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THE USE OF THE T-CULVERT GUARD TO PROTECT ROAD CULVERTS FROM PLUGGING DAMAGE BY BEAVERS

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ABSTRACT

Since 1978 there has been a continual effort by Region 9 of the New York State Department of Environmental Conservation to develop devices capable of protecting road culverts from plugging damage by beavers (Castor canadensis). Various protective devices were developed. The most successful was the T-culvert guard. Trial installations of T-culvert guards were made at 4 sites experiencing beaver damage. T-culverts consisted of a 4 ft. or larger diameter culvert and a smaller diameter culvert which connected it to the road culvert. Directions for construction, installation and maintenance of T-culverts are given. Costs for a typical 4 ft. diameter T-culvert at 1985 prices were $226.00 for materials, $160.000 for backhoe rental and 3 worker days for labor. Average annual maintenance cost was estimated to be .27 worker days and .27 hrs. of backhoe time. T-culverts alleviated beaver damage by concealing flows which were considered detectable to beavers. It is believed that these devices may prove useful in protecting water level control structures such as are used in ponds and marshes.

INTRODUCTION

The plugging of road culverts by beavers (Castor canadensis) is a significant and costly wildlife damage problem in New York State. From April 1986 to March 1987, 83 beaver damage complaints were inspected by the author in Cattaraugus County of western New York. Of these 24% involved damage to road culverts. In a survey of highway superintendents in central New York, Purdy and Decker (1985) determined that 58% of the superintendents surveyed believed that culvert damage was their most important problem with beavers. From superintendents' estimates the average repair cost for each incidence of culvert damage was determined to be about $2,200.00 (Purdy and Decker, 1985).

Conversely, it is recognized that beavers provide important benefits at beaver flows. Ermer (1984) considered marsh habitat, pelt production and trapping recreation to be important benefits of occupied beaver flows in western New York. Unfortunately, many flows which contain significant benefits, are adjacent to road culverts.

Beavers are not tolerated at these sites because of ensuing culvert damage. Although some offending beavers are trapped during the regular trapping season and sometimes control devices are tried, the predominant solution is the immediate destruction of beavers. Since 1978, there has been continual effort by Region 9[2/] of the Department of Environmental Conservation to develop devices capable of protecting culverts from beaver damage. Through the use of such devices, beavers have been allowed to remain at selected damage sites. Various protective devices have been tried, among them: plastic tubing as described by Roblee (1984a), wire culverts as described by Roblee (1984b) and fences similar to those used by Laramie (1963). These devices were successful but they were easily damaged when highway departments attempted to remove debris from them. They also required significant maintenance to keep them operating properly. From experience with these devices more durable culvert guards were developed for differing conditions of flow and depth encountered at culvert sites. The most successful device, as judged by its durability, ability to discourage plugging damage and its low

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2/Region 9 includes Allegany, Cattaraugus, Chautauqua, Erie, Niagara and Wyoming Counties of western New York.

maintenance cost, was the T-culvert guard.

Figure 1 shows a T-culvert in place in front of a road culvert. T-culverts were constructed from new or discarded road culverts of 4 ft. or more diameter, a smaller connecting culvert and concrete reinforcing wire.

During the period from May 1984 to February 1987 4 T-culverts were installed and maintained on a trial basis at damage sites in Allegany, Cattaraugus and Chautauqua Counties. Records were kept of the initial cost of installation and maintenance. This paper presents the considerations and techniques developed for installing T-culverts effectively.

Thanks are extended to the highway departments of the Towns of Chautauqua, Gainesville and Rushford and the Division of Operations of the D.E.C. for their assistance in the construction and installation of these devices.

METHODS AND MATERIALS

Prerequisites for T-Culvert Use

T-culverts were designed to work effectively at culvert sites having certain conditions present. If the following conditions are not present or cannot be provided at the site a T-culvert is unsuitable. Another type of

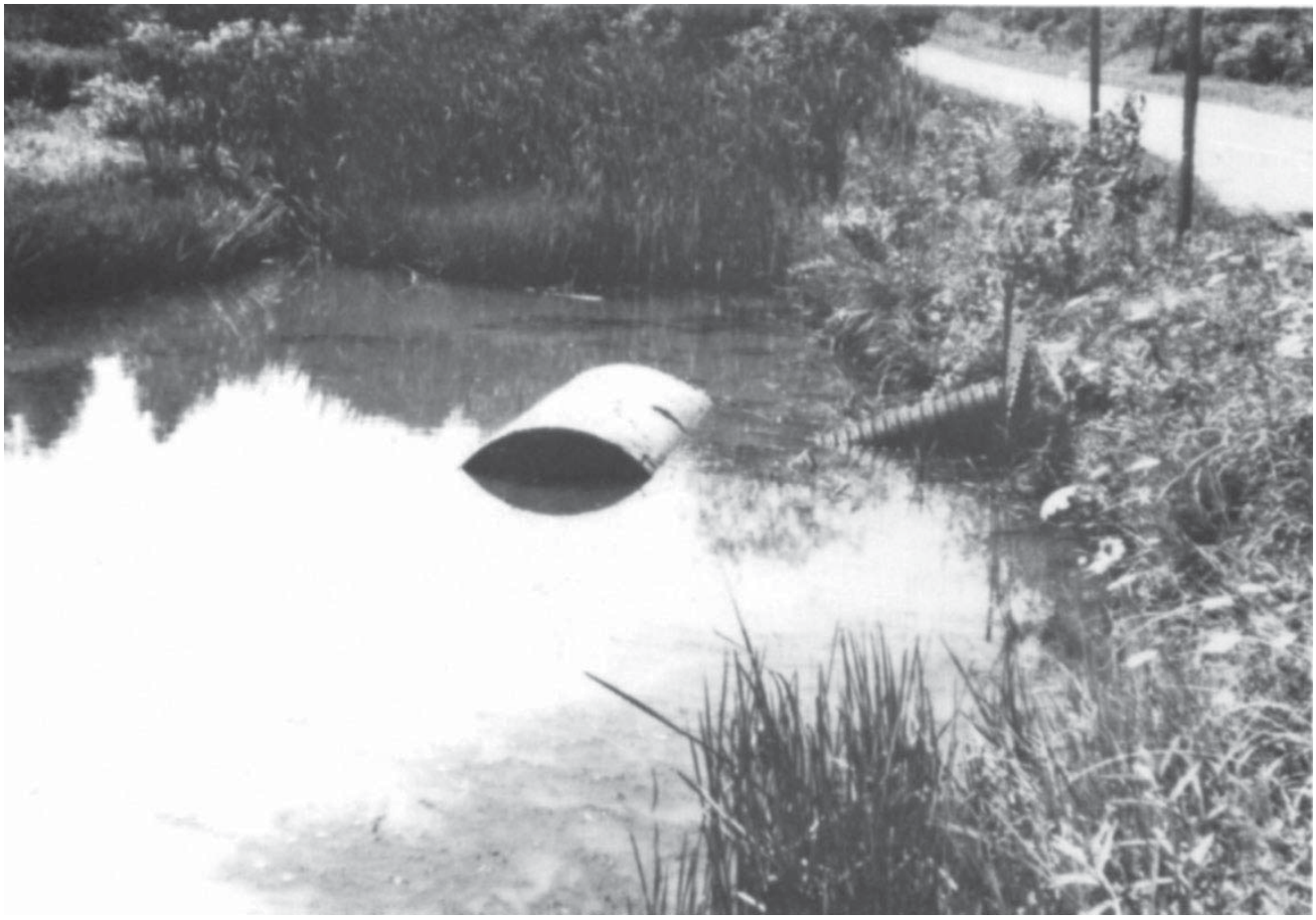

Figure 1. Typical T-culvert guard in place at a culvert damage site. Large culvert is perpendicular to road culvert and parallel to road surface.

protective device should be used.

Stream flow -- Actual measurements of stream flows were not made during this study. However, stream flow is important to the proper function of a T-culvert. As a guideline the road culverts protected were 3 feet in diameter or less with normal flows approximately $\frac{1}{4}$ of their diameters. (This recommendation is based on experience with culvert guards in place thus far. Further testing may reveal that larger culverts may be effectively protected.) Table 1 gives road culvert diameters at the 4 installation sites. T-culverts were observed to work effectively during brief flows of $\frac{1}{2}$ the road culvert diameters.

Water depth -- T-culverts require relatively still water from 4 to 6 feet in depth at both inlet ends. At trial installations this depth was usually provided by excavation before the T-culvert was set in place. It is necessary for excavating equipment to be able to reach the area to be excavated, initially and during later cleaning maintenance.

Substrate -- The area excavated for the T-culvert should not fill quickly by natural means, i.e., the sloughing off and flow of an unstable substrate such as muck or the deposition of gravel from a gravel bottom stream with a high gradient. Substrate problems can be overcome, however, through the use of special adaptations presented later in this paper.

Required Materials and Tools

The following are required to construct and install each of the trial T-culverts:

1. (1) Corrugated road culvert of

Table 1. Specifications, installation time, days of control and maintenance time for trial installations of T-culvert guards in western New York.

Installation site	Road culvert diameter (inches)	Large culvert diameter (inches)	Date installed	Installation Time: Labor (worker days[1])	Installation Time: Machine (hrs.)	Days of control[2]	Maintenance: Labor (worker days)	Maintenance: Machine (hrs.)
Punky Road Marsh	14	48	May 3, 1984	2.75	4	607	0	0
Rush Creek Road	36	60	Sept. 17, 1984	2.00	4	894	0	0
Shearing Road	24	72	April 25, 1985	4.50	6	674	.5	0
Mt. Pleasant Road	24 X 36	48	July 31, 1985	2.50	4	577	1.5	2
TOTAL				11.75	18	2,752 or 7.54 yrs.	2	2
Averages				2.94/ site	4.5/ site		.27/ site/ yr.	.27/ site/ yr.

1/A worker day was considered to be 8 hrs. and included driving time to and from job.

2/Includes only time when beaver were present at sites from date of installation to February 28, 1987.

4 ft. - 6 ft. diameter and 8 ft. - 12 ft. lengths.
2. (1-2) No. 6-gauge concrete reinforcing mesh panel(s) 10 ft. x 5 ft.
3. (10 ft.) No. 10-gauge galvanized wire.
4. (1) Corrugated road culvert of 12 in. - 24 in. diameter and 6 ft. - 8 ft. length.
5. Acetylene cutting torch.
6. 3/8 in. drill motor.
7. 3/8 in. drill.
8. Bolt cutters.
9. Large pliers.
10. Excavating machine.

Culvert Construction

The 4 trial T-culverts were constructed in the following manner. The two culverts used for construction of a T-culvert may be either corrugated aluminum or corrugated galvanized steel. The large diameter culvert is used to create inlets for the road culvert. These inlets experience low water velocities. Such inlets, when exposed to beaver, are rarely plugged. In general, the larger the road culvert and corresponding flow the larger the diameter needed for the large culvert. This will properly reduce water velocity at its exposed inlets. For road culverts of 6 in. - 18 in. diameter, a 4 ft. minimum diameter large culvert is recommended. For road culverts of 20 in. - 36 in. diameter, a 5 ft. or 6 ft. minimum diameter culvert is recommended. A smaller diameter culvert is used to connect the road culvert to the large culvert. The diameter of this connecting culvert must be near that of the road culvert so it will not reduce flow into the road culvert excessively. It also must be small enough in diameter to fit into the road culvert 6 or more inches at an upward angle as shown in Figure 1.

The large culvert is prepared for installation by cutting it to a length of 8 ft. to 12 ft. When space is available at a site the longer length is recommended. A hole is cut in the center of the side of the culvert at approximately 2/3 of the distance from the culvert's top. The diameter of this hole is large enough to allow the connecting culvert to pass into it at an angle approximated by Figure 1. Figure 2 shows the correct location of this hole. The ends of the large culvert are covered with No. 6-gauge reinforcing wire mesh. The mesh is attached with No. 10-gauge galvanized wire passed through holes drilled or burned through the large culvert. It may also be attached by passing the protruding ends of the mesh through premeasured holes and bending them over. Figure 2 shows mesh in place over the culvert ends.

The smaller culvert is prepared by cutting it to a length sufficient to connect the road culvert to the large culvert, normally 6 ft. to 8 ft.

Installation

Before the T-culvert can be installed at a site, sufficient water depth must be present in front of the road culvert to nearly submerge the large culvert and provide a similar water depth 6 ft. to 8 ft. outward from its ends. If this depth is not present then it must be provided by excavation. If this excavation is done in muck or gravel substrate, surrounding material may collapse or wash into the large culvert. This will reduce water depth and subsequently the effectiveness of the T-culvert. This can be prevented by fencing the unstable material back from the large culvert openings. One method of fencing is to place stone filled wire gabions around and 6 ft. distant from the openings. Another method is to cut the large culvert so that the bottom half of the culvert ends extend approximately 3 ft. beyond the wire grate coverings as shown in Figure 3. Plywood is then placed against the extended ends to hold back loose substrate.

Proper depth is checked for by

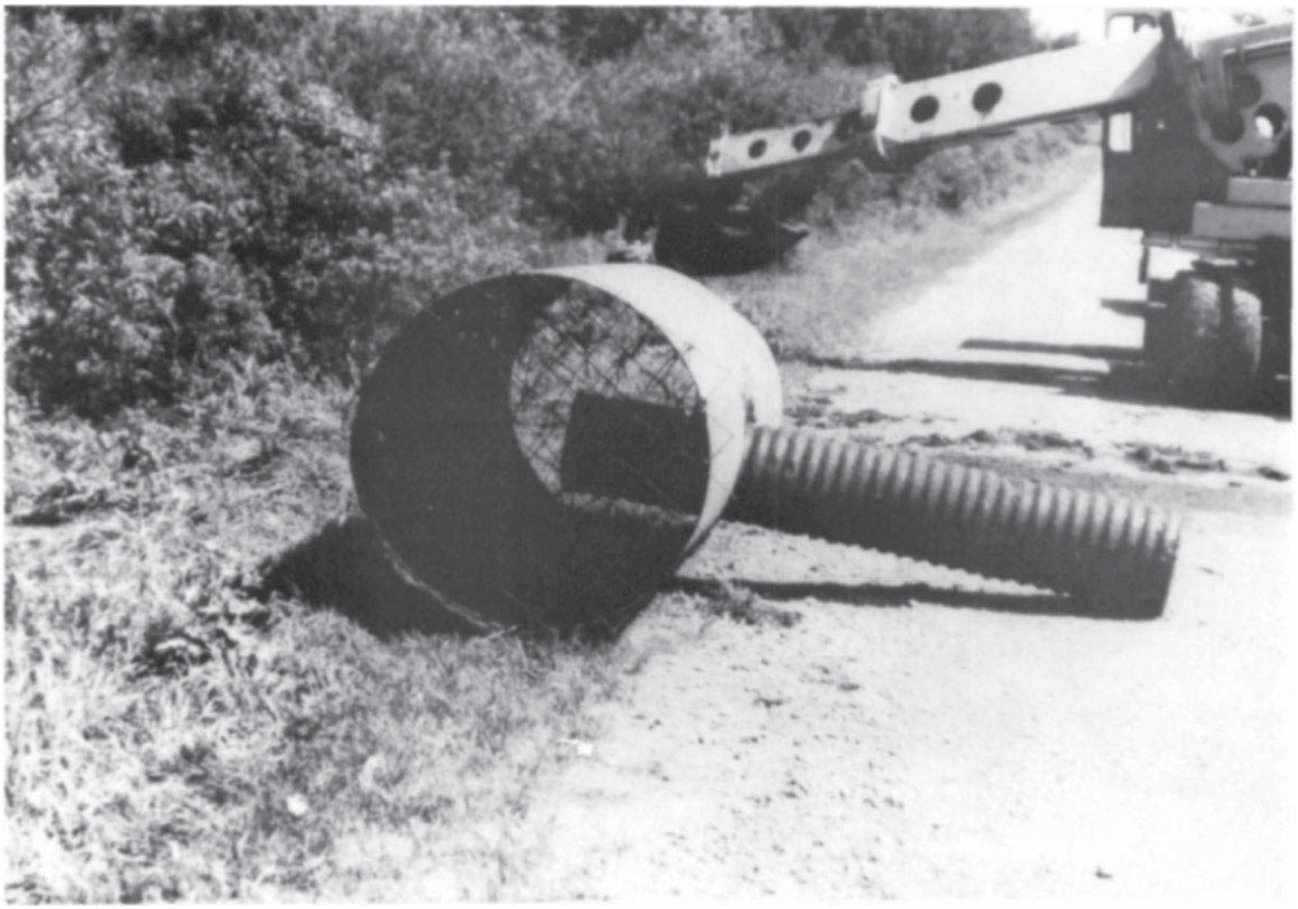

Figure 2. Large culvert showing placement of hole cut for smaller diameter connecting culvert. Wire mesh is in place on culvert ends.

placing the large culvert in position momentarily.

The T-culvert assembly is most easily installed by placing 1 ft. to 2 ft. of the connecting culvert into the large culvert and then lowering the assembly into position (Figure 4). The large culvert is placed 4 ft. to 6 ft. from the inlet end of the road culvert in a position perpendicular to the road culvert and parallel to the road surface. The entire assembly is then moved toward the road culvert as the remaining end of the connecting culvert is placed 6 in. into the road culvert. Any remaining opening of the road culvert not covered by the connecting culvert should be covered with No. 6-gauge reinforcing mesh to exclude beaver. Figure 5 shows the proper placement of the connecting culvert into the road culvert. It may be necessary to place a small amount of excavated material behind the large culvert to prevent it from rocking. Figure 6 shows a completed T-culvert installation which uses extended ends and plywood fencing to exclude muck substrate.

Installation Costs

The cost of materials for a T-culvert varied according to the diameters of the culverts used. The cost of a typical 4 ft. diameter T-culvert at 1985 prices is given as an example.

Materials -- Culverts, reinforcing mesh panel and galvanized wire =

Figure 3. A 6 ft. diameter large culvert with extended ends used in fencing back unstable substrate.

$226.00.

Equipment rental -- 4 hrs. backhoe rental = $160.00.

Labor -- 3 worker days (Table 1).

Maintenance Required

T-culverts are durable structures which are not easily vandalized or damaged when cleaning. The galvanized portions of these structures should have a useful life of 20 years. If used, aluminum culverts would have an even longer life. It may be necessary to replace the 6-gauge reinforcing mesh after five years of use.

Beaver may place debris in front of the large culvert inlet ends or material may accumulate naturally. In the event that this occurs, the material must be removed by excavation before the inlet ends are ½ filled. If this is not done, the water velocity through the inlets will increase. This will cause beaver to detect flow through the inlets and cause them to plug the remaining openings. Once beaver have learned how to plug a T-culvert they will persist in doing so. Periodic inspections should be made of T-culverts especially during the 2 weeks following installation to monitor plugging activity and prevent culvert disfunction.

RESULTS AND DISCUSSION

Each of the T-culvert installations

Figure 4. Lowering assembled T-culvert in place in front of road culvert.

were effective in preventing damage to the road culverts. Beaver plugging activity at damage sites was almost non existent. A varying amount of maintenance was required to insure this. Table 1 gives the required maintenance time for each installation.

No maintenance was required at the Punky Road and Rush Creek Road sites where beaver made no attempt to plug the large culvert openings. Inspection time was not recorded for these sites since inspections were of short duration (5-10 minutes) and were made during other assigned activities.

At the Shearing Road site beavers placed a small amount of mud and sticks in front of the inlet ends of the T-culvert over a period of several weeks and then stopped. This material was removed every 2 weeks with a potato hook. It should be noted that beavers were familiar with placing material against a previous fence at this location. This may have been a continuation of a learned activity.

The large culvert at the Mt. Pleasant Road site filled with silt and was removed, cleaned and replaced. It is not known to what extent beavers were responsible for this problem as a great amount of silt had washed into the site from an adjacent marsh.

Maintenance costs for T-culverts have been the least of any culvert protective device tried in Region 9. Average annual maintenance time for an

Figure 5. Smaller diameter connecting culvert in place in road culvert.

installation was estimated from the data in Table 1 by converting the total days of control to years and dividing the total worker days and backhoe time by that (i.e. 2 worker days ÷ 7.54 yrs. = .27 worker days per site per year). Average annual backhoe time required was .27 hrs. per site per year. In comparison the average annual maintenance time for comparable installations using plastic tubing was estimated as .67 mandays per site per year (Roblee 1984).

T-culverts alleviated damage at road culverts by preventing beaver access to water velocities which they could detect. Such flows are present in the connecting culvert of the guard. Beavers were exposed to greatly reduced water velocities at the large culvert openings. It is assumed that beavers were not stimulated to plug these openings. Water velocities there were below a minimum velocity detectable to beaver. Further research is needed to determine what this minimum water velocity is. This knowledge would be valuable in prescribing culvert diameters for effective T-culvert installations.

T-culverts have proven to be durable and effective devices for protecting road culverts from beaver damage. It is believed that T-culverts or similar devices based on this principle can also be used to protect water level control struc-

Figure 6. T-culvert shown in Figure 3 in place. Metal posts support plywood fencing against the extended culvert ends.

tures. This is currently being tried in the Region.

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