Proposed Design and Considerations for Use of Amphibian and Reptile Tunnels in New England

Scott Jackson
Department of Natural Resources Conservation
University of Massachusetts Amherst
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Based on my experience with salamander tunnels used in Amherst, MA, and knowledge of other amphibian tunnels in Europe and elsewhere I propose the following underpass design for facilitating overland passage of amphibians and reptiles (See figures 1, 2 and 3). It is important to note that this design has not been extensively tested and that future work may indicate the need to significantly change this design.

1. The tunnel should be in the form of a box culvert at least 2'x 2' square and should be the minimum length necessary to accommodate safety issues and achieve other design features. I imagine that the culvert would be made of concrete, although other material would probably be acceptable. A proper base must be used to prevent disruption of the road surface due to frost heaves.
2. The tunnel should be open at the top and fitted with an iron grate that would sit flush with the road surface. The iron grate must allow ample rain, light and air circulation into the culvert.
3. Sandy soil (sandy loam) should be used to cover the bottom of the tunnel to provide a more natural substrate for travel.
4. Wing walls should angle out from each end of the tunnel at approximately 45 degrees.
5. Vertical retaining walls at least 18" high should angle out away from the wing walls at a broad angle for a length of 100-200 feet. The tops of these retaining walls should be flush with the ground surface on the side closest to the road, and present a vertical surface at least 18" high.
6. Ideally, crossing structures should be placed no more than 100 feet apart, although for many species a 200-foot distance between structures may be acceptable.

It is important to note that amphibian and reptile tunnels are experimental techniques for conservation. In New England we know that they work for spotted salamanders. We suspect that they will work equally well for other mole salamanders if they are well designed. A recent study in California of mole salamander use of tunnels indicated that the tunnels were ineffective, probably because the fence system was parallel to the road and failed to adequate funnel the salamanders to the passage structures.

A 2'x 2' tunnel is actually quite small with a very small openness ratio (cross-sectional area divided by length). It is hoped that the inclusion of an open top (essential for meeting the moisture requirements of many amphibians) will help compensate for the confining nature of these passages. The challenge of highway mitigation is always a matter of getting the most out of limited mitigation dollars. If they prove effective, small low-cost reptile and amphibian structures would make it more

practical to create multiple structures, perforating sections of roadway rather than relying on single passages. Because many amphibians and reptiles have limited mobility, there are considerable drawbacks to concentrating mitigation efforts at a single location.

We have done some preliminary tests that indicate that tunnels may work for painted turtles, but that fence designs for turtles must be carefully considered. A very large tunnel is reported to be used by spotted turtles in Eastern MA. There are early indications that a tunnel and wall system in eastern MA does not work for Blanding's turtles, even though the tunnel is quite large. In Europe, toads and newts will use tunnels. So it might be expected that tunnels will work for New England species of toads and newts. However, these structures have not been adequately tested for other species such as small mammals (shrews, moles, voles, etc), snakes, box turtles or several other species of turtles (wood, spotted, snapping etc.).

We do know that particular design features may be necessary to facilitate tunnel use by certain species. Size, placement, moisture, hydrology, temperature, and noise have all been demonstrated to affect wildlife use of underpasses. Until a tunnel design is tested for a wide variety of species, I would not recommend it for wide application. If the tunnel design does not meet the needs of a wide variety of species, fences that are necessary to channel some wildlife to the tunnels may act as barriers to movement for other species.

Therefore, I only recommend the use of tunnels when:

1. There is a documented need
    - Is there a known population at risk?
    - Is there a known crossing point?
    - Are rare species involved?
    - Will traffic volumes be high enough to represent a serious threat?
    - Are we dealing with a species that is vulnerable to additive mortality from roads (e.g. species characterized by low reproductive potential and high adult survival rates like turtles and mole salamanders)?
2. The benefits for a particular species outweigh the risks to other species that may have their movements blocked if the tunnels don't function as intended.
3. The tunnel systems are carefully designed, located and constructed.
4. An adequate maintenance plan is in place.

I do not recommend the routine use of tunnels for sub-division roads or light volume access roads.

For smaller roads and driveways, the most important design feature to consider is curbing. Granite curbs and some traditional curbing can act as a barrier to amphibian movements. I know of situations in MA and Canada where large numbers of salamanders have been intercepted in their migrations by curbs and catch basins. Use of Cape Cod berms rather than traditional curbing may be one solution. Alternative, where storm water management systems require more traditional curbing, it may be possible to design in escape ramps on either side of each catch basin.

Use of large embedded culverts or open bottom structures (arches or bridges) at stream crossings may also help facilitate wildlife movement for species that naturally follow streams (without requiring fences). The goal is to use structures that preserve the natural stream bottom. Preserving the natural stream bottom will likely facilitate movement of salamanders, fish, turtles and stream invertebrates through the culvert. Culverts wide enough to allow for some dry ground on one or both sides of the stream will be even more effective for facilitating wildlife passage in general.

There is a need for much more research before we can put forward a design for reptile and amphibian passage that can be used with high confidence. In the meantime, where roads and highways threaten amphibian or reptile populations, we must experiment with designs based on our best guesses. Whenever passage structures are used it is very important that they are monitored to determine their effectiveness. For the time being, trial and error is the chief source of information we have for designing passage structures. If you have information about amphibian and reptile use of crossing structures that you are willing to share, please contact me at:

Scott Jackson
Department of Natural Resources Conservation
Holdsworth Hall
University of Massachusetts
Amherst, MA 01003
(413) 545-4743 (voice)
(413) 545-4358 (fax)
sjackson@umext.umass.edu

Figure 1.

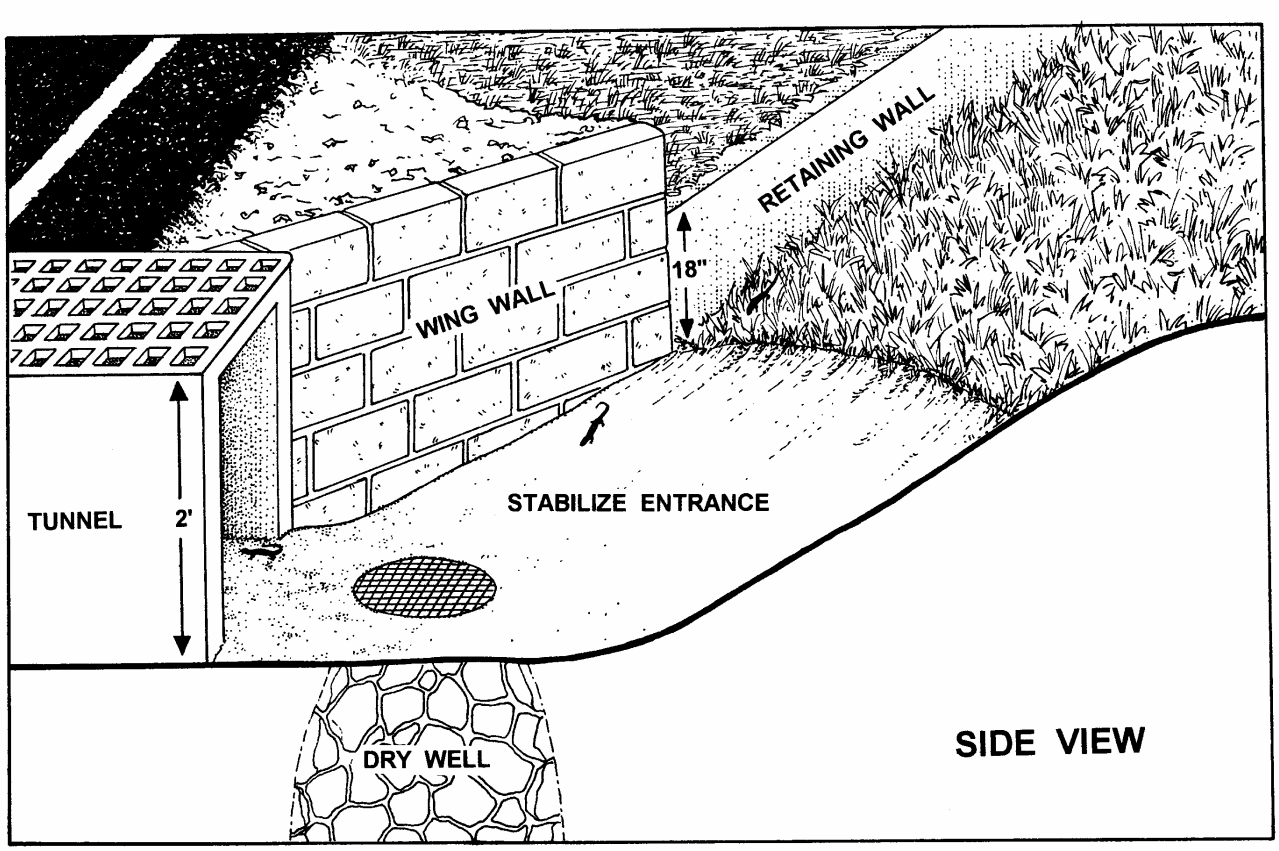
RETAINING WALL
18"
WING WALL
TUNNEL
2'
STABILIZE ENTRANCE
DRY WELL
SIDE VIEW

Figure 2.

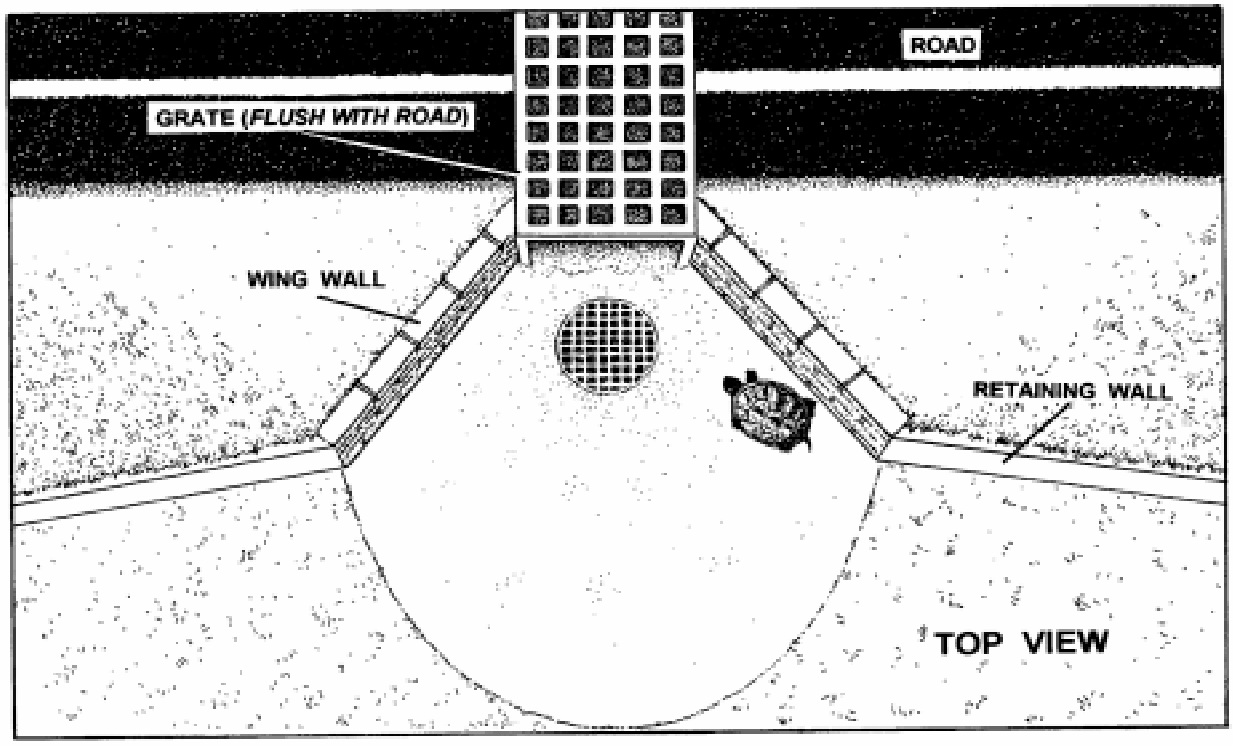

Figure 3.