Wildlife Crossing Guideline

City of Guelph

Version 1

October 2023

Table of Contents

Cover photo credit: Devin Bettencourt, North-South Environmental Inc.

List of Tables

List of Figures

Type text here

1. Introduction

Roads bisect habitats and create barriers to wildlife movement, requiring wildlife to cross roads to reach suitable habitat to complete their life cycle requirements. Wildlife risk injury or mortality when crossing roads. The populations of some wildlife, especially reptiles and amphibians, can be highly impacted by these occurrences. In response to these impacts, a field of scientific study called road ecology has emerged to study the interactions between the natural environment and roads to gain insights on how to prevent road mortality and its contribution to biodiversity loss.

Wildlife Crossings, which are a component of Guelph's Natural Heritage System, consist of confirmed locations where deer and amphibians cross roads, and areas where habitat is found on both sides of the road and wildlife are likely to cross (Official Plan, February 2022 Consolidation). Guelph's Official Plan establishes that Wildlife Crossings and the associated mitigation measures needed to minimize impacts to wildlife and property damage are confirmed through Environmental Impact Studies or Environmental Assessments that are prepared for development or infrastructure projects. Official Plan policies also establish that the mitigation measures are to be implemented through the related project and commit the City to posting wildlife warning signs where warranted. Wildlife Crossings that have been implemented or are identified on Schedule 4 of Guelph's Official Plan are illustrated on Figure 1 of this Guideline.

Guelph's Wildlife Crossing Guideline addresses Official Plan policy 4.1.5.6 and the City's commitment to develop guidelines to inform the implementation of road ecology mitigation measures that are necessary to reduce road mortality and facilitate wildlife movement. This guideline is a tool for City staff, developers, engineers, consultants, and contractors who play a role in the implementation of wildlife tunnels and exclusion fencing in Guelph.

Wildlife-road mitigation measures considered in this Guideline include Wildlife Signage, and Exclusion Fencing and Wildlife Tunnels. This Guideline outlines when each mitigation measure is considered and outlines a process for planning, design, construction, and monitoring.

2. Wildlife Warning Signs

The City proactively posts warning signs at Wildlife Crossings to minimize and mitigate impacts to wildlife, property damage and threats to human safety at locations where wildlife are known or likely to cross roads.

Deer warning signs are posted in accordance with the Ontario Traffic Manual Book 6 Warning Signs. Other wildlife warning signs used in Guelph include warning signs for turtles and turtles and snakes (Appendix A). A warning sign for amphibians (frogs, toads, salamanders) is not widely available. The warning sign for turtles and snakes is used at amphibian Wildlife Crossings.

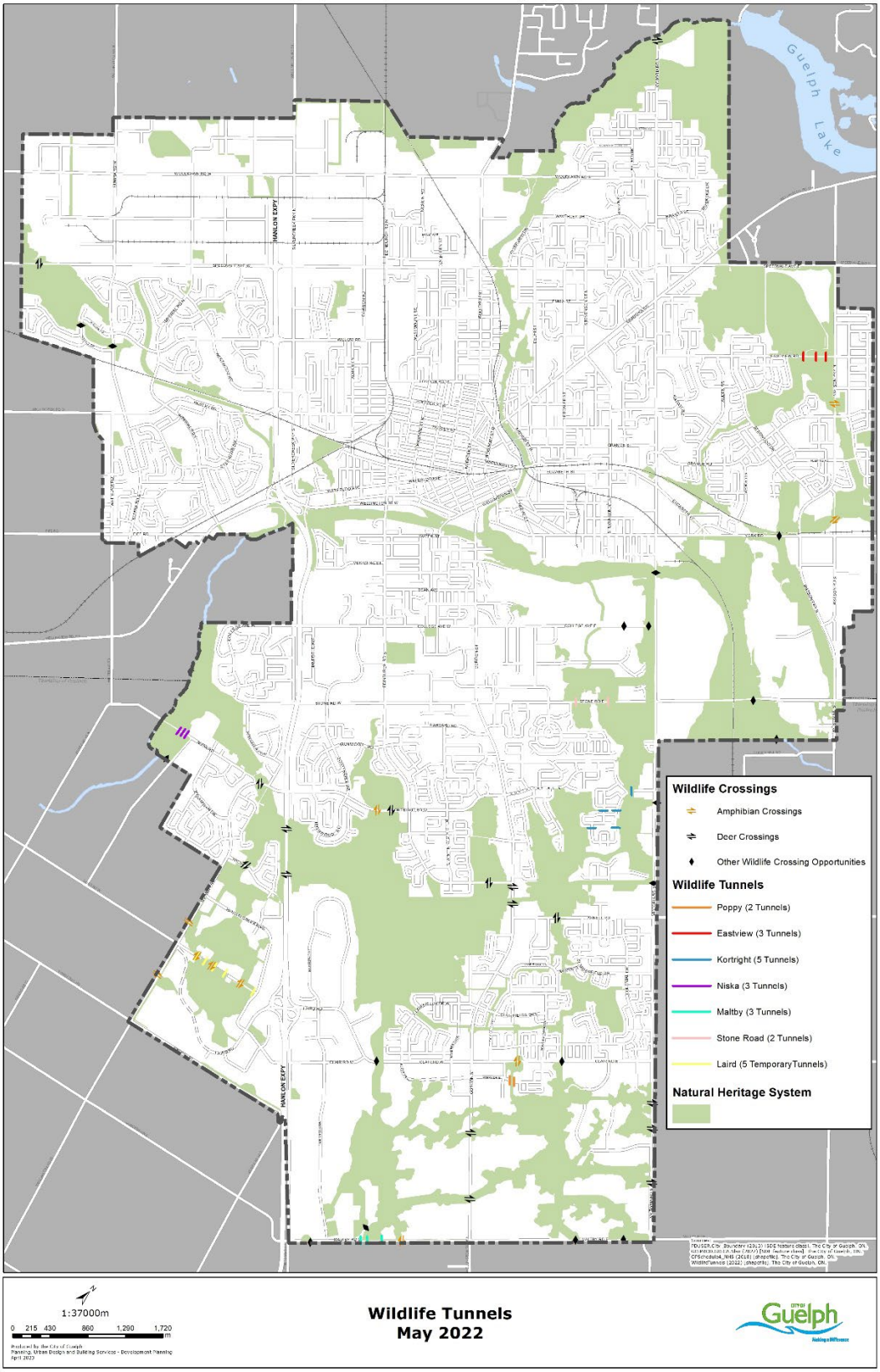


Figure 1 Location of Wildlife Crossings and wildlife tunnels in Guelph

3. Wildlife Tunnels and Exclusion Fencing

This section outlines six phases in the planning, design, construction and maintenance of wildlife tunnels and exclusion fencing. The six phases align with development approvals and the completion of municipal infrastructure and construction projects.

- Phase 1 Screening is completed at the pre-consultation stage of development to inform the scoping of Environmental Impact Study, or at the outset of municipal infrastructure or construction projects.
- Phase 2 Assessment of Need and Phase 3 Design are completed as components of Environmental Impact Studies prepared in support of development, or through background studies prepared for municipal infrastructure or construction projects.
- Phase 4 Construction aligns with the construction phase of development, or municipal infrastructure or construction projects.
- Phase 5 Performance Monitoring aligns with the warranty period for development, or municipal infrastructure or construction projects.
- Phase 6 Inspection and Maintenance aligns with long-term inspection and maintenance of city-owned infrastructure.

3.1. Phase 1 Screening

Phase 1 (Screening) is completed for all road projects, including road improvements, road reconstruction and construction projects, and bridge or culvert replacements and is completed at the pre-consultation stage of development to inform the scoping of Environmental Impact Studies or at the outset of municipal infrastructure and/or construction projects (e.g., through the scoping of Environmental Assessments, if required).

The Phase 1 Screening is completed by environmental planners, ecologists or other qualified professionals using Official Plan Natural Heritage System mapping (Schedules 4 and 4A through 4E), Wildlife Crossing locations (Figure 1) and aerial imagery to answer the following screening criteria questions:

1. Does the study area bisect or run adjacent to the Natural Heritage System?
2. Is the study area located within 30 metres of the Natural Heritage System?
3. Does the study area include a wildlife crossing?

If one or more of the Phase 1 Screening Criteria are met, proceed to Phase 2: Assessment of Need. If no criteria are met, further action is not required.

3.2. Phase 2 Assessment of Need

Phase 2 Assessment of Need is completed for road projects that met one or more of the Phase 1 Screening Criteria. It is completed as a component of an Environmental Impact Studies prepared for development, or background studies completed for municipal infrastructure and/or construction projects.

The Assessment of Need is completed by environmental planners, ecologists or other qualified professionals using available background information, and primary data collection and analysis to answer the following Assessment of Need criteria questions:

1. Is a Species at Risk reptile or amphibian known to occur in the study area?

2. Is a Locally Significant Species of reptile or amphibian known to occur in the study area?
3. Does a Significant Wetland(s) occur in the study area?
4. Does Significant Wildlife Habitat for reptiles or amphibians occur in the study area?
5. Does road mortality occurrence data indicate a road ecology issue in the study area?

Available background information and requirements for primary data collection are determined through a Terms of Reference and completed through Environmental Impact Studies and background studies or at pre-design for municipal construction projects following the standard methods and survey protocols outlined in Guelph's Environmental Impact Study Guidelines.

If one or more of the Assessment of Need criteria are met, proceed to Phase 3 Design. If no criteria are met, further action is not required. Road projects that proceed to Phase 3 Design require the construction of wildlife tunnels and/or exclusion fencing.

3.3. Phase 3 Design

Phase 3 Design is completed for road projects that met one or more of the Phase 2 Assessment of Need criteria and require the construction of wildlife tunnels and/or exclusion fencing. Phase 3 Design is completed through Environmental Implementation Reports and the detailed design of subdivisions, and Pre-design, Preliminary Design and Detailed Design prepared for municipal infrastructure and construction projects. Phase 3 Design is completed by engineers, environmental planners, and ecologists.

Design (material, sizing, etc.) is informed by numerous factors; the typical drawings provided illustrate the basic design, final dimensions will be established through this Phase 3 Design. Phase 3 Design is informed by the typical design drawings provided in Appendix B for:

- Small Wildlife Tunnel,
- Medium Wildlife Tunnel,
- Wildlife Exclusion Fencing,
- Wildlife Tunnel Inlet / Outlet Treatment, and
- Wildlife Exclusion Fencing Connection.

Once Pre-designs have been reviewed and approved, Preliminary Design may proceed, followed by Detailed Design. Detailed Design must be approved prior to proceeding to Phase 4 Construction.

3.3.1. Adjacent Land Use

Adjacent land use informs the Phase 3 Design. Where suitable habitat occurs on both sides of the road, the design includes a wildlife tunnel and exclusion fencing to facilitate wildlife movement. Where suitable habitat occurs on one side of the road, the design includes exclusion fencing to prevent wildlife from accessing the road. Figure 2 illustrates how adjacent land use informs the Phase 3 Design.

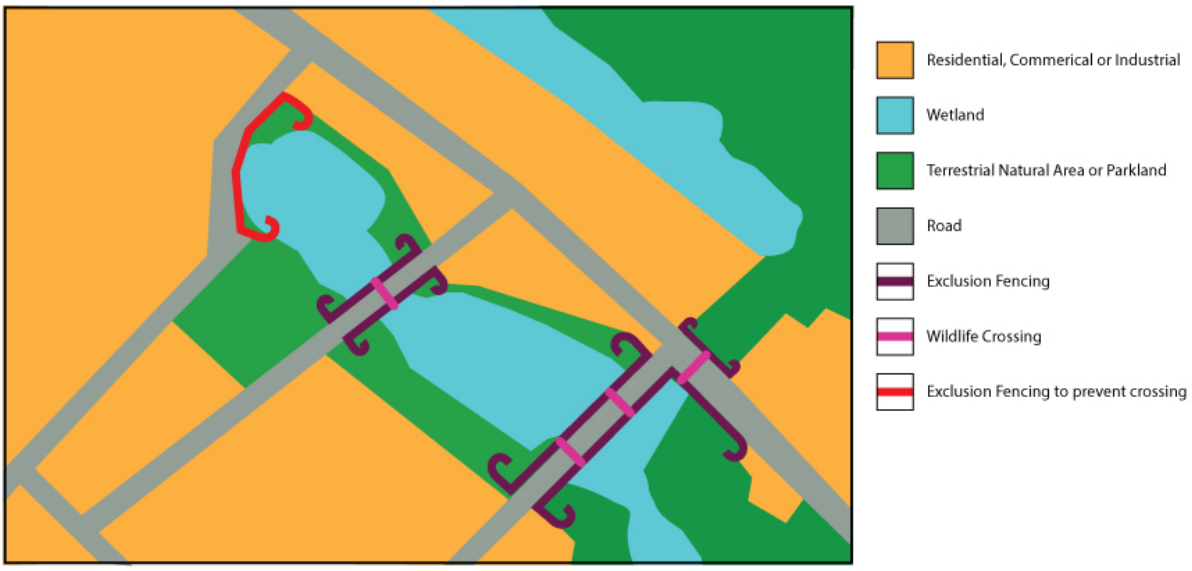


Figure 2 Influence of adjacent land use on Phase 3 Design

3.3.2. Wildlife Tunnel Design

Phase 3 Design incorporates wildlife tunnels where suitable habitat occurs on both sides of the road. Wildlife tunnels facilitate wildlife movement between habitats that are bisected by a road. Road and roadside conditions and the openness ratio required by target species inform the location and spacing of wildlife tunnels, the type and length of wildlife tunnel used in the design, and additional design elements needed to achieve the recommended openness ratio.

Location and Spacing

Wildlife tunnels are constructed in areas of suitable habitat, such as wetlands or at watercourse crossings. Wildlife tunnel locations are determined based on:

- the need to maintain the hydrologic condition and function of adjacent natural features,
- the location and depth of buried infrastructure and utilities,
- topography and the presence of low points or high points along the road,
- slopes and the need to avoid perching wildlife tunnels above adjacent habitats, which can cause wildlife to miss tunnel entrances and deter use, and
- the need to inset the wildlife tunnel to direct wildlife to the tunnel entrance (see drawing in Appendix B).

Wildlife tunnels are generally spaced 150 to 200 m apart within a given feature. However, site-specific factors such as road mortality hotspots, driveways, etc. may warrant different spacing.

Openness ratio

Openness ratio, the cross-sectional area of a tunnel divided by its length, is used to select the appropriate wildlife tunnel size to facilitate the movement of the target species group. Studies have been completed on the minimum recommended openness ratio for different groups of wildlife based on preferences for light, air flow, moisture and direct sight lines

(CVC 2017). Table 1 outlines the recommended and minimum openness ratios per target species group.

The openness ratio of a box culvert is calculated as follows:

Box Culvert = [Height X Width] / Length

The openness ratio of an HDPE pipe is calculated as follows:

HDPE Pipe = [$\prod r^2$] / Length
where $\prod$ = 3.14 and r = radius of pipe opening

Table 1 Recommended and minimum openness ratios per target species group

	Turtles	Amphibians, Snakes and Small Mammals	Medium Mammals
Recommended Openness Ratio	≥0.25	≥0.1	≥0.4
Minimum Openness Ratio	0.1	0.07	0.1

Wildlife tunnels must be designed to minimize the length of the tunnel, maximize the size of the opening, and meet the recommended openness ratio where feasible. When it is demonstrated that the minimum openness ratio cannot be met, the design must incorporate open cover maintenance holes or a precast riser with a metal grate that is mortared in place to increase airflow and light in the tunnel. Maintenance holes or grates are placed on the road centreline and in the centre of each travel lane to minimize maintenance issues. They are also placed on the road shoulder or boulevard. Maintenance holes or grates are not to be placed on sidewalks or multi-use paths that require a smooth path of travel.

Wildlife Tunnel Type

Wildlife tunnel design may use purpose-built structures (e.g., ACO climate tunnel) or retrofitted culverts or HDPE pipes.

ACO Climate Tunnel

The ACO climate tunnel (or equivalent) is used to facilitate the movement of amphibians, reptiles, and small mammals. The ACO climate tunnel comes in pre-cast polymer concrete tunnel sections with slotted tops to maintain airflow and maximize light and humidity. Each tunnel section is 100 cm in length, 63 cm wide, and 52 cm tall (ACO 2021). ACO climate tunnels are installed flush with the surface of the road and are used when they are accessible from and not perched above adjacent habitats. ACO climate tunnels can accommodate occasional flooding during snowmelt or high rain but should not be used in areas that are permanently flooded. The slotted top of the ACO climate tunnel is covered where it intersects the curb, sidewalk, multi-use pathway or boulevards. Prior to covering, the slotted top is covered by filter fabric to prevent sediment from entering the tunnel.

Concrete Culverts and HDPE Pipes

Concrete culverts and HDPE pipes are used as wildlife tunnels when the tunnel must also convey water and withstand flooding. Concrete culverts and HDPE pipes can be retrofitted to facilitate the movement of amphibians, reptiles and small to medium-sized mammals through the addition of a dry crossing ledge within the structure, and the addition of maintenance holes and grates to increase airflow, light and humidity. Maintenance holes and grates used for this purpose do not receive directed flow during frequent storm events, are located above the 5-year storm flood line and are not placed in road sags. Concrete culverts and HDPE pipes are also used when an ACO Climate Tunnel is not feasible based on

site-specific and design considerations, or when a larger structure is needed to achieve the openness ratio of the target species group.

Substrate

Gravel is easy to install, clean out and replace. Therefore, it is used as the substrate in ACO climate tunnels and in smaller wildlife tunnel designs that use HDPE pipes. Larger wildlife tunnel designs that use concrete culverts or HDPE pipes, but do not convey water, use native substrate (soils) as the substrate (Appendix B). For larger wildlife tunnel designs that convey water, substrate type and sizing is informed by hydraulic conditions.

3.3.3. Exclusion Fencing Design

Exclusion fencing is installed to prevent wildlife from accessing the road and to direct wildlife to the entrance of a wildlife tunnel. At confirmed Wildlife Crossings, Phase 3 Design incorporates wildlife exclusion fencing:

- where suitable habitat occurs on both sides of the road, placed on both sides of the road, in conjunction with a wildlife tunnel, and
- where suitable habitat occurs on one side of the road, placed only on the side of the road that abuts suitable habitat (Figure 2).

Exclusion fencing is to be designed to ensure that there are no gaps between the exclusion fencing and tunnel entrance or between fencing segments, prevent erosion, and maintain the hydrologic condition and function of adjacent natural features. Phase 3 Design of exclusion fencing establishes fencing height, length and buried depth, the layout and design of turnarounds and escape ramps, exclusion fencing materials, backfill material and substrate.

Fencing Height, Length and Buried Depth

Table 2 outlines the recommended above ground height and buried depth below ground of exclusion fencing for small wildlife (frogs, toads, salamanders, turtles, snakes and small mammals) and medium sized wildlife (coyote, fox). Table 2 is considered at the beginning of Phase 3 Design. The top 10 cm of all exclusion fencing is folded or is curved downward to form a lip that prevents wildlife from climbing over the fencing. Exclusion fencing is designed to extend the full length of suitable habitat to maximize the likelihood of wildlife encountering it and directing wildlife away from the road.

Table 2 Minimum exclusion fence height, buried depth and lip width

	Small Wildlife	Medium Wildlife
Minimum height (above ground)	50 cm	100 cm
Minimum buried depth	10 cm	20 cm
Lip width	10 cm	10 cm

Turnarounds and Escape Ramps

Turnarounds are placed at the ends of exclusion fencing to redirect wildlife away from gaps in fencing, and toward habitat or a crossing structure (Appendix B). Turnarounds are a continuation of the exclusion fencing that form a U-shape. Turnarounds for amphibians and reptiles are designed to be 2.0 m long, running parallel to the exclusion fence, at 0.5 m from the exclusion fence (MECP 2021).

Exclusion fencing can inadvertently trap wildlife in the area that includes the road in between the fencing. Therefore, the design of exclusion fencing includes escape ramps to allow wildlife to move off the road, over the exclusion fencing and into the natural area.

Exclusion fencing that is installed below the elevation of the road surface can provide a natural escape ramp, where wildlife can move across the top of the fencing. Escape ramps for exclusion fencing that is installed above the elevation of the road surface are formed by grading earthen ramps, or by using one-way gates or funnels (Gunson and Healy 2014). One escape ramp is to be provided every 0.5-1.0 km of exclusion fencing as a minimum.

Exclusion Fencing Materials

Exclusion fencing materials are described below.

Retaining Walls

- poured in place concrete, or precast concrete stone
- designs accommodate site-specific needs
- lifespan of 30+ years
- may require chain link fencing to address safety concerns per Guelph's Linear Infrastructure Standards
- optimal when roadbed is elevated greater than 1.0 m above surrounding area
- durable
- low maintenance
- minimize erosion-related issues
- expensive

525 mm High Density Polyethylene Half Pipe (Figure 3)

- made of black polyethylene plastic
- fence height of 0.52 m
- lifespan of 10+ years
- installation below grade improves aesthetics
- rebar used to fasten fence segments together requires capping or bending to address safety concerns
- fence segments can be cut to size to accommodate site-specific needs
- optimal when roadbed is elevated greater than 1.0 m above the surrounding area
- fencing material not permeable to water
- drainage and erosion must be considered in designs using this fencing material
- fencing segments require additional supports to prevent damage from snow loading
- frost heave can form gaps between fence segments and at tunnel entrances
- inexpensive

ANIMEX Wildlife Fencing (Figure 4)

- made of recycled plastic or metal alloy
- various heights available: 0.55, 0.75 or 1.05 m
- lifespan of 5-15+ years
- may impede sightlines
- optimal when installed at the top of a slope to prevent damage from snow loading and erosion
- fencing material not permeable to water
- AMX-40, AMX-48, and AMX-60
  - made of black recycled plastic fencing
  - require attachment to a chain link fence for support
  - best suited to straight runs requiring minimal breaks in fencing
  - prone to erosion, cracking, warping leading to gaps and holes
  - fencing segments can be cut out and replaced as needed
  - inexpensive
- AMX-PL and AMX-XP

  - AMX-PL is made of recycled plastic that looks like concrete
  - AMX-XP is made of metal alloy
  - comes in small segments and can accommodate breaks in fencing
  - less prone to maintenance issues
  - moderately expensive

ERTEC E-Fence

- made of black polyethylene plastic
- various heights available
- lifespan of 10+ years
- requires attachment to chain link fence or posts for support
- sturdy and can be installed on slopes without risk of fencing failure
- permeable to water
- comes in small segments
- inexpensive

ACO One Way Fence

- made of black polyethylene plastic
- fence height of 0.35 m
- lifespan of 30+ years
- fencing material not permeable to water
- drainage and erosion must be considered in designs using this fencing material
- prone to maintenance issues
- difficult to install
- prone to erosion, cracking, warping leading to gaps and holes
- optimal when installed at the top of a slope to prevent damage from snow loading and erosion
- moderately expensive

Backfill Material and Substrate

Granular A (gravel mixed with sand) is used to backfill exclusion fencing and toe in the bottom of the fencing is covered with natural soils. Areas that receive seasonal flows are lined with sediment cloth and topped with gravel to prevent erosion.

Figure 3 ACO climate tunnel at Niska Road, Guelph with HDPE half-pipe exclusion fencing in foreground and ANIMEX fencing in background (Photo credit: Pauline Catling, North-South Environmental Inc.)

Figure 4 ANIMEX fencing installed on chain link at Niska Road, Guelph (Photo credit: Devin Bettencourt, North-South Environmental Inc.)

3.3.4. Temporary Wildlife Exclusion Fencing

Erosion and Sediment Control Plans are prepared as a component of Detailed Design for all construction projects. These plans identify the type and location of erosion and sediment control measures that are needed to protect natural areas from sedimentation during construction. The City of Guelph's standard requirements for Erosion and Sediment Control Plans are provided in the following documents:

- Development Engineering Manual
- Linear Infrastructure Standards
- Design Guidelines and Supplemental Specifications for Municipal Services

For wildlife tunnel and exclusion fencing construction projects, Erosion and Sediment Control Plans also identify the type and location of erosion and sediment control fencing needed to exclude wildlife from construction zones. When erosion and sediment control fencing is used for this purpose, it is labelled temporary wildlife exclusion fencing. Temporary wildlife exclusion fencing is installed for all road ecology construction projects, regardless of whether construction occurs during the construction timing windows outlined in Table 3.

The design of temporary wildlife exclusion fencing must:

- isolate natural feature from work areas,
- be positioned to redirect wildlife to suitable habitat,
- incorporate turn backs at each fence terminus,
- account for an above ground height of 60 cm, and
- be buried a minimum of 10 cm underground so wildlife cannot pass underneath.

The following notes must be included on Erosion and Sediment Control Plans prepared as a component of Detailed Design for road ecology construction projects:

- Prior to installing temporary wildlife exclusion fencing, a wildlife biologist must inspect the area to detect and relocate wildlife to suitable habitat outside the construction area.
- If evidence of breeding / nesting is identified by the wildlife biologist, construction must be postponed until hatchlings are mobile and have dispersed or until another suitable mitigation measure is determined by the wildlife biologist and supported by the City.
- Temporary wildlife exclusion fencing must be inspected and maintained throughout construction.
- Routine inspections of temporary wildlife exclusion fencing must be completed to inspect fencing condition and detect wildlife within the area of construction.
- Temporary wildlife exclusion fencing must be removed once soils have stabilized, and vegetation has established.

3.3.5. Construction Timing Windows

Wildlife tunnel and exclusion fencing construction projects are generally avoided during peak movement periods and are generally completed during the construction timing windows outlined in Table 3. Peak movement periods and construction timing windows should be noted on Detailed Design drawings. When work is required to occur outside recommended construction timing windows, a wildlife biologist may be required to work with the City construction inspector to identify and address site-specific construction issues and recommend the mitigation measures needed to protect wildlife.

Table 3 Peak movement periods and construction timing windows

	Peak Movement Period	Construction Timing Window
Frogs and Toads	March 1 to June 30	July 1 to February 28
Snakes	March 1 to June 30	July 1 to February 28
Turtles	April 1 to October 31	November 1 to March 31

To comply with the *Migratory Birds Conventions Act*, 1994, vegetation removal should occur outside of the breeding bird window between April 1st and September 30th to the greatest extent feasible. Vegetation removal may occur between April 1st and September 30th if a nest sweep is completed by a wildlife biologist within 48 hours prior to the vegetation removals occurring. Nest sweeps should only be considered if the entire area of vegetation removal can be adequately searched to confirm the presence or absence of nests. Habitat complexity and size of the area of vegetation removal should be considered when assessing this feasibility. If a nest is identified by the wildlife biologist, vegetation removal surrounding the nest must be postponed until the nest is confirmed inactive or hatchlings have fledged.

Road ecology projects involving fish habitat must adhere to requirements of the *Fisheries Act*. Measures to protect fish and fish habitat as identified by the Department of Fisheries and Oceans (DFO) should be followed to the greatest extent feasible and in-water works should be scheduled to respect the timing windows prescribed for the fish species present. Regardless, all projects involving fish habitat must determine if the project needs to be reviewed by DFO. In some cases, an authorization under the *Fisheries Act* may be needed.

3.4. Phase 4 Construction

Phase 4 Construction is the implementation of the wildlife tunnel and/or exclusion fencing project. A wildlife biologist with experience in road ecology oversees the construction of road ecology projects and completes site inspections to confirm that the approved design has been constructed and identify site-specific construction issues.

3.4.1. Construction of Approved Design

The following questions are used by the wildlife biologist to confirm the construction of the approved design:

1. Is the approved design and layout of road ecology mitigation measures complete?
2. Are the approved construction standards for wildlife crossing structures and wildlife exclusion fencing constructed and complete?
3. Is the approved grading around the wildlife crossing structures and wildlife exclusion fencing complete?
4. Is the wildlife crossing structure constructed in the correct location?
5. Is the constructed wildlife crossing structure the correct length?
6. Are the approved materials for the wildlife crossing structure, structure entrances and wildlife exclusion fencing used?
7. Are escape ramps constructed in the approved design and layout?
8. Are turn backs in place at the terminus of wildlife exclusion fencing?

The wildlife biologist works with the City construction inspector and contractor to identify and address deficiencies in the construction of the approved design.

3.4.2. Site-specific Construction Issues

The following questions are used by the wildlife biologist to identify site-specific construction issues:

1. Are there any gaps between the wildlife crossing structure and the structure entrance?
2. Are there any gaps between segments of wildlife exclusion fencing?
3. Are there any locations where the bottom 10-20 cm of the wildlife exclusion fencing is not buried?
4. Are there any locations where the top 10 cm of the wildlife exclusion fencing is not curved downward?
5. Are there any erosion issues?
6. Is there a build up of debris or sediment in the wildlife crossing structure?
7. Are there any chips or cracks in the wildlife crossing structure?

The wildlife biologist works with the City construction inspector and contractor to identify and address deficiencies in the construction of the approved design and site-specific construction issues.

3.5. Phase 5 Performance Monitoring

Environmental Impact Studies, Environmental Implementation Reports or Environmental Assessments prepared for wildlife tunnel and exclusion fencing projects outline the requirements for post-construction performance monitoring. Phase 5 Performance Monitoring implements the approved requirements for post-construction performance monitoring. Phase 5 Performance Monitoring begins after Phase 4 Construction and is completed for a minimum of two years. Performance monitoring is completed to confirm that wildlife use the constructed mitigation measures, identify performance issues with the constructed mitigation measures during the warranty period, and address and confirm correction of performance issues prior to the end of construction warranty periods. Performance monitoring is completed by wildlife ecologists with expertise in species identification, survey methods and data analysis.

3.5.1. Wildlife Crossing Structure Monitoring

Wildlife crossing structure monitoring is completed using digital wildlife cameras to confirm that wildlife use the constructed wildlife crossing structure to safely pass under the road. The following guidelines for wildlife crossing structure monitoring must be reflected in Environmental Impact Studies, Environmental Implementation Reports and/or documents prepared for municipal infrastructure and construction projects.

- Install a digital wildlife camera, facing inward and on a downward angle to maximize the field of view, at each wildlife crossing structure entrance.
- Complete monitoring for a minimum of eight weeks per year.
- Complete monitoring during peak movement periods.
- Use a digital wildlife camera capable of infrared motion sensing photography.

- Program digital wildlife cameras to record a photograph every 30 seconds, 24 hours a day, seven days a week for the minimum eight-week monitoring period.
- Process photographs manually or using software and quality management protocols.
- Record species, wildlife crossing structure entrance and number of complete crossings.

3.5.2. Road Mortality Surveys

Road mortality surveys are completed to identify locations of dead, injured or living wildlife on the road. Data collected during road mortality surveys is used to identify and pinpoint the location of performance issues. Performance issues identified through road mortality surveys include the following:

- locations where the wildlife tunnel or exclusion fencing is circumvented by wildlife,
- gaps in wildlife tunnel or exclusion fencing allowing wildlife to access road, and
- lack of escape ramps causing wildlife to become trapped on road.

The following guidelines for road mortality surveys must be reflected in Environmental Impact Studies, Environmental Implementation Reports and/or documents prepared for municipal infrastructure and construction projects.

- Complete a minimum of three road mortality surveys during peak movement between mid-April to mid-October, for two years.
- Complete surveys on warm rainy nights.
- Collect data on foot by walking the length of the study area.
- Document the species, location (GPS coordinates, lane number) and species condition (dead, alive, injured) of each observation.
- Where possible, document the size (snout to vent length), age (adult, juvenile) and sex of each observation.

Localized areas of road mortality may indicate where wildlife tunnels and exclusion fencing are circumvented by wildlife and may assist in identifying the location of gaps that allow wildlife to access the road. Localized areas of wildlife trapped on the road may indicate the need for an additional escape ramp. Once the performance issue is known, the corrective action is identified and implemented prior to the end of construction warranty periods.

3.5.3. Performance Monitoring Report

Performance monitoring reports are prepared to document the methods and findings of performance monitoring. The following requirements for performance monitoring reporting must be reflected in Environmental Impact Studies, Environmental Implementation Reports and/or documents prepared for municipal infrastructure and construction projects:

- the type and methods of monitoring used to assess the performance of the constructed road ecology mitigation measures,
- the frequency, timing, level of effort and duration of each monitoring activity,
- the results of performance monitoring including current year and previous years,
- a description of the analysis used to assess the performance of the constructed road ecology mitigation measures,

- a description of corrective actions needed to address issues identified in performance,
- roles and responsibilities for implementing corrective actions needed to address issues identified in performance,
- assessment of implemented corrective actions,
- recommendations for Phase 5 Performance Monitoring, and
- recommendations for Phase 6 Inspection and Maintenance.

Performance monitoring results are reported annually for a minimum of two years. Recommendations for continuing Phase 5 Performance Monitoring may be identified if performance issues are identified, and corrective actions are implemented. Phase 5 Performance Monitoring is complete after two years of monitoring or, if a performance issue is identified once corrective actions have been implemented and confirmed by an additional year of performance monitoring.

3.6. Phase 6 Inspection and Maintenance

Phase 6 Inspection and Maintenance begins following the completion of Phase 5 Performance Monitoring. Phase 6 Inspection and Maintenance is completed by the City's Operations Department with support from Technical Services and Environmental Planning.

3.6.1. Annual Inspections

Operations staff inspect wildlife tunnels and exclusion fencing annually to identify site-specific maintenance issues:

- gaps between the wildlife tunnel and tunnel entrance,
- gaps between segments of exclusion fencing,
- locations where the bottom 10-20 cm of the exclusion fencing is not buried,
- locations where the top 10 cm of the exclusion fencing is not curved downward,
- locations where exclusion fencing is unstable or has failed,
- locations of erosion,
- buildup of debris or sediment in the wildlife tunnel,
- chips or cracks in the wildlife tunnel, road surface, catch basins or maintenance holes, and
- vegetation overhanging wildlife tunnels and/or exclusion fencing allowing wildlife to climb over and access the road.

If site-specific maintenance issues are identified, an additional inspection occurs when corrective actions have been completed to verify that the actions have been completed to an acceptable standard.

An inspection report is prepared to document the location, type and severity of maintenance issues and provide a description of the corrective actions needed to address the maintenance issue. The inspection report informs the annual maintenance schedule.

3.6.2. Annual Maintenance

Annual maintenance is completed by Operations staff to address site-specific maintenance issues identified in annual inspection reports. Maintenance issues are corrected as follows:

- A gap between a wildlife tunnel and tunnel entrance is repaired by removing and reinstalling the tunnel entrance to be flush with the wildlife tunnel. Refer to the typical design drawing in Appendix B.
- A gap between segments of exclusion fencing is repaired by removing the segments and reinstalling the segments to be flush. Additional segments of fencing may be required to fill gaps or address damage that has resulted in a gap or deficiency. Refer to the typical design drawing in Appendix B.
- Locations where the bottom 10-20 cm of the exclusion fencing is not buried is repaired by digging a 10-20 cm deep trench at the bottom of the fencing segment and then backfilling the trench with removed soil. Areas prone to erosion may require seeding following soil disturbance. Temporary soil stabilization may be warranted in some cases. Refer to the typical design drawing in Appendix B.
- Locations where the top 10 cm of the exclusion fencing is not curved downward is repaired by curving the top 10 cm of each fencing segment downwards using manufacturer-supplied clips or rust-proof wire. Fencing segments may require adjustment, reinstallation or an additional segment of fencing may be required to address this maintenance issue. Refer to the typical design drawing in Appendix B.
- Locations where exclusion fencing is unstable or has failed are repaired by reinstalling the unstable or failed fencing segments. If existing materials are undamaged, they may be reused. If they are damaged, new fencing materials should be installed. Refer to the typical design drawing in Appendix B.
- Locations of erosion are repaired by regrading to address drainage issues and reseeding to stabilize soils. Additional soil or rocks may be needed to stabilize soils. The use of native material is recommended. Refer to the Linear Infrastructure Standard for the SS-22 Specification for Seeding and Mulching.
- The buildup of debris and sediment in wildlife tunnels is removed by flushing out the tunnel using a flusher truck. Debris and sediment removed from the tunnel is disposed of off site. Native substrate or gravel is placed in the wildlife tunnel after debris and sediment has been removed. Refer to the Typical Design Drawing in Appendix B.
- A chip or crack in a wildlife tunnel, road surface, maintenance hole or grate is repaired by patching with asphalt. A catch basin, maintenance hole or wildlife tunnel grate may require replacement if significant damage has occurred.
- Vegetation overhanging wildlife tunnels and/or exclusion fencing is maintained by trimming back vegetation with a trimmer. Lawnmowers should not be used near wildlife tunnels and exclusion fencing. They can be harmful to wildlife and can damage the infrastructure.

4. Roles and Responsibilities

4.1. City and Developer Roles and Responsibilities

For municipal infrastructure projects involving wildlife tunnels and/or exclusion fencing, the City is the proponent and is responsible for the design, review and approval of engineering drawings prior to construction, construction, construction inspection, performance monitoring and long-term inspection and maintenance.

For private development projects involving wildlife tunnels and/or exclusion fencing, the developer is the proponent and is responsible for the design of engineering drawings for the City's review and approval prior to construction, construction, construction inspection and performance monitoring. The City is responsible for long-term inspection and maintenance following assumption of the asset. Engineering drawings are reviewed based on the requirements established in this guideline and the following City documents:

- Guidelines for the Preparation of Environmental Impact Studies,
- Linear Infrastructure Standards,
- Development Engineering Manual,
- Design Guidelines and Supplemental Specifications for Municipal Services, and
- Subdivision Assumption Guidance Manual.

4.2. Additional Requirements

The Grand River Conservation Authority regulates river and stream valleys, wetlands, and natural hazards. A permit may be required for road ecology projects that are proposed within Grand River Conservation Authority's regulation limit.

The Ontario Ministry of the Environment, Conservation and Parks administers the *Endangered Species Act*. Road ecology projects that have the potential to impact Species at Risk or their habitats may require an authorization or permit.

The Federal Department of Fisheries and Oceans administers the *Fisheries Act*. Road ecology projects that have the potential to impact fish or fish habitat may require an authorization or permit.

The Species at Risk Act is applicable to aquatic Species at Risk across Ontario and applies to terrestrial species for federally funded projects, federally regulated industries or on federal land. Applicability of the Species at Risk Act should be considered on a project-by-project basis.

References

ACO Canada. 2021. ACO Specification Information. https://www.wildlife.aco/

ANIMEX. 2021a. ANIMEX Fencing. https://animexfencing.com/

City of Guelph. 2019a. Development Engineering Manual version 2.0. January 2019. https://guelph.ca/wp-content/uploads/Development-Engineering-Manual.pdf

City of Guelph. 2019b. Subdivision Assumption Guidance Manual. January 2019. https://guelph.ca/wp-content/uploads/Subdivision-Assumption-Guidance-Manual.pdf

City Guelph. 2020. Guidelines for the preparation of Environment Impact Studies. April 2020. https://guelph.ca/wp-content/uploads/EIS-Guideline.pdf

City of Guelph. 2022a. The City of Guelph Official Plan. February 2022 Consolidation. https://guelph.ca/wp-content/uploads/Official-Plan-February-2022-Consolidation.pdf

City of Guelph. 2022b. Linear Infrastructure Standards 2022. March 2022. https://guelph.ca/wp-content/uploads/2022-Linear-Infrastructure-Standards.pdf

Credit Valley Conservation. 2017. CVC Fish and Wildlife Crossing Guidelines. https://cvc.ca/document/cvc-fish-and-wildlife-crossing-guidelines/

Ministry of Environment, Conservation and Parks Ontario. 2021. Reptile and amphibian exclusion fencing. https://www.ontario.ca/page/reptile-and-amphibian-exclusion-fencing#section-2

Ministry of Transportation Ontario. 2001.Ontario Traffic Manual - Book 6 - Warning Signs. https://www.library.mto.gov.on.ca/SydneyPLUS/Sydney/Portal/default.aspx?component=AAAAIY&record=01770351-8895-4f48-a8b5-62a03145ae1c

Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services. February 2022. https://www.regionofwaterloo.ca/en/doing-business/resources/Documents/2022-DGSSMS.pdf

Toronto Zoo. 2023. Adopt-A-Pond Resources. https://www.torontozoo.com/adoptapond/resources

Appendix A: Wildlife Warning Signs

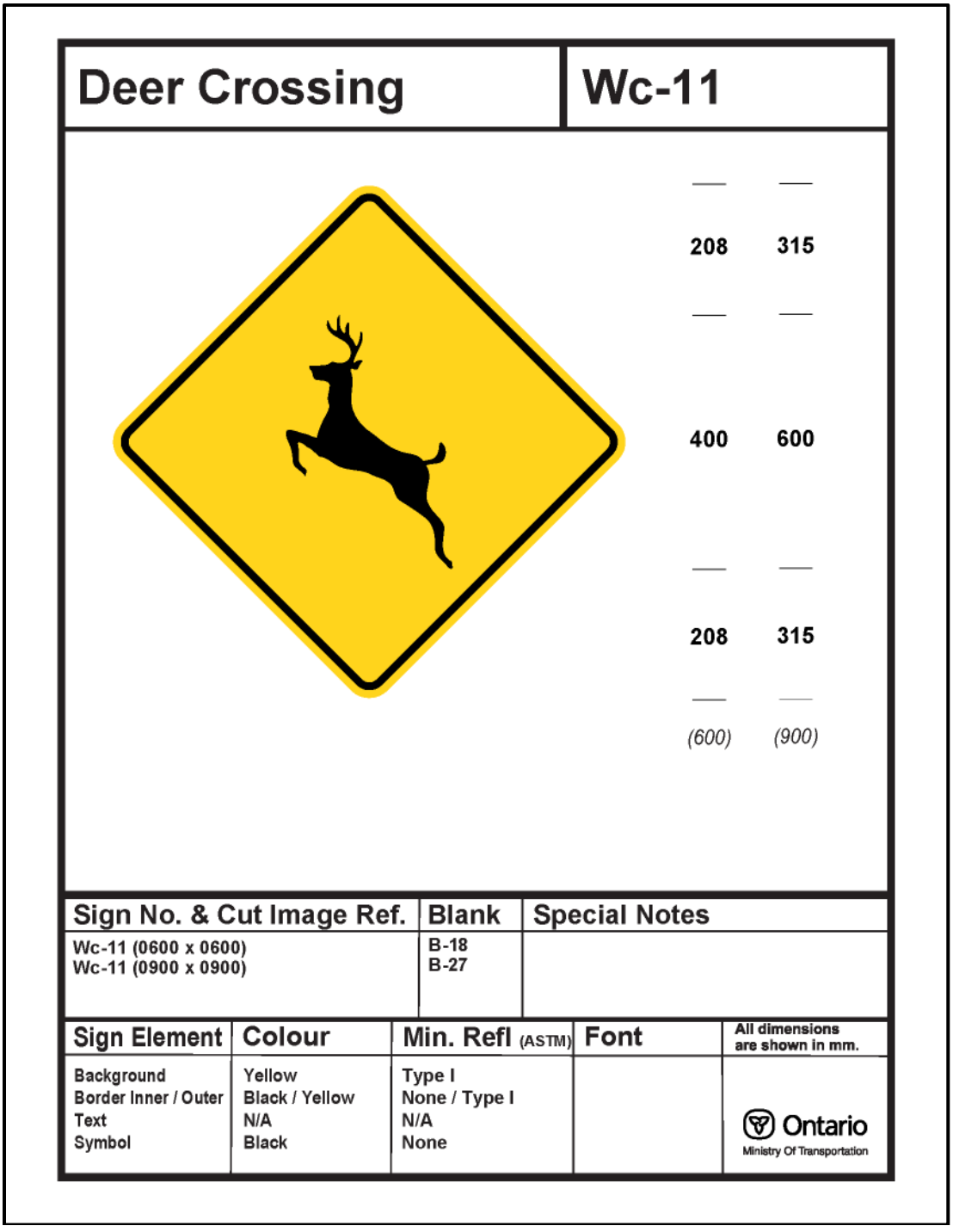


Figure 1. Ministry of Transportation Ontario Deer Crossing warning sign

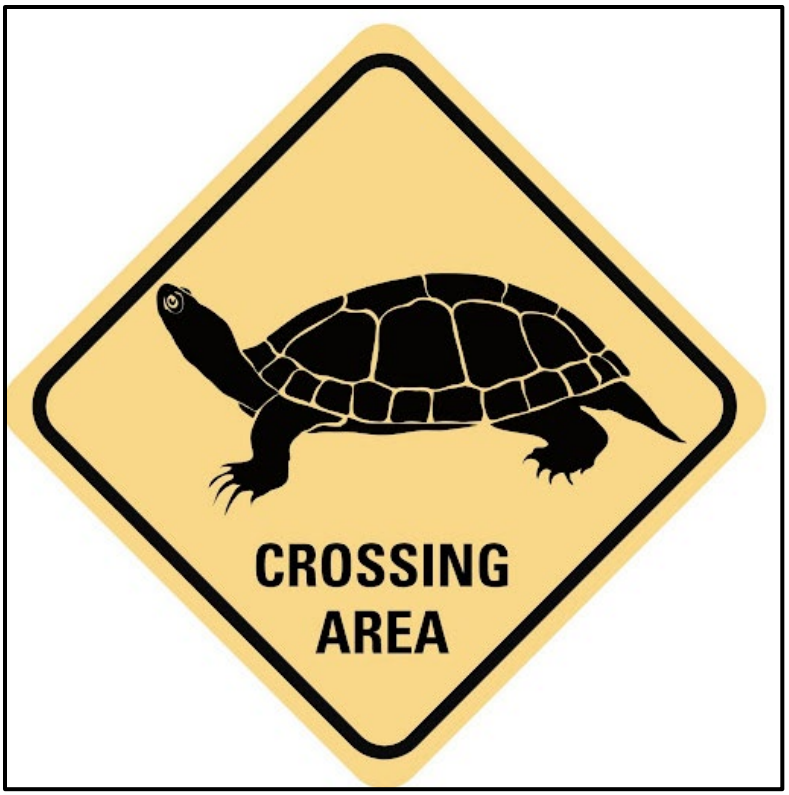


Figure 2. Toronto Zoo Adopt-A-Pond Turtle Crossing warning sign

Figure 3. Toronto Zoo Adopt-A-Pond Turtle and Snake Crossing warning sign

Appendix B: Typical Design Drawings

Appendix B provides typical design drawings for:

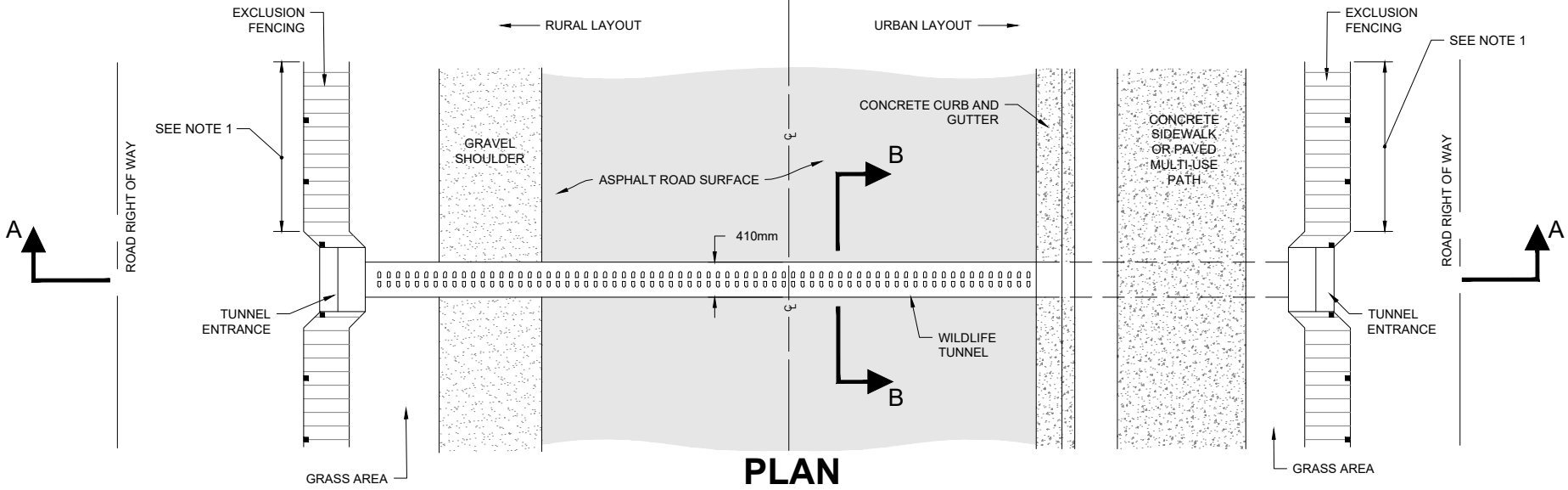
Small Wildlife Tunnel: Typical design of wildlife tunnel used for small wildlife.

Medium Wildlife Tunnel: Typical design of retrofitted precast concrete box culvert (OPSD 3920.100) for medium-sized wildlife.

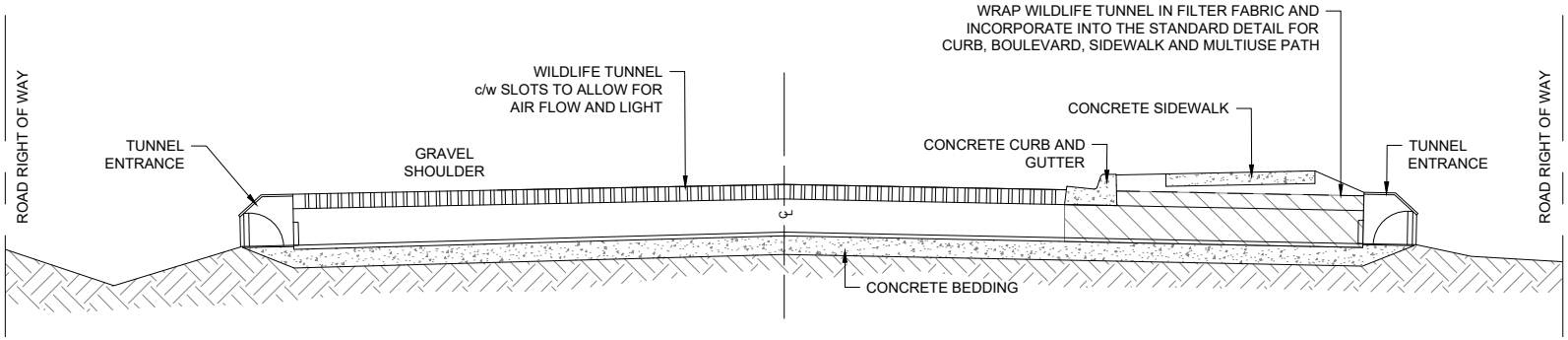
Wildlife Tunnel Inlet / Outlet Treatment: Typical design of wildlife tunnel openings and funnel-shaped exclusion fencing.

Wildlife Exclusion Fencing: Typical design of wildlife exclusion fencing including fence height, length, turnarounds and escape ramps.

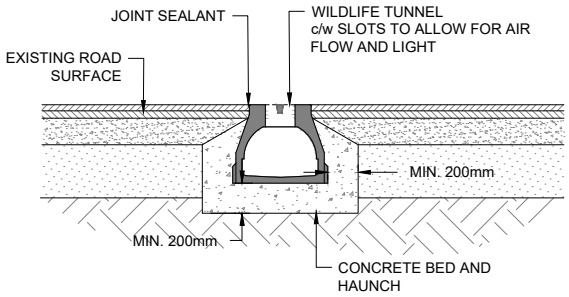
Wildlife Exclusion Fencing Connection: Typical design for connecting two segments of exclusion.



PLAN



SECTION A



SECTION B

NOTE:
1. PROVIDE MIN. 3m SEPARATION FROM TUNNEL ENTRANCE TO ADJACENT DRIVEWAY OR ROAD TO FACILITATE EXCLUSION FENCE TURN AROUND. MORE THAN 5m SEPARATION IS PREFERRED, WHERE FEASIBLE.

THIS DRAWING IS NOT DIMENSIONED.

- REFER TO GUELPH'S LINEAR INFRASTRUCTURE STANDARDS SECTION 5 FOR TYPICAL ROAD CROSS SECTIONS AND DIMENSIONS.
- REFER TO GUELPH'S ROAD ECOLOGY GUIDELINE FOR DIRECTION REGARDING WILDLIFE TUNNEL DESIGN.

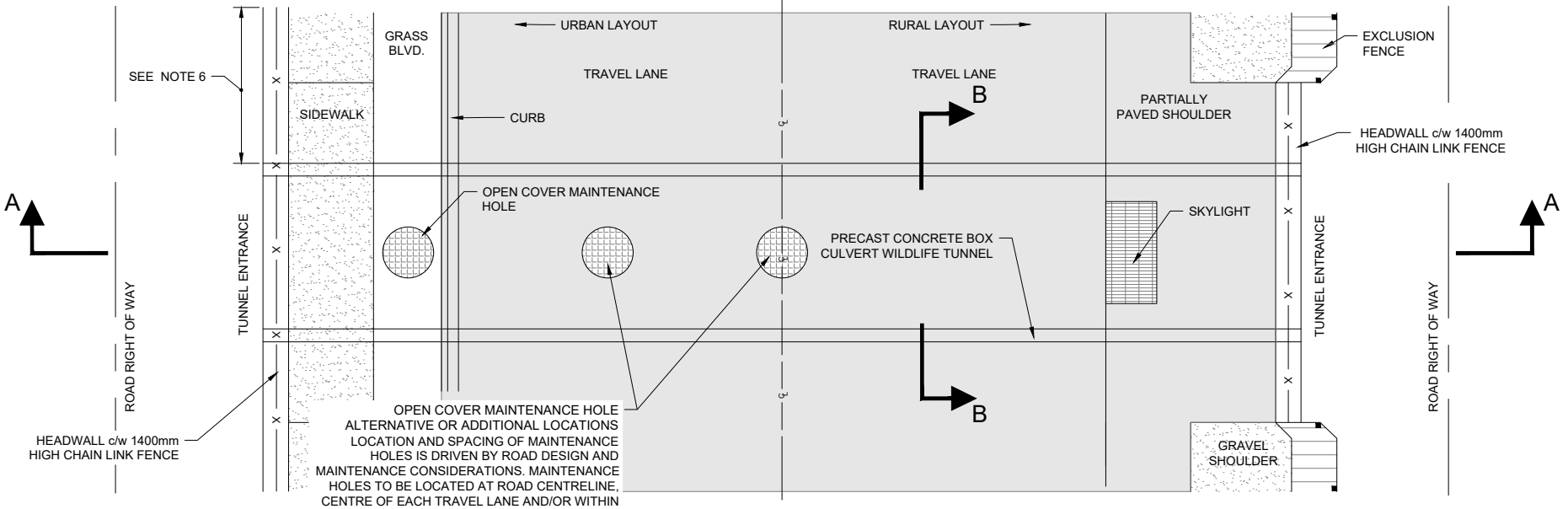
CITY OF GUELPH STANDARD DRAWING

SMALL WILDLIFE CROSSING STRUCTURE

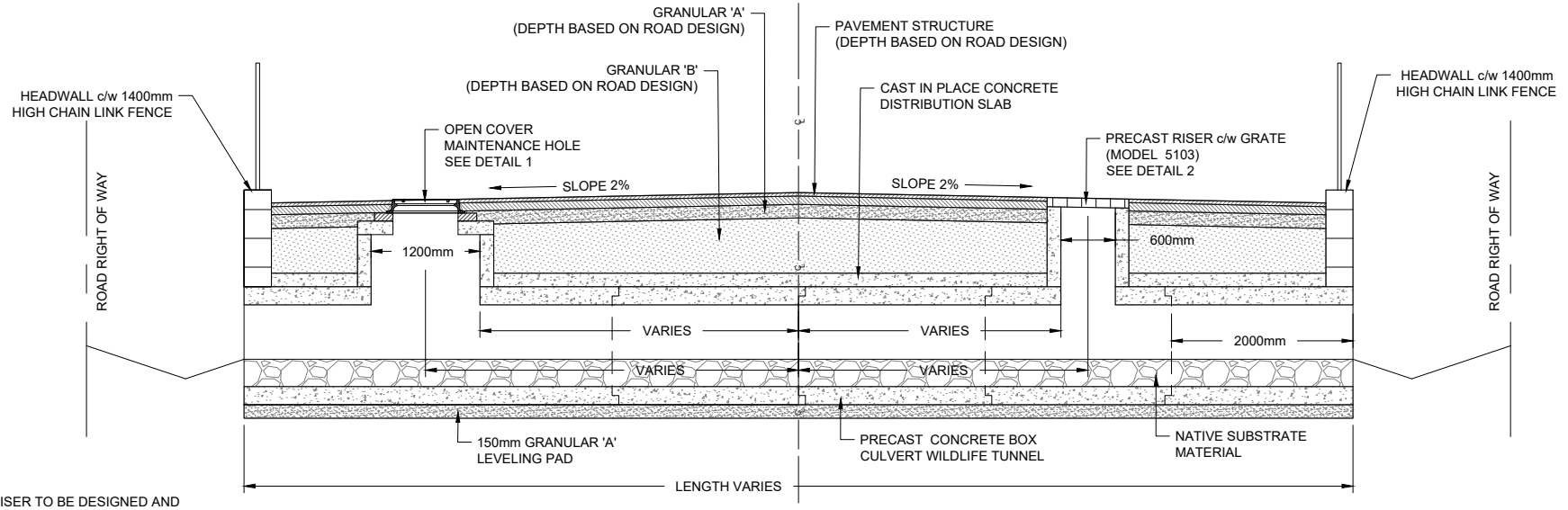
DATE DRAWN :	REV. No. :
DESCRIPTION :	
REV. DATE :	REV. BY. :
APPROVED BY:	
CITY ENGINEER	

CITY OF Guelph Making a Difference

ENGINEERING



PLAN



SECTION A

NOTE:
1. PRECAST CONCRETE RISER TO BE DESIGNED AND SUPPLIED BY BOX CULVERT MANUFACTURER.
2. PRECAST CONCRETE RISER TO BE RIGIDLY CONNECTED TO PRECAST BOX CULVERT AS PER MANUFACTURES INSTRUCTIONS.
3. CONTRACTOR TO PROVIDE ENGINEERED SHOP DRAWINGS FOR BOX CULVERTS AND RISERS.
4. FRAME/GRATE TO BE SET TO BASE COURSE ASPHALT ELEVATION.
5. ALTERNATE CROSSING STRUCTURE TYPES COULD BE UTILIZED. STRUCTURE MUST BE DESIGNED AND CONSTRUCTIONS AS PER MANUFACTURED RECOMMENDATIONS.
6. PROVIDE MIN. 3m SEPARATION FROM TUNNEL ENTRANCE TO ADJACENT DRIVEWAY OR ROAD TO FACILITATE EXCLUSION FENCE TURN AROUND. MORE THAN 5m SEPARATION IS PREFERRED, WHERE FEASIBLE.

CITY OF GUELPH STANDARD DRAWING

MEDIUM WILDLIFE CROSSING STRUCTURE (1 OF 2)

DATE DRAWN :	REV. No. :
DESCRIPTION :	
REV. DATE :	REV. BY. :
APPROVED BY:	
CITY ENGINEER	

CITY OF Guelph Making a Difference

ENGINEERING

USE THE RECOMMENDED OPENNESS RATIO TO SELECT THE APPROPRIATE WILDLIFE TUNNEL SIZE.

OPENNESS RATIO IS THE CROSS-SECTIONAL AREA DIVIDED BY THE LENGTH OF THE TUNNEL.

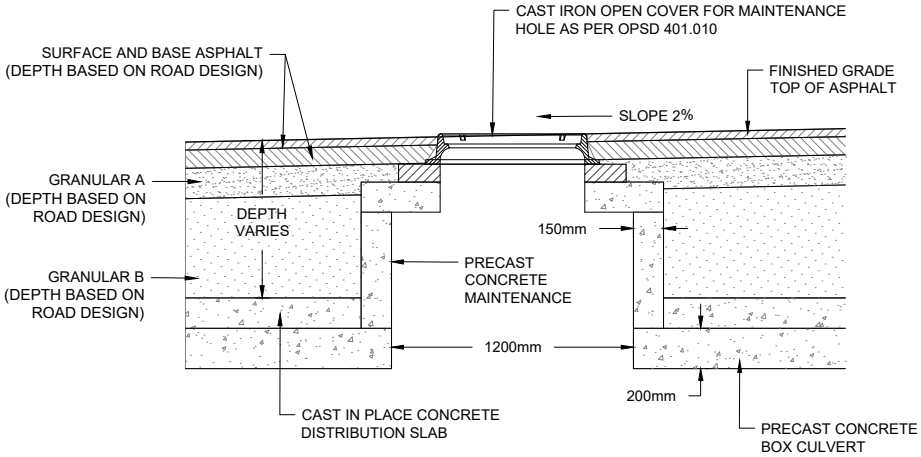
BOX CULVERT = [HEIGHT x WIDTH] / LENGTH

CORRUGATED STEEL PIPE = [∏r2] / LENGTH
WHERE ∏ = 3.14 AND r = RADIUS OF PIPE OPENING

RECOMMENDED OPENNESS RATIO PER TARGET SPECIES GROUP:

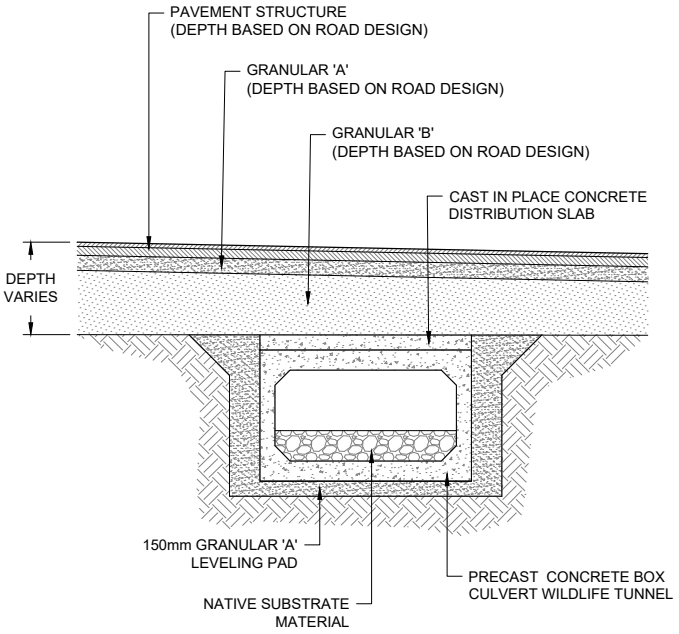
	TURTLES	AMPHIBIANS, SNAKES AND SMALL MAMMALS	MEDIUM MAMMALS
RECOMMENDED OPENNESS RATIO	≥0.25	≥0.1	≥0.4
MINIMUM OPENNESS RATIO	0.10	0.07	0.10

TURTLES = >/= 0.25
AMPHIBIANS, SNAKES AND SMALL MAMMALS = >/= 0.1
MEDIUM MAMMALS = >/= 0.4



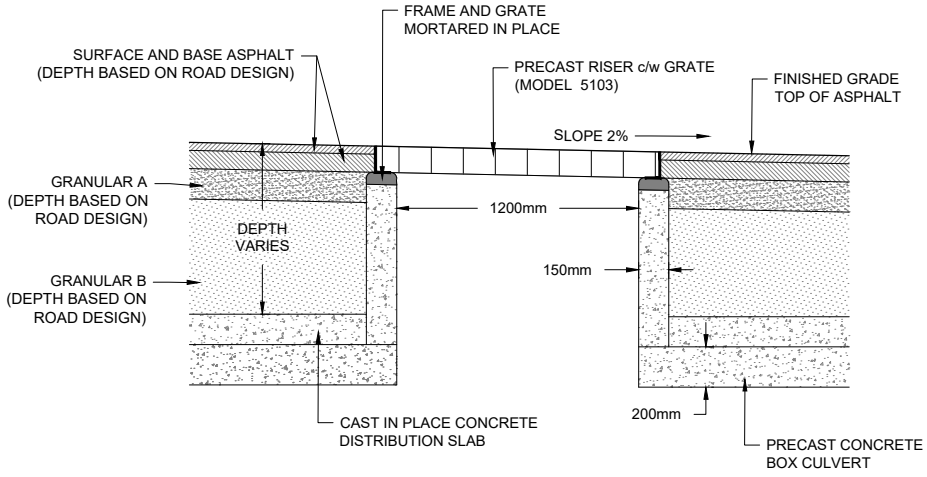
DETAIL 1

N.T.S.



SECTION B

N.T.S.



DETAIL 2

N.T.S.

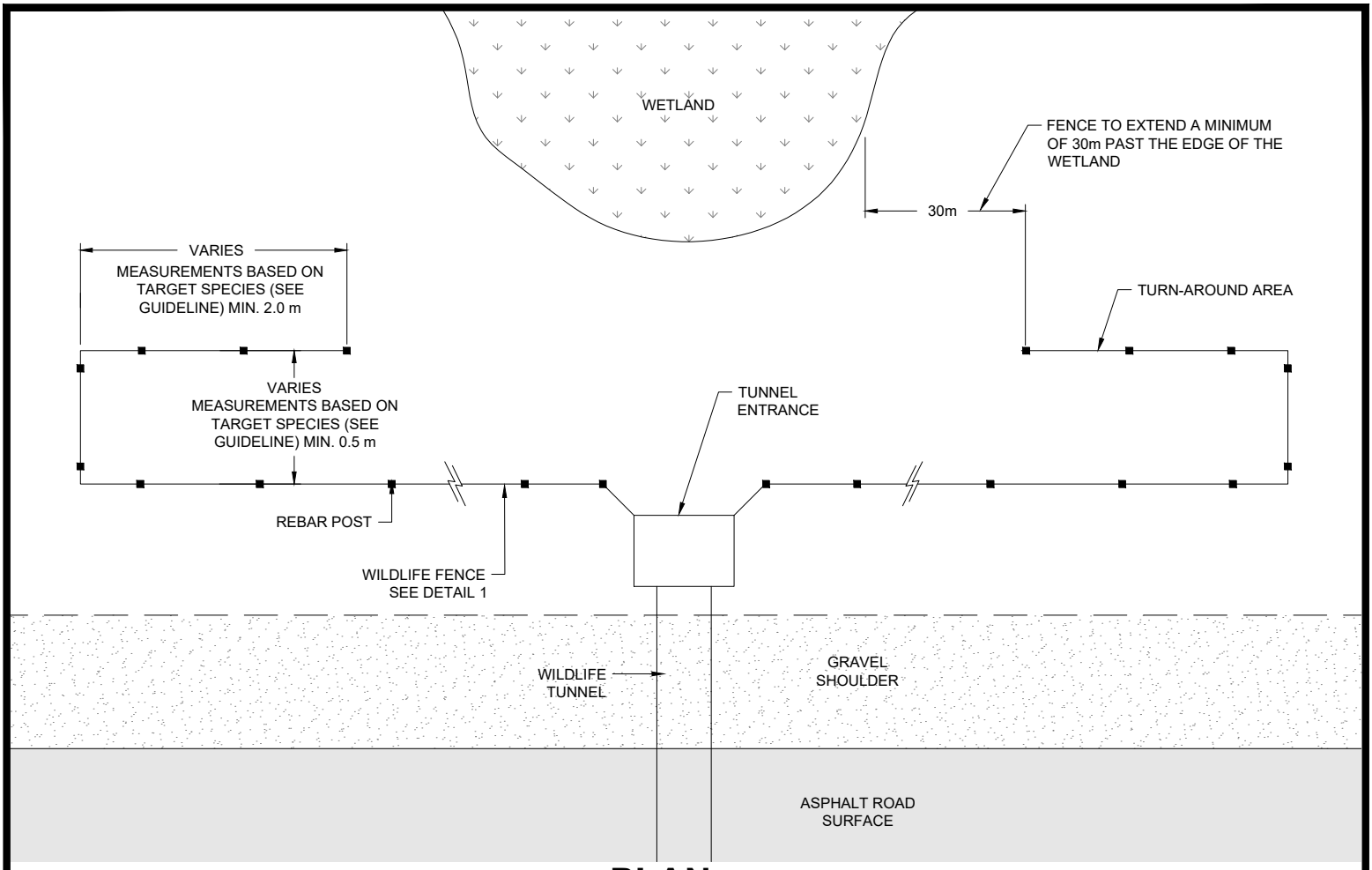
NOTE:
1. PRECAST CONCRETE RISER TO BE DESIGNED AND SUPPLIED BY BOX CULVERT MANUFACTURER.
2. PRECAST CONCRETE RISER TO BE RIGIDLY CONNECTED TO PRECAST BOX CULVERT AS PER MANUFACTURES INSTRUCTIONS.
3. CONTRACTOR TO PROVIDE ENGINEERED SHOP DRAWINGS FOR BOX CULVERTS AND RISERS.
4. FRAME/GRATE TO BE SET TO BASE COURSE ASPHALT ELEVATION.

CITY OF GUELPH STANDARD DRAWING

MEDIUM WILDLIFE CROSSING STRUCTURE (2 OF 2)

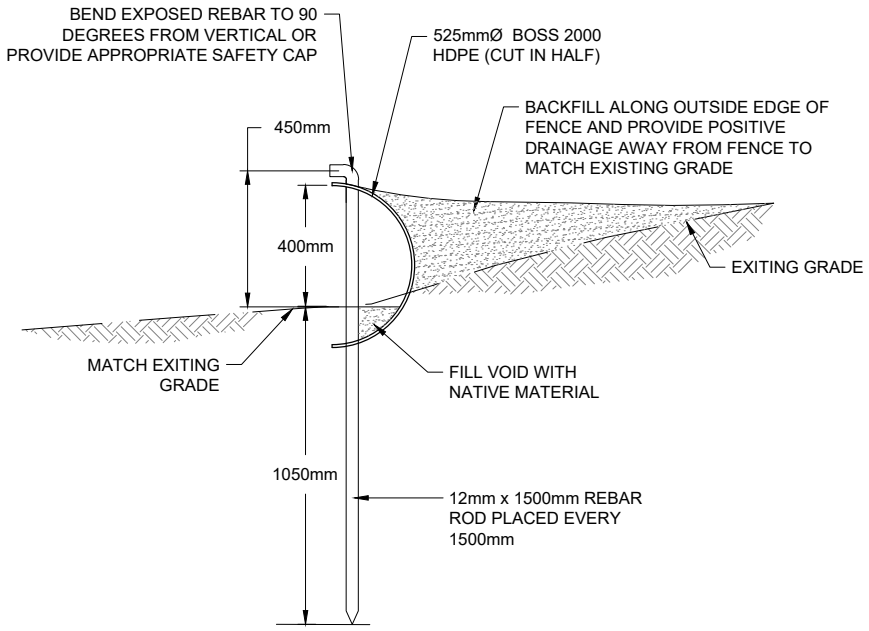
DATE DRAWN : | REV. No. :
DESCRIPTION :
REV. DATE : | REV. BY. :
APPROVED BY:
CITY ENGINEER

CITY OF Guelph Making a Difference
ENGINEERING



PLAN

N.T.S.

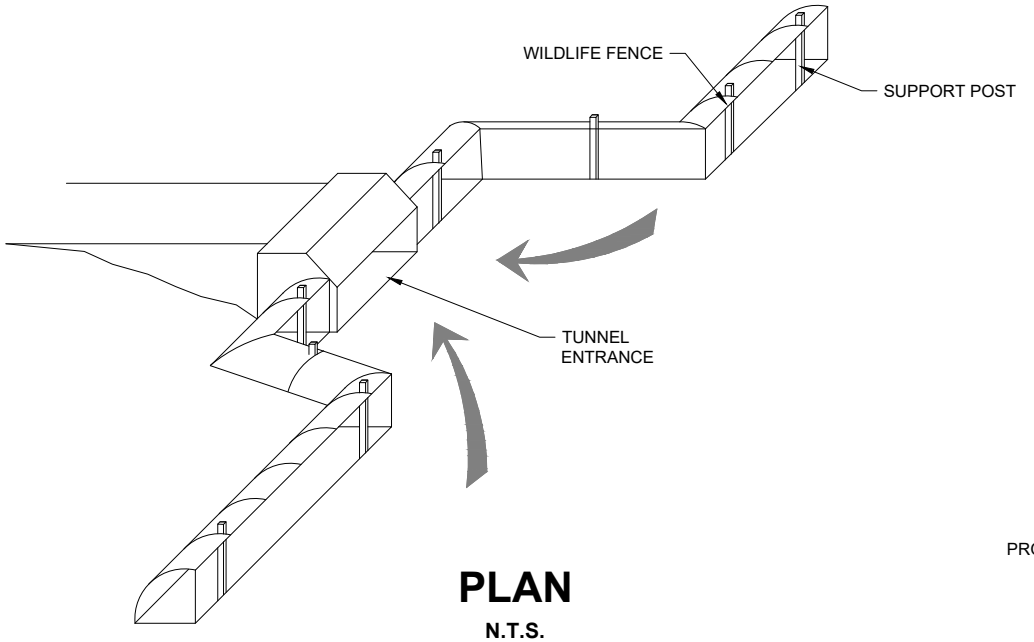


DETAIL 1

N.T.S.

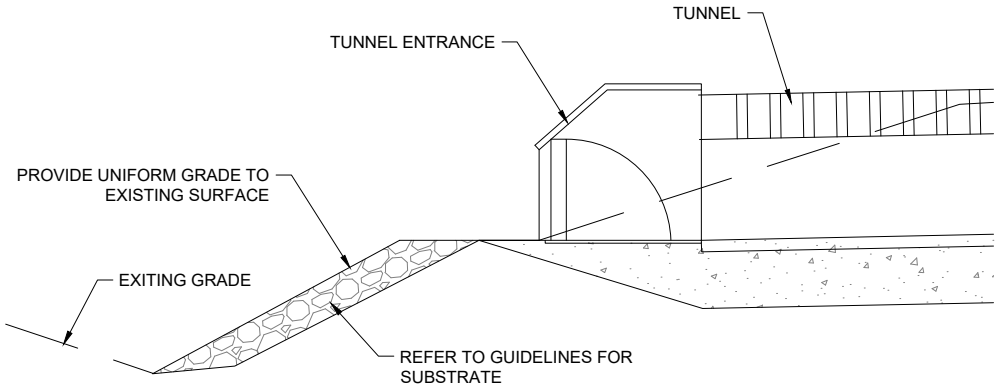
CITY OF GUELPH STANDARD DRAWING	DATE DRAWN :	REV. No. :	CITY OF Guelph Making a Difference
	DESCRIPTION :		
	REV. DATE :	REV. BY. :	ENGINEERING
	APPROVED BY:		
	CITY ENGINEER		

WILDLIFE EXCLUSION BARRIER



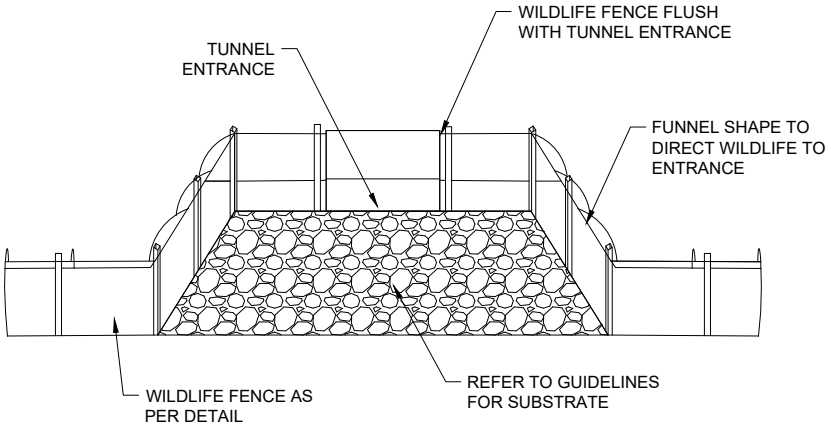
PLAN

N.T.S.



DETAIL 2

N.T.S.



DETAIL 1

N.T.S.

CITY OF GUELPH STANDARD DRAWING

WILDLIFE CROSSING STRUCTURE
INLET / OUTLET TREATMENT

DESCRIPTION :

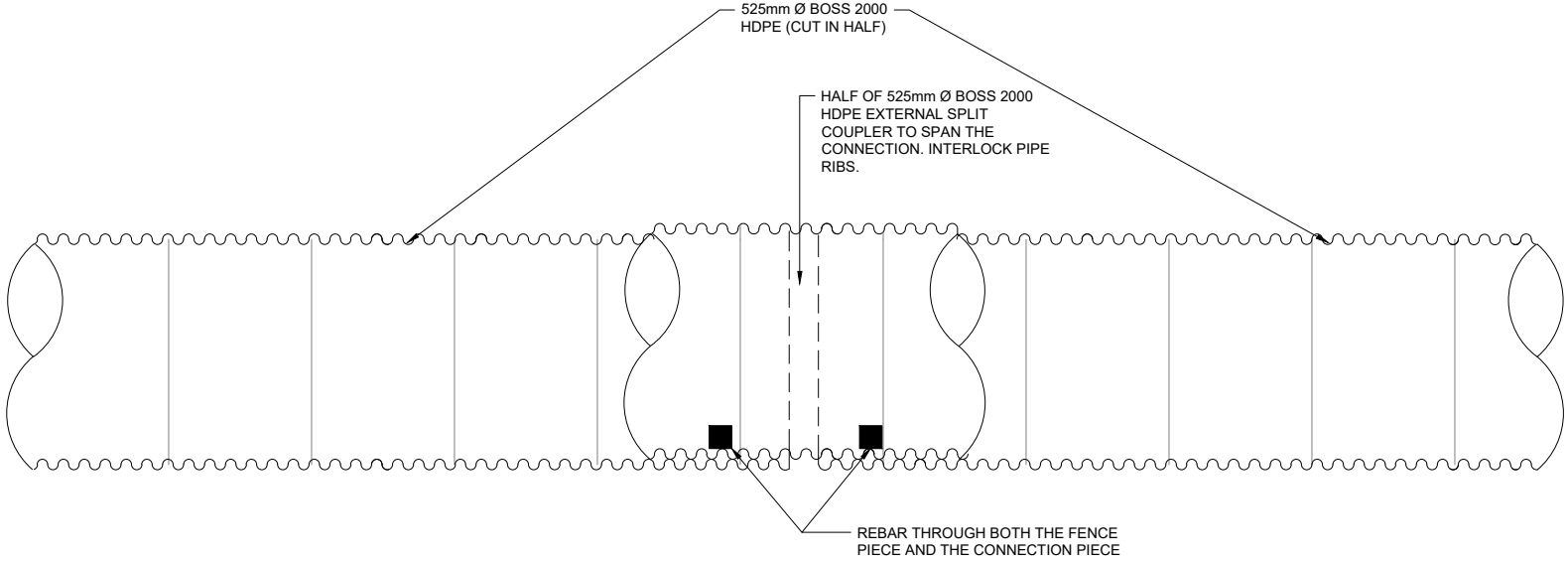
REV. DATE : | REV. BY. :

APPROVED BY:

CITY ENGINEER

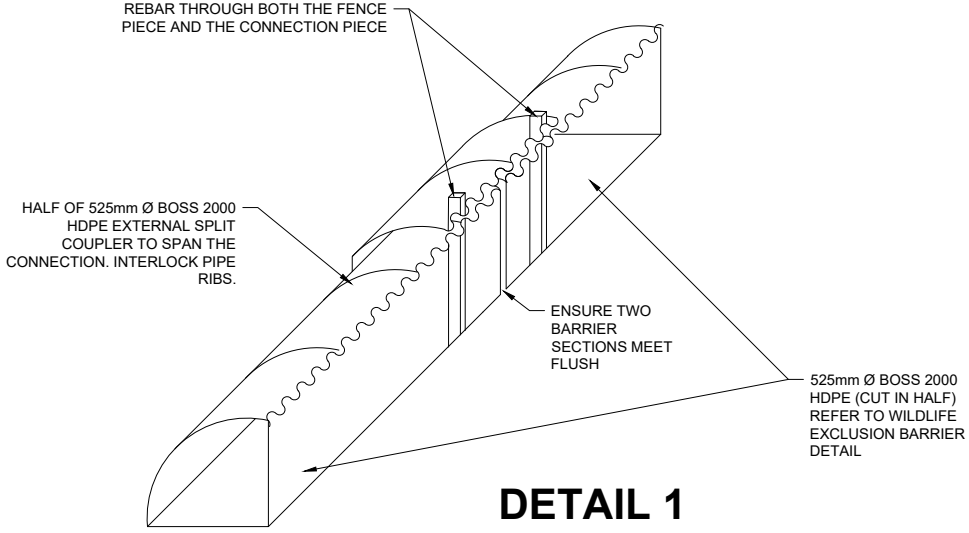
CITY OF Guelph
Making a Difference

ENGINEERING



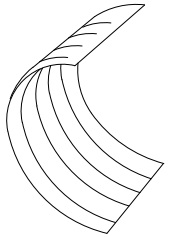
PLAN

N.T.S.



DETAIL 1

N.T.S.



EXTERNAL SPLIT COUPLER

N.T.S.

CITY OF GUELPH STANDARD DRAWING

WILDLIFE EXCLUSION BARRIER CONNECTION

DESCRIPTION :	
REV. DATE :	REV. BY. :
APPROVED BY:	
CITY ENGINEER	

CITY OF Guelph
Making a Difference

ENGINEERING