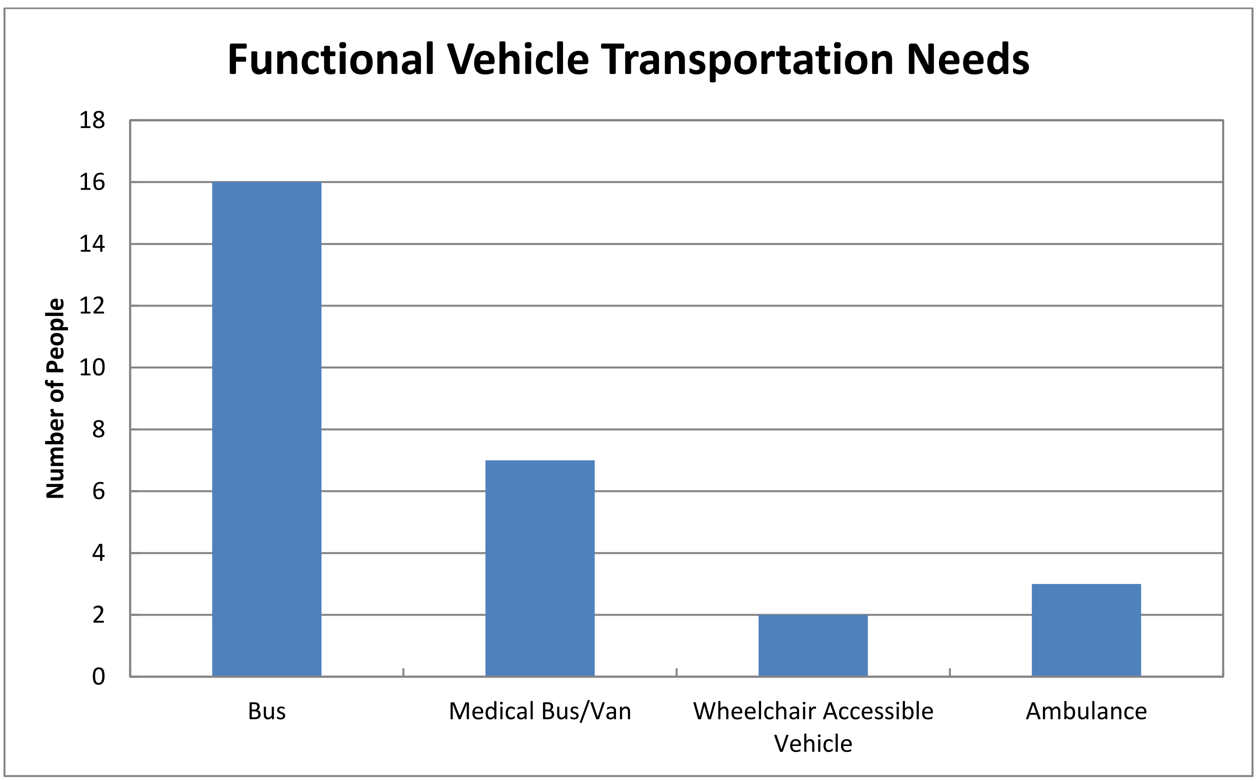



**Figure F-9. People with Functional or Transportation Needs**

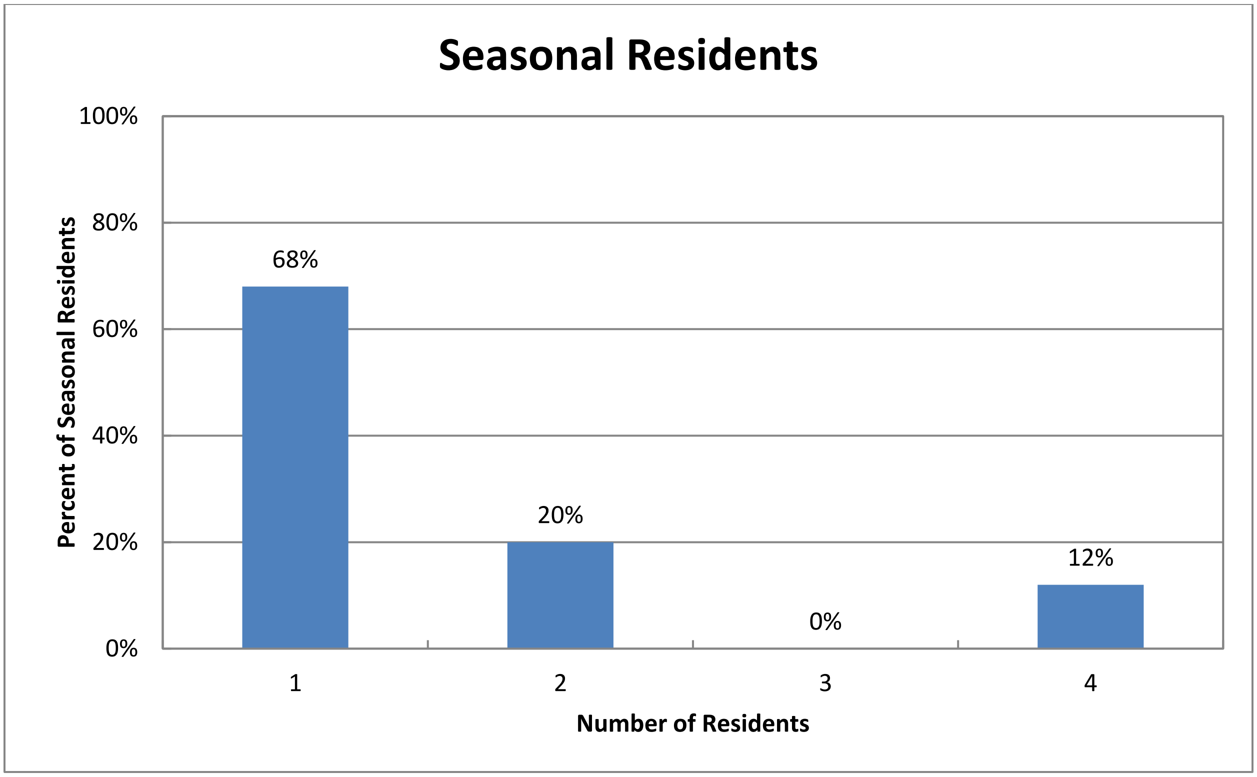



**Figure F-10. Households with Seasonal Residents**

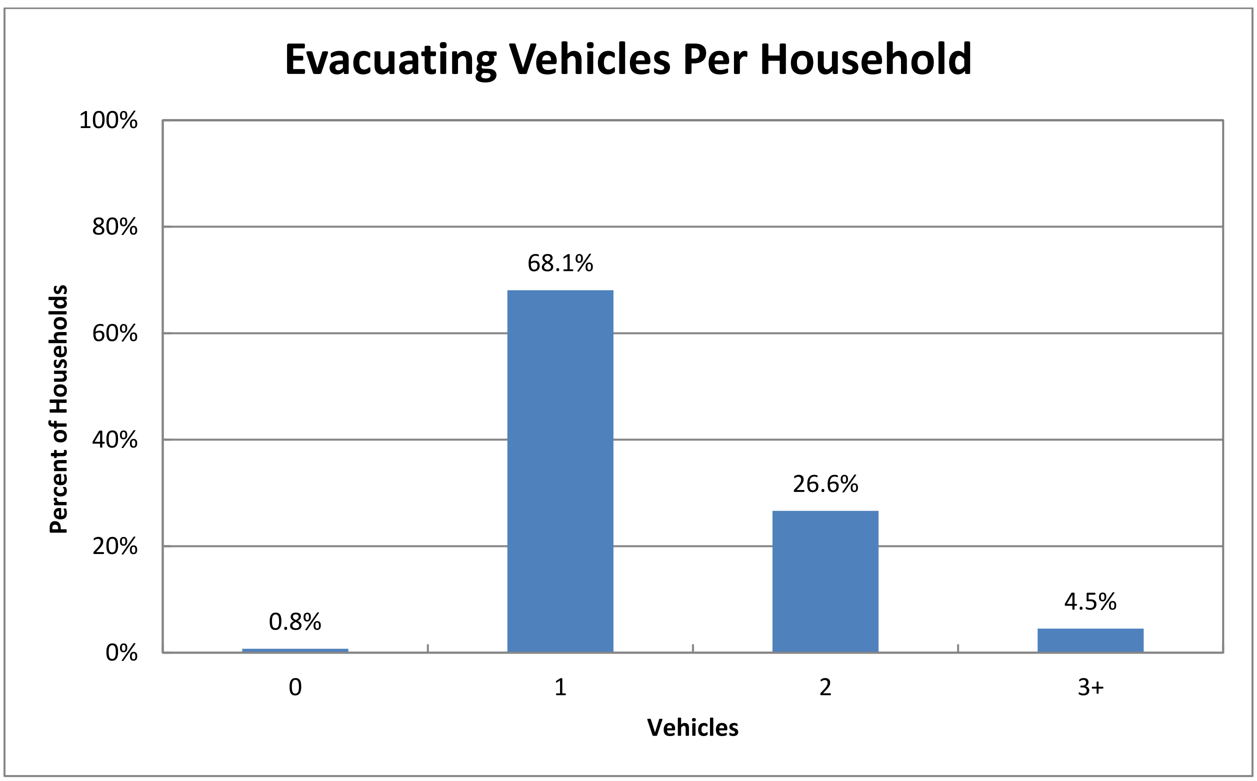



**Figure F-11. Number of Vehicles Used for Evacuation**

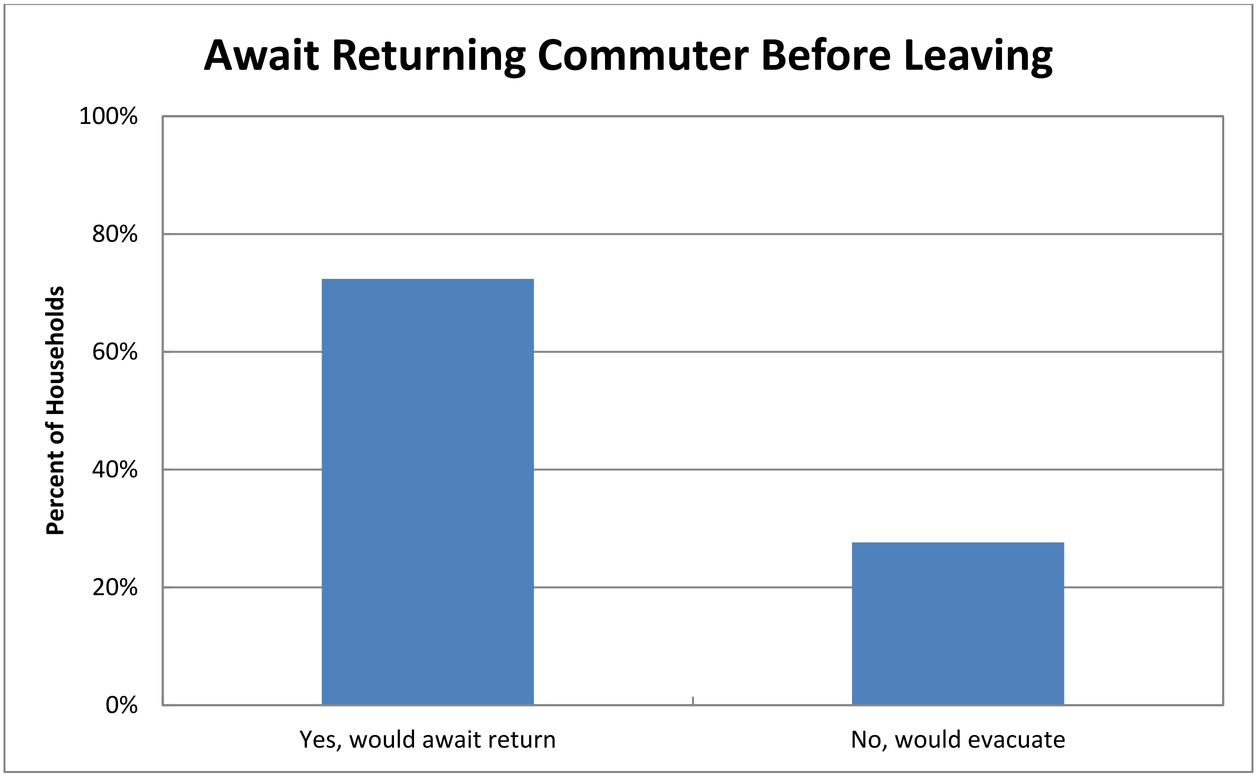



**Figure F-12. Percent of Households that Await Returning Commuter Before Evacuating**

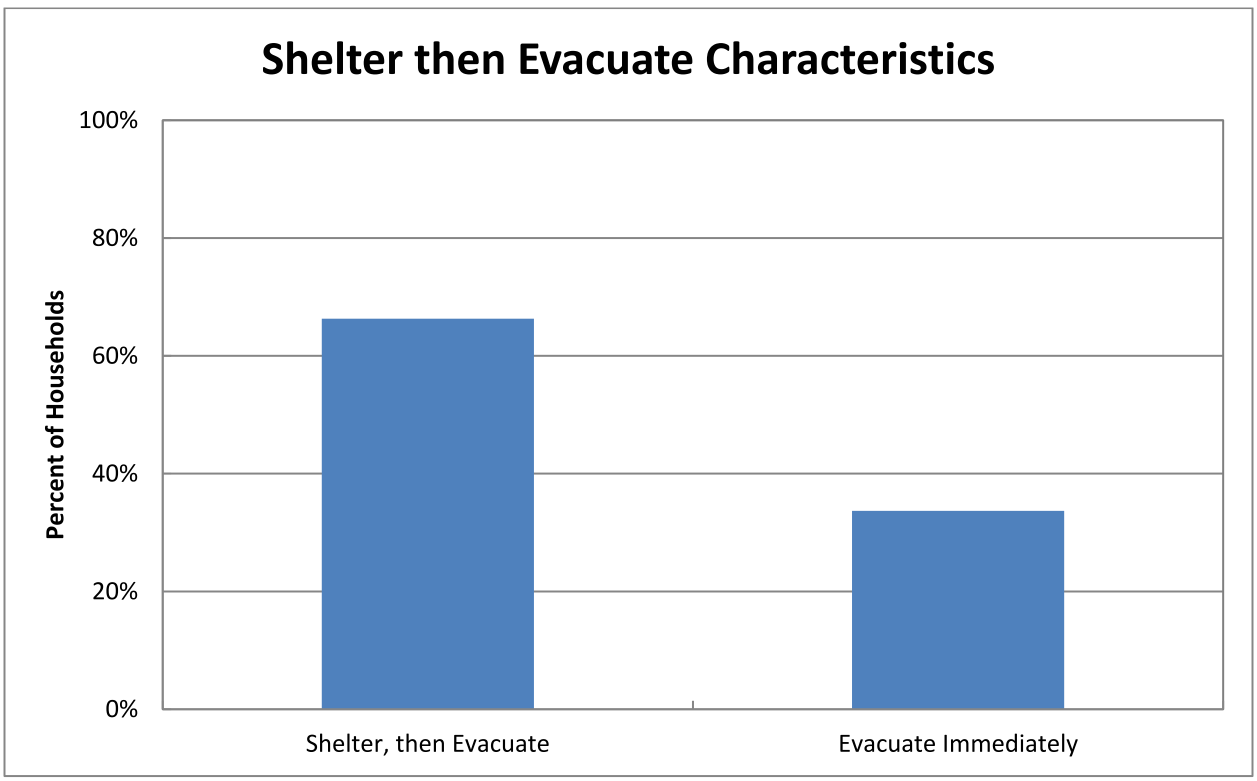



**Figure F-13. Shelter then Evacuate Characteristics**

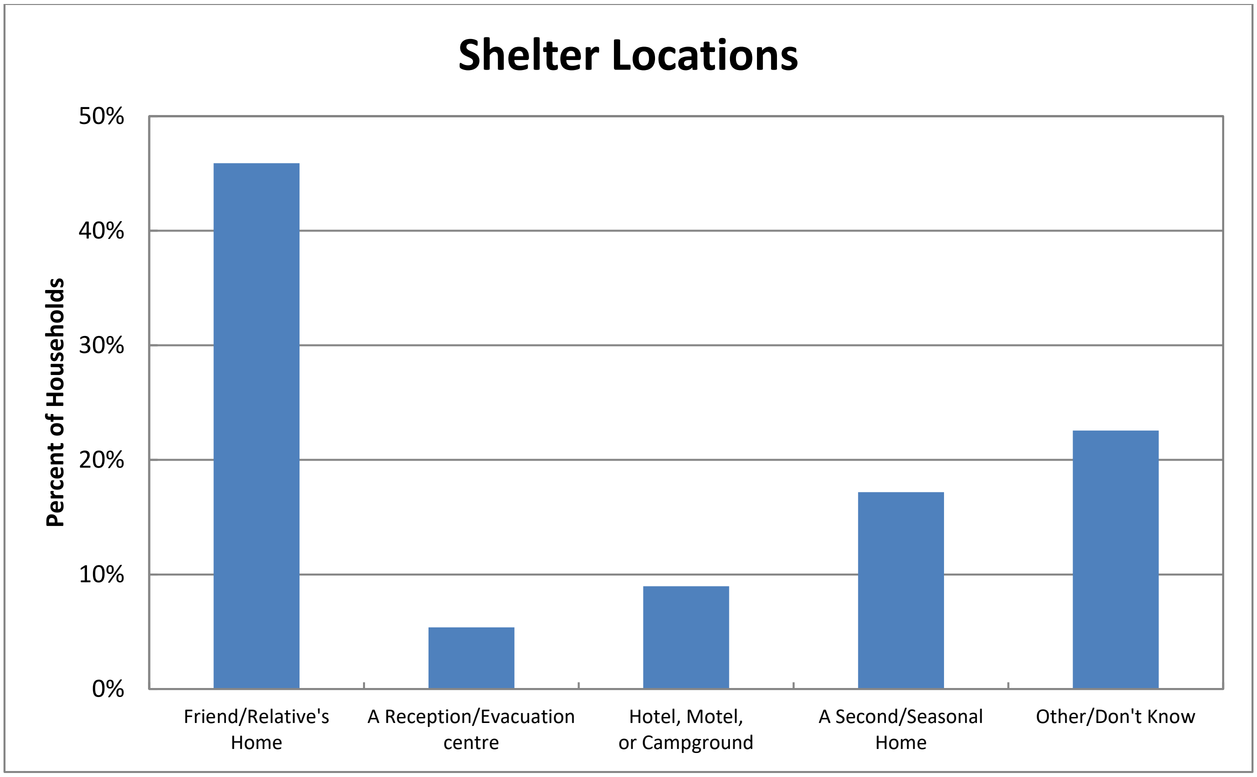



**Figure F-14. Planning Zone Evacuation Destinations**

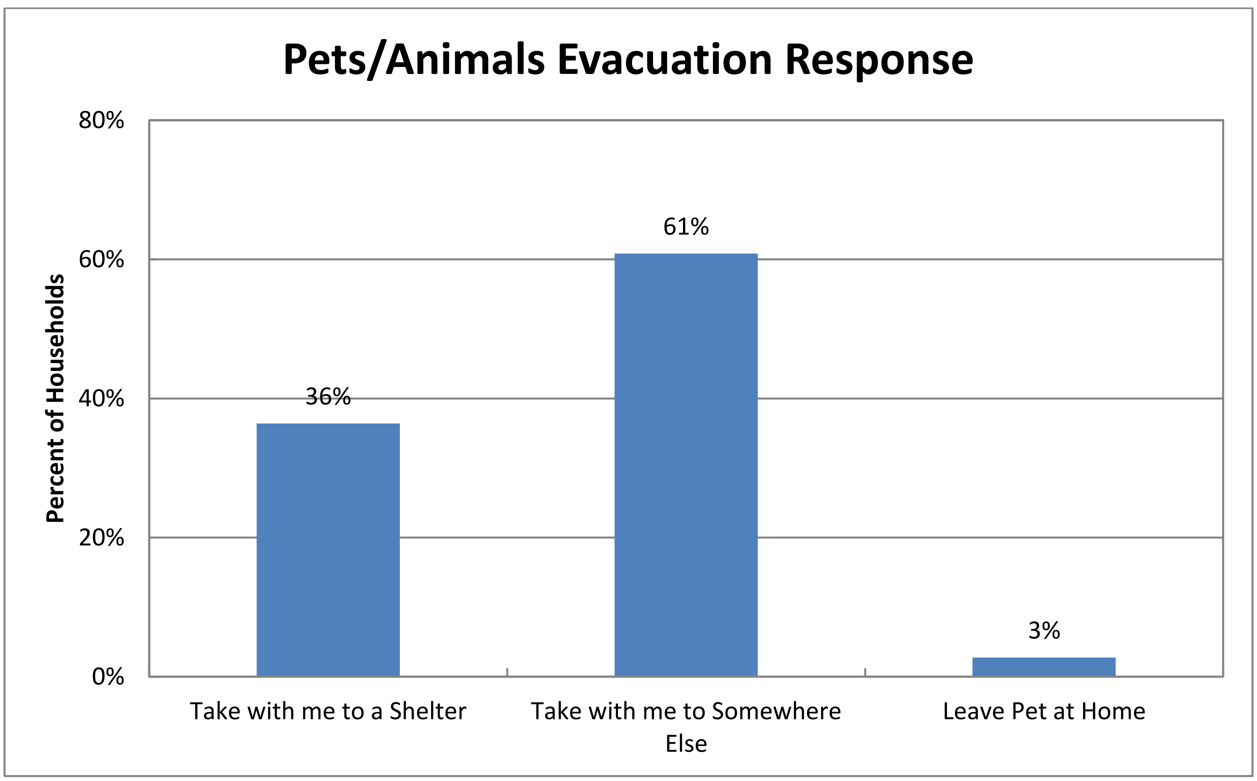



**Figure F-15. Households Evacuating with Pets/Animals**

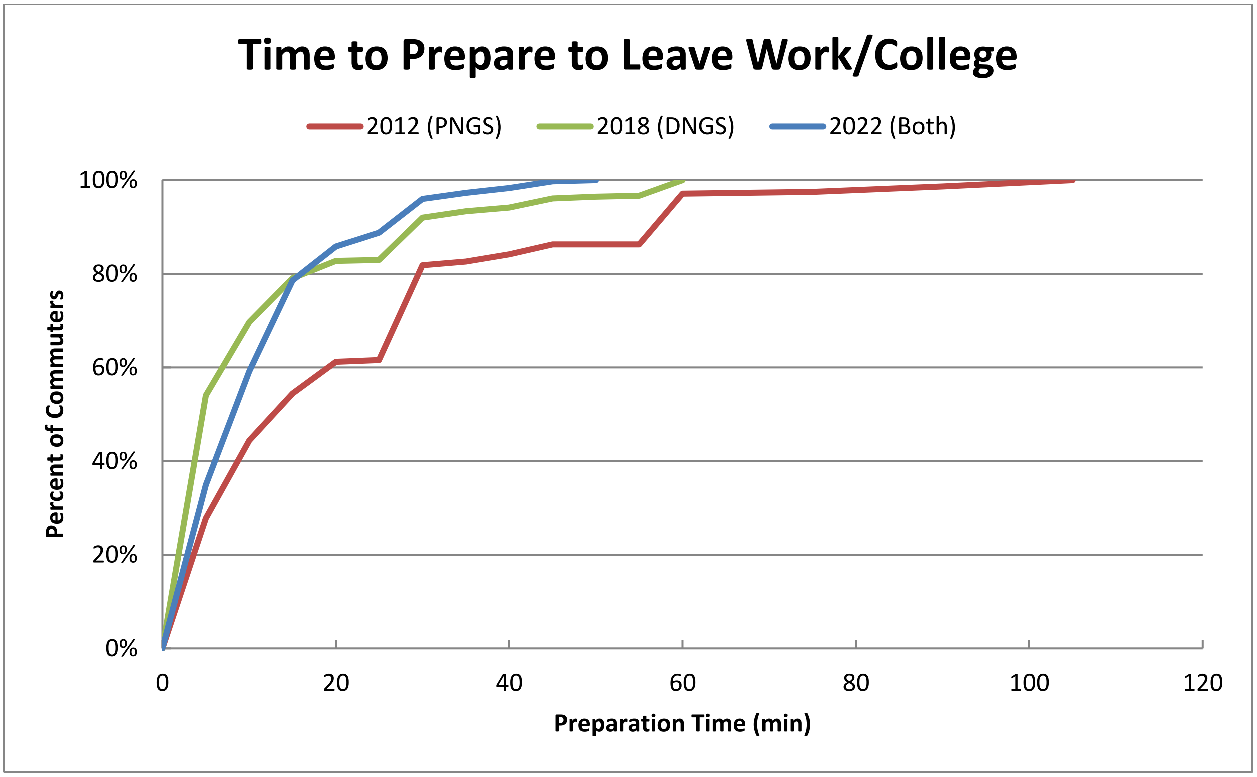



**Figure F-16. Time Required to Prepare to Leave Work/College**

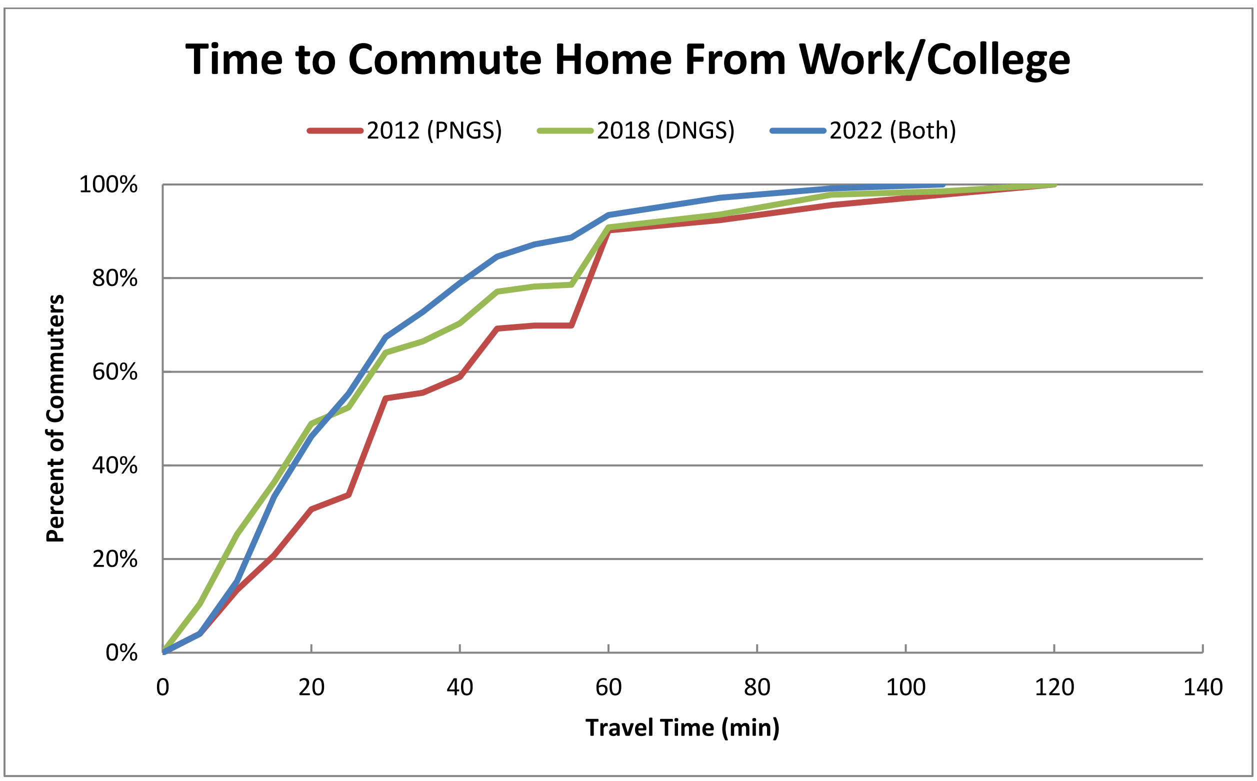



**Figure F-17. Time to Commute Home from Work/College**

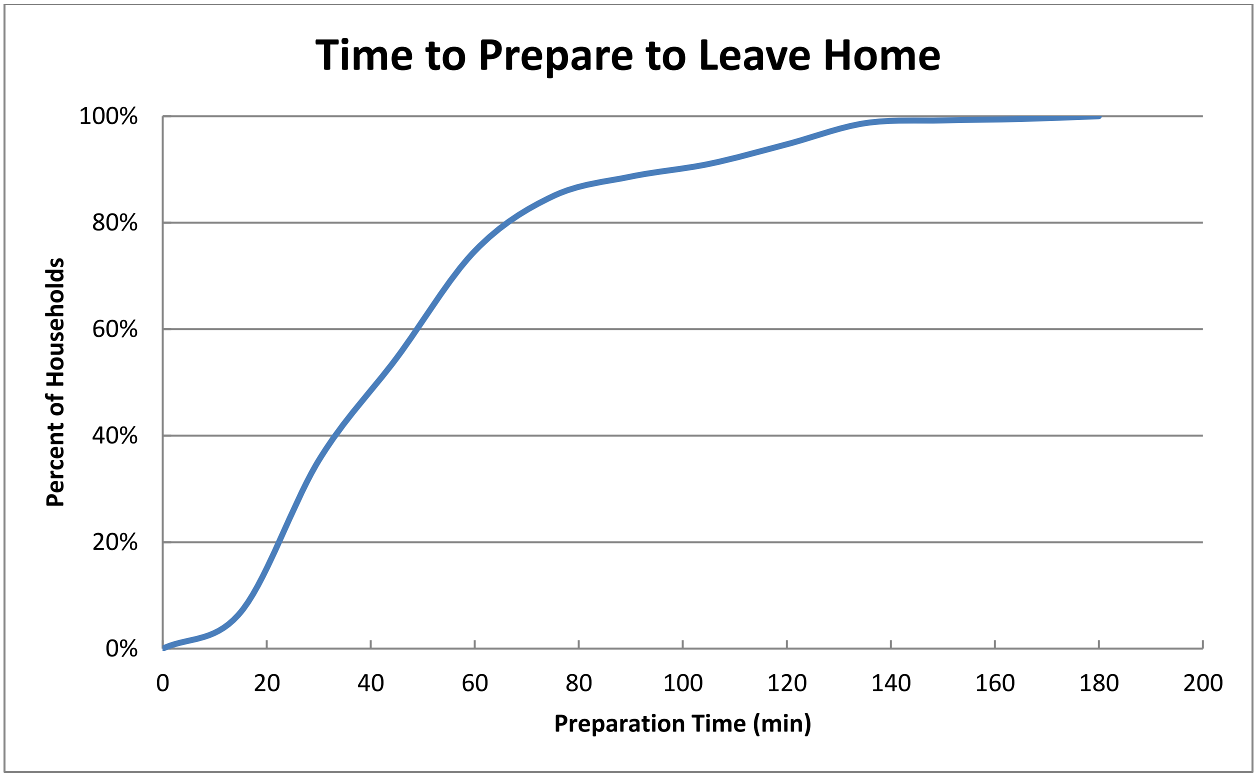



**Figure F-18. Time to Prepare Home for Evacuation**

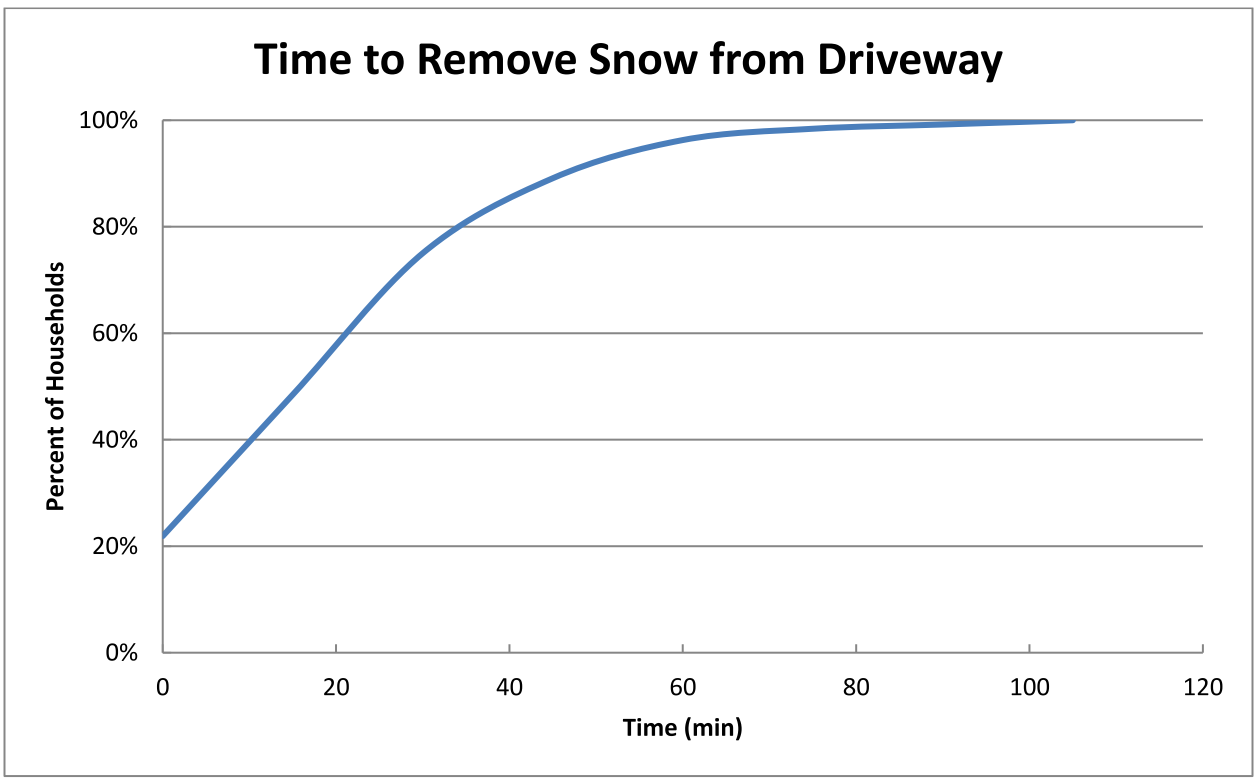



**Figure F-19. Time to Clear Driveway of 15-20 cm of Snow**

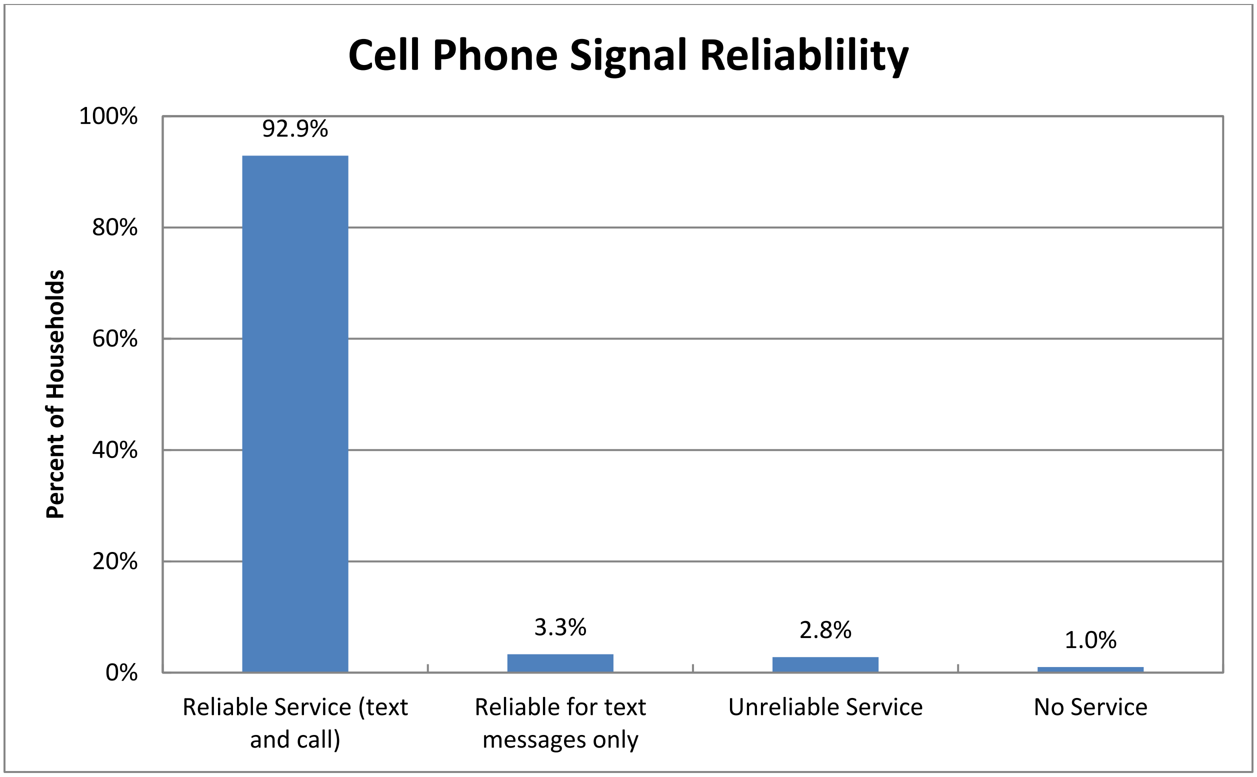



**Figure F-20. Cell Phone Signal Reliability (for Phone Call and/or Text Message)**

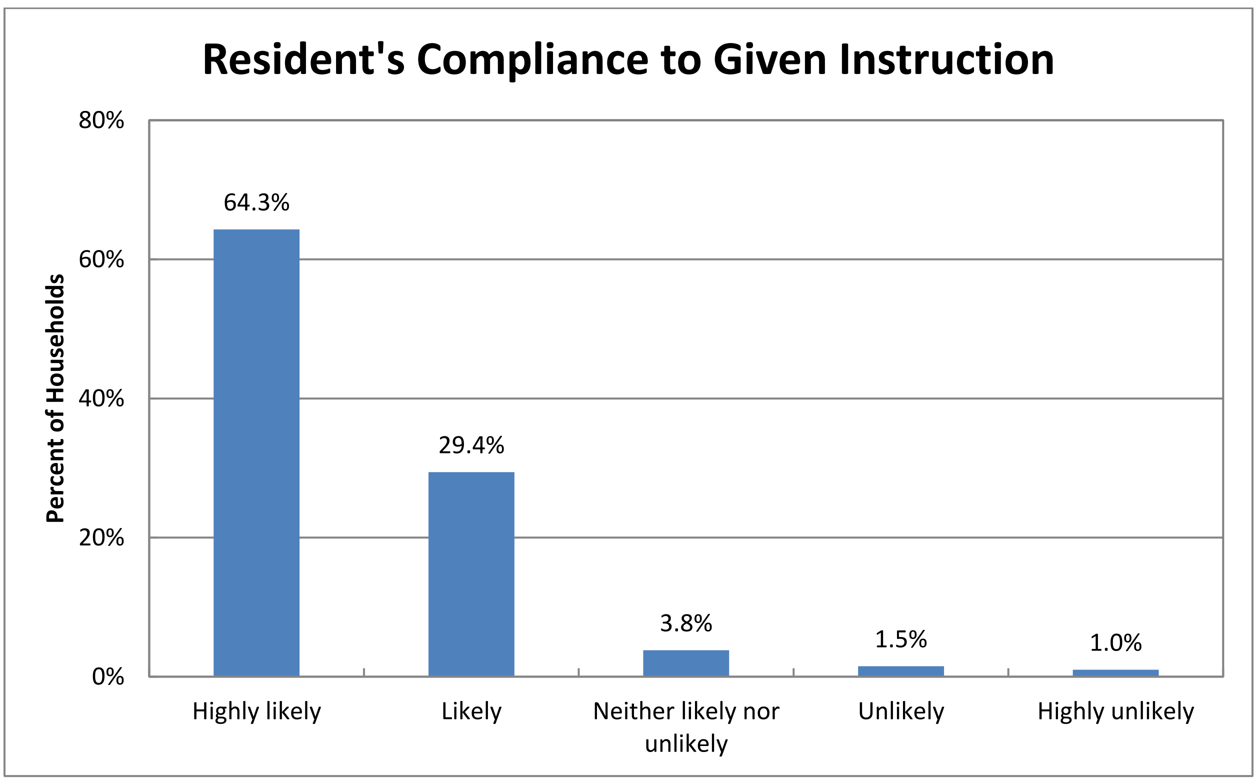



**Figure F-21. Resident's Compliance to Given Instruction (by Emergency Management Officials)**

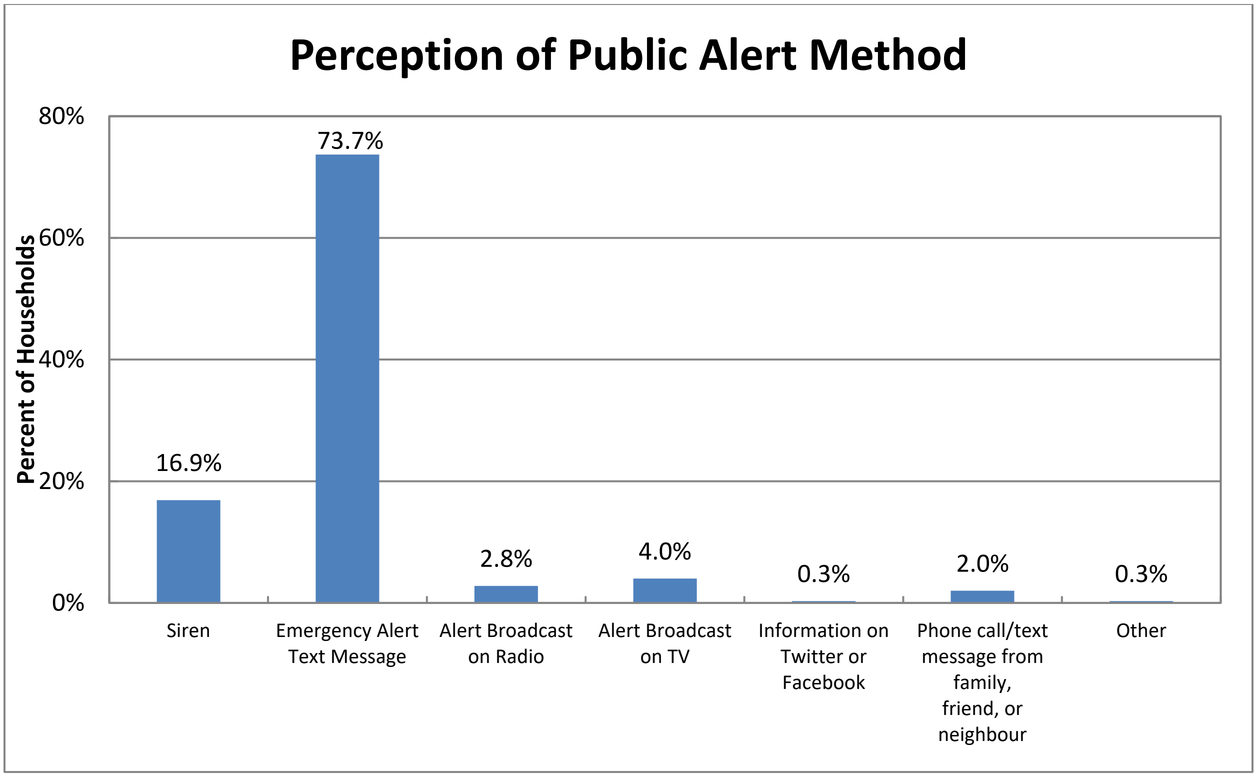



**Figure F-22. Perception of Public Alert Method**

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ATTACHMENT A

Demographic Survey Instrument

# Purpose

The purpose of this survey is to identify local behaviour during potential emergency situations. The information gathered in this survey will be shared with local and provincial emergency planners to enhance emergency response plans in your area. Your responses will greatly contribute to local emergency preparedness. **Please only complete one survey per household. Please have the head of the household (18 years or older) complete the survey.** Do not provide your name or any personal information, and the survey will take less than 10 minutes to complete.

* Required

1. 1A. What is your gender?

*Mark only one oval.*

- Male
- Female
- Decline to State
- Other: ______

2. 1B. What is your age?

*Mark only one oval.*

- 18 to 24 years
- 25 to 34 years
- 35 to 44 years
- 45 to 54 years
- 55 to 64 years
- 65 years and over
- Decline to state
- Other (please state below)

3. Fill in OTHER answers for question 1B

______

4. 2. What is your home postal code? *

______

5. 3A. In total, how many running cars, or other vehicles are usually available to the household?

*Mark only one oval.*

- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine or more
- Zero (None)
- Decline to state

6. 3B. In an emergency, could you get a ride out of the area with a neighbour or friend?

*Mark only one oval.*

- Yes
- No
- Decline to state

7. 4. How would you evacuate in an emergency?

*Mark only one oval.*

- I would evacuate by personal vehicle
- I would rideshare with a neighbour or friend
- I would evacuate by bicycle
- I would evacuate by bus
- I would evacuate by train
- I would evacuate by foot
- I would not evacuate
- Decline to state

8. 4B. What would you do if the train was not available?

*Mark only one oval.*

- I would evacuate by personal vehicle
- I would rideshare with a neighbour or friend
- I would evacuate by bicycle
- I would evacuate by bus
- I would evacuate by foot
- I would require assistance from local/provincial agencies
- I would not evacuate
- Decline to state

9. 4B. What would you do if buses were not available?

*Mark only one oval.*

- I would evacuate by personal vehicle
- I would rideshare with a neighbour or friend
- I would evacuate by bicycle
- I would evacuate by train
- I would evacuate by foot
- I would require assistance from local/provincial agencies
- I would not evacuate
- Decline to state

10. 5. How many vehicles would your household use during an evacuation?

*Mark only one oval.*

- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine or more
- Zero (None)
- I would evacuate by bike
- I would evacuate by bus
- Decline to state

11. 6A. How many people usually live in this household?

*Mark only one oval.*

- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine
- Ten
- Eleven
- Twelve
- Thirteen
- Fourteen
- Fifteen
- Sixteen
- Seventeen
- Eighteen
- Nineteen or more
- Decline to state

12. 6B. Of these people that live in this household, are any of them seasonal residents?

*Mark only one oval.*

- Yes
- No
- Decline to State

13. 6C. How many of the household residents are seasonal?

*Mark only one oval.*

- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine
- Ten
- Eleven
- Twelve
- Thirteen
- Fourteen
- Fifteen
- Sixteen
- Seventeen
- Eighteen
- Nineteen or more
- Decline to state

14. 6D. What season do the seasonal residents live in this home?

*Mark only one oval.*

- Summer
- Fall / Winter / Spring
- Decline to State

COVID-19

15. 7. How many people in your household have a work and/or school commute that has been impacted due to the COVID-19 pandemic?

*Mark only one oval.*

- Zero
- One
- Two
- Three
- Four or more
- Decline to state

Commuters

16. 8. How many people in the household normally (during non-COVID conditions) commute to a place of employment, or to school on a daily basis? *

*Mark only one oval.*

- Zero
- One
- Two
- Three
- Four or more
- Decline to state

Mode of Travel

17. 9. Thinking about each commuter, how does each person usually commute (during non-COVID conditions)?

*Mark only one oval per row.*

| | Rail | Bus | Walk/Bicycle | Drive Alone | Carpool-2 or more people | Don't know |
|---|---|---|---|---|---|---|
| **Commuter 1** | | | | | | |

18. 9A. Thinking about each commuter who travels by rail, if an evacuation was ordered at the station the commuters vehicle is parked, would they return to their vehicle?

*Mark only one oval per row.*

| | Yes | No | Decline to State |
|---|---|---|---|
| **Commuter 1** | | | |

19. 9B. Thinking about each commuter who travels by rail and indicated they will return to their vehicle, would they return home before evacuating?

*Mark only one oval per row.*

| | Yes | No | Not Applicable/Decline to State |
|---|---|---|---|
| **Commuter 1** | | | |

20. 9. Thinking about each commuter, how does each person usually commute (during non-COVID conditions)?

*Mark only one oval per row.*

| | Rail | Bus | Walk/Bicycle | Drive Alone | Carpool-2 or more people | Don't know |
|---|---|---|---|---|---|---|
| **Commuter 1** | | | | | | |
| **Commuter 2** | | | | | | |

21. 9A. Thinking about each commuter who travels by rail, if an evacuation was ordered at the station the commuters vehicle is parked, would they return to their vehicle?

*Mark only one oval per row.*

| | Yes | No | Decline to State |
|---|---|---|---|
| **Commuter 1** | | | |
| **Commuter 2** | | | |

22. 9B. Thinking about each commuter who travels by rail and indicated they will return to their vehicle, would they return home before evacuating?

*Mark only one oval per row.*

| | Yes | No | Not Applicable/Decline to State |
|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ |

23. 9. Thinking about each commuter, how does each person usually commute (during non-COVID conditions)?

*Mark only one oval per row.*

| | Rail | Bus | Walk/Bicycle | Drive Alone | Carpool-2 or more people | Don't know |
|---|---|---|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Commuter 3 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

24. 9A. Thinking about each commuter who travels by rail, if an evacuation was ordered at the station the commuters vehicle is parked, would they return to their vehicle?

*Mark only one oval per row.*

| | Yes | No | Decline to State |
|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ |
| Commuter 3 | ◯ | ◯ | ◯ |

25. 9B. Thinking about each commuter who travels by rail and indicated they will return to their vehicle, would they return home before evacuating?

*Mark only one oval per row.*

| | Yes | No | Not Applicable/Decline to State |
|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ |
| Commuter 3 | ◯ | ◯ | ◯ |

26. 9. Thinking about each commuter, how does each person usually commute (during non-COVID conditions)?

*Mark only one oval per row.*

| | Rail | Bus | Walk/Bicycle | Drive Alone | Carpool-2 or more people | Don't know |
|---|---|---|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Commuter 3 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Commuter 4 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

27. 9A. Thinking about each commuter who travels by rail, if an evacuation was ordered at the station the commuters vehicle is parked, would they return to their vehicle?

*Mark only one oval per row.*

| | Yes | No | Decline to State |
|---|---|---|---|
| Commuter 1 | ◯ | ◯ | ◯ |
| Commuter 2 | ◯ | ◯ | ◯ |
| Commuter 3 | ◯ | ◯ | ◯ |
| Commuter 4 | ◯ | ◯ | ◯ |

28. 9B. Thinking about each commuter who travels by rail and indicated they will return to their vehicle, would they return home before evacuating?

*Mark only one oval per row.*

| | Yes | No | Not Applicable/Decline to State |
|---|---|---|---|
| **Commuter 1** | ◯ | ◯ | ◯ |
| **Commuter 2** | ◯ | ◯ | ◯ |
| **Commuter 3** | ◯ | ◯ | ◯ |
| **Commuter 4** | ◯ | ◯ | ◯ |

*Skip to question 29*

Travel Home From Work/College

29. 10-1. How much time on average, would it take Commuter #1 to travel home from a place of employment or school (during non-COVID conditions)?

*Mark only one oval.*

- ◯ 5 minutes or less
- ◯ 6-10 minutes
- ◯ 11-15 minutes
- ◯ 16-20 minutes
- ◯ 21-25 minutes
- ◯ 26-30 minutes
- ◯ 31-35 minutes
- ◯ 36-40 minutes
- ◯ 41-45 minutes
- ◯ 46-50 minutes
- ◯ 51-55 minutes
- ◯ 56 - 1 hour
- ◯ Over 1 hour, but less than 1 hour 15 minutes
- ◯ Between 1 hour 16 minutes and 1 hour 30 minutes
- ◯ Between 1 hour 31 minutes and 1 hour 45 minutes
- ◯ Between 1 hour 46 minutes and 2 hours
- ◯ Over 2 hours
- ◯ Decline to state

30. If Over 2 Hours for Question 10-1, Specify Here

_______________________________

31. 10-2. How much time on average, would it take Commuter #2 to travel home from a place of employment or school (during non-COVID conditions)?

*Mark only one oval.*

- ◯ 5 minutes or less
- ◯ 6-10 minutes
- ◯ 11-15 minutes
- ◯ 16-20 minutes
- ◯ 21-25 minutes
- ◯ 26-30 minutes
- ◯ 31-35 minutes
- ◯ 36-40 minutes
- ◯ 41-45 minutes
- ◯ 46-50 minutes
- ◯ 51-55 minutes
- ◯ 56 - 1 hour
- ◯ Over 1 hour, but less than 1 hour 15 minutes
- ◯ Between 1 hour 16 minutes and 1 hour 30 minutes
- ◯ Between 1 hour 31 minutes and 1 hour 45 minutes
- ◯ Between 1 hour 46 minutes and 2 hours
- ◯ Over 2 hours
- ◯ Decline to state

32. If Over 2 Hours for Question 10-2, Specify Here

_______________________________

33. 10-3. How much time on average, would it take Commuter #3 to travel home from a place of employment or school (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

34. If Over 2 Hours for Question 10-3, Specify Here

35. 10-4. How much time on average, would it take Commuter #4 to travel home from a place of employment or school (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

36. If Over 2 Hours for Question 10-4, Specify Here

*Skip to question 37*

Preparation to leave Work/College

37. 11-1. Approximately how much time would it take Commuter #1 to complete preparation for leaving a place of employment or school prior to starting the trip home (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

38. If Over 2 Hours for Question 11-1, Specify Here

______________________________

39. 11-2. Approximately how much time would it take Commuter #2 to complete preparation for leaving a place of employment or school prior to starting the trip home (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

40. If Over 2 Hours for Question 11-2, Specify Here

______________________________

41. 11-3. Approximately how much time would it take Commuter #3 to complete preparation for leaving a place of employment or school prior to starting the trip home (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

42. If Over 2 Hours for Question 11-3, Specify Here

_______________________________________________

43. 11-4. Approximately how much time would it take Commuter #4 to complete preparation for leaving a place of employment or school prior to starting the trip home (during non-COVID conditions)?

*Mark only one oval.*

- 5 minutes or less
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-25 minutes
- 26-30 minutes
- 31-35 minutes
- 36-40 minutes
- 41-45 minutes
- 46-50 minutes
- 51-55 minutes
- 56 - 1 hour
- Over 1 hour, but less than 1 hour 15 minutes
- Between 1 hour 16 minutes and 1 hour 30 minutes
- Between 1 hour 31 minutes and 1 hour 45 minutes
- Between 1 hour 46 minutes and 2 hours
- Over 2 hours
- Decline to state

44. If Over 2 Hours for Question 11-4, Specify Here

_______________________________________________

*Skip to question 45*

Additional Questions

45. 12. Please choose one of the following:

*Mark only one oval.*

- I would await the return of household members to evacuate together.
- I would evacuate independently and meet other household members later.
- Decline to State

46. 13. If you were advised by local authorities to evacuate, how much time would it take the household to pack clothing, medications, secure the house, load the car, and complete preparations prior to evacuating the area?

*Mark only one oval.*

- Less than 15 minutes
- 15-30 minutes
- 31-45 minutes
- 46 minutes - 1 hour
- 1 hour to 1 hour 15 minutes
- 1 hour 16 minutes to 1 hour 30 minutes
- 1 hour 31 minutes to 1 hour 45 minutes
- 1 hour 46 minutes to 2 hours
- 2 hours to 2 hours 15 minutes
- 2 hours 16 minutes to 2 hours 30 minutes
- 2 hours 31 minutes to 2 hours 45 minutes
- 2 hours 46 minutes to 3 hours
- 3 hours to 3 hours 15 minutes
- 3 hours 16 minutes to 3 hours 30 minutes
- 3 hours 31 minutes to 3 hours 45 minutes
- 3 hours 46 minutes to 4 hours
- 4 hours to 4 hours 15 minutes
- 4 hours 16 minutes to 4 hours 30 minutes
- 4 hours 31 minutes to 4 hours 45 minutes
- 4 hours 46 minutes to 5 hours
- 5 hours to 5 hours 30 minutes
- 5 hours 31 minutes to 6 hours
- Over 6 hours
- Will not evacuate
- Decline to State

47. If Over 6 Hours for Question 13, Specify Here

_______________________________

48. 14. If there are 15-20 centimetres of snow on your driveway or curb, would you need to shovel out to evacuate? If yes, how much time, on average, would it take you to clear the 15-20 centimetres of snow to move the car from the driveway or curb to begin the evacuation trip? Assume the roads are passable.

*Mark only one oval.*

- Less than 15 minutes
- 15-30 minutes
- 31-45 minutes
- 46 minutes - 1 hour
- 1 hour to 1 hour 15 minutes
- 1 hour 16 minutes to 1 hour 30 minutes
- 1 hour 31 minutes to 1 hour 45 minutes
- 1 hour 46 minutes to 2 hours
- 2 hours to 2 hours 15 minutes
- 2 hours 16 minutes to 2 hours 30 minutes
- 2 hours 31 minutes to 2 hours 45 minutes
- 2 hours 46 minutes to 3 hours
- Over 3 hourz
- No, will not shovel out
- Decline to State

49. If Over 3 Hours for Question 14, Specify Here

_______________________________

50. 15. Please specify the number of people in your household who require functional or transportation needs in an evacuation. The intent of this question is to identify those households who will require assistance from a local/provincial agency in an evacuation. If you own your own transportation and do not need assistance from a local/provincial agency, please select "0" below.

*Mark only one oval per row.*

| | 0 | 1 | 2 | 3 | 4 | More than 4 |
|---|---|---|---|---|---|---|
| Bus | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Medical Bus/Van | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Wheelchair Accessible Vehicle | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Ambulance | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| Other | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

51. Specify "Other" Transportation Need Below

52. 15B. You indicated in your response to Question 15 that you would require assistance from a local/provincial agency in an evacuation. Have you already registered with local/provincial agencies for support (for example, Red Cross Transportation)?

*Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Decline to state

53. 16A. Emergency officials advise you to shelter-in-place (staying inside your house with the windows closed and ventilation to the outside turned off) in an emergency because you are not in the area of risk. Would you:

*Mark only one oval.*

- ◯ Shelter-in-place
- ◯ Evacuate
- ◯ Decline to state

54. 16B. Emergency officials advise you to shelter-in-place (staying inside your house with the windows closed and ventilation to the outside turned off) now in an emergency and possibly evacuate later while people in other areas are advised to evacuate now. Would you:

*Mark only one oval.*

- ◯ Shelter-in-place
- ◯ Evacuate
- ◯ Decline to state

55. 16C. Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?

*Mark only one oval.*

- ◯ A relative's or friend's home
- ◯ A Reception/Evacuation centre
- ◯ A hotel, motel or campground
- ◯ A second/seasonal home
- ◯ Would not evacuate
- ◯ Don't know
- ◯ Other (Specify Below)
- ◯ Decline to state

56. Fill in "Other" answers for question 16C

57. 17. In the event of an emergency evacuation, would you use a toll road at any point along your route?

*Mark only one oval.*

- Yes
- Yes, if tolls were waived
- No
- Decline to state

Pet Questions

58. 18A. Do you have any pet(s) and/or animal(s)?

*Mark only one oval.*

- Yes
- No
- Decline to state

59. 18B. What type of pet(s) and/or animal(s) do you have?

*Check all that apply.*

- [ ] Dog
- [ ] Cat
- [ ] Bird
- [ ] Reptile
- [ ] Horse
- [ ] Fish
- [ ] Chicken
- [ ] Goat
- [ ] Pig
- [ ] Other small pets/animals (Specify Below)
- [ ] Other large pets/animals (Specify Below)
- [ ] Decline to state
- [ ] Other: ______________________

60. 18C. What would you do with your pet(s) and/or animal(s) if you had to evacuate?

*Mark only one oval.*

- Take pet with me to a shelter
- Take pet with me somewhere else
- Leave pet at home
- Decline to state

61. 18D. Do you have sufficient room in your vehicle(s) to evacuate with your pet(s) and/or animal(s)?

*Mark only one oval.*

- Yes
- No
- Will use a trailer
- Decline to state
- Other: ______________________

*Skip to question 62*

Emergency Communications

62. 19A. At your place of residence, how reliable is your cell phone signal?

*Mark only one oval.*

- Very reliable to receive texts and phone calls
- Reliable for text messages only
- I do not always receive cell communications at my residence
- I do not have cell service at my residence

63. 19B. Emergency management officials in your region/province may send text messages, similar to AMBER Alerts, with emergency directions for the public during an emergency. How likely would you be to take action on these directions, if you received the message?

*Mark only one oval.*

- Highly likely
- Likely
- Neither likely nor unlikely
- Unlikely
- Highly unlikely

64. 19C. Which of the following emergency communication methods do you think is most likely to alert you at your residence?

*Mark only one oval.*

- A siren sounding near your home
- A text message from emergency officials
- Alert Broadcast on radio
- Alert broadcast on TV
- Information on Twitter or Facebook
- Phone call/text message from family, friend, or neighbour
- OTHER

65. Fill in OTHER answers for question 19C

________________________________________

# APPENDIX G

Traffic Management Plan

# G. TRAFFIC MANAGEMENT PLAN

NUREG/CR-7002 Rev. 1 indicates that the existing Evacuation Traffic Points (Traffic Control Points) and Diversion Traffic Control Points (or Access Control Points) identified by the offsite agencies should be used in the evacuation simulation modelling. The Region Traffic Control/Sector Book Plan (RTCP) was provided by Durham Region. This plan was reviewed for utilization in this analysis. Durham Emergency Management officers indicated that Durham Region Police Service would not have adequate officers to deploy to all intersections due to staffing resource limits and would only deploy officers based on immediate needs of the impacted intersections. As such, none of the Diversion and Evacuation Traffic Points listed in the RTCP were modelled as Traffic Control Points or Access Control Points, except those located at actuated traffic signalized intersections or those stopping external traffic.

## G.1 Traffic Control Points

Usually, traffic control points (TCPs) at intersections (that are controlled) are modelled as actuated signals. If an intersection has a pre-timed signal, stop, or yield control, and the intersection is identified as a TCP, the control type would be changed to an actuated signal in the model. Due to resource limitations, all stop and yield controlled intersections were left as is. Due to the presence of a traffic management centre, and the ability to modify signal timings on demand, TCPs at existing actuated traffic signalized intersections were essentially left alone. Police officers will provide traffic control along major evacuation routes based on the immediate needs during the evacuation according to emergency management representatives from Durham Region. They will also be responsible for coordinating access control points (ACPs) for areas taking shelter or evacuating.

## G.2 Access Control Points

As discussed in Section 2, it is assumed that ACPs, typically established on the periphery of the PZs to stop the flow of traffic entering the PZs, will be established within 4 hours after the Emergency Bulletin to evacuate. The ACPs will assist in discouraging through travellers from using major through routes which traverse the PZs. As discussed in Section 3.9, external traffic was considered on the major routes which traverse the study area – Highway (Hwy) 401, Hwy 407 and Route 115/35 – in this analysis. The generation of the external trips ceases at 4 hours after the Emergency Bulletin to evacuate in the simulation due to the implementation of the ACPs.

# APPENDIX H

Evacuation Regions

# H. EVACUATION REGIONS

This appendix presents the evacuation percentages (Table H-1 and Table H-2) for each Evacuation Region and maps (Figure H-1 through Figure H-50) of all Evacuation Regions. The percentages presented in Table H-1 and Table H-2 are based on the methodology discussed in assumption 8 of Section 2.2 and shown in Figure 2-1.

Note the baseline ETE study assumes 30 percent of households will not comply with the shelter advisory, as per discussions with OPG and the Ministry of Transportation of Ontario (MTO).

## Table H-1. Percent of Response Sector Population Evacuating for Each Region

| Radial Regions | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Description | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R01 | AAZ | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% |
| R02 | DPZ Inner Ring | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% |
| R03 | DPZ Outer Ring | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% |
| R04 | Full PZ | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Evacuate AAZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Wind Direction Towards: | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R05 | N | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 100% |
| R06 | NNE | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% |
| R07 | NE | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% |
| R08 | ENE | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| R09 | E | 100% | 100% | 30% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| R10 | ESE, SE | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% |
| R11 | SSE | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% |
| R12 | S | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 30% | 30% | 30% |
| R13 | SSW | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% |
| R14 | SW | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 30% |
| R15 | WSW | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% |
| R16 | W | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% |
| R17 | WNW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% |
| R18 | NW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |
| R19 | NNW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |
| Evacuate DPZ and Downwind to CPZ Boundary | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Region | Wind Direction Towards: | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| R20 | N | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 100% |
| R21 | NNE | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% |
| R22 | NE | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% |
| R23 | ENE | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| R24 | E | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| R25 | ESE, SE | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% |
| R26 | SSE | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% |
| R27 | S | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 30% | 30% | 30% |
| R28 | SSW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% |
| R29 | SW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 30% |

| | | |
|---|---|---|
| Response Sector(s) Evacuate | Response Sector(s) Shelter-in-Place | Response Sector not within Plume, but Evacuates because it is surrounded by other Response Sectors which are Evacuating |

| Region | Wind Direction Towards: | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| **R30** | WSW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% |
| **R31** | W | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% |
| **R32** | WNW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% |
| **R33** | NW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |
| **R34** | NNW | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |

**Response Sector(s) Evacuate** | **Response Sector(s) Shelter-in-Place**

**Table H-2. Percent of Response Sector Population Evacuating for Each Staged Region**

**Staged Evacuation - Evacuate AAZ and Downwind to CPZ Boundary**

| Region | Wind Direction Towards: | Response Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DNGS | D1 | D2 | D3 | D4 | D5 | D6A | D6B | D7 | D8A | D8B | D9 | D10 | D11 | D12 | D13 | D14 | D15 | D16 | CPZ1 | CPZ2 | CPZ3 | CPZ4 | CPZ5 | CPZ6 | CPZ7 | CPZ8 |
| **R35** | N | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 100% |
| **R36** | NNE | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% |
| **R37** | NE | 100% | 100% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% |
| **R38** | ENE | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| **R39** | E | 100% | 100% | 30% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 30% | 100% | 100% | 30% | 30% | 30% | 30% | 30% |
| **R40** | ESE, SE | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 30% | 30% | 30% | 30% |
| **R41** | SSE | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% |
| **R42** | S | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 30% | 30% | 30% |
| **R43** | SSW | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% |
| **R44** | SW | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 30% | 30% |
| **R45** | WSW | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% |
| **R46** | W | 100% | 100% | 100% | 30% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 30% |
| **R47** | WNW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% | 100% |
| **R48** | NW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |
| **R49** | NNW | 100% | 100% | 100% | 100% | 30% | 30% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 30% | 100% | 30% | 30% | 100% | 30% | 30% | 30% | 30% | 30% | 100% | 100% |
| **R50** | Full PZ | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

**Response Sector(s) Evacuate** | **Response Sector(s) Shelter-in-Place** | **Response Sector (s) Shelter-in-Place until 90% ETE for R01, then Evacuate**

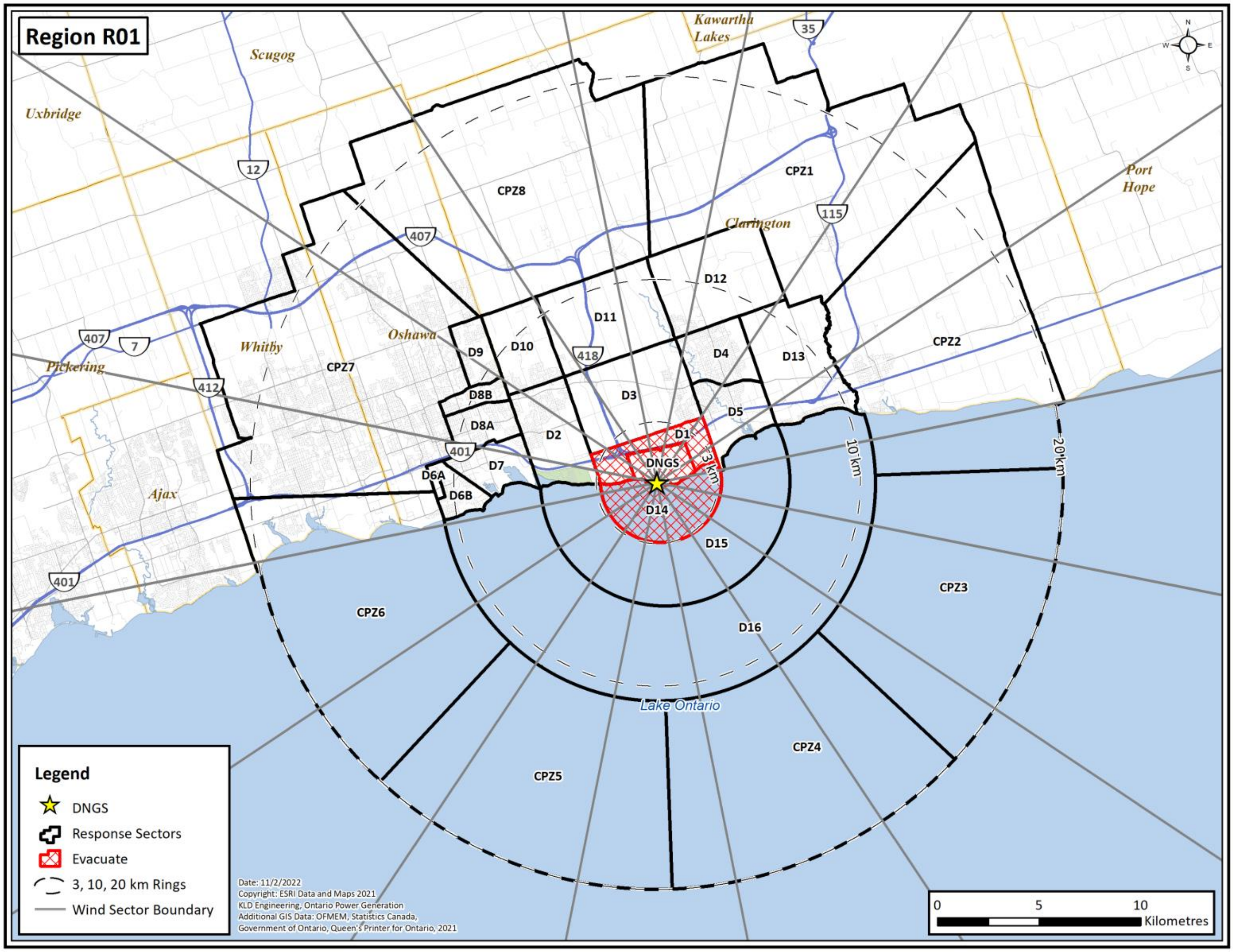



**Figure H-1. Region R01**

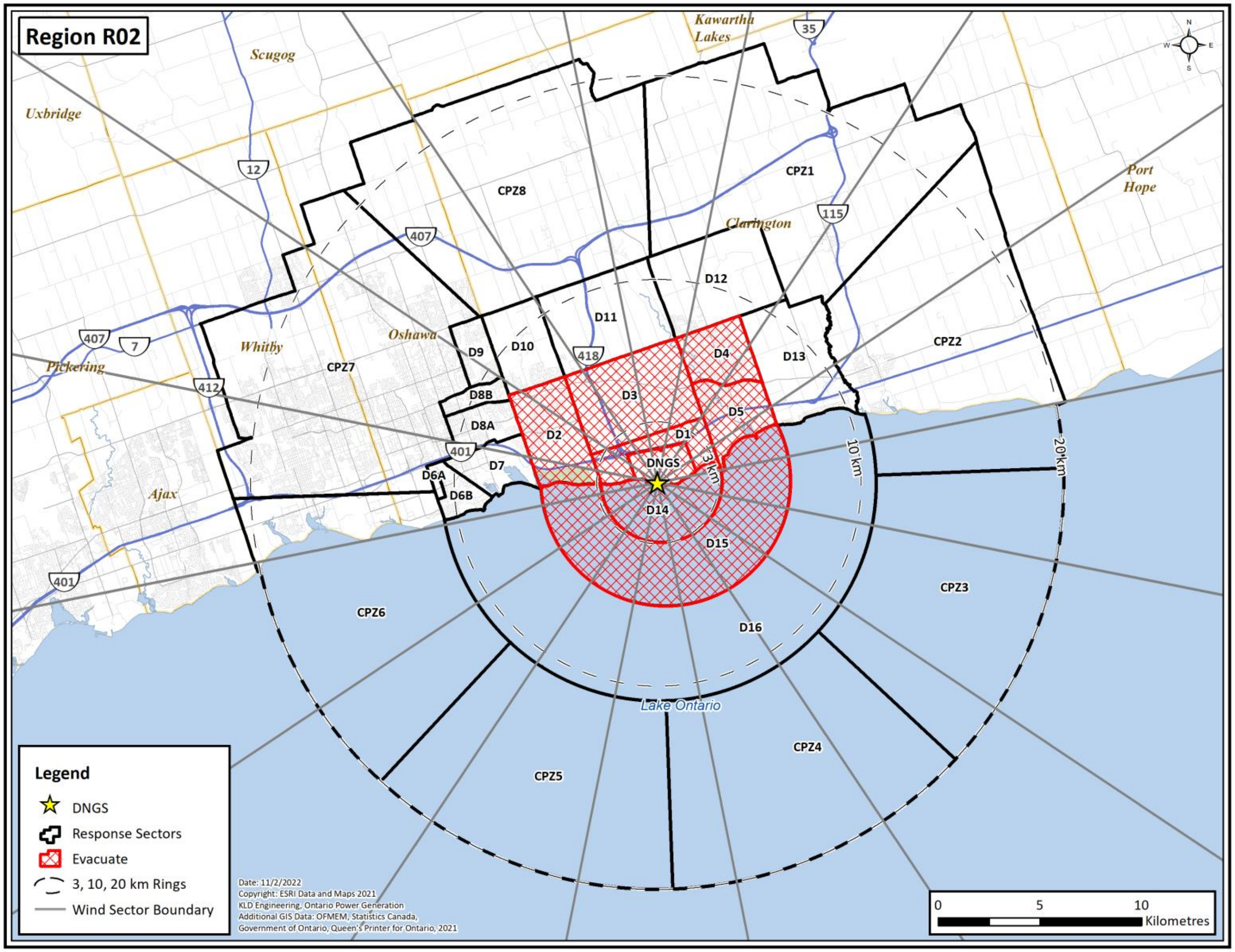



**Figure H-2. Region R02**

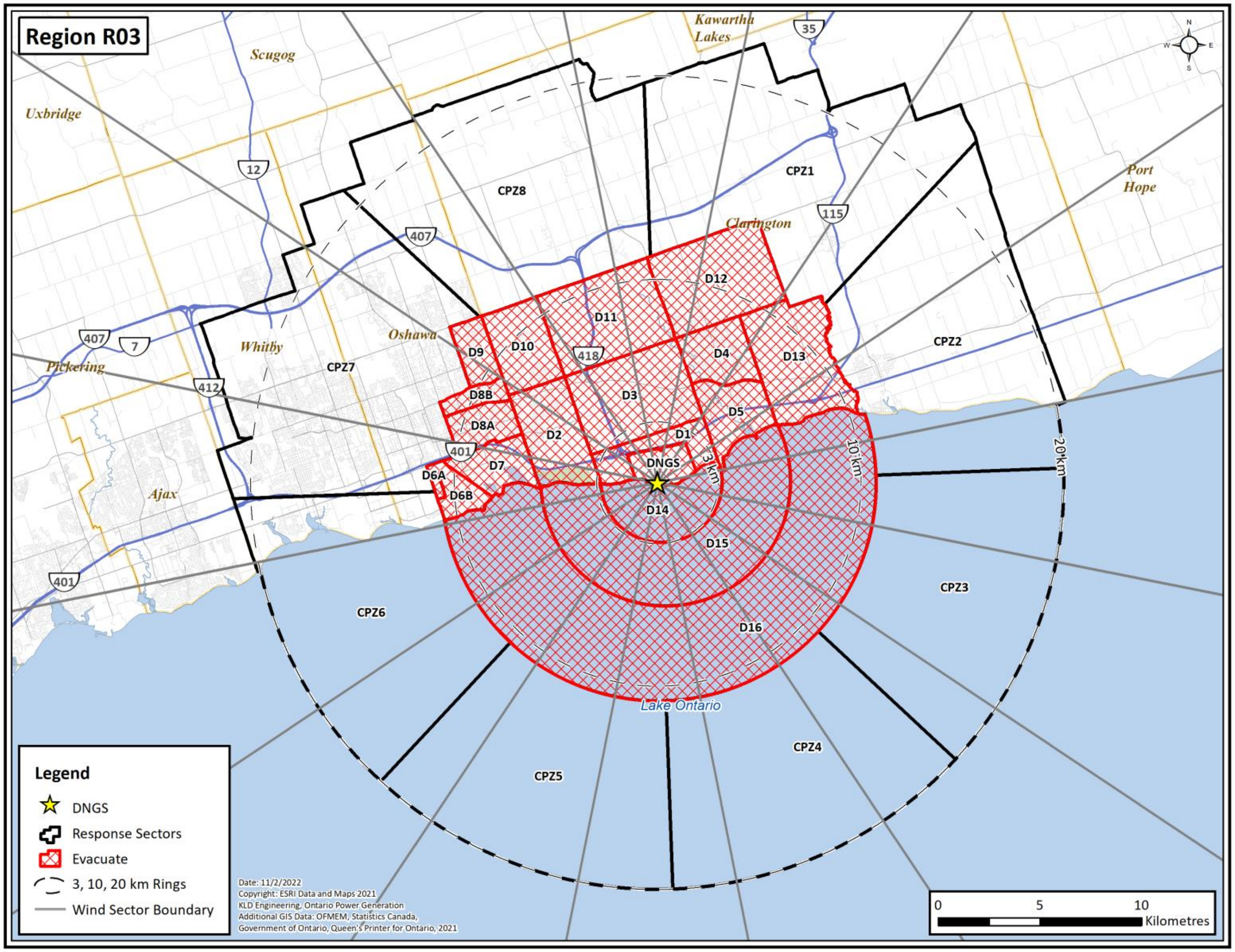



**Figure H-3. Region R03**

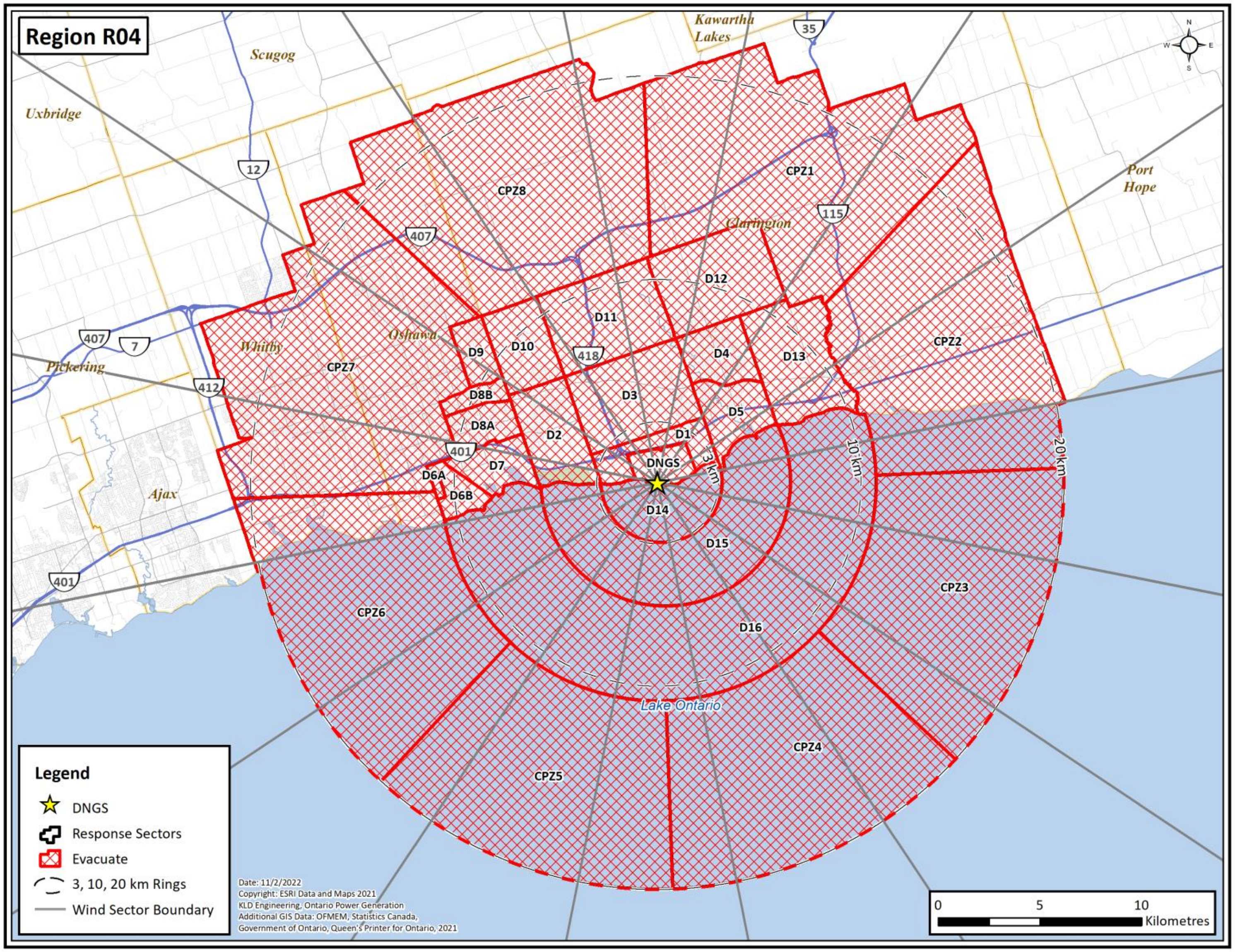



**Figure H-4. Region R04**

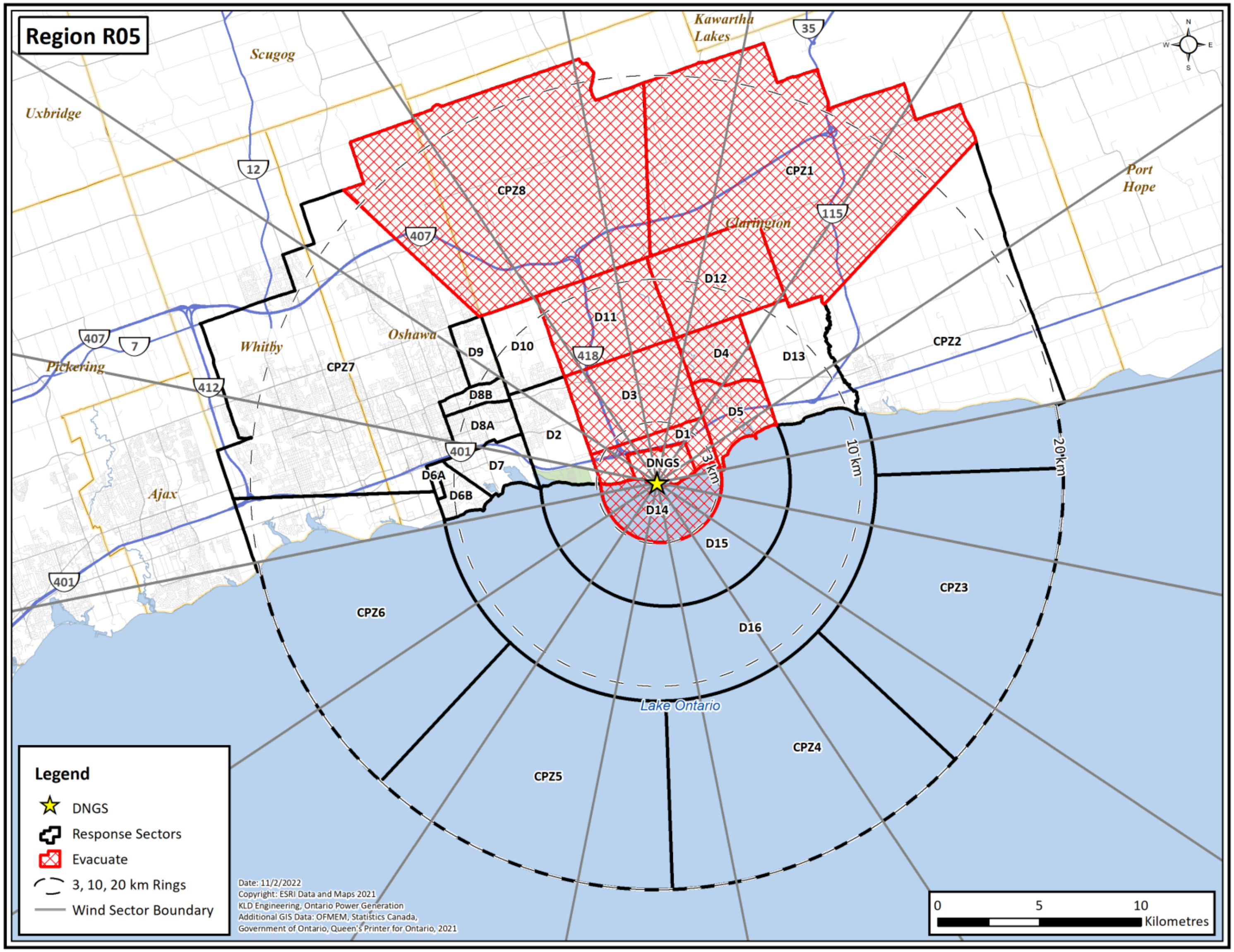



**Figure H-5. Region R05**

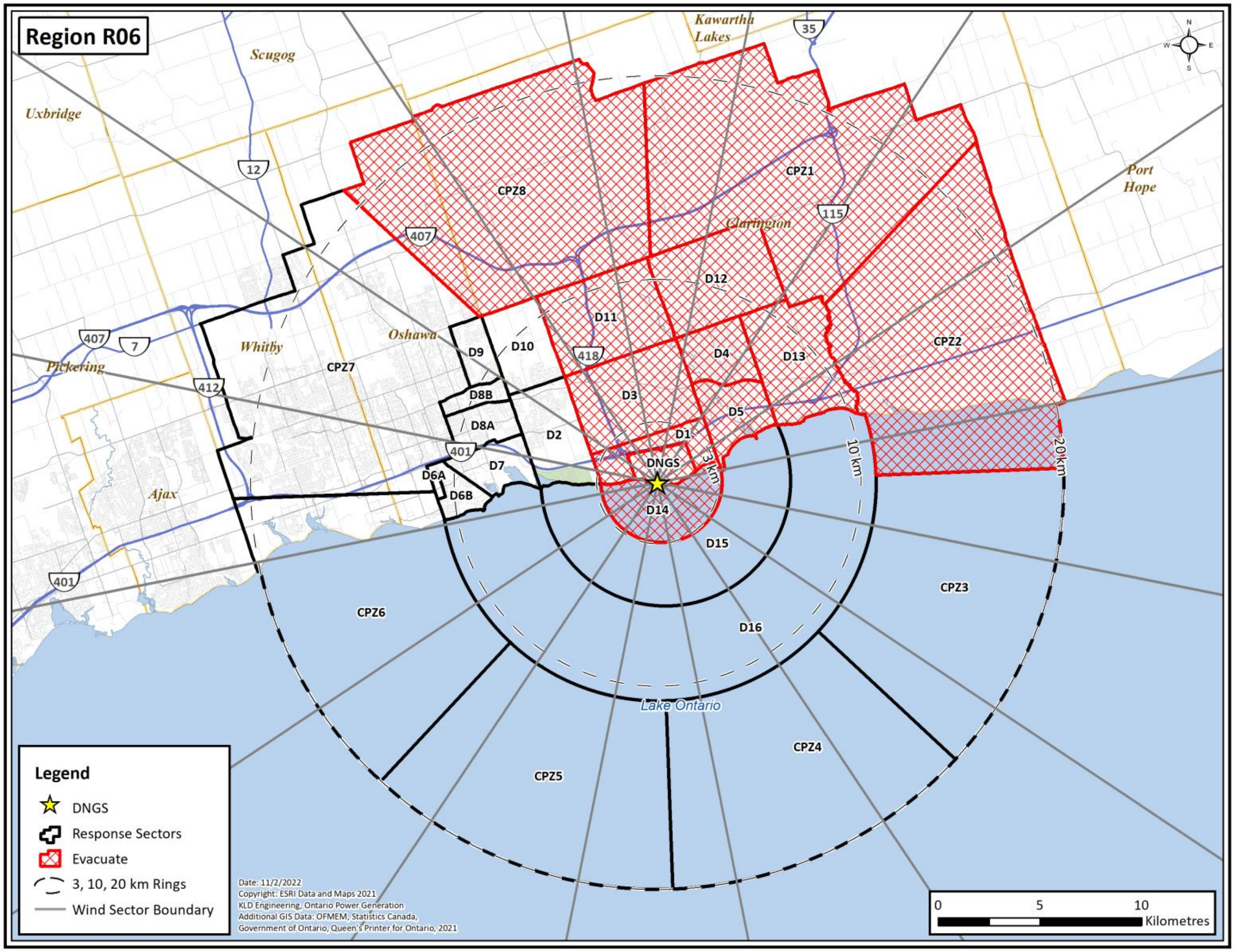



**Figure H-6. Region R06**

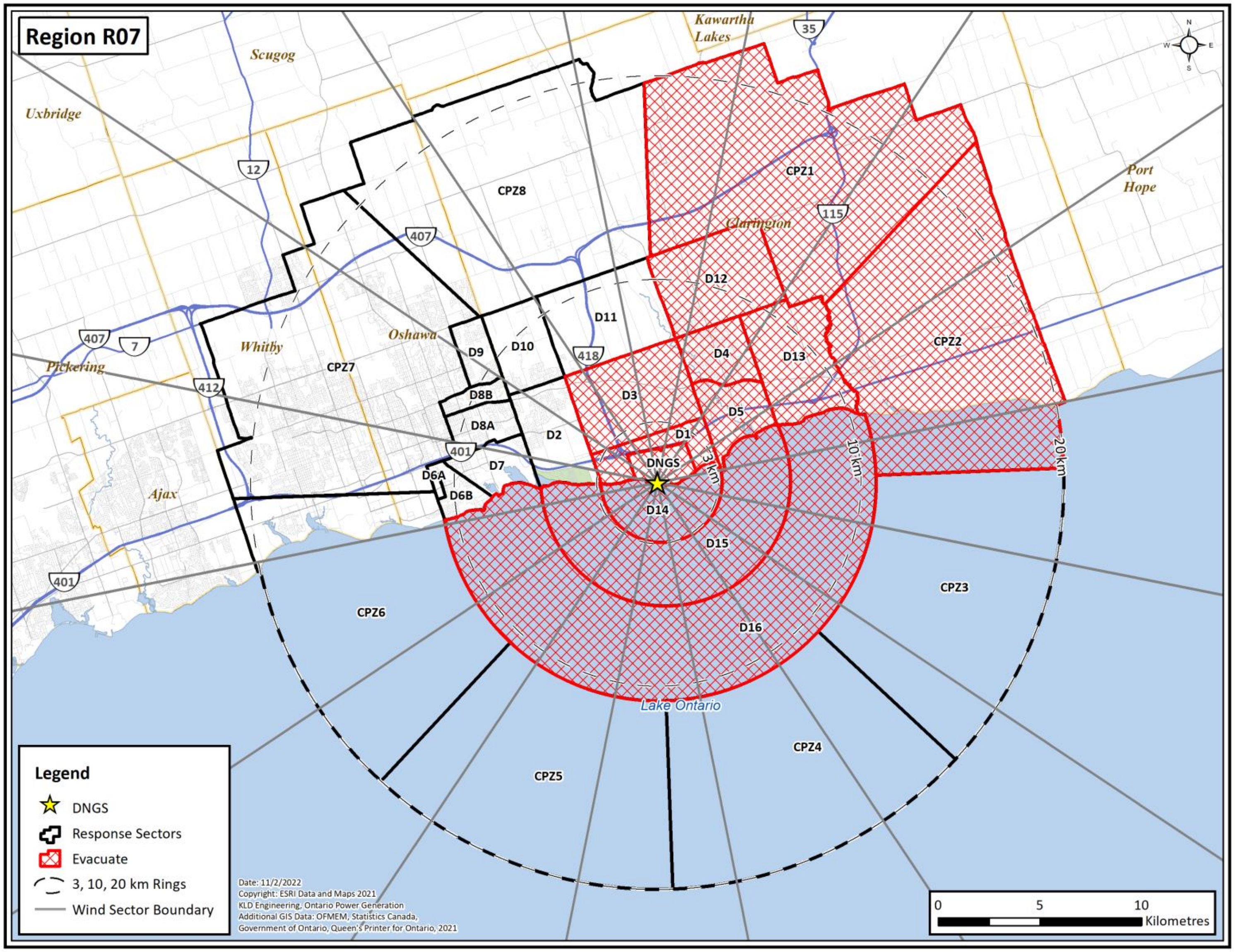



**Figure H-7. Region R07**

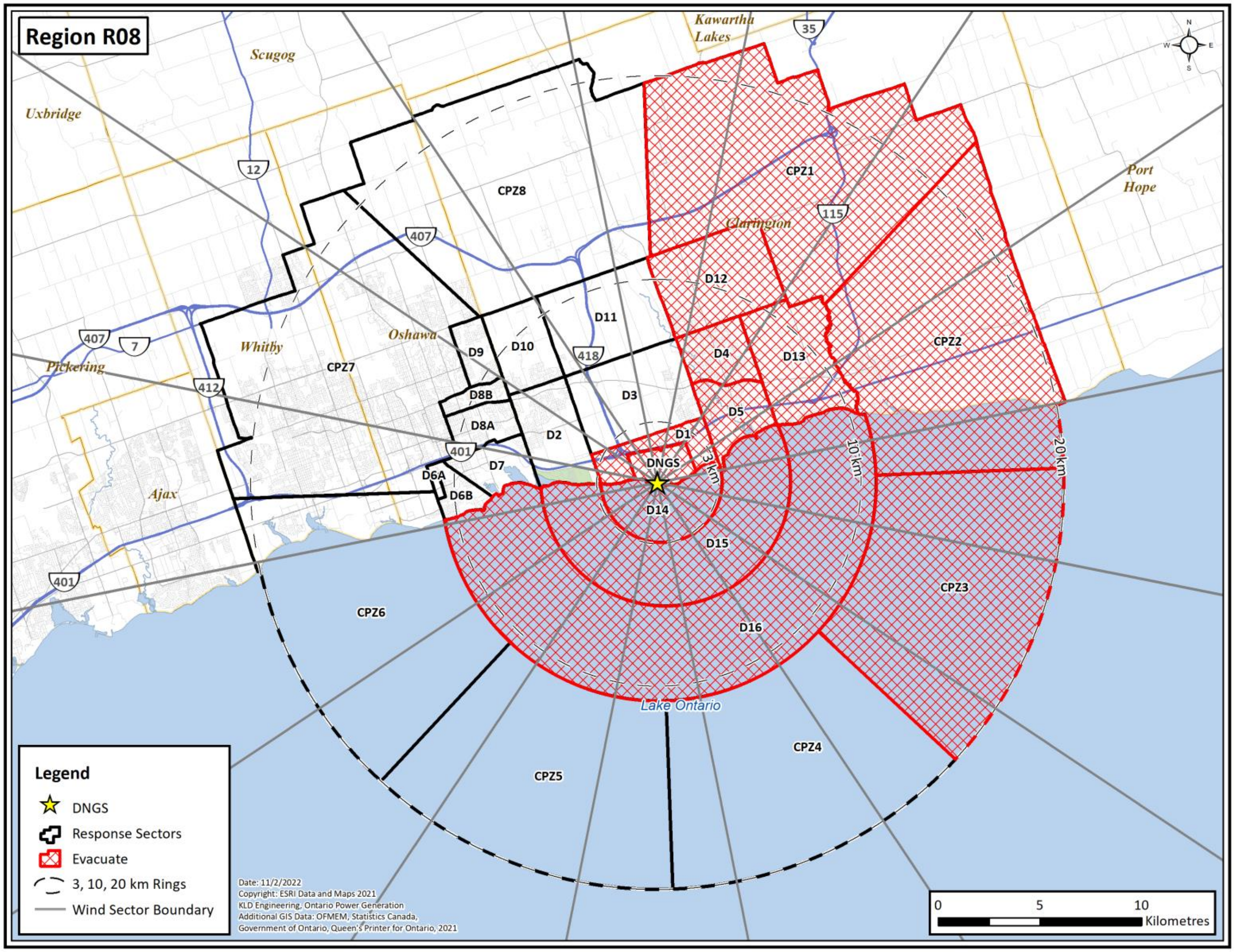



**Figure H-8. Region R08**

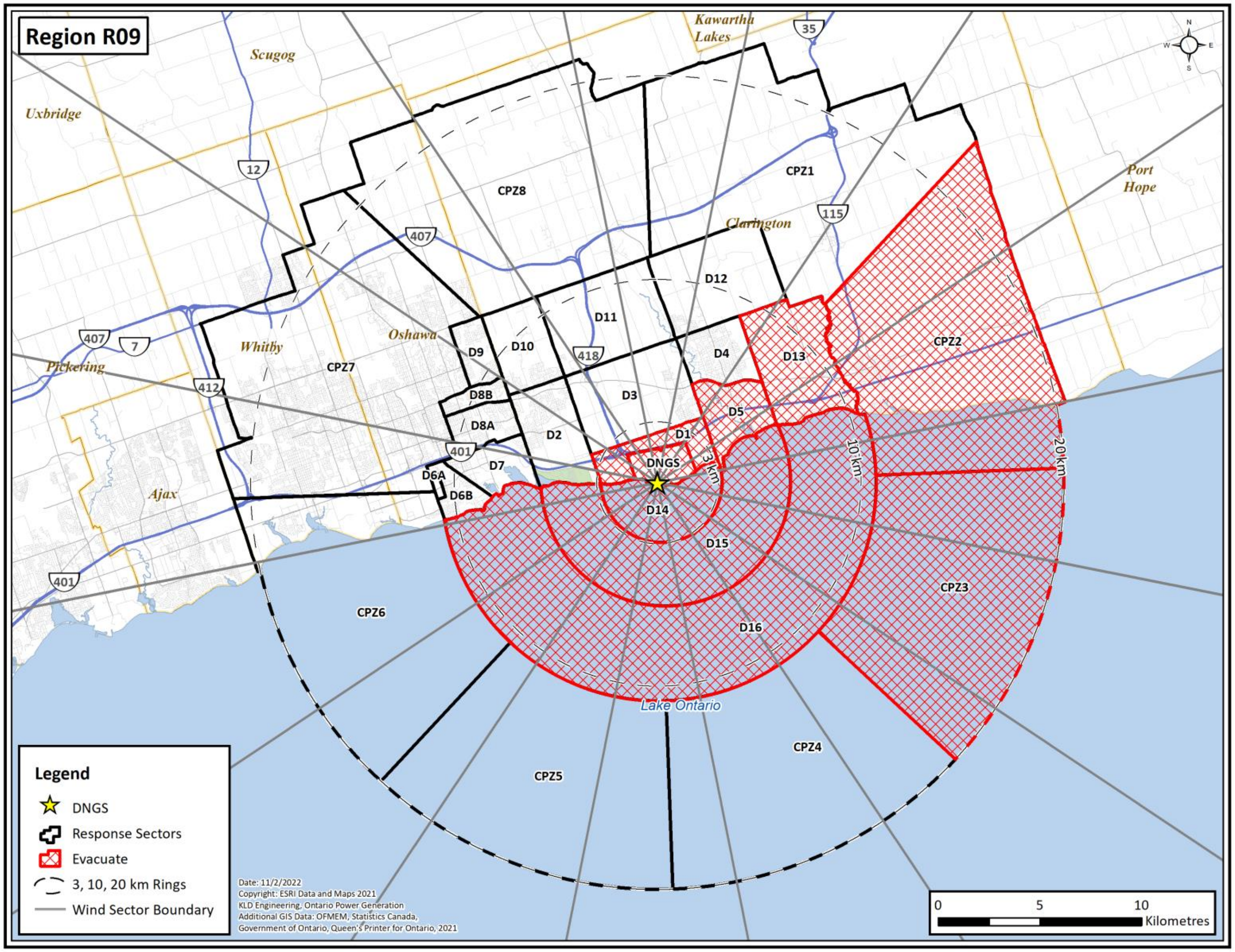



Figure H-9. Region R09

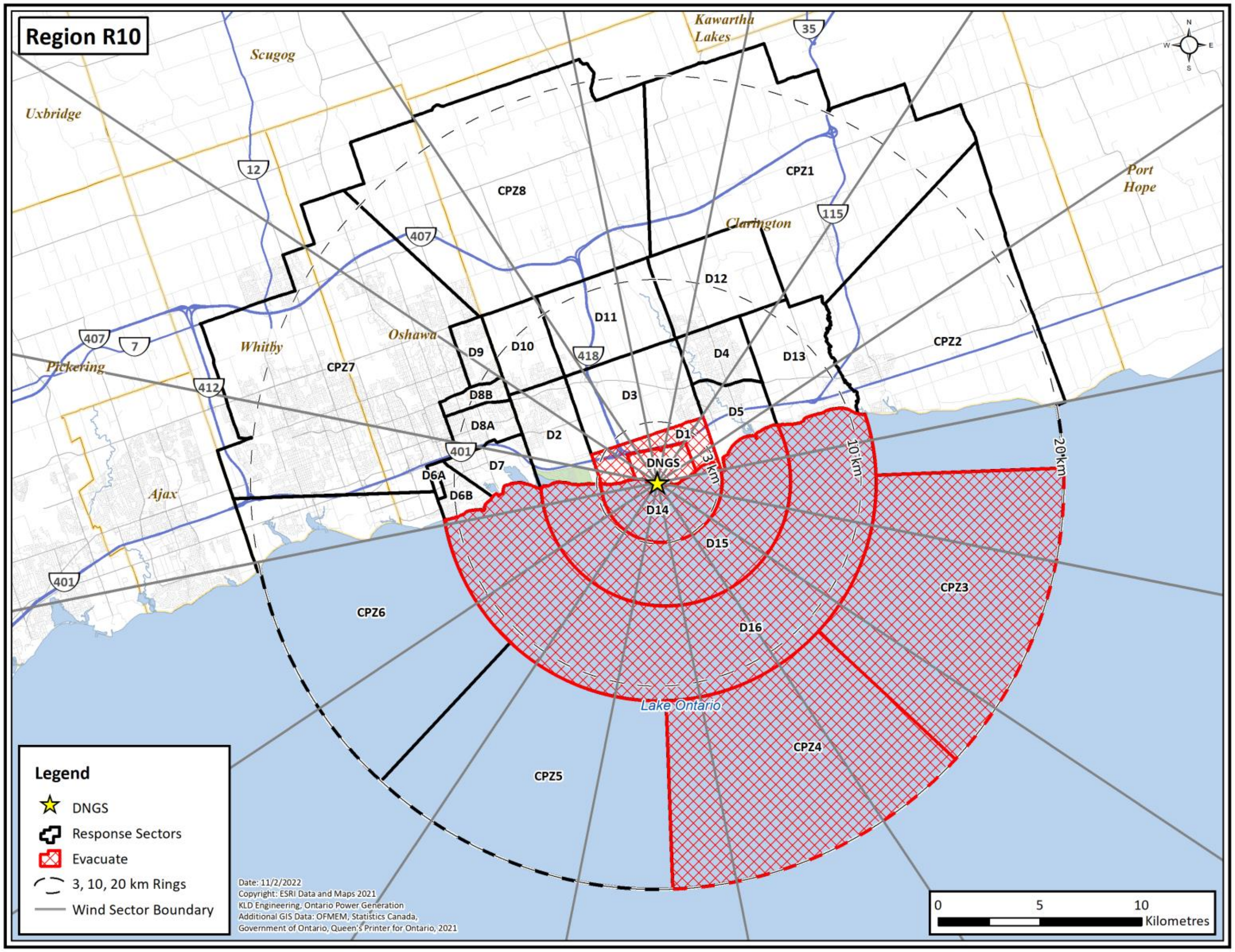



**Figure H-10. Region R10**

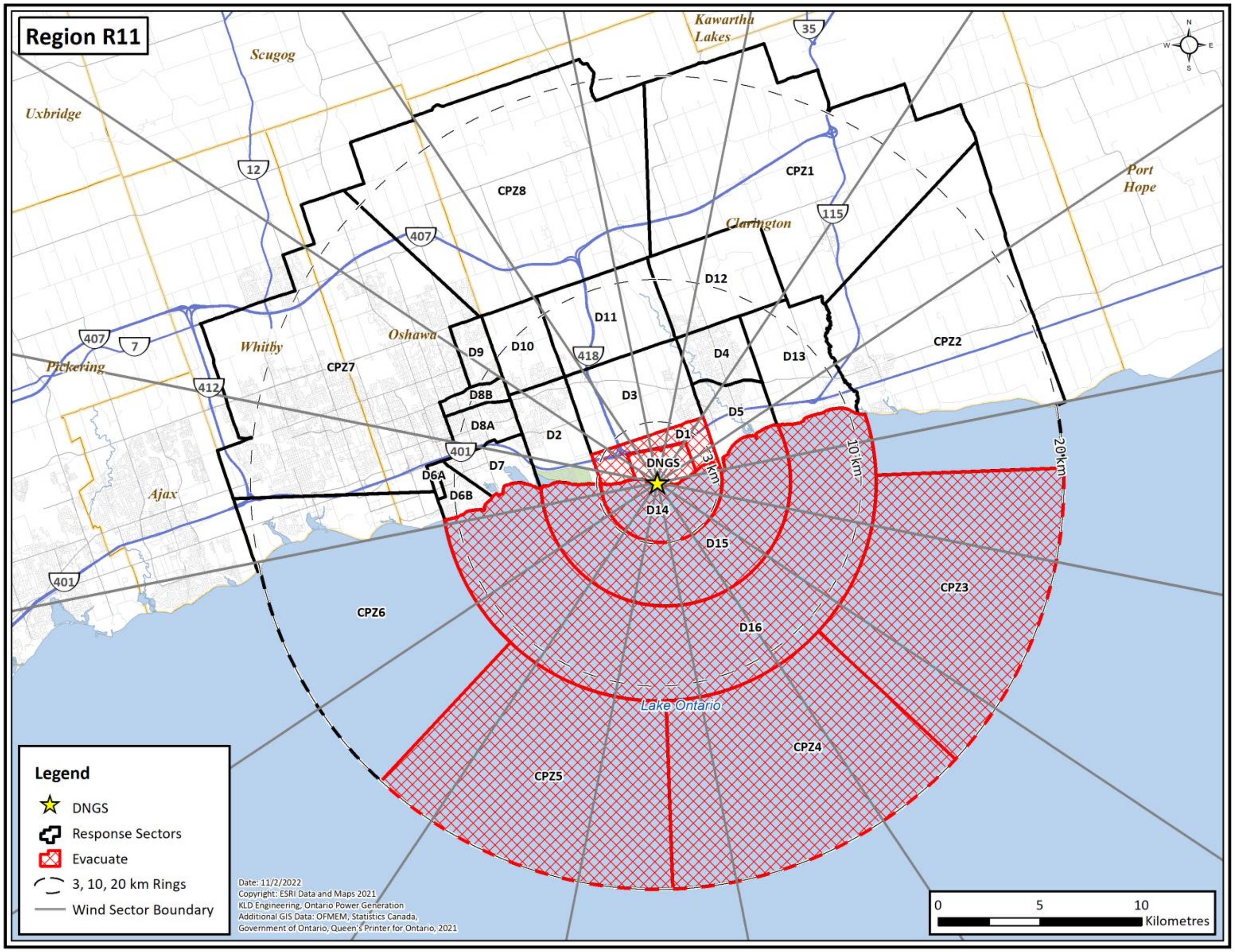



**Figure H-11. Region R11**

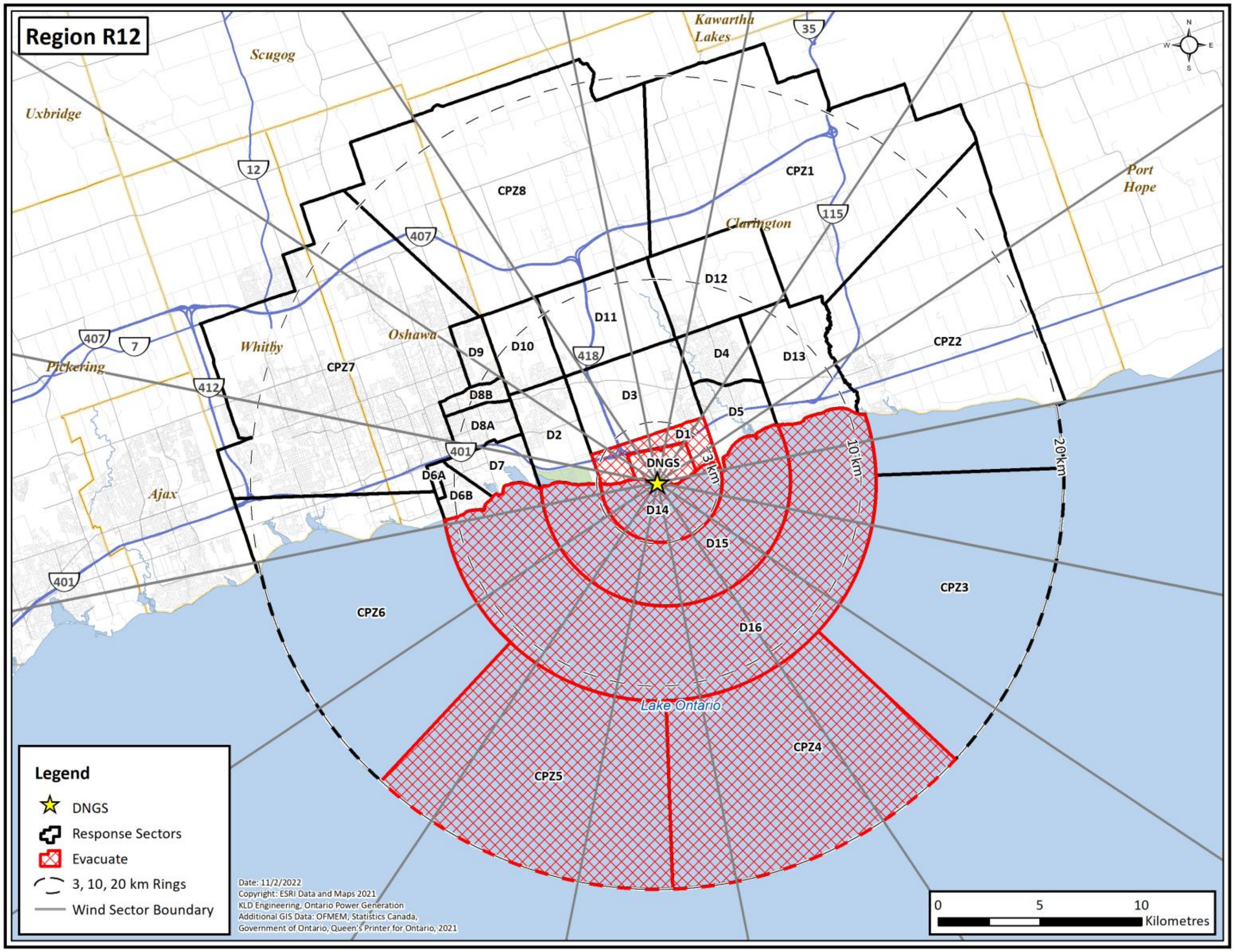



**Figure H-12. Region R12**

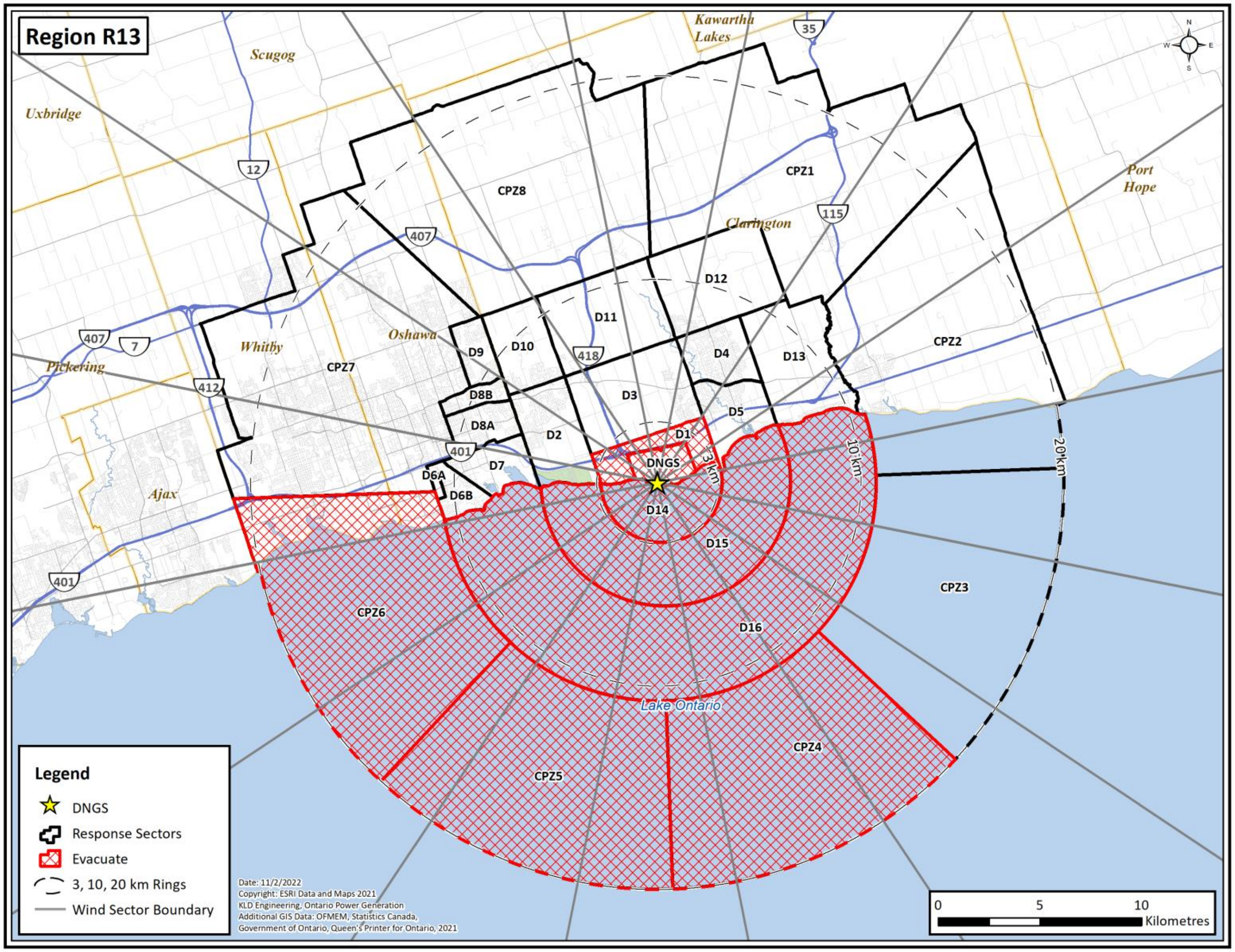



**Figure H-13. Region R13**

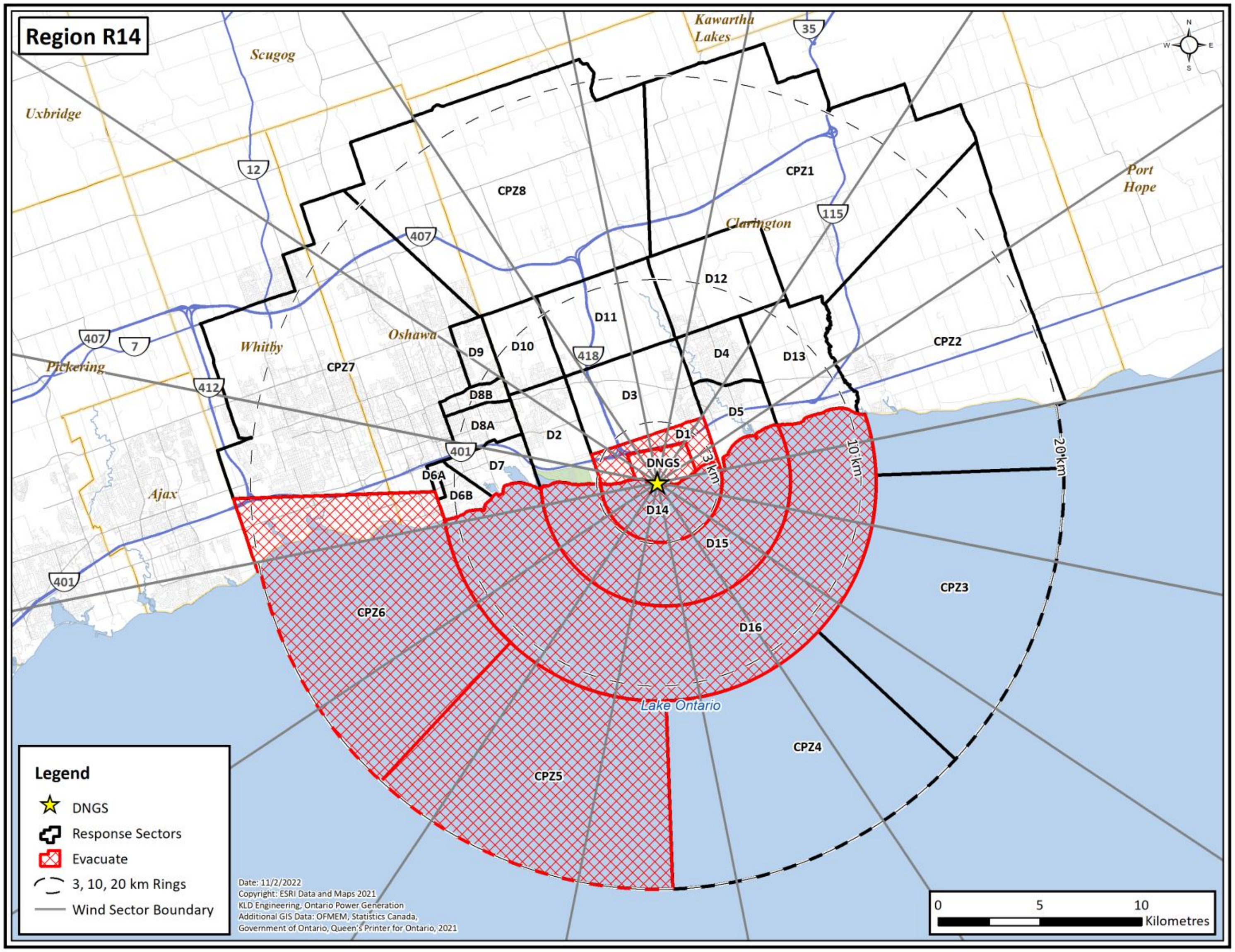



**Figure H-14. Region R14**

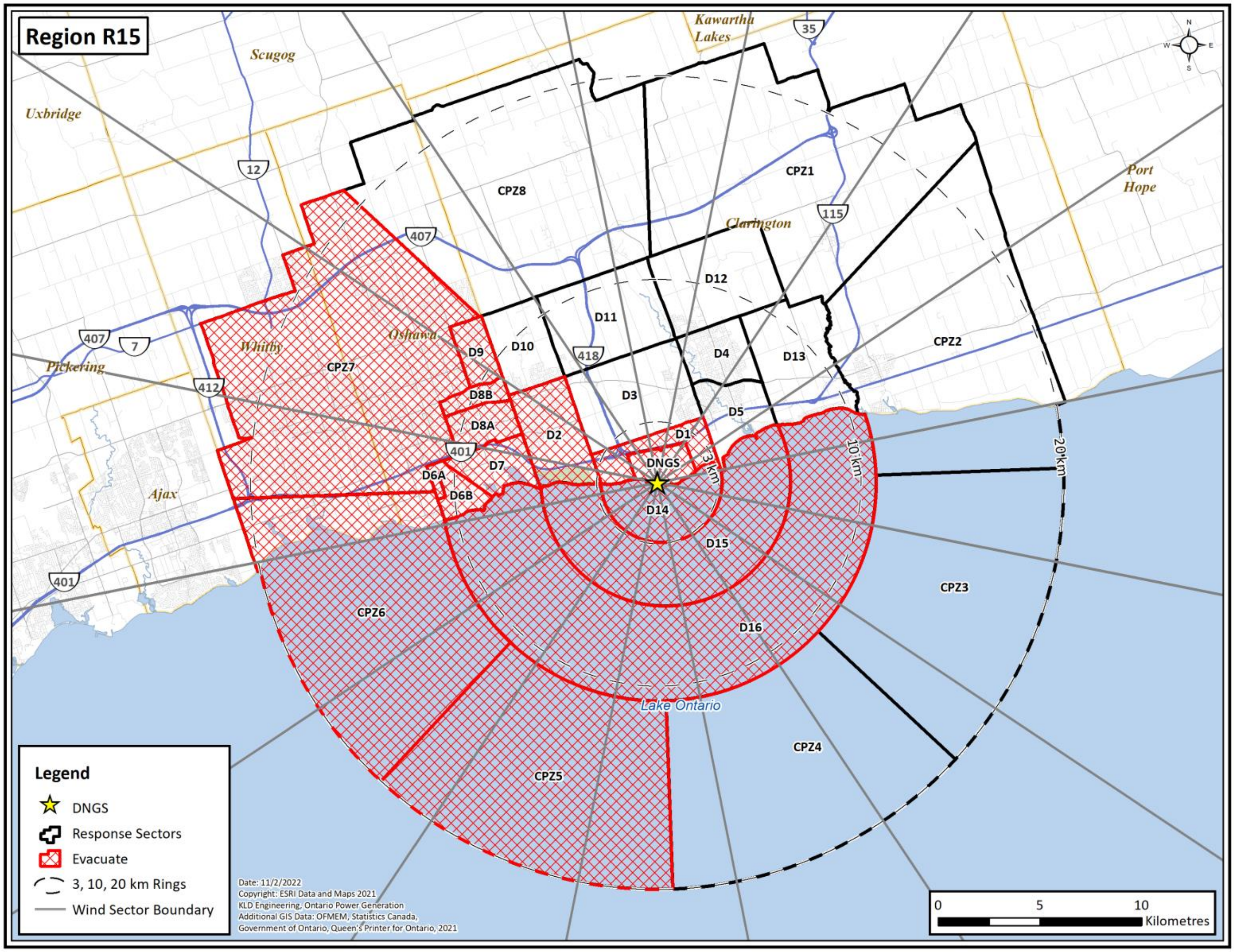



**Figure H-15. Region R15**

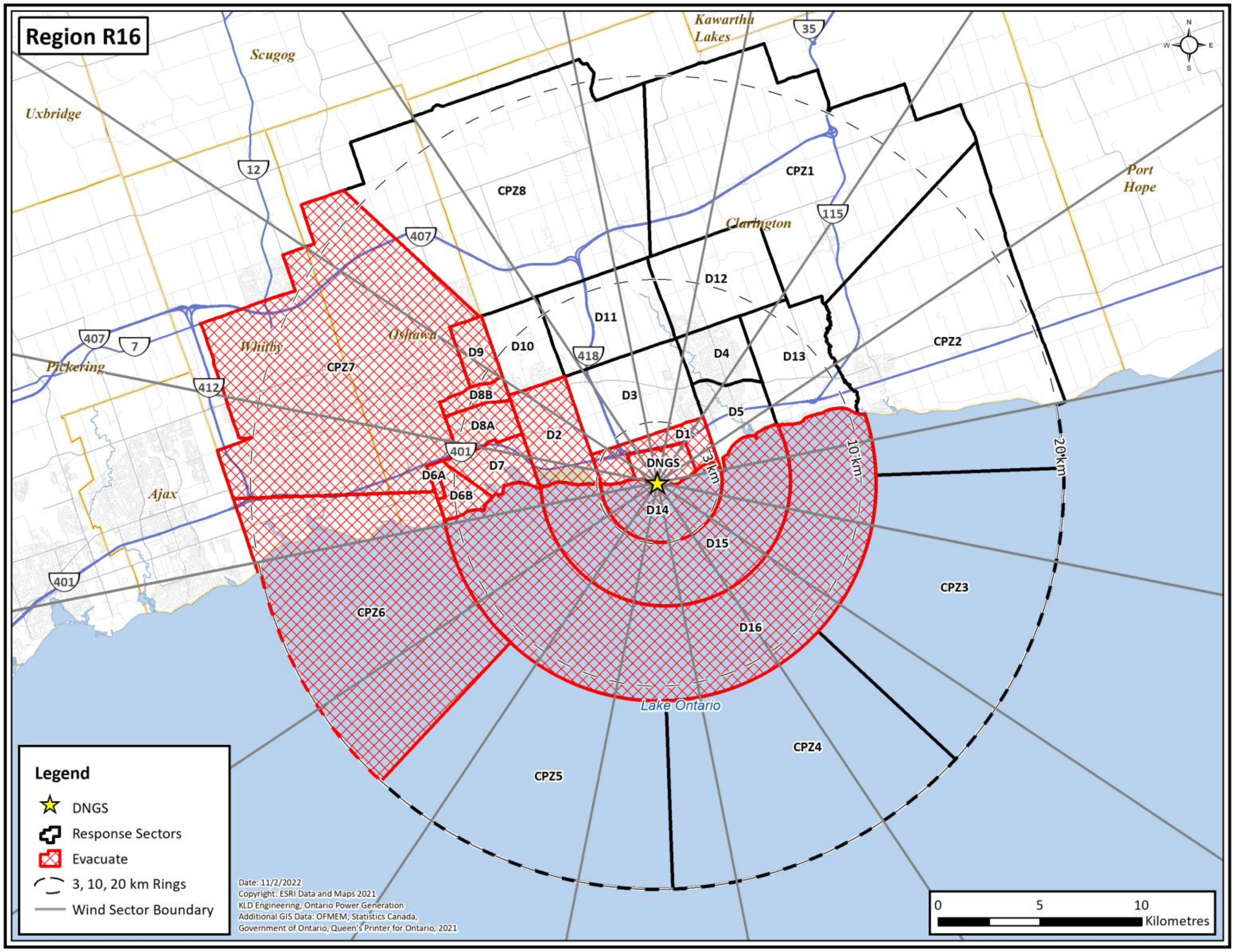



**Figure H-16. Region R16**

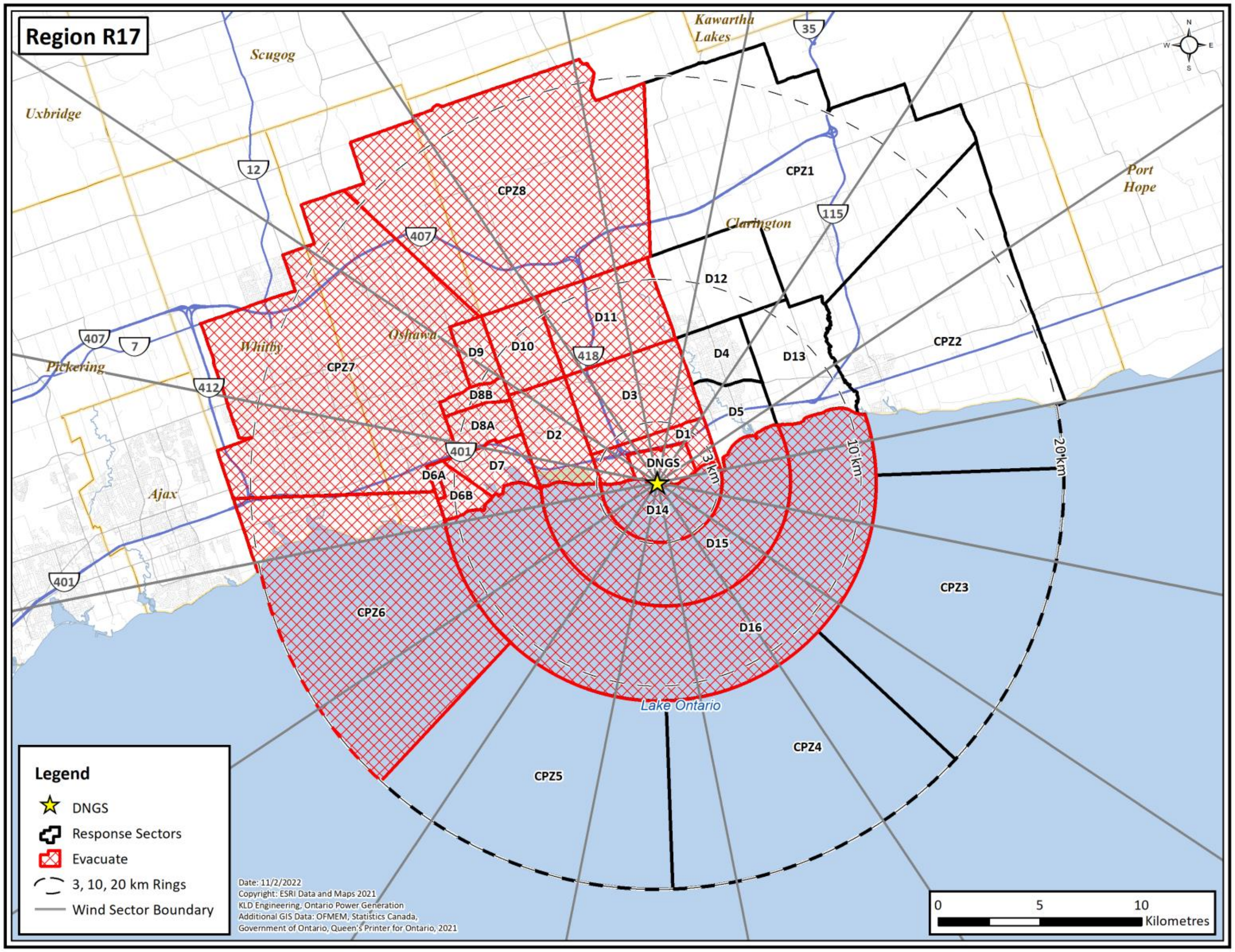



**Figure H-17. Region R17**

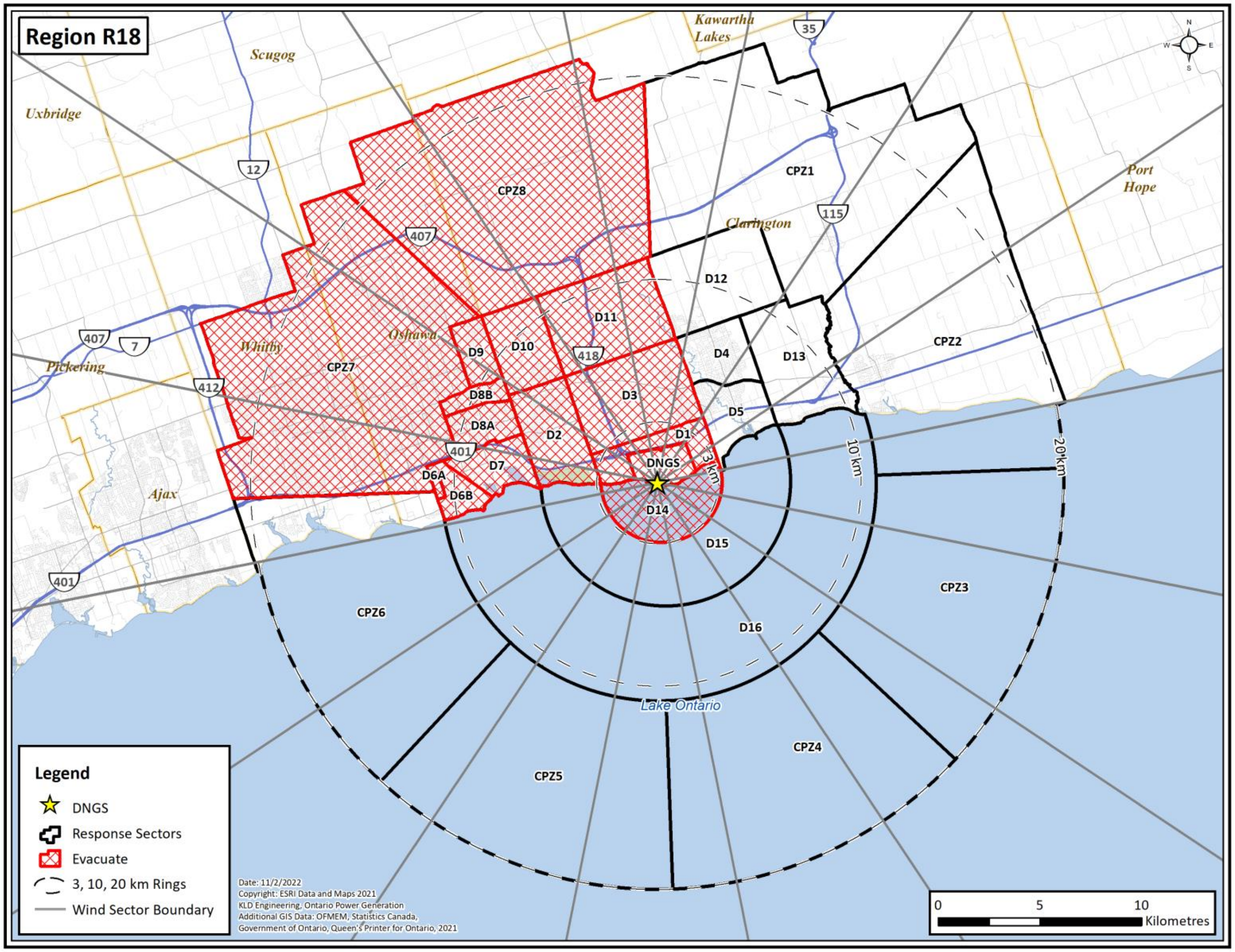



**Figure H-18. Region R18**

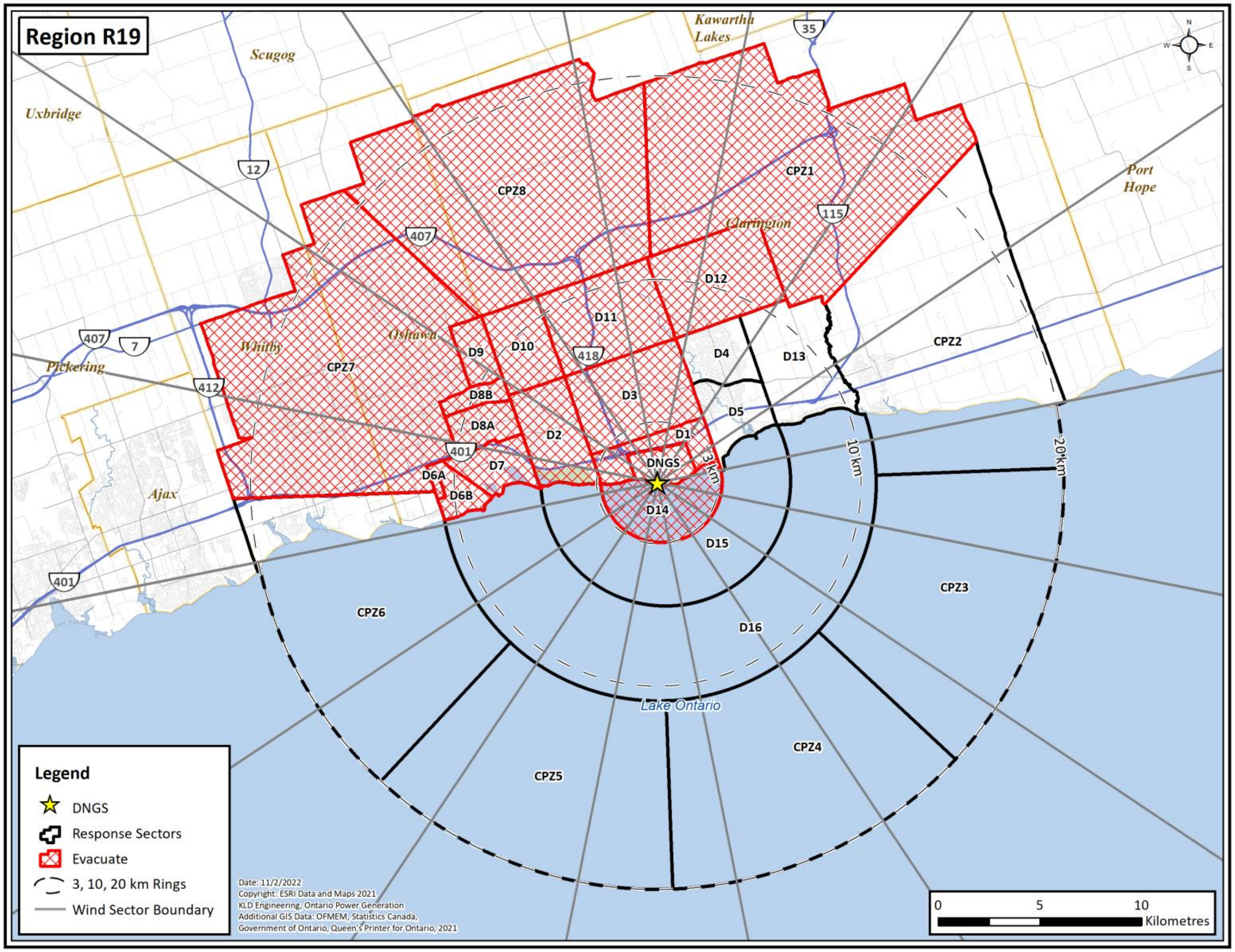



**Figure H-19. Region R19**

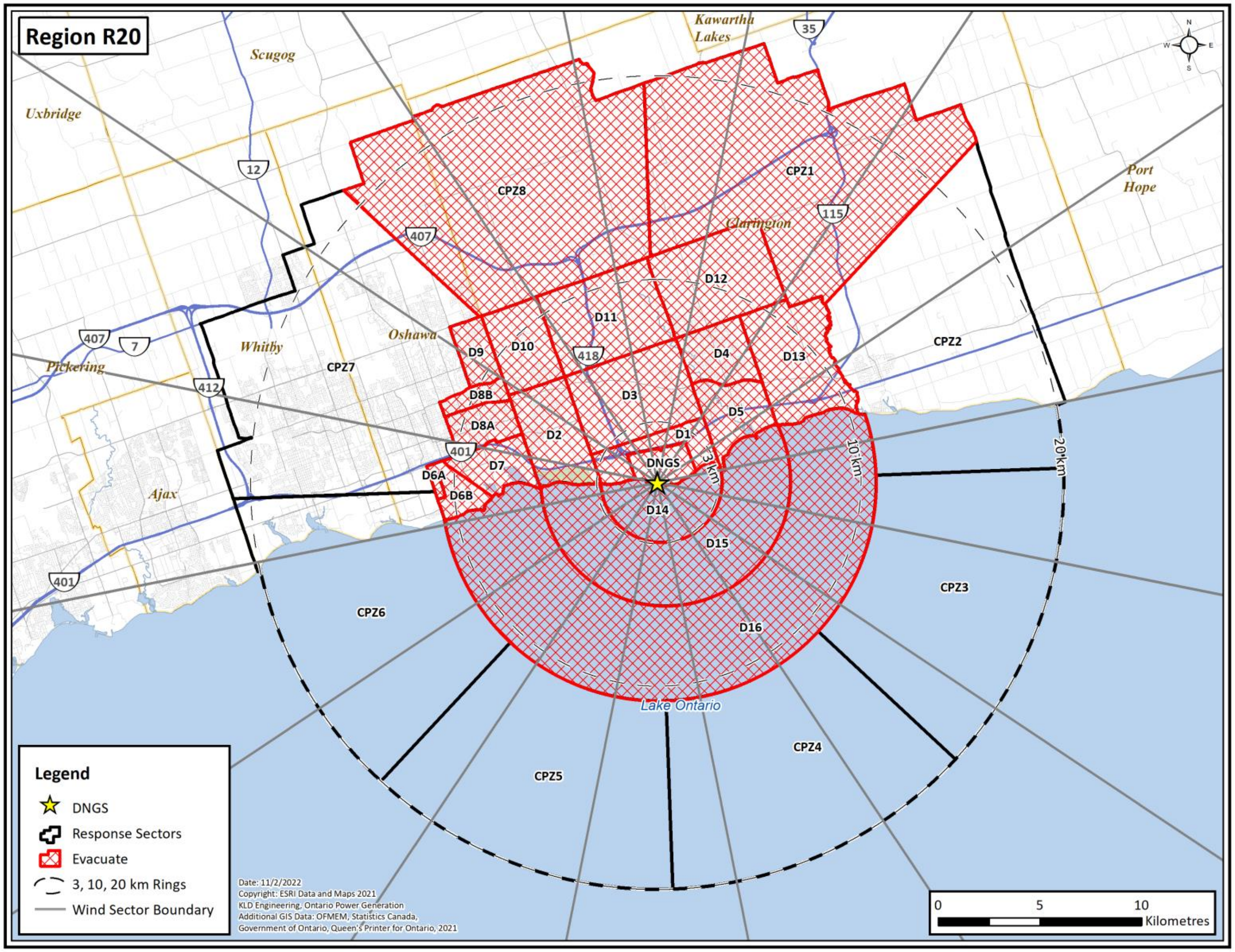



**Figure H-20. Region R20**

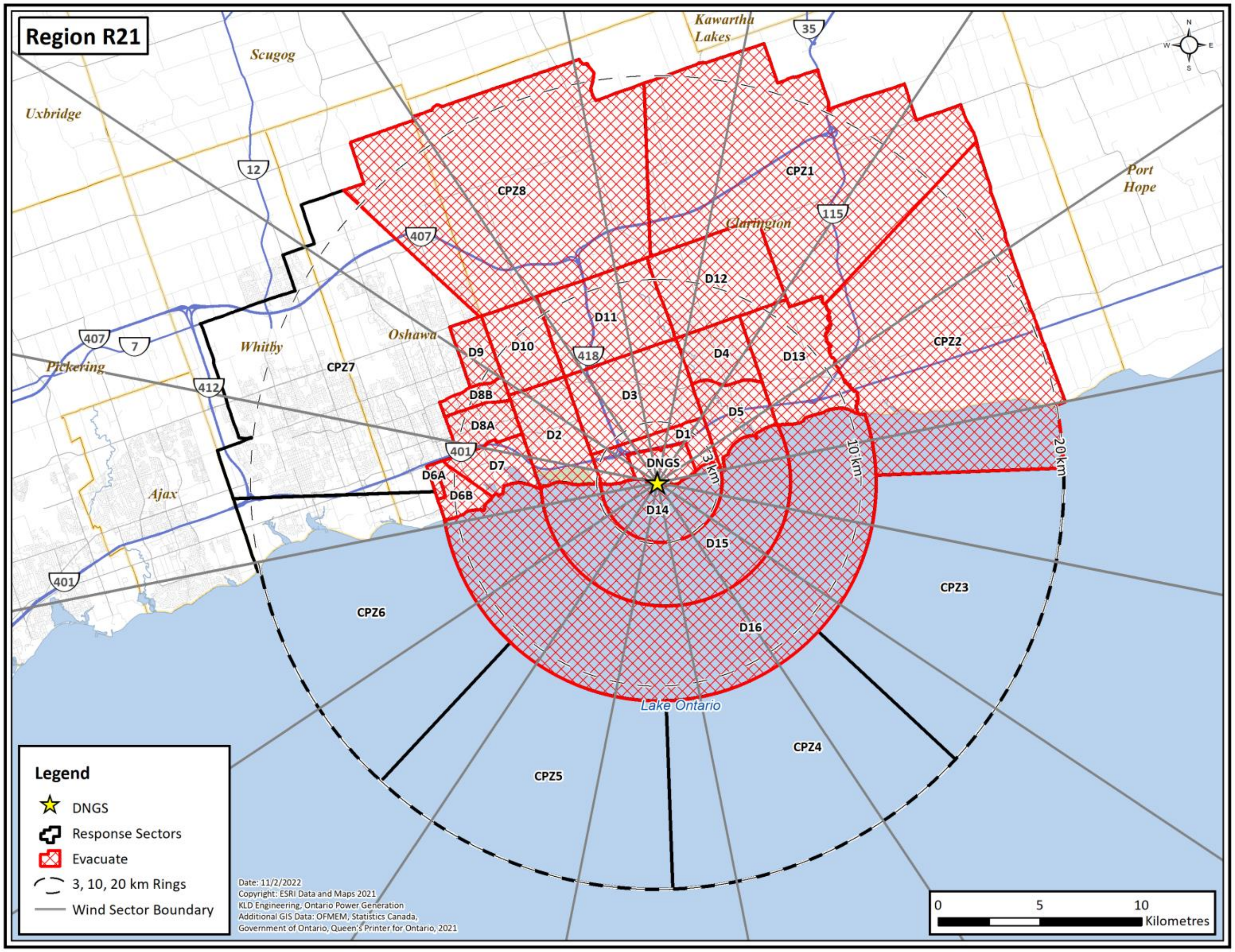



**Figure H-21. Region R21**

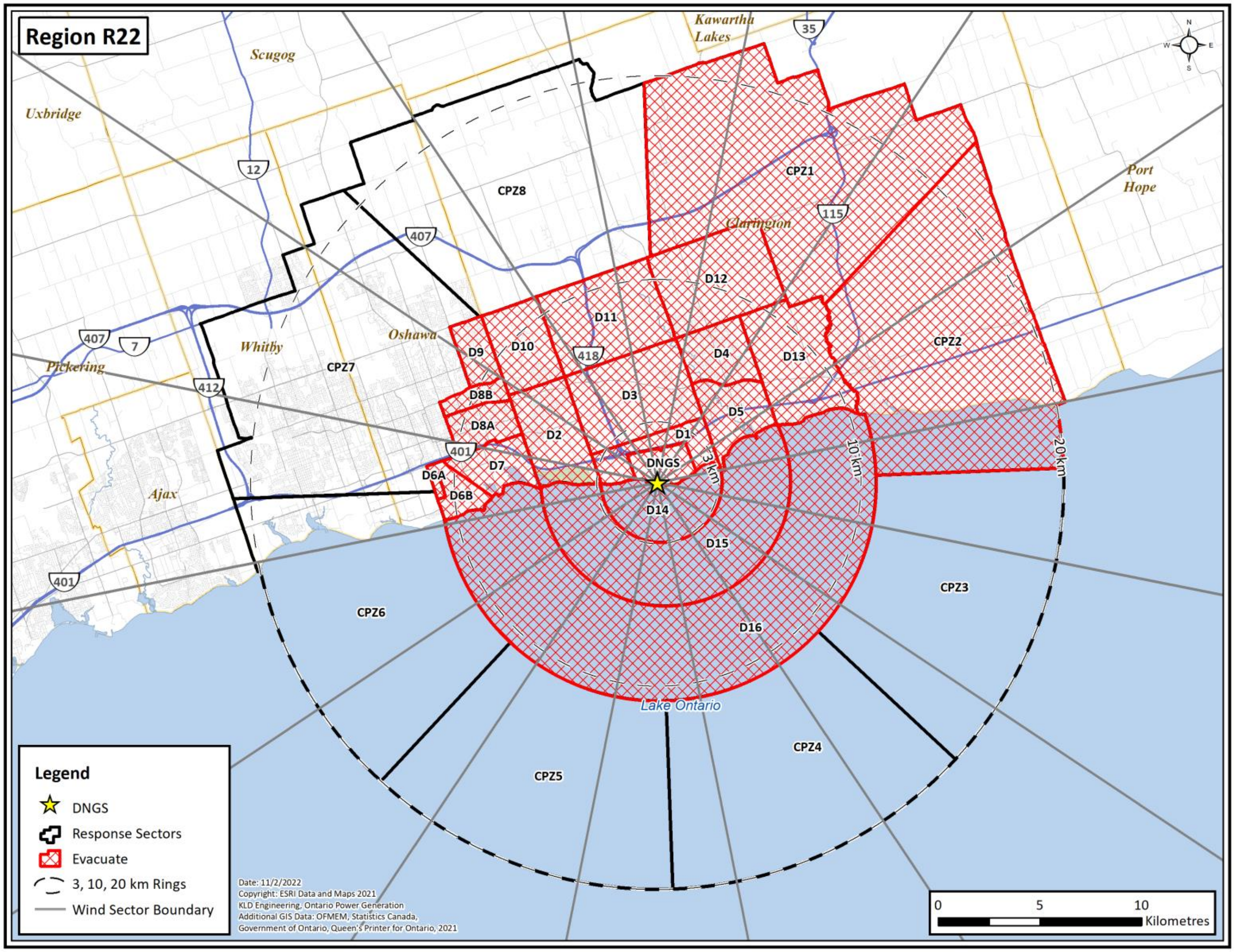



**Figure H-22. Region R22**

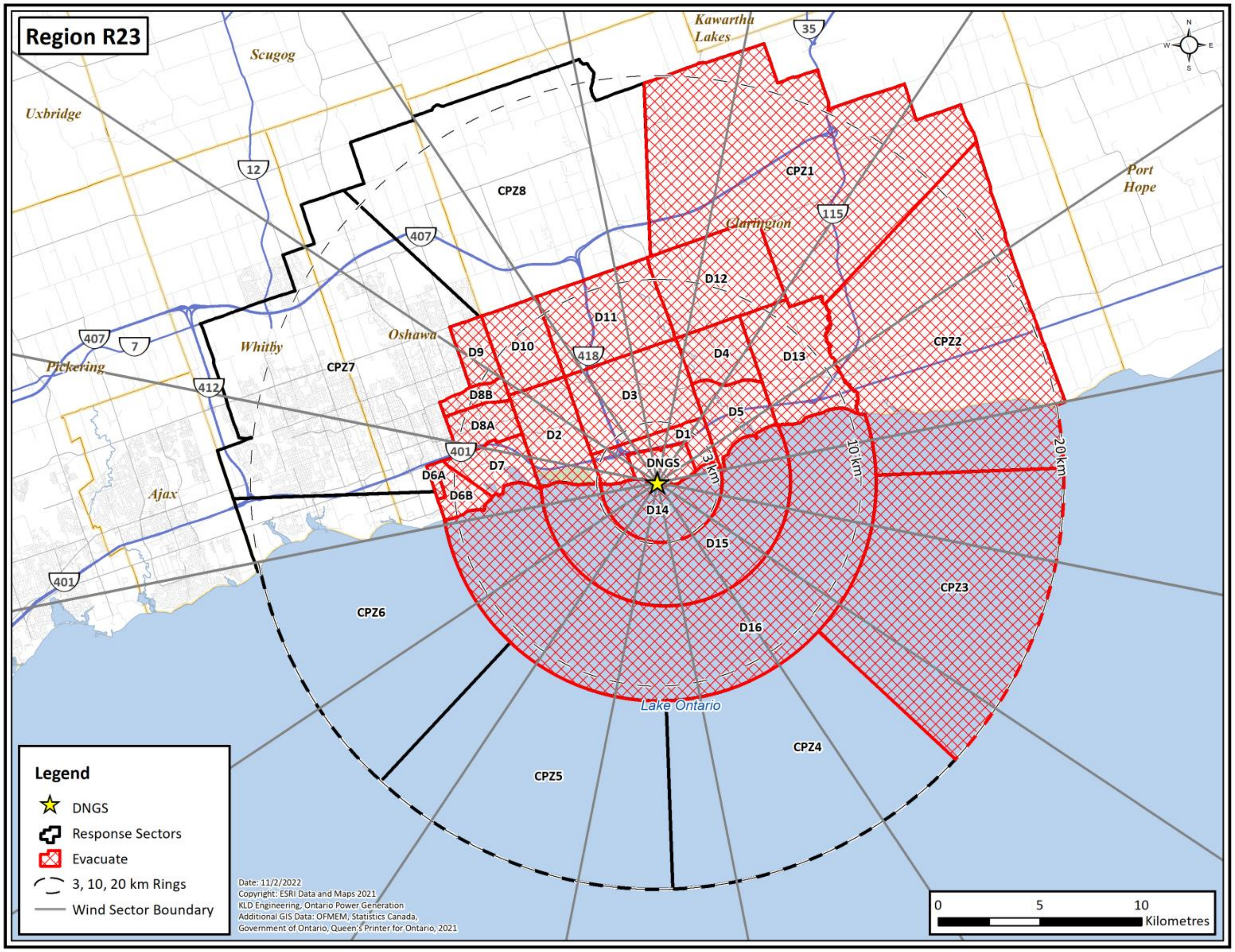



**Figure H-23. Region R23**

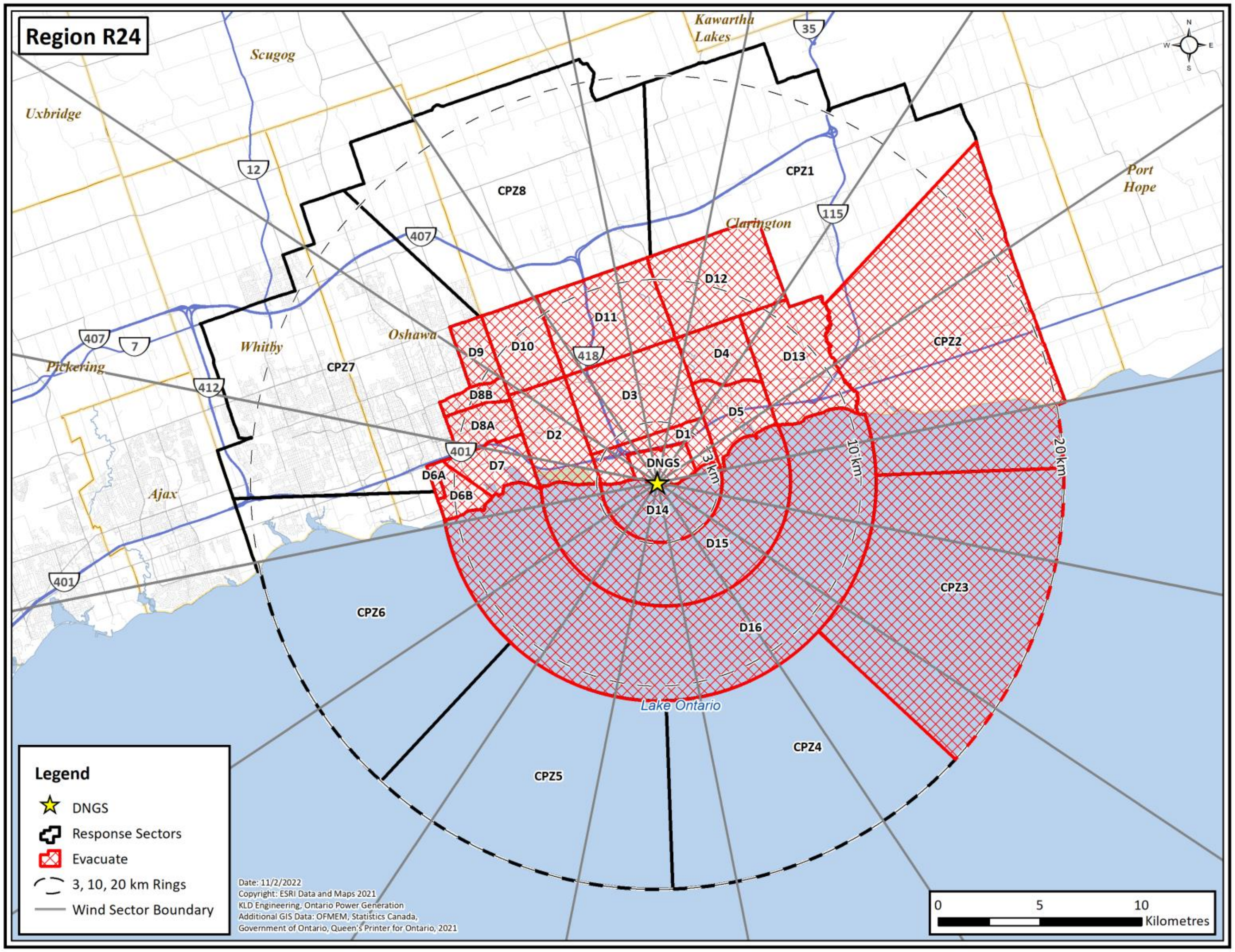



**Figure H-24. Region R24**

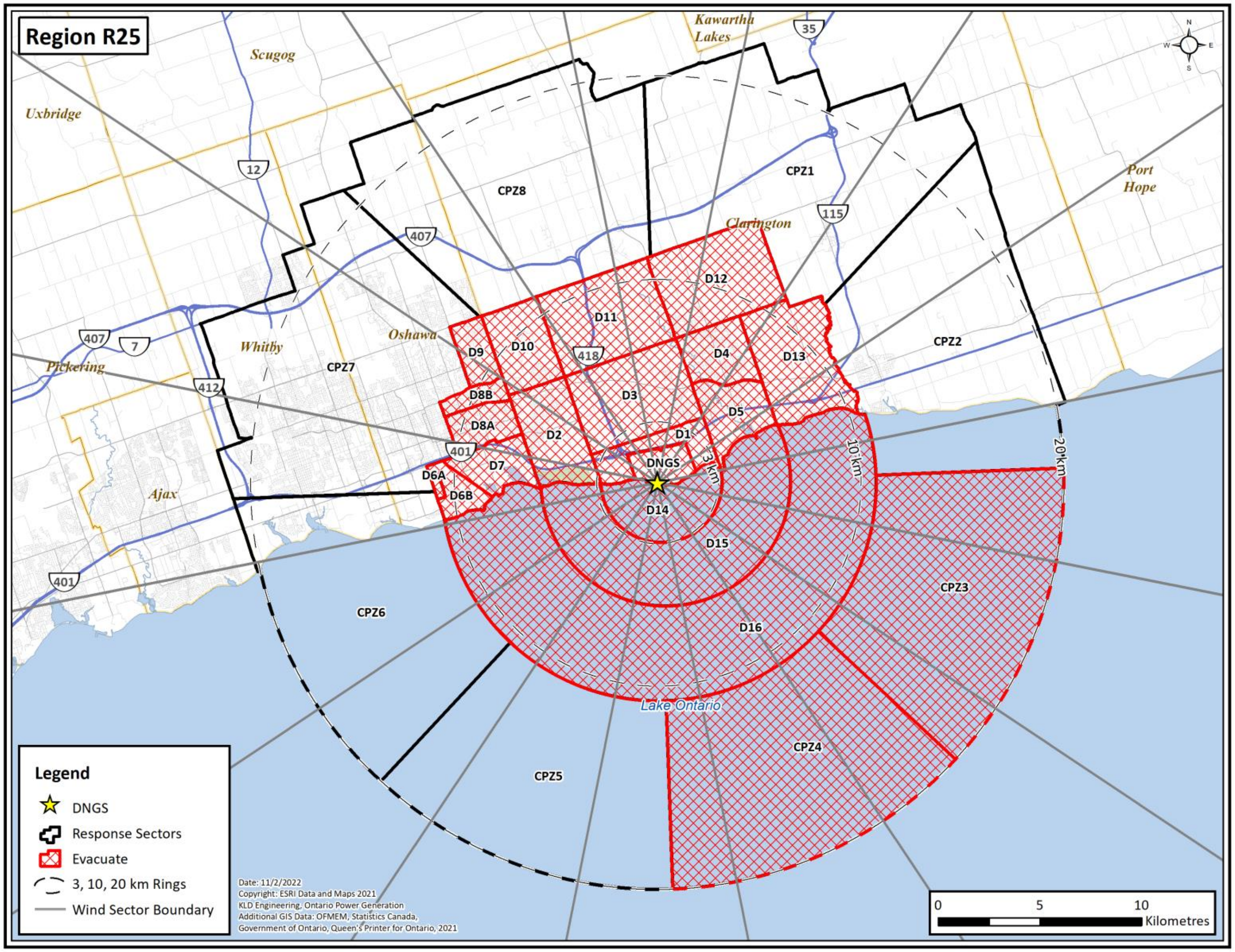



**Figure H-25. Region R25**

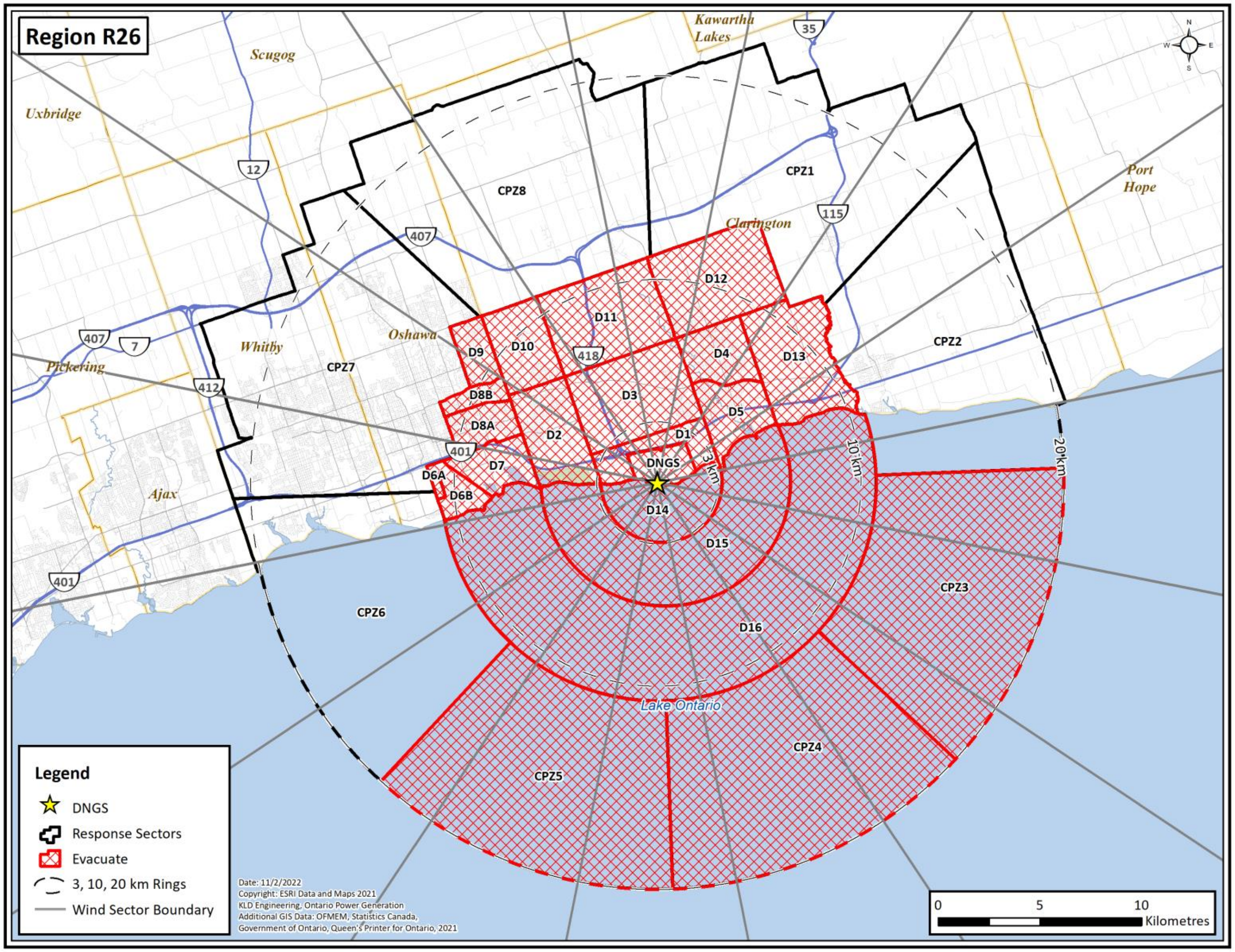



**Figure H-26. Region R26**

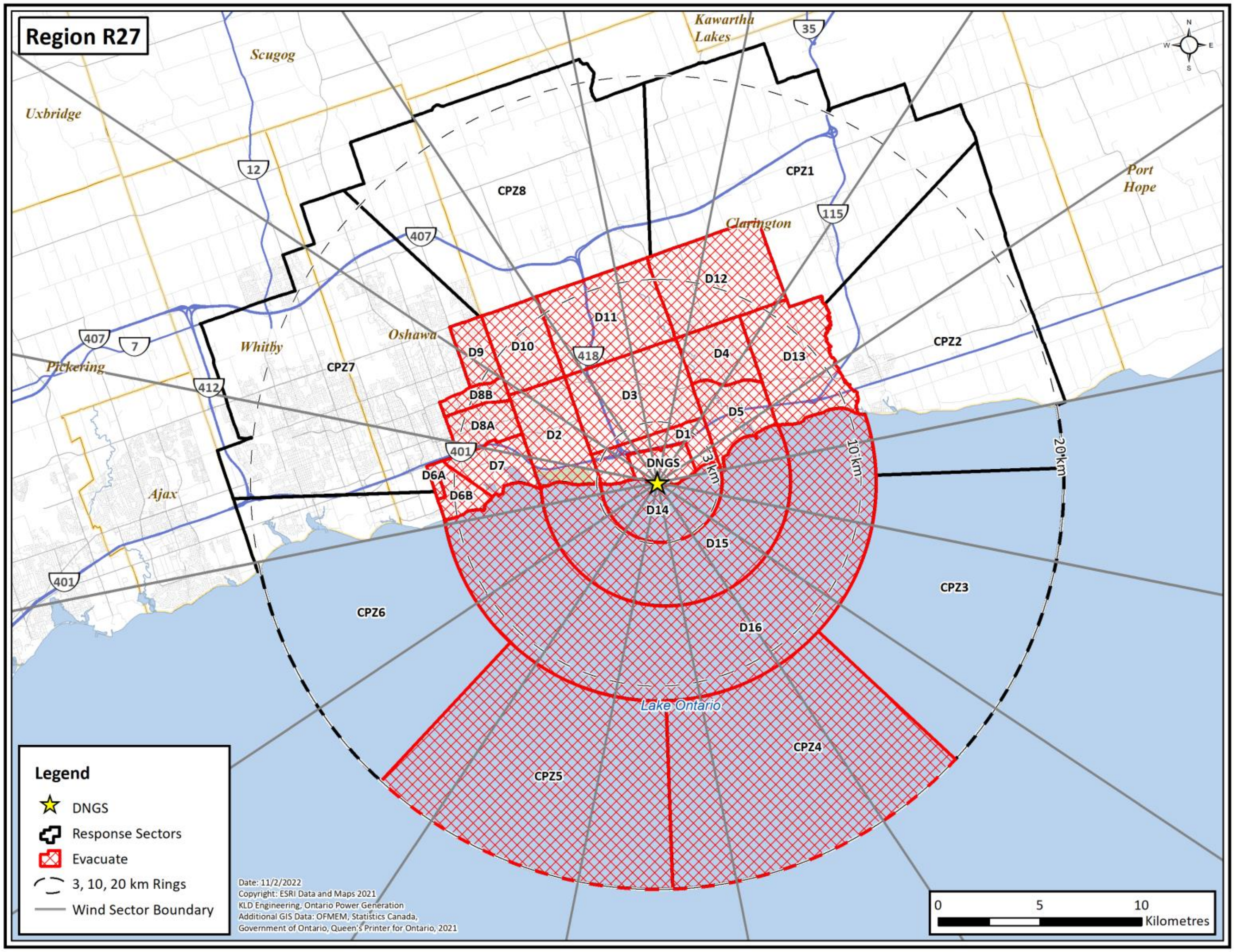



**Figure H-27. Region R27**

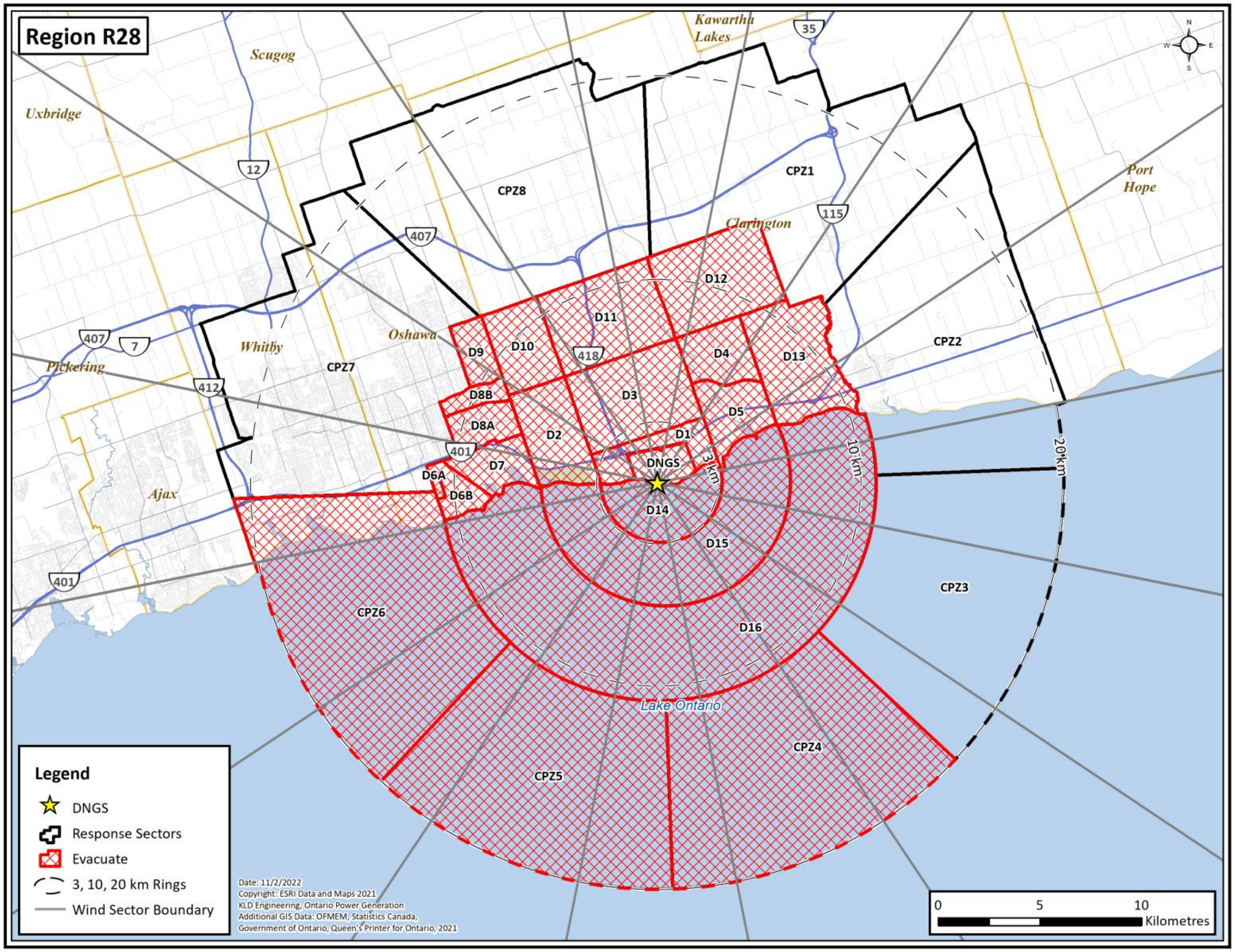



**Figure H-28. Region R28**

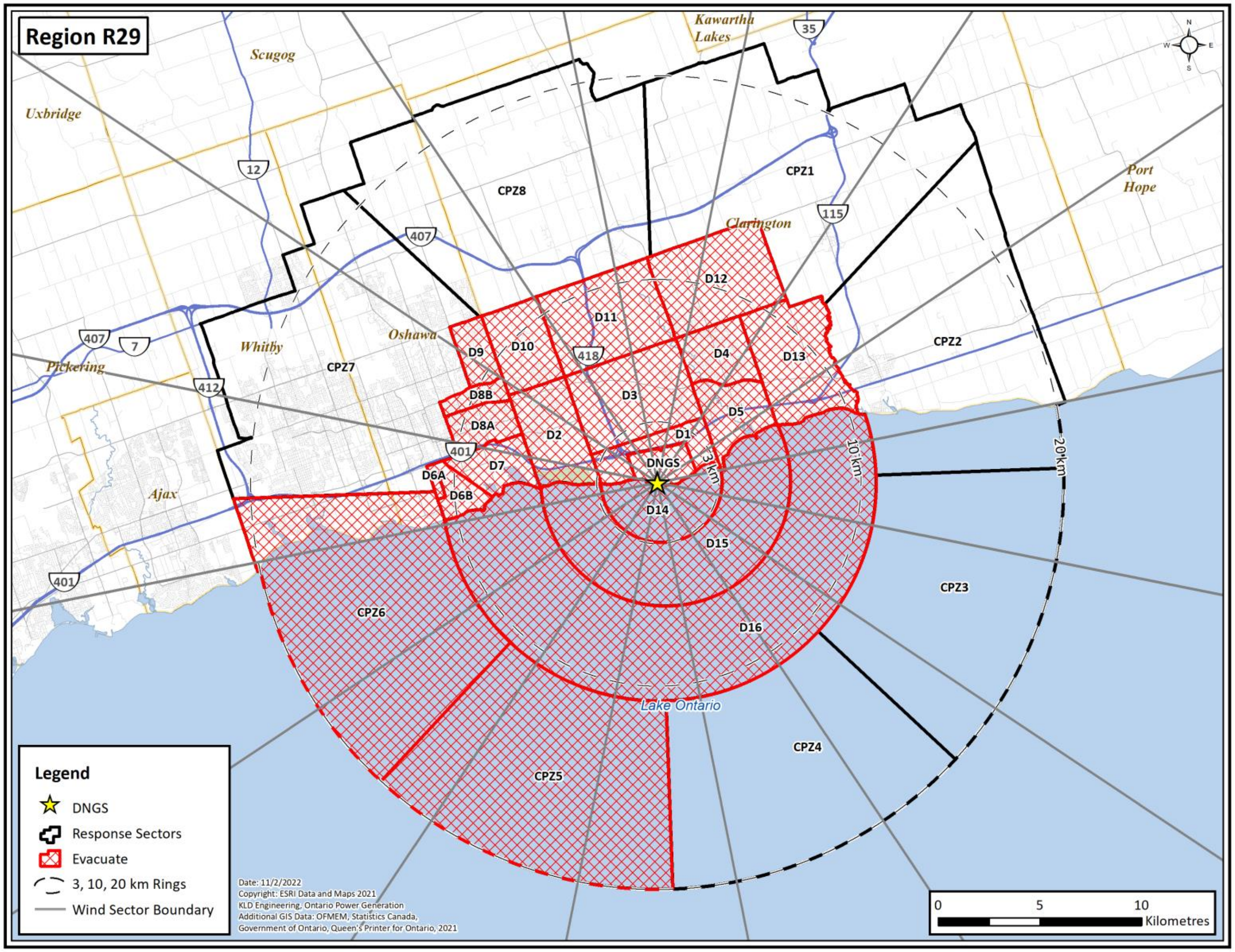



**Figure H-29. Region R29**

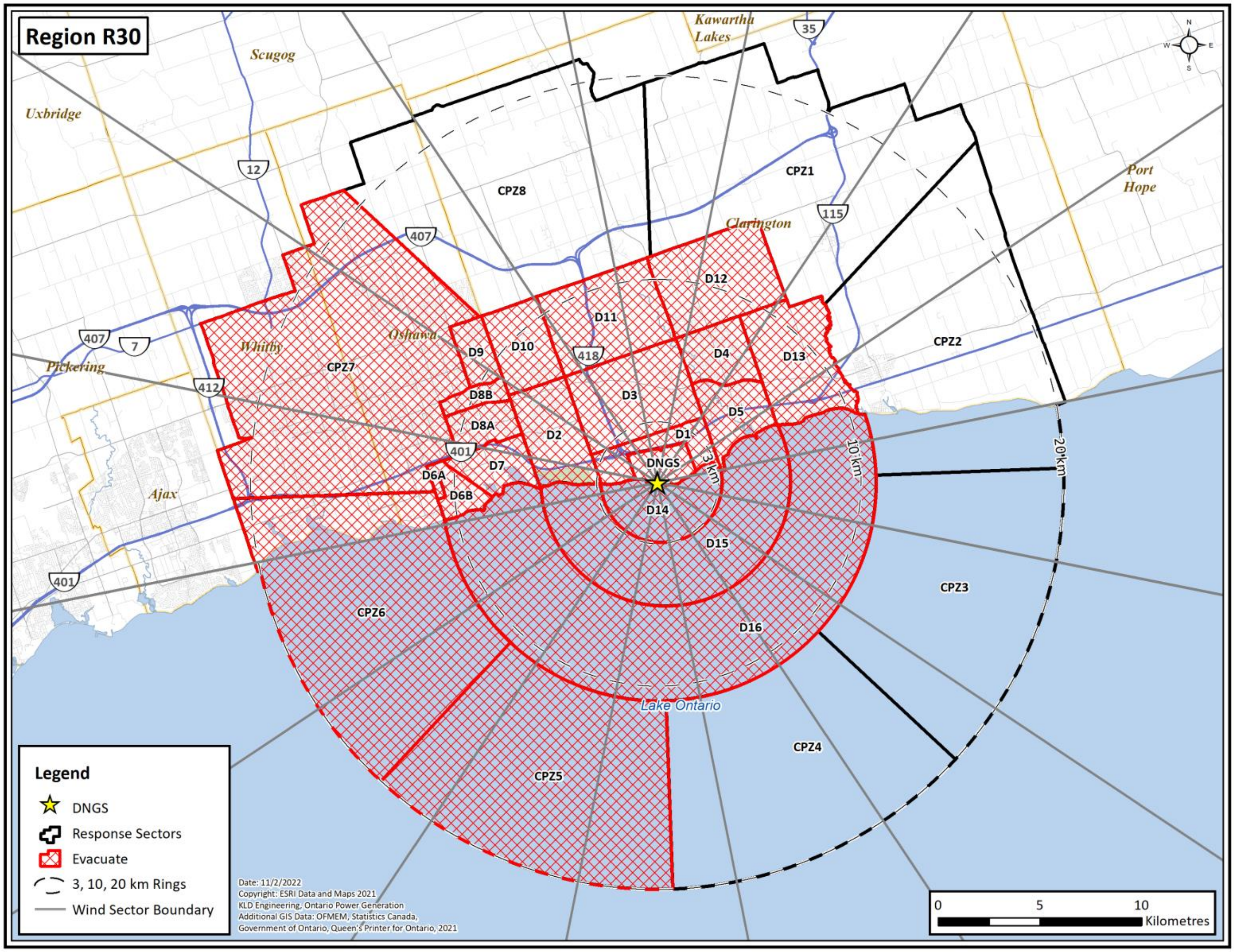



**Figure H-30. Region R30**

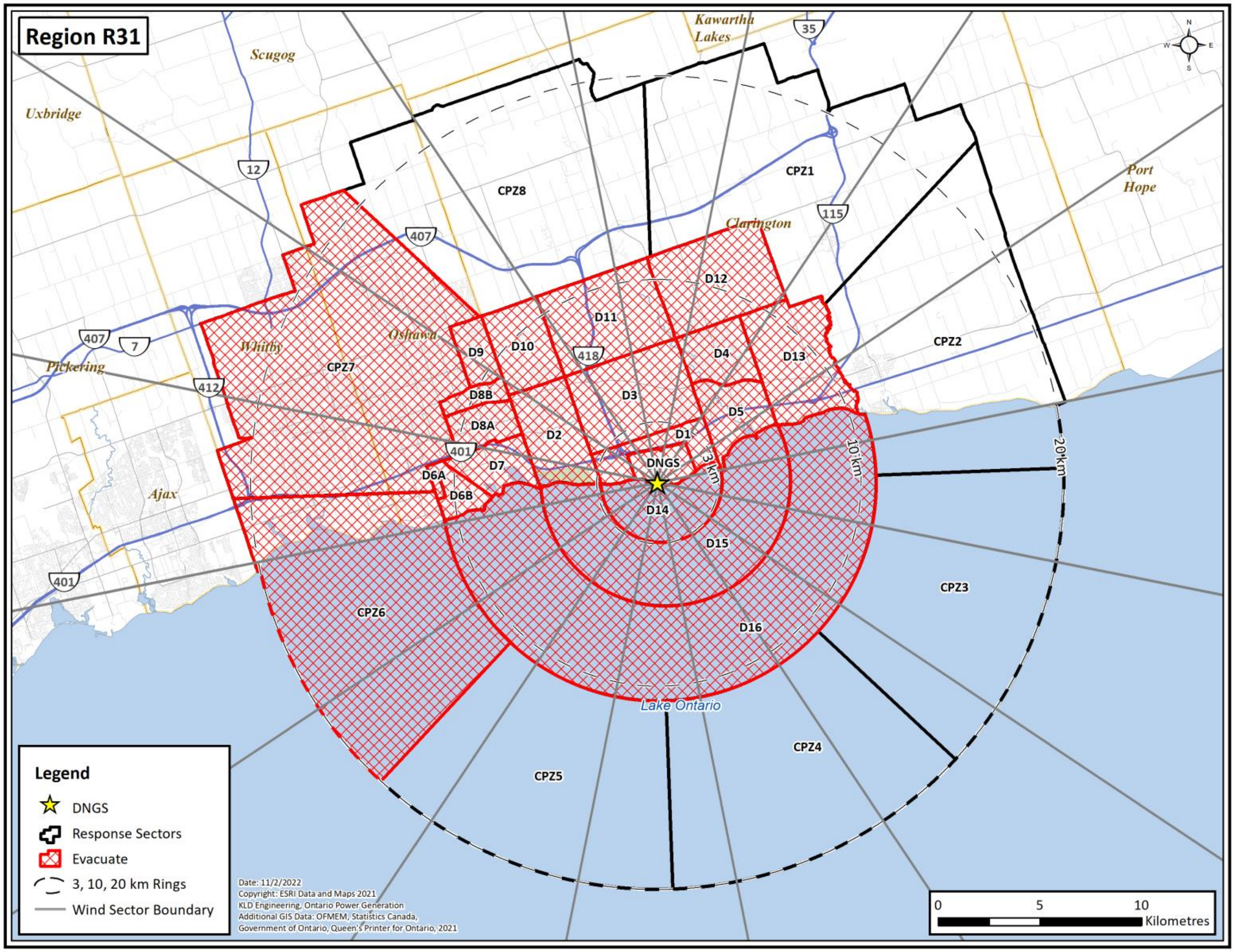



**Figure H-31. Region R31**

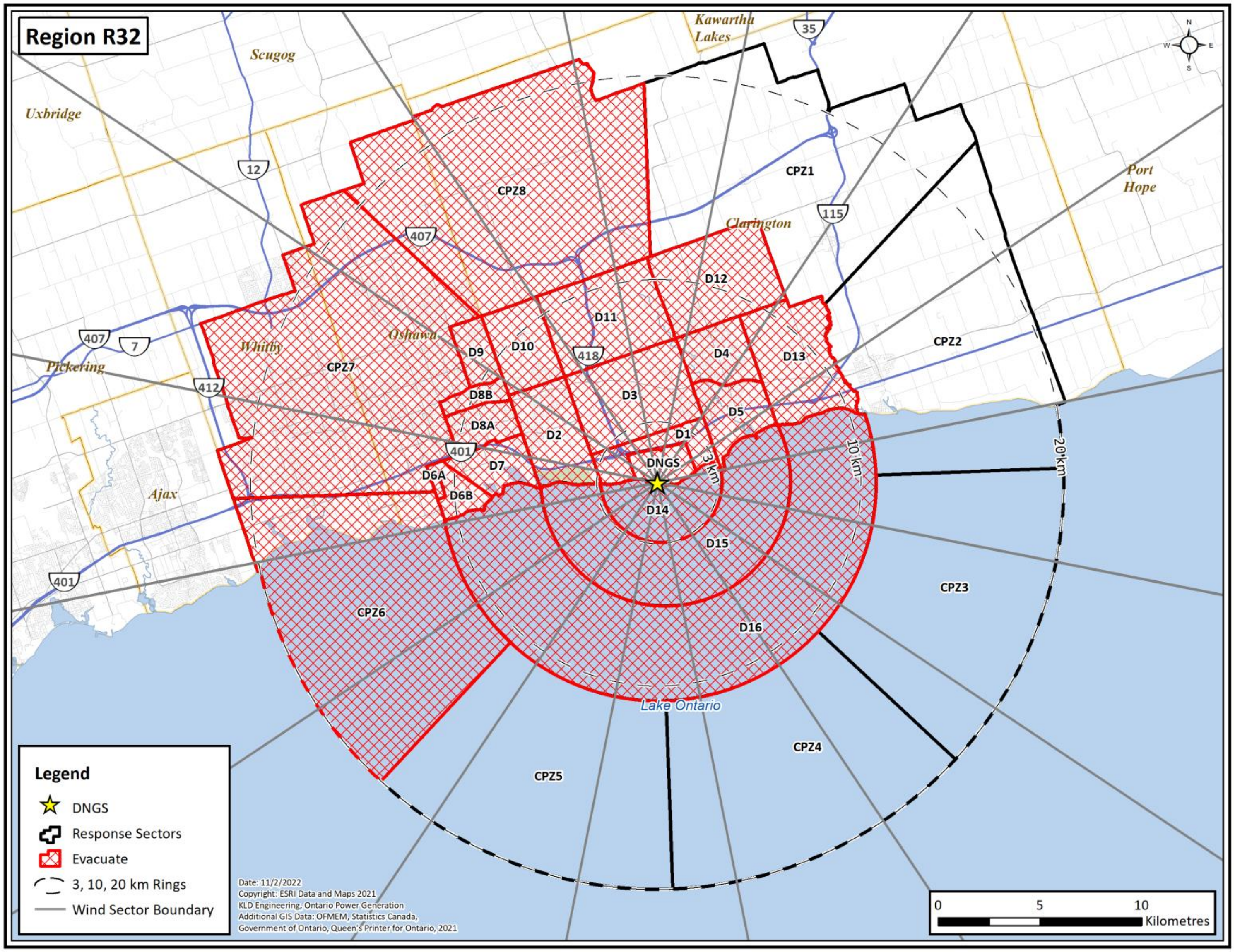



**Figure H-32. Region R32**

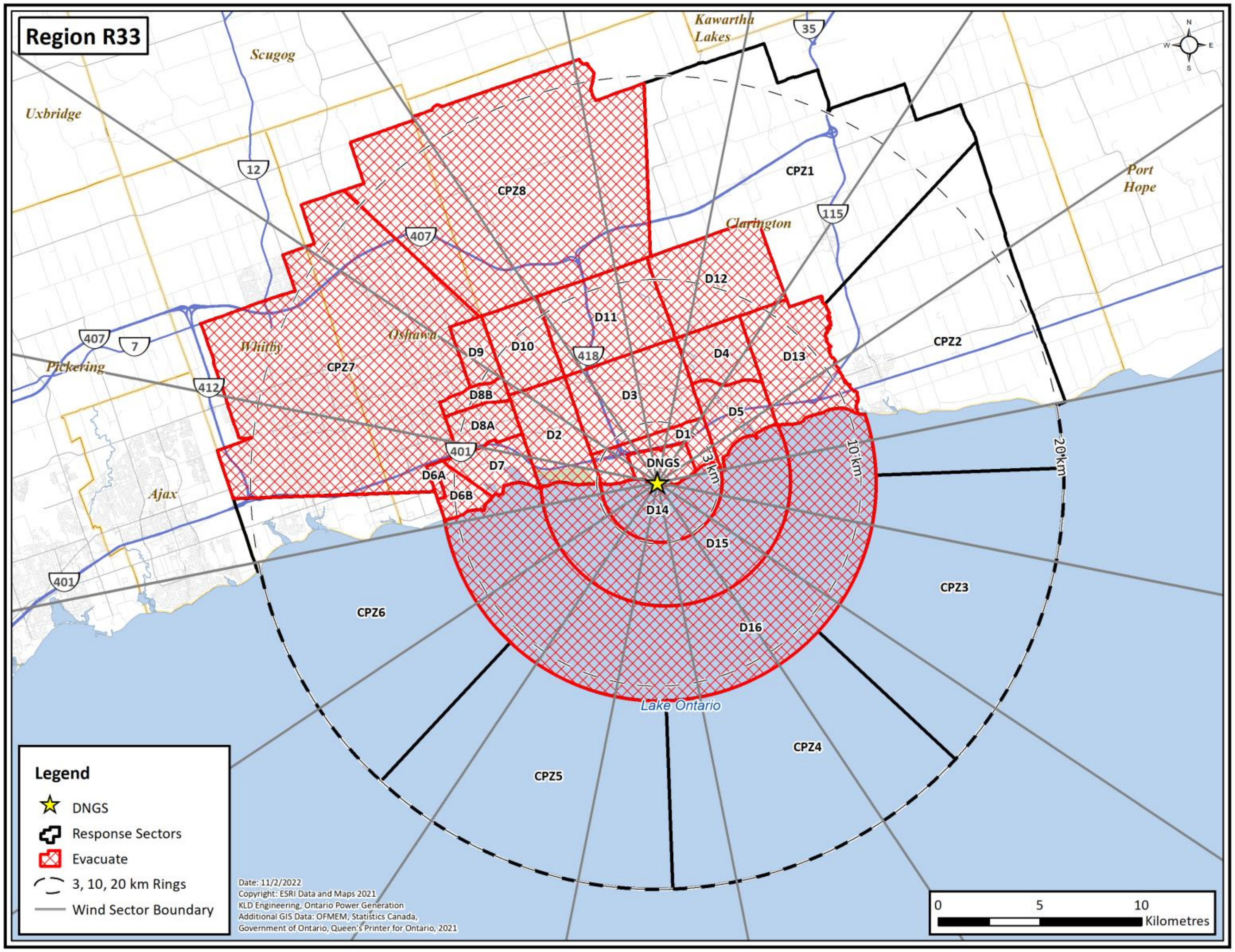



**Figure H-33. Region R33**

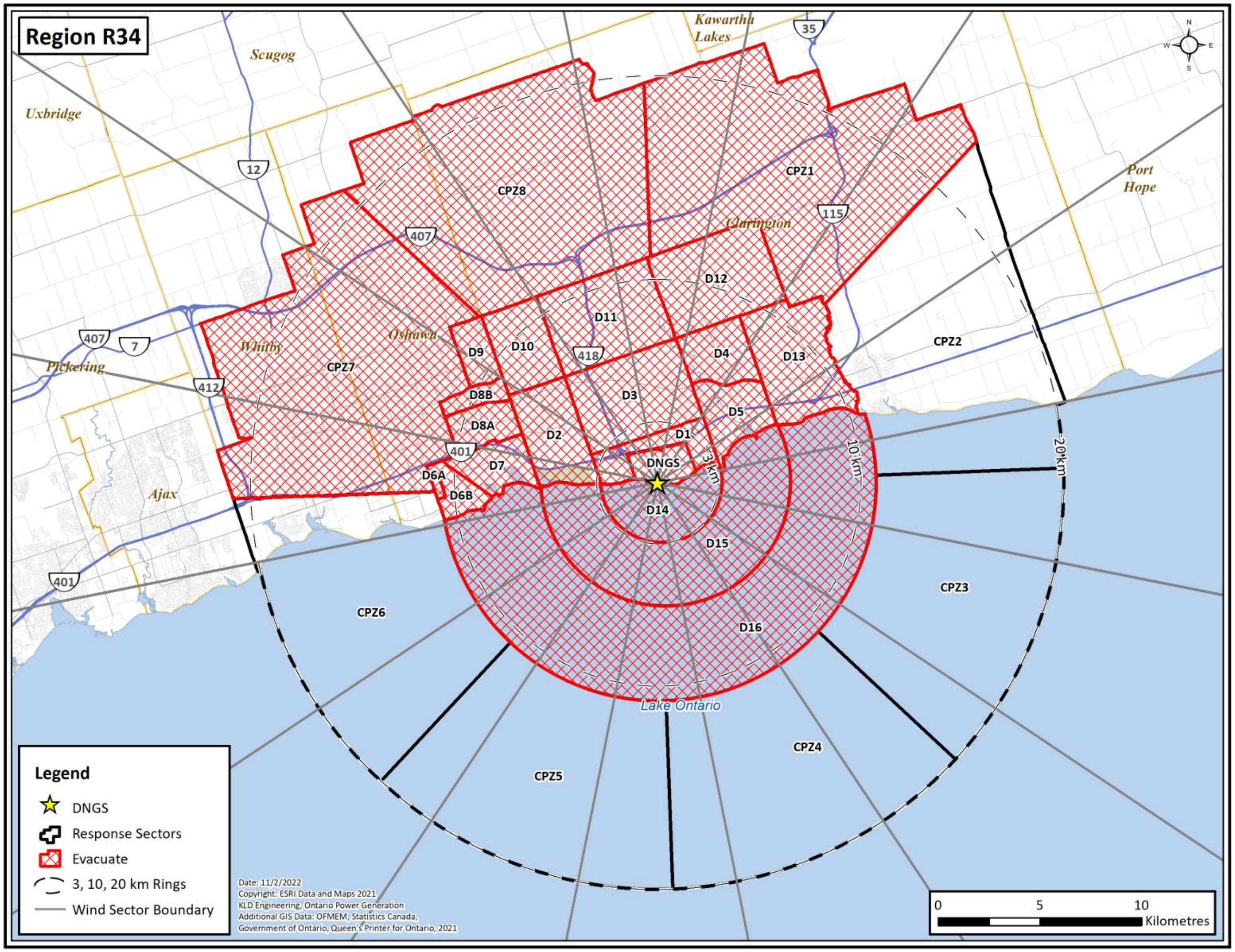



**Figure H-34. Region R34**

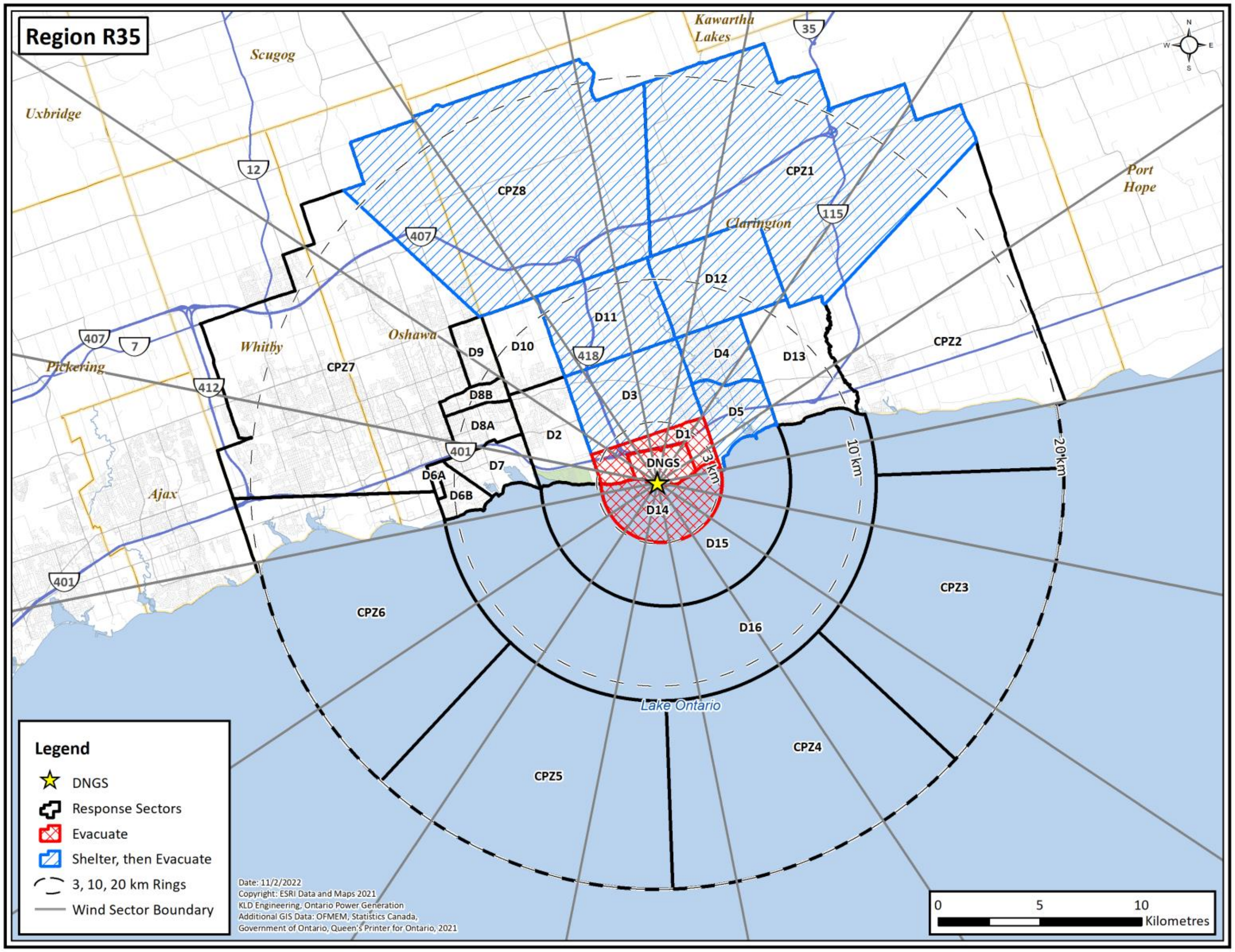



**Figure H-35. Region R35**

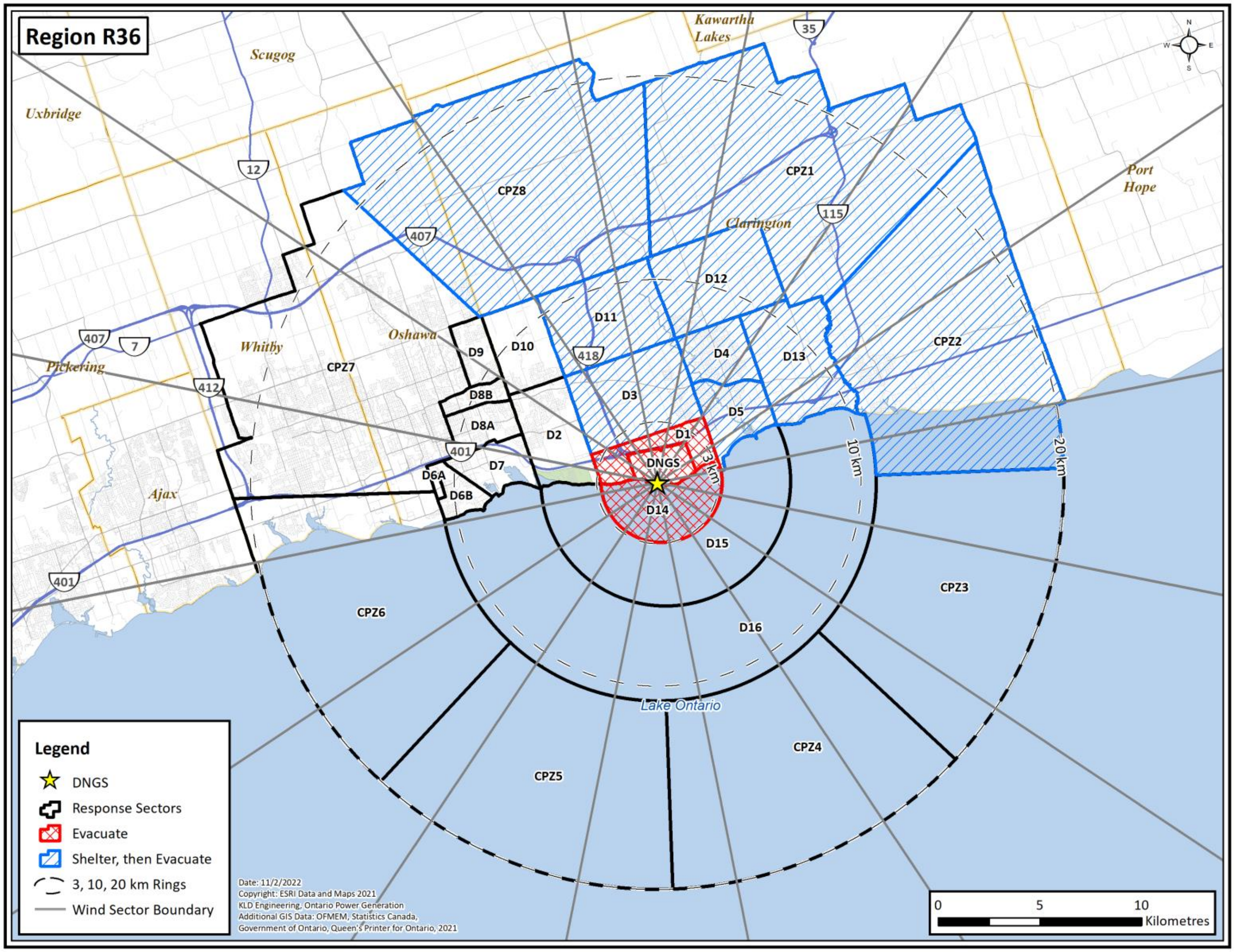



**Figure H-36. Region R36**

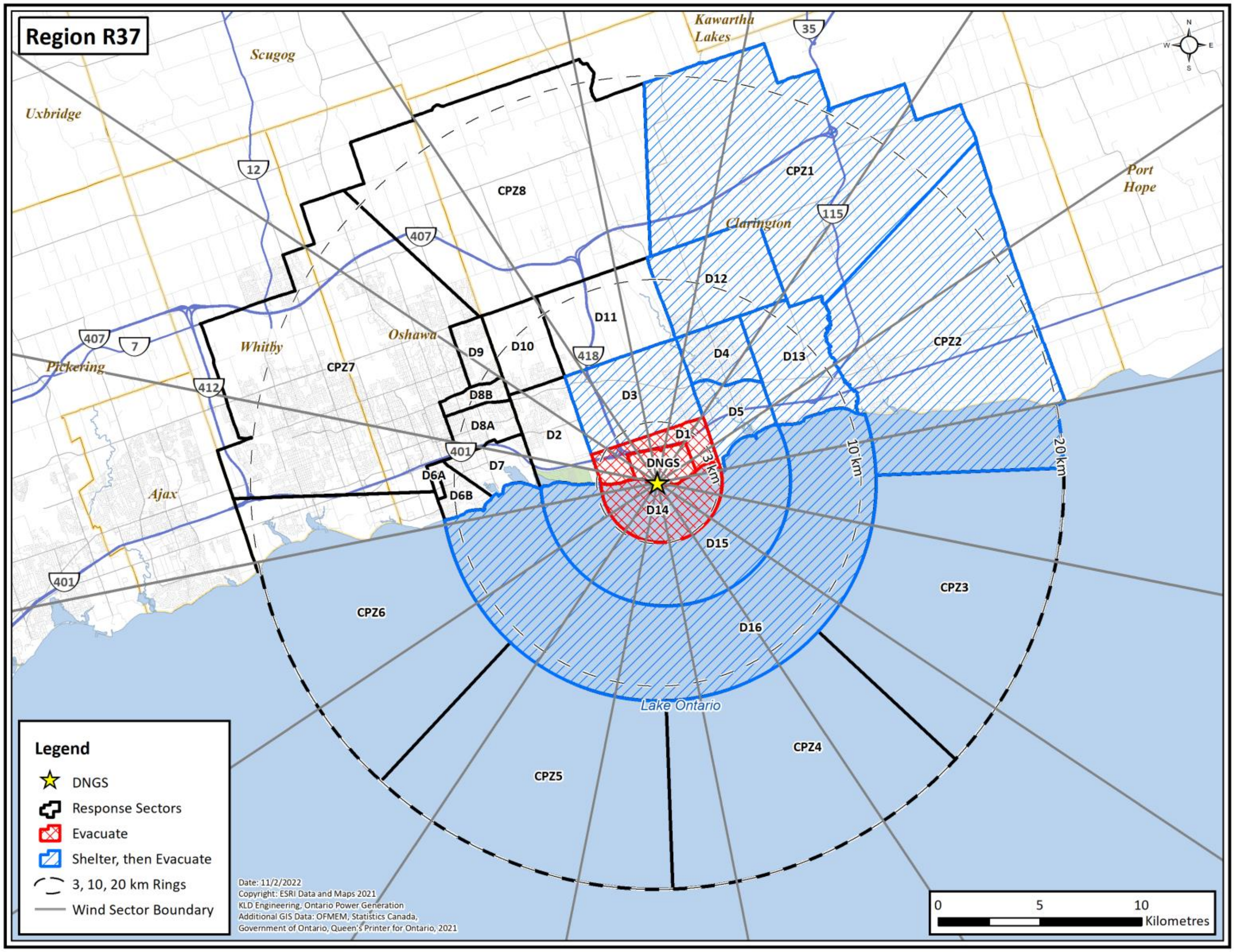



**Figure H-37. Region R37**

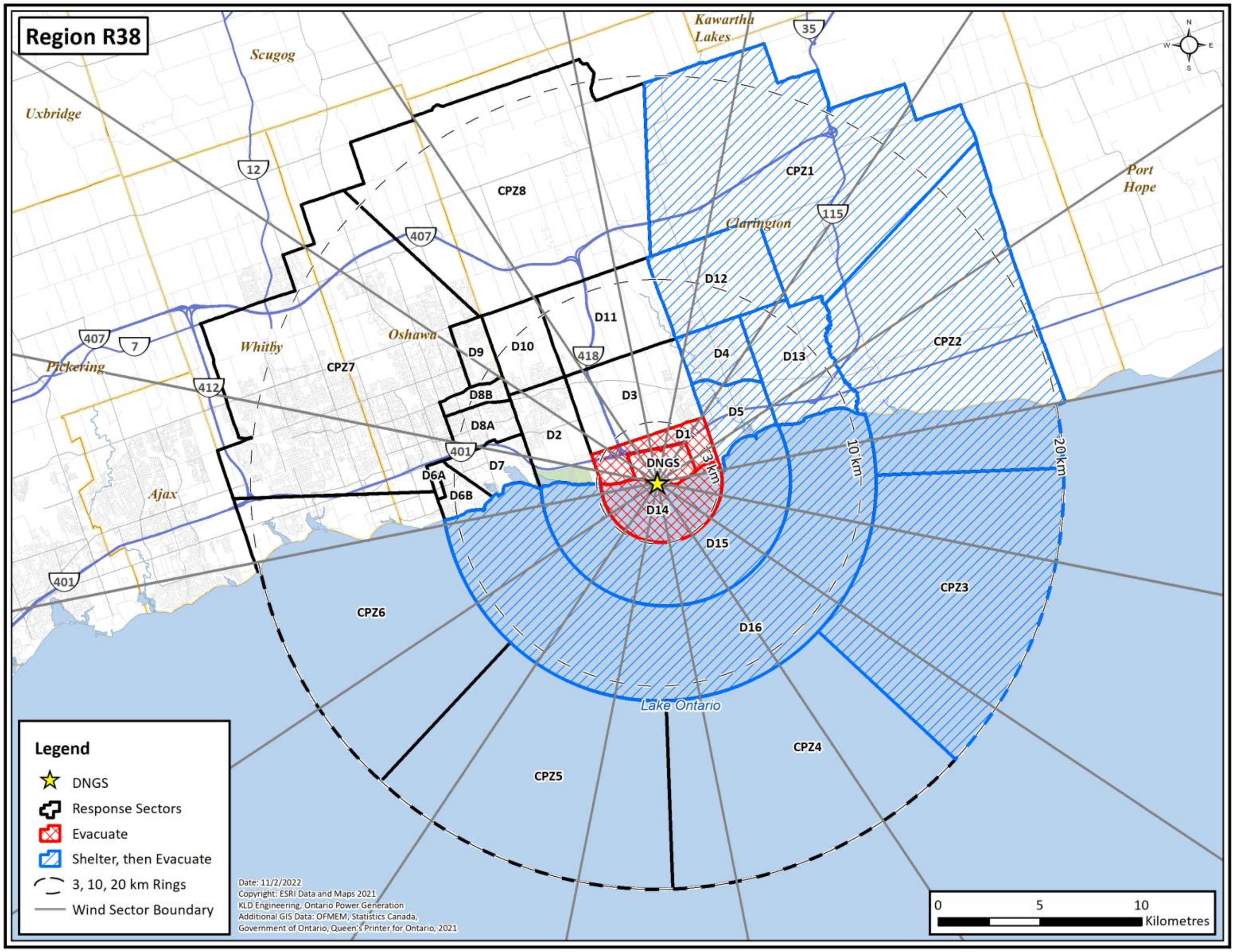



**Figure H-38. Region R38**

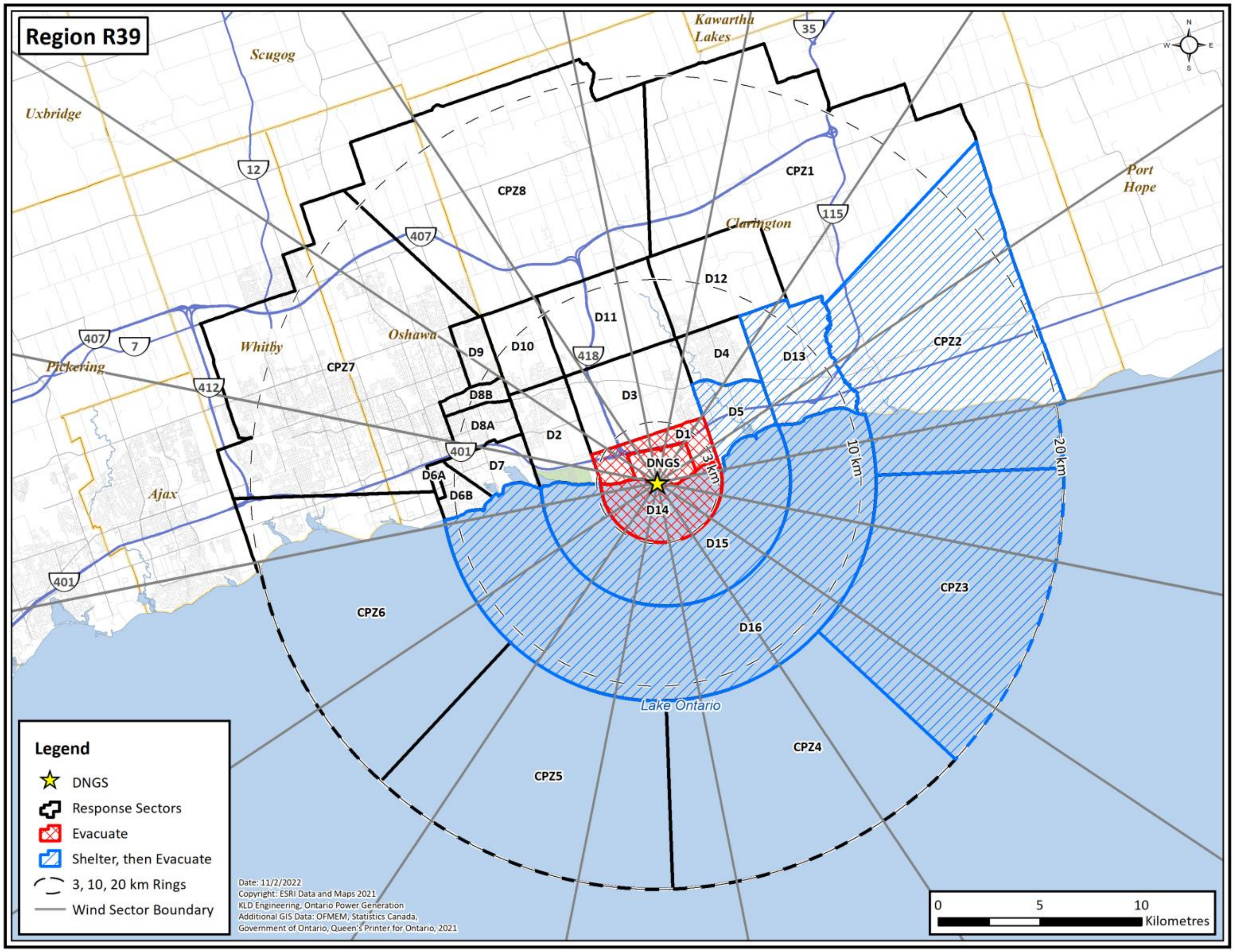



**Figure H-39. Region R39**

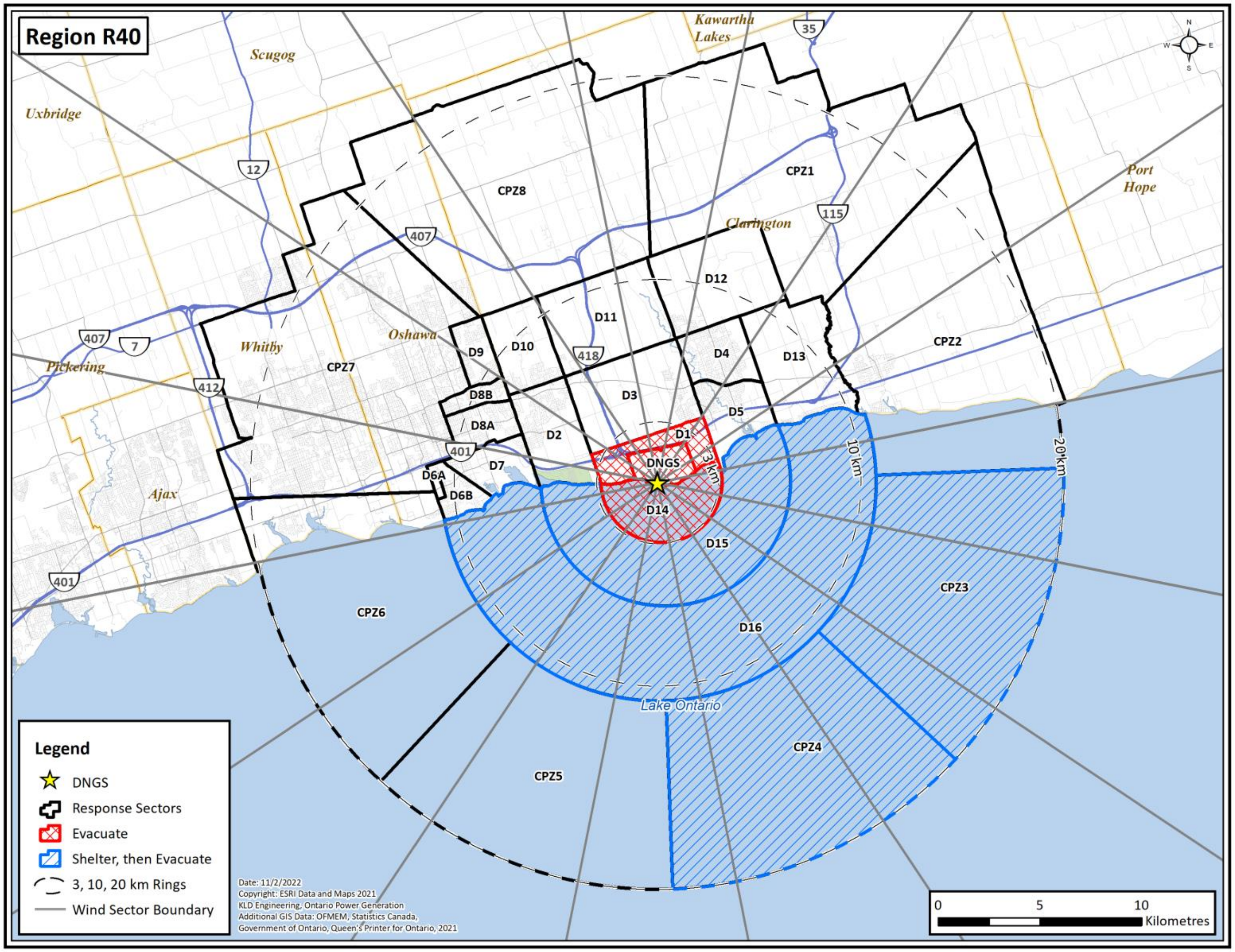



**Figure H-40. Region R40**

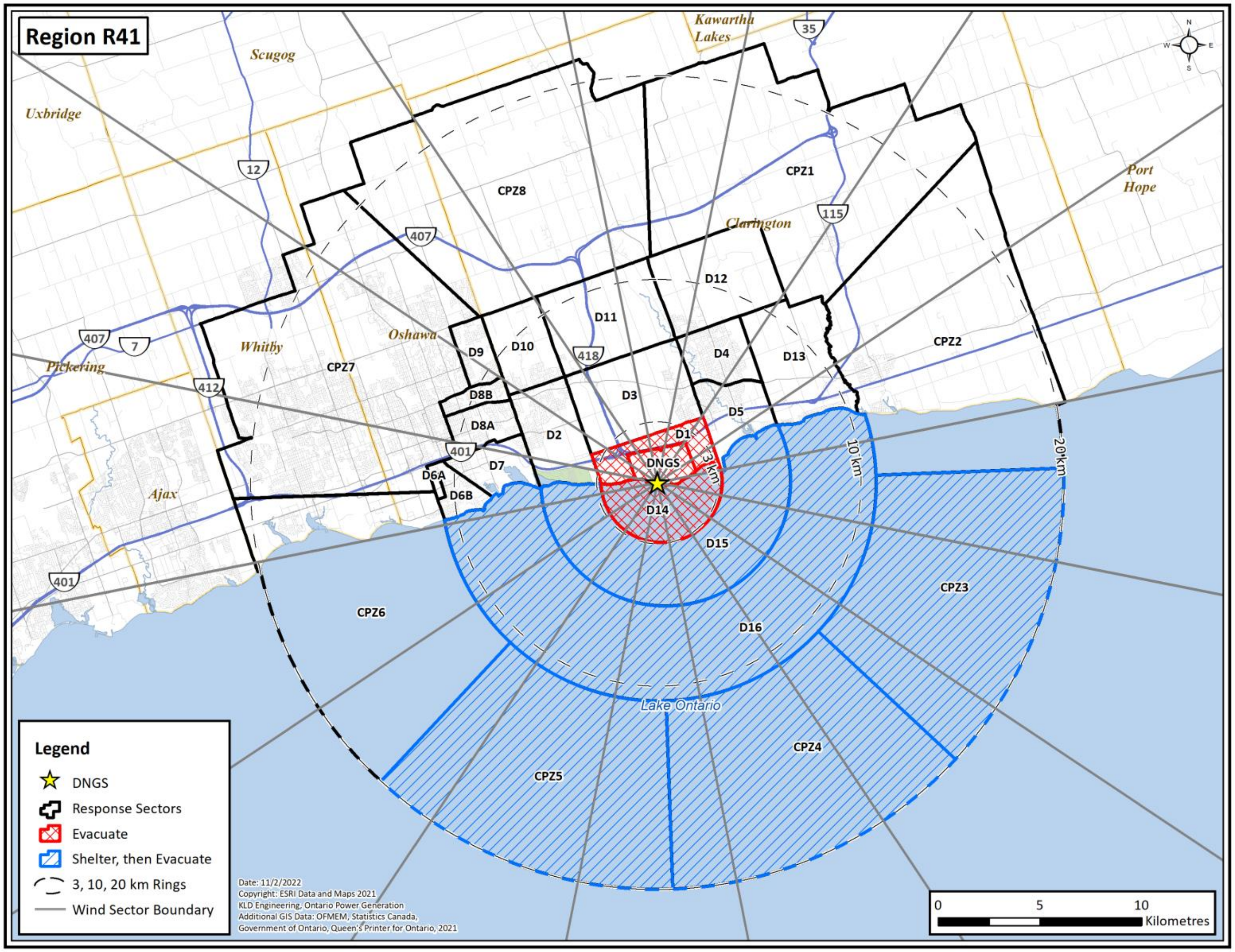



**Figure H-41. Region R41**

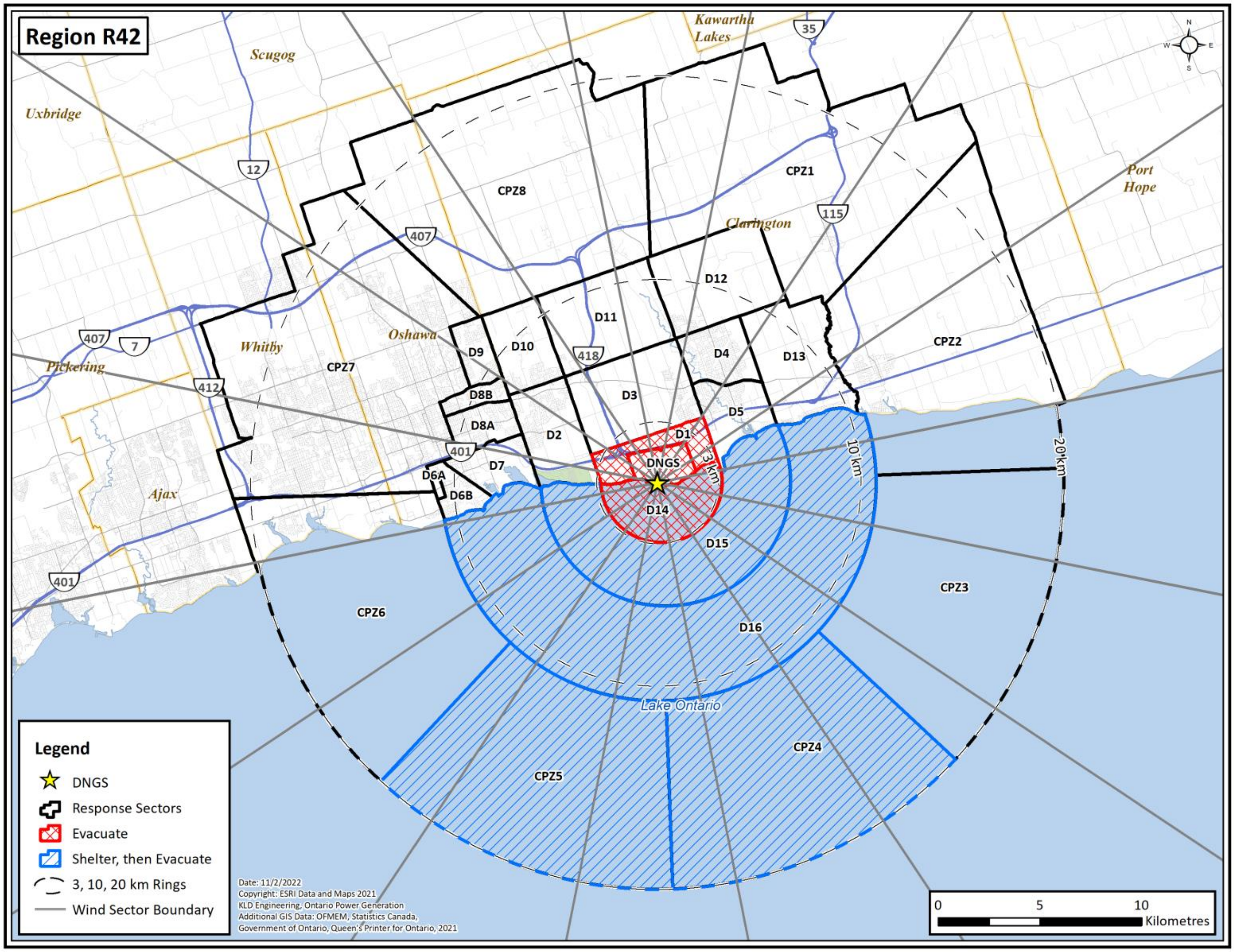



**Figure H-42. Region R42**

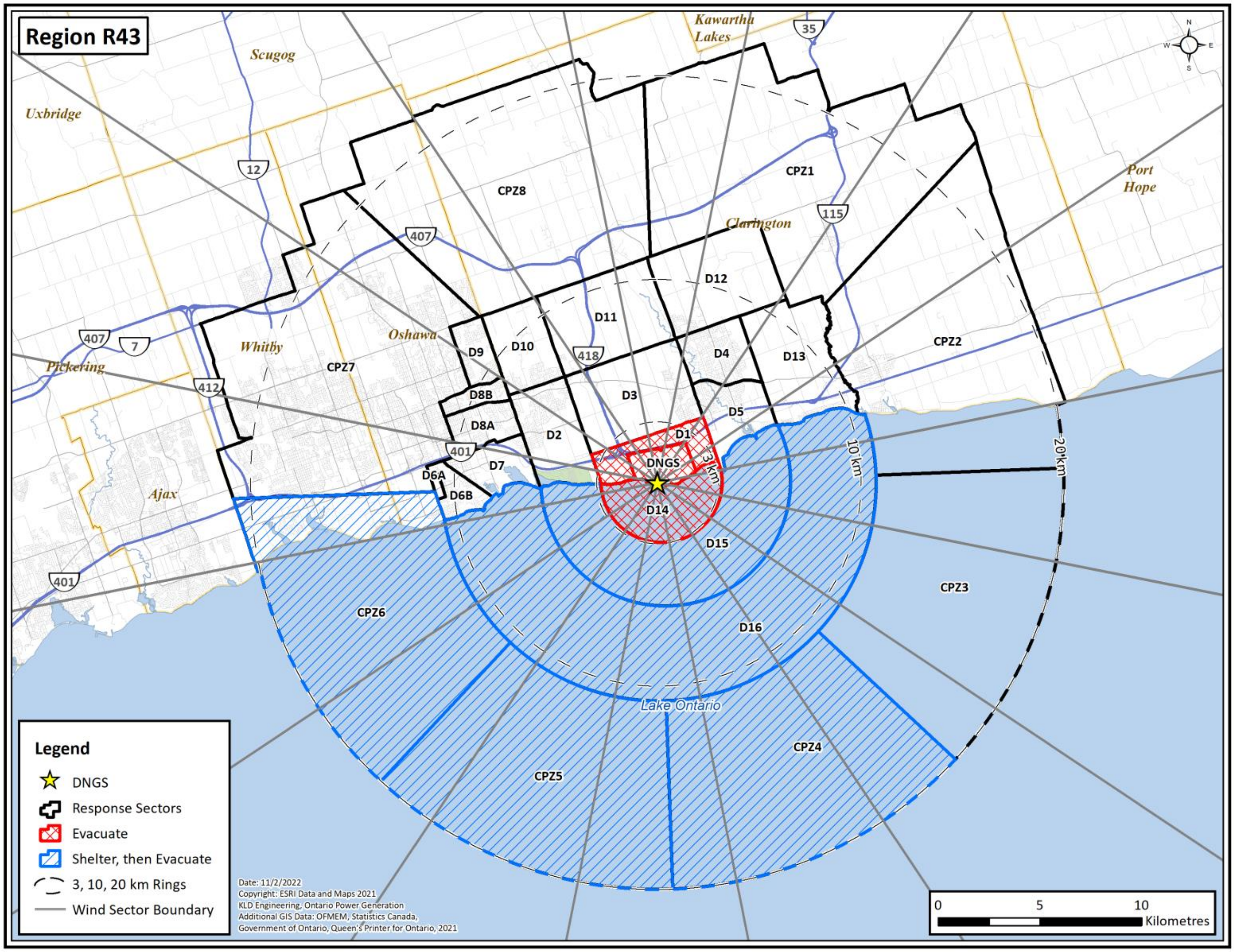



**Figure H-43. Region R43**

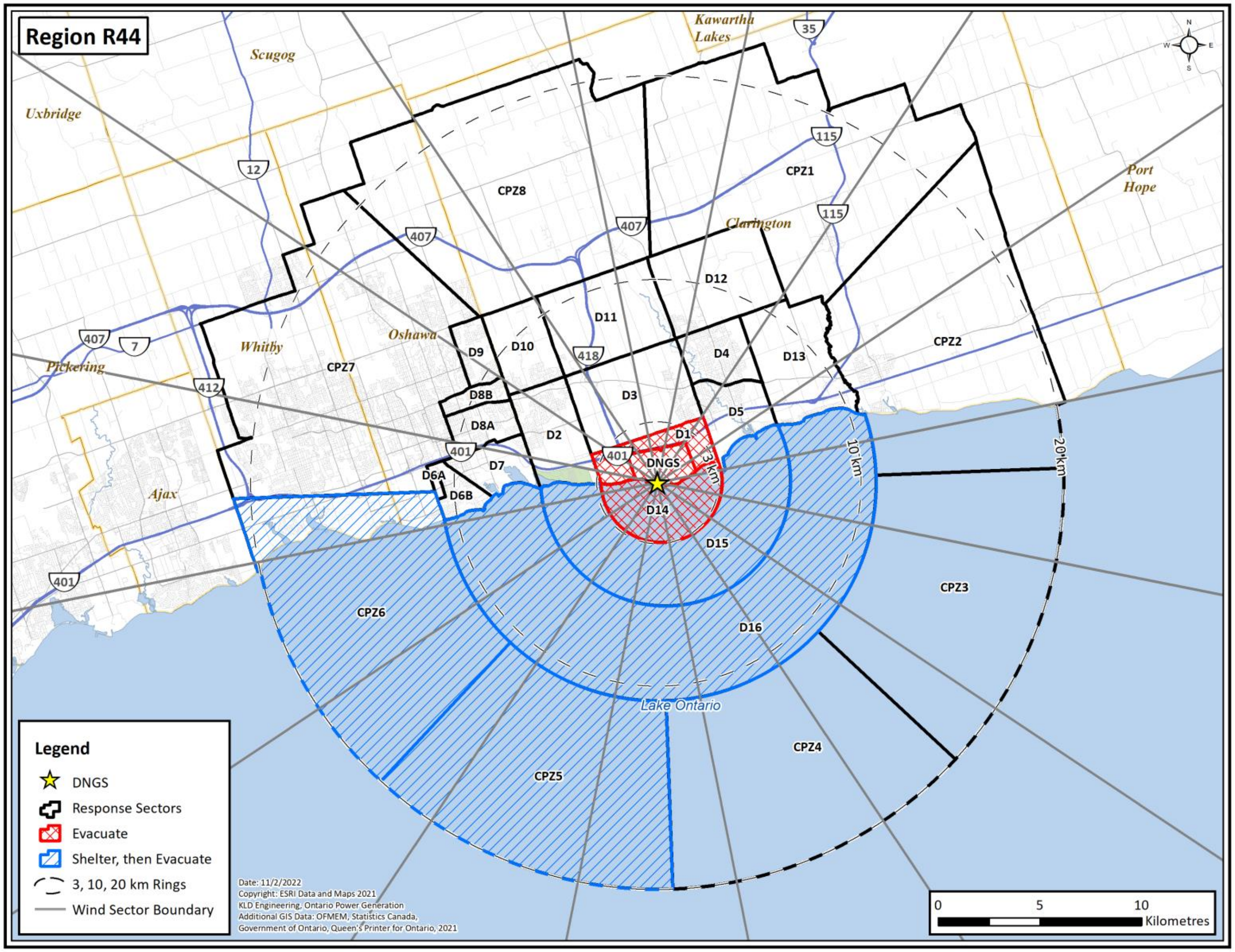



**Figure H-44. Region R44**

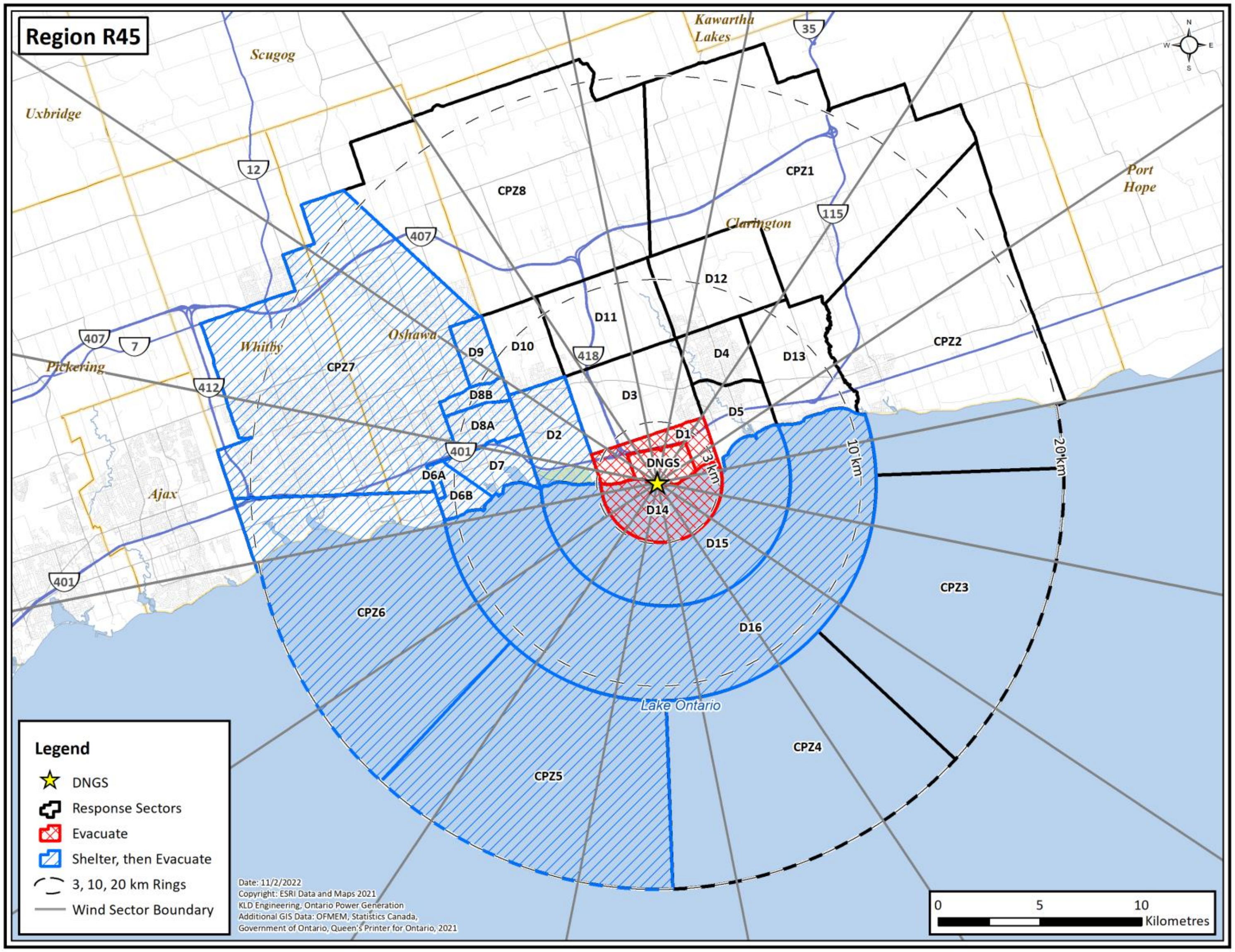



**Figure H-45. Region R45**

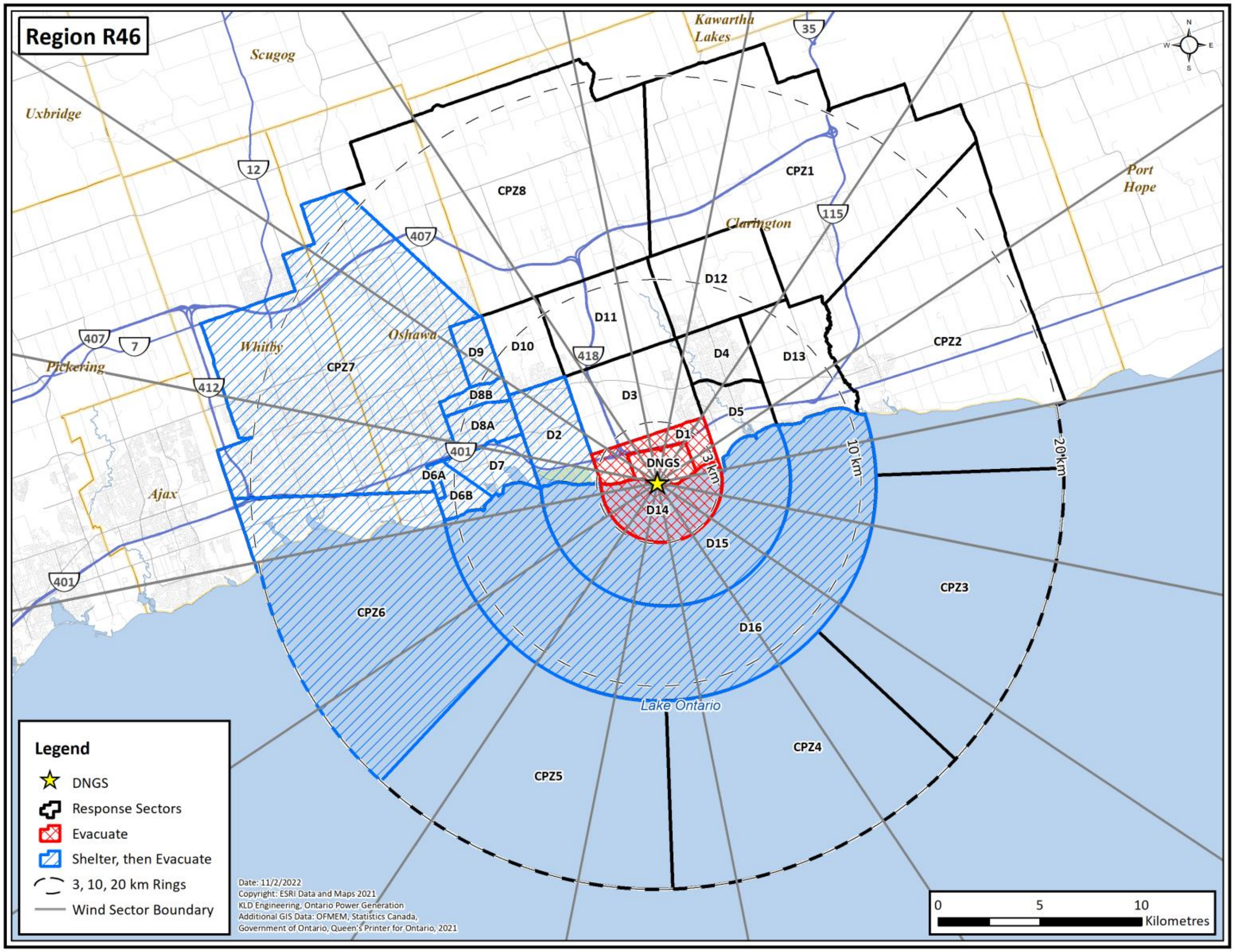



**Figure H-46. Region R46**

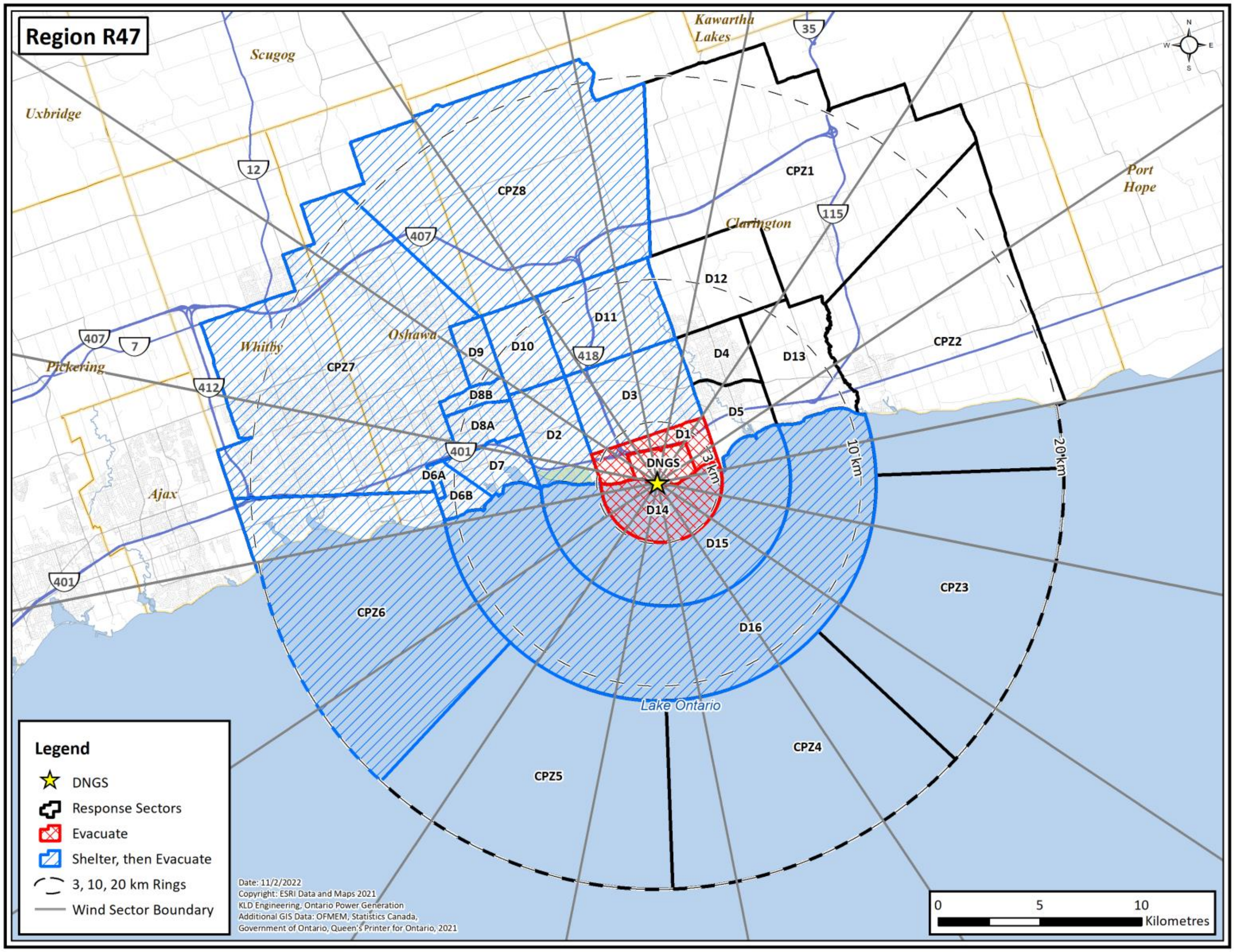



**Figure H-47. Region R47**

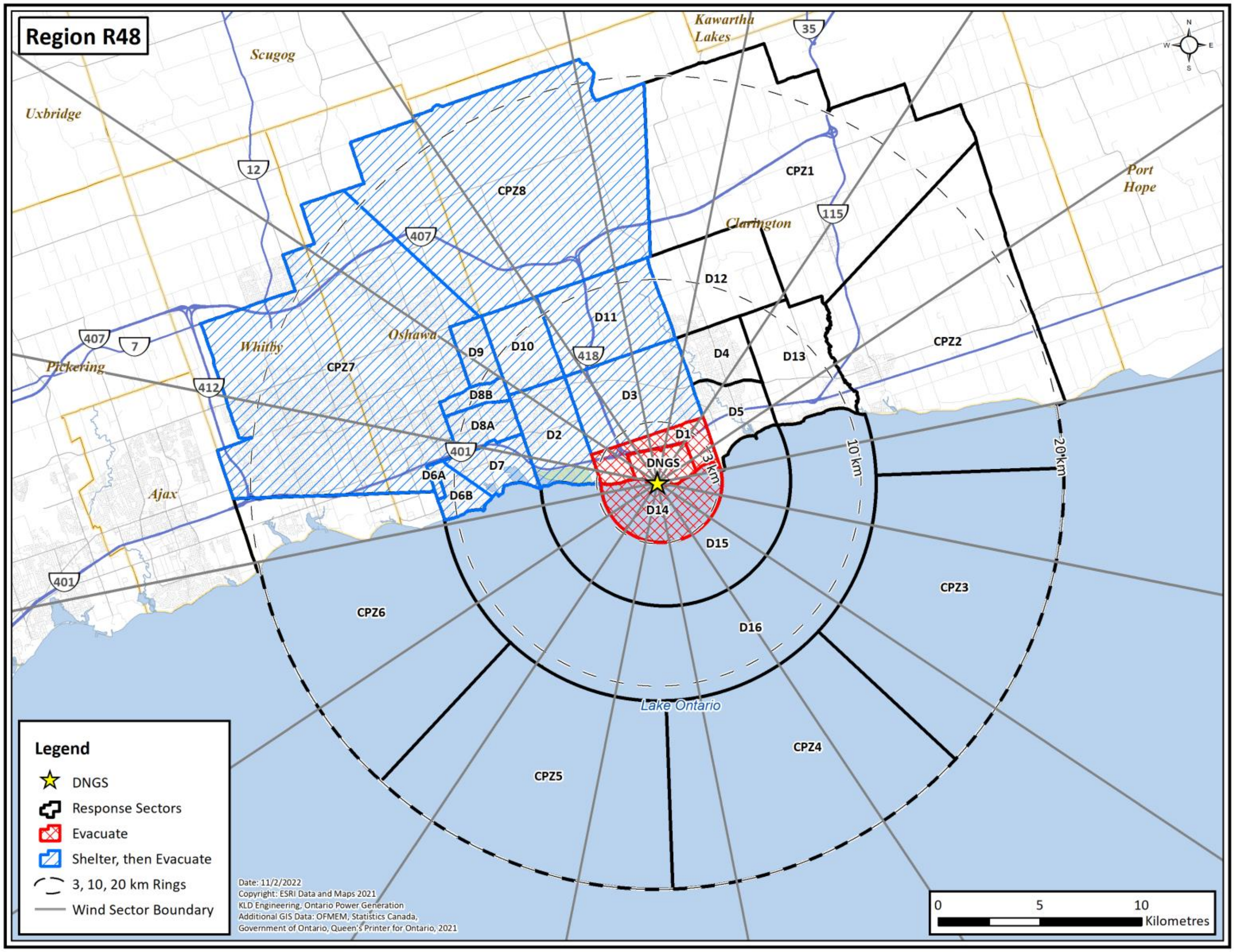



**Figure H-48. Region R48**

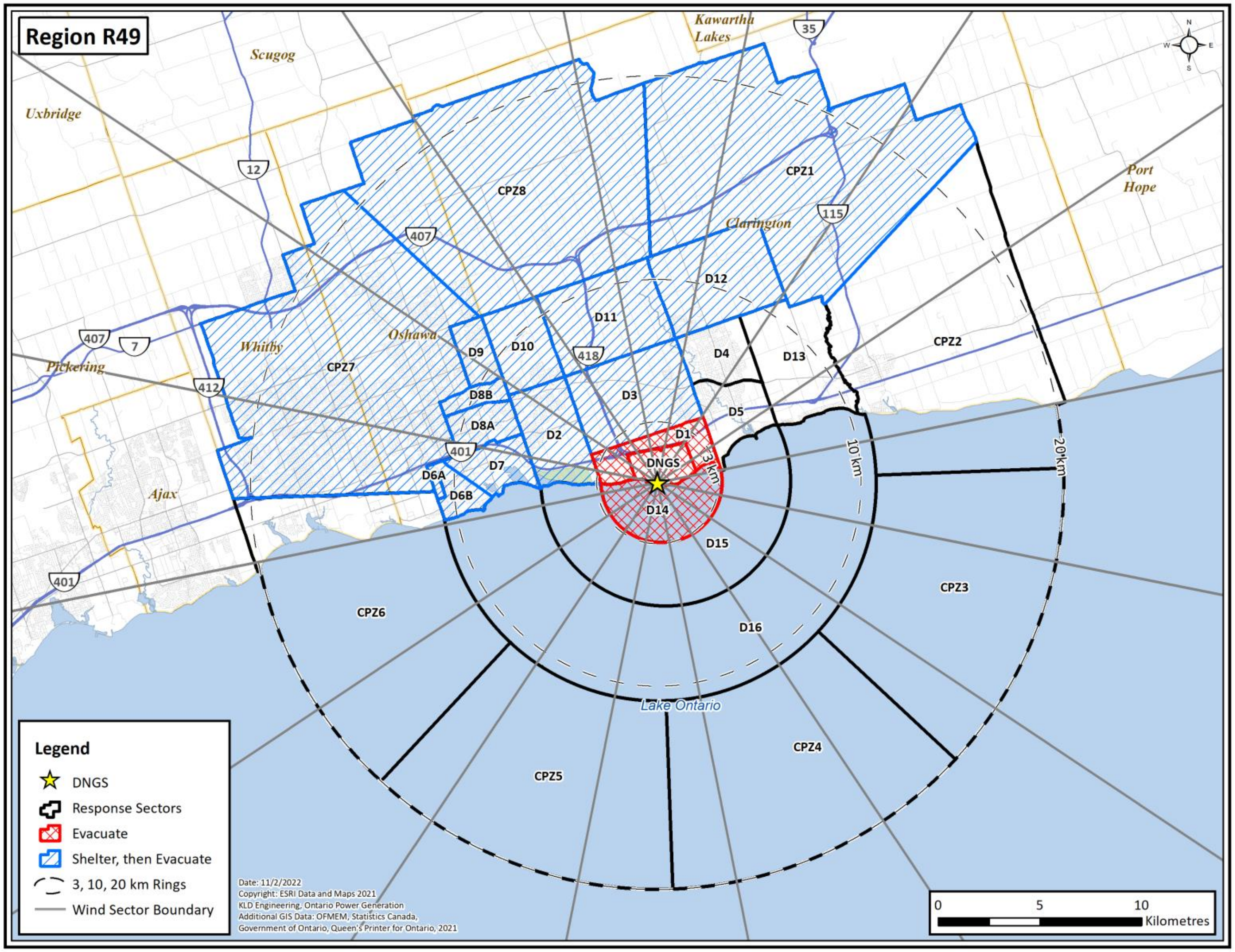



**Figure H-49. Region R49**

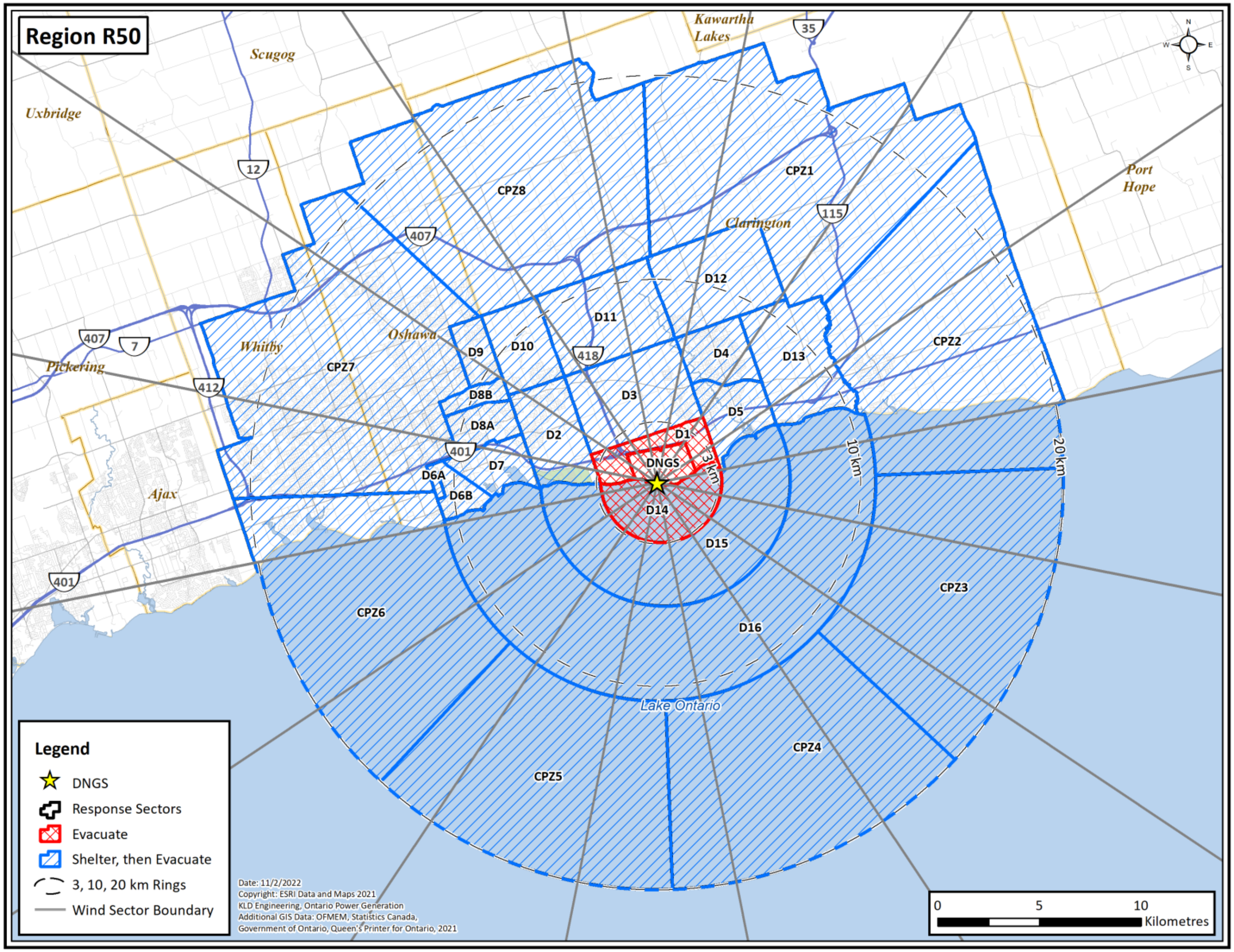



**Figure H-50. Region R50**

# APPENDIX J

Representative Inputs to and Outputs from the DYNEV II System

## J. REPRESENTATIVE INPUTS TO AND OUTPUTS FROM THE DYNEV II SYSTEM

This appendix presents data input to and output from the DYNEV II System.

Table J-1 provides source (vehicle loading) and destination information for several roadway segments (links) in the analysis network. In total, there are a total of 800 source links (origins) in the model. The source links are shown as centroid points in Figure J-1. On average, evacuees travel a straight-line distance of approximately 3.5 km to exit the network.

Table J-2 provides network–wide statistics (average travel time, average delay time[1], average speed and number of vehicles) for an evacuation of the Detailed Planning Zone (DPZ) Outer Ring (Region R03) for each scenario. As expected, the heavy snow scenarios (Scenarios 8 and 11) exhibit slower average speeds, longer average delay times and longer average travel times when compared to good weather and rain scenarios.

Table J-3 provides statistics (average speed and travel time) for the major evacuation routes – Highway (Hwy) 401, Hwy 407, and Route (Rt) 115/35 – for an evacuation of the entire DPZ (Region R03) under Scenario 1 conditions (summer, midweek, midday, with good weather conditions). Average speeds along Hwy 401 are high for the first hour before the congestion starts to build and drops low during the second hours and stays low through to fifth hour of evacuation due to the volume of external-to-external trips and number of evacuees that utilize it in the evacuation. Hwy 407 slows down during the second through fifth hours of evacuation as vehicles start to mobilize and evacuate along this highway. Hwy 401 and Hwy 407 are essentially free flowing at 6 hours in both directions.

Table J-4 provides the number of vehicles discharged and the cumulative percent of total vehicles discharged for each link exiting the analysis network, for an evacuation of the DPZ Outer Ring (Region R03) under Scenario 1 conditions.

Figure J-2 through Figure J-15 plot the trip generation time versus the ETE for each of the 14 Scenarios considered. The distance between the trip generation and ETE curves is the travel time. Plots of trip generation versus ETE are indicative of the level of traffic congestion during evacuation. For low population density sites, the curves are close together, indicating short travel times and minimal traffic congestion. For higher population density sites, the curves are farther apart indicating longer travel times and the presence of traffic congestion.

As seen in Figure J-2 through Figure J-15, the curves are spatially separated for non-evening scenarios as a result of the significant traffic congestion within in the DPZ Outer Ring (Region R03), which clears at 5 hours and 25 minutes after the Emergency Bulletin to evacuate for a winter, midweek, midday, good weather scenario, as discussed in detail in Section 7.3.

[1] Computed as the difference of the average travel time and the average ideal travel time under free flow conditions.

**Table J-1. Sample Simulation Model Input**

| Road Name | Upstream Node | Downstream Node | Vehicles Entering Network on this Link | Directional Preference | Destination Nodes | Destination Capacity |
|---|---|---|---|---|---|---|
| Green Rd | 262 | 1214 | 10 | NE | 8956 | 4,500 |
| | | | | | 8000 | 6,750 |
| | | | | | 8002 | 1,700 |
| Green Rd | 3230 | 1764 | 420 | N | 8956 | 4,500 |
| | | | | | 8000 | 6,750 |
| | | | | | 8002 | 1,700 |
| Malaga Rd | 876 | 354 | 464 | W | 8019 | 11,250 |
| | | | | | 8994 | 1,700 |
| | | | | | 8997 | 6,750 |
| Adelaide Ave E/Rt 58 | 610 | 611 | 310 | NW | 8020 | 2,850 |
| | | | | | 8994 | 1,700 |
| | | | | | 8997 | 6,750 |
| Main St/Rt 17 | 737 | 722 | 38 | NE | 8956 | 4,500 |
| | | | | | 8000 | 6,750 |
| | | | | | 8809 | 2,850 |
| 1st Ave | 449 | 450 | 80 | W | 8019 | 11,250 |
| Coldstream Dr | 1042 | 1036 | 91 | NW | 8020 | 2,850 |
| | | | | | 8994 | 1,700 |
| | | | | | 8997 | 6,750 |
| Whitburn St | 1605 | 1464 | 80 | W | 8019 | 11,250 |
| | | | | | 8997 | 6,750 |
| | | | | | 8016 | 2,850 |
| Hillcroft St | 3349 | 3348 | 220 | NW | 8019 | 11,250 |
| | | | | | 8994 | 1,700 |
| | | | | | 8997 | 6,750 |
| Canary St | 3533 | 1467 | 192 | W | 8019 | 11,250 |
| | | | | | 8997 | 6,750 |
| | | | | | 8994 | 1,700 |

**Table J-2. Selected Model Outputs for the Evacuation of the DPZ Outer Ring (Region R03)**

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Network-Wide Average Travel Time (Min/Veh-km) | 2.3 | 2.6 | 2.1 | 2.4 | 2.0 | 2.1 | 2.6 |
| Network-Wide Average Delay Time (Min/Veh-km) | 1.5 | 1.8 | 1.3 | 1.6 | 1.3 | 1.4 | 1.8 |
| Network-Wide Average Speed (kph) | 26.1 | 22.9 | 28.9 | 24.7 | 29.3 | 28.0 | 23.1 |
| Total Vehicles Exiting Network | 178,918 | 180,625 | 162,978 | 164,018 | 132,128 | 179,495 | 180,799 |
| **Scenario** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| Network-Wide Average Travel Time (Min/Veh-km) | 3.2 | 2.1 | 2.4 | 3.0 | 2.1 | 2.0 | 2.3 |
| Network-Wide Average Delay Time (Min/Veh-km) | 2.4 | 1.3 | 1.6 | 2.2 | 1.3 | 1.2 | 1.5 |
| Network-Wide Average Speed (kph) | 19.0 | 28.8 | 25.1 | 19.9 | 28.3 | 30.3 | 26.6 |
| Total Vehicles Exiting Network | 181,890 | 161,285 | 162,056 | 163,854 | 132,281 | 163,592 | 178,798 |

**Table J-3. Average Speed (kph) and Travel Time (min) for Major Evacuation Routes (Region R03, Scenario 1)**

| Major Evacuation Route Name | Elapsed Time (hours) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1:00 | | 2:00 | | 3:00 | | 4:00 | | 5:00 | | 6:00 | |
| | Length (km) | Speed (kph) | Travel Time (min) | Speed (kph) | Travel Time (min) | Speed (kph) | Travel Time (min) | Speed (kph) | Travel Time (min) | Speed (kph) | Travel Time (min) | Speed (kph) | Travel Time (min) |
| Rt 115/35 SB (to Hwy 407 WB) | 47.7 | 107.2 | 26.7 | 44.1 | 64.8 | 10.0 | 286.3 | 9.8 | 289.1 | 27.4 | 104.3 | 101.2 | 28.2 |
| Hwy 407 EB (to Rt 115/35 NB) | 48.5 | 105.1 | 27.7 | 41.8 | 69.4 | 31.4 | 92.6 | 32.5 | 89.5 | 50.5 | 57.6 | 108.1 | 26.9 |
| Hwy 401 EB | 49.0 | 81.4 | 36.1 | 82.7 | 35.5 | 80.3 | 36.6 | 93.8 | 31.3 | 118.3 | 24.9 | 118.4 | 24.8 |
| Hwy 401 WB | 49.0 | 104.3 | 28.2 | 19.3 | 152.0 | 9.0 | 324.7 | 9.8 | 301.8 | 15.9 | 183.8 | 72.7 | 40.5 |
| Hwy 401 EB (to Rt 115/35 NB) | 58.4 | 104.6 | 33.5 | 83.4 | 42.0 | 66.6 | 52.6 | 59.9 | 58.5 | 63.4 | 55.3 | 111.8 | 31.3 |
| Rt 115/35 SB (to Hwy 401 WB) | 58.2 | 102.4 | 34.2 | 22.0 | 158.2 | 10.6 | 330.6 | 11.4 | 307.8 | 18.3 | 189.9 | 75.2 | 46.5 |

**Table J-4. Simulation Model Outputs at Network Exit Links for Region R03, Scenario 1**

| Road Name | Upstream Node | Downstream Node | Elapsed Time (hours) 1:00 | 2:00 | 3:00 | 4:00 | 5:00 | 6:00 |
|---|---|---|---|---|---|---|---|---|
| | | | Cumulative Vehicles Discharged by the Indicated Time | | | | | |
| | | | Cumulative Percent of Vehicles Discharged by the Indicated Time | | | | | |
| Regional Hwy 2 | 1289 | 1290 | 880 | 2,416 | 3,689 | 4,312 | 4,944 | 5,699 |
| | | | 4.58% | 4.38% | 4.00% | 3.34% | 3.06% | 3.22% |
| Concession Rd 7 | 1543 | 1519 | 645 | 2,089 | 3,404 | 4,552 | 5,642 | 5,831 |
| | | | 3.36% | 3.79% | 3.69% | 3.53% | 3.50% | 3.29% |
| Lakeshore Rd | 1552 | 1276 | 3 | 9 | 301 | 1,000 | 1,958 | 2,006 |
| | | | 0.00% | 0.00% | 0.33% | 0.77% | 1.22% | 1.13% |
| Hwy 401 | 1555 | 1696 | 5,560 | 12,294 | 18,782 | 25,328 | 28,815 | 29,352 |
| | | | 28.94% | 22.28% | 20.36% | 19.63% | 17.86% | 16.58% |
| Hwy 407 | 1840 | 1854 | 2,079 | 6,469 | 11,244 | 16,016 | 20,413 | 24,080 |
| | | | 10.82% | 11.72% | 12.19% | 12.42% | 12.65% | 13.61% |
| Winchester Rd | 1914 | 1476 | 493 | 2,426 | 4,006 | 5,701 | 7,958 | 8,420 |
| | | | 2.57% | 4.40% | 4.34% | 4.42% | 4.93% | 4.76% |
| Myrtle Rd | 1930 | 1810 | 29 | 1,026 | 2,577 | 4,042 | 5,618 | 6,027 |
| | | | 0.15% | 1.86% | 2.79% | 3.13% | 3.48% | 3.41% |
| Hwy 401 | 3018 | 1493 | 4,720 | 12,292 | 19,061 | 25,938 | 32,504 | 38,652 |
| | | | 24.56% | 22.28% | 20.66% | 20.11% | 20.15% | 21.84% |
| Rossland Rd | 3037 | 1587 | 437 | 1,037 | 1,829 | 2,432 | 3,249 | 3,555 |
| | | | 2.28% | 1.88% | 1.98% | 1.88% | 2.01% | 2.01% |
| Rt 115/Rt 35 | 3061 | 1897 | 1,186 | 5,363 | 9,410 | 13,460 | 17,512 | 19,536 |
| | | | 6.17% | 9.72% | 10.20% | 10.43% | 10.85% | 11.04% |
| Regional Road 22 | 3178 | 1592 | 1,329 | 3,694 | 5,984 | 8,371 | 10,362 | 10,739 |
| | | | 6.92% | 6.69% | 6.49% | 6.49% | 6.42% | 6.07% |
| Dundas St | 3181 | 1597 | 766 | 2,345 | 4,550 | 6,135 | 7,237 | 7,616 |
| | | | 3.99% | 4.25% | 4.93% | 4.76% | 4.49% | 4.30% |
| Taunton Rd | 3182 | 1602 | 1,037 | 3,415 | 5,872 | 8,535 | 11,247 | 11,441 |
| | | | 5.40% | 6.19% | 6.36% | 6.62% | 6.97% | 6.46% |
| Hwy 7A | 3597 | 3093 | 25 | 94 | 508 | 1,078 | 1,391 | 1,462 |
| | | | 0.13% | 0.17% | 0.55% | 0.84% | 0.86% | 0.83% |
| Goodwood Rd | 3611 | 1481 | 25 | 213 | 1,040 | 2,099 | 2,495 | 2,564 |
| | | | 0.13% | 0.39% | 1.13% | 1.63% | 1.55% | 1.45% |

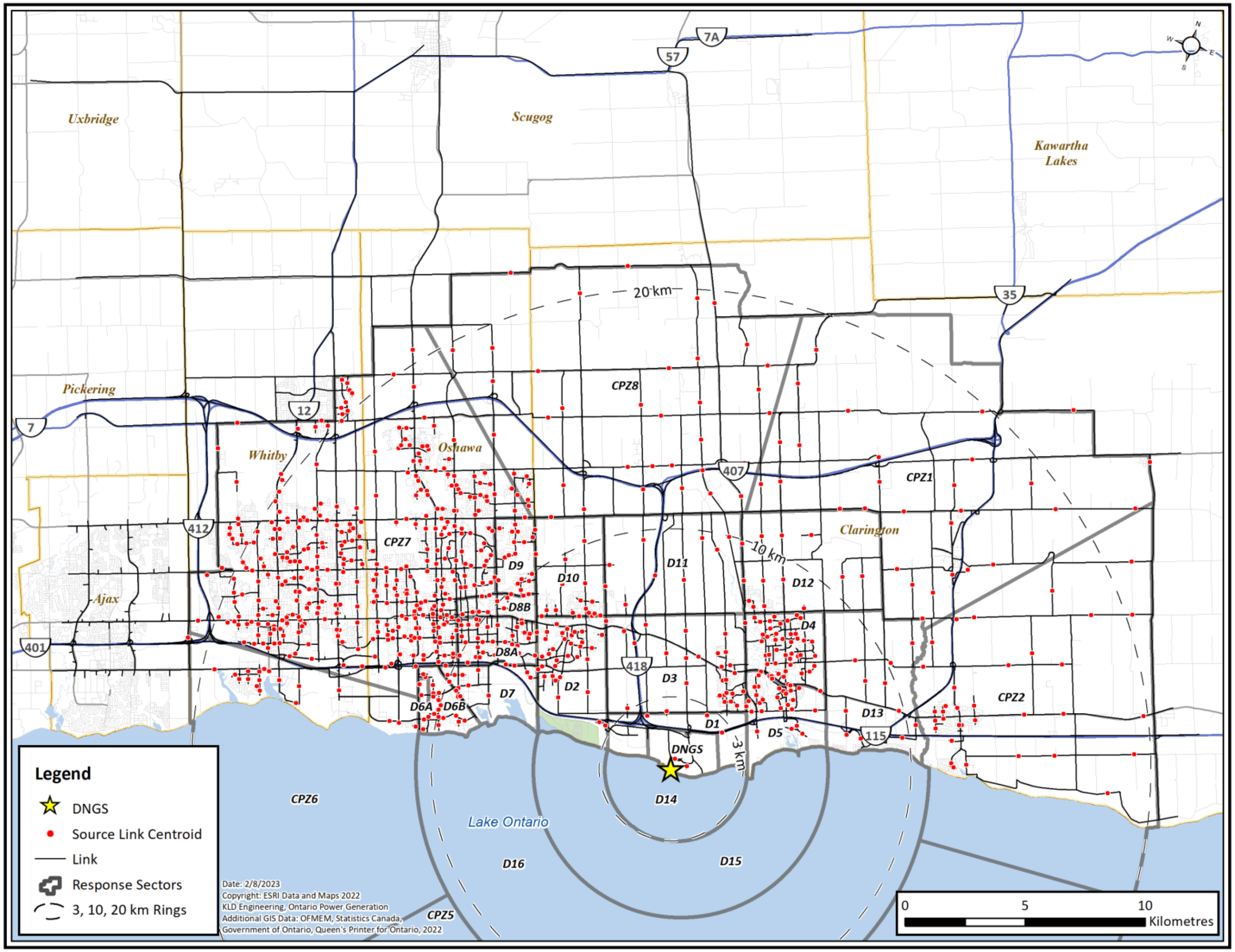



**Figure J-1 Network Sources/Origins**

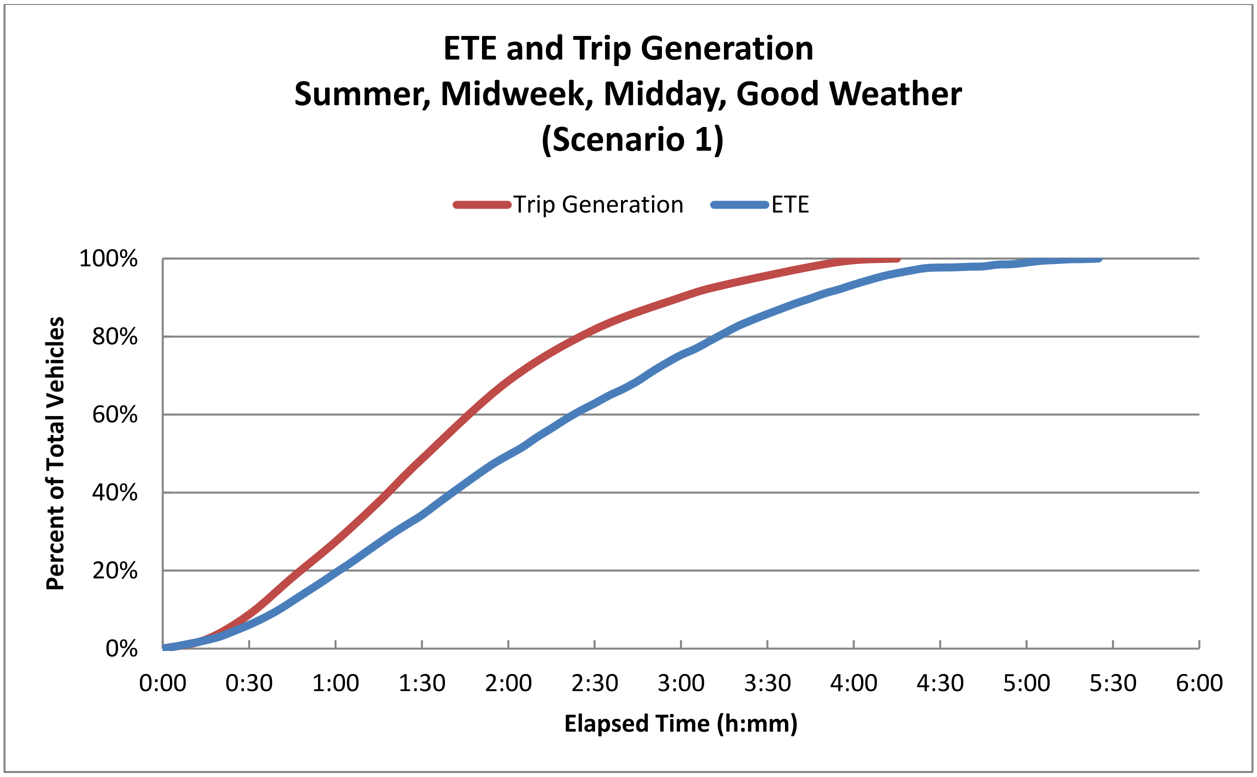



**Figure J-2. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather (Scenario 1)**

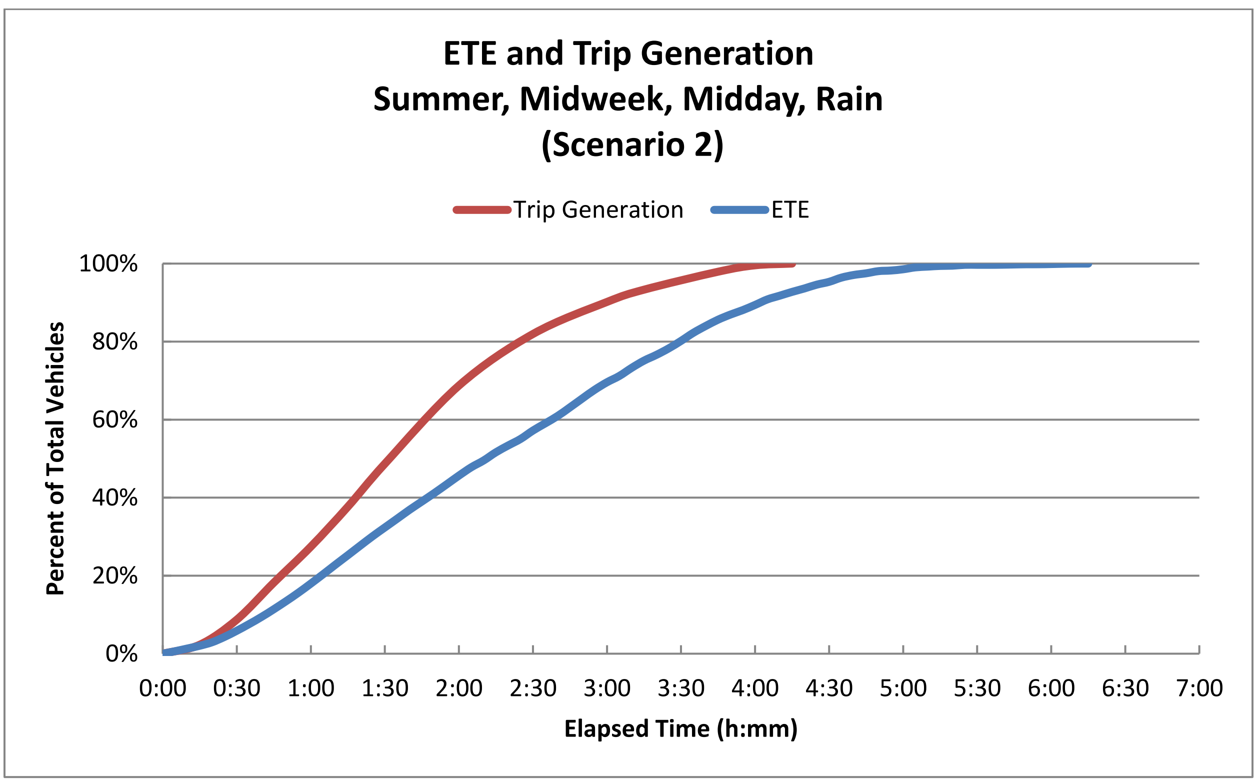



**Figure J-3. ETE and Trip Generation: Summer, Midweek, Midday, Rain (Scenario 2)**

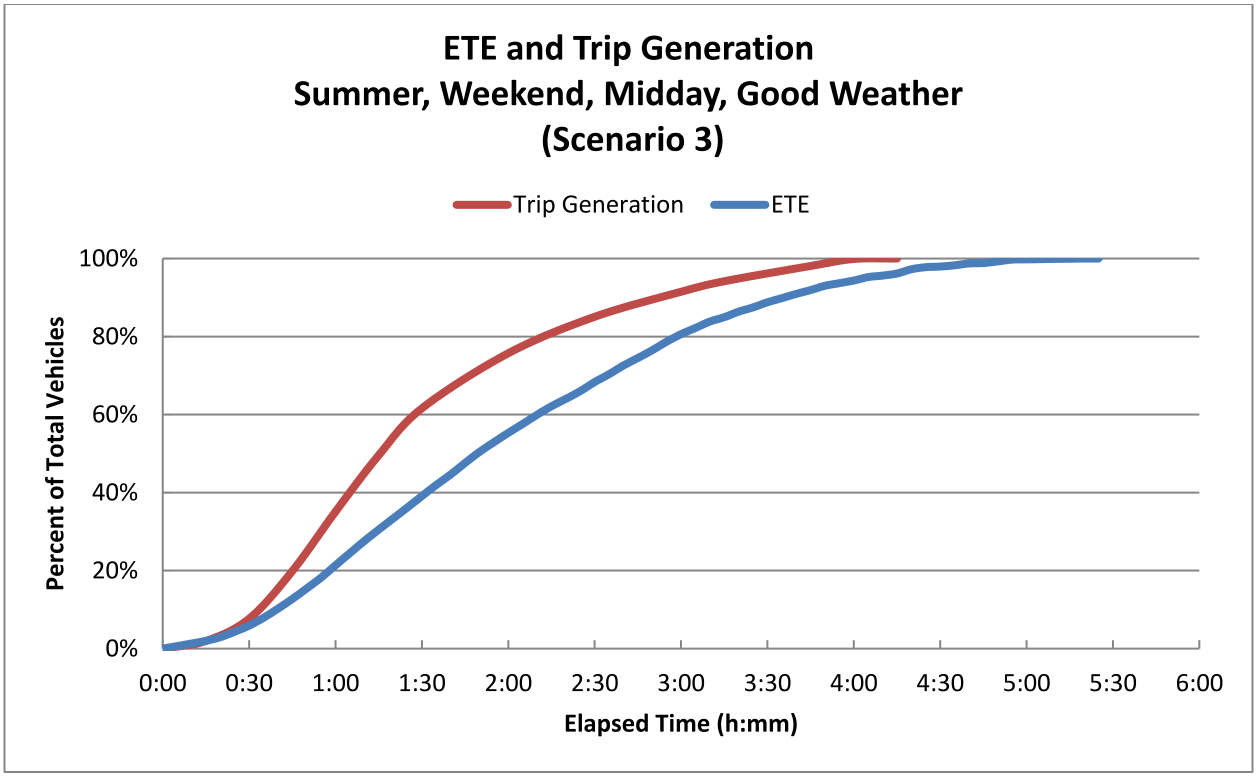



**Figure J-4. ETE and Trip Generation: Summer, Weekend, Midday, Good Weather (Scenario 3)**

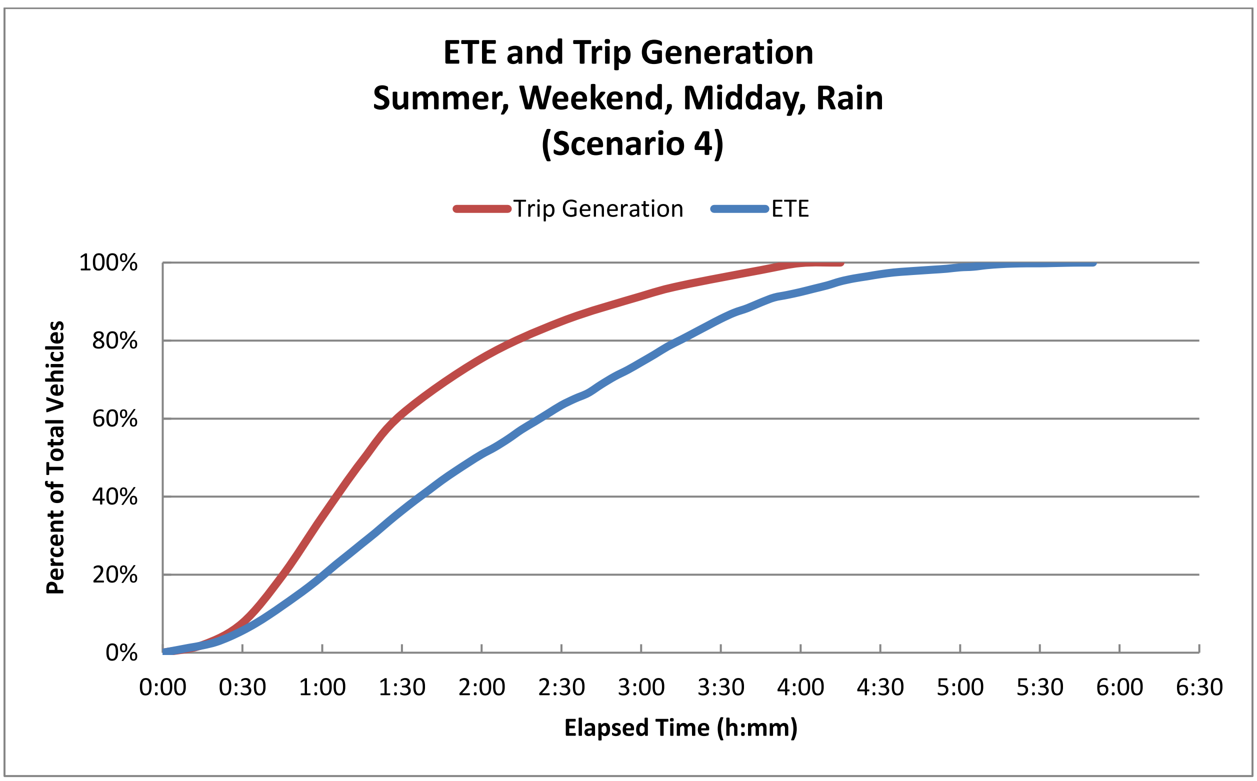



**Figure J-5. ETE and Trip Generation: Summer, Weekend, Midday, Rain (Scenario 4)**

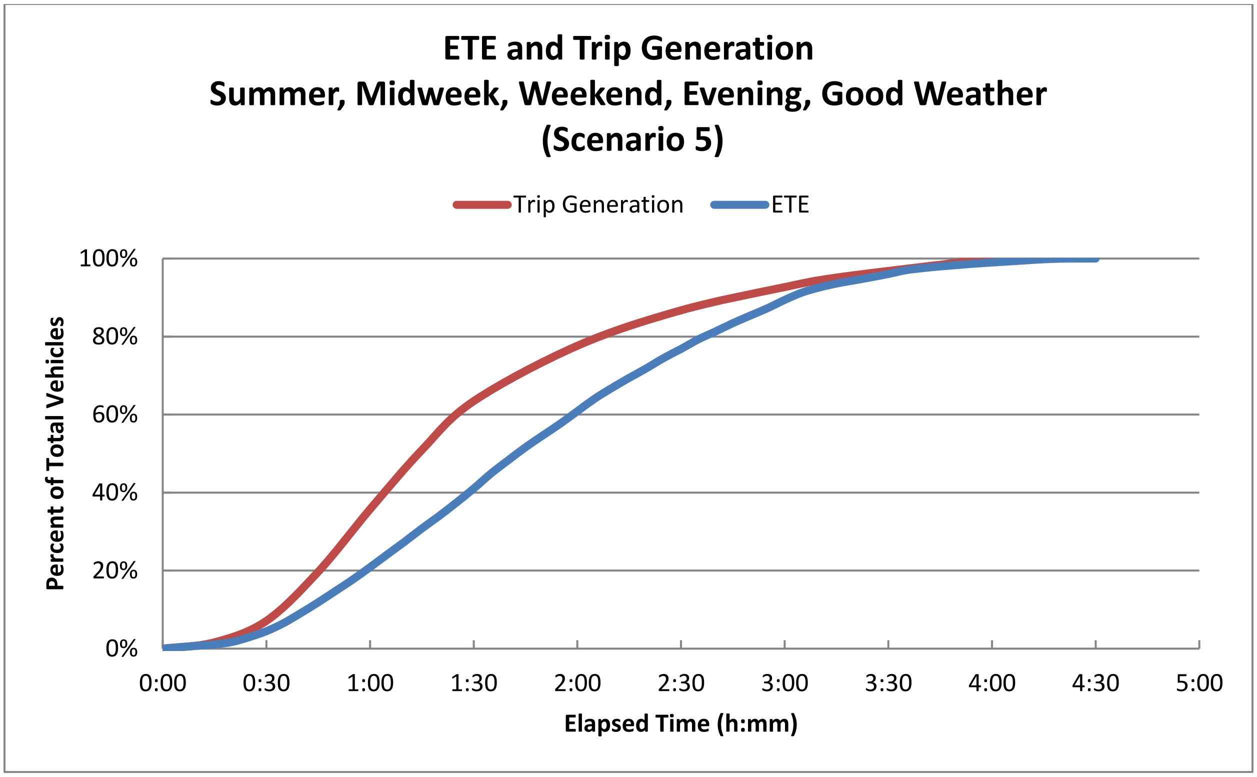



**Figure J-6. ETE and Trip Generation: Summer, Midweek, Weekend, Evening, Good Weather (Scenario 5)**

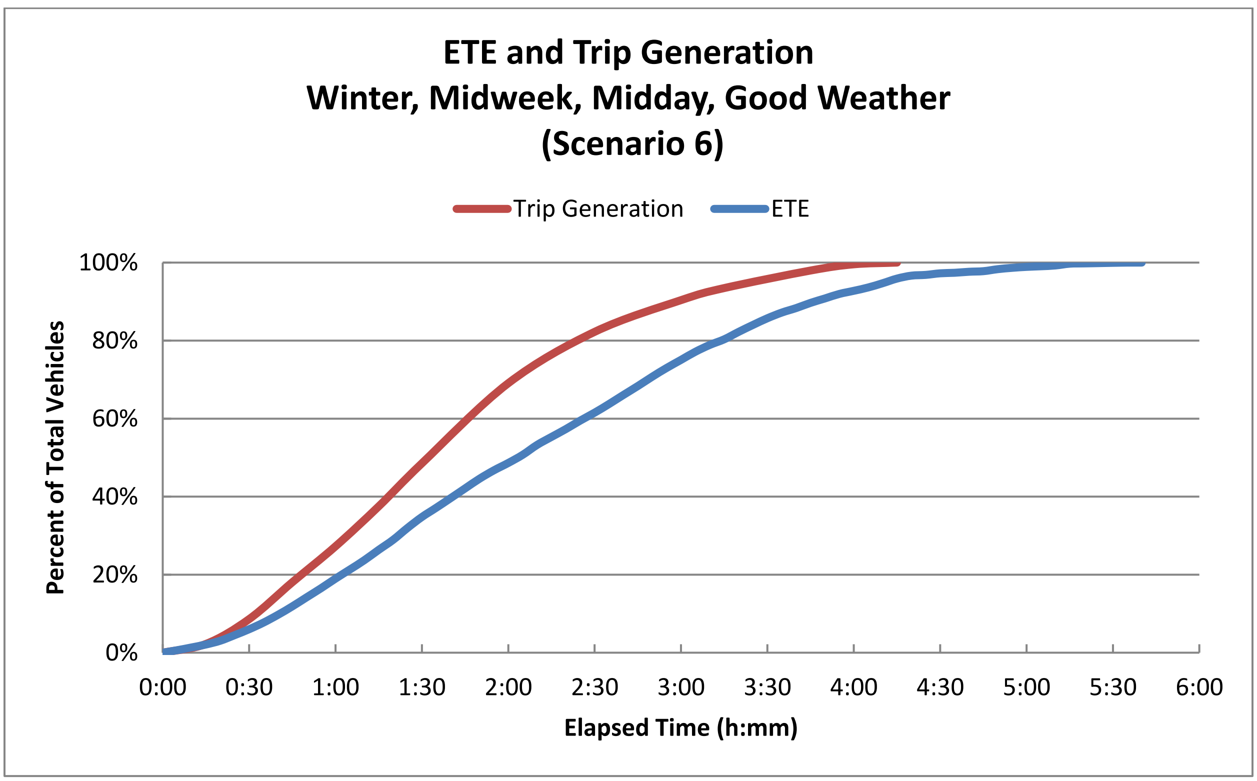



**Figure J-7. ETE and Trip Generation: Winter, Midweek, Midday, Good Weather (Scenario 6)**

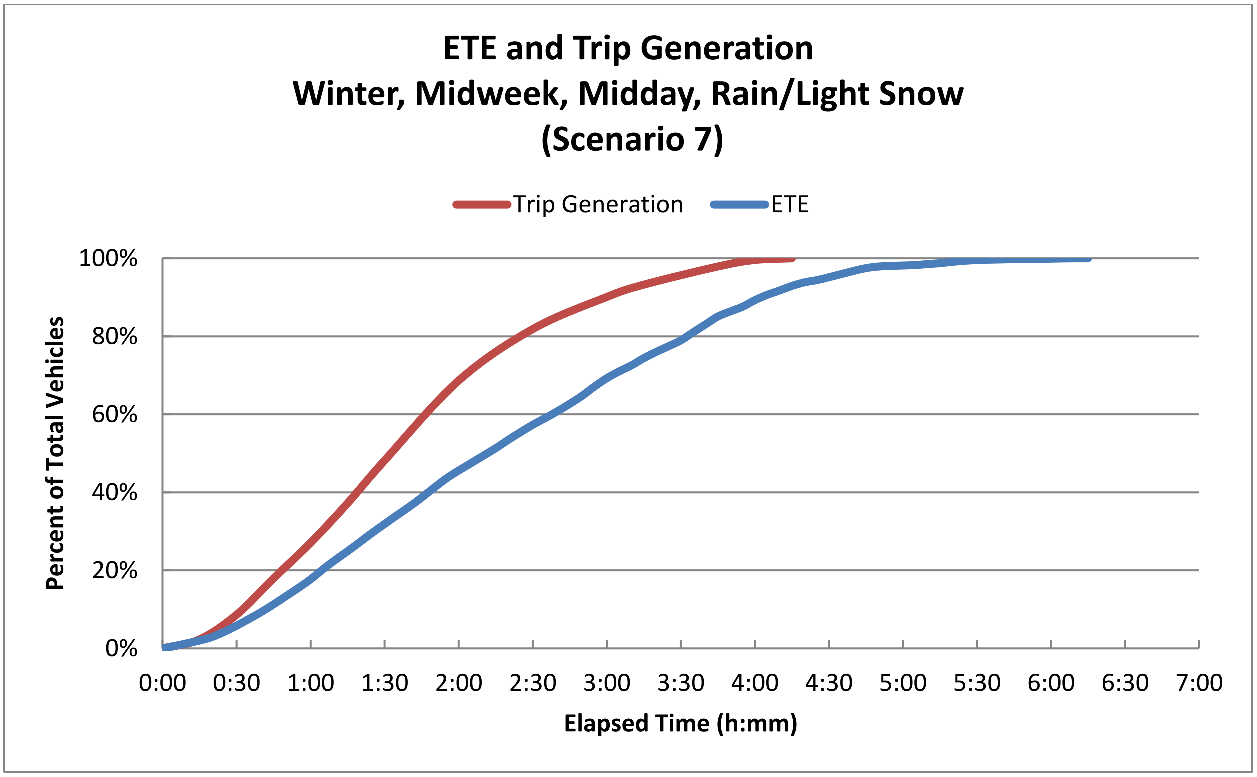



**Figure J-8. ETE and Trip Generation: Winter, Midweek, Midday, Rain/Light Snow (Scenario 7)**

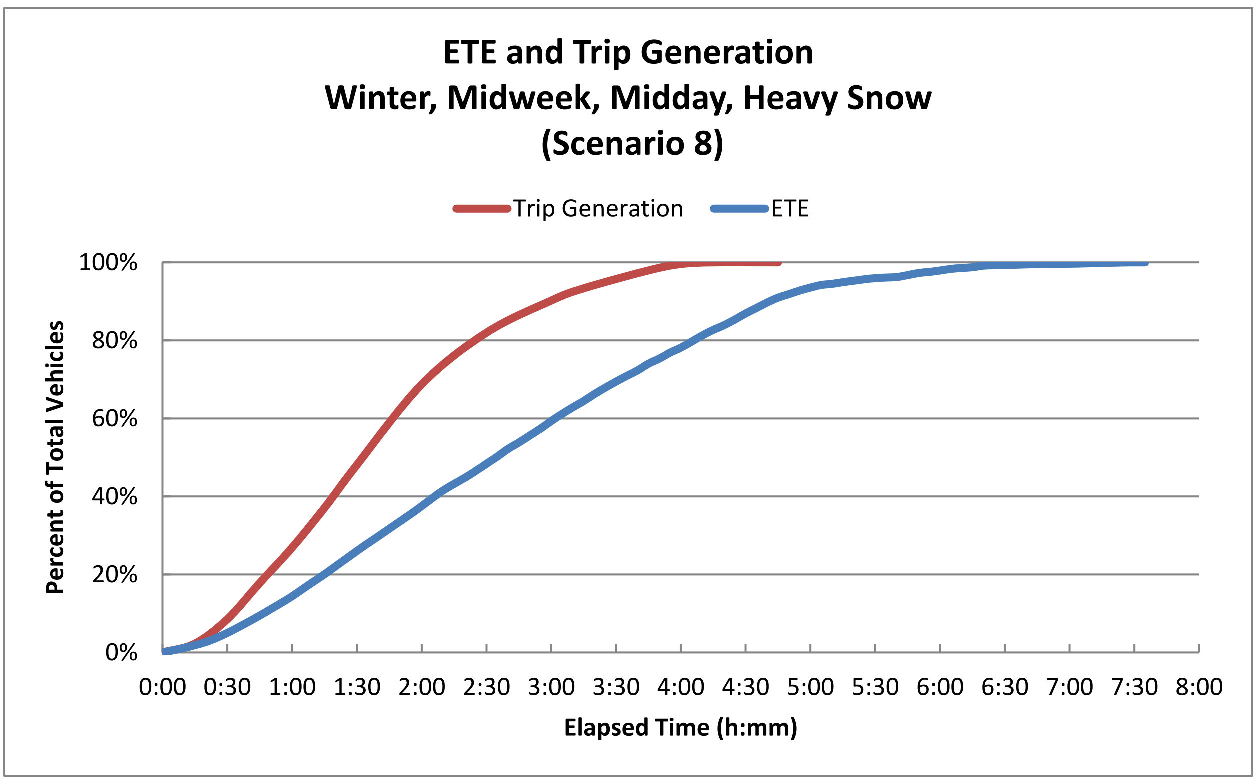



**Figure J-9. ETE and Trip Generation: Winter, Midweek, Midday, Heavy Snow (Scenario 8)**

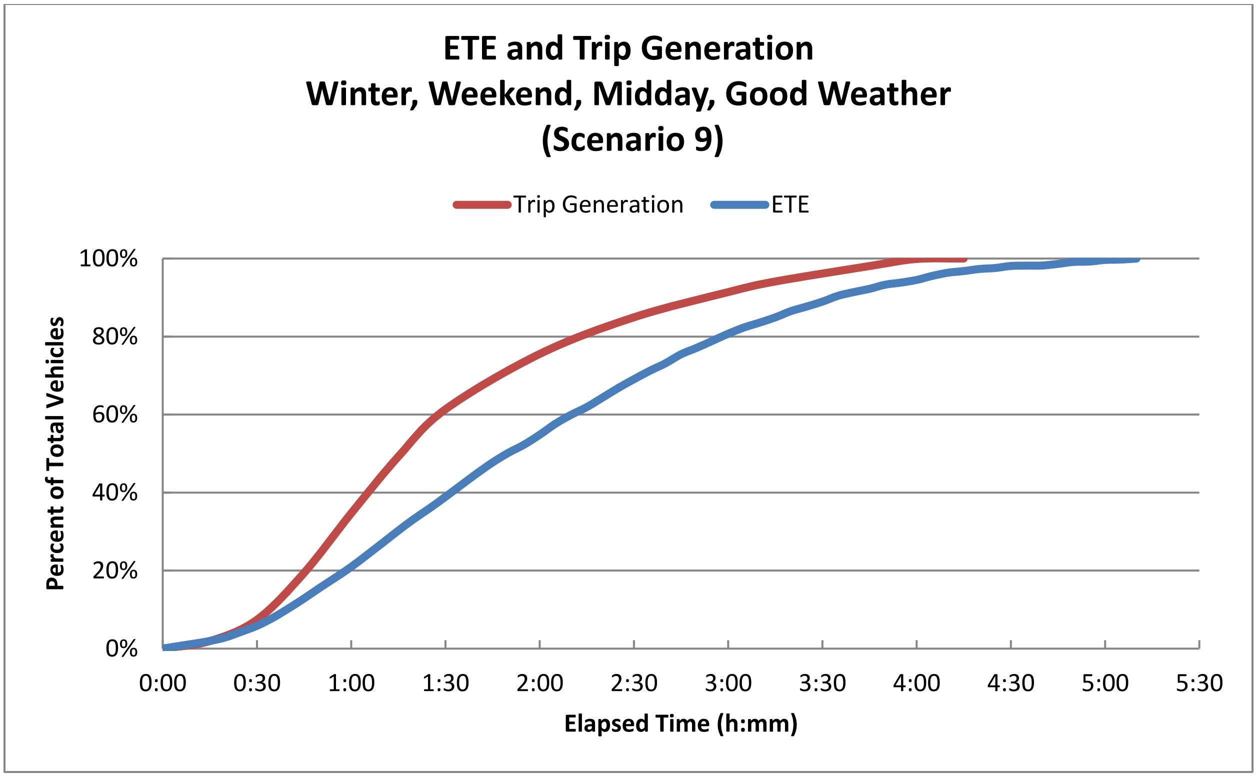



**Figure J-10. ETE and Trip Generation: Winter, Weekend, Midday, Good Weather (Scenario 9)**

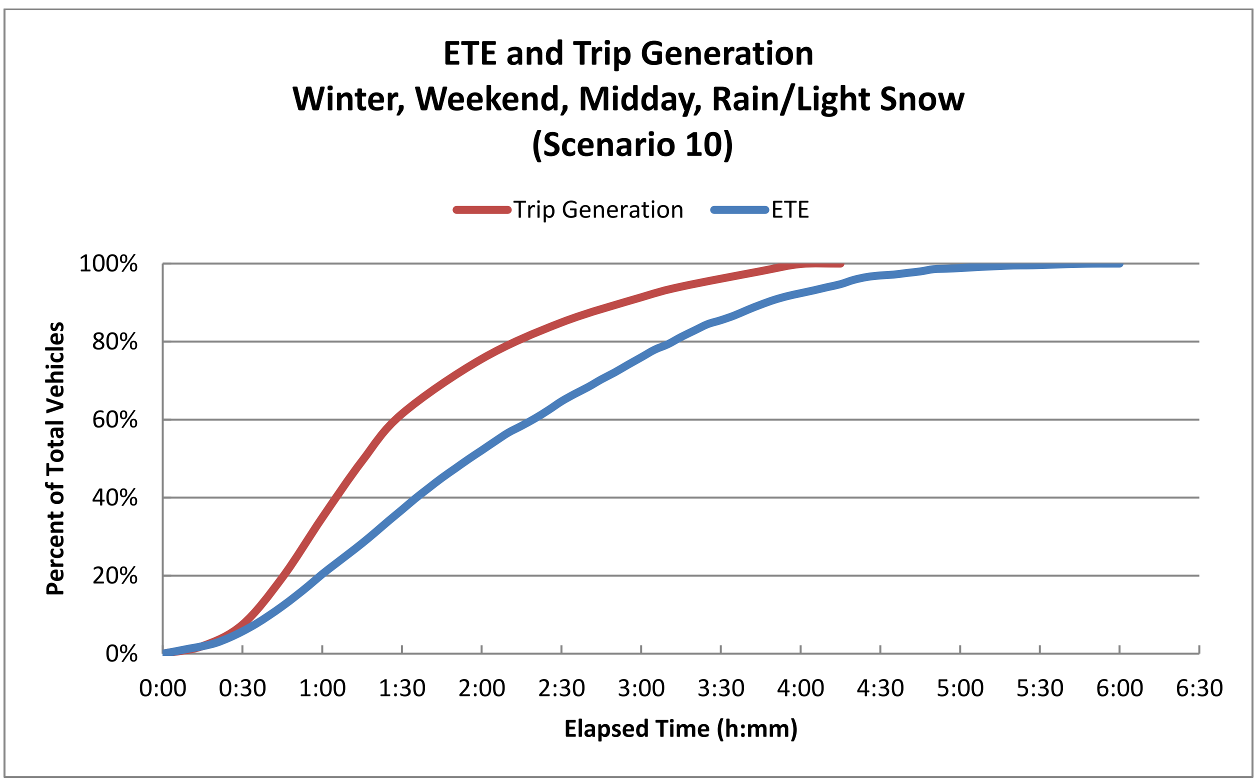



**Figure J-11. ETE and Trip Generation: Winter, Weekend, Midday, Rain/Light Snow (Scenario 10)**

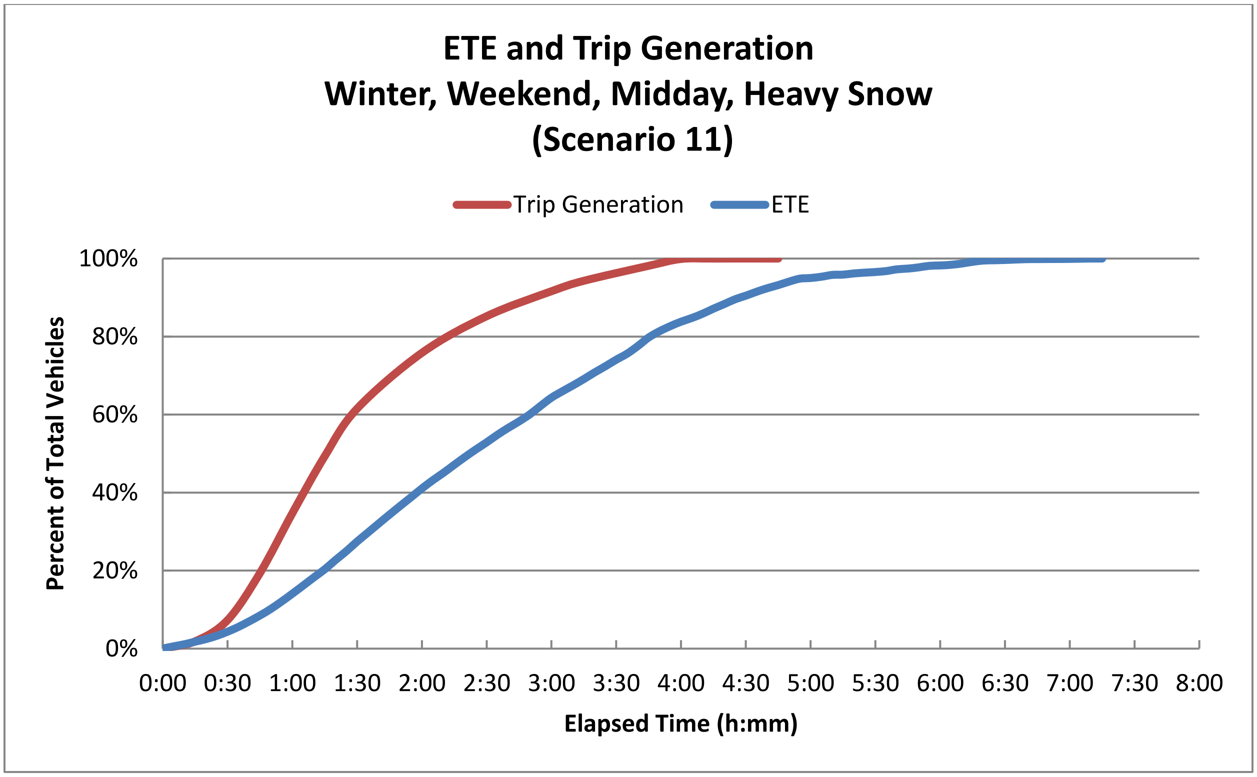



**Figure J-12. ETE and Trip Generation: Winter, Weekend, Midday, Heavy Snow (Scenario 11)**

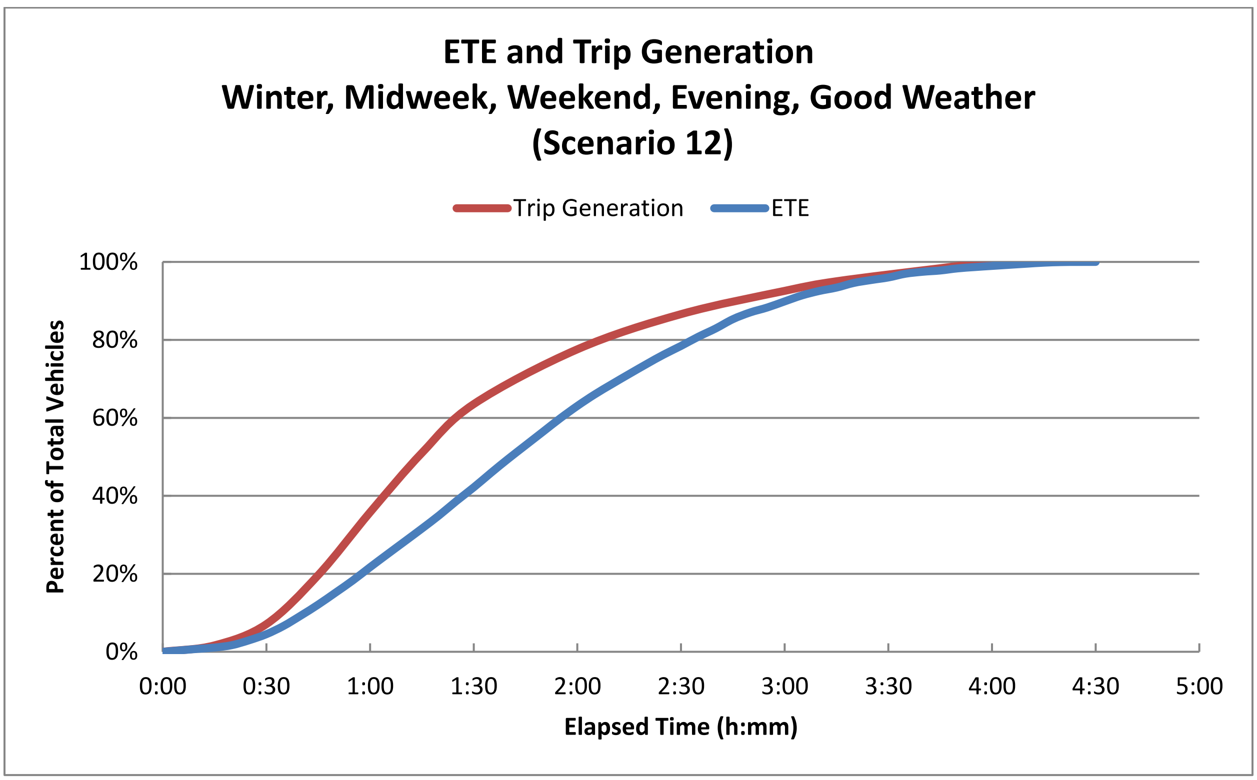



**Figure J-13. ETE and Trip Generation: Winter, Midweek, Weekend, Evening, Good Weather (Scenario 12)**

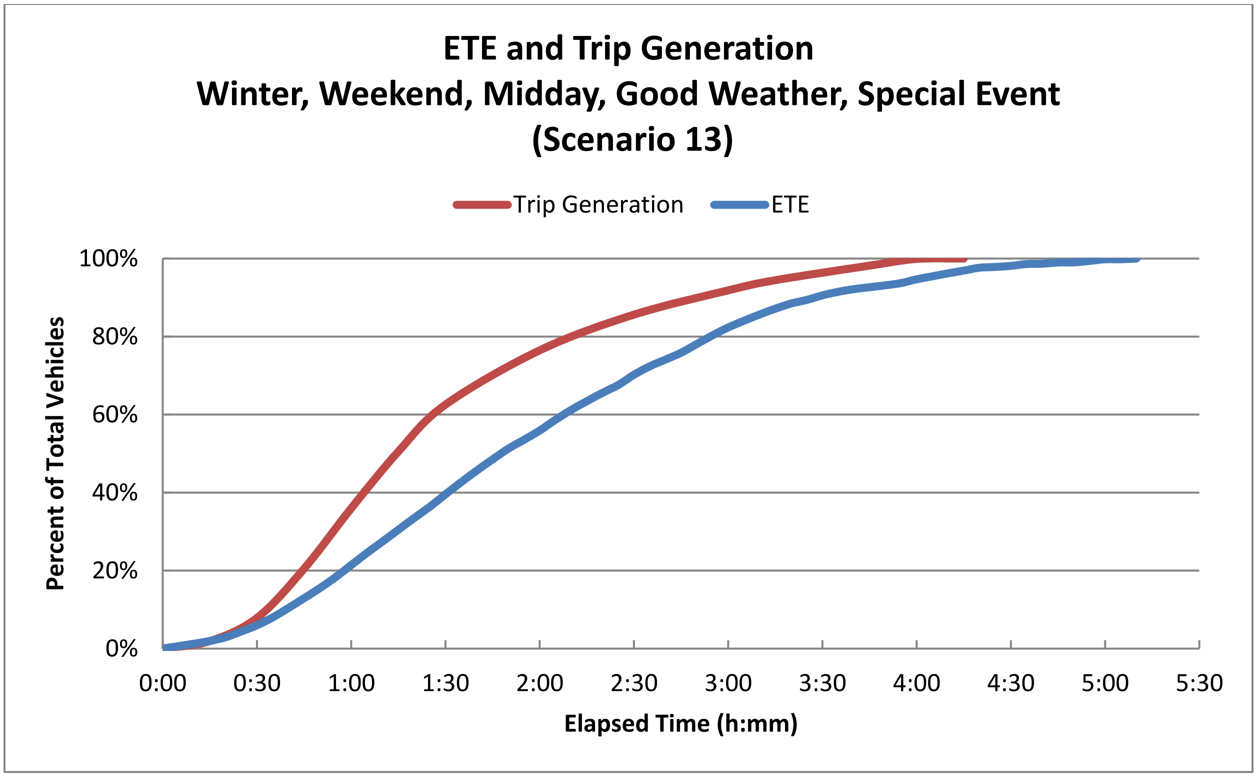



**Figure J-14. ETE and Trip Generation: Winter, Weekend, Midday, Good Weather, Special Event (Scenario 13)**

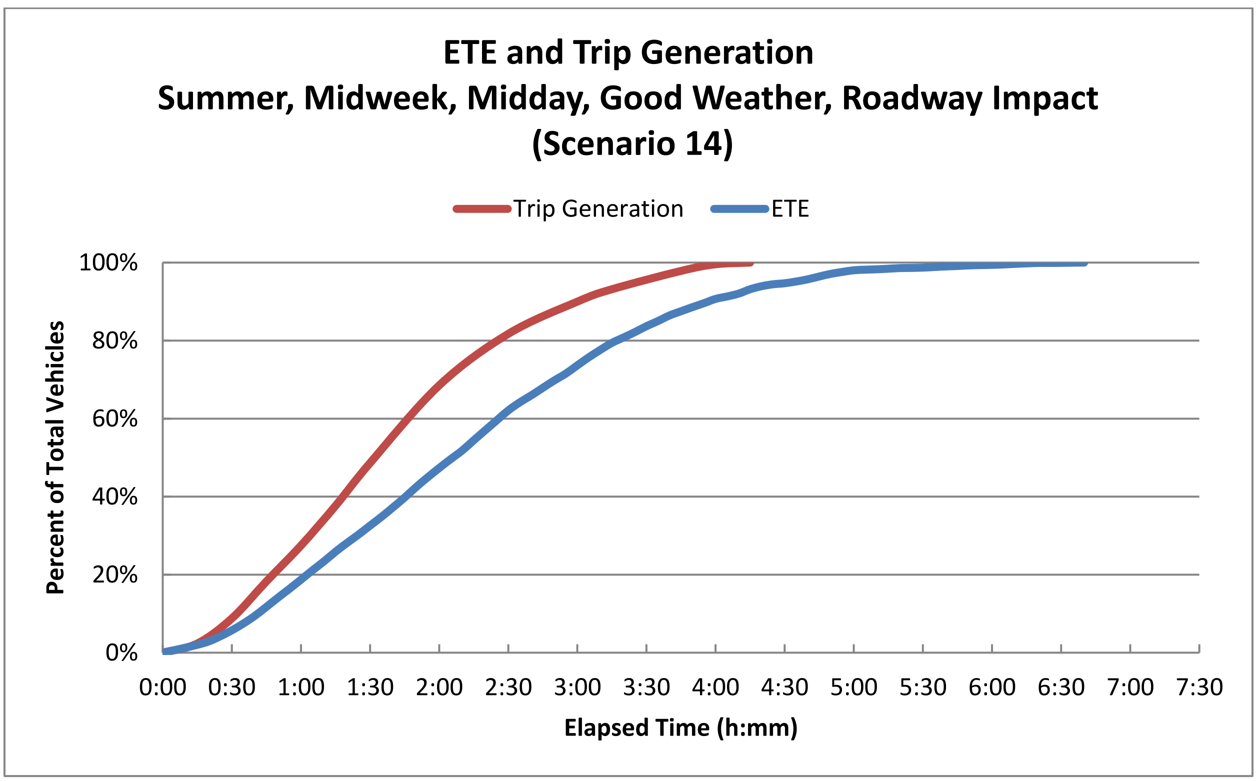



**Figure J-15. ETE and Trip Generation: Summer, Midweek, Midday, Good Weather, Roadway Impact (Scenario 14)**

# APPENDIX K

Evacuation Roadway Network

## K. EVACUATION ROADWAY NETWORK

As discussed in Section 1.3, a link-node analysis network was constructed to model the roadway network within the study area. Figure K-1 provides an overview of the link-node analysis network. The figure has been divided up into 64 more detailed figures (Figure K-2 through Figure K-65) which show each of the links and nodes in the network.

The analysis network was calibrated using the observations made during the field surveys conducted in April 2022.

Table K-1 summarizes the number of nodes by the type of control (stop sign, yield sign, pre-timed signal, actuated signal, or uncontrolled).

**Table K-1. Summary of Nodes by the Type of Control**

| Control Type | Number of Nodes |
|---|---|
| Uncontrolled | 1,590 |
| Pretimed | 0 |
| Actuated | 413 |
| Stop | 477 |
| Yield | 32 |
| **Total:** | **2,512** |

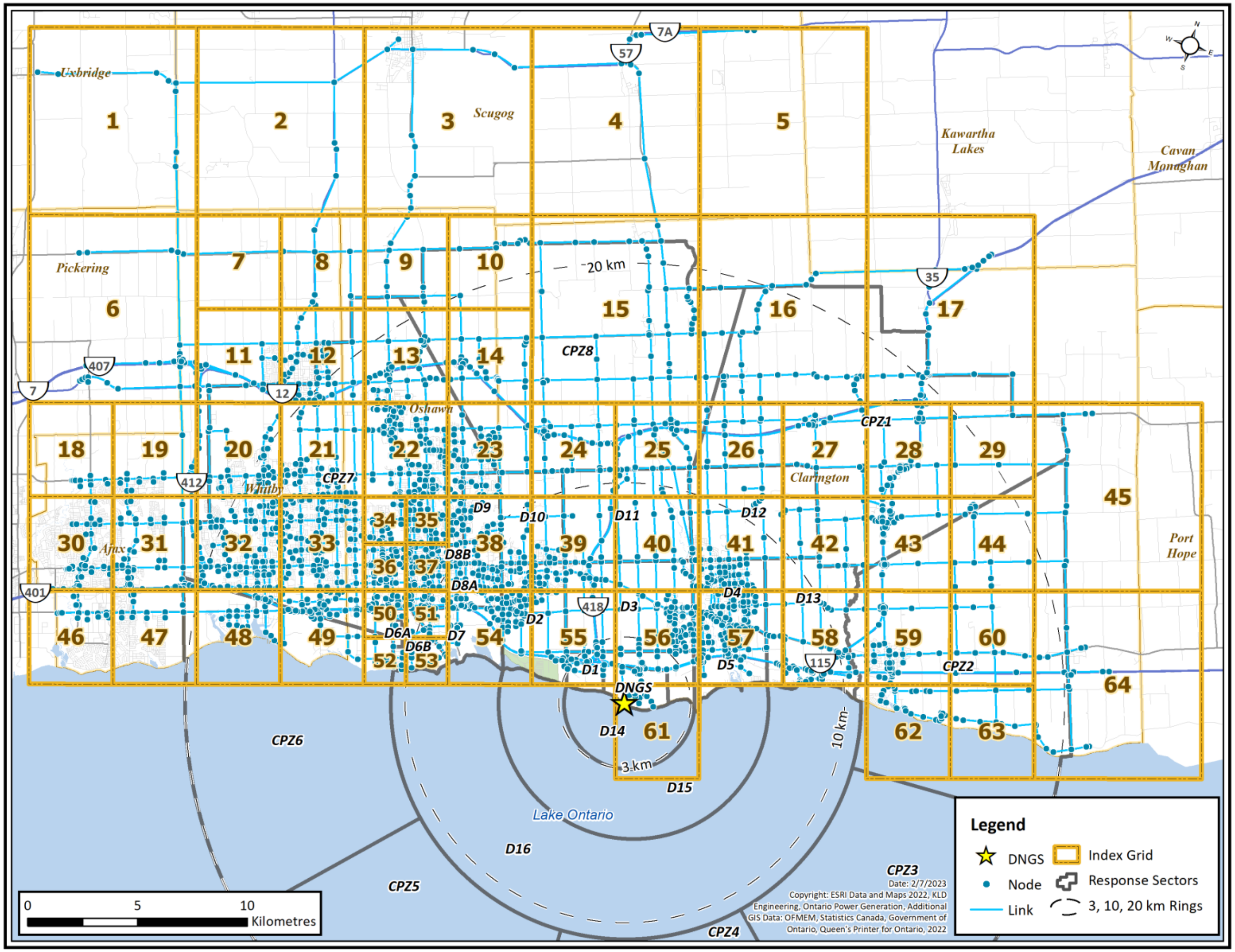



**Figure K-1. DNGS Link-Node Analysis Network**

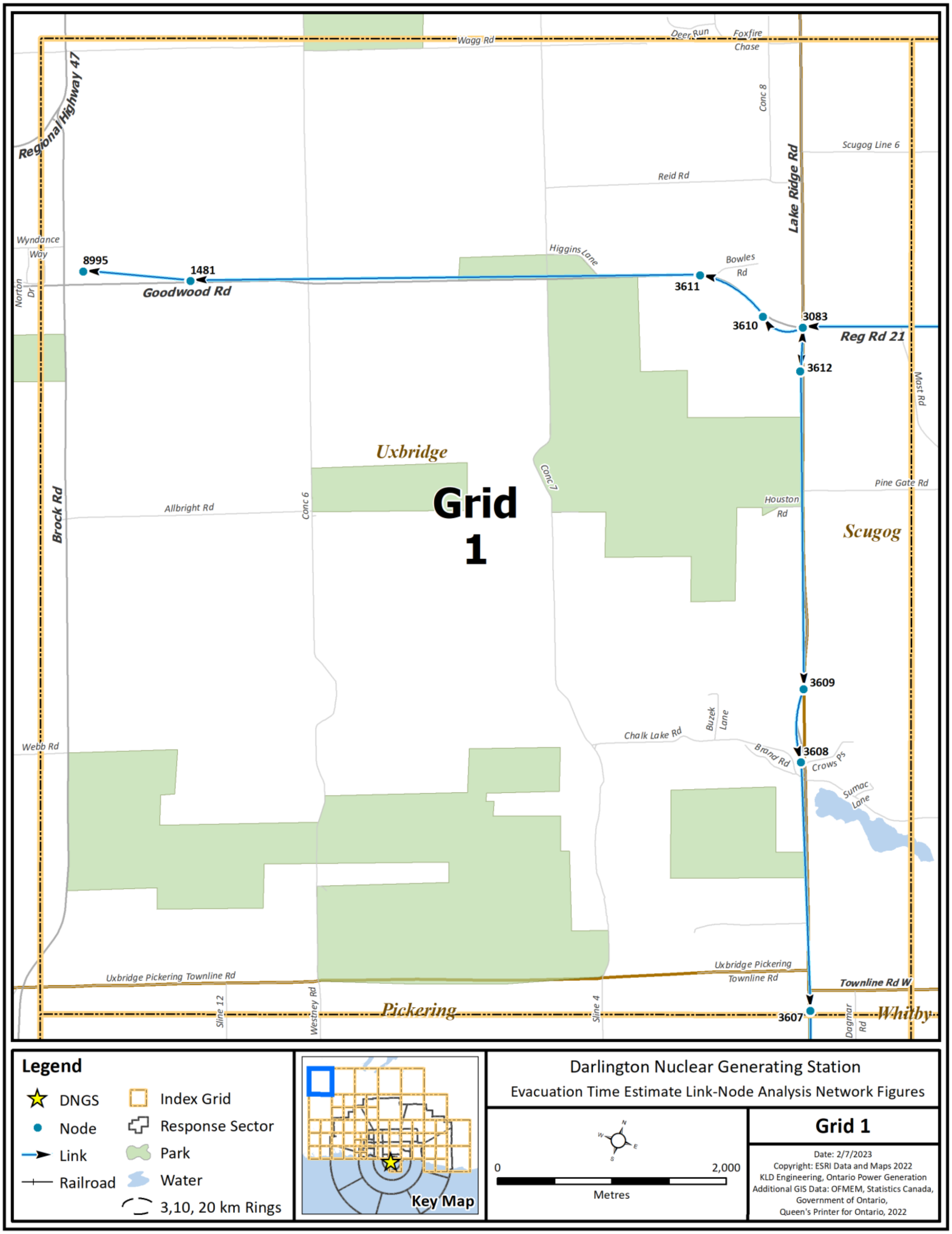



**Figure K-2. Link-Node Analysis Network – Grid 1**

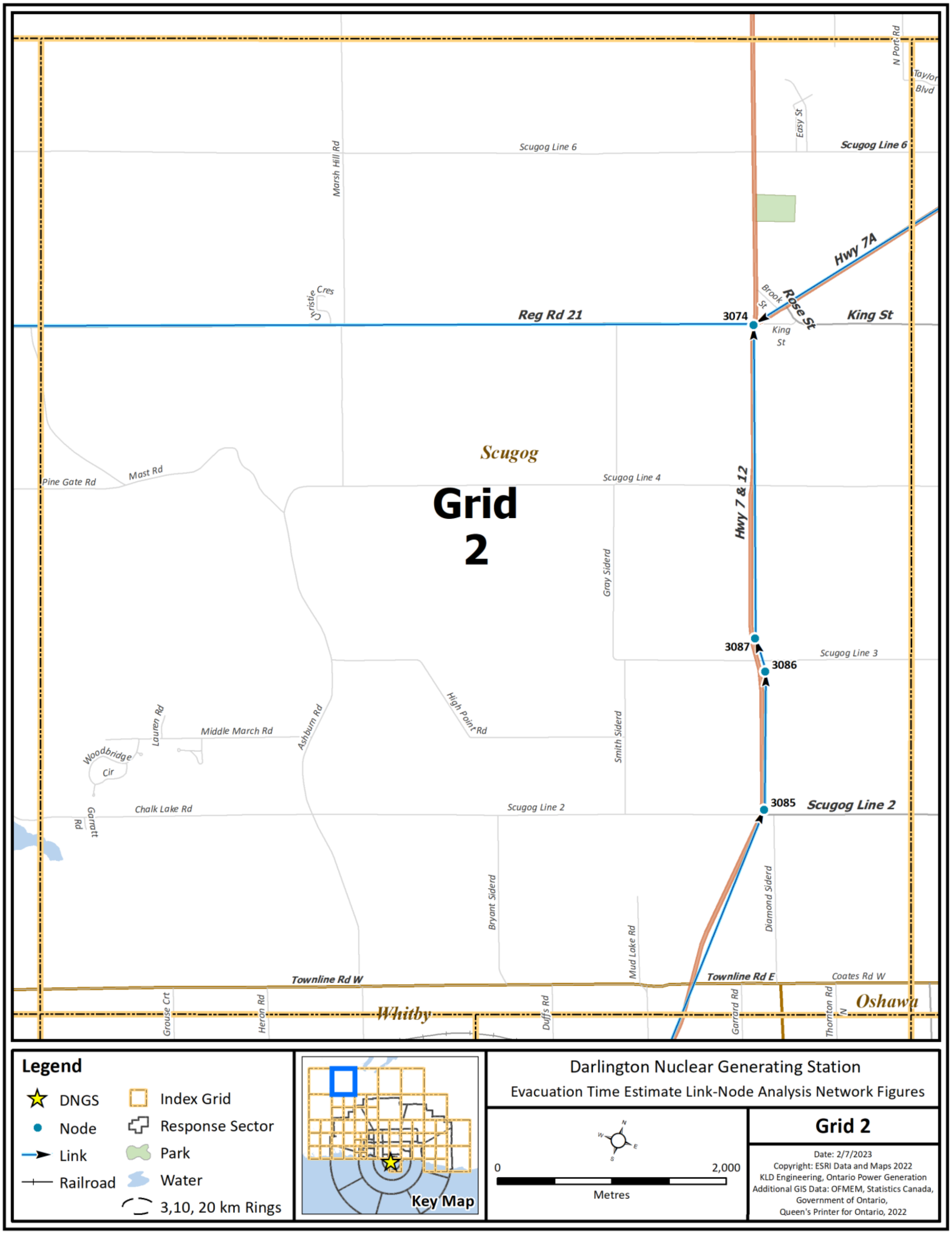



**Figure K-3. Link-Node Analysis Network – Grid 2**

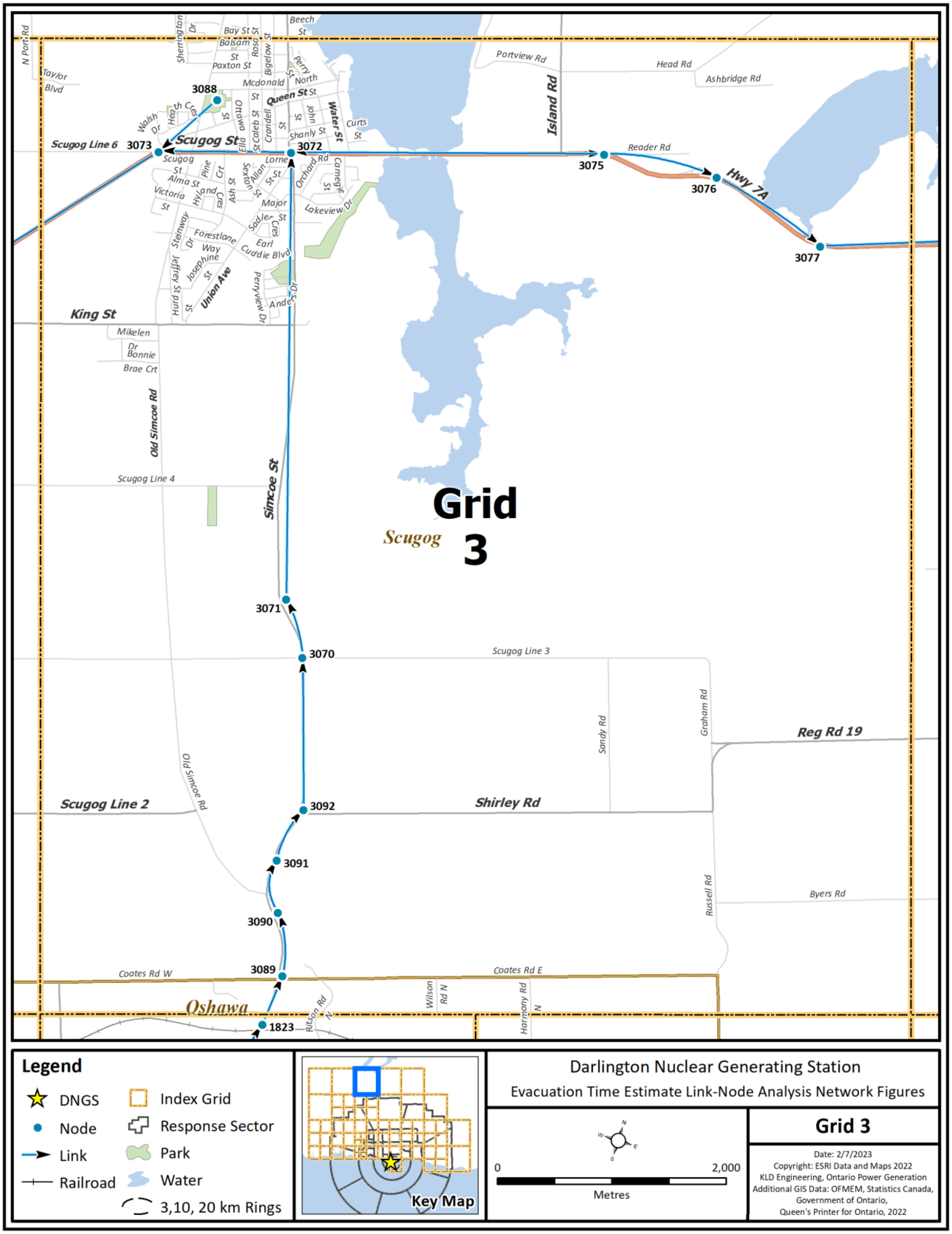



**Figure K-4. Link-Node Analysis Network – Grid 3**

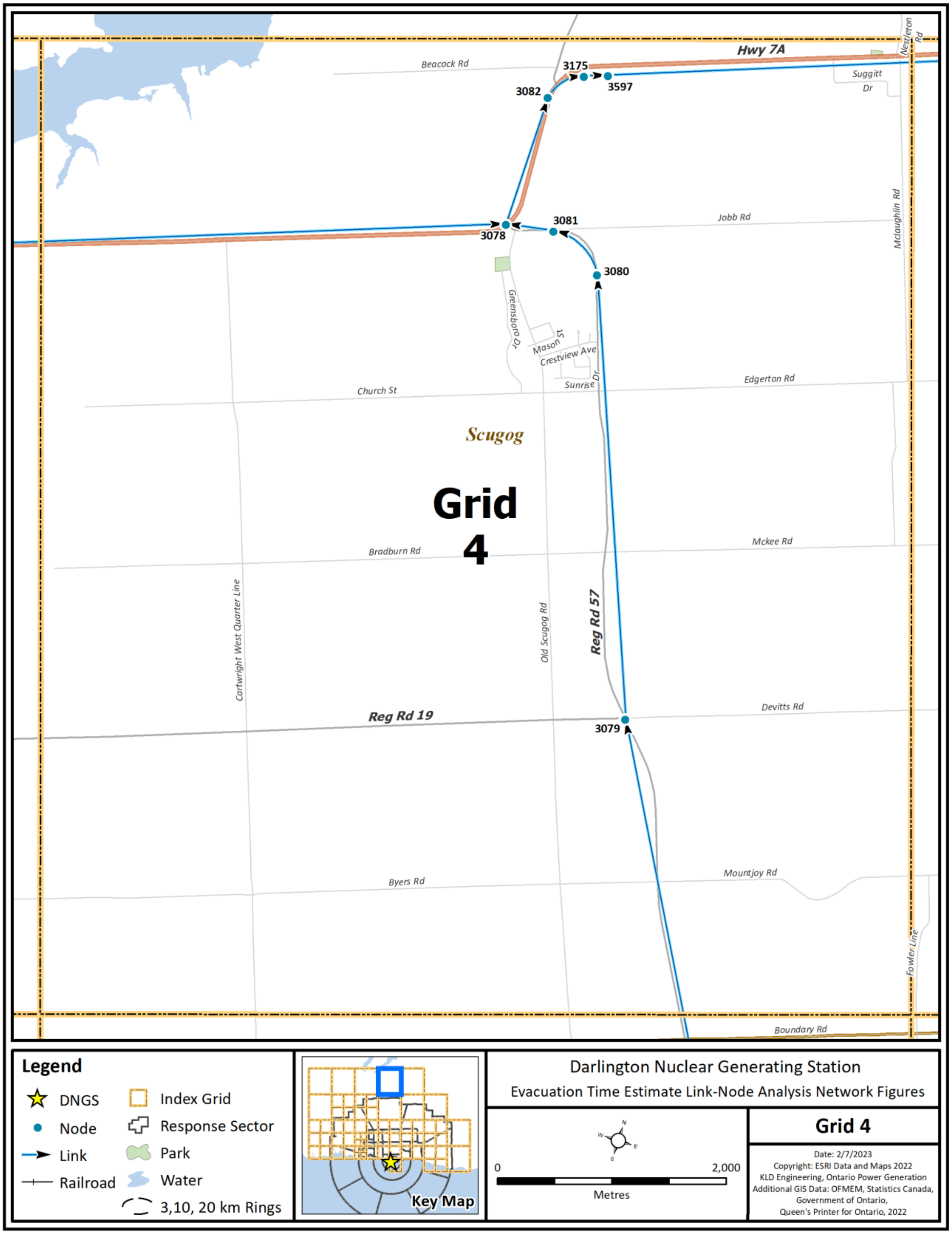



**Figure K-5. Link-Node Analysis Network – Grid 4**

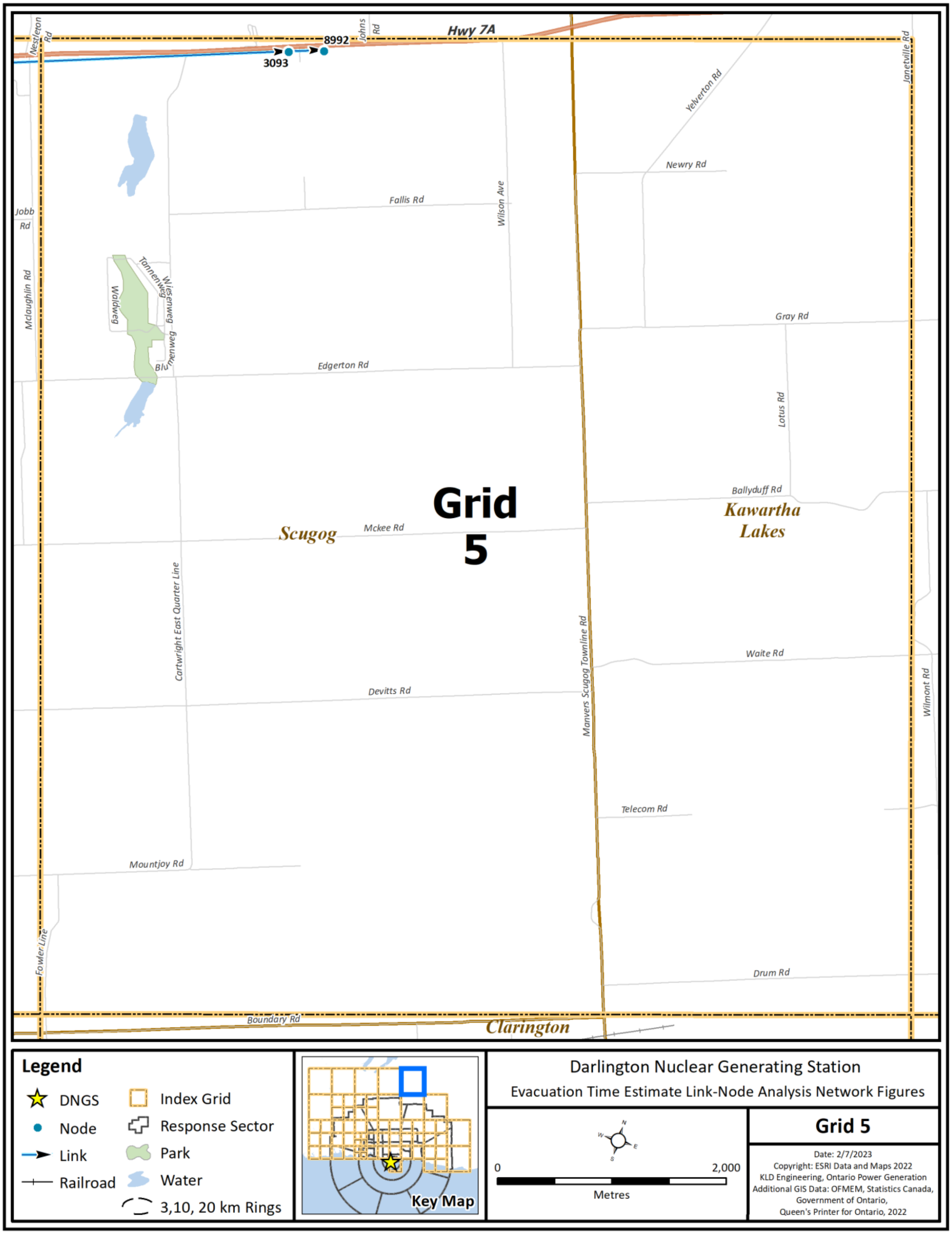



**Figure K-6. Link-Node Analysis Network – Grid 5**

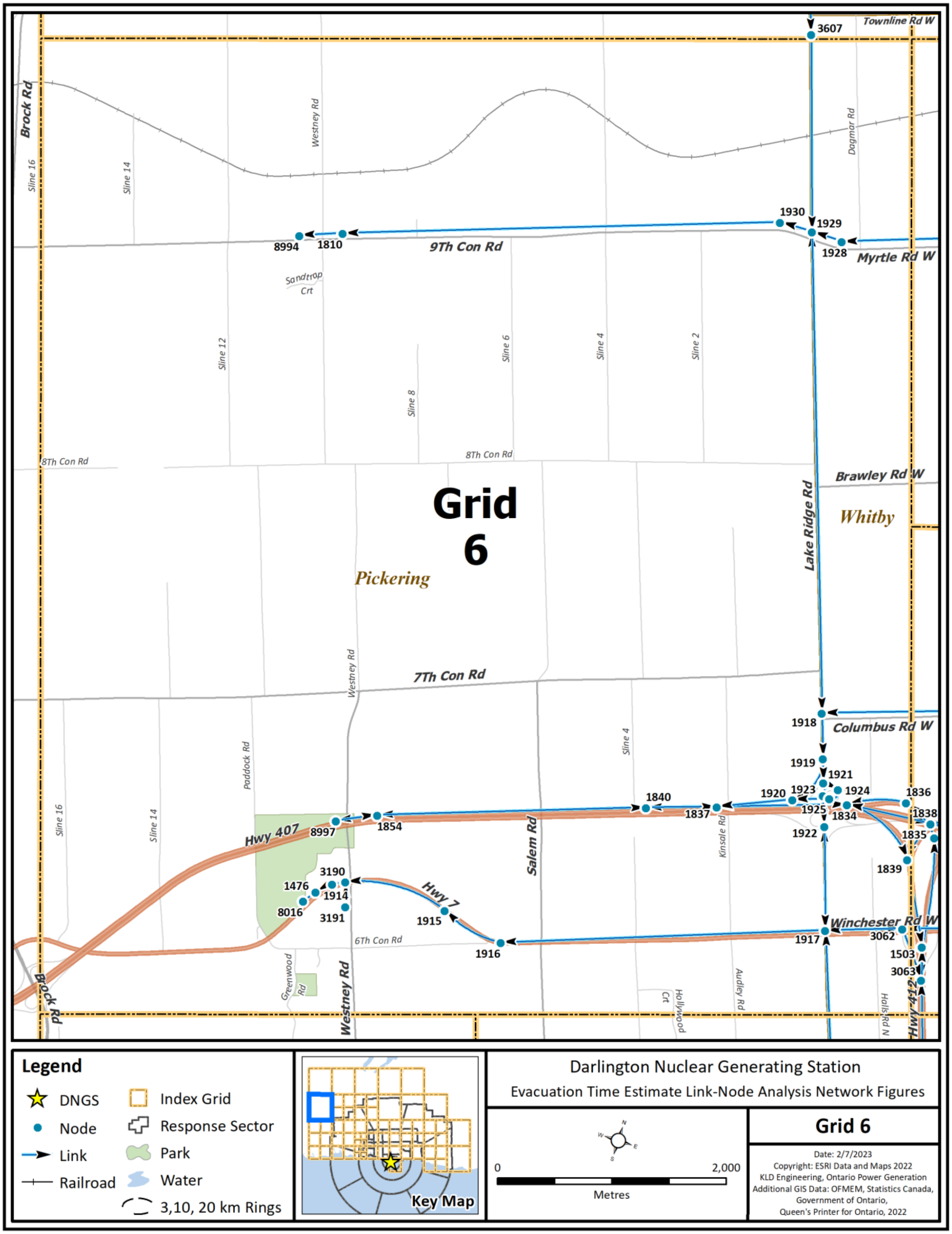



**Figure K-7. Link-Node Analysis Network – Grid 6**

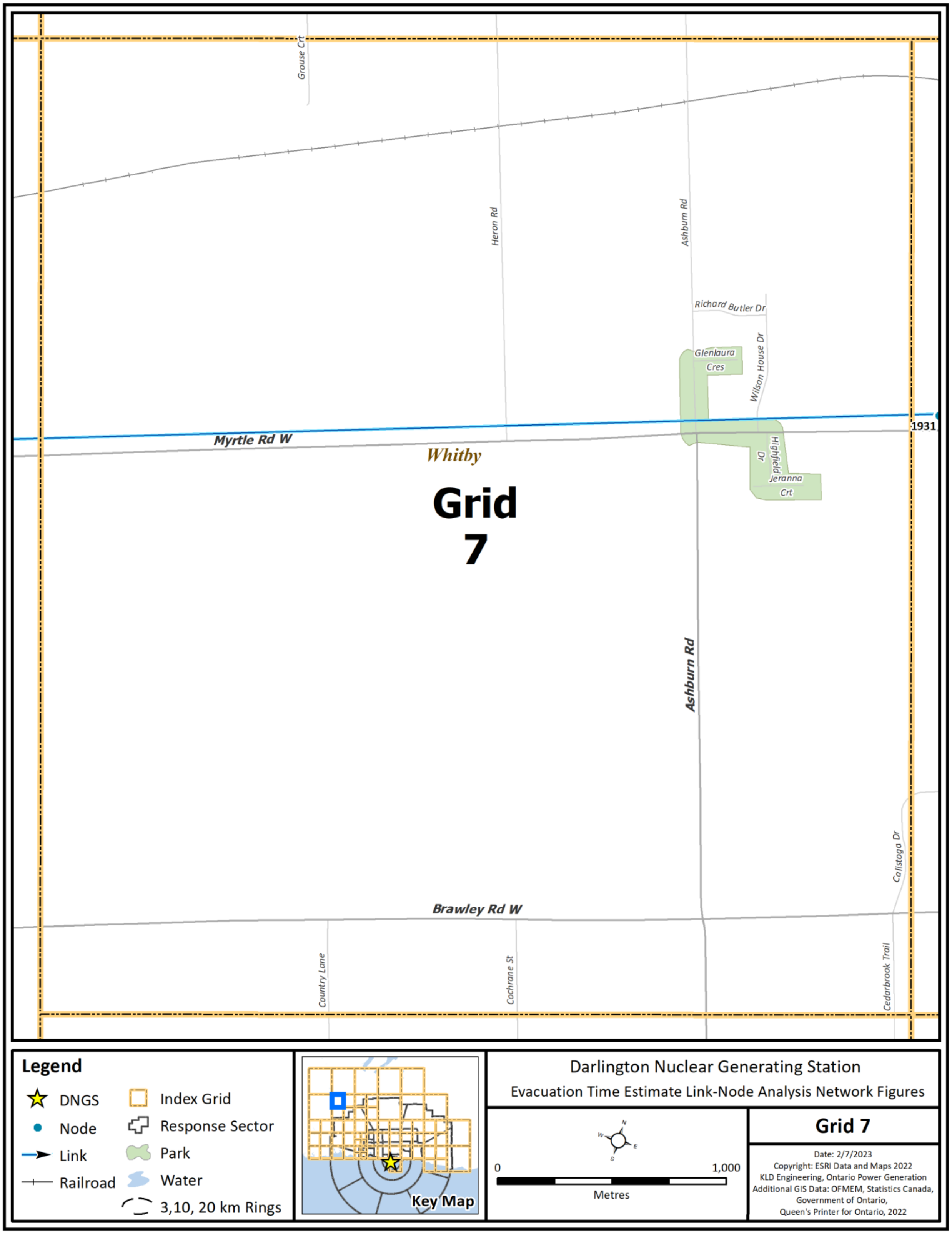



**Figure K-8. Link-Node Analysis Network – Grid 7**

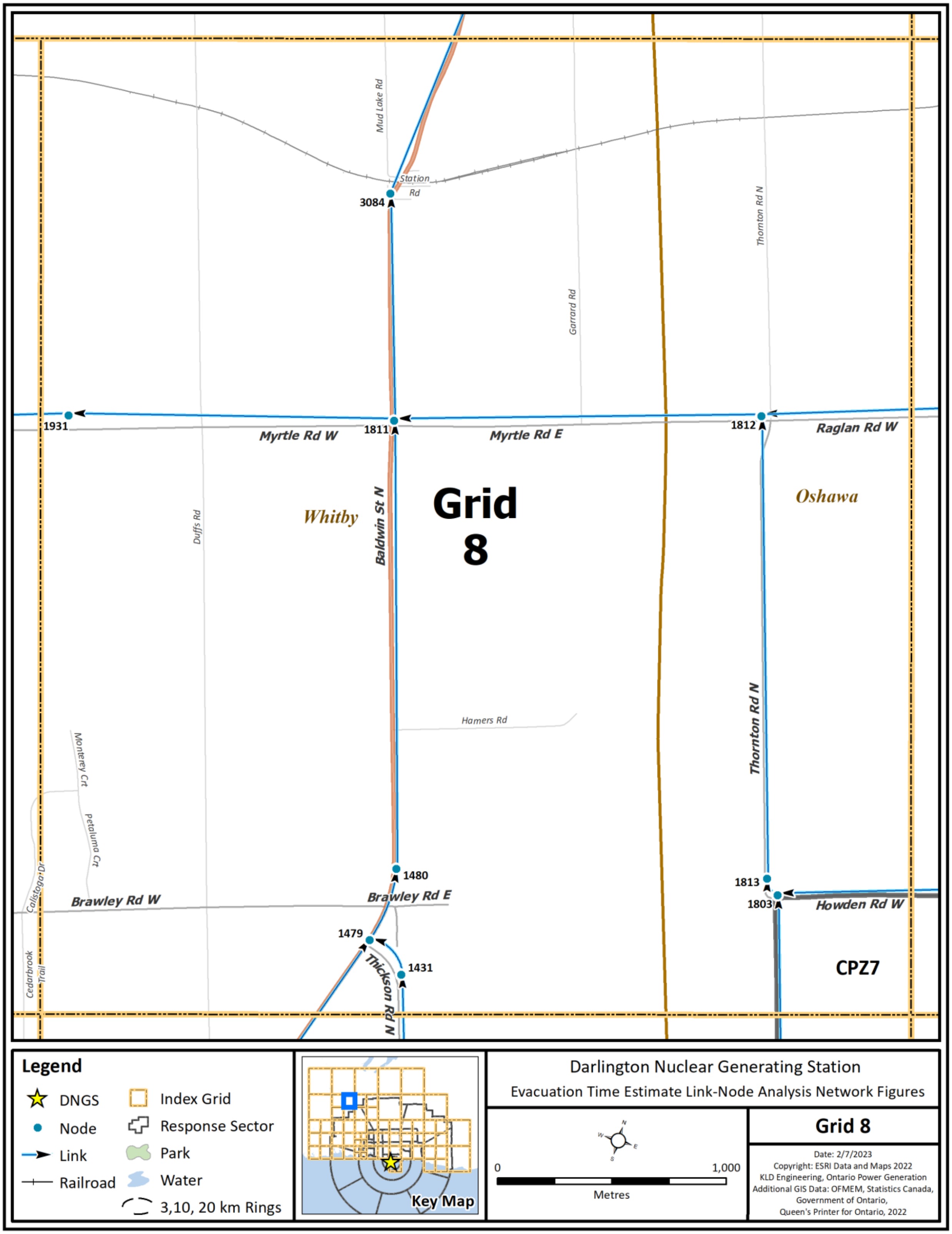



**Figure K-9. Link-Node Analysis Network – Grid 8**

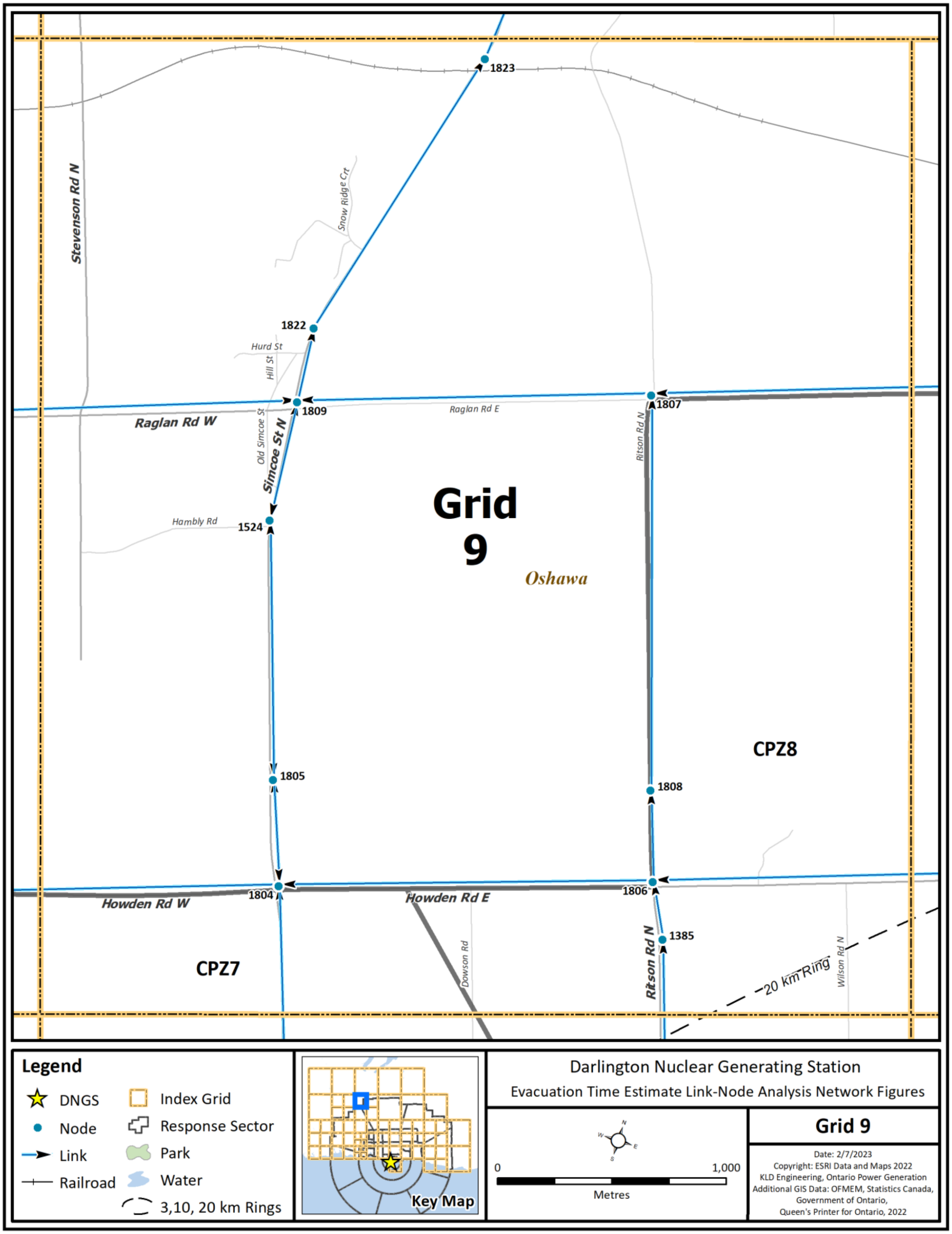



**Figure K-10. Link-Node Analysis Network – Grid 9**

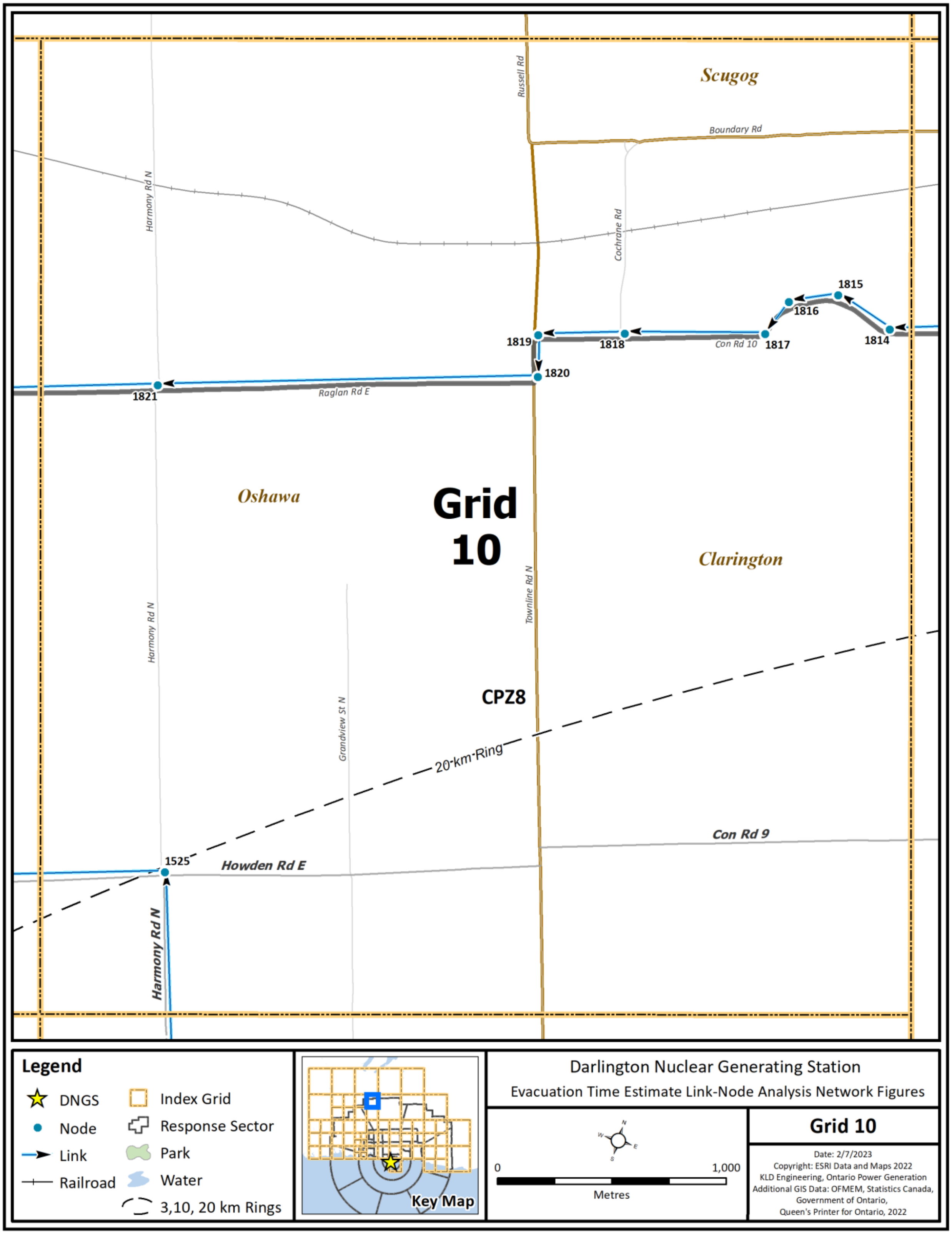



**Figure K-11. Link-Node Analysis Network – Grid 10**

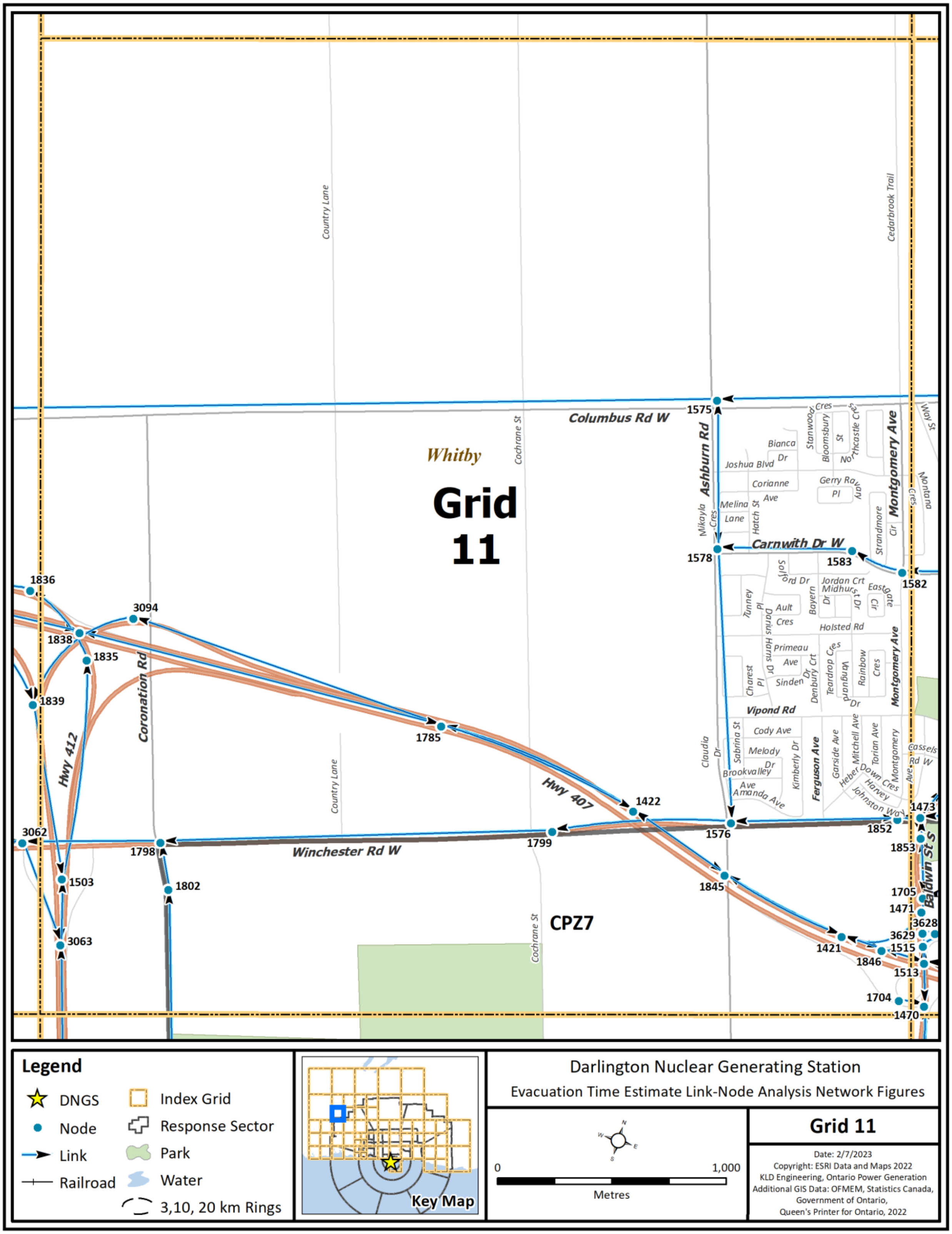



**Figure K-12. Link-Node Analysis Network – Grid 11**

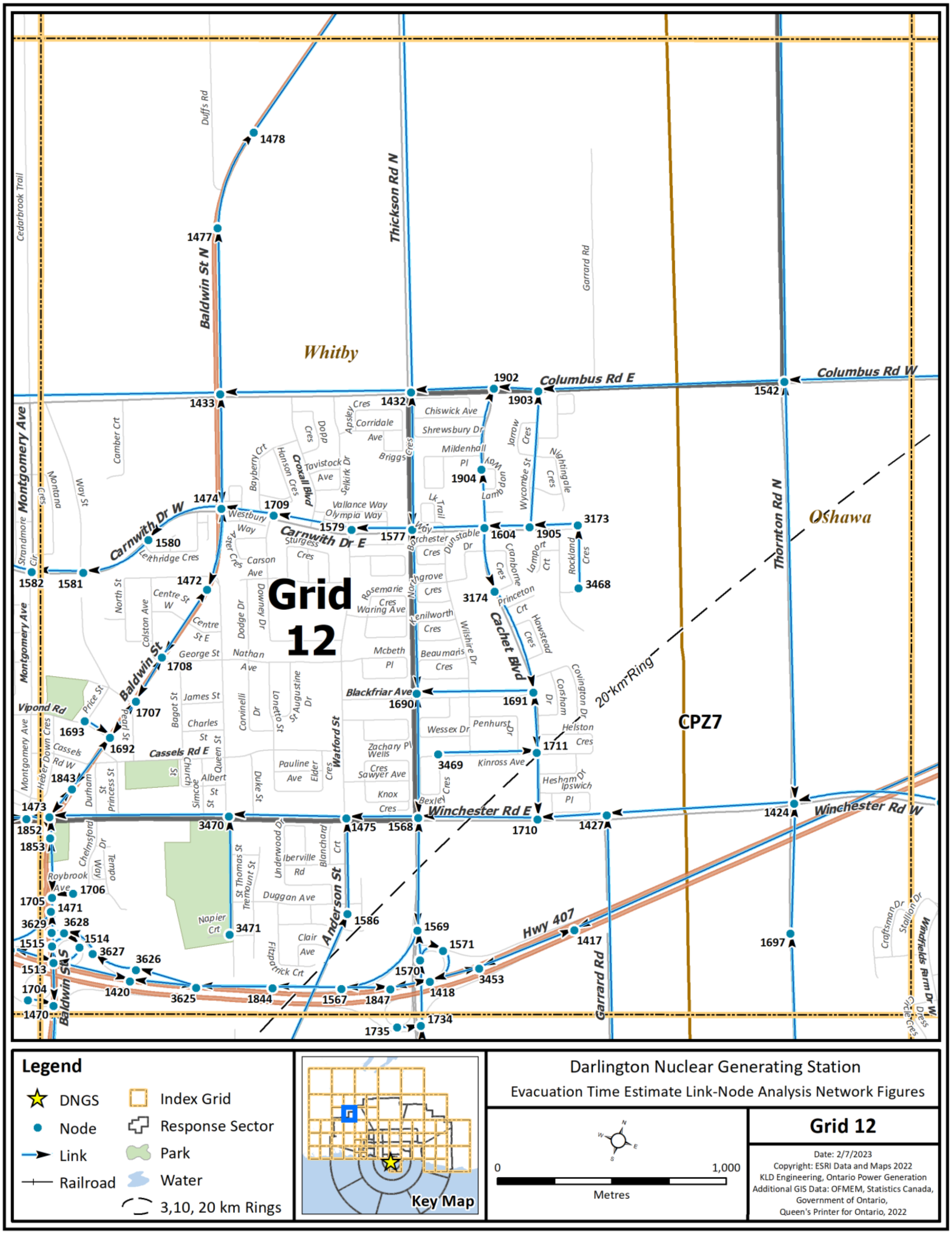



**Figure K-13. Link-Node Analysis Network – Grid 12**

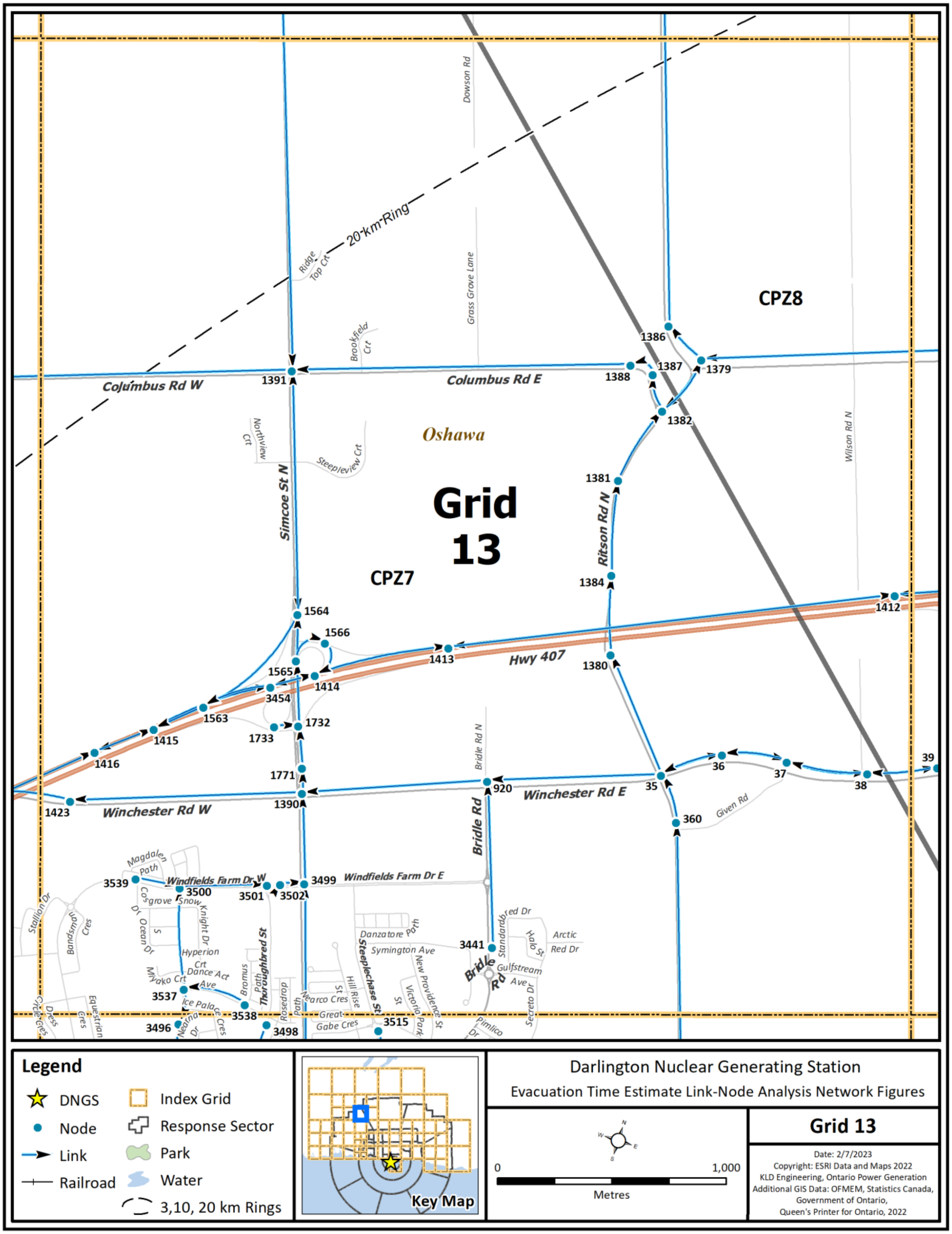



**Figure K-14. Link-Node Analysis Network – Grid 13**

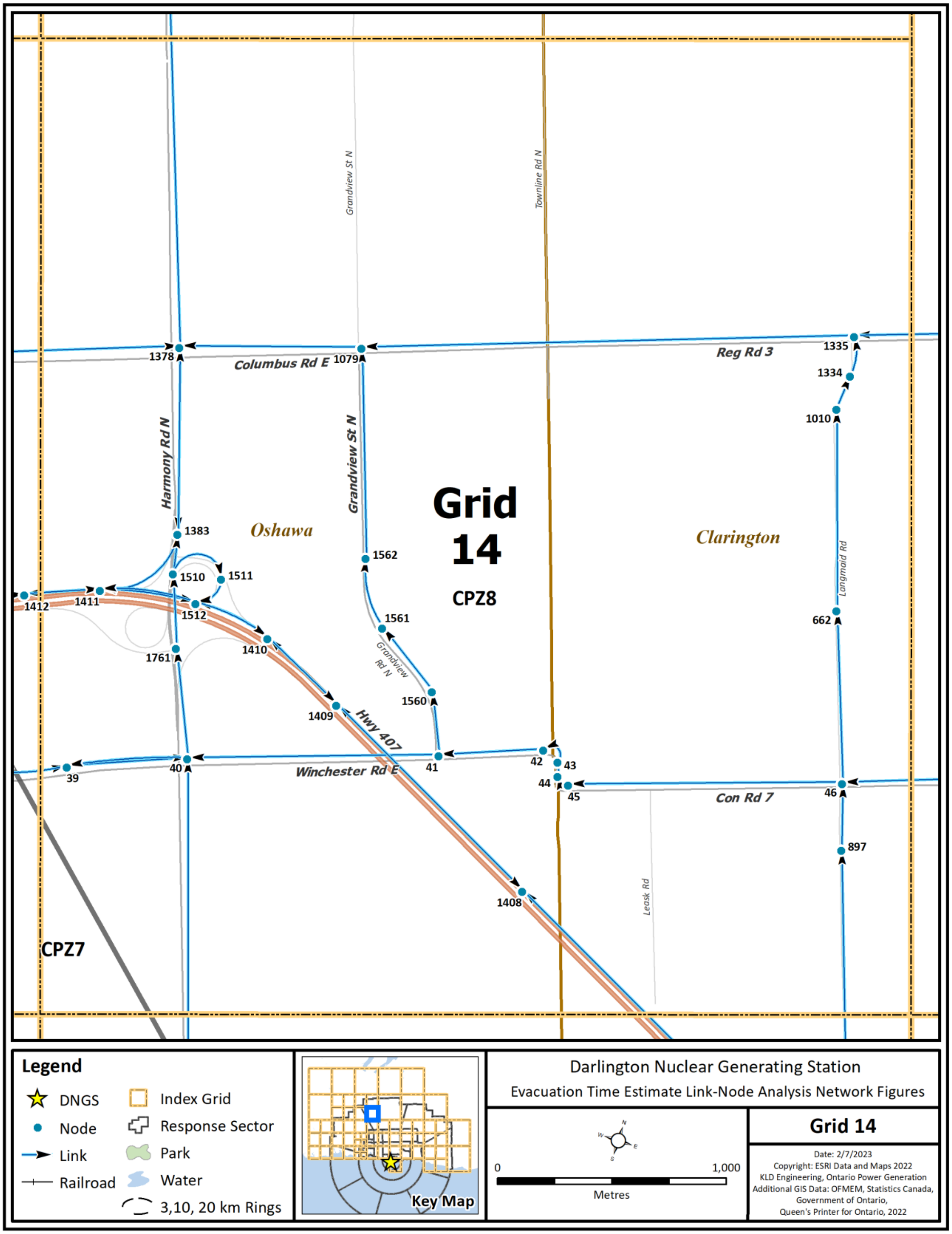
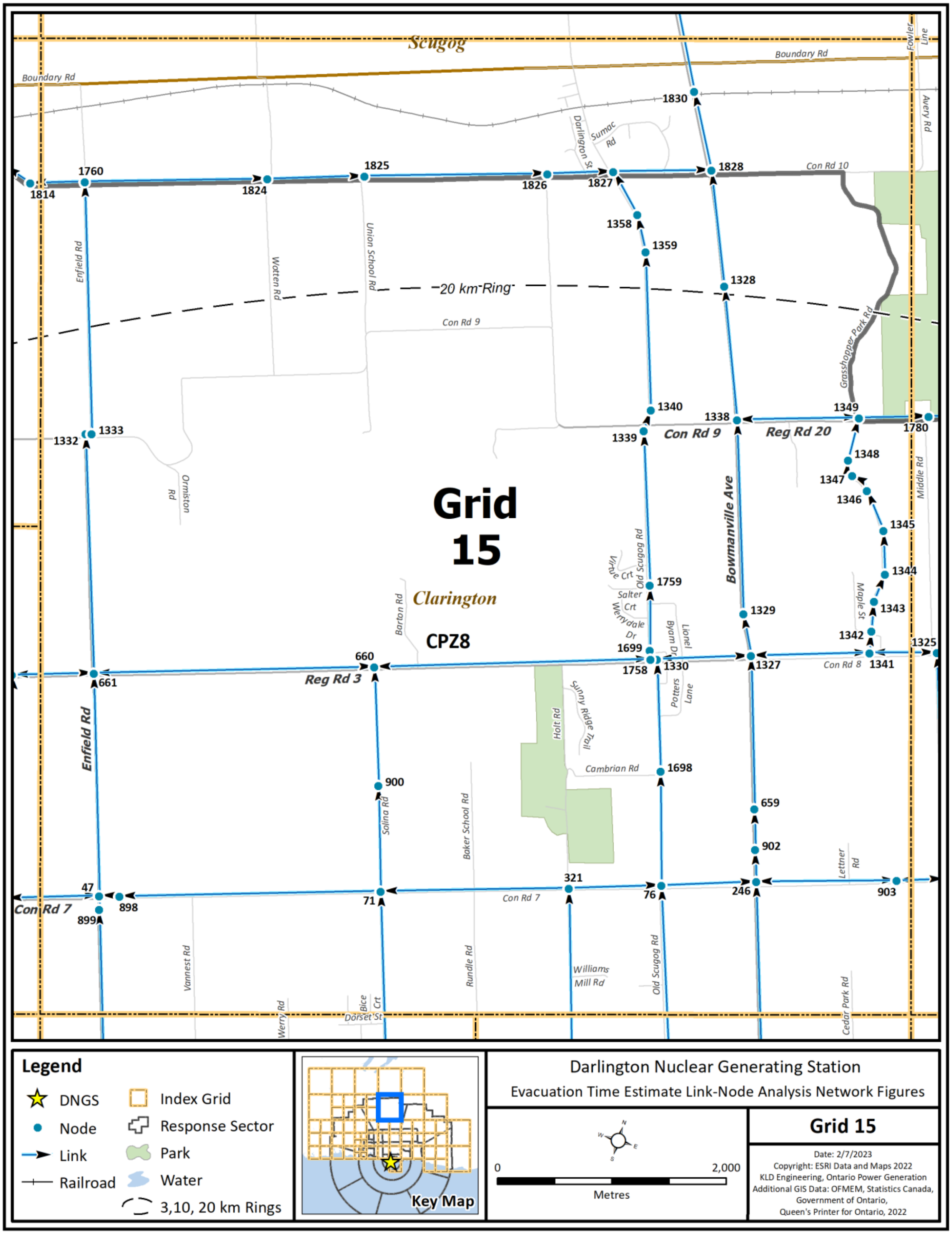



**Figure K-15. Link-Node Analysis Network – Grid 14**

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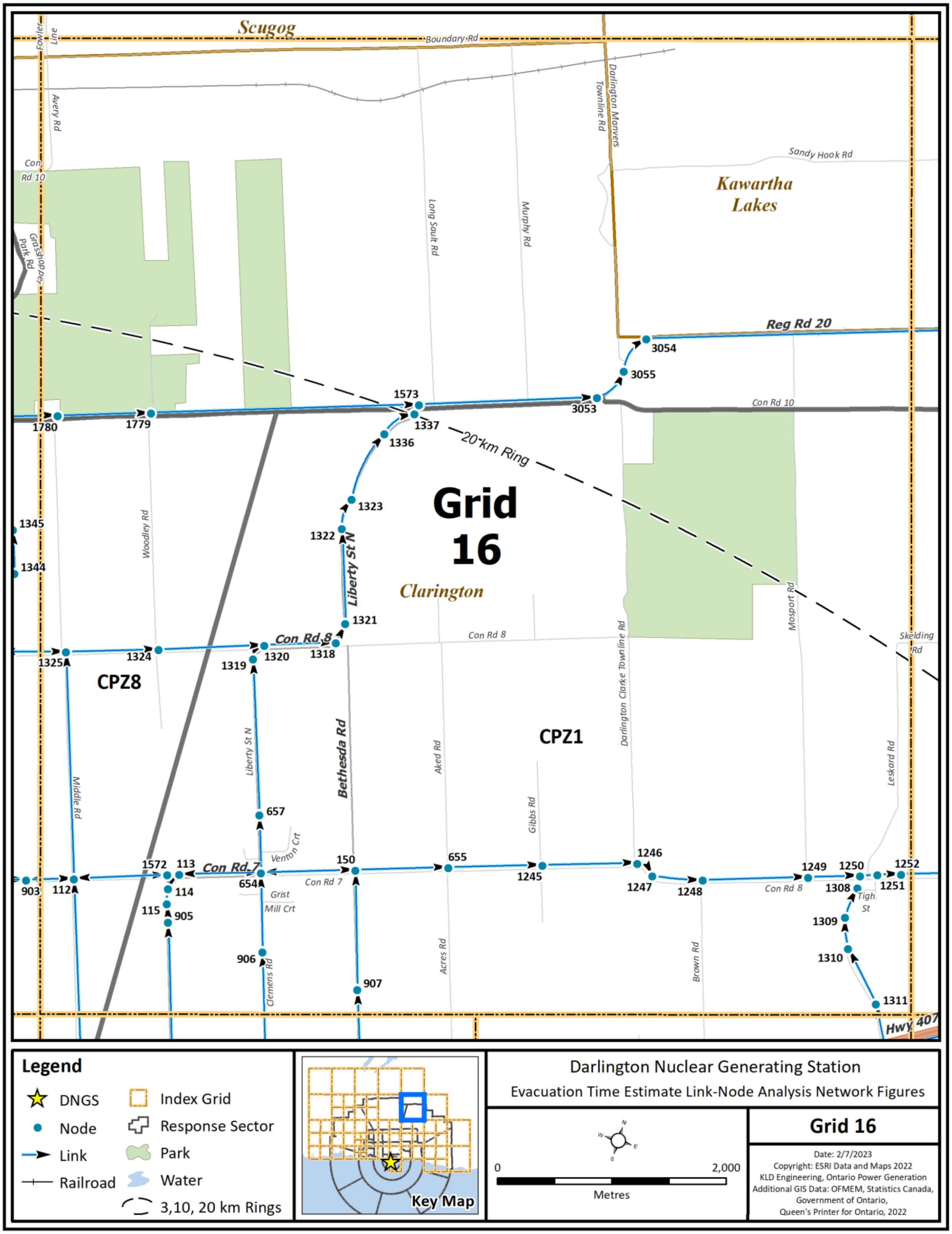


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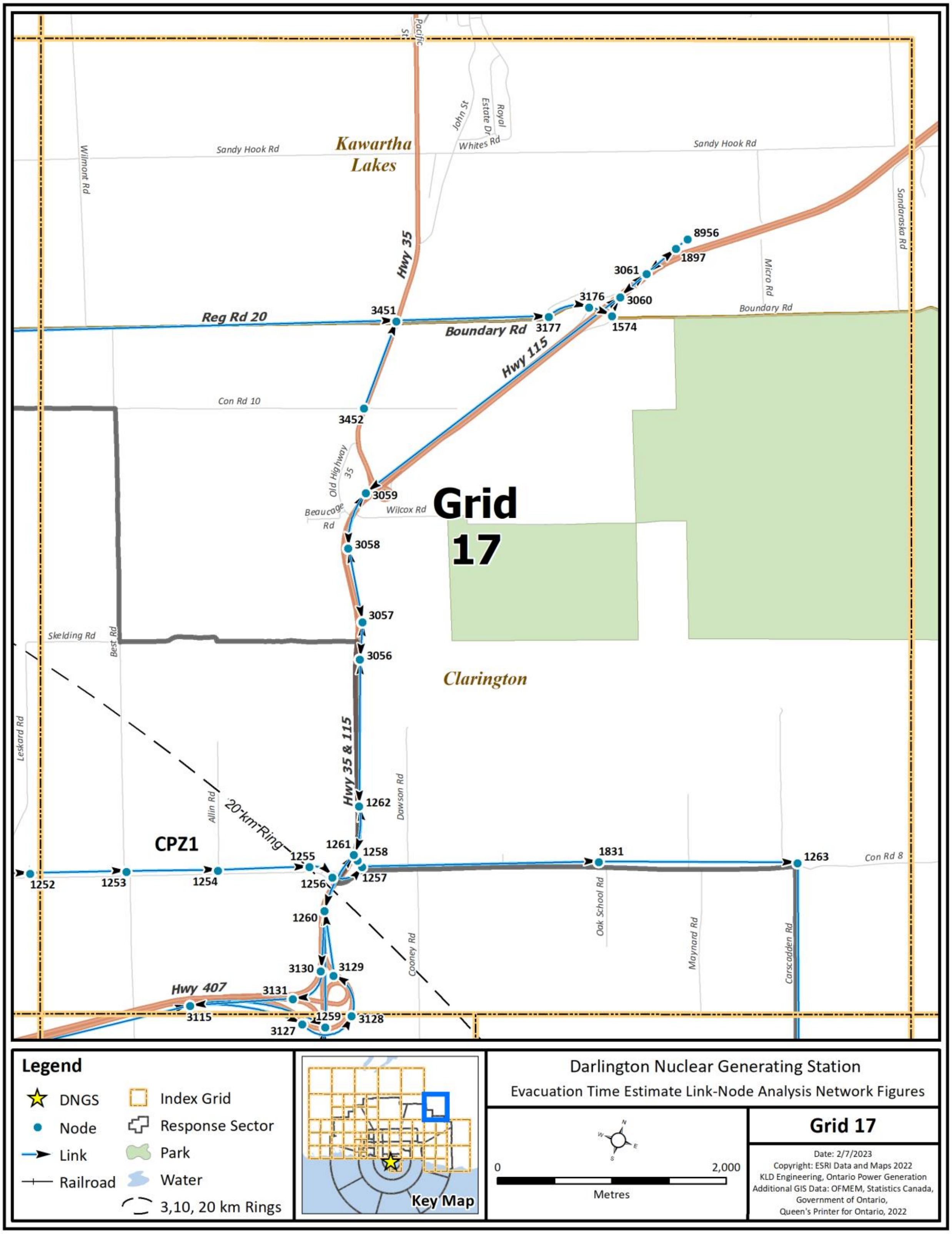


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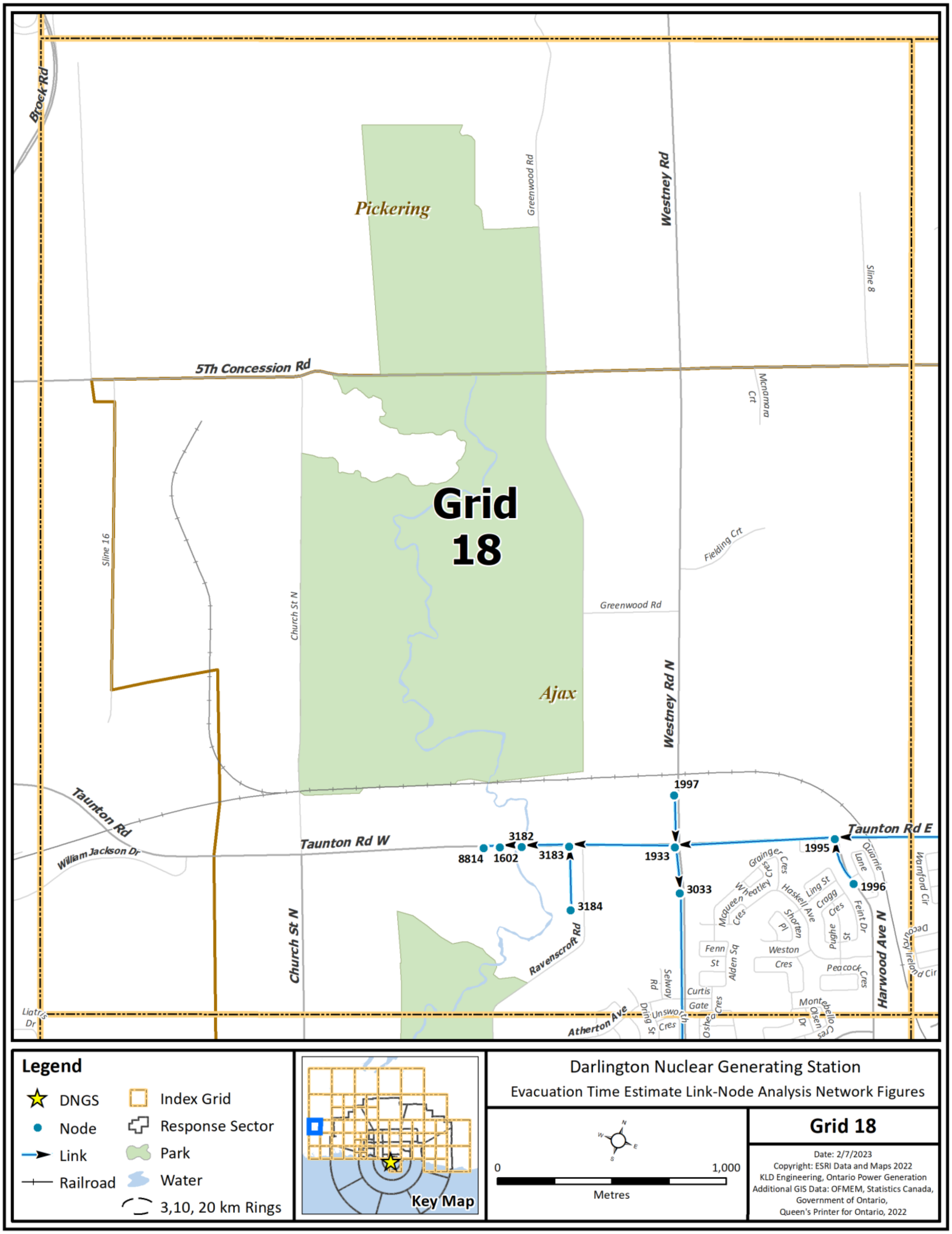


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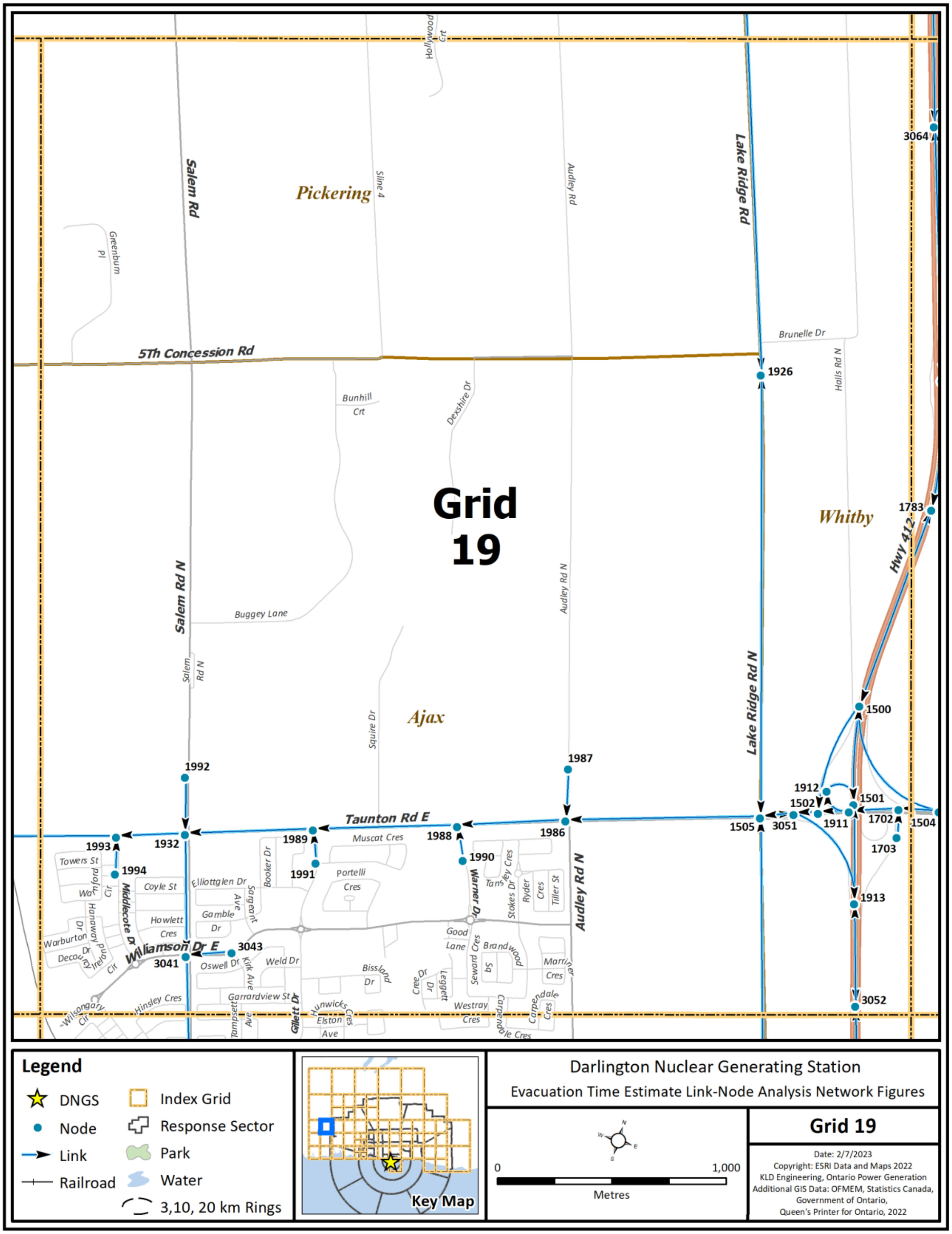


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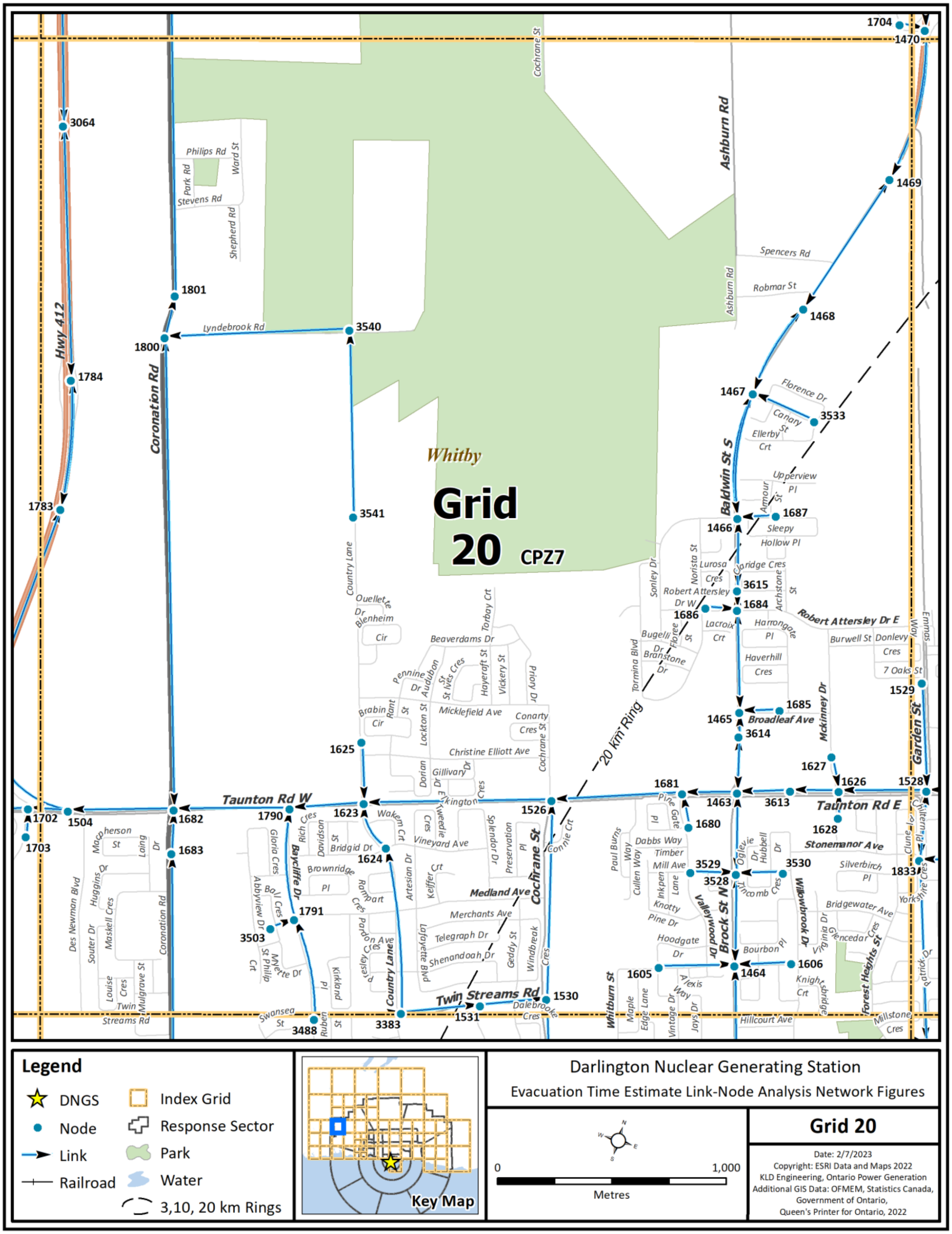


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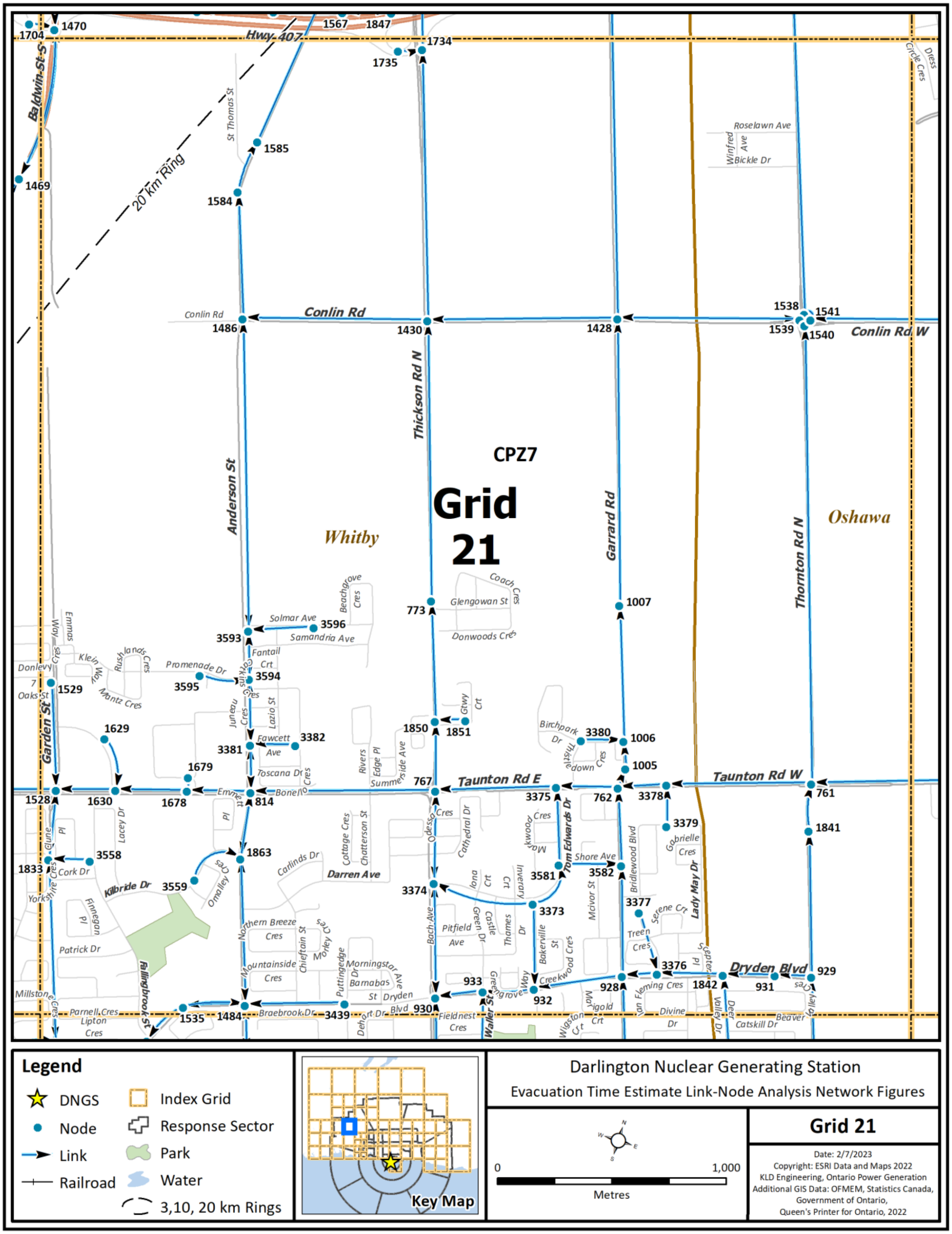


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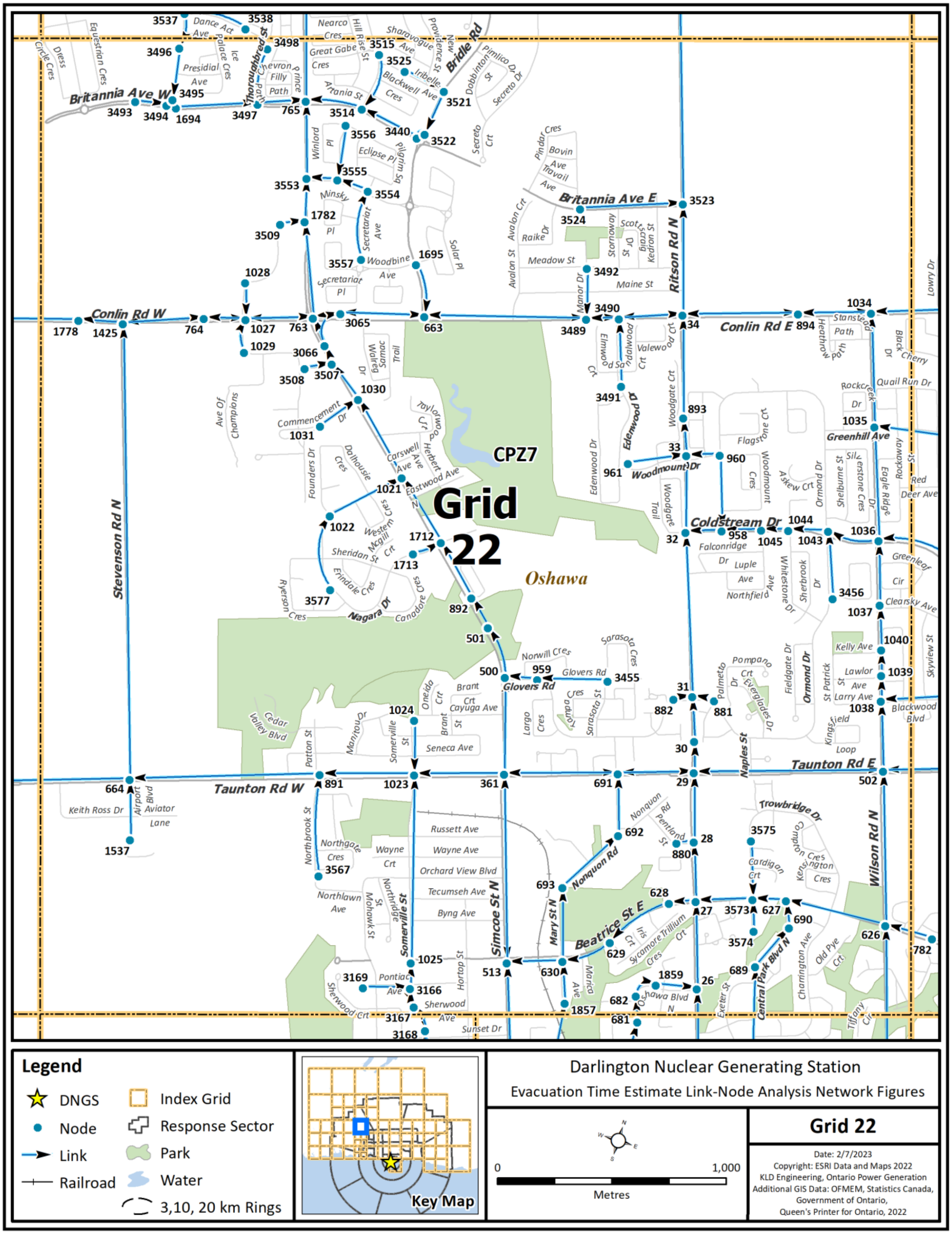


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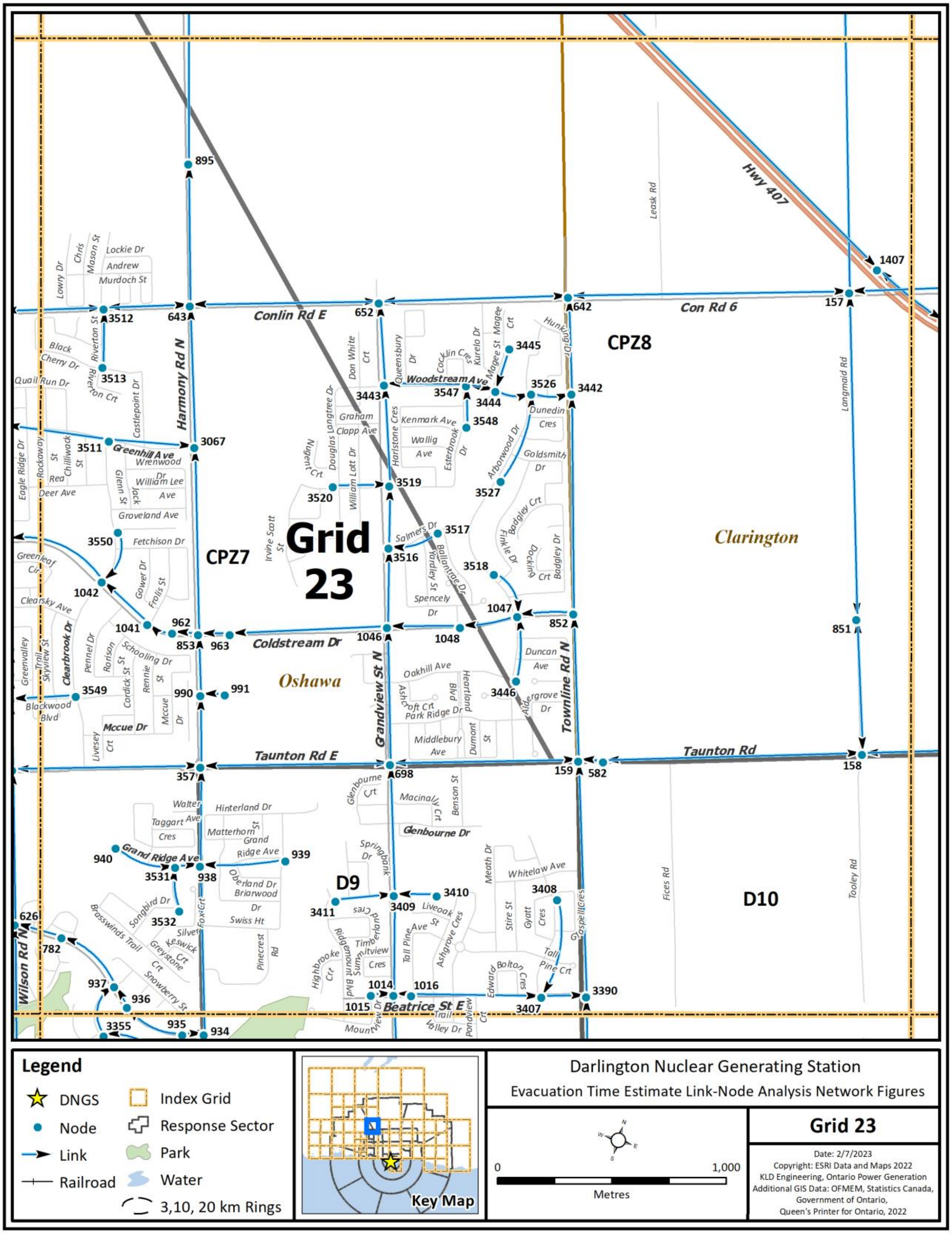


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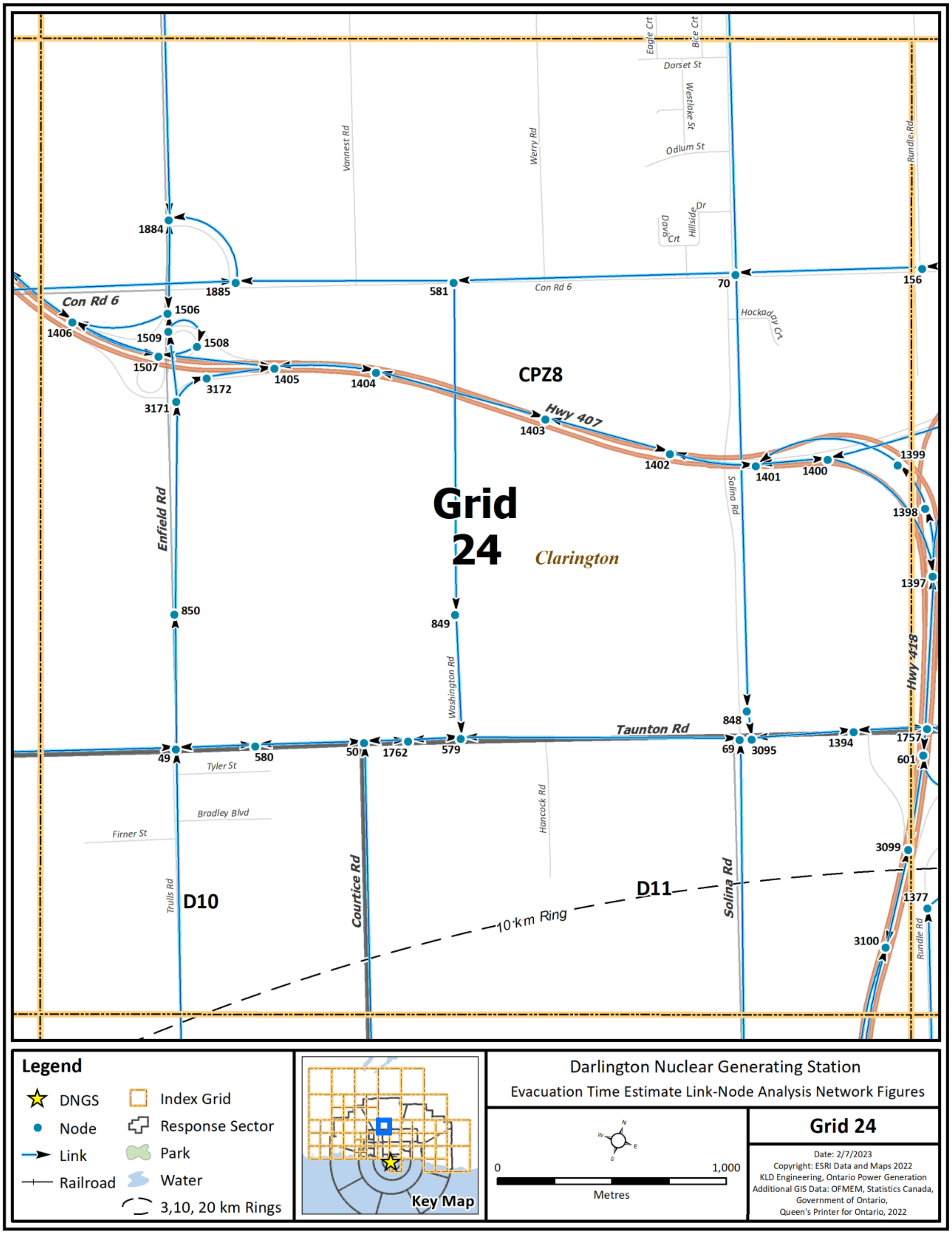


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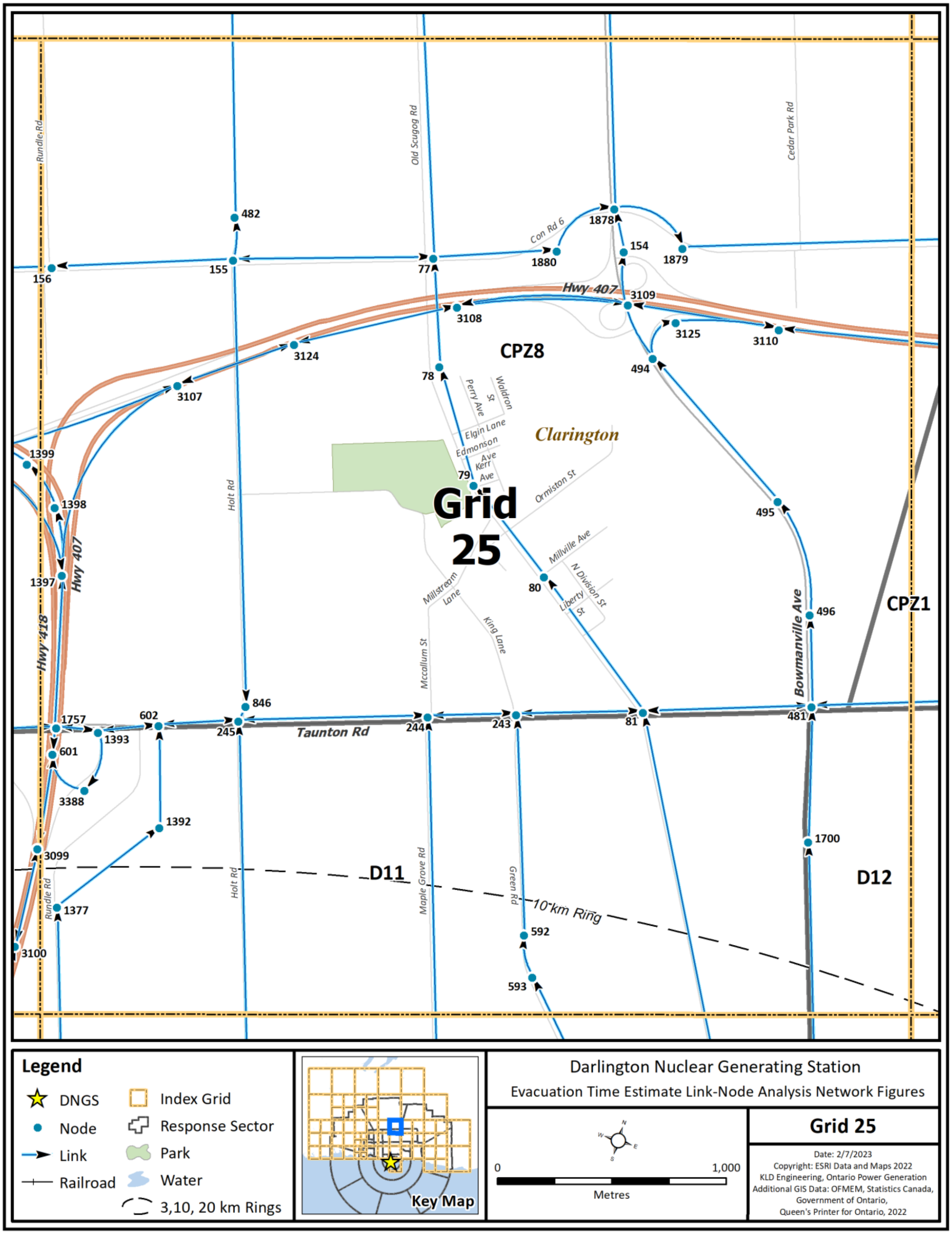


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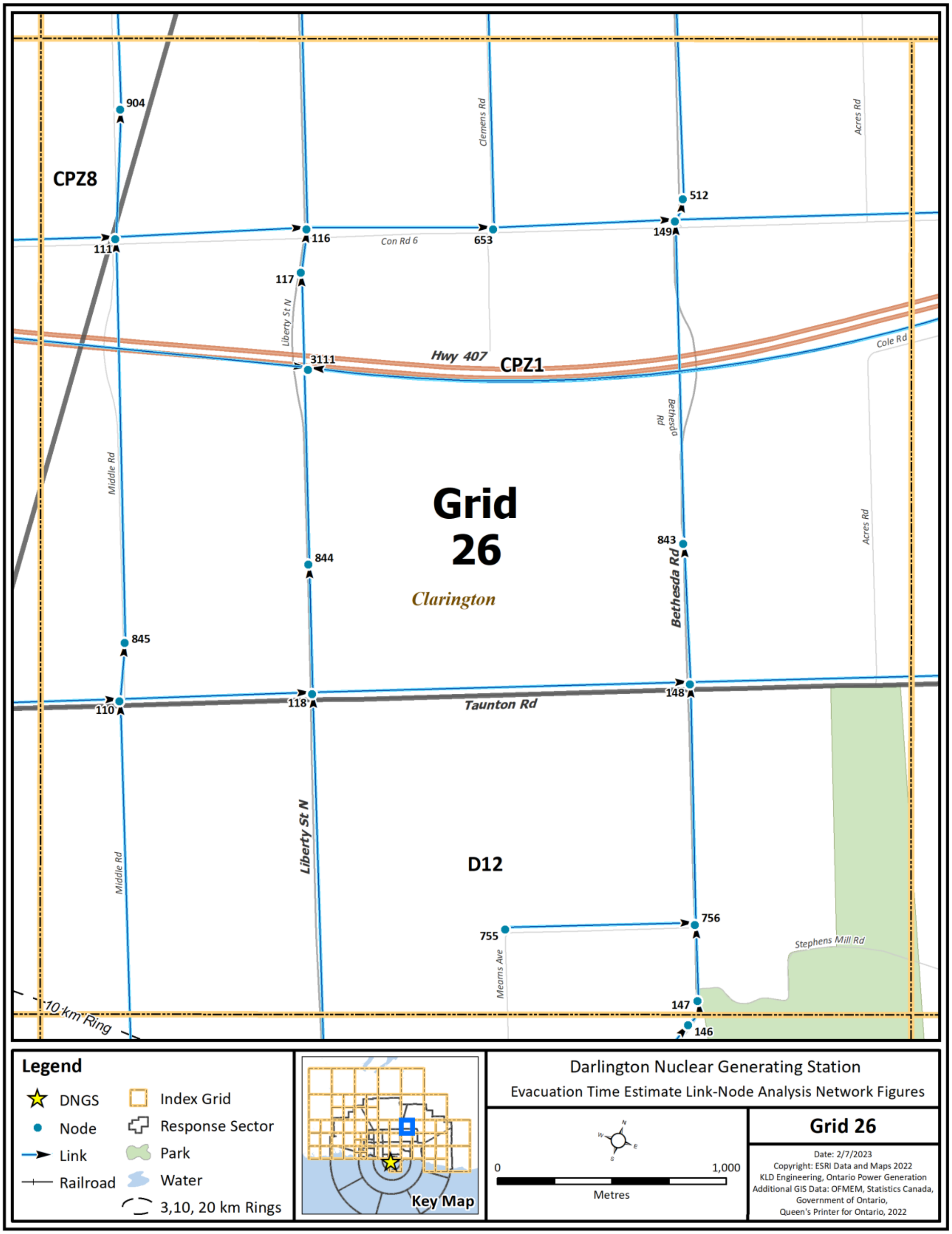


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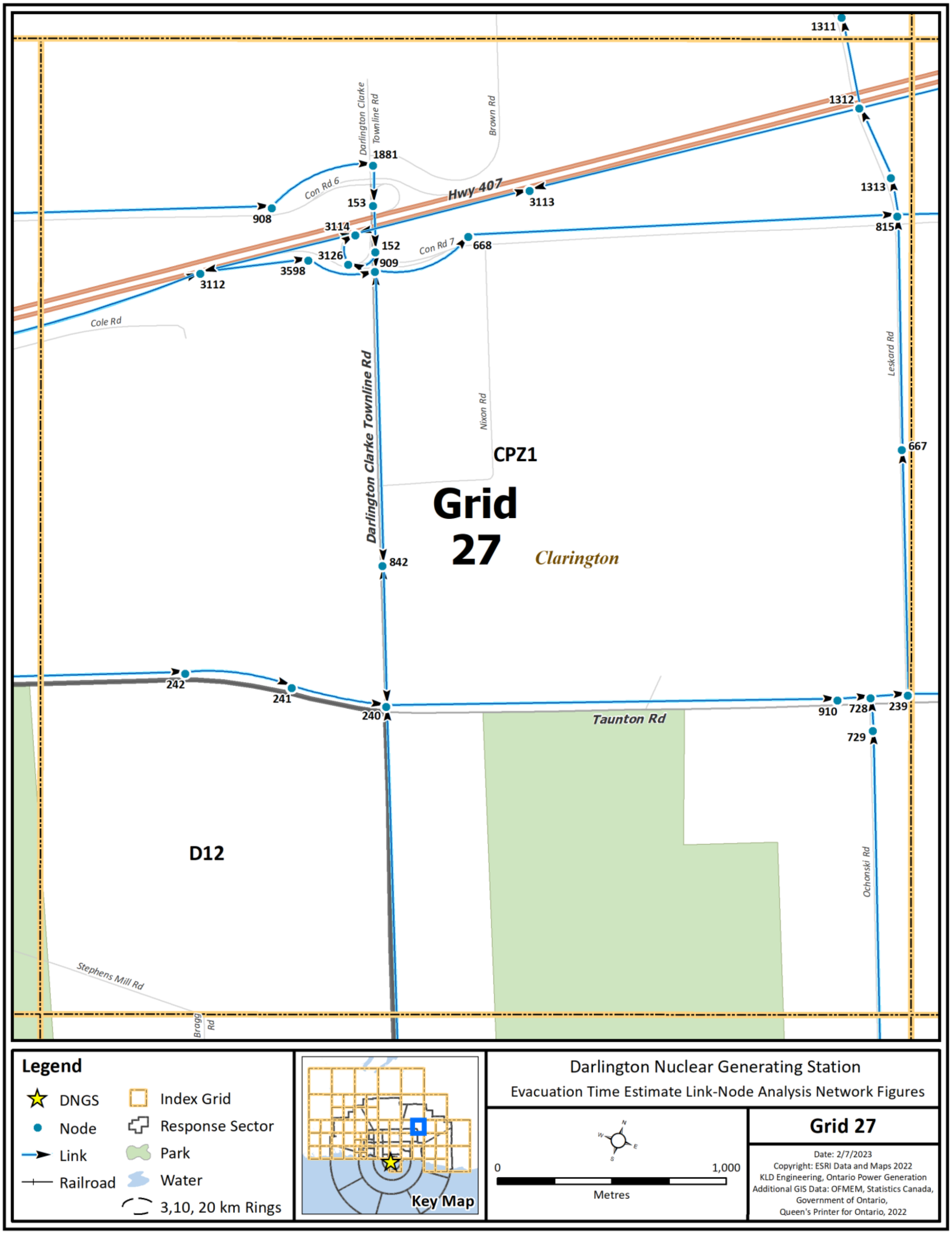


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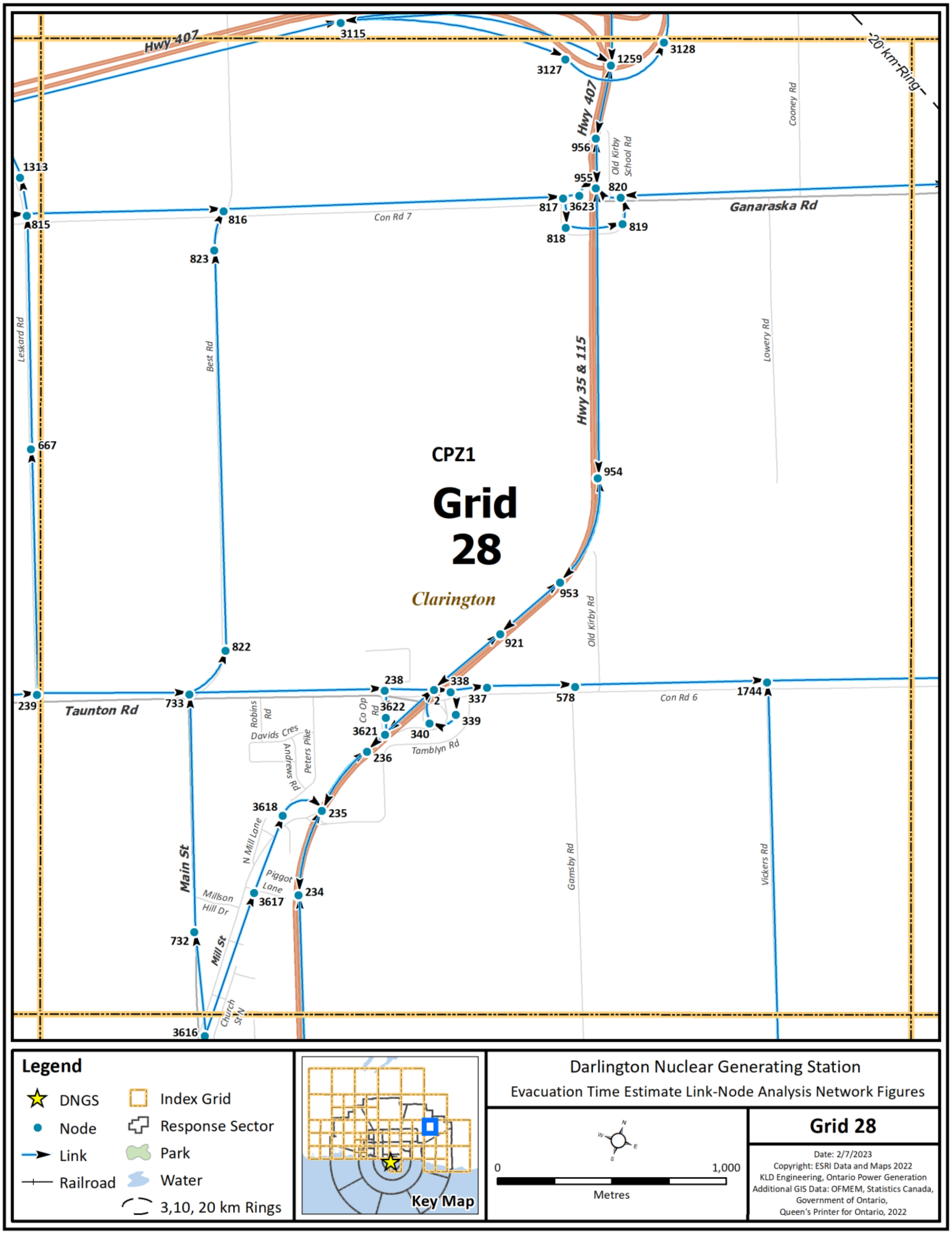


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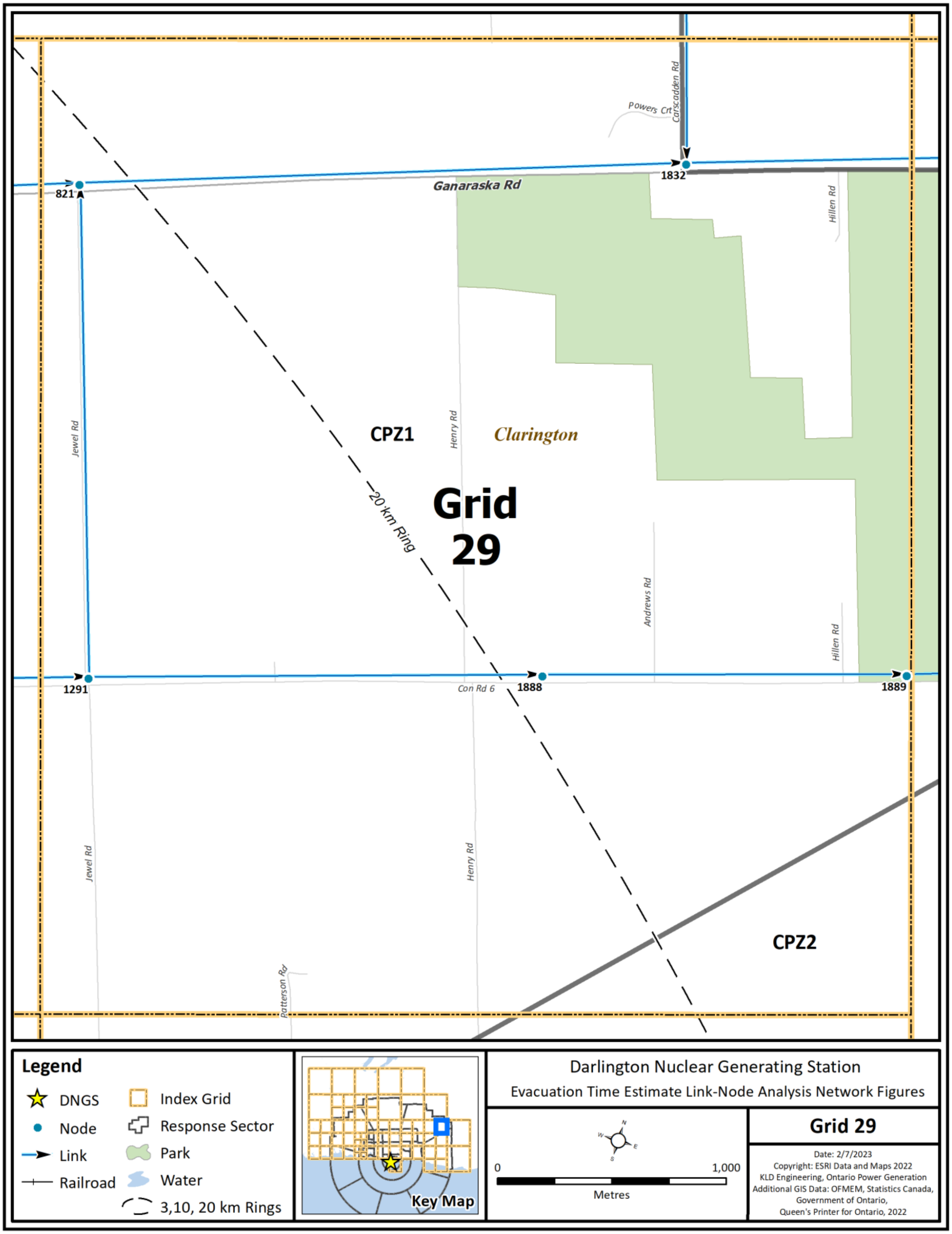


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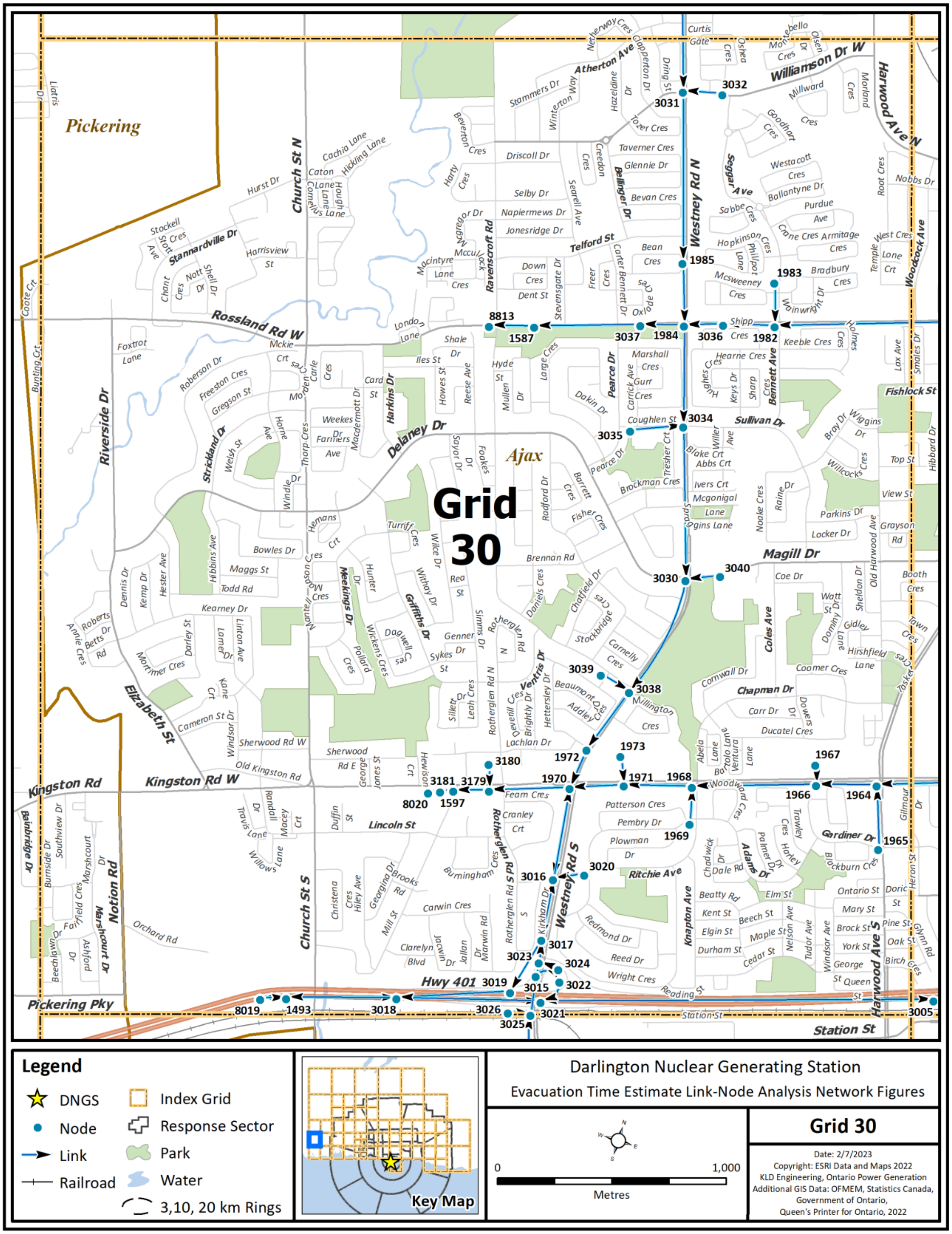


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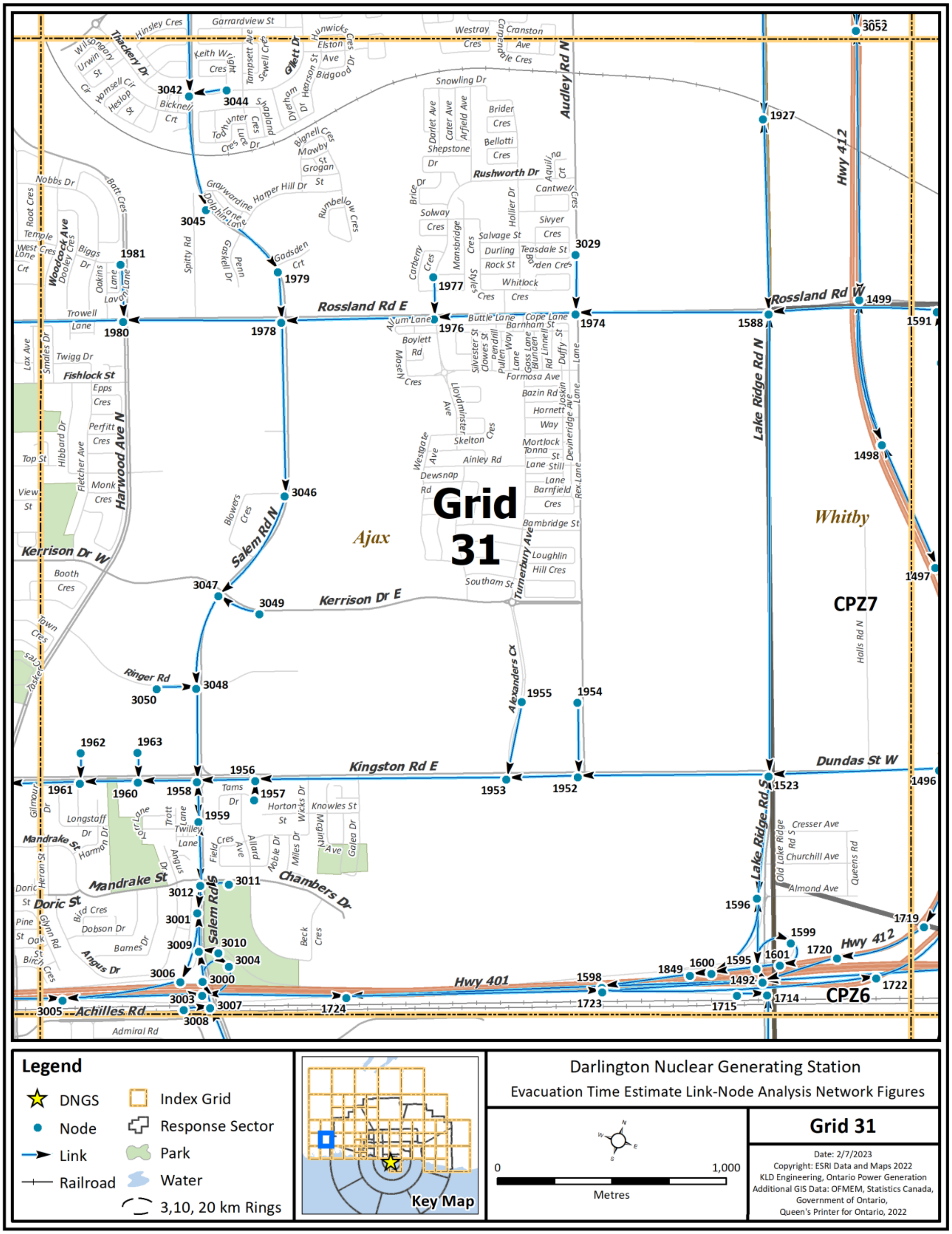


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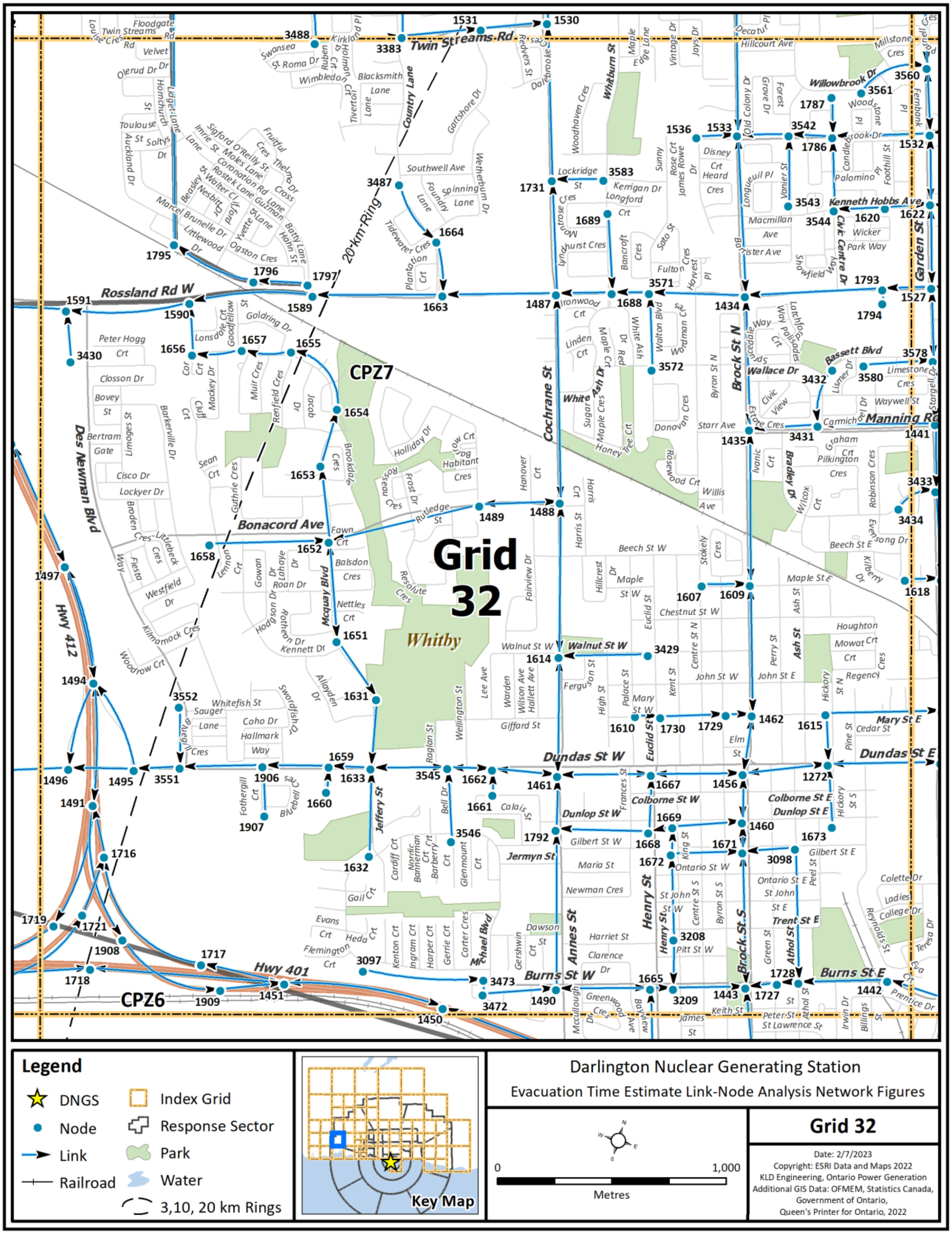


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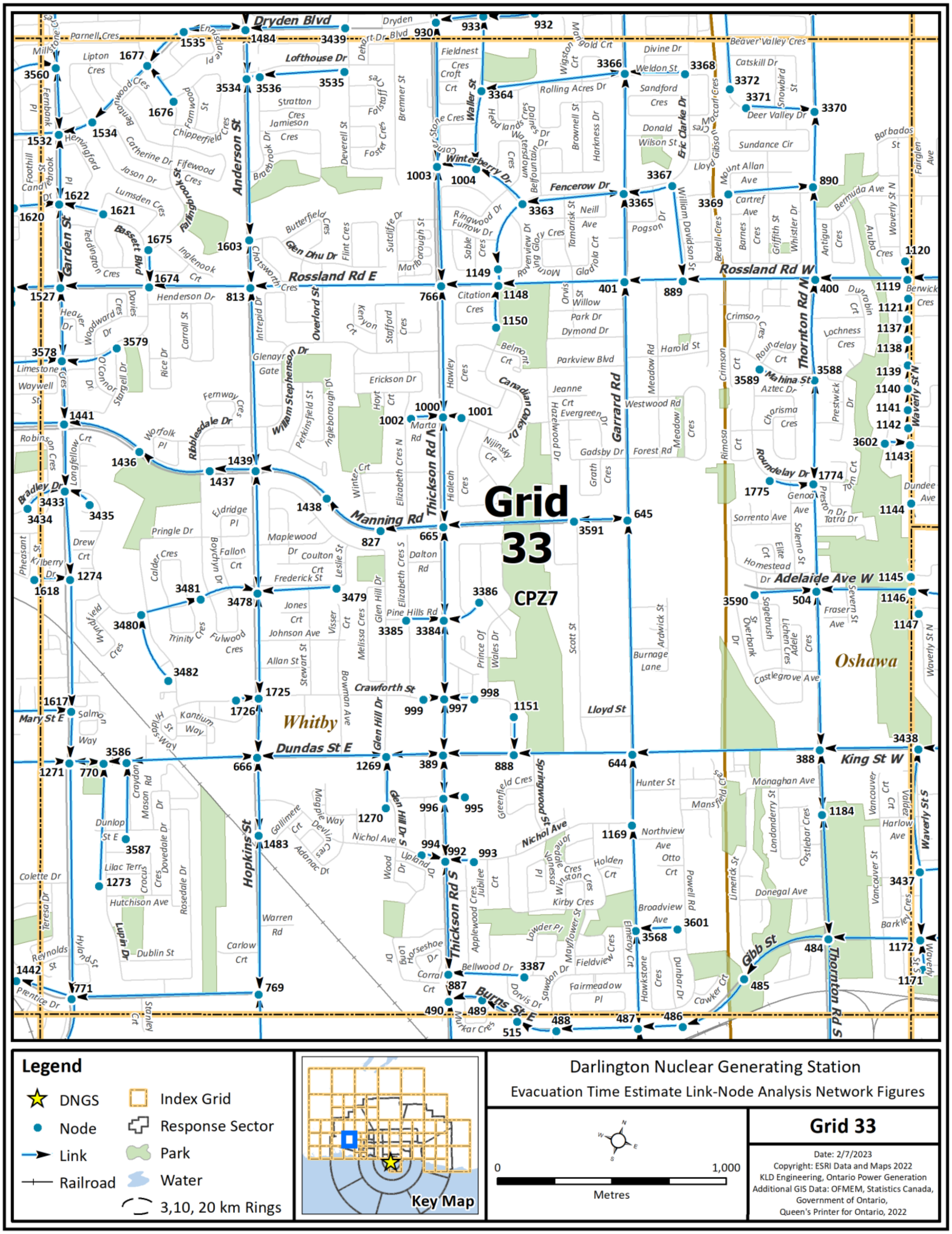


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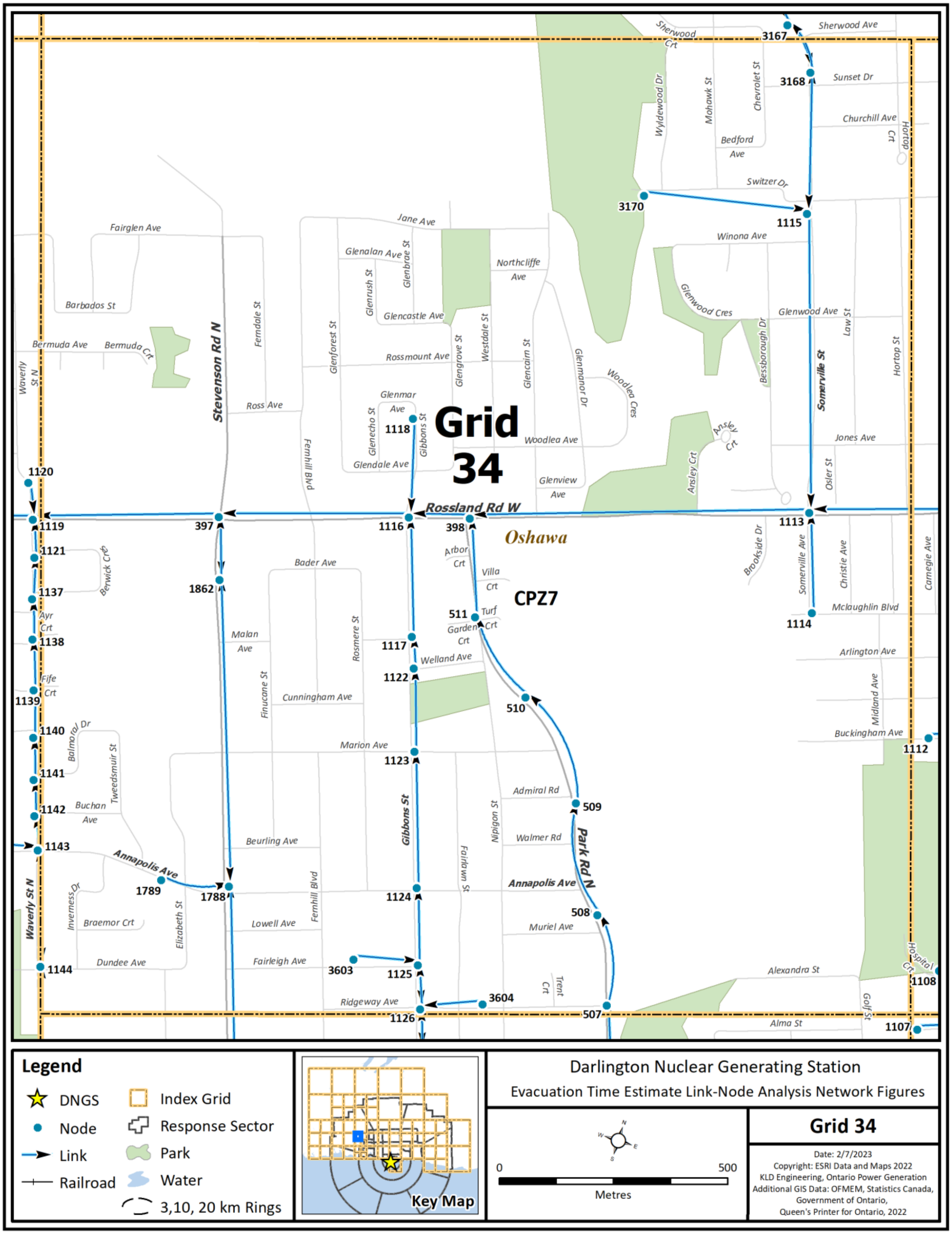


**Figure K-35. Link-Node Analysis Network – Grid 34**

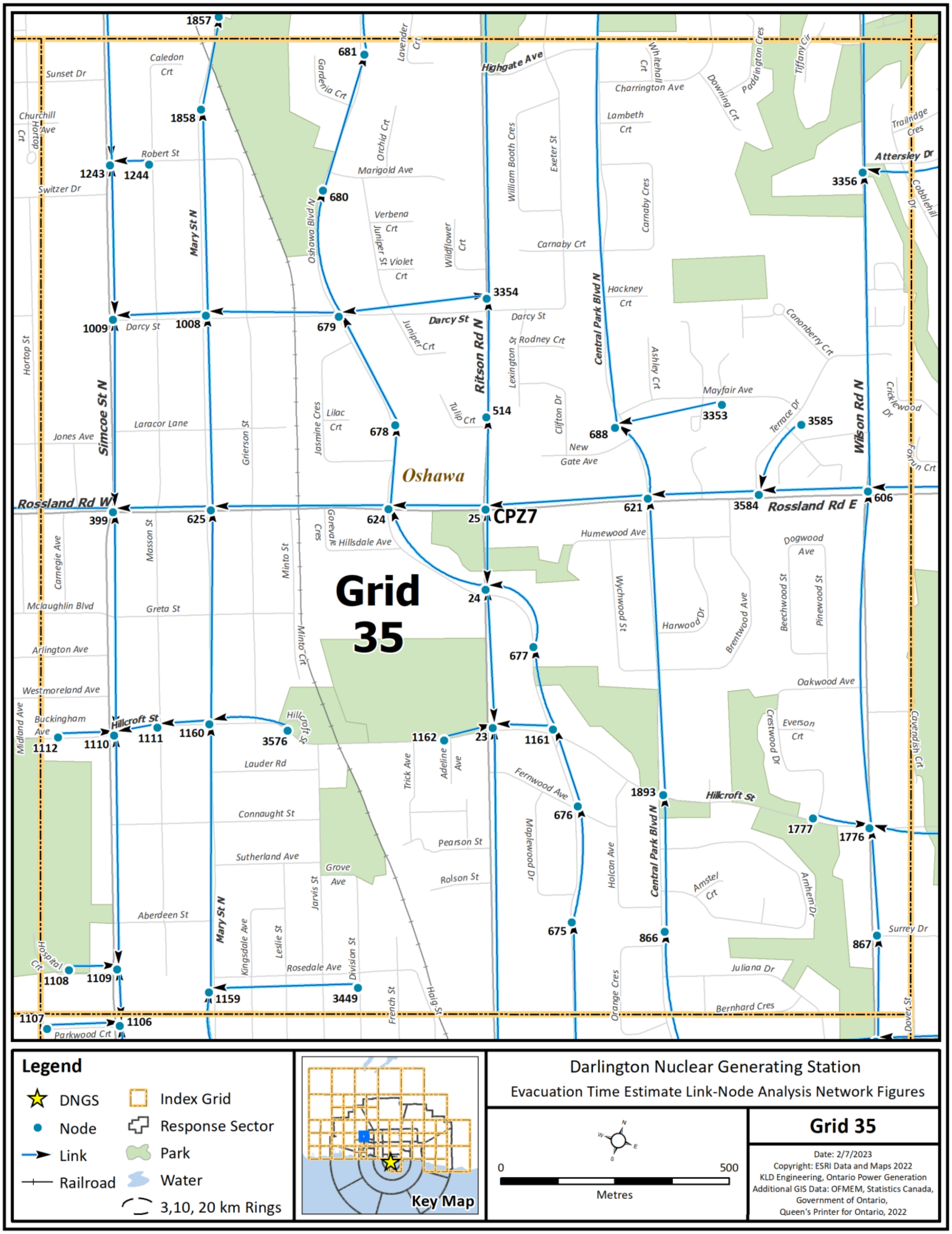


**Figure K-36. Link-Node Analysis Network – Grid 35**

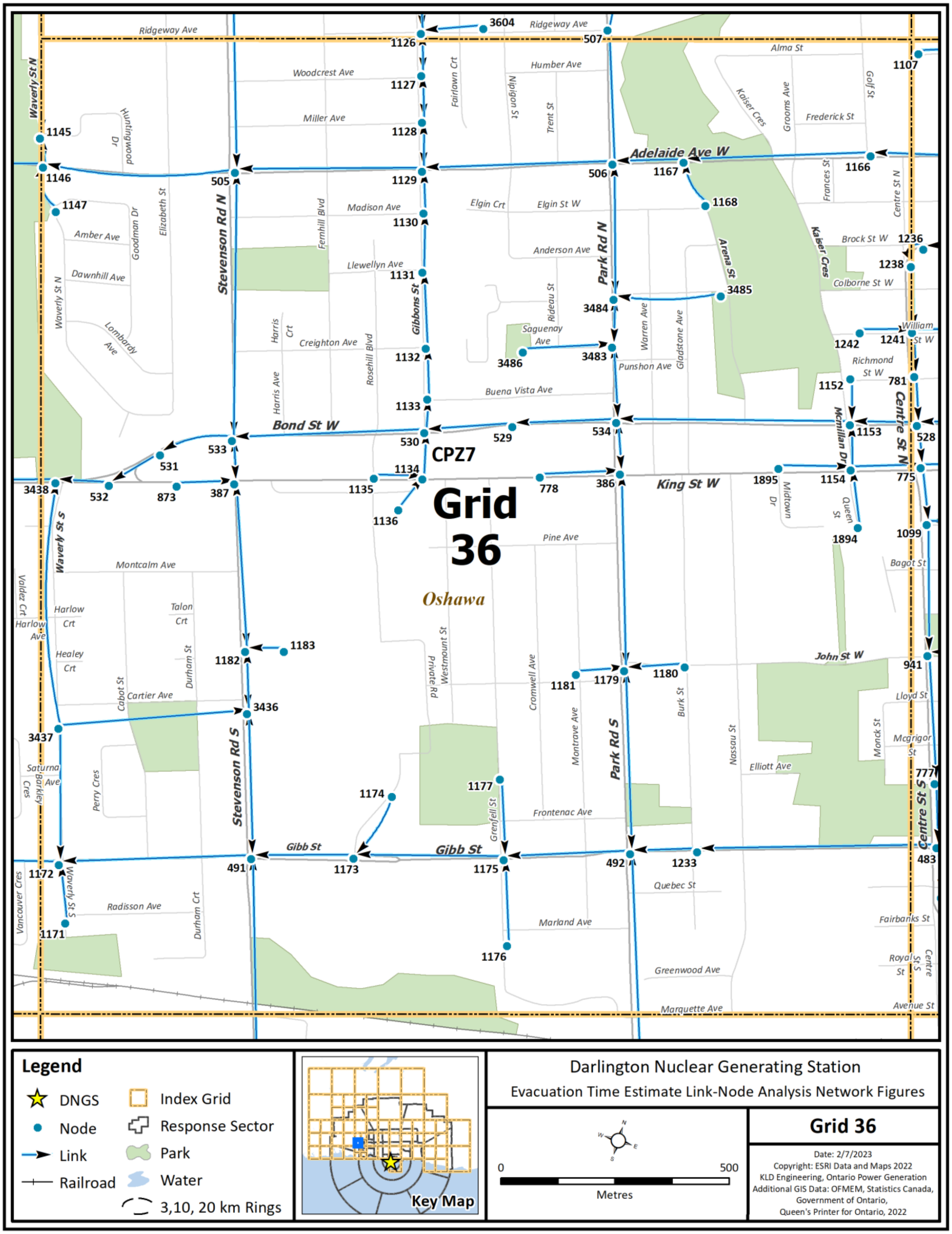


**Figure K-37. Link-Node Analysis Network – Grid 36**

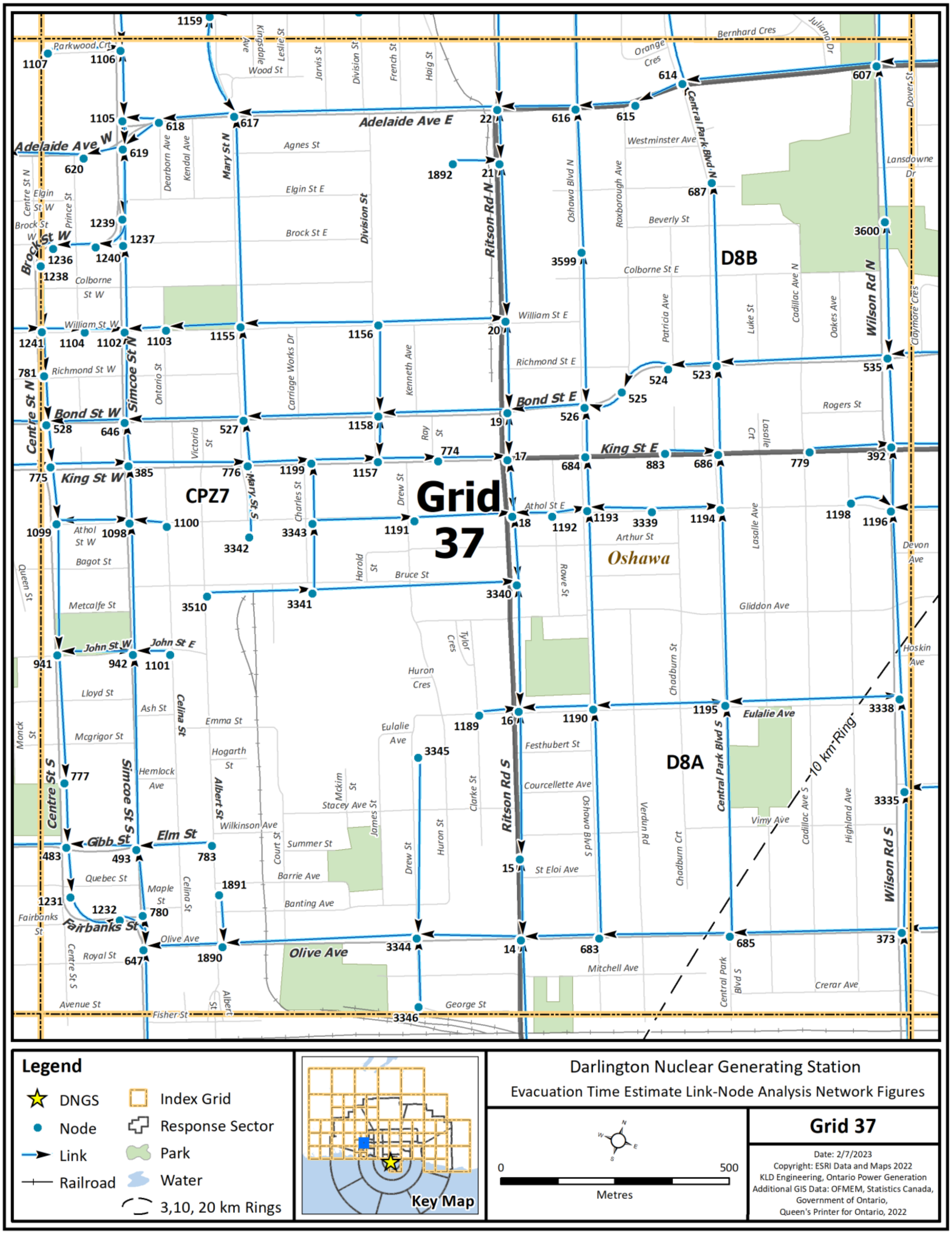


**Figure K-38. Link-Node Analysis Network – Grid 37**

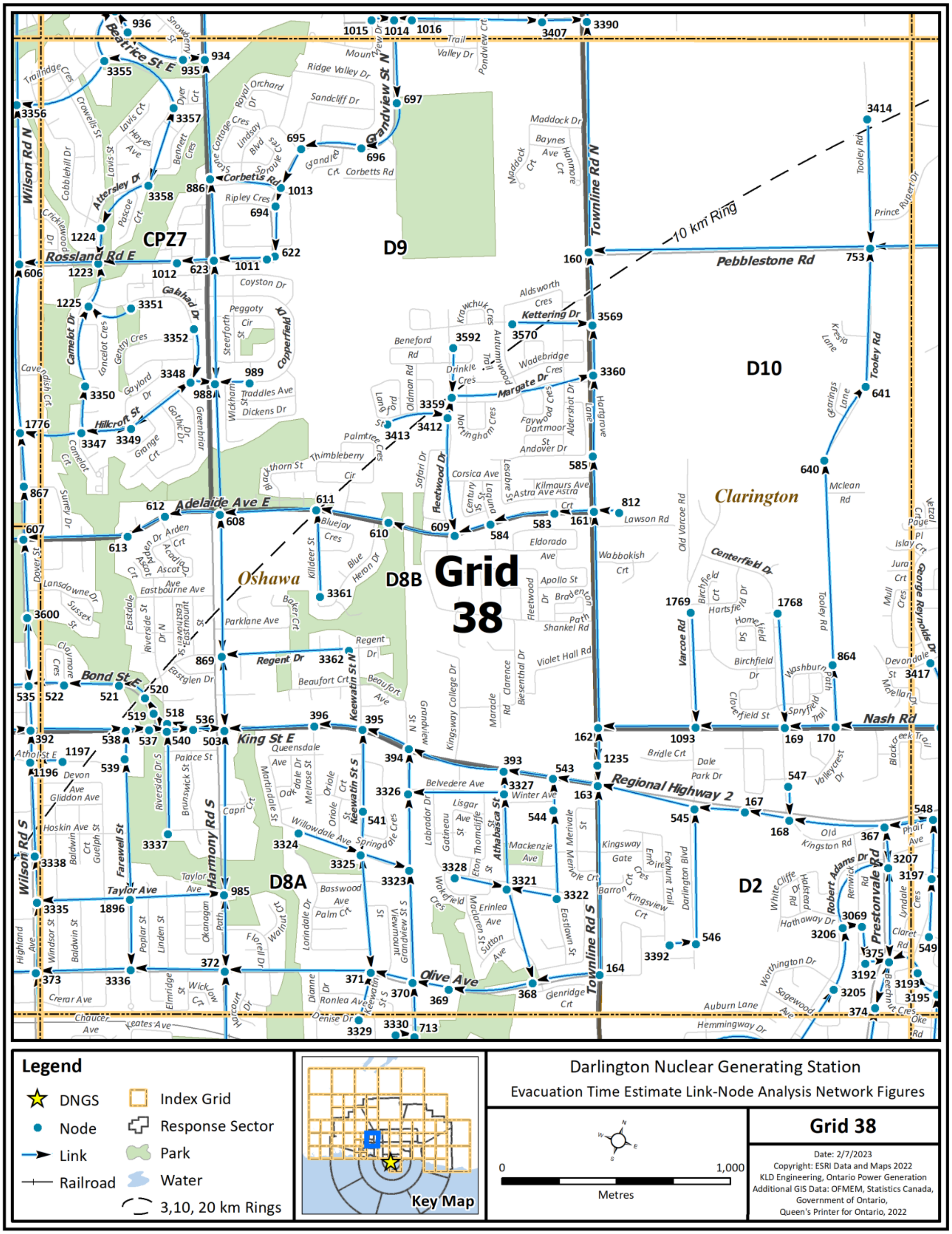


**Figure K-39. Link-Node Analysis Network – Grid 38**

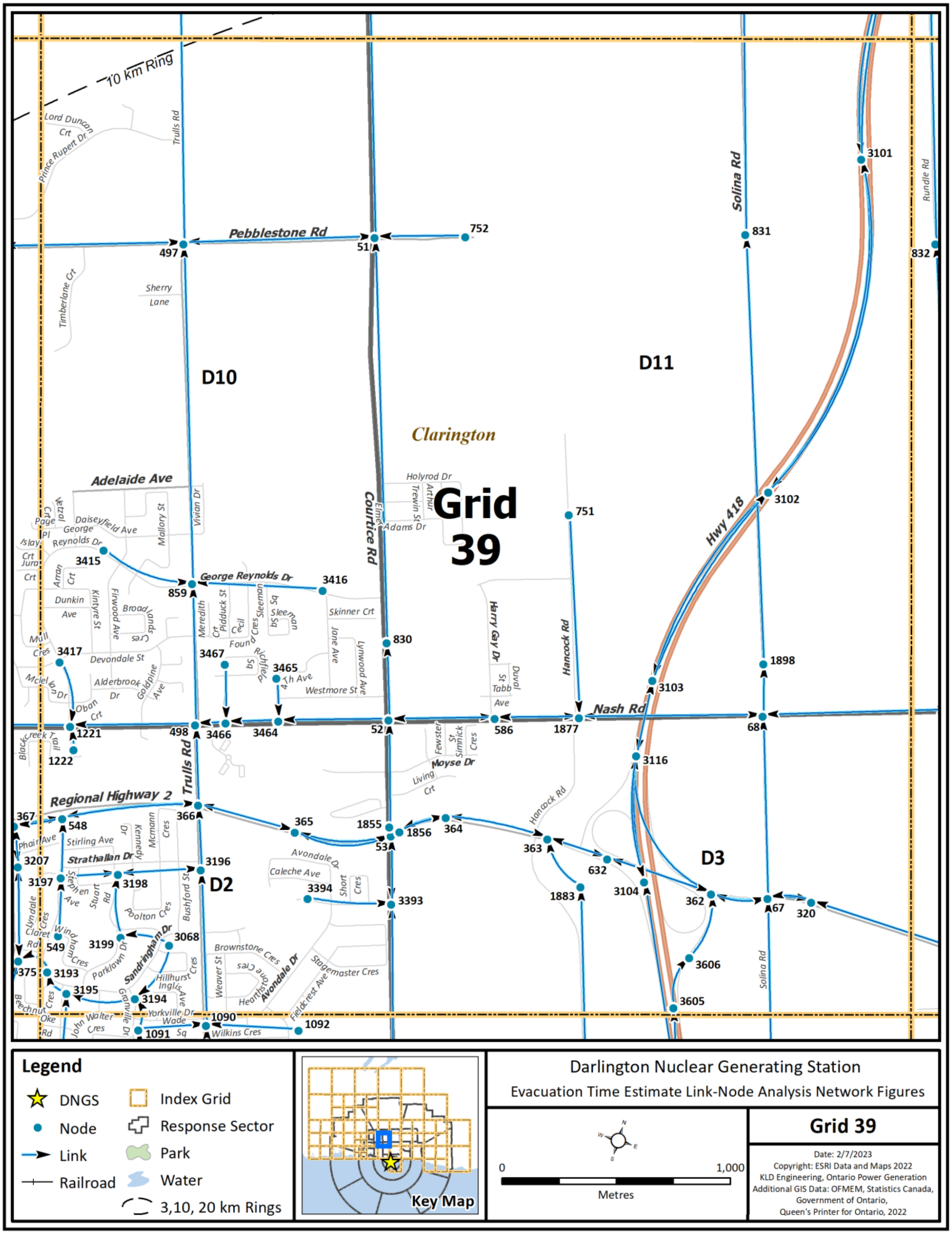


**Figure K-40. Link-Node Analysis Network – Grid 39**

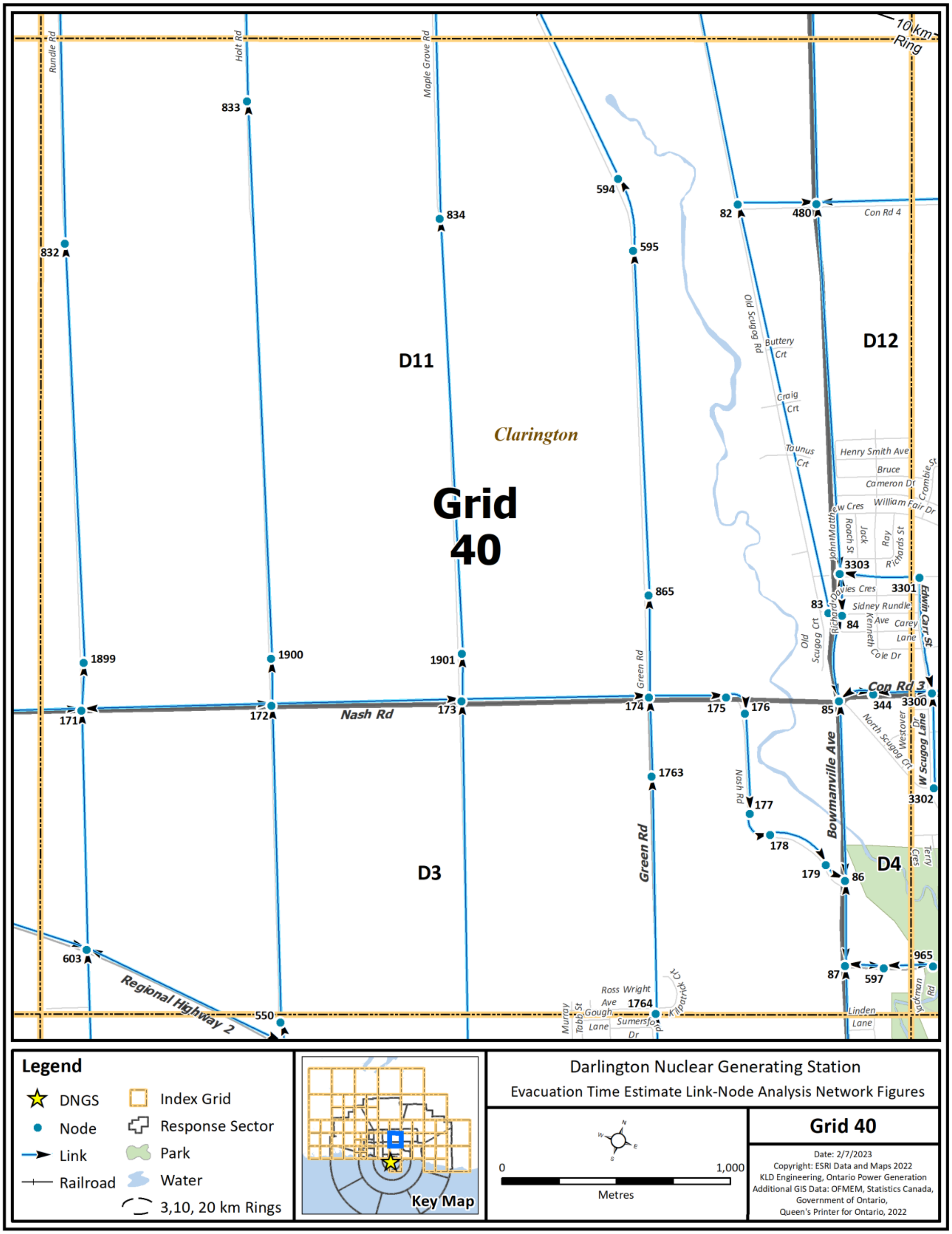


**Figure K-41. Link-Node Analysis Network – Grid 40**

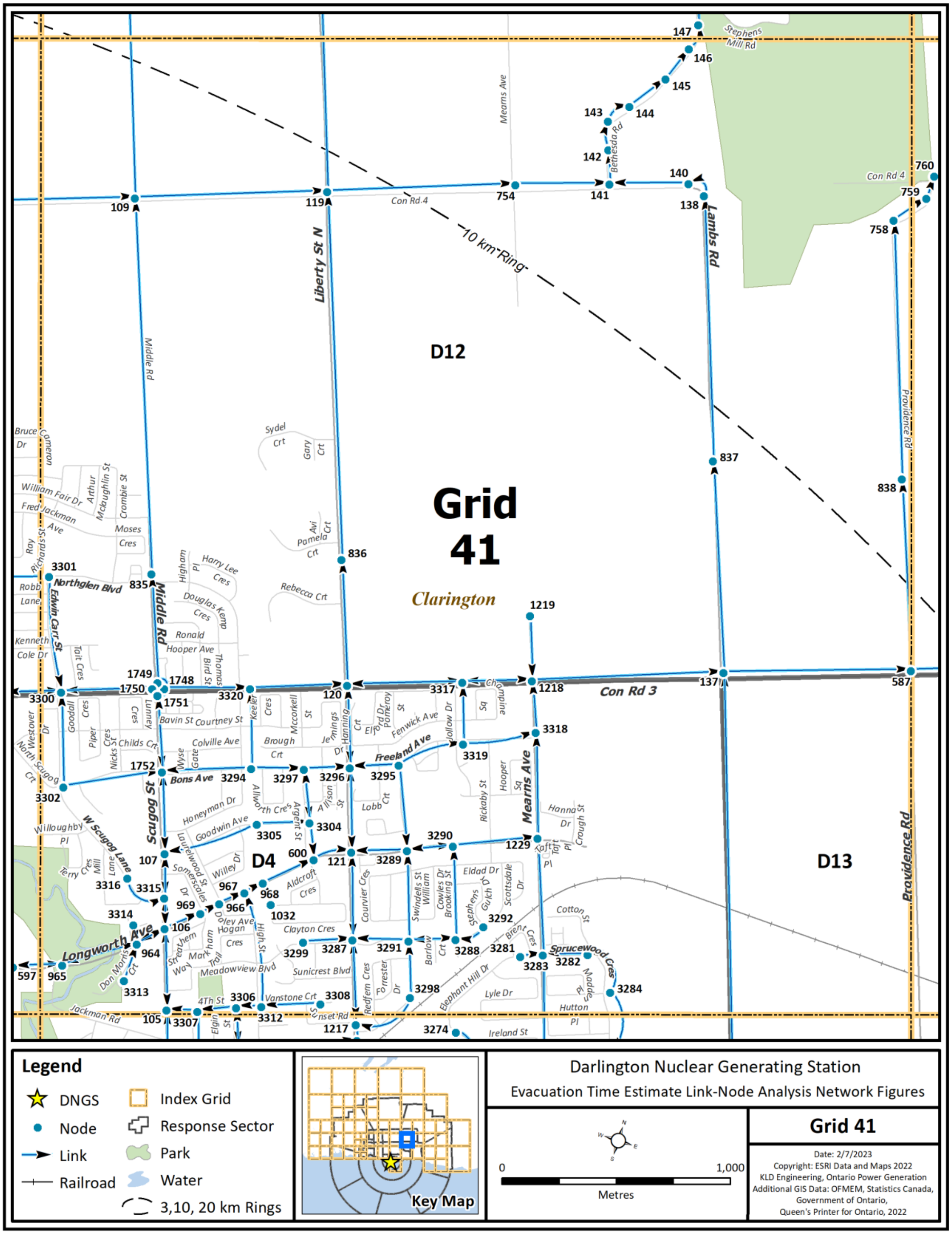


**Figure K-42. Link-Node Analysis Network – Grid 41**

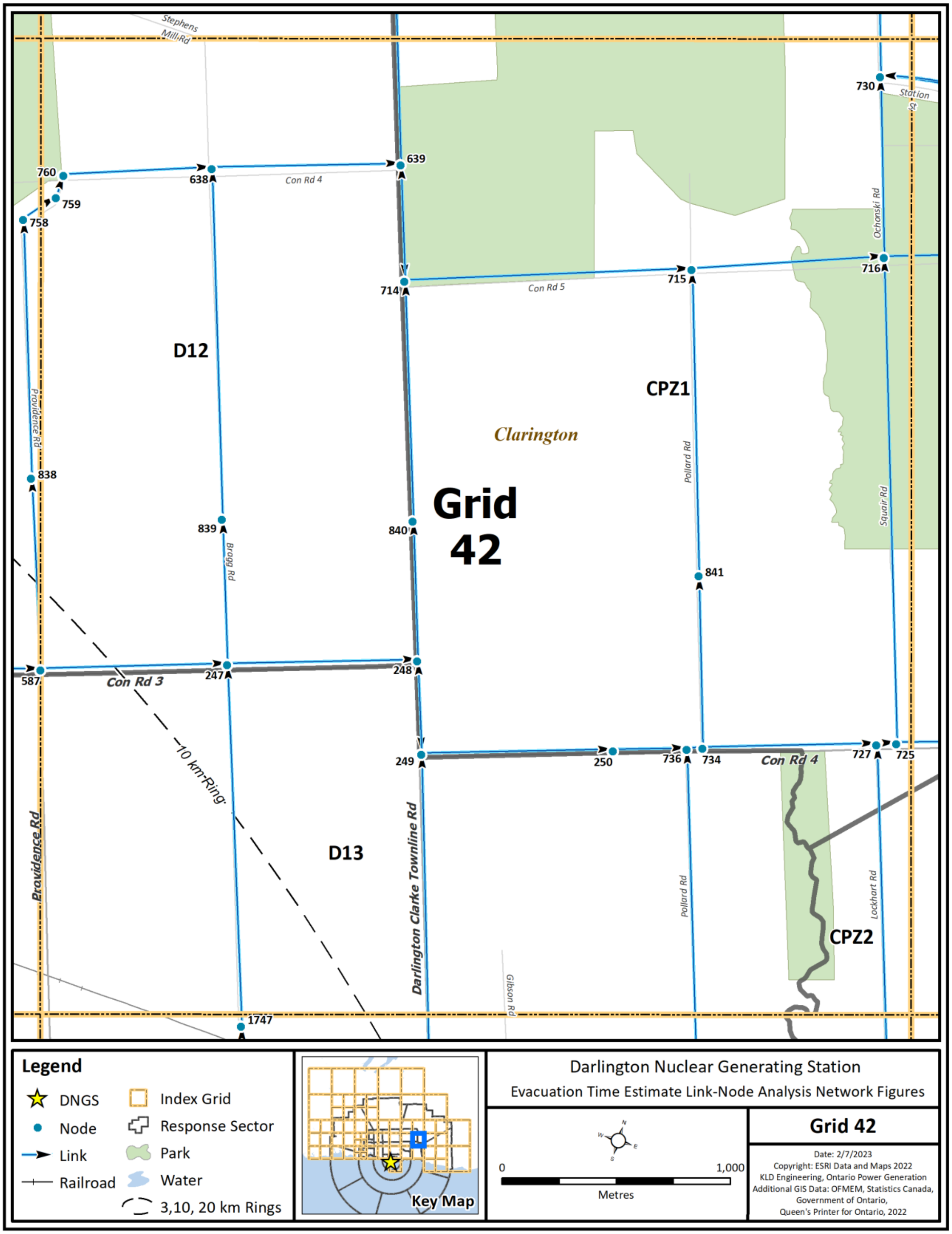


**Figure K-43. Link-Node Analysis Network – Grid 42**

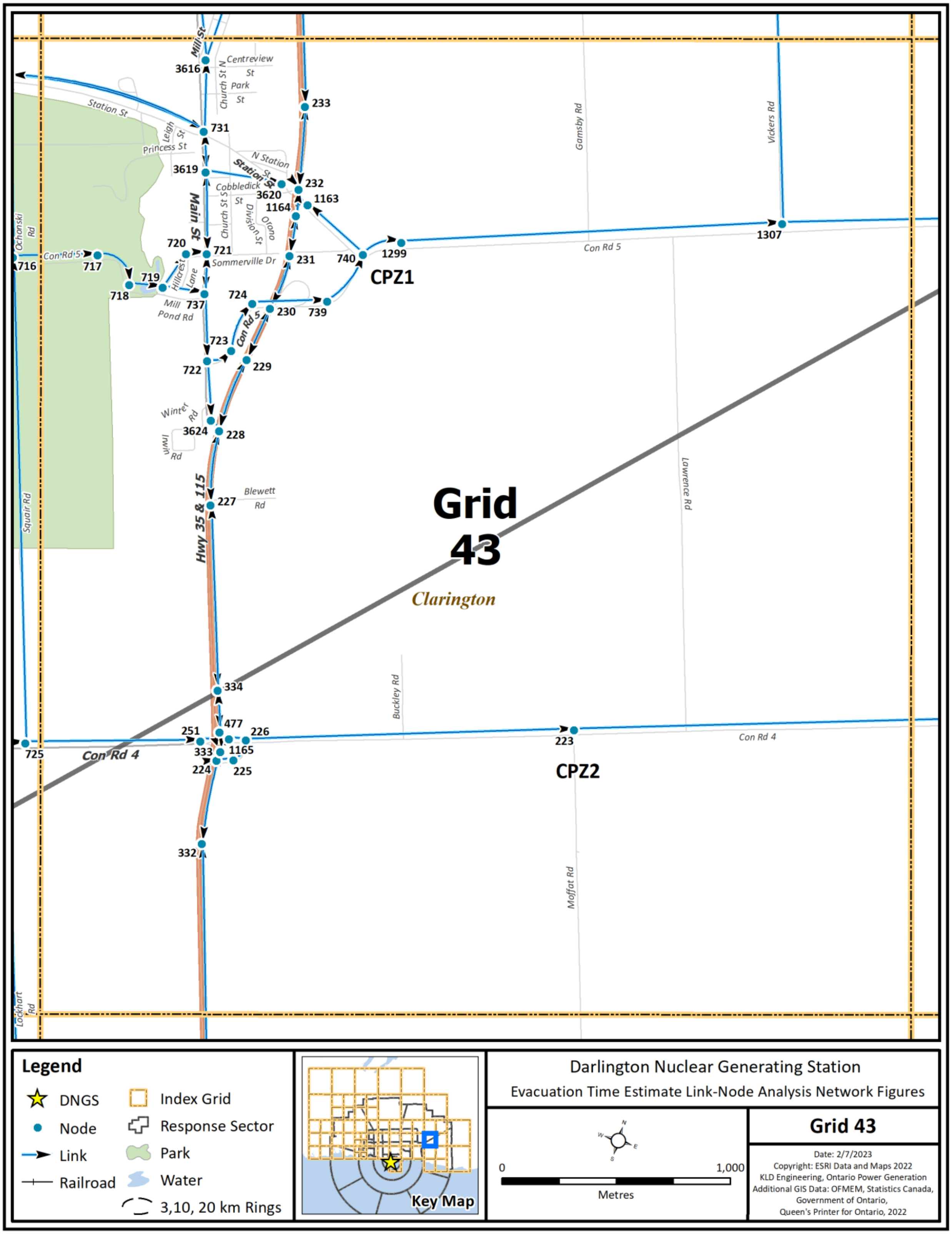


**Figure K-44. Link-Node Analysis Network – Grid 43**

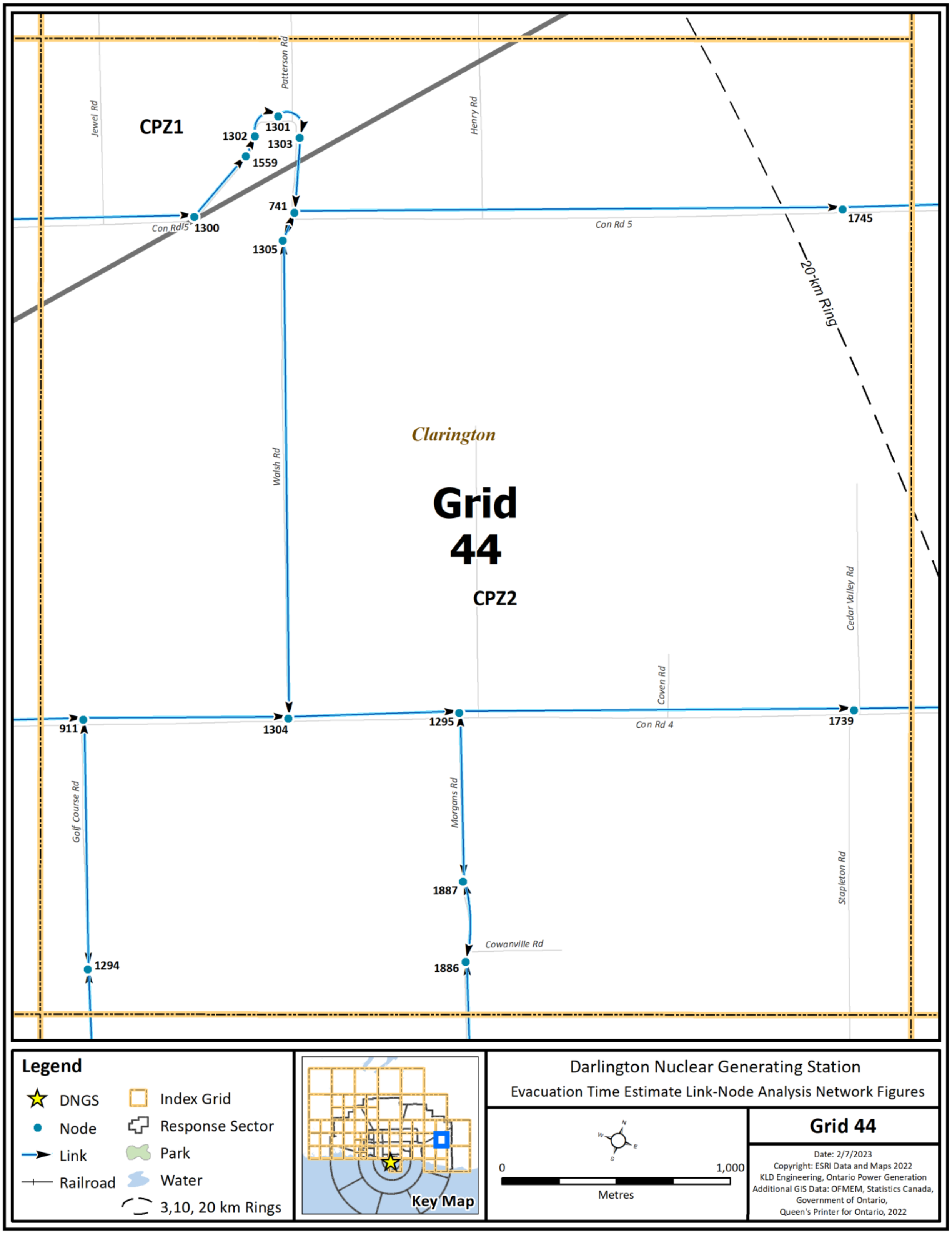


**Figure K-45. Link-Node Analysis Network – Grid 44**

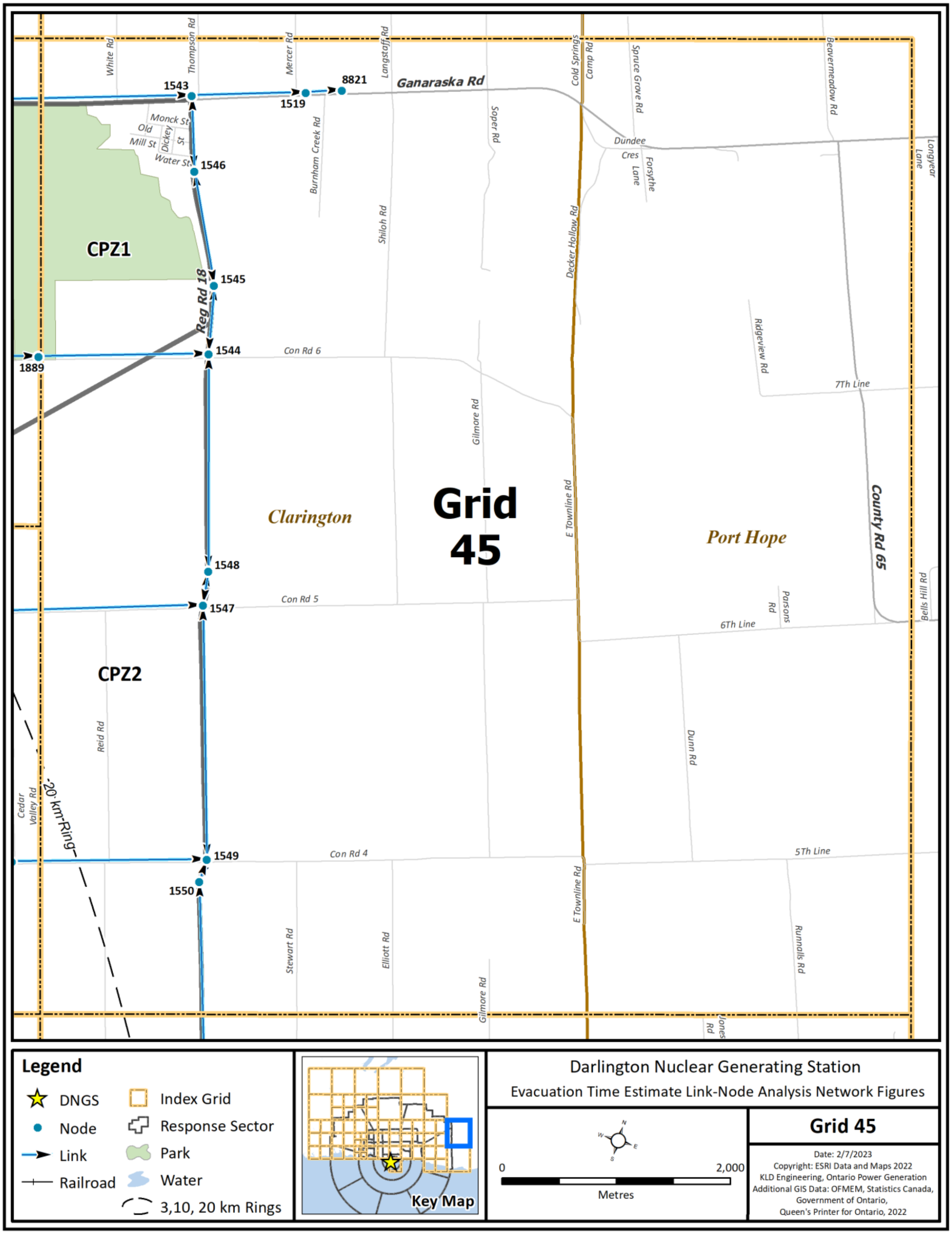


**Figure K-46. Link-Node Analysis Network – Grid 45**

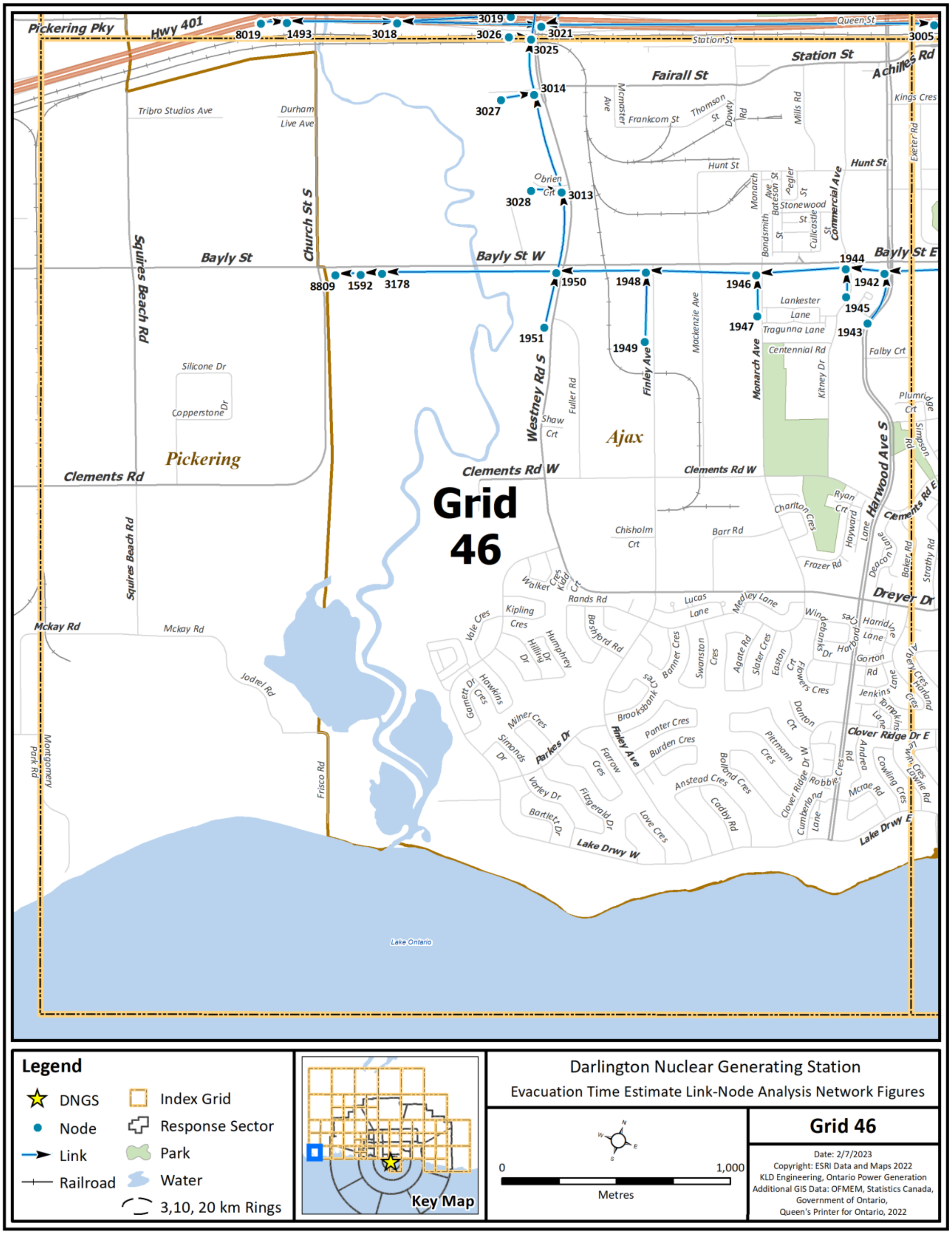


**Figure K-47. Link-Node Analysis Network – Grid 46**

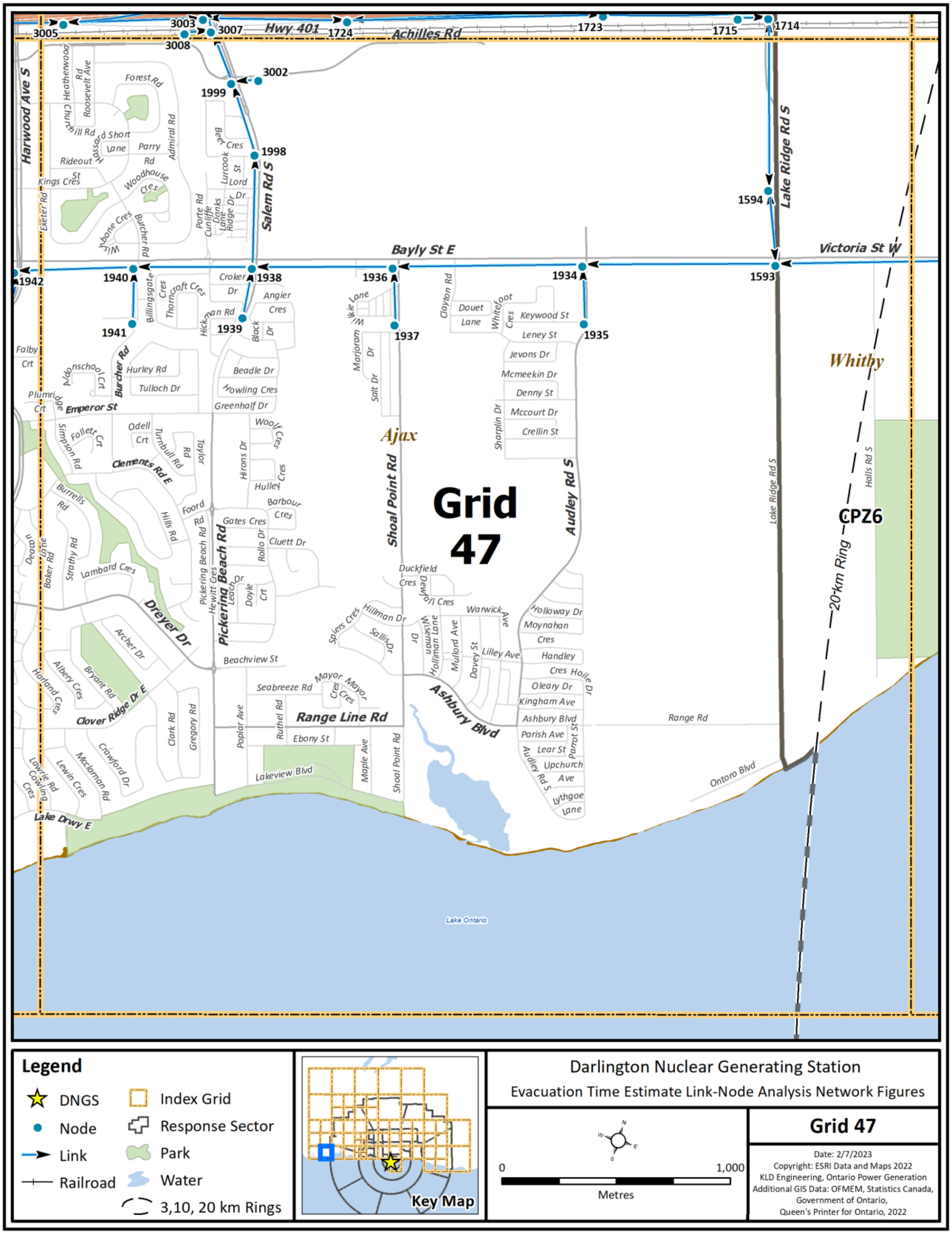


**Figure K-48. Link-Node Analysis Network – Grid 47**

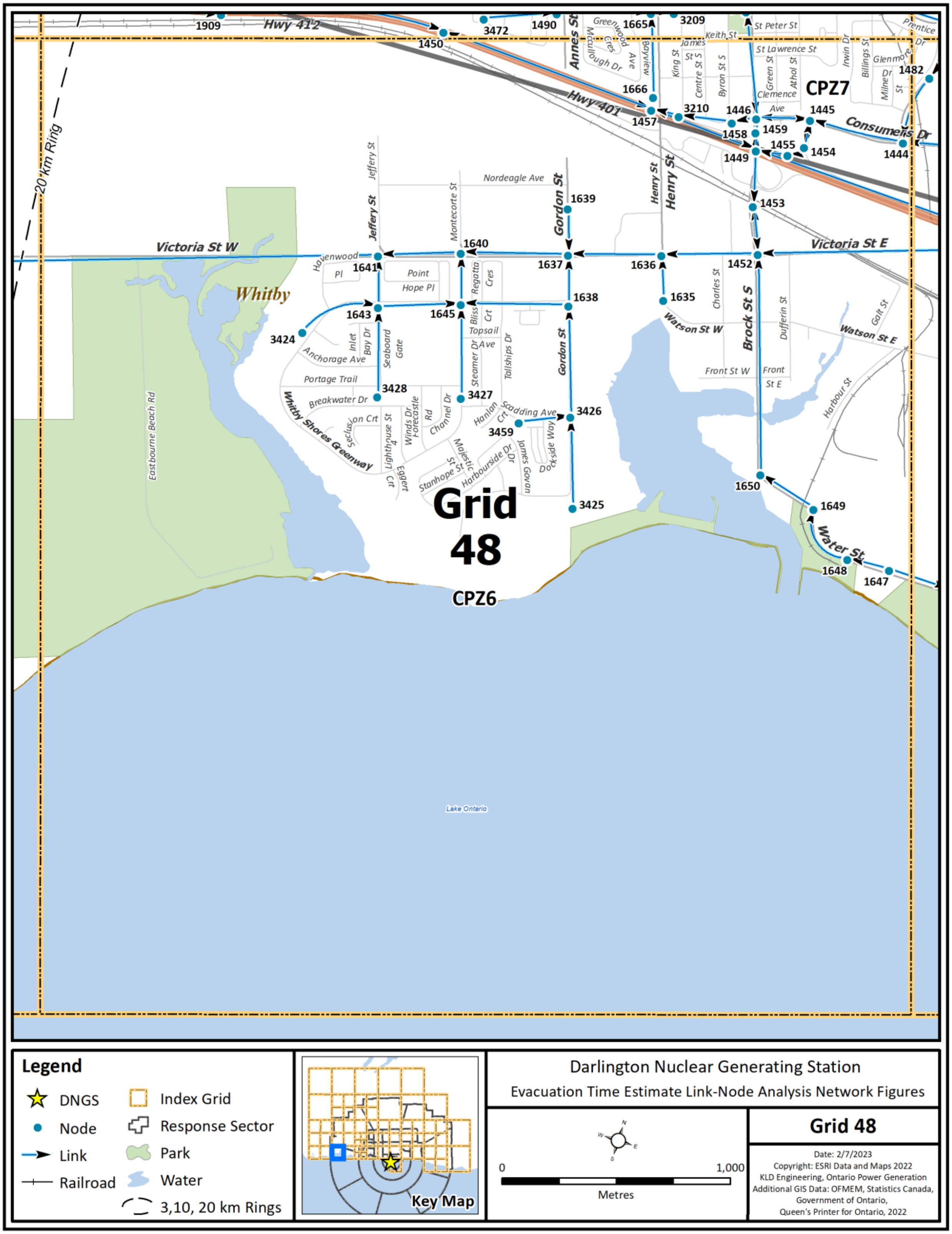


**Figure K-49. Link-Node Analysis Network – Grid 48**

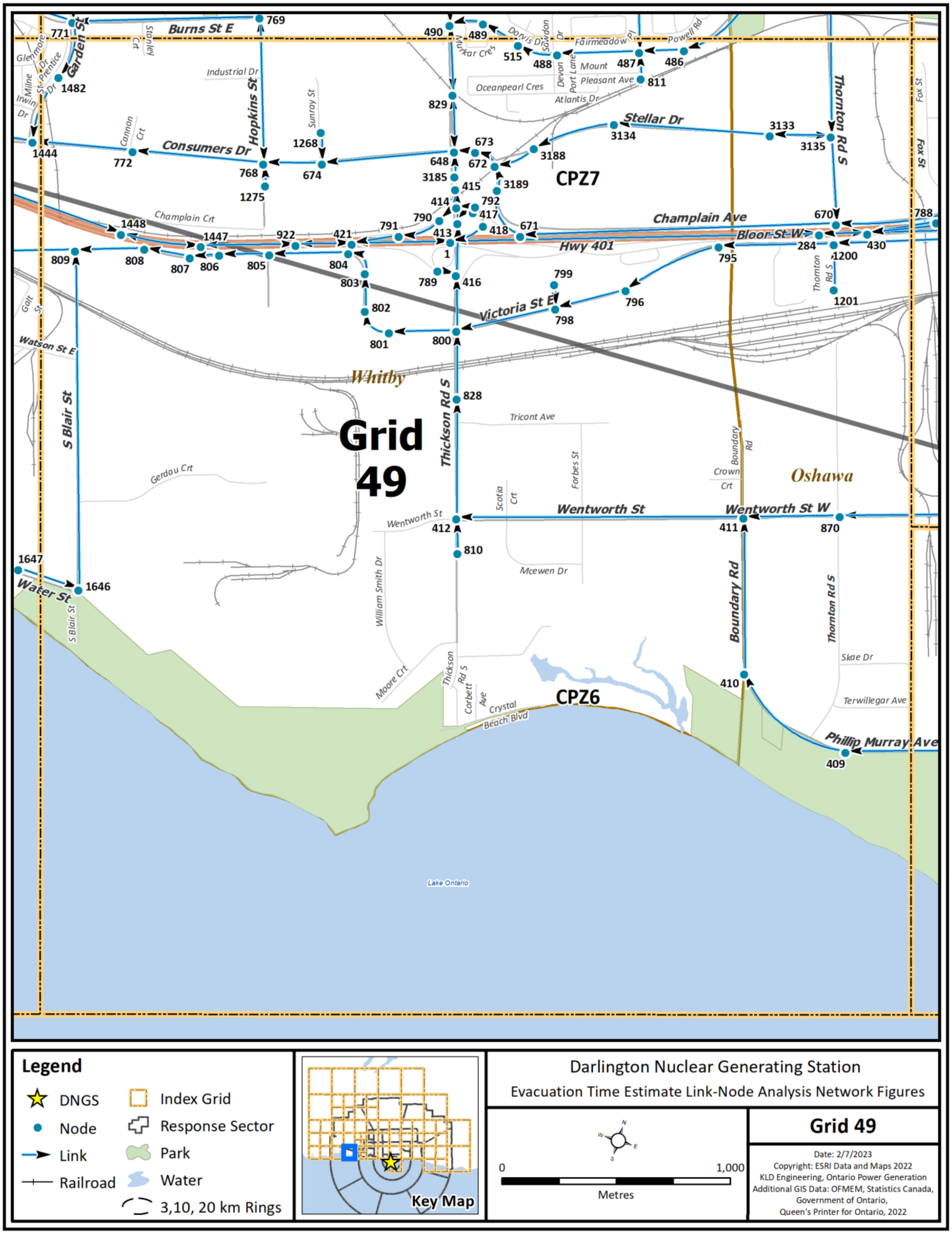


**Figure K-50. Link-Node Analysis Network – Grid 49**

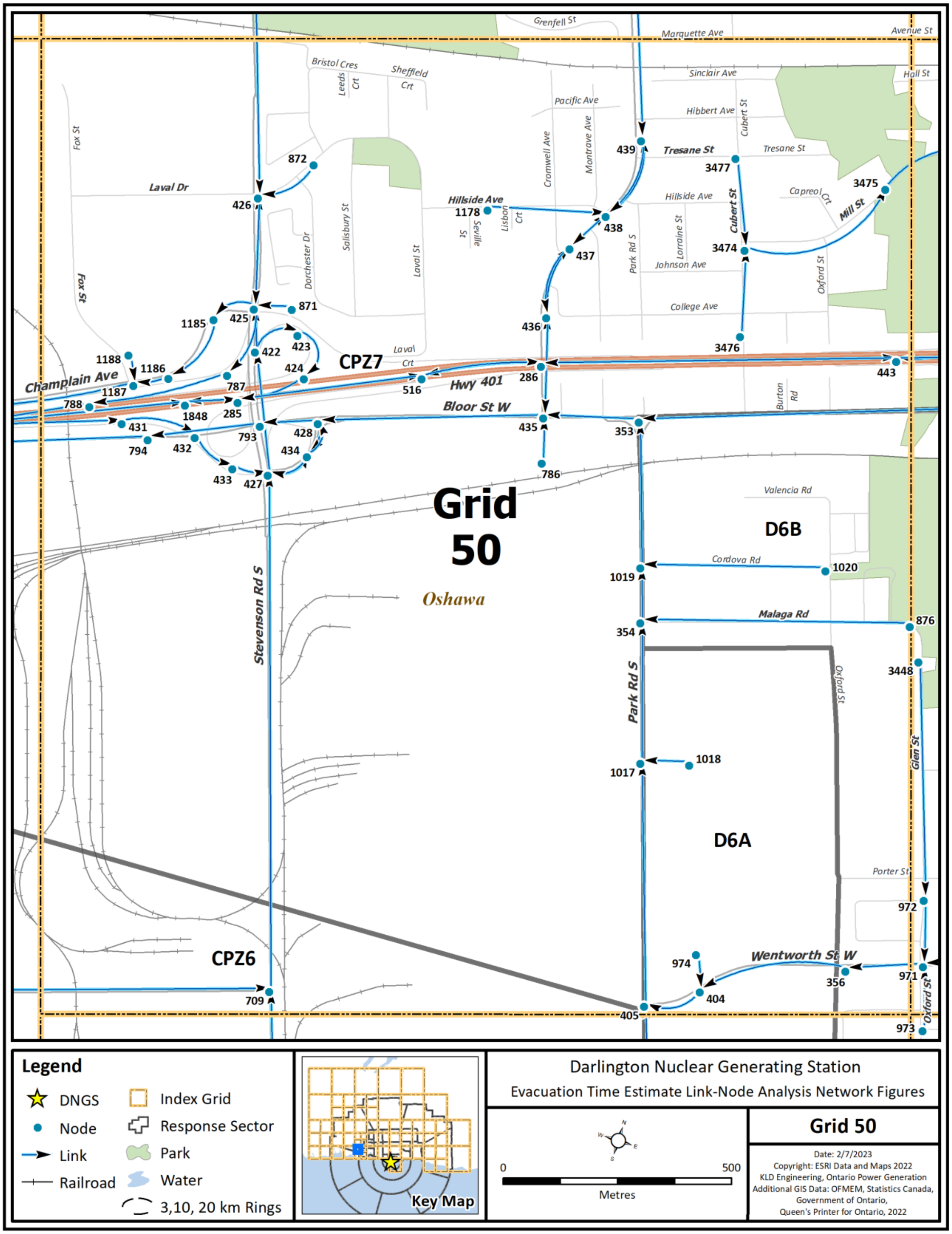


**Figure K-51. Link-Node Analysis Network – Grid 50**

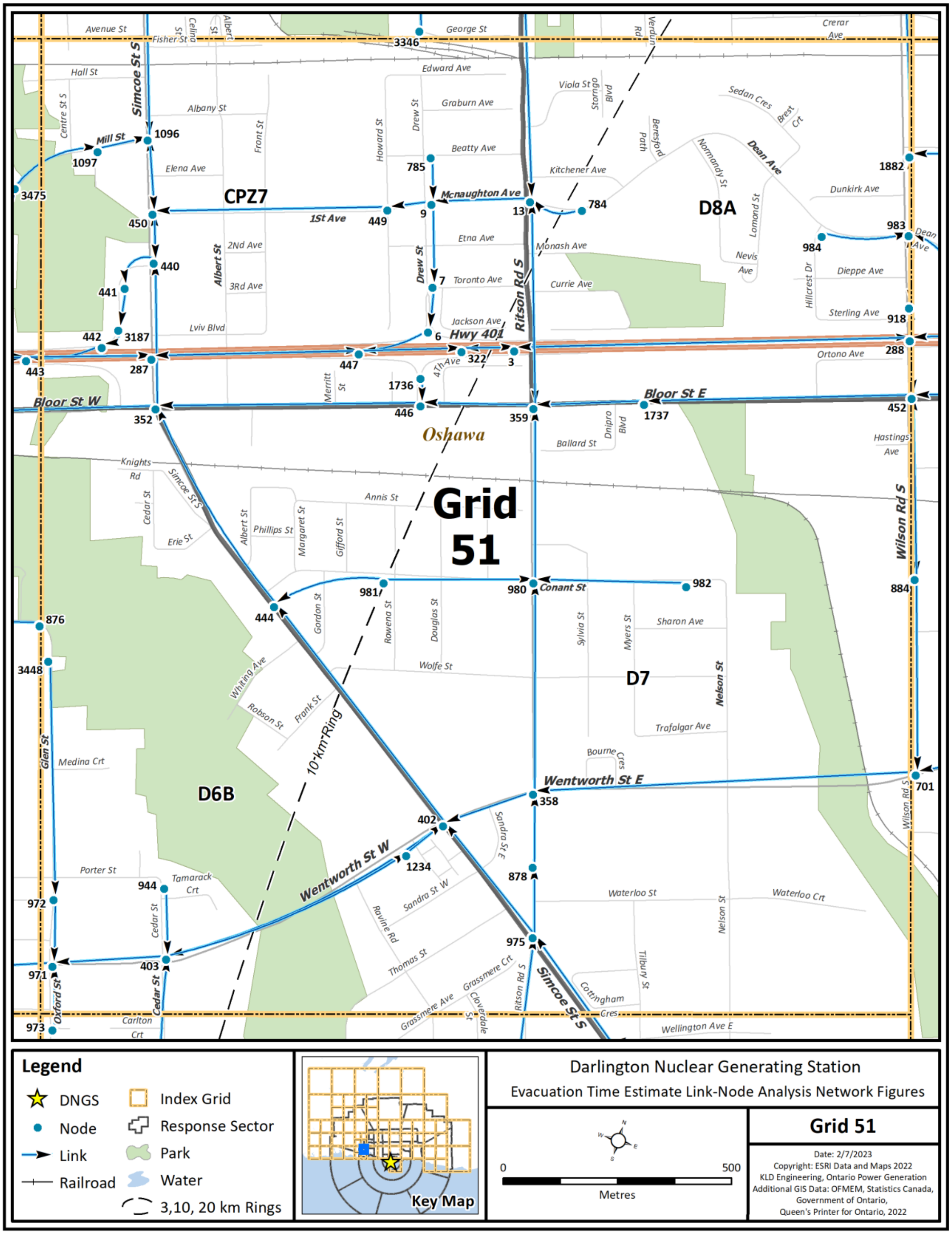


**Figure K-52. Link-Node Analysis Network – Grid 51**

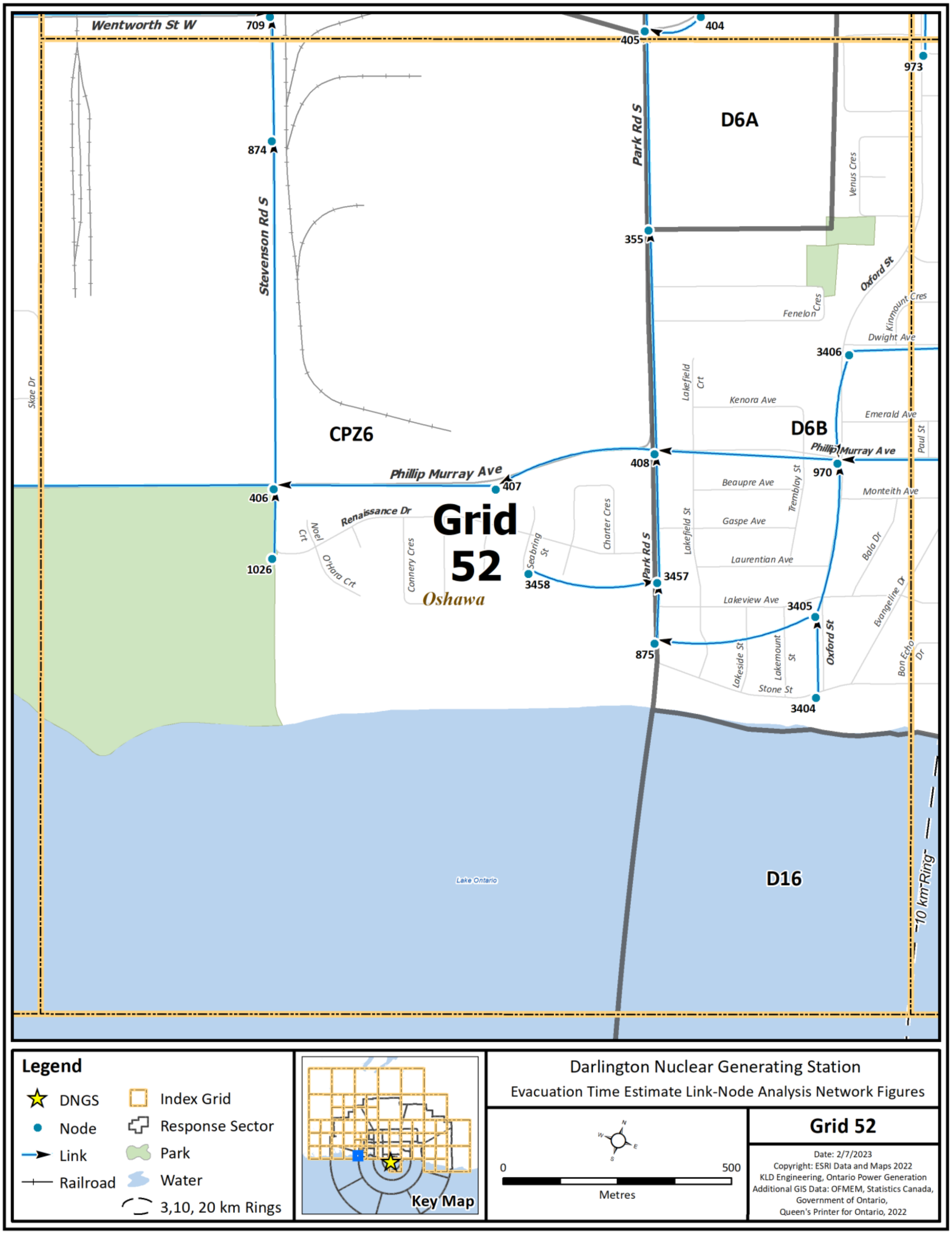


**Figure K-53. Link-Node Analysis Network – Grid 52**

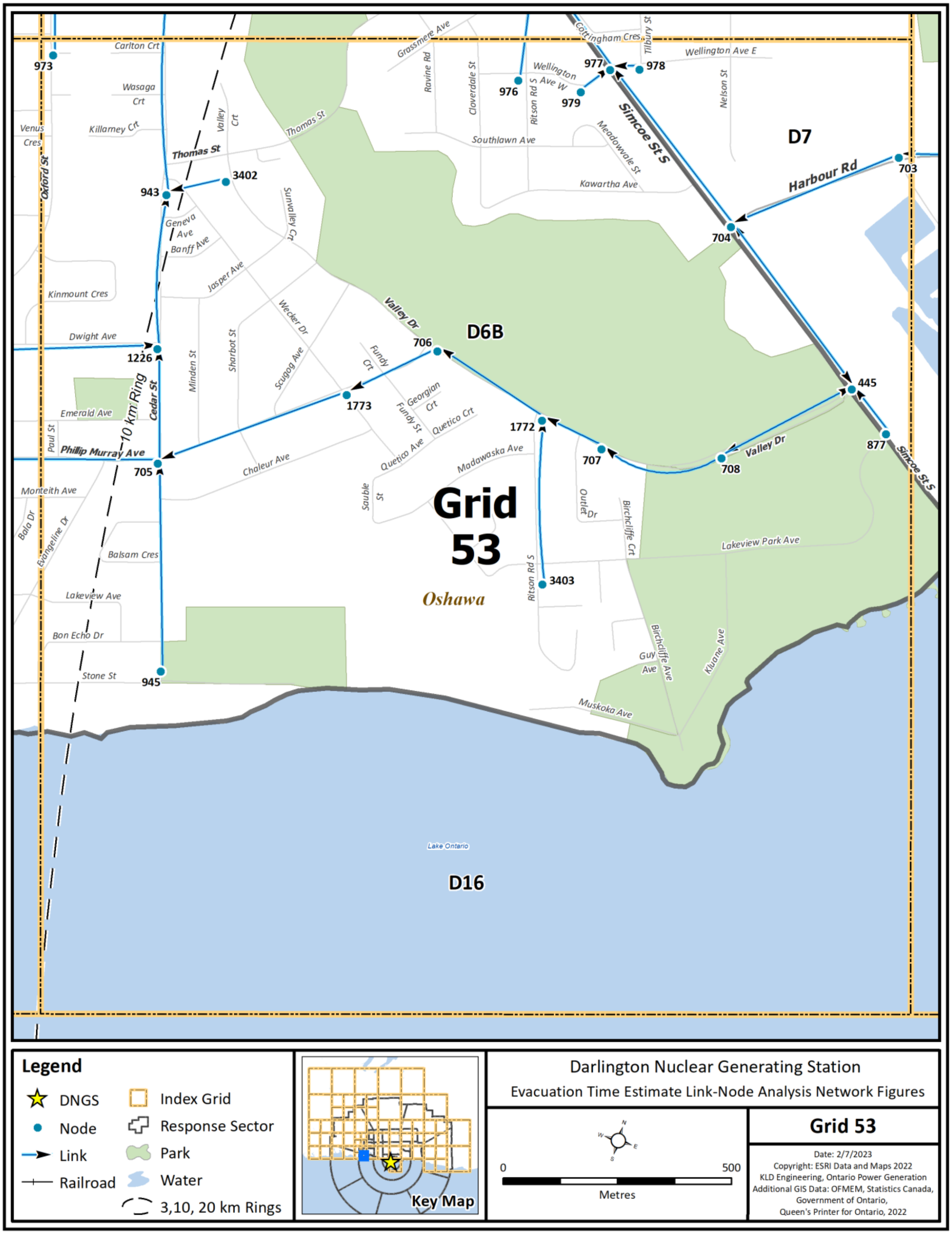


**Figure K-54. Link-Node Analysis Network – Grid 53**

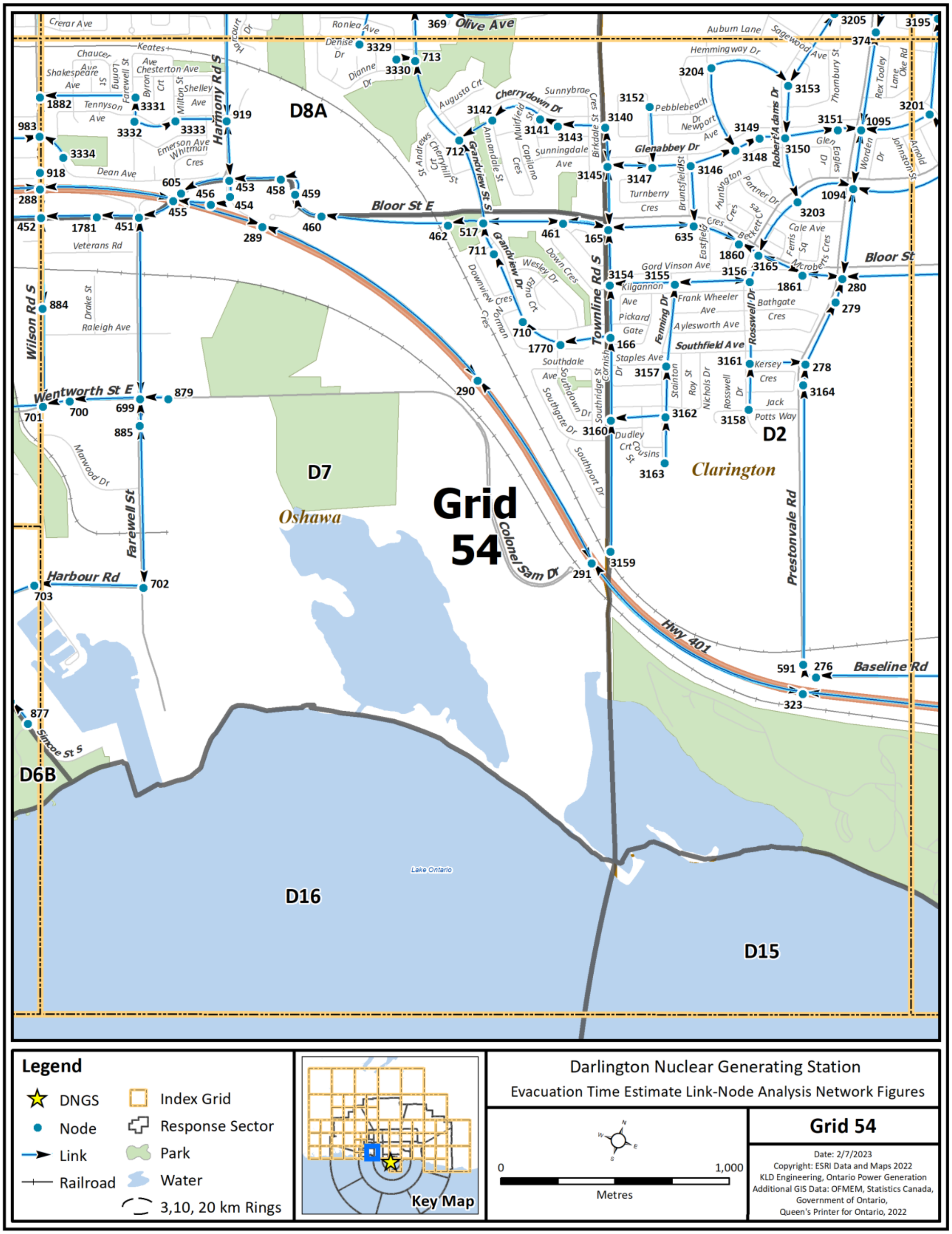


**Figure K-55. Link-Node Analysis Network – Grid 54**

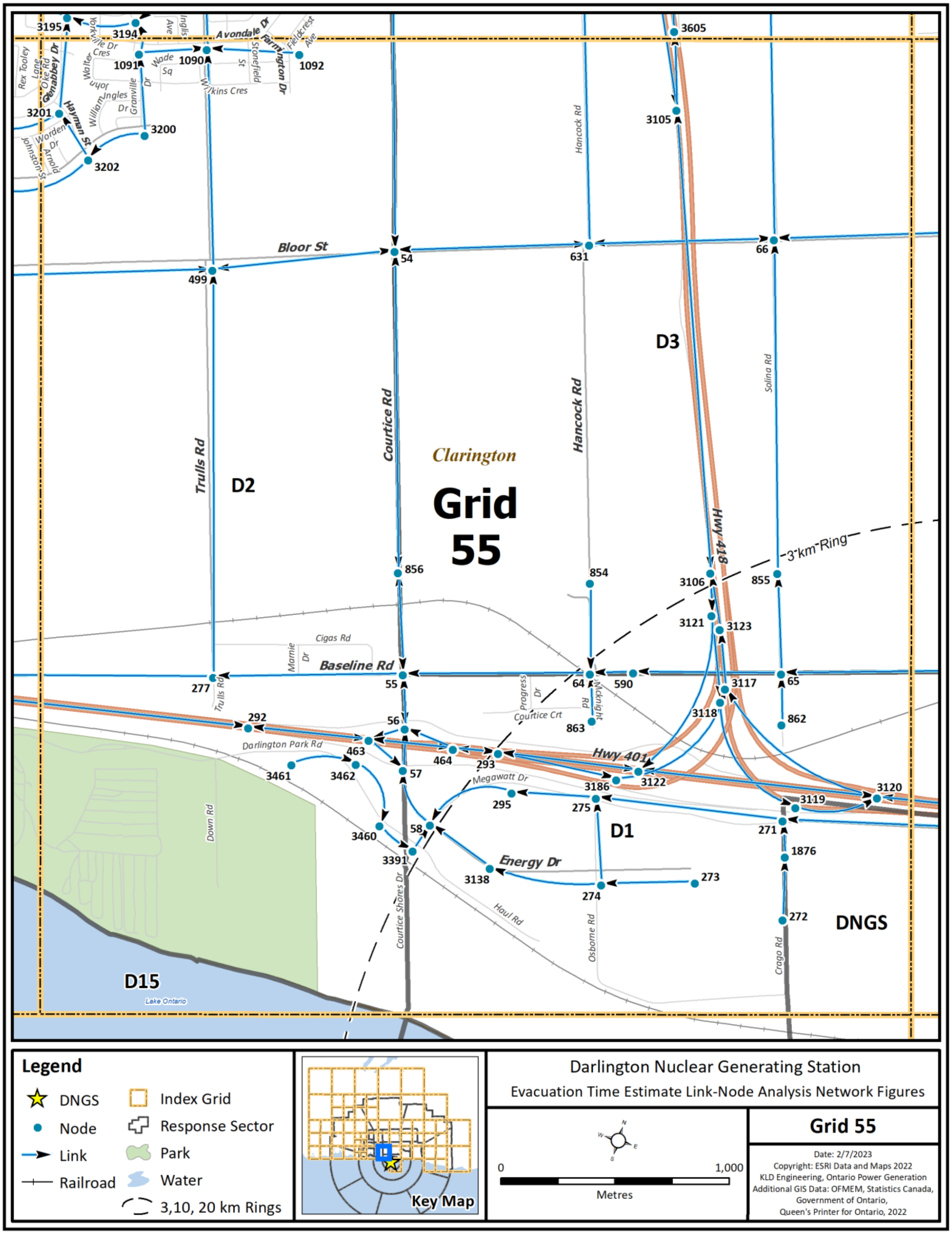


**Figure K-56. Link-Node Analysis Network – Grid 55**

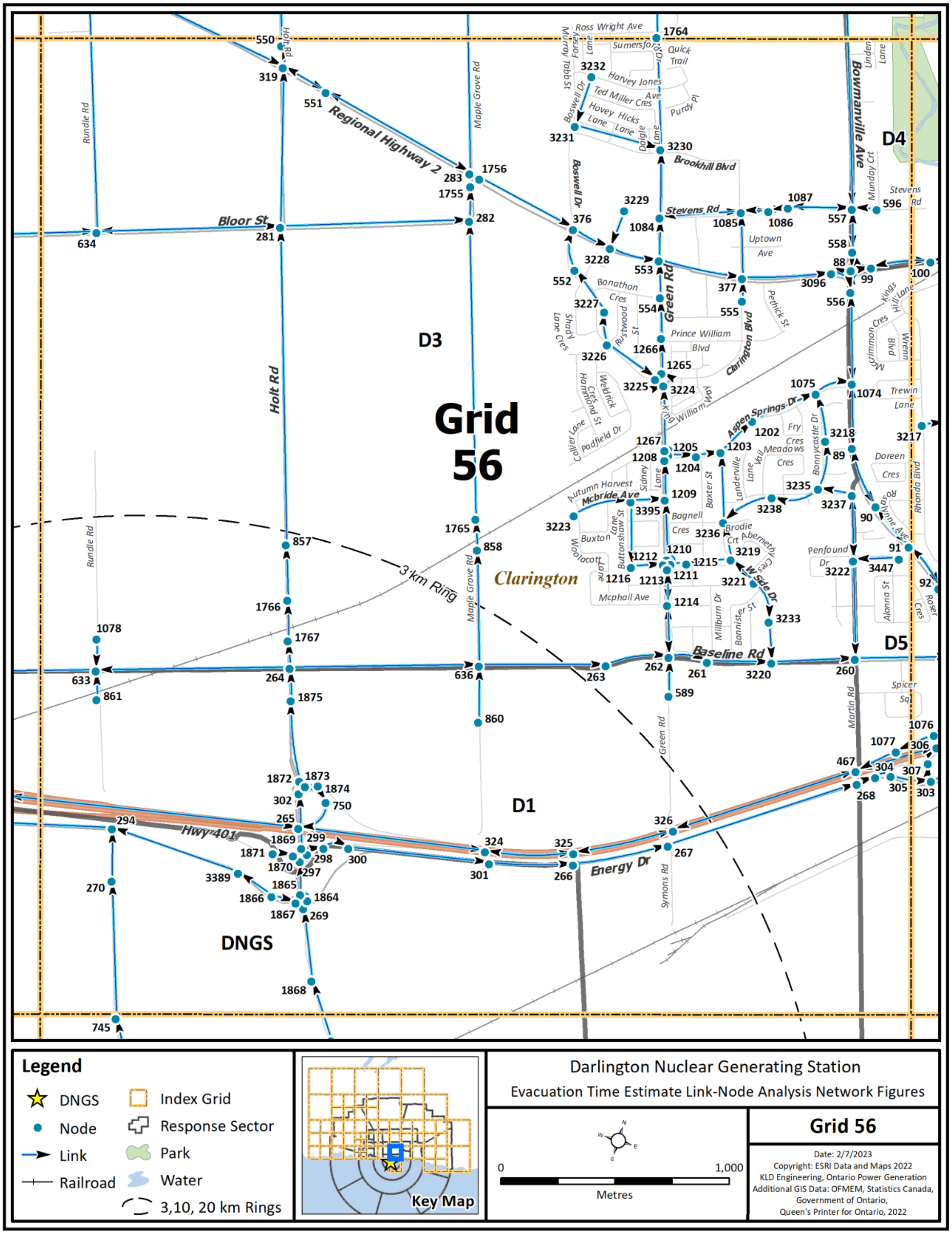


**Figure K-57. Link-Node Analysis Network – Grid 56**

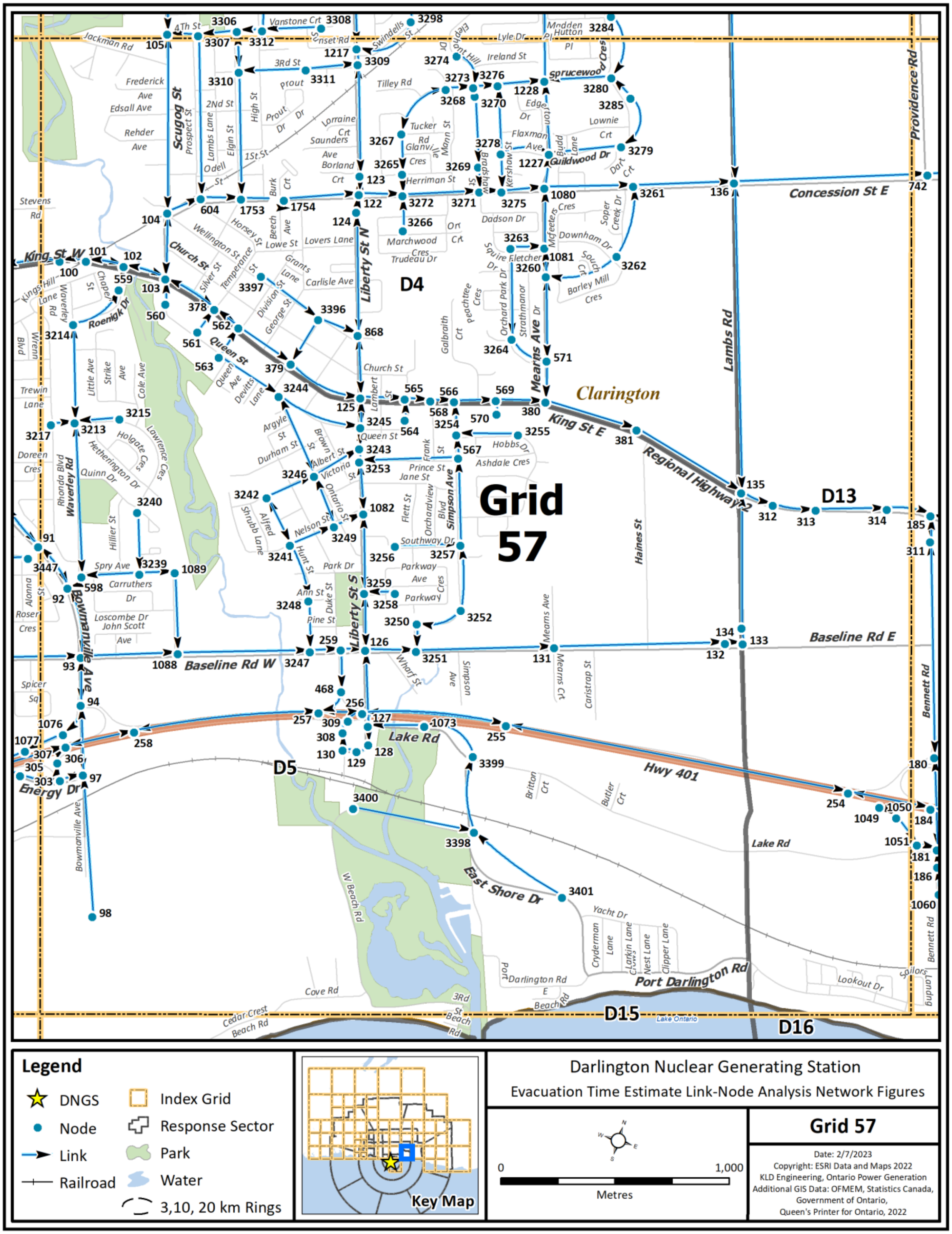


**Figure K-58. Link-Node Analysis Network – Grid 57**

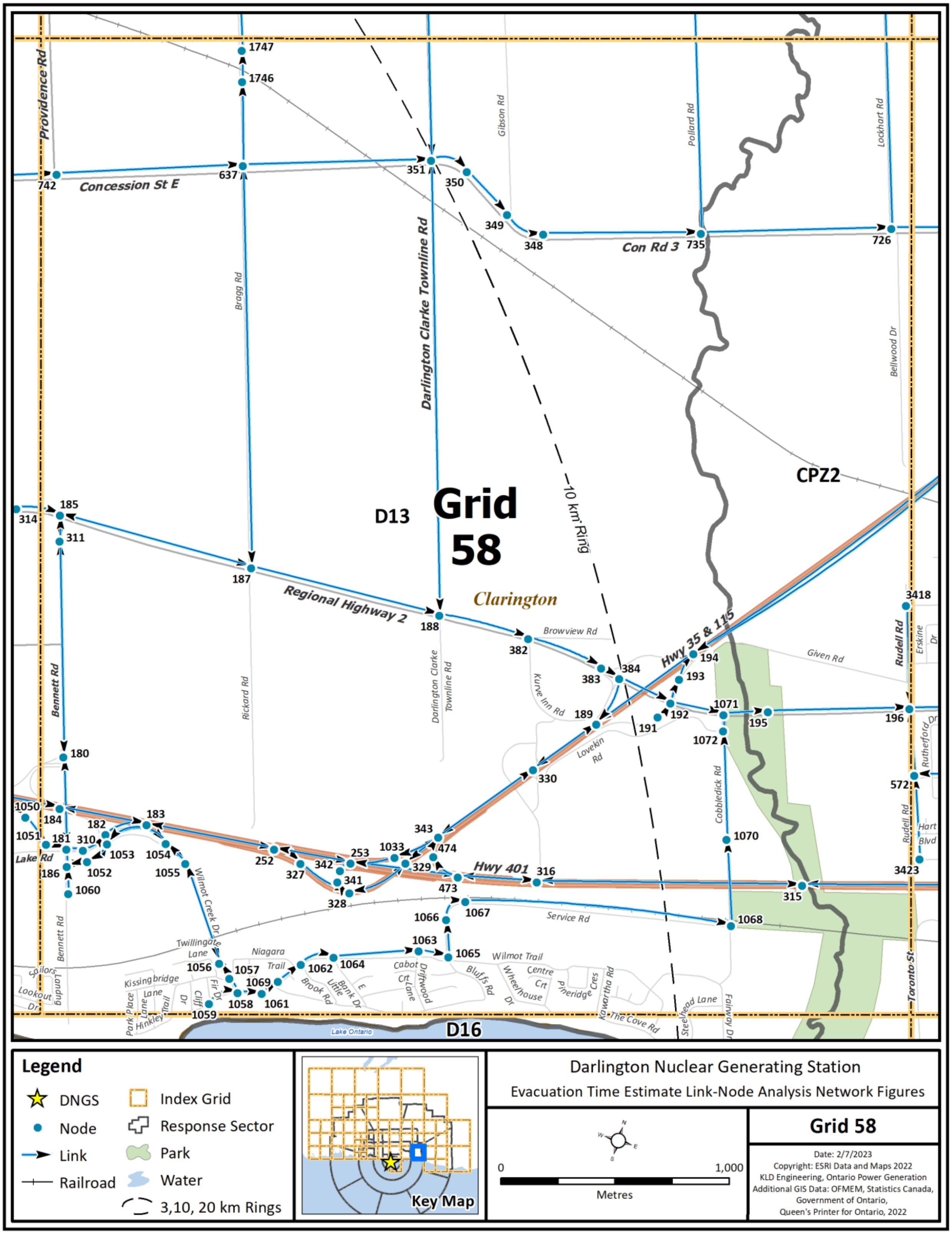


**Figure K-59. Link-Node Analysis Network – Grid 58**

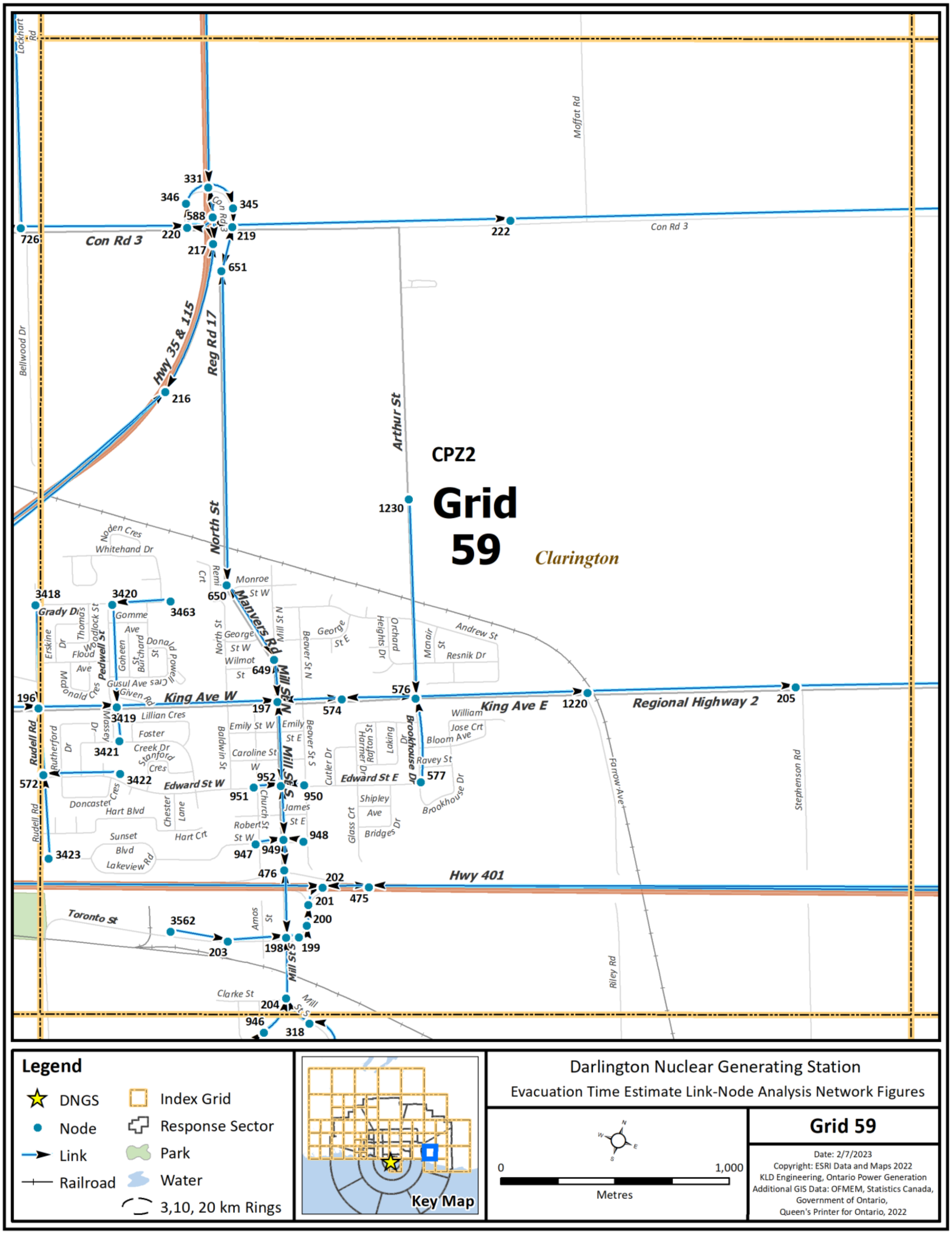


**Figure K-60. Link-Node Analysis Network – Grid 59**

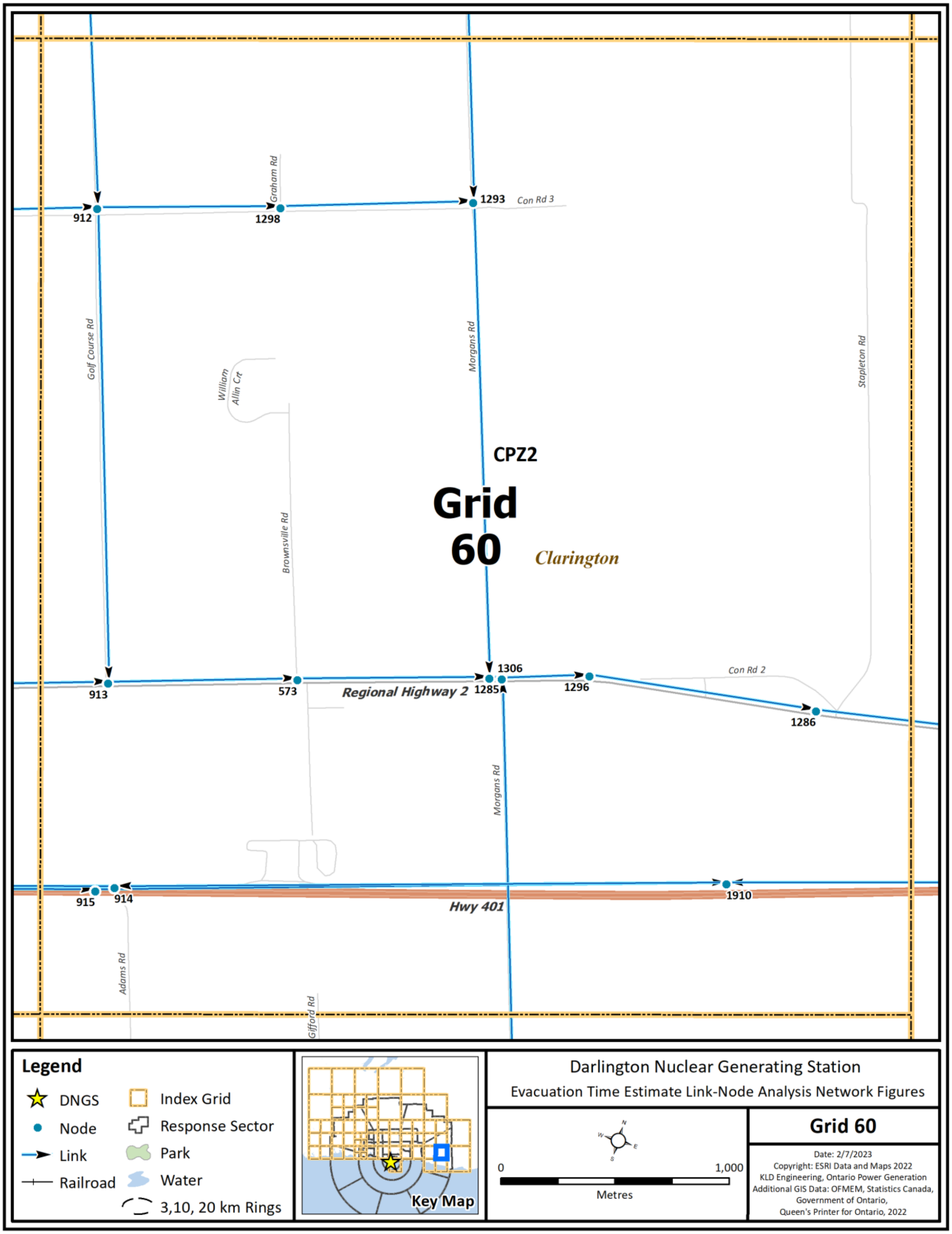


**Figure K-61. Link-Node Analysis Network – Grid 60**

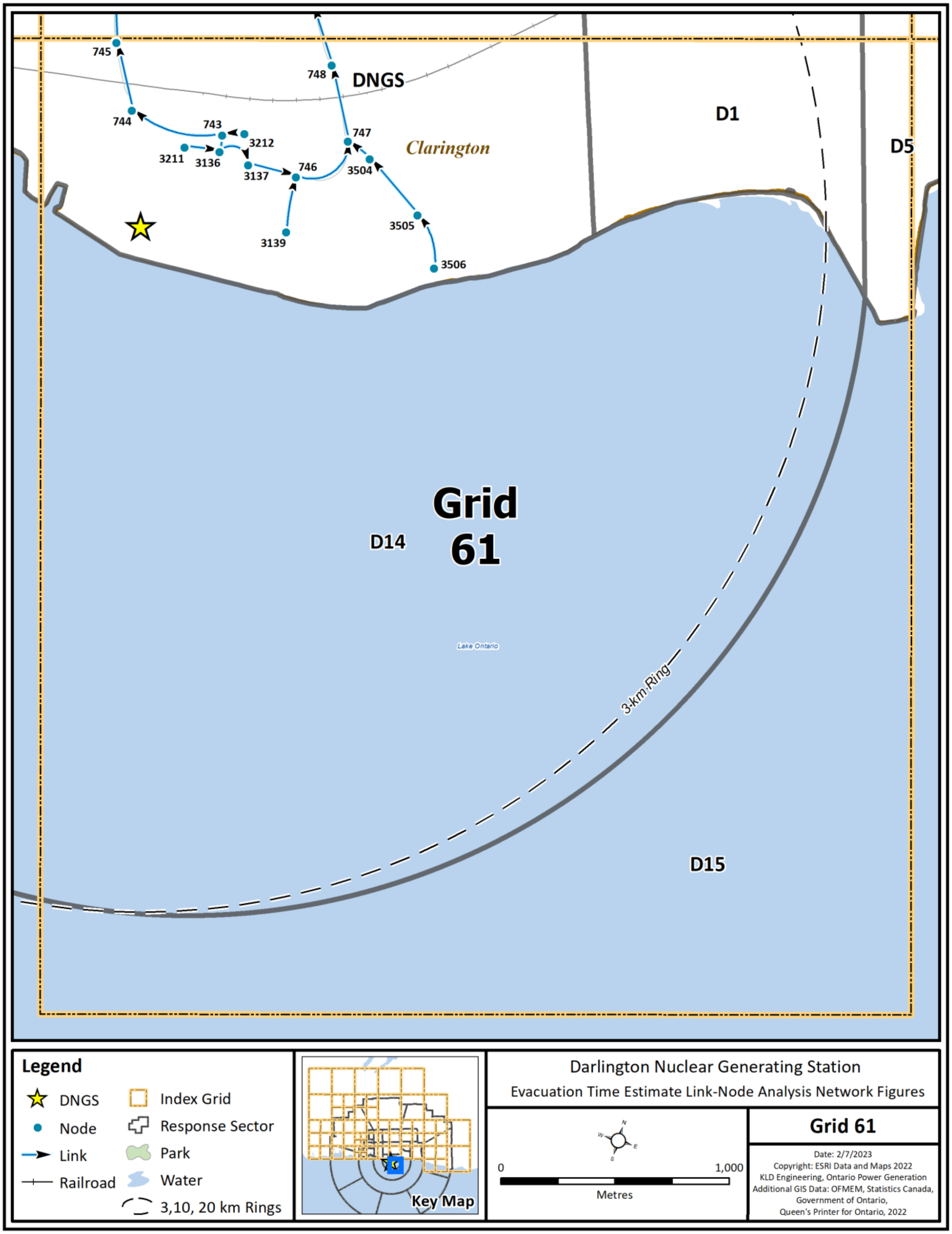


**Figure K-62. Link-Node Analysis Network – Grid 61**

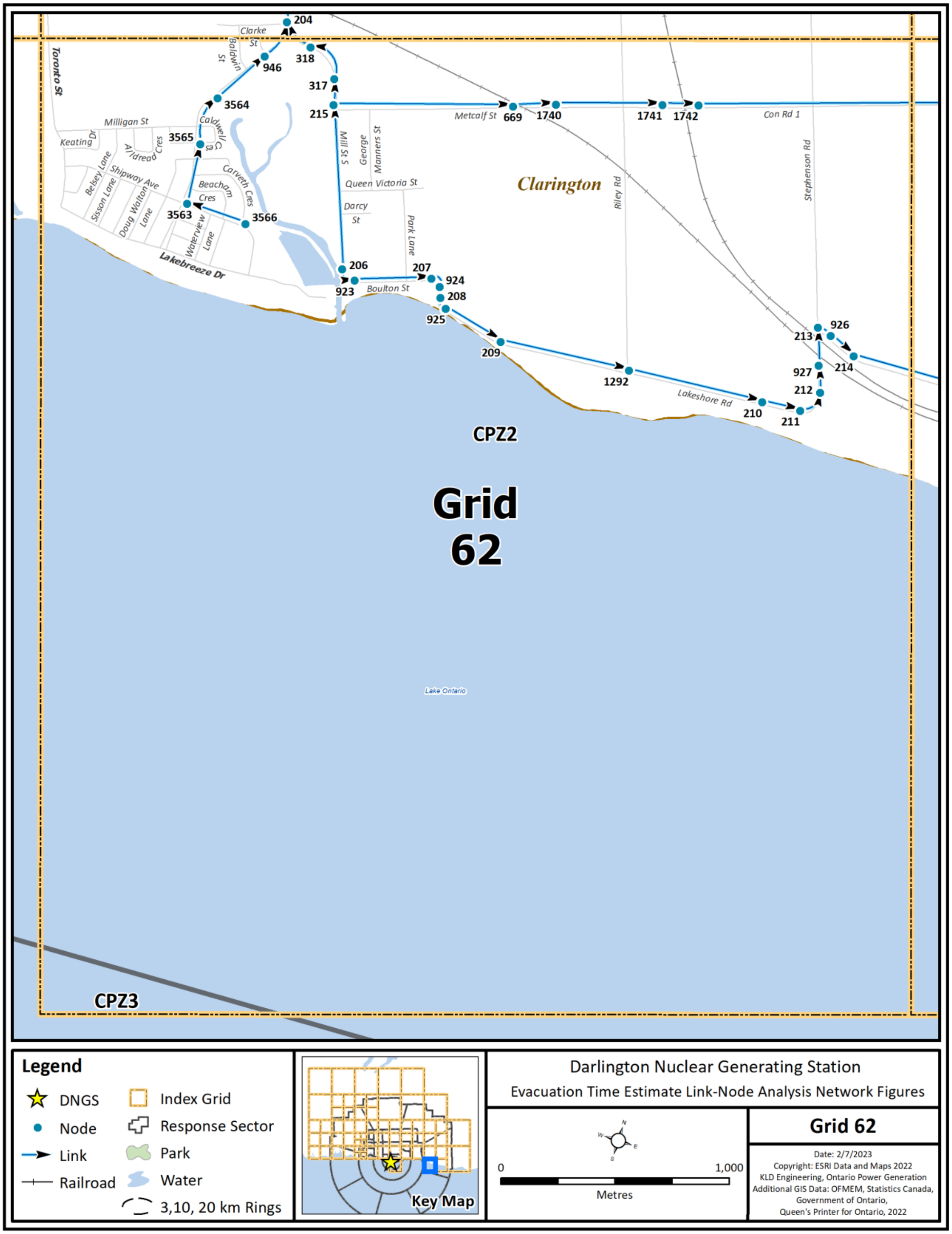


**Figure K-63. Link-Node Analysis Network – Grid 62**

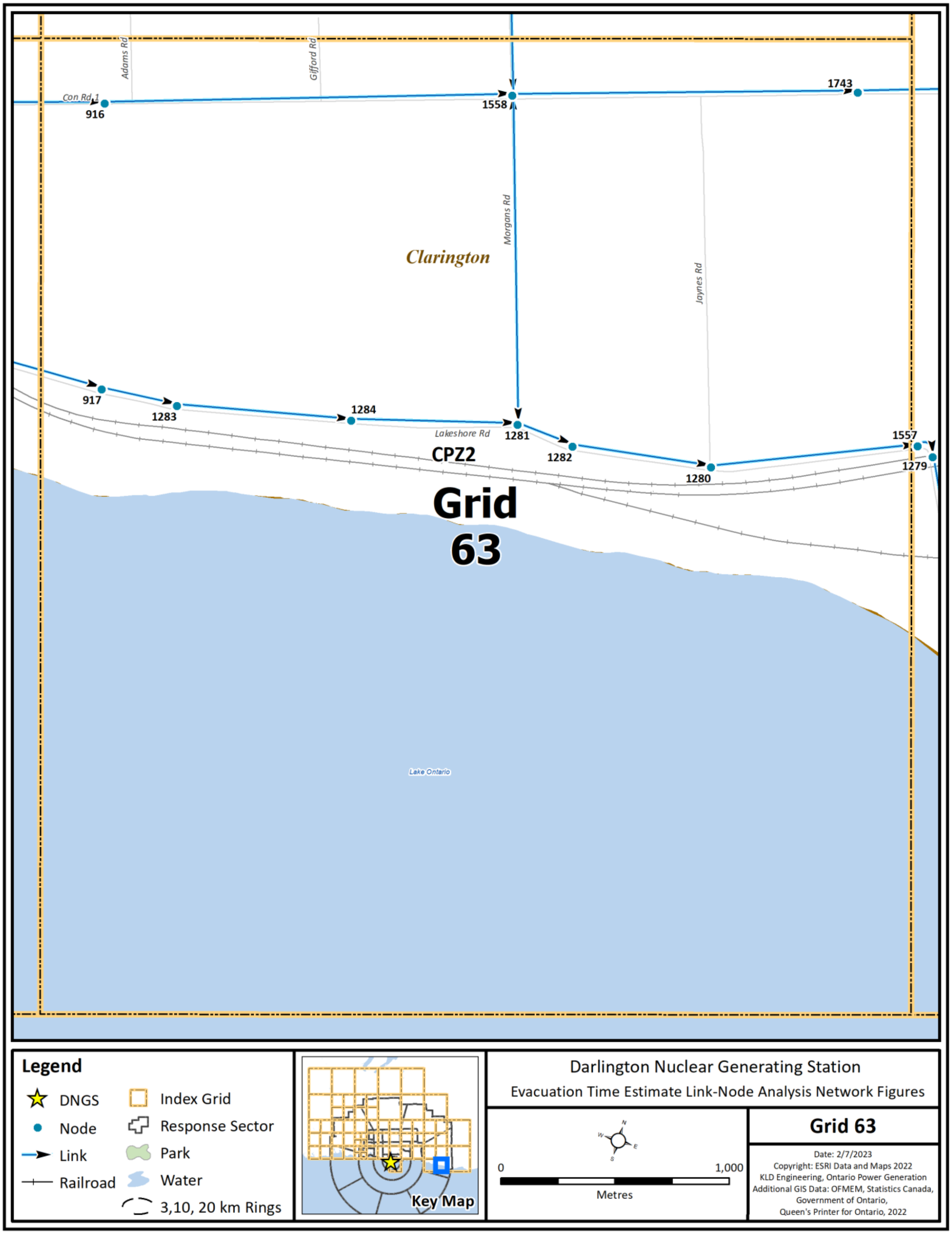


**Figure K-64. Link-Node Analysis Network – Grid 63**

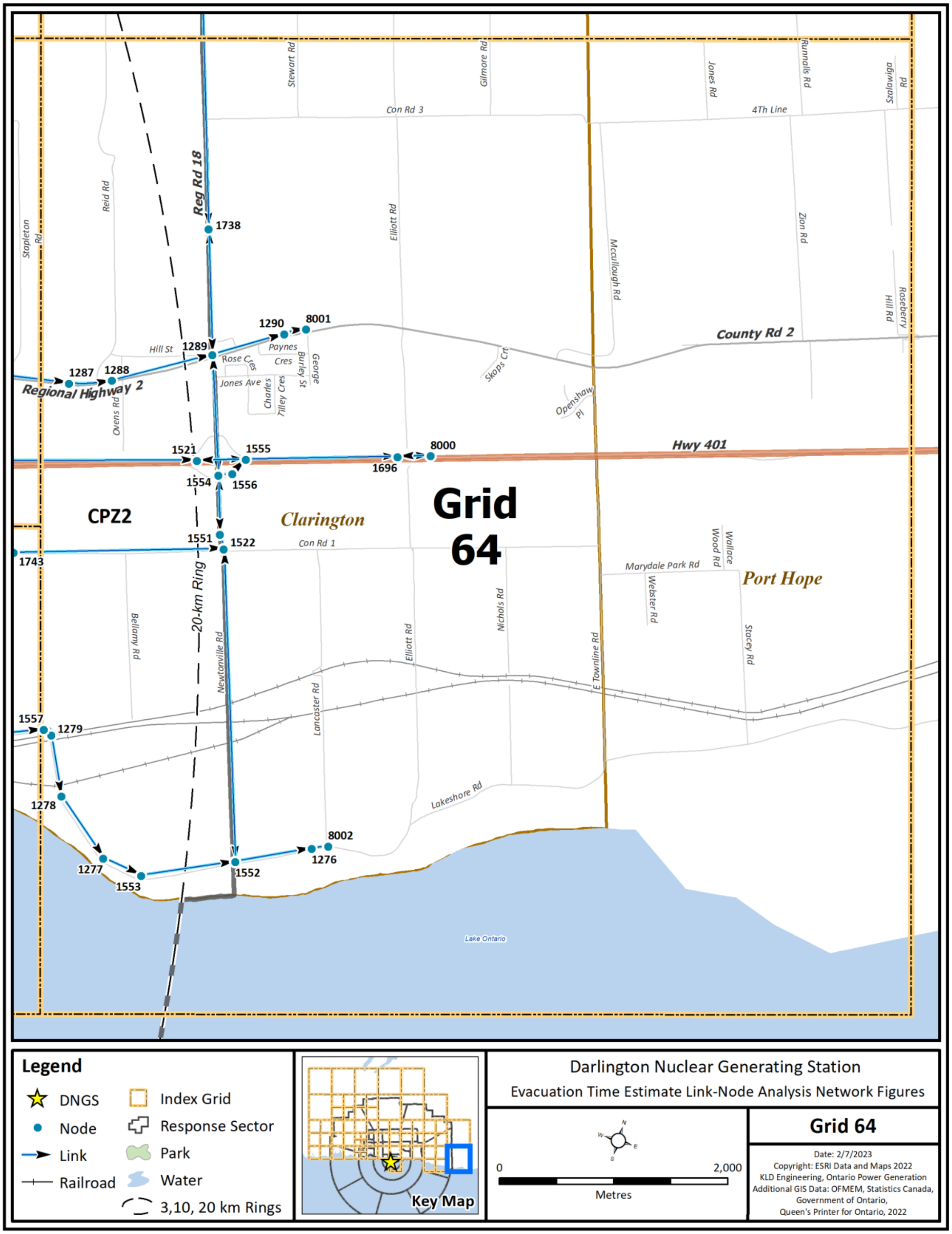


**Figure K-65. Link-Node Analysis Network – Grid 64**

# APPENDIX L

Response Sector Boundaries

## L. RESPONSE SECTOR BOUNDARIES

The Detailed Planning Zone (DPZ) for the Darlington Nuclear Generating Station (DNGS) is made up of Response Sectors DNGS and D1 through D16, which fall into the following sector rings around the plant:

- Automatic Action Zone (AAZ): Sectors DNGS, D1, and Lake Sector D14
- Inner Ring: Sectors D2 through D5 and Lake Sector D15
- Outer Ring: Sectors D6A, D6B, D7, D8A, D8B, D9 through D13 and Lake Sector D16

The Contingency Planning Zone (CPZ) is made up of Response Sectors CPZ1 through CPZ8. All Response Sectors make up the full Planning Zone (PZ).

| | |
|---|---|
| Response Sector DNGS | Region: Durham<br>Defined as the area within the following boundary: DNGS site boundary |
| Response Sector D1 | Region: Durham<br>Defined as the area within the following boundary: Baseline Road; Martin Road; Lake Ontario; Courtice Road |
| Response Sector D2 | Region: Durham<br>Defined as the area within the following boundary: Nash Road; Courtice Road/RR 34; Lake Ontario; Townline Road/RR 55 |
| Response Sector D3 | Region: Durham<br>Defined as the area within the following boundary: Nash Road; Martin Road/RR 57; Baseline Road; Courtice Road/RR 34 |
| Response Sector D4 | Region: Durham<br>Defined as the area within the following boundary: Concession Road #3; Lambs Road; Highway 2; Martin Road/RR 57 |
| Response Sector D5 | Region: Durham<br>Defined as the area within the following boundary: Highway 2; Lambs Road; Lake Ontario; Martin Road/RR 57 |
| Response Sector D6A | Region: Durham<br>Defined as the area within the following boundary: General Motors Parking Lot |

| | |
|---|---|
| Response Sector D6B | Region: Durham<br>Defined as the area within the following boundary: Bloor Street/RR 22; Simcoe Street/RR 2; Lake Ontario; Park Road/RR 54 |
| Response Sector D7 | Region: Durham<br>Defined as the area within the following boundary: Bloor Street/RR 22; Townline Road/RR 55; Lake Ontario; Simcoe Street/RR 2 |
| Response Sector D8A | Region: Durham<br>Defined as the area within the following boundary: King Street; Townline Road/RR 55; Bloor Street/RR 22; Ritson Road/RR16 |
| Response Sector D8B | Region: Durham<br>Defined as the area within the following boundary: Adelaide Ave; Townline Road/RR 55; King Street; Ritson Road/RR16 |
| Response Sector D9 | Region: Durham<br>Defined as the area within the following boundary: Taunton Road/RR 4; Townline Road/RR 55; Adelaide Avenue/RR 58; Harmony Road/RR 33 |
| Response Sector D10 | Region: Durham<br>Defined as the area within the following boundary: Taunton Road/RR 4; Courtice Road/RR 34; Nash Road; Townline Road/RR 55 |
| Response Sector D11 | Region: Durham<br>Defined as the area within the following boundary: Taunton Road/RR 4; Martin Road/RR 57; Nash Road; Courtice Road/RR 34 |
| Response Sector D12 | Region: Durham<br>Defined as the area within the following boundary: Taunton Road/RR 4; Darlington-Clarke Townline/RR 42; Concession Road #3; Martin Road/RR 57 |
| Response Sector D13 | Region: Durham<br>Defined as the area within the following boundary: Concession Road #3; Concession Road #4; Wilmot Creek; Lake Ontario; Lambs Road |
| Response Sector D14 | Defined as the area within the following boundary: Lake Ontario out to the 3km |
| Response Sector D15 | Defined as the area within the following boundary: Lake Ontario out to the 6km |

| | |
|---|---|
| Response Sector D16 | Defined as the area within the following boundary: Lake Ontario out to the 10km |
| Response Sector CPZ1 | Region: Durham<br><br>Defined as the area within the following boundary (north; east; south; west): Regional Road 20, Concession Road 10, Best Road, Skelding Road, Highway 35, Concession Road 8, Carscadden Road, Ganaraska Road and Newtonville Road; a straight line 45° Northeast of DNGS coastline; Concession Road 4, Darlington Clarke Townline Road and Taunton Road; a straight line 360°/0° North of DNGS coastline |
| Response Sector CPZ2 | Region: Durham<br><br>Defined as the area within the following boundary (north; east; south; west): a straight line 45° Northeast of DNGS; Newtonville Road; a straight line 90° East DNGS coastline; Wilmot Creek |
| Response Sector CPZ3 | Defined as the area within the following boundary: a straight line 90° East of DNGS coastline to a straight line 135° Southeast of DNGS coastline; Lake Ontario from DPZ out to CPZ |
| Response Sector CPZ4 | Defined as the area within the following boundary: a straight line 135° Southeast of DNGS coastline to a straight line 180° South of DNGS coastline; Lake Ontario from DPZ out to CPZ |
| Response Sector CPZ5 | Defined as the area within the following boundary: a straight line 180° South of DNGS coastline to a straight line 225° Southwest of DNGS coastline; Lake Ontario from DPZ out to CPZ |
| Response Sector CPZ6 | Region: Durham<br><br>Defined as the area within the following boundary (north; east; south; west): a straight line 270° West of DNGS coastline; Park Road and Lake Ontario from DPZ out to CPZ; a straight line 225° Southwest of DNGS coastline; Lake Ridge Road |
| Response Sector CPZ7 | Region: Durham<br><br>Defined as the area within the following boundary (north; east; south; west): a straight line 315° Northwest of DNGS coastline; Taunton Road, Harmony Road, Adelaide Avenue, Ritson Road, Bloor Street and Park Road; a straight line 270° West of DNGS coastline; Old Lake Ridge Road, Lake Ridge Road, Rossland Road, Coronation Road, Winchester Road, Thickson Road, Columbus Road, Thornton Road and Howden Road |

| | |
|---|---|
| Response Sector CPZ8 | Region: Durham<br><br>Defined as the area within the following boundary (north; east; south; west): Howden Road, Ritson Road, Ragland Road, Townline Road, Concession Road 10, Grasshopper Park Road and Regional Road 20; a straight line 360°/0° North of DNGS coastline; Taunton Road; a straight line 315° Northwest of DNGS coastline |

# APPENDIX M

Evacuation Sensitivity Studies

# M. EVACUATION SENSITIVITY STUDIES

This appendix presents the results of a series of sensitivity analyses. These analyses are designed to identify the sensitivity of the evacuation time estimate (ETE) to changes in some base evacuation conditions.

## M.1 Effect of Changes in Trip Generation Times

A sensitivity study was performed to determine whether changes in the estimated trip generation time have an effect on the ETE for the entire Detailed Protective Zone (DPZ). Specifically, if the tail of the mobilization distribution were truncated (i.e., if those who responded most slowly to the Emergency Bulletin to evacuate, could be persuaded to respond much more rapidly) or if the tail were elongated (i.e., spreading out the departure of evacuees to limit the demand during peak times), how would the ETE be affected? The case considered was Scenario 6, Region R03; a winter, midweek, midday, with good weather conditions) evacuation of the entire DPZ. Table M-1 presents the results of this study.

If evacuees mobilize 1 hour quicker or take an additional hour longer, there is no impact to the $90^{th}$ and $100^{th}$ percentile ETE. As discussed in Section 7.3, traffic congestion persists within the DPZ for 5 hours and 25 minutes after the Emergency Bulletin. As such, the ETE is not affected by the trip generation time (plus a 10-minute travel time to the DPZ boundary), but by the time needed to clear the congestion within the DPZ.

## M.2 Effect of Changes in the Number of People in the Shadow Region Who Relocate

A sensitivity study was conducted to determine the effect on ETE due to changes in the percentage of people who decide to relocate from the Shadow Region. The case considered was Scenario 6, Region R03; a winter, midweek, midday, with good weather evacuation of the entire DPZ. The movement of people in the Shadow Region has the potential to impede vehicles evacuating from an Evacuation Region within the DPZ. Refer to Sections 3.2 and 7.1 for additional information on population within the Shadow Region.

Table M-2 presents the ETE for each of the cases considered[1]. The results show that eliminating the shadow evacuation percentage (0%) reduces the $90^{th}$ and $100^{th}$ percentile ETE by 5 minutes and 40 minutes, respectively. Doubling (60%) the shadow evacuation percentage increases the $90^{th}$ percentile ETE by 30 minutes and increases the $100^{th}$ percentile ETE by 45 minutes. Full evacuation (100%) of the Shadow Region increases the $90^{th}$ and $100^{th}$ percentile ETE by 1 hour and 45 minutes and 1 hour 40 minutes, respectively –significant changes. The significant increase in the ETE is due to the proximity of the DPZ boundary to Oshawa, which is a highly populated municipality within the Shadow Region. As shown in Figure 7-3 through Figure 7-10, there is significant traffic congestion within this area. As such, the congestion in Oshawa increases significantly as the Shadow Evacuation increases. The more congestion within Oshawa, the less roadway capacity is available for DPZ evacuees, thus prolonging ETE.

[1] Seventeen percent (17%) shadow participation was analyzed as it was the results obtained from the demographic survey.

## M.3 Effects of Changes in Access Control Establish Time

A sensitivity study was conducted to determine the effect on ETE due to changes in time to establish access control along major evacuation routes. It is assumed that access control along Highway 401, Highway 407 and Route 115/35 can be established within 4 hours after the Emergency Bulletin to evacuate for the base scenario, as per discussions with MTO. A total of 41,896 external traffic vehicles to traverse the Study Area over 4 hours (see Section 3.9). For this sensitivity study, the time to establish access control was reduced to 2 hours. The case considered was Scenario 6, Region R03; a winter, midweek, midday, with good weather evacuation of the entire DPZ. Table M-3 presents the results of this study.

When access control is established within 2 hours the number of external traffic vehicles that traverse the study area is reduced by 50% (20,948 vehicles compared to 41,896 vehicles), as shown in Table M-3. This was computed, using the same methodology as 4 hours (see Section 3.9). This reduction in external traffic demand reduces the 90$^{th}$ and 100$^{th}$ percentile ETE by 30 minutes and 70 minutes, respectively – both significant changes for an evacuation of the DPZ. When there are less external traffic vehicles occupying Highway 401, Highway 407 and Route 115/35 for a shorter period of time, there is more available capacity for the DPZ evacuees, hence, reducing the ETE.

## M.4 Future Year Evacuation Time Estimates

The federal regulations (Section 2.2.4 of CNSC REGDOC-2.10.1) stipulate all licensees of reactor facilities with a thermal capacity greater than 10MW shall collaborate with the municipal or regional authorities to develop and maintain public ETE based on current census data, and future population growth projections on a per-decade estimation until the end of the life of the facility.

A sensitivity study was conducted for the DPZ boundary and Shadow Region (DPZ study area) for future year ETE for the years 2033, 2043, 2053, 2063, 2073, 2083 and 2088. Population growth and roadway improvements discussed in the following planning datasets and documents were reviewed as part of this analysis:

- Statistics Canada annual population updates by census subdivision from 2001 through 2021; only the most recent years – 2016 through 2021 – were used to calculate annual growth rates for the permanent resident population.
- Statistics Canada labour force data by census subdivision of 2016 and 2021 were used to calculate annual growth rates for employee population.
- 407 Express Toll Route[2]
- Ontario Ministry of Transportation[3]
- Durham Transportation Management Plan 2017, December 2017
- Connecting the GGH: A Transportation Plan for the Greater Golden Horseshoe, February 2022

[2] https://407etr.com/en/highway/corporate/usage-statistics.html
[3] https://icorridor-mto-on-ca.hub.arcgis.com/

- Ontario Power Generation Small Modular Reactors[4]

### M.4.1 Assumptions

The following assumptions were made for future year ETE:

1. Growth rates for permanent resident and employee population were computed from Statistics Canada data.
2. There are 1,592 employee vehicles commuting to the DNGS during peak times and it is assumed that these employee numbers will stay consistent for all future years.
3. The 1,150 employees associated with the DNGS Refurbishment and the Darlington Small Modular Reactor (DNNP) site preparation is eliminated for future years, as these projects is assumed to be completed by 2028, prior to future year 2033.
4. Permanent resident population to be considered for the DPZ study area.
5. The number of transit dependent residents will increase due to the increase in DPZ population.
6. All planned roadway improvements provided in the aforementioned planning documents will occur on schedule.
7. The population at all transient and special facilities (discussed in Section 3) will remain the same for all future year ETE.
8. External traffic vehicles travelling along Highway 401, Highway 407 and Route 115/35 increases for the future year.
9. The new OPG headquarters (at the old GM building) was not considered for the future year analysis since it was announced after the analysis was completed. Since REGDOC 2.10.1 states that ETE should be computed based on current census data, it is likely that the baseline ETE will be updated prior to 2033 (the first future year ETE presented in this study). The updated ETE, based on future census data, will include updates to the study area at that time, which will include the new OPG headquarters.

### M.4.2 Methodology

#### *Population Growth and Estimates*

The base permanent resident population for the 2023 ETE documented in Section 7 of this report was estimated using 2021 Census population data provided on the Statistics Canada website[5] projected to the year 2023 (see Section 3.1 for detailed methodology). The Response Sectors that comprise the approximate 10-kilometre DPZ for the DNGS can be seen in Figure 3-1. The population estimates[6] used for this study are for the time period from July 1, 2016 to July

[4] https://www.opg.com/innovating-for-tomorrow/small-modular-nuclear-reactors/
[5] https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E
[6] Detailed methodology of intercensal population estimates can be found at the following Statistics Canada webpage: https://www150.statcan.gc.ca/n1/pub/91-214-x/91-214-x2022001-eng.htm

1, 2021. This data is presented in Table 3-1 by census subdivision (municipality). The Census boundaries for the DNGS study area are shown in Figure 3-2.

Using the methodology discussed in Section 3.1 the permanent resident population was projected to 2033, 2043, 2053, 2063, 2073, 2083 and 2088. Table M-4 presents the extrapolated 2023 permanent resident population and estimated permanent resident population for the future years by Response Sector, for the Automatic Action Zone (AAZ), DPZ Inner Ring, the DPZ as a whole (Outer Ring), the Shadow Region and the entire study area (DPZ & Shadow Region (CPZ).

### *Employment Growth*

The 2016 and 2021 Census data products provide labour force statistics for each census subdivision. Using the same methodology discussed in Section 3.1 for the permanent resident population, these employee datasets were used to compute the annual growth rate for employees within the DPZ projected out to 2033, 2043, 2053, 2063, 2073, 2083 and 2088. The annual employment growth rates for each municipality used in this sensitivity study are provided in Table M-5.

Employment at DNGS and the new Darlington Small Modular Reactor (planned to be fully operational by 2033) was assumed to stay constant for all future years. The DNGS refurbishment employees (assumed completion of DNGS refurbishment) and DNNP site preparation employees (DNNP is fully operational by 2033) are eliminated for all future years. It is assumed that there will be 2,500 employees[7] at the new DNNP and similar to DNGS, 52% of them will commute from outside of the PZ. This results in 1,300 employees and 1,300 commuting employee vehicles (1 employee per vehicle). See Appendix E for employment at DNGS.

### *Transit Dependent Residential Demand*

As discussed in Section 3.7, the demographic survey results were used to estimate the portion of the population requiring transit service based on the percentage of households with no vehicle available. When the growth factor is applied to the permanent resident population of the DPZ, the transit dependent population will also increase. The calculations for the years 2033, 2043, 2053, 2063, 2073, 2083 and 2088 were performed using the methodology discussed in Section 3.7. Table M-6 presents the total increase in transit buses due to the increase in residential population and subsequent increase in transit dependent population. As discussed in Section 3.7, buses are represented as two passenger cars in this analysis.

### *External Traffic*

Traffic traveling through the study area was grown as well. An average annual growth rate was computed for external traffic based on AADT data from the years 2009 through 2019 (data taken from the Ontario Ministry of Transportation Traffic Volumes for 1988 – 2019) for Highway 401 and Route 115/35 and the 407 ETR Usage Statistics website[8] for Highway 407 from 2010 to 2019. This annual growth rate was then applied to the external traffic used in the baseline

[7] https://www.opg.com/documents/darlington-new-nuclear-project-insert-winter-2022-pdf/
[8] https://www.407etr.com/en/highway/corporate/usage-statistics.html

study to project the external traffic to 2033, 2043, 2053, 2063, 2073, 2083 and 2088.  shows the volume of external traffic that was loaded onto each highway for each study year. Note that Ontario Ministry of Transportation Traffic does not have traffic volumes beyond 2019. Even though this information was available for Highway 407, it was not utilized as the data appeared to be skewed by the COVID-19 pandemic.

Within the 10 years analyzed for Highway 401 and Route 115/35 (from 2009 to 2019) and 9 years for Highway 407 (from 2010 to 2019), the AADT along Highway 401 increased by 1.48%, and Highway 407 by 0.77%. It is assumed that these trends will continue over the next 10-year period from 2023 to 2033 and until 2088. Thus, the hourly volume rates along these highways were increased accordingly. These hourly volumes were multiplied by 4 since it takes 4 hours to establish access control along these highways.

#### *Roadway Improvements*

All roadway improvements discussed in the aforementioned planning documents were incorporated into each future year link-node analysis network depending on the estimated time of completion. Links and/or nodes were added, changed, or removed to accurately model each of the planned improvements. The roadway improvements provided in Table M-8 were modelled accordingly.

Appendix 4 of the Durham Region Transportation Master Plan (DRTMP) documents all proposed regional road expansion project planned between 2004 and 2031. The planned roadway improvements within the DNGS study area provided by these sources are provided in Table M-8. The appropriate changes were made to the 2023 link-node analysis network to compute the future year ETEs. Since all roadway improvements are listed until 2031 and beyond, the link node analysis networks for all future year studies were kept the same. “Connecting the Greater Gold Horseshoe (GGH): A Transportation Plan for the Greater GHH”, dated February 2022 provided infrastructure improvements for year 2051. However, this report does not provide any specific details on capacity improvements on certain highways. This report discusses that the capacity of Highway 401 from Brock Road to Route 35/115 will be increased but does not provide any specific details, hence, this improvement was not considered.

### M.4.3 Results

#### *2033*

Table M-9 and Table M-10 provide the 90th and 100th percentile projected ETE for 2033, respectively. The 90th percentile ETE for the AAZ (Region R01) ranges from 1 hour and 50 minutes to 2 hours and 25 minutes. The 90th percentile ETE for the DPZ Inner Ring (Region R02) ranges from 3 hours and 5 minutes to 4 hours and 30 minutes. The 90th percentile ETE for the full DPZ (R03) ranges from 3 hours and 25 minutes to 5 hours and 10 minutes.

The 100th percentile ETE for the AAZ is dictated by mobilization time of 4 hours and 15 minutes for non-heavy snow conditions and 4 hours and 45 minutes for heavy snow scenarios. For the

DPZ Inner and Outer Rings, on average, the ETE is 75 minutes and 120 minutes higher than the mobilization time, respectively, for non-heavy snow scenarios.

In comparison to the 2023 ETE results presented in Table 7-1 and Table 7-2, the 90th percentile ETE increases by at most 35 minutes. The 100th percentile ETE for the AAZ is not affected, however, the 100th percentile ETE for the DPZ Inner and Outer Rings increase by 1 hour 35 minutes and 1 hour 45 minutes, respectively. These increases are due to the increase in resident population within the study area. The increase in capacity from the roadway improvements is not sufficient to offset the increase in demand.

### *2043*

Table M-11 and Table M-12 provide the 90th and 100th percentile projected ETE for 2043, respectively. The 90th percentile ETE for the AAZ ranges from 1 hour and 55 minutes to 2 hours and 25 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 3 hours and 25 minutes to 4 hours and 50 minutes. The 90th percentile ETE for the full DPZ ranges from 3 hours and 55 minutes to 5 hours and 50 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, the ETE is 1 hour and 40 minutes and 3 hours higher than the mobilization time, on average, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 30 minutes for the AAZ, 35 minutes for DPZ Inner Ring and up to 80 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is not affected, however, the 100th percentile ETE for the DPZ Inner and Outer Rings increase by 2 hours 10 minutes and 2 hours 15 minutes at most, respectively.

In comparison to the 2033 ETE in Table M-9 and Table M-10, the 90th percentile ETE increase by 5 minutes for the AAZ, and by 25 minutes and 55 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ remains the same and the DPZ Inner Ring and Outer Ring increases by 30 minutes and 55 minutes on average, respectively.

### *2053*

Table M-13 and Table M-14 provide the 90th and 100th percentile projected ETE for 2053, respectively. The 90th percentile ETE for the AAZ ranges from 1 hour and 55 minutes to 2 hours and 25 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 3 hours and 45 minutes to 5 hours and 35 minutes. The 90th percentile ETE for the full DPZ ranges from 4 hours and 30 minutes to 6 hours and 45 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, the ETE is on average, 2 hours and 40 minutes and 3 hours and 55 minutes higher than the mobilization time, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 30 minutes for the AAZ, 1 hour and 15 minutes for the DPZ Inner Ring and up to 2 hours and 10 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is not affected, however, the 100th percentile ETE for the DPZ Inner and Outer Rings increase by 2 hours 55 minutes and 3 hours 15 minutes at most, respectively.

In comparison to the 2043 ETE in Table M-11 and Table M-12, the 90th percentile ETE remains the same for the AAZ and increases by 45 minutes and 60 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ remains the same and the DPZ Inner Ring and Outer Ring increases by 60 minutes, on average.

### *2063*

Table M-15 and Table M-16 provide the 90th and 100th percentile projected ETE for 2063, respectively. The 90th percentile ETE for the AAZ ranges from 1 hour and 55 minutes to 2 hours and 25 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 4 hours and 20 minutes to 6 hours and 15 minutes. The 90th percentile ETE for the full DPZ ranges from 5 hours and 30 minutes to 8 hours and 15 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, the ETE is 3 hours and 25 minutes and 5 hours higher than the mobilization time, on average, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 30 minutes for the AAZ, 1 hour and 55 minutes for the DPZ Inner Ring and up to 3 hours and 35 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is not affected, however, the 100th percentile ETE for the DPZ Inner and Outer Rings increase by at most 4 hours and 4 hours 35 minutes, respectively.

In comparison to the 2053 ETE in Table M-13 and Table M-14, the 90th percentile ETE remains the same for the AAZ and increases by 50 minutes and 90 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ remains the same and the DPZ Inner Ring and Outer Ring increases by 50 minutes and 65 minutes on average, respectively.

### *2073*

Table M-17 and Table M-18 provide the 90th and 100th percentile projected ETE for 2073, respectively. The 90th percentile ETE for the AAZ ranges from 1 hour and 55 minutes to 2 hours and 25 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 4 hours and 55 minutes to 7 hours and 25 minutes. The 90th percentile ETE for the full DPZ ranges from 6 hours and 40 minutes to 9 hours and 35 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, the ETE is 4 hours and 25 minutes and 6 hours and 10 minutes higher than the mobilization time, on average, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 30 minutes for the AAZ, 3 hours and 5 minutes for the DPZ Inner Ring and up to 4 hours and 55 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is not affected, however, the 100th percentile ETE for the DPZ Inner and Outer Rings increase by at most 4 hours and 45 minutes and 6 hours 10 minutes, respectively.

In comparison to the 2063 ETE in Table M-15 and Table M-16, the 90th percentile ETE increases by 5 minutes for the AAZ and increases by 1 hour and 10 minutes and 1 hour and 40 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ remains the same and the DPZ Inner Ring and Outer Ring increases by 60 minutes and 75 minutes on average, respectively.

### *2083*

Table M-19 and Table M-20 provide the 90th and 100th percentile projected ETE for 2083, respectively. The 90th percentile ETE for the AAZ ranges from 2 hours to 2 hours and 30 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 5 hours and 45 minutes to 8 hours and 40 minutes. The 90th percentile ETE for the full DPZ ranges from 8 hours and 20 minutes to 12 hours and 5 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, the ETE is 5 hours and 35 minutes and 8 hours and 40 minutes higher than the mobilization time, on average, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 35 minutes for the AAZ, 4 hours and 20 minutes for the DPZ Inner Ring and up to 7 hours and 25 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is increased by 5 minutes and the DPZ Inner and Outer Rings increase by 6 hours and 15 minutes and 9 hours 20 minutes at most, respectively.

In comparison to the 2073 ETE in Table M-17 and Table M-18, the 90th percentile ETE increases by 5 minutes for the AAZ and increases by 75 minutes and 2 hours and 30 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ increases by 5 minutes and the DPZ Inner Ring and Outer Ring increases by 75 minutes and 2 hours and 25 minutes on average, respectively.

### *2088*

Table M-21 and Table M-22 provide the 90th and 100th percentile projected ETE for 2088, respectively. The 90th percentile ETE for the AAZ ranges from 2 hours to 2 hours and 40 minutes. The 90th percentile ETE for the DPZ Inner Ring ranges from 6 hours and 20 minutes to 9 hours and 20 minutes. The 90th percentile ETE for the full DPZ ranges from 9 hours and 20 minutes to 12 hours and 55 minutes.

The 100th percentile ETE for the AAZ is still dictated by mobilization time. For the DPZ Inner and Outer Rings, on average, the ETE is 6 hours and 15 minutes and 10 hours and 5 minutes higher than the mobilization time, respectively, for non-snow scenarios.

Compared to the 2023 ETE results, the 90th percentile ETE increases by at most 45 minutes for the AAZ, 5 hours for the DPZ Inner Ring and up to 8 hours and 15 minutes for the DPZ Outer Ring. The 100th percentile ETE for the AAZ is increased by 5 minutes and the DPZ Inner and Outer Rings increase by 7 hours and 30 minutes and 10 hours 50 minutes at most, respectively.

In comparison to the 2083 ETE in Table M-19 and Table M-20, the 90th percentile ETE increases by 10 minutes for the AAZ and increases by 55 minutes and 70 minutes at most for the DPZ Inner Ring and DPZ Outer Ring, respectively. The 100th percentile ETE for AAZ increases by 5 minutes and the DPZ Inner Ring and Outer Ring increases by 45 minutes and 90 minutes on average, respectively.

## M.5 Enhancements in Evacuation Time

This appendix documents sensitivity studies on critical variables that could impact ETE.

- Changes in the trip generation time have little to no impact on ETE (Section M.1) when reducing the trip generation because congestion dictates the ETE for the DNGS DPZ until 5 hours and 25 minutes. If the trip generation time surpasses 5 hours and 25 minutes the 100$^{th}$ percentile ETE would be affected.
- Shadow evacuation can have a significant impact on ETE (Section M.2). Public outreach could be considered to inform those people within the DPZ (and potentially beyond the DPZ) that if they are not advised to evacuate, they should not, as they may delay those who are more at risk.
- The number of external traffic vehicles that traverse the study area can have a significant impact on ETE (See Section M.3). Access control along major highways should be established as quickly as possible. When establishing access control, care should be given to allow first responders and emergency managers into the study area. It should be noted, an earlier activation of access control could delay returning commuters, including those using GO trains,
- Significant population growth results in more evacuating vehicles which could significantly increase ETE (Section M.4). Public outreach to inform those people within the DPZ to evacuate as a family in a single vehicle would reduce the number of evacuating vehicles and could reduce ETE or offset the impact of increased population.
- Roadway improvements can increase roadway capacity which could decrease ETE. Construction schedules and plans should be monitored to determine if ETE will be impacted.

**Table M-1. Evacuation Time Estimates for Trip Generation Sensitivity Study**

| Trip Generation Period | Evacuation Time Estimate for Entire DPZ | |
|---|---|---|
| | 90th Percentile | 100th Percentile |
| 3 hours and 15 minutes | 3:45 | 5:40 |
| 4 hours and 15 minutes (Base) | 3:45 | 5:40 |
| 5 hours and 15 minutes | 3:45 | 5:40 |

**Table M-2. Evacuation Time Estimates for Shadow Sensitivity Study**

| Percent Shadow Evacuation | Evacuating Shadow Vehicles[9] | Evacuation Time Estimate for Entire DPZ | |
|---|---|---|---|
| | | 90th Percentile | 100th Percentile |
| 0 | 0 | 3:40 | 5:00 |
| 17 (Survey) | 25,198 | 3:40 | 5:30 |
| 20 | 29,644 | 3:40 | 5:30 |
| 30 (Base) | 44,466 | 3:45 | 5:40 |
| 40 | 59,288 | 3:55 | 5:55 |
| 60 | 88,932 | 4:15 | 6:25 |
| 80 | 118,576 | 4:50 | 6:50 |
| 100 | 148,220 | 5:30 | 7:20 |

**Table M-3. Evacuation Time Estimates for Time to Establish Access Control Time Sensitivity Study**

| Time to Establish ACP | Number of External Traffic Vehicles | Evacuation Time Estimate for Entire DPZ | |
|---|---|---|---|
| | | 90th Percentile | 100th Percentile |
| 2 Hours | 20,948 | 3:15 | 4:30 |
| 4 Hours (Base) | 41,896 | 3:45 | 5:40 |

[9] The Evacuating Shadow Vehicles, in Table M-2, represent the residents and employees who will spontaneously decide to relocate during the evacuation. The basis, for the base values shown, is a 30% relocation of shadow residents along with a proportional percentage of shadow employees. See Section 6 for further discussion.

**Table M-4. DPZ Population by Study Year**

| Response Sector | 2023 Extrapolated Population | 2033 Extrapolated Population | 2043 Extrapolated Population | 2053 Extrapolated Population | 2063 Extrapolated Population | 2073 Extrapolated Population | 2083 Extrapolated Population | 2088 Extrapolated Population |
|---|---|---|---|---|---|---|---|---|
| DNGS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D1 | 77 | 92 | 109 | 134 | 161 | 194 | 232 | 254 |
| D14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **AAZ:** | **77** | **92** | **109** | **134** | **161** | **194** | **232** | **254** |
| D2 | 19,619 | 23,616 | 28,420 | 34,230 | 41,199 | 49,597 | 59,700 | 65,502 |
| D3 | 11,590 | 13,950 | 16,780 | 20,219 | 24,338 | 29,294 | 35,265 | 38,690 |
| D4 | 24,445 | 29,429 | 35,393 | 42,634 | 51,322 | 61,789 | 74,373 | 81,599 |
| D5 | 9,452 | 11,369 | 13,673 | 16,486 | 19,842 | 23,891 | 28,751 | 31,541 |
| D15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **DPZ Inner Ring:** | **65,106** | **78,364** | **94,266** | **113,569** | **136,701** | **164,571** | **198,089** | **217,332** |
| D6A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D6B | 15,041 | 18,280 | 22,213 | 26,985 | 32,790 | 39,841 | 48,402 | 53,365 |
| D7 | 4,933 | 5,993 | 7,283 | 8,849 | 10,751 | 13,066 | 15,874 | 17,500 |
| D8A | 17,398 | 21,144 | 25,692 | 31,211 | 37,921 | 46,083 | 55,984 | 61,715 |
| D8B | 6,214 | 7,552 | 9,179 | 11,154 | 13,550 | 16,463 | 20,003 | 22,049 |
| D9 | 14,200 | 17,245 | 20,954 | 25,463 | 30,937 | 37,593 | 45,673 | 50,343 |
| D10 | 8,263 | 9,945 | 11,966 | 14,411 | 17,346 | 20,889 | 25,142 | 27,581 |
| D11 | 2,043 | 2,457 | 2,956 | 3,560 | 4,285 | 5,160 | 6,209 | 6,815 |
| D12 | 4,538 | 5,465 | 6,568 | 7,914 | 9,531 | 11,474 | 13,810 | 15,152 |
| D13 | 2,304 | 2,771 | 3,333 | 4,018 | 4,841 | 5,824 | 7,015 | 7,698 |
| D16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **DPZ Outer Ring:** | **74,934** | **90,852** | **110,144** | **133,565** | **161,952** | **196,393** | **238,112** | **262,218** |
| **Shadow Region (CPZ):** | **270,207** | **326,627** | **394,735** | **477,352** | **577,081** | **697,623** | **843,380** | **927,362** |
| **DPZ & Shadow Region:** | **410,324** | **495,935** | **599,254** | **724,620** | **875,895** | **1,058,781** | **1,279,813** | **1,407,166** |

**Table M-5. Employment Growth Rates**

| Municipality | Annual Growth Rate |
|---|---|
| Clarington | 0.25% |
| Oshawa | 0.21% |
| Whitby | -0.07% |

**Table M-6. Transit Bus Needs**

| Study Year | DPZ Transit Dependent Population | Buses Needed for the DPZ |
|---|---|---|
| 2023 | 1,474 | 55 |
| 2033 | 1,780 | 65 |
| 2043 | 2,151 | 78 |
| 2053 | 2,600 | 84 |
| 2063 | 3,143 | 87 |
| 2073 | 3,798 | 89 |
| 2083 | 4,590 | 94 |
| 2088 | 5,046 | 96 |

**Table M-7. External Traffic Demand Growth**

| Road Name | 2023 Hourly Volume | Percent Change in 10 Years | 2033 Hourly Volume | 2043 Hourly Volume | 2053 Hourly Volume | 2063 Hourly Volume | 2073 Hourly Volume | 2083 Hourly Volume | 2088 Hourly Volume |
|---|---|---|---|---|---|---|---|---|---|
| Hwy 401 | 3,121 | 1.48% | 3,167 | 3,214 | 3,262 | 3,311 | 3,360 | 3,410 | 3,460 |
| Hwy 401 | 4,459 | 1.48% | 4,525 | 4,592 | 4,661 | 4,730 | 4,800 | 4,871 | 4,944 |
| Hwy 407 | 778 | 0.77% | 784 | 790 | 796 | 802 | 808 | 815 | 821 |
| Hwy 115/35 | 1,338 | 1.48% | 1,358 | 1,378 | 1,398 | 1,419 | 1,440 | 1,462 | 1,483 |
| | 778 | 0.77% | 784 | 790 | 796 | 802 | 808 | 815 | 821 |
| **Totals** | **10,474** | | **10,618** | **10,765** | **10,913** | **11,064** | **11,217** | **11,372** | **11,529** |

**Table M-8. Roadway Improvements**

| Project Road Description | Endpoints of Construction Project | Project Description |
|---|---|---|
| Regional Road 57 | Baseline Road to south of King Street | Widen from 2 to 4 lanes (1 to 2 lanes in one direction) |
| Regional Road 57 | South of King Street to north of Stevens Road | Widen from 2 to 4 lanes (1 to 2 lanes in one direction) |
| Manning Road/Adelaide Ave | Garrard Road to Thornton Road | Construct new connection to 3 lanes, with new crossing of Corbett Creek |
| Victoria Street | South Blair Street to west of Thickson Road | Construct a new alignment and widen from 2 to 5 lanes (2 to 3 lanes in one direction) |
| Lake Ridge Road | Bayly Street/Victoria Street to Kingston Road/Dundas Street | Widen from 2 to 4/5 lanes (2 to 3 lanes in one direction) |
| Thickson Road | Wentworth Street to CNR Kingston | Widen from 2 to 4 lanes (1 to 2 lanes in one direction) |
| Simcoe Street | Conlin Road to Winchester Road | Widen from 2/4 to 5 lanes (1 to 3 lanes in one direction) |
| Liberty Street | Baseline Road to King Street | Widen from 2 to 3 lanes (1 to 2 lanes in one direction) |
| Gibb Street | East of Stevenson Road to Simcoe Street | Widen from 3 to 4/5 lanes (1 to 2 lanes in one direction) |
| Rossland Road | Riston Road to Harmony Road | Widen from 3 to 5 lanes (1 to 2 lanes in one direction) |
| Hopkins Street | Victoria Street to Consumers Drive | Construct new 4-lane overpass of Highway 401 |
| Thornton Road | North of Consumers Drive Extension to King Street | Widen from 2 to 4 lanes, with new CPR grade separation |
| Regional Road 57 | North of Stevens Road to north of Nash Road | Widen from 2 to 4 lanes (1 to 2 lanes in one direction) |
| Bloor Street | Harmony Road to Grandview Drive | Construct new alignment to 4 lanes, with new CPR grade separation and bridge crossing of Farewell Creek |
| Lake Ridge Road | Kingston Road/Dundas Street to Rossland Road | Widen 2 to 4/5 lanes (2 to 3 lanes in one direction) |
| Thickson Road | Consumers Drive to Dundas Street | Widen from 5 to 7 lanes (1 to 2 lanes in one direction) |
| Thickson Road | Taunton Road to Highway 407 | Widen from 2 to 4/5 lanes (2 to 3 lanes in one direction |
| Thickson Road | Winchester Road to Baldwin Street | Widen from 2 to 4/5 lanes (2 to 3 lanes in one direction |
| Ritson Road | Taunton Road to Conlin Road | Widen from 2/3 to 5 lanes (2 to 3 lanes in one direction) |
| Adelaide Avenue | Townline Road to Trulls Road | Construct new bridge crossing of Farewell Creek and new 3-lane connection |
| Baldwin Street (Regional Highway 12) | Taunton Road to Highway 407 | Widen from 2 to 4/5 lanes (1 to 3 lanes in one direction) |
| Gibb Street/Olive Avenue | Simcoe Street to Ritson Road | Construct new connection and widen from 2/3 lanes to 4/5 lanes (1 to 2 lanes in one direction) |
| Bayly Street | Brock Road to Westney Road | Widen from 5 to 7 lanes (3 to 4 lanes in one direction) |
| Bayly Street | Harwood Avenue to Salem Road | Widen from 4 to 6 lanes (3 lanes in one direction) |
| Bloor Street | Ritson Road to Farewell Street | Widen from 3 to 5 lanes (2 to 3 lanes in one direction |

| Project Road Description | Endpoints of Construction Project | Project Description |
|---|---|---|
| Rossland Road | Harmony Road to east of Townline Road | Construct new alignment to 3 lanes including new bridge crossing of Harmony Creek tributary (1 to 2 lanes in each direction) |
| Wilson Road | Bloor Street to Olive Avenue | Widen from 2/3 to 4 lanes (2 lanes in each direction |
| Regional Highway 2 | East of Newcastle | Widen railway overpass tunnel from 1 to 2 lanes (bridge replacement) (1 lane in each direction) |
| Simcoe Street | Winchester Road to Howden Road | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Winchester Road | Garrard Road to Simcoe Street | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Taunton Road | Simcoe Street to Townline Road | Widen from 5 to 6/7 lanes (3 to 4 lanes in each direction) |
| Bloor Street | Grandview Drive to Prestonvale Road | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Lake Ridge Road | Highway 7 to Brawley Road | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Westney Road | Bridges under Highway 401 and CNR/GO Rail corridor | Widen bridges to 6/7 lanes (3 to 4 lanes in each direction) |
| Harmony Road | Britannia Avenue to Winchester Road | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Courtice Road | Bloor Street to Highway 401 | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Wilson Road | Olive Avenue to Bond Street | Widen from 3 to 4 lanes (2 lanes in each direction) |
| Townline Road | Olive Avenue to Bloor Street | Construct new bridge crossing of Farewell Creek, with widening of approach roads from 2 to 3 lanes (1 to 2 lanes in each direction) |
| Townline Road | Adelaide Avenue to Pebblestone Road | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Gibb Street | Stevenson Road to Thornton Road | Widen from 2 to 4 lanes (2 lanes in each direction) |
| King Street | Townline Road to Highway 418 | Widen from 4/5 lanes to 7 lanes (3 to 4 lanes in each direction) |
| King Street / Regional Highway 2 | Mearns Avenue to Highway 35/115 | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Baseline Road | Holt Road to Regional Road 57 | Widen from 2 to 4 lanes (2 lanes in each direction) |
| Bloor Street | Courtice Road to Holt Road | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Columbus Road | Whitby/Oshawa boundary to Grandview Street | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Harmony Road | Winchester Road to Highway 407 | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| King Street | Harmony Road to Townline Road | Widen from 4/5 lanes to 7 lanes (3 to 4 lanes in each direction) |
| Lambs Road | Durham Highway 2 to Highway 401 | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Thornton Road | Taunton Road to Howden Road | Widen from 2 to 4/5 lanes (2 to 3 lanes in each direction) |
| Townline Road | Conlin Road to Winchester Road | Construct new 3-lane road and grade separation over Highway 407 (1 to 2 lanes in each direction) |

Table M-9. Time to Clear the Indicated Area of *__90__* Percent of the Affected Population – 2033

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 1:50 | 2:00 | 2:00 | 2:00 | 2:00 | 1:55 | 2:05 | 2:25 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:55 |
| **R02** | 3:45 | 4:05 | 3:35 | 4:00 | 3:05 | 3:55 | 4:15 | 4:30 | 3:35 | 3:45 | 4:25 | 3:05 | 3:35 | 3:45 |
| **R03** | 4:10 | 4:25 | 3:50 | 4:05 | 3:30 | 4:10 | 4:40 | 5:10 | 3:50 | 4:05 | 4:40 | 3:25 | 3:50 | 4:10 |

Table M-10. Time to Clear the Indicated Area of *__100__* Percent of the Affected Population – 2033

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 5:35 | 6:00 | 5:00 | 6:00 | 4:25 | 6:00 | 6:30 | 7:10 | 4:55 | 5:25 | 6:40 | 4:25 | 5:05 | 5:55 |
| **R03** | 6:40 | 7:00 | 5:50 | 6:30 | 4:50 | 6:50 | 8:00 | 8:10 | 5:45 | 6:45 | 7:25 | 4:35 | 5:55 | 6:40 |

**Table M-11. Time to Clear the Indicated Area of *90* Percent of the Affected Population – 2043**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 1:55 | 2:05 | 2:00 | 2:00 | 2:00 | 1:55 | 2:05 | 2:25 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:55 |
| **R02** | 4:00 | 4:30 | 3:45 | 4:15 | 3:30 | 4:00 | 4:25 | 4:50 | 3:45 | 4:10 | 4:30 | 3:25 | 3:55 | 4:10 |
| **R03** | 4:45 | 5:10 | 4:20 | 4:50 | 3:55 | 4:50 | 5:25 | 5:50 | 4:15 | 4:40 | 5:35 | 3:55 | 4:15 | 4:50 |

**Table M-12. Time to Clear the Indicated Area of *100* Percent of the Affected Population – 2043**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 6:00 | 6:55 | 5:30 | 6:35 | 4:35 | 6:15 | 6:30 | 7:40 | 5:35 | 6:10 | 6:40 | 4:25 | 5:50 | 7:00 |
| **R03** | 7:40 | 8:05 | 6:45 | 8:05 | 5:40 | 7:10 | 8:10 | 8:10 | 6:20 | 7:40 | 8:25 | 5:25 | 6:50 | 8:25 |

**Table M-13. Time to Clear the Indicated Area of *__90__* Percent of the Affected Population – 2053**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 1:55 | 2:05 | 2:00 | 2:00 | 2:00 | 1:55 | 2:05 | 2:25 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:55 |
| **R02** | 4:25 | 4:55 | 4:15 | 4:40 | 3:45 | 4:20 | 4:50 | 5:35 | 4:05 | 4:35 | 5:10 | 3:50 | 4:15 | 4:25 |
| **R03** | 5:25 | 6:10 | 5:00 | 5:35 | 4:30 | 5:35 | 5:55 | 6:45 | 5:10 | 5:40 | 6:30 | 4:40 | 5:10 | 5:35 |

**Table M-14. Time to Clear the Indicated Area of *__100__* Percent of the Affected Population – 2053**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 7:00 | 7:30 | 7:20 | 7:25 | 5:00 | 6:50 | 7:55 | 8:05 | 6:40 | 7:35 | 8:30 | 5:05 | 6:55 | 7:10 |
| **R03** | 8:10 | 9:30 | 7:35 | 8:40 | 6:10 | 8:15 | 8:35 | 9:55 | 8:00 | 9:00 | 9:25 | 6:40 | 8:00 | 9:00 |

**Table M-15. Time to Clear the Indicated Area of *90* Percent of the Affected Population – 2063**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 1:55 | 2:05 | 2:00 | 2:00 | 2:00 | 1:55 | 2:05 | 2:25 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:55 |
| **R02** | 5:00 | 5:40 | 4:35 | 5:05 | 4:20 | 5:10 | 5:30 | 6:15 | 4:35 | 5:10 | 5:55 | 4:20 | 4:35 | 5:10 |
| **R03** | 6:45 | 7:05 | 6:05 | 6:35 | 5:30 | 6:25 | 7:15 | 8:15 | 6:05 | 6:35 | 7:25 | 5:30 | 5:55 | 6:40 |

**Table M-16. Time to Clear the Indicated Area of *100* Percent of the Affected Population – 2063**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 7:55 | 8:55 | 7:20 | 7:55 | 6:05 | 8:25 | 8:30 | 9:55 | 7:00 | 8:00 | 9:00 | 6:00 | 7:25 | 8:20 |
| **R03** | 10:00 | 10:00 | 9:00 | 9:35 | 7:55 | 9:10 | 10:30 | 11:25 | 8:30 | 9:30 | 10:25 | 7:55 | 8:30 | 10:10 |

Table M-17. Time to Clear the Indicated Area of ***90*** Percent of the Affected Population – 2073

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | **Midday** | | **Midday** | | **Evening** | **Midday** | | | **Midday** | | | **Evening** | **Midday** | **Midday** |
| | **Good Weather** | **Rain** | **Good Weather** | **Rain** | **Good Weather** | **Good Weather** | **Rain/Light Snow** | **Heavy Snow** | **Good Weather** | **Rain/Light Snow** | **Heavy Snow** | **Good Weather** | **Special Event** | **Roadway Impact** |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 2:00 | 2:05 | 2:00 | 2:00 | 2:00 | 2:00 | 2:10 | 2:25 | 2:00 | 2:00 | 2:25 | 2:00 | 2:00 | 1:55 |
| **R02** | 6:00 | 6:35 | 5:30 | 6:05 | 4:55 | 5:50 | 6:20 | 7:25 | 5:30 | 6:05 | 6:50 | 5:00 | 5:35 | 5:55 |
| **R03** | 7:55 | 8:30 | 7:15 | 7:55 | 6:40 | 7:40 | 8:35 | 9:35 | 7:05 | 8:00 | 9:05 | 6:40 | 7:05 | 7:40 |

Table M-18. Time to Clear the Indicated Area of ***100*** Percent of the Affected Population – 2073

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| **Scenario:** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** |
| **Region** | **Midday** | | **Midday** | | **Evening** | **Midday** | | | **Midday** | | | **Evening** | **Midday** | **Midday** |
| | **Good Weather** | **Rain** | **Good Weather** | **Rain** | **Good Weather** | **Good Weather** | **Rain/Light Snow** | **Heavy Snow** | **Good Weather** | **Rain/Light Snow** | **Heavy Snow** | **Good Weather** | **Special Event** | **Roadway Impact** |
| **Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring** | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:15 |
| **R02** | 9:00 | 9:30 | 8:25 | 9:20 | 6:55 | 8:35 | 9:30 | 11:00 | 8:40 | 9:35 | 10:35 | 7:00 | 8:40 | 9:00 |
| **R03** | 10:30 | 11:45 | 9:50 | 11:00 | 9:25 | 10:35 | 11:45 | 13:45 | 9:40 | 11:15 | 12:45 | 9:40 | 9:40 | 10:30 |

Table M-19. Time to Clear the Indicated Area of *90* Percent of the Affected Population – 2083

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 2:00 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:10 | 2:30 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:00 |
| **R02** | 6:55 | 7:20 | 6:20 | 7:00 | 5:45 | 6:55 | 7:20 | 8:40 | 6:20 | 6:55 | 8:05 | 6:15 | 6:40 | 7:00 |
| **R03** | 9:15 | 10:15 | 8:50 | 9:40 | 8:30 | 9:20 | 10:10 | 12:05 | 8:50 | 9:30 | 11:00 | 8:20 | 8:40 | 9:20 |

Table M-20. Time to Clear the Indicated Area of *100* Percent of the Affected Population – 2083

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 4:15 | 4:15 | 4:15 | 4:15 | 4:15 | 4:20 | 4:20 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:20 |
| **R02** | 10:25 | 10:30 | 9:00 | 10:05 | 8:15 | 10:00 | 10:30 | 12:45 | 9:05 | 10:00 | 12:00 | 9:00 | 10:25 | 10:35 |
| **R03** | 13:00 | 13:55 | 12:15 | 13:20 | 11:55 | 13:00 | 13:55 | 16:55 | 12:25 | 13:20 | 15:30 | 12:10 | 12:25 | 13:00 |

**Table M-21. Time to Clear the Indicated Area of *90* Percent of the Affected Population – 2088**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:05 | 2:10 | 2:40 | 2:05 | 2:05 | 2:30 | 2:05 | 2:05 | 2:00 |
| **R02** | 7:35 | 8:15 | 7:10 | 7:25 | 6:20 | 7:25 | 7:55 | 9:20 | 6:45 | 7:35 | 8:35 | 6:25 | 7:15 | 7:30 |
| **R03** | 10:20 | 11:05 | 9:35 | 10:30 | 9:20 | 10:20 | 11:05 | 12:55 | 9:35 | 10:30 | 12:10 | 9:20 | 9:35 | 10:10 |

**Table M-22. Time to Clear the Indicated Area of *100* Percent of the Affected Population – 2088**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Weekend | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Rain/Light Snow | Heavy Snow | Good Weather | Special Event | Roadway Impact |
| Evacuate Automatic Action Zone, Detailed Planning Zone Inner Ring, and Detailed Planning Zone Outer Ring | | | | | | | | | | | | | | |
| **R01** | 4:20 | 4:20 | 4:15 | 4:15 | 4:15 | 4:20 | 4:20 | 4:45 | 4:15 | 4:15 | 4:45 | 4:15 | 4:15 | 4:20 |
| **R02** | 10:25 | 12:25 | 10:35 | 10:35 | 9:15 | 10:00 | 11:30 | 14:00 | 9:40 | 11:35 | 13:00 | 9:05 | 10:25 | 10:55 |
| **R03** | 14:50 | 15:25 | 13:50 | 14:45 | 13:30 | 14:50 | 15:30 | 18:25 | 13:40 | 14:30 | 17:40 | 13:25 | 13:50 | 14:30 |

# APPENDIX N

ETE Criteria Checklist

## N. ETE CRITERIA CHECKLIST

**Table N-1. ETE Review Criteria Checklist**

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **1.0 Introduction** | | |
| a. The study area (AAZ, DPZ Inner Ring, DPZ Outer Ring & CPZ) and surrounding area should be described. | Yes | Section 1.2 |
| b. A map should be included that identifies primary features of the site, including major roadways, significant topographical features, boundaries of municipalities, and population centres within the study area. | Yes | Figures 1-1, Figure 3-1, Figure 6-1 |
| c. A comparison of the current and previous ETE should be provided and includes similar information as identified in Table 1-1, "ETE Comparison," of NUREG/CR-7002, Rev.1. | Yes | Table 1-3 |
| **1.1 Approach** | | |
| a. A general approach is described in the report as outlined in Section 1.1, "Approach," of NUREG/CR-7002, Rev. 1. | Yes | Section 1.1, Section 1.3, Appendix D<br>Table 1-1 |
| **1.2 Assumptions** | | |
| a. Assumptions consistent with Table 1-2, "General Assumptions," of NUREG/CR-7002, Rev. 1 are provided and include the basis to support use. | Yes | Section 2 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **1.3 Scenario Development** | | |
| a. The scenarios in Table 1-3, “Evacuation Scenarios,” are developed for the ETE analysis. A reason is provided for use of other scenarios or for not evaluating specific scenarios. | Yes | Table 2-1, Section 6, Table 6-3 |
| **1.4 Evacuation Planning Areas** | | |
| a. A map of the study area with response sectors should be included. | Yes | Figure 3-1, Figure 6-1 |
| **1.4.1 Keyhole Evacuation** | | |
| a. A table similar to Table 1-4 “Evacuation Areas for a Keyhole Evacuation”, is provided identifying the Response Sector considered for each ETE calculation by downwind direction. | Yes | Table 6-1, Table 6-2, Table 7-5, Table 7-6, Table H-1 |
| **1.4.2 Staged Evacuation** | | |
| a. The approach used in development of a staged evacuation is discussed | Yes | Section 5.4.2, Section 7.7, Table 6-2, Table 7-6 |
| b. A table similar to Table 1-4, “Evacuation Areas for a Staged Evacuation Keyhole,” of NUREG/CR-7002, Rev. 1 should be provided and includes the complete evacuation of the 3, 6, and 10 kilometre areas and for the 3 kilometre area/10 kilometre keyhole evacuations. | Yes | Table 6-2, Table 7-6 |
| **2.0 Demand Estimation** | | |
| a. Demand estimation should be developed for the four population groups, including permanent residents of the study area, transients, special facilities, and schools. | Yes | Section 3 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **2.1 Permanent Residents and Transient Population** | | |
| a. The U.S. Census should be the source of the population values, or another credible source should be provided. | Yes | Section 3.1, Used 2021 Statistics Canada |
| b. The availability date of the census data is provided. | Yes | Section 3.1 |
| c. Population values are adjusted as necessary for growth to reflect population estimates to the year of the ETE. | Yes | Section 2.1, Item 2 and Section 3.1 |
| d. A sector diagram, similar to Figure 2-1, "Population by Sector," of NUREG/CR-7002, Rev. 1, showing the population distribution for permanent residents. | Yes | Figure 3-3 and Figure 3-4 |
| **2.1.1 Permanent Residents with Vehicles** | | |
| a. The persons per vehicle value should be between 1 and 3 or justification should be provided for other values. | Yes | Section 3.1, Appendix F |
| **2.1.2 Transient Population** | | |
| a. A list of facilities which attract transient populations should be included, and peak and average attendance for these facilities is listed. The source of information used to develop attendance values is provided. | Yes | Section 3.3, Table E-6 through Table E-9 |
| b. Major employers are listed. | Yes | Section 3.4, Table E-5 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| c. The average population during the season is used, itemized and totalled for each scenario. | Yes | Table 3-5 through Table 3-7 and Appendix E itemize the transient population and employee estimates. These estimates are multiplied by the scenario specific percentages provided in Table 6-4 to estimate transient population by scenario. – See Table 6-5 and Table 6-6. |
| d. The percentage of permanent residents assumed to be at facilities should be estimated. | Yes | Section 3.3, |
| e. The number of people per vehicle is provided. Numbers may vary by scenario, and if so, reasons for the variation are discussed. | Yes | Section 3.3, Table 6-4 |
| f. A sector diagram is included, similar to Figure 2-1 of NUREG/CR-7002, Rev 1., showing the population distribution for the transient population. | Yes | Figure 3-7 and Figure 3-8 (transients) and Figure 3-11 and Figure 3-12 (employees) |
| **2.2 Transit Dependent Permanent Residents** | | |
| a. The methodology (e.g., surveys, registration programs) used to determine the number of transit dependent residents is discussed. | Yes | Section 3.7 |
| b. The regional/local evacuation plans for transit dependent residents should be used in the analysis. | Yes | Section 8.1 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
| --- | --- | --- |
| c. The methodology used to determine the number of people with disabilities and those with access and functional needs who may need assistance and do not reside in special facilities should be provided. Data from local/regional registration programs are used in the estimate. | Yes | Section 3.7 |
| d. Capacities are provided for all types of transportation resources. Bus seating capacity of 50 percent is used or justification is provided for higher values. | Yes | Section 2.4 – Item 3 (which includes Footnote No. 11), Section 3.7 |
| e. An estimate of the transit dependent population is provided. | Yes | Section 3.7, Table 3-12 |
| f. A summary table showing the total number of buses, ambulances, or other transport assumed available to support evacuation is provided. The quantification of resources is detailed enough to ensure that double counting has not occurred. | Yes | Table 3-15, Section 8.1, Table 8-1 |
| **2.3 Special Facility Residents** | | |
| a. Special facilities, including the type of facility, location, and average population, are listed. Special facility staff is included in the total special facility population. | Yes | Table E-4 lists all medical facilities by facility name, location, and average population. Staff estimates were not provided. |
| b. The method of obtaining special facility data is discussed. | Yes | Section 3.5 |
| c. An estimate of the number and capacity of vehicles assumed available to support the evacuation of the facility is provided. | Yes | Section 2.4 - Item 3, Table 3-8 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| d. The logistics for mobilizing specially trained staff (e.g., medical support or security support for prisons, jails, and other correctional facilities) are discussed when appropriate. | Yes | Section 8.1 – under Evacuation of Medical Facilities |
| **2.4 Schools** | | |
| a. A list of schools including name, location, student population, and transportation resources required to support the evacuation, is provided. The source of this information should be identified. | Yes | Section 3.6, Table 3-9 through Table 3-11, Table E-1 through Table E-3 |
| b. Transportation resources for elementary and middle schools are based on 100 percent of the school capacity. | Yes | Section 3.6 |
| c. The estimate of high school students who will use personal vehicle to evacuate is provided and a basis for the values used is given. | Yes | Section 3.6 |
| d. The need for return trips is identified. | Yes | Section 8.1 - under Evacuation of Schools and Summer Day Camps |
| **2.5 Other Demand Estimate Considerations** | | |
| **2.5.1 Special Events** | | |
| a. A complete list of special events is provided including information on the population, estimated duration, and season of the event. | Yes | Section 3.8 |
| b. The special event that encompasses the peak transient population is analyzed in the ETE. | Yes | Section 3.8 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| c. The percentage of permanent residents attending the event is estimated. | Yes | Section 3.8 |
| **2.5.2 Shadow Evacuation** | | |
| a. A shadow evacuation of 20 percent is included consistent with the approach outlined in Section 2.5.2 of NUREG/CR-7002, Rev 1., "Shadow Evacuation". | Yes | Item 8 (b & c) of Section 2.2 , Figure 2-1, Section 3.2 and Figure 7-1. A shadow evacuation of 30% was used as the base. |
| b. Population estimates for the shadow evacuation beyond the DPZ are provided by sector. | Yes | Section 3.2, Table 3-4, Figure 3-4 and Figure 3-6 |
| c. The loading of the shadow evacuation onto the roadway network is consistent with the trip generation time generated for the permanent resident population. | Yes | Section 5 - Table 5-9 (first footnote) |
| **2.5.3 Background and Pass-Through Traffic** | | |
| a. The volume of background traffic and pass-through traffic is based on the average daytime traffic. Values may be reduced for nighttime scenarios. | Yes | Section 3.9 and Section 3.10 |
| b. The method of reducing background and pass-through traffic is described. | Yes | Section 2.2 – Assumptions 12 and 13<br>Section 2.5<br>Section 3.9 and Section 3.10<br>Table 6-4 – External Through Traffic footnote |
| c. Pass-through traffic is assumed to have stopped entering the study area about two (2) hours after the initial notification. | Yes | Section 2.5, Section 9 and Appendix G. Four (4) hours was used for this study. |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **2.6 Summary of Demand Estimation** | | |
| a. A summary table is provided that identifies the total populations and total vehicles used in the analysis for permanent residents, transients, transit dependent residents, special facilities, schools, shadow population, and pass-through demand in each scenario. | Yes | Table 3-14, Table 3-15, Table 6-5, and Table 6-6 |
| **3.0 Roadway Capacity** | | |
| a. The method(s) used to assess roadway capacity is discussed. | Yes | Section 4 |
| **3.1 Roadway Characteristics** | | |
| a. The process for gathering roadway characteristic data is described including the types of information gathered and how it is used in the analysis. | Yes | Section 1.3, Appendix D |
| b. Legible maps are provided that identify nodes and links of the modeled roadway network similar to Figure A-1, "Roadway Network Identifying Nodes and Links," and Figure A-2, "Grid Map Showing Detailed Nodes and Links." of NUREG/CR-7002, Rev. 1. | Yes | Appendix K |
| **3.2 Model Approach** | | |
| a. The approach used to calculate the roadway capacity for the transportation network is described in detail, and the description identifies factors that are expressly used in the modeling. | Yes | Section 4 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| b. Route assignment follows expected evacuation routes and traffic volumes | Yes | Appendix B and Appendix C |
| c. A basis is provided for static route choices if used to assign evacuation routes | N/A | Static route choices are not used to assign evacuation routes. Dynamic traffic assignment is used. |
| d. Dynamic traffic assignment models are described including calibration of the route assignment. | Yes | Appendix B and Appendix C |
| **3.3 Intersection Control** | | |
| a. A list that includes the total numbers of intersections modeled that are unsignalized, signalized, or manned by response personnel is provided. | Yes | Table K-1 |
| b. The use of signal cycle timing, including adjustments for manned traffic control, is discussed. | Yes | Section 4 and Appendix G |
| **3.4 Adverse Weather** | | |
| a. The adverse weather conditions are identified. | Yes | Section 2.6 – Item 2, Item 3 and Item 4 |
| b. The speed and capacity reduction factors identified in Table 3-1, "Weather Capacity Factors," of NUREG/CR-7002, Rev. 1, are used or a basis is provided for other values, as applicable to the model. | Yes | Table 2-2 |
| c. The calibration and adjustment of driver behavior models for adverse weather conditions are described, if applicable. | N/A | This review criteria is for Microscopic simulation models only. This analysis uses a Macroscopic model and is therefore not applicable. |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| d. The effect of adverse weather on mobilization is considered and assumptions for snow removal on streets and driveways are identified, when applicable. | Yes | Section 2.6 – Item 5, Table 2-2, Section 5.3 |
| **4.0 Development of Evacuation Times** | | |
| **4.1 Traffic Simulation Models** | | |
| a. General information about the traffic simulation model used in the analysis is provided. | Yes | Section 1.3, Table 1-3, Appendix B, Appendix C |
| b. If a traffic simulation model is not used to perform the ETE calculation, sufficient detail is provided to validate the analytical approach used. | N/A | Not applicable since a traffic simulation model was used. |
| **4.2 Traffic Simulation Model Input** | | |
| a. Traffic simulation model assumptions and a representative set of model inputs are provided. | Yes | Section 2, Appendix J |
| b. The number of origin nodes and method for distributing vehicles among the origin nodes are described. | Yes | Appendix J, Appendix C |
| c. A glossary of terms is provided for the key performance measures and parameters used in the analysis. | Yes | Appendix A, Table C-1 and Table C-3 |
| **4.3 Trip Generation Time** | | |
| a. The process used to develop trip generation times is identified. | Yes | Section 5 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| b. When surveys are used, the scope of the survey, area of the survey, number of participants, and statistical relevance are provided. | Yes | Appendix F |
| c. Data used to develop trip generation times are summarized. | Yes | Appendix F and Section 5 |
| d. The trip generation time for each population group is developed from site-specific information. | Yes | Section 5 |
| e. The methods used to reduce uncertainty when developing trip generation times are discussed, if applicable. | Yes | Appendix F – Results of the demographic survey were compared to the 2018 DNGS telephone survey (the most recent previous survey) to minimize uncertainty. |
| **4.3.1 Permanent Residents and Transient Population** | | |
| a. Permanent residents are assumed to evacuate from their homes but are not assumed to be at home at all times. Trip generation time includes the assumption that a percentage of residents will need to return home before evacuating. | Yes | Section 5 discusses trip generation for households with and without returning commuters.<br>Table 6-3 presents the percentage of households with returning commuters and the percentage of households either without returning commuters or with no commuters.<br>Appendix F presents the percent households who will await the return of commuters.<br>Section 2.3, Item 3 |
| b. The trip generation time accounts for the time and method to notify transients at various locations. | Yes | Section 5 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| c. The trip generation time accounts for transients potentially returning to hotels before evacuating. | Yes | Section 5, Figure 5-1 |
| d. The effect of public transportation resources used during special events where a large number of transients are expected is considered. | Yes | Section 3.8 |
| **4.3.2 Transit Dependent Residents** | | |
| a. If available, existing and approved plans and bus routes are used in the ETE analysis. | Yes | Section 10<br>Section 8.1 under Evacuation of Transit-Dependent Population |
| b. The means of evacuating ambulatory and non-ambulatory residents are discussed. | Yes | Section 8.1 under Evacuation of Transit-Dependent Population |
| c. Logistical details, such as the time to obtain buses, brief drivers and initiate the bus route are used in the analysis. | Yes | Section 8.1, Figure 8-1 |
| d. The estimated time for transit dependent residents to prepare and then travel to a bus pickup point, including the expected means of travel to the pickup point, is described. | Yes | Section 8.1 under Evacuation of Transit-Dependent Population |
| e. The number of bus stops and time needed to load passengers are discussed. | Yes | Section 8.1, Table 8-5 though Table 8-7 |
| f. A map of bus routes is included. | Yes | Figure 10-2 through Figure 10-4 |
| g. The trip generation time for non-ambulatory persons including the time to mobilize ambulances or special vehicles, time to drive to the home of residents, time to load, and time to drive out of the study area is provided. | Yes | Section 8.1 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| h. Information is provided to support analysis of return trips, if necessary. | Yes | Section 8.1 |
| **4.3.3 Special Facilities** | | |
| a. Information on evacuation logistics and mobilization times is provided. | Yes | Section 2.4, Section 8.1, Table 8-8 through Table 8-10 |
| b. The logistics of evacuating wheelchair and bed bound residents are discussed. | Yes | Section 8.1, Section 8.1, Table 8-8 through Table 8-10 |
| c. Time for loading of residents is provided. | Yes | Section 2.4 – Item 5, Section 8.1, Table 8-8 through Table 8-10 |
| d. Information is provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 8.1 |
| e. Discussion is provided on whether special facility residents are expected to pass through the reception centre before being evacuated to their final destination. | Yes | Section 8.1 |
| f. Supporting information is provided to quantify the time elements for each trip, including destinations if return trips are needed. | N/A | Section 8.1 – Due to uncertainty of host facility reception centres, a second wave ETE could not be considered or computed. |
| **4.3.4 Schools** | | |
| a. Information on evacuation logistics and mobilization times is provided. | Yes | Section 2.4, Section 8.1, Table 8-2 through Table 8-4 |
| b. Time for loading of students is provided. | Yes | Section 2.4, Section 8.1, Table 8-2 through Table 8-4 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| c. Information is provided that indicates whether the evacuation can be completed in a single trip or if additional trips are needed. | Yes | Section 8.1 |
| d. Information reception centres should be identified. A discussion is provided on whether students are expected to pass through the reception centres before being evacuated to their final destination. | Yes | Section 8.1, Based on discussions with OPG, reception centre locations are not to be listed in the ETE study as they may change after the report is final. |
| e. Supporting information is provided to quantify the time elements for each trip, including destinations if return trips are needed. | Yes | Section 8.1, Table 8-2 through Table 8-4 |
| **4.4 ETE Stochastic Model Runs** | | |
| a. The number of simulation runs needed to produce average results is discussed. | N/A | DYNEV does not rely on simulation averages or random seeds for statistical confidence. For DYNEV/DTRAD, it is a meso-scopic simulation and uses dynamic traffic assignment model to obtain the "average" (stable) network work flow distribution. This is different from microscopic simulation, which is monte-carlo random sampling by nature relying on different seeds to establish statistical confidence. Refer to Appendix B for more details |
| b. If one run of a single random seed is used to produce each ETE result, the report includes a sensitivity study on the 90 percent and 100 percent ETE using 10 different random seeds for evacuation of the full study area under Summer, Midweek, Daytime, Normal Weather conditions. | N/A | |
| **4.5 Model Boundaries** | | |
| a. The method used to establish the simulation model boundaries is discussed. | Yes | Section 4.5 |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| b. Significant capacity reductions or population centres that may influence the ETE and that are located beyond the evacuation area or shadow region are identified and included in the model, if needed. | Yes | Section 4.5 |
| **4.6 Traffic Simulation Model Output** | | |
| a. A discussion of whether the traffic simulation model used must be in equilibration prior to calculating the ETE is provided. | Yes | Appendix B |
| b. The minimum following model outputs for evacuation of the entire study area are provided to support review:<br>1. Evacuee average travel distance and time.<br>2. Evacuee average delay time.<br>3. Number of vehicles arriving at each destination node.<br>4. Total number and percentage of evacuee vehicles not exiting the study area.<br>5. A plot that provides both the mobilization curve and evacuation curve identifying the cumulative percentage of evacuees who have mobilized and exited the study area.<br>6. Average speed for each major evacuation route that exits the study area. | Yes | 1. Appendix J, Table J-2<br>2. Table J-2<br>3. Table J-4<br>4. None and 0%. 100% ETE is based on the time the last vehicle exits the evacuation area<br>5. Figures J-2 through J-15 (one plot for each scenario considered)<br>6. Table J-3 |
| c. Colour coded roadway maps are provided for various times (e.g., at 2, 4, 6 hrs.) for DPZ and CPZ evacuation scenarios, identifying areas where congestion exists. | Yes | Figure 7-3 through Figure 7-10 for the DPZ and Figure 7-11 through Figure 7-18 for the CPZ |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **4.7 Evacuation Time Estimates for the General Public** | | |
| a. The ETE includes the time to evacuate 90 percent and 100 percent of the total permanent resident and transient population. | Yes | Table 7-1 and Table 7-2 |
| b. Termination criteria for the 100 percent ETE are discussed, if not based on the time the last vehicle exits the evacuation zone. | N/A | The 100 percent ETE is based on the time the last vehicle exits the evacuation zone. |
| c. The ETE for 100 percent of the general public includes all members of the general public. Any reductions or truncated data is explained | Yes | Section 5.4.1 – truncating survey data to eliminate statistical outliers<br>Table 7-2 – 100$^{th}$ percentile ETE for general population |
| d. Tables are provided for the 90 and 100 percent ETEs similar to Table 4-3, "ETEs for a Staged Evacuation," and Table 4-4, "ETEs for a Keyhole Evacuation." of NUREG/CR-7002, Rev. 1. | Yes | Table 7-3 and Table 7-4 |
| e. ETEs are provided for the 100 percent evacuation of special facilities, transit dependent, and school populations. | Yes | Section 8 |
| **5.0 Other Considerations** | | |
| **5.1 Development of Traffic Control Plans** | | |
| a. Information that responsible authorities have approved the traffic control plan used in the analysis are discussed. | Yes | Discussed with local authorities during the final meeting. |
| b. Adjustments or additions to the traffic control plan that affect the ETE is provided. | Yes | Section 9, Appendix G |

| NRC Review Criteria | Addressed in ETE Analysis (Yes/No/NA) | Comments |
|---|---|---|
| **5.2 Enhancements in Evacuation Time** | | |
| a. The results of assessments for enhancing evacuations are provided. | Yes | Appendix M |
| **5.3 Provincial and Regional Review** | | |
| a. A list of agencies contacted is provided and the extent of interaction with these agencies is discussed. | Yes | Table 1-1 |
| b. Information is provided on any unresolved issues that may affect the ETE. | Yes | Results of the ETE study were formally presented to municipalities and provincial agencies at the final project meeting. Comments on the draft report were provided and were addressed in the final report. There are no unresolved issues. |
| **5.4 Reviews and Updates** | | |
| a. The criteria for when an updated ETE analysis is required to be performed and submitted to the NRC is discussed. | No | Not Applicable in Canada |
| **5. 4.1 Extreme Conditions** | | |
| a. The updated ETE analysis reflects the impact of the study area conditions not adequately reflected in the scenario variations | N/A | This ETE is being updated for regulatory requirements. |
| **5.5 Reception Centres and Congregate Care Centre** | | |
| a. A map of congregate care centres and reception centres is provided. | Yes | Based on discussions with OPG, reception centre locations are not to be listed in the ETE study as they may change after the report is final. |