NCHRP 25-25, Task 113

ROAD PASSAGES AND BARRIERS FOR SMALL TERRESTRIAL WILDLIFE SPECIES

SUMMARY CONSIDERATIONS FOR NON-DESIGNATED DRAINAGE CULVERTS

Prepared for:

AASHTO Committee on Environment and Sustainability

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DISCLAIMER

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SUMMARY CONSIDERATIONS FOR NON-DESIGNATED DRAINAGE CULVERTS

This document summarizes considerations for small animal use of existing non-designated passages, primarily drainage culverts that were installed to convey water. This summary is based on the literature review, survey report, and knowledge and experience of the authors. The literature review and survey report are available as separate documents produced for this project (NCHRP 25-25, Task 113).

A. GENERAL CONSIDERATIONS

General considerations include the design and operation and maintenance issues associated with existing structures that were implemented for purposes other than small animal passage, primarily to convey water under a road. The location of the structure, structure type, structure dimensions, and habitat near or adjacent to the structure were at least partially designed for water passage and are only later considered for passage by amphibians, reptiles, or mammal species smaller than a coyote (Canis latrans).

The structures need to be evaluated to assess whether they are in the correct location and are designed adequately to meet the passage criteria of the target species. Several passage assessments have been developed for small animal passage (Kintsch & Cramer 2011). In some cases, a drainage culvert will not require any modifications other than supplementary exclusion fencing (Case Study 2). It is important to assess these types of existing structures to evaluate the modifications required. In some cases when culvert replacements are completed, recommendations such as upsizing culverts can be implemented (see Evaluation below).

Characteristics

Location: Drainage structures are constructed in lower wet areas, often along streams or adjacent to wetlands, and are only functional for small animals that occur in or can move through this type of habitat. In turn, smaller animals that move in relatively dry upland habitat will require designated structures installed in higher ground that remain dry when drainage structures are filled with water (Case Study 3). In some cases, structures in ephemeral or intermittent drainages that remain dry for part or most of the year can provide dry animal passages (Case Study 3).

Structure Type: This summary addresses smaller structures (less than or equal to 3 meters [m] diameter, height, and width). These structures vary in shape from round, elliptical, arched, or box and are made of various materials such as metals, e.g. corrugated steel pipe, plastics (high density polyethylene [HDPE]) and polyvinyl chloride (PVC), or cement. In most cases, these structures will have a bottom; however, in some cases, arched culverts may be installed on footings to maintain the natural substrate conditions.

Hydrology: Drainage culverts are existing structures in roads that have been installed for the passage of water. Water flow is intermittent or permanent, depth varies, and the structure is partially to fully submerged during certain periods of the year. Therefore, it is essential to evaluate if these conditions are suitable for the target small animal species.

Evaluation: Existing drainage culverts were selected for small animal passage and evaluated for potential amphibian, reptile, and small mammal passage 16, 30, and 35 times, respectively, at various box and round drainage culverts (Literature Review Report). In the 26 studies that monitored passage use, 20 (77%) documented passage by small animals. The following are a list of general considerations to evaluate whether existing drainage structures are suitable for small animal use:
• Location, i.e., existing suitable habitat for target species
• Number and spacing of existing structures within habitat bisected by road
• Size of structure, i.e., width, height (or diameter) and length
• Micro-habitat conditions, i.e., water flow, depth and permanency, temperature adjacent to and inside structure

Existing structures may be modified to encourage use by small animals. Rails and shelving were helpful to allow dry passage by terrestrial mammals (Goldingay et al. 2018, see Case Study 3). Also, several studies found that the use of crossing structures by small animals was negatively correlated with length (Smith 2003; Ascensão & Mira 2007; Chambers & Bencini 2015). Other options to facilitate use by small animals include creation of habitat such as vegetation and natural substrate at crossing approaches, in medians, and inside structure (if possible due to small size) to enhance use. For amphibians, dry refugia such as smooth and flat boulders can be beneficial.

The primary modification to enhance species use in the reviewed studies was the addition of both temporary or permanent exclusion barriers and/or funneling guide-walls to direct small animals to existing structures. Therefore, the adjacent terrain and road features must also be evaluated to assess feasibility for this type of installation (see Barrier Considerations Report).

**Maintenance:** Maintenance of non-designated crossing structures is focused on maintaining adequate permeability of water flows and animal passage. Specific maintenance includes ensuring scouring or erosion does not create a “perched entrance” or other barriers that prevent the target animal access to a structure, preventing beaver damming inside the culvert, and removing debris. Vegetation such as cattails (Typha sp.) and common reed (Phragmites sp.) may need to cleared routinely.

**Species-specific Considerations**

**Aquatic Small Animals (e.g., Freshwater Turtles, Aquatic Amphibians, Snakes, and Mammals):**
Existing drainage culverts with intermittent or permanent water are potentially suitable structures for animals that live in aquatic habitat (e.g., wetlands, ponds or along streams). When water flow is adequate, these animals can swim or, in cases of shallow water, walk through the culverts. These structures are more suitable when they are not fully submerged because they allow some light into the tunnel, which is especially important for turtles (Caverhill et al. 2011; Heaven et al. 2019).

In several studies, substantial water flow impeded upstream passage by spotted salamanders ((Jackson & Tyning 1989; Patrick et al. 2010) and long-toed salamanders (Atkinson-Adams 2015). Possible modifications to allow both upstream and downstream movements include modifying hydraulic flow with the use of boulders and baffles to reduce water velocity at entrances and inside the culverts. Stepping stones can also be added to the stream floor to allow rest stops during passage.

In some cases, screens can be added to culvert entrances to deter debris from plugging culverts or to inhibit other wildlife such as beavers from damming inside the structures (Figure 1). These screens may trap other wildlife and block animals from entering the culverts. More research is needed to find solutions that allow wildlife passage for target animals and discourage debris accumulation and damming by beavers. One potential solution includes modifying the screen (i.e., changing the mesh size to allow permeability of the target species while still excluding debris and beavers). Other solutions include using flow devices, diversionary dams, and fence barriers strategically placed to deter beavers from damming.
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culverts and entrances. Wildlife passage must be considered in these solutions, and include integration of a gap, gate, or door in the diversionary barrier (Danby & Gunson in prep).

Figure 1: A metal grate on a drainage culvert to deter beaver access and associated beaver dams inside drainage culvert; these screens impede movement by turtles and other animals through drainage culvert. Photo Credit: Ausable Bayfield Conservation Authority.

Snakes: Habitat requirements vary considerably among snake species; therefore, drainage culvert adequacy will vary. Some evidence suggests that temperature may influence when snakes and turtles will cross through culverts and that these animals tend to cross in the afternoon when diurnal temperatures peak (Colley et al. 2017; Eco-Kare International 2019). Aquatic or semi-aquatic snakes are more prone to use existing drainage culverts with some water; however, water temperatures may be more of a limiting factor for snakes than turtles. Research has shown that snakes turn around more often at culvert entrances filled with water than turtles do (Gunson 2019). Drainage culverts that dry out in unison with peak terrestrial snake movements are ideal for connectivity across roads.

Snakes tend to bask in warm places and often seek cover. Potential modifications to drainage structures include installation of skylights in tunnels, especially at the entrances. When structures are dry, inclusion of root wads’ cover boards, sandy soils, wood chips, and other vegetation debris both inside culverts and near culvert entrances improve microhabitat conditions during crossing and facilitate snakes entering the culverts.

Terrestrial Small Mammals and Tortoises: Drainage culverts that are dry or have little water may provide suitable conditions for passage by terrestrial small animals such as desert tortoises and mammals. Some research shows tortoises used various round and box drainage culverts that were dry and ranged from 33–66 m in length when fencing was present (Boarman & Sazaki 1996). When drainage culverts are permanently flooded but not fully submerged, adequately sized ledges and rails may be used to facilitate
drier passage for these animals (see Case Study II). Cinder blocks and PVC pipe may also be used as cover objects for small mammals (Tracey et al. 2014; Figure 2).

![Cinder blocks laid on top of black PVC pipe in a dry culvert built for larger animals. Photo Credit: (For a U.S. Geological Survey project) Jeff Tracey, Western Ecological Research Center, U.S. Geological Survey.](image)

**Figure 2:** Cinder blocks laid on top of black PVC pipe in a dry culvert built for larger animals. Photo Credit: (For a U.S. Geological Survey project) Jeff Tracey, Western Ecological Research Center, U.S. Geological Survey.

**REFERENCES**


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