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Master's Project: Evaluating the Effectiveness of Best Management Practices on Rural Backroads of Vermont: A Retrospective Assessment and Cost Analysis

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Evaluating the Effectiveness of Best Management Practices on Rural Backroads of Vermont: A Retrospective Assessment and Cost Analysis

Final Project Report Prepared for
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Ecosystem Restoration Program

by

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Abstract

Repeated erosion of over 7,000 miles of unpaved roads in Vermont is degrading water quality and draining limited town budgets. Best Management Practices (BMPs), including stone-lined ditches, turn outs, check dams, revetments, culverts and vegetative controls, are recommended by the Vermont Department of Transportation as low cost means of reducing the sediment and phosphorous run-off from backroads. However, their effectiveness, longevity and cost benefit are unknown. To address this gap, I assessed 100 BMPs at 43 erosion control projects constructed between 2005 and 2012 with funding from the Vermont Better Backroads program. BMP condition was compared to environmental factors that foreseeably affected how long they would remain intact. Increased road grade and exposure to flood events were the most significant predictors of project deterioration, although increased age affected specific BMPs. Only ten percent of assessed BMPs had failed, indicating that when properly maintained, BMPs may remain operable for over eight years. To understand the availability and distribution of town funds spent on backroad maintenance, I interviewed road foremen in five small, mountainous towns in Vermont. Town expenditures on repairing repeated road washouts were comparable to annual funds needed for “permanent fixes” of roads preliminarily identified to pose the highest risk to water quality. All towns indicated a willingness to construct more BMPs with further funding, suggesting that a proactive approach to erosion control on backroads will be an efficient use of state money allocated to improving water quality.

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Introduction

A network of over 7,000 miles of unpaved road lines the hills and valleys of Vermont, connecting its communities and providing passage for both residents and commuters. Also called backroads, unpaved roads are an integral and historic part of town transportation systems. However, they are vulnerable to persistent degradation during typically seasonal rainstorms and risk catastrophic failure during large storm events. Repeated repairs of problematic eroding roads add strain to already limited budgets in small Vermont towns, while large washouts can be so costly that federal funding is required to rebuild infrastructure.

When the silt, sand and gravel of an unpaved road leave the road surface, the effects of the erosion are not limited to human safety and convenience. The sediment-laden road run-off adds excess nutrients and phosphorous to receiving streams and rivers, often altering the physical progression of their channels. A 2013 study funded by the Lake Champlain Basin Program and the New England Interstate Water Pollution Commission found that unpaved roads are an important source of water quality degradation in upland settings of the basin, contributing between 6 and 30% of the mean annual suspended sediment load and between 2 and 11% of the mean annual total phosphorous load transported by the Winooski River to the Lake (Wemple, 2013). Although the mileage, slope and connectivity of unpaved roads to waterways varies among watersheds, the effects of unpaved roads as sources and conduits for pollutants into waterways is substantial and detrimental.

In the face of increasing storm events, town road crews are finding their budgets and staff unprepared to repair and ensure safety on damaged roads. Town officials, in cooperation with state agencies and town road foreman, now promote erosion reduction practices on unpaved roads not only to protect local waterways from non-point source sediment and phosphorus pollution, but also to reduce repeat expenditure on road repairs and maintenance that could be avoided by employing Vermont town road and bridge standards (Vermont Agency of Natural Resources & Vermont Agency of Transportation, 2013). The implementation of these Best Management Practices (BMPs) mitigates the effect of roads on water quality by promoting construction guidelines that direct water away from the road surface, slow road run-off, and encourage sediment deposition outside of waterways (Northern Vermont & George D. Aiken RC&D Councils, 2009).

Vermont Better Backroads Program

The Vermont Better Backroads Program, established in 1997, was formed as a partnership between the Vermont Local Roads Program, the Vermont Agency of Transportation, the Vermont Agency of Natural Resources and the Northern Vermont and the George D. Aiken Resource Conservation and Development Councils (Vermont Agency of Natural Resources & Vermont Agency of Agriculture, Food, and Markets, 2009). The organization provides funding and technical guidance to towns and non-profits addressing chronic erosion problems on their backroads while reducing sediment and pollutant runoff into Vermont waterways.

Maintenance practices employed by Better Backroads include construction or improvement of stone lining and vegetation in eroding roadside ditches, rebuilding and stabilization inlets and outlets of culverts, stabilization of roadside stream and lake banks, and re-direction of water away from road surfaces. Selection of the most appropriate BMP to implement on or alongside an unpaved road depends on the slope of the road, the direction of water flow over or around the road, the proximity of a receiving waterway and the slope of the surrounding landscape. Grants awarded by Better Backroads support either:

A) road inventory and capital budget planning of erosion-related problems and potential BMPs, or

B) the on-site implementation of these BMPs, known as erosion control projects.

Purpose and Objectives of this Study

To date, no comprehensive or formal analysis of historic Better Backroads Category B projects has been completed. This study aimed to improve understanding of BMP efficacy over time by comparing the condition of BMPs implemented under the guidance of Better Backroads recommendations to the occurrence of multiple environmental factors that foreseeably affect how long BMPs remain intact in the field. This study does not quantifiably measure the efficacy of BMPs by, for example, the mass of road sediment or phosphorus retained by a practice; instead, it employed visual comparison of similar BMP types and guidance provided by the Better Backroads program technician to assess whether and how long a BMP has remained intact. By inference, a functional BMP is assumed to provide water quality improvements as designed.

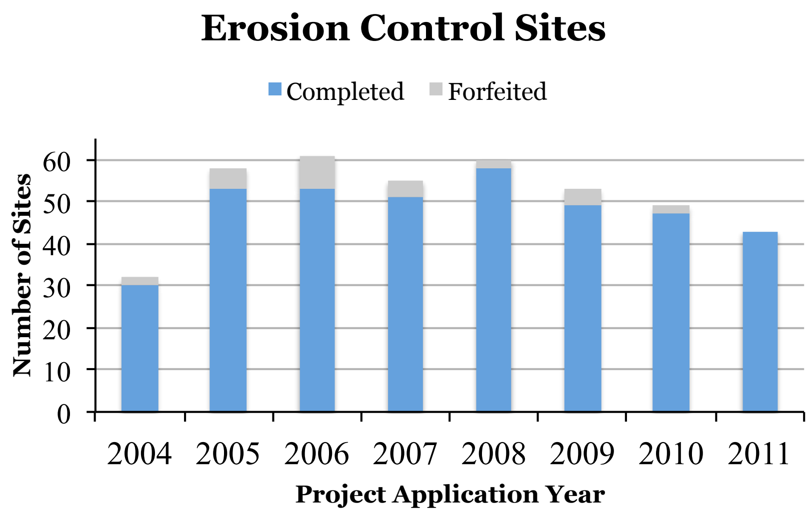
In light of VT DEC efforts to improve water quality impairments at the town level through additional funding, I interviewed five road foremen and town administrators to identify the current costs of unpaved road maintenance as a fraction of total town road expenditures. This cost estimate is used to compare road maintenance practices in which roads are repeatedly repaired after storm events, to a "proactive" approach that funds BMP construction at erosion-prone sites and alleviates repeated post-storm maintenance. Through identifying road crew tasks performed during non-winter maintenance and the materials used for these purposes, I compared the amount of money each town spends on temporarily patching road damage caused by erosion to the current funding spent constructing the BMPs necessary to reduce yearly maintenance costs. These interviews also ground-truthed erosion control priorities identified by a GIS-based model currently within the VT ANR Flood Ready Atlas. Lastly, a survey gathered information on the level of awareness at the town level of BMP effectiveness and the perceived ease of grant applications.

Background of Better Backroads Erosion Control Projects

Limited historic Better Backroads project data, including project cost, grant allocation, and local match amount, are recorded in Excel spreadsheets provided by Jarrod Becker, Better Backroads business manager. A compiled spreadsheet of this data is provided in *Appendix 1*. However, full project application and reports of project completion exist only as paper files. These folders contain maps, photographs and construction details regarding BMP type and location that the more limited electronic databases do not provide. Files from the 2004 to 2011 application years[1] were accessed at the Northern Vermont Resource Conservation and Development office in Berlin, Vermont. Project files prior to 2004 have been discarded and without these files, field assessments of were not possible. As such, this project examines eight years of project data constructed between one and eight years ago.

Better Backroads funded 414 Category B projects between 1997 and 2011; 375 of those were funded since 2004 (Figure 1). Thirty-six projects have been forfeited and 24 project applications have been denied since 2004. A total of $4,532,402 was spent on Better Backroads Category B projects from 2004 to 2011; $2,356,005 was from Better Backroads grant funding and $2,176,397 was from local match funding, usually in the form of in-kind services.

[1] The filing system used to store and record Better Backroads project applications was initially labeled by the year the application was received. After a project is granted Better Backroads funding, the applicant has 18 months to complete the construction. For example, a project approved in the autumn of 2005 may not be constructed until 2006 or the spring of 2007. As such, statistics regarding project applications and funding are categorized by their application year, but the actual age of the project, or number of years since the completion of BMP construction, is used to compare the condition of BMPs. In 2010, Better Backroads began labeling project applications by the fiscal year instead of the calendar year. However, for the sake of consistency, this study labels and discusses projects by the application calendar year only.



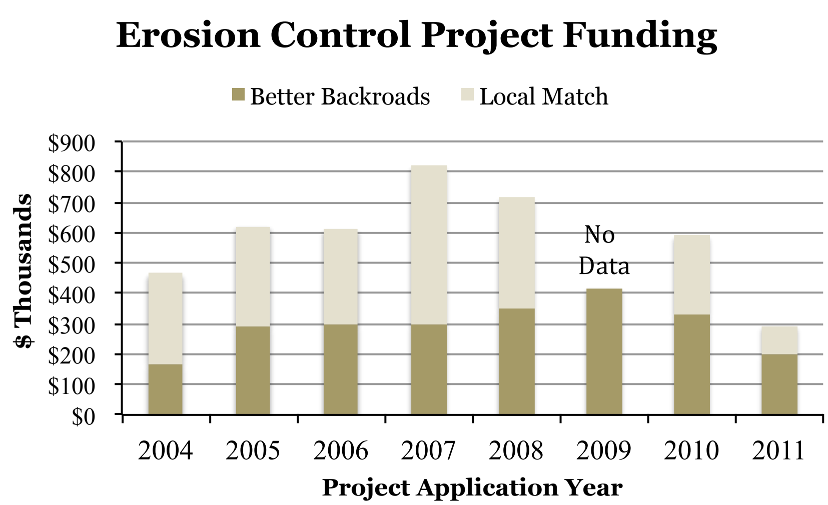


Figure 1: Distribution of project applications and funding.

Methodology

Field Assessments

To understand how Better Backroads erosion control projects have performed since their implementation, I assessed best management practices at 45 historic Better Backroads sites, or 12% of the total number of completed Better Backroads projects. Projects were chosen based on two criteria: first, the availability of paper project files that outlined precise project locations and the work completed during the construction phase, and second, geographic proximity to other projects and to Montpelier, VT, in order to minimize travel time and expense. Projects were selected regardless of BMP type or age. The location and age distribution of assessed projects are shown in comparison to all Better Backroads projects in Figure 2 and Figure 3.

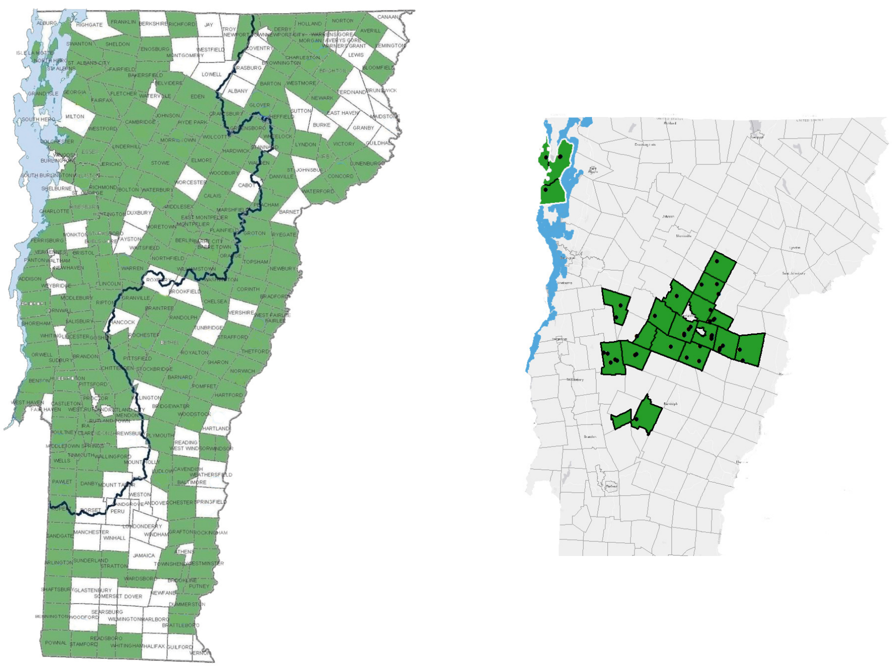


Figure 2: Better Backroads project locations since 1997 (left) and project locations assessed in 2013 (right).

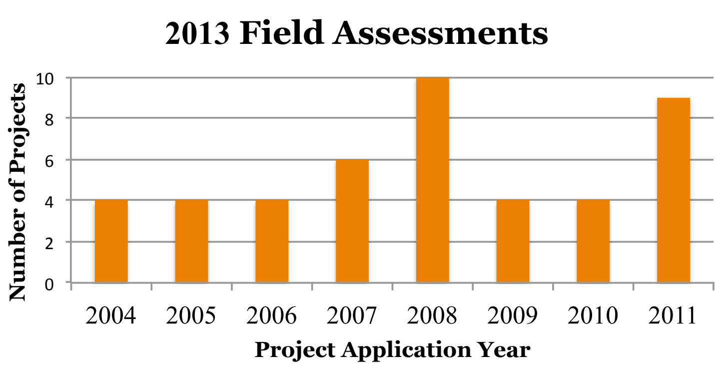


Figure 3: Distribution of application years of assessed projects.

For this study, BMPs were ultimately grouped into four categories based on construction techniques, materials, purpose and behavior over time (RC&D, 2009).

- **Stonework** included the following BMPs: stone lined ditches, check dams, turnouts, settling pools, plunge pools, rock aprons, stone dikes and stone water bars.
- **Culvert** work included the installation or replacement of stream and ditch culverts, and any associated headwalls, whether log, stone or concrete.
- **Revetments**, although constructed with stone, were grouped separately from stonework due to their placement on the landscape with respect to water flow and their behavior over time. Revetments observed in this study were entirely riprap systems placed on the banks of streams or lakes, or above or below roads cutting across steep slopes. Also included in this category, but not observed in the field, were gabion walls, log or timber cribs, and rock walls.
- **Vegetated Soil Stabilization** comprised primarily of grass lined ditching, seeding and mulching, and one log water bar. Included in the category, but not observed in the field, were live wattle/stake placement, sprig or plug planting, and terracing.

No electronic records exist of the number of specific BMPs funded by Better Backroads since its inception. A tally of the BMPs described in the project folders was collected from the paper files of the 2007, 2009 and 2011 application years. The distribution of the BMPs, grouped by BMP types described above, is displayed in Figure 4.

During the field season of 2013, 100 BMPs were assessed in 43 project locations. The BMP type distribution assessed during the 2013 field season was approximately representative of the total BMP type distribution funded by Better Backroads since 2004, as displayed in Figure 5.

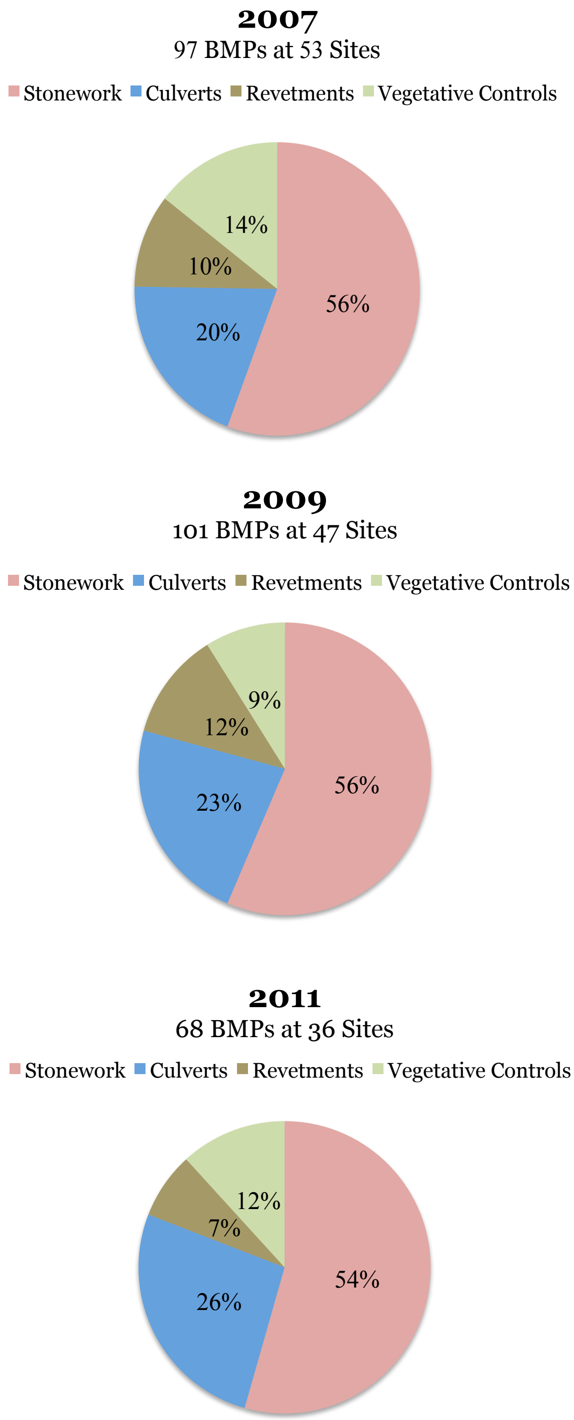


Figure 4: Distribution of BMP types funded over three application years.

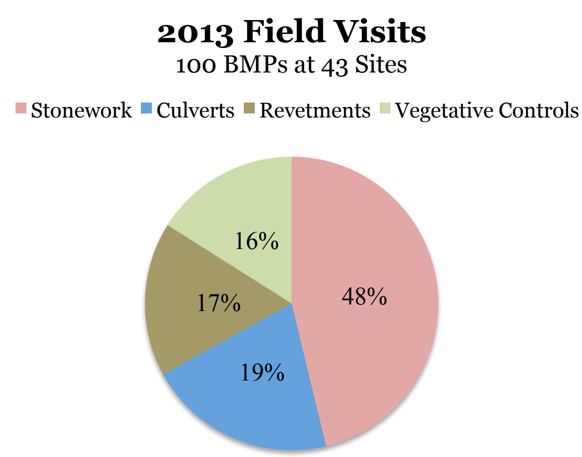


Figure 5: Distribution of BMP types assessed during field season.

In order to understand the most relevant factors reflecting the condition of BMPs on unpaved roads prior to the start of formal field assessments, twelve projects were informally evaluated in May and June of 2013 with aid from Better Backroads technician Alan May. Stone lined ditches, grass lined ditches, stone check dams, culvert replacements and revetments comprised the most commonly observed BMPs. Stone plunge pools, water bars, and compost socks also provided context for the longevity assessment of BMPs installed during Better Backroads projects.

A uniform set of data at each site was recorded on a field sheet designed for this study. A set of blank field sheets is included in *Appendix 2*. Background data collected for each site included project location, description, cost and amount of the awarded grant. Any erosion of, or deposition on, BMPs or road surfaces due to overland water flow was noted on the date of the field visit, although recent grading of roads often erased any evidence of erosion or deposition. Specific data on culverts, namely the condition of the inlets, outlets, headwalls and pipes, was collected to inform any future assessments of culvert longevity. Factors hypothesized to affect BMP condition included site conditions listed below.

- **The age of a BMP** is the most uniformly applied evaluation criteria that affects BMP condition. Ideally, a field study would follow one particular BMP over multiple years to assess how long it remained functional in its specific location. Due to the brief nature of this field project, the change of BMPs over time was assessed using a chronosequence in which different BMP types between one and eight years old were considered temporally related. For example, the "snapshots" of stonework BMPs between one and eight years old were assumed to represent the progression that a singular stonework BMP would follow over eight years. Although road slope, surrounding landscape, storm exposure and construction technique differ between BMP localities, this study assumes that a rough progression BMP conditions over time is represented in the assessed field sites.

- **The grade of the road** plays a critical role in determining what type of BMP will effectively keep road sediment out of local waterways. Better Backroads recommends grass lined ditches to drain roads with grades of less than 5% grade; roads steeper than 5% grade generally require stone lined ditches to redirect fast-flowing water without eroding the ditch substrate itself. Projects were grouped based on road grade of less than 5%, between 5% and 9% (inclusive), and greater than 9%.

- **The placement of the road on the landscape** affects the direction and velocity of both surface water flow and seeps that intersect road cuts. Roads that lie parallel to the slope of the landscape easily channel water down their length unless the road is effectively managed. Roads that lie at an angle to the slope of the landscape may redirect emerging water from upslope into the road. To investigate if BMP longevity is affected by the parallel or angled placement of roads on the landscape, roads at assessed sites were classified as either Parallel-Slope or Cross-Slope.

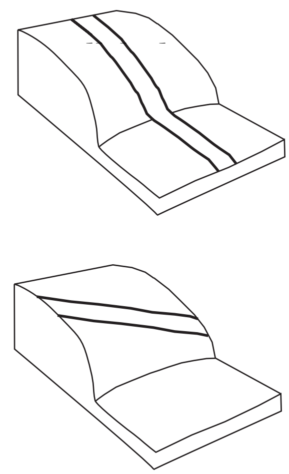


Figure 6: Parallel-slope (above) and cross-slope (below) roads.

- **The crown of a road** enables quick water movement from the road surface into the ditches and, when sloped correctly, prevents water from running lengthwise down the road. Although road crowning practice is recommended in the Better Backroads Manual (RC&D, 2013), some road

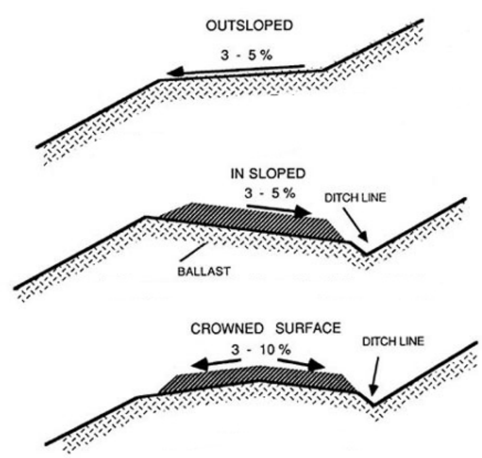


Figure 7: Road cross section shapes that enable drainage (FAO, 1998).

surfaces are outsloped (tilted downhill) or insloped (tilted uphill). Roads at each project were classified as Crowned, Outsloped, or Insloped.

- **Vegetation between the BMP and road** provides a free, renewable and biodegradable method to slow water and trap sediment, reducing the burden on the constructed BMPs. This study investigated whether or not an established vegetated border between the BMP and the road increased the efficacy of BMPs. The study categorized sites as exhibiting No Vegetated Border, Some Vegetated Border or Extensive Vegetated Border. Sites were rated based on a subjective comparison to each other and included observation of any type of vegetative cover. Seventy-four BMPs at 34 projects were evaluated for the presence of a vegetated border. Data collection was omitted at the remaining projects.

- **Exposure to extreme flood events** can cause extensive damage to BMPs. Assessing which BMPs are intact after a flood event may aid in determining the most effective placement and types of BMPs used on unpaved roads. To assess flood exposure for study sites included in this project, flood data was accessed from a GIS database released by the Vermont Department of Environmental Conservation in 2013 in conjunction with the Lake Champlain and Upper Richelieu River flood resilience report (Lake Champlain Basin Program, 2013). Using ArcGIS, the map of field study project locations was compared to the areas impacted by floods since the implementation of the assessed BMPs. This produced a list of BMPs that were exposed to flood events since installation.

Each BMP constructed as part of a Better Backroads funded project was assigned an overall score on page 2 of the Field Check Sheet; 1 = Intact, 2 = Compromised, and 3 = Failed. The evaluation criteria were established by comparing the BMPs to other BMPs assessed with Better Backroads technician Alan May earlier in the field season, by comparing the BMP to date with photos taken immediately after implementation, and through visual evidence of BMPs reducing the volume of sediment traveling to receiving waterways.

Photographs of the project locations and BMPs were recorded on page 3 of the Field Check Sheet and were provided to the Ecosystem Restoration Program on CD-ROM as *Appendix 3.*

Statistical Analysis

Based on BMP assessments, each of the Better Backroads projects was assigned an overall project condition of either “All BMPs Intact” (i.e. complete project success) or “Some BMPs Compromised or Failed” (i.e. partial or complete project failure). Reclassifying project condition as a binary variable enabled use of a logistic regression of the field data to examine the likelihood that measured variables could explain the condition and overall efficacy of a project. A sufficient amount of field data on stone lined ditches and culverts also enabled statistical analysis of the effect of measured variables on these specific types of BMPs. Summary statistics for logistic regression models fit the set of explanatory variables. All models have the form:

$$\ln(\text{odds}_{\text{compromise or failure}}) = \beta_o + \beta_i X_i$$

where X_i is an individual or set of proposed variables in the model (i.e. age, road grade, road profile, orientation, vegetated border and exposure to a flood event). Logistic regressions were performed using the SPSS statistical software package.

Cost Analysis

During the summer of 2014, road foremen and town administrators in the towns of Corinth, Huntington, Hyde Park, Waitsfield and West Windsor agreed to participate in interviews conducted designed to assess town expenditures on their roads. All towns had previously received Better Backroads grants and had implemented BMPs according to Better Backroads recommendations.

Before participating in the interviews, each town provided a line item list of road budgets and expenditures for the most recent calendar or fiscal year. Interviews captured town-specific information that enabled calculation of the proportion of expenditures dedicated to five unpaved road maintenance tasks occurring outside of the winter months:

- **Routine Maintenance**: tasks required for basic care of well-maintained unpaved roads, e.g. routine grading, chloride application, mowing
- **Mud Season Repairs:** seasonal fixes caused by road erosion and sediment deposition during spring melts and temporary winter thaws, e.g. filling potholes and ruts, smoothing washboards
- **Fixing "Problem Roads"**: repeated maintenance of road damage caused by erosion from the road or deposition in ditches, including gravel application, ditch reshaping and excavation, clearing of obstructed culverts
- **Constructing BMPs**: capital improvements to roads, roadside ditches or slopes
- **Maintaining BMPs**: repairs to, or excavation of sediment from, operating BMPs

To divide road crew into expenditures by task, I collected monthly information on the number of hours worked per week, the number of employees, and the percentage of time spent on unpaved roads. Additionally, I calculated the distribution of vacation hours, winter maintenance and time spent on the five tasks listed above. To estimate road materials costs, I selected budget line items that pertained to non-winter unpaved road maintenance and asked the road foreman to estimate the division of materials used over the same five maintenance tasks. Material line items included, but were not limited to, fuel, culverts, chloride, gravel or aggregate, stone, hay, seed, mowing, and equipment rental. Because the intent of the budget study was to itemize funds spent on unpaved road maintenance during the non-winter months, line items excluded from the study addressed equipment maintenance or repairs, town garage expenses, signage, paving or tar patching, and materials used for winter maintenance, such as sand and salt. Sample road crew hours and materials field sheets are included in *Appendix 4* and *Appendix 5*.

Erosion-control prioritization

Stone Environmental, Inc. of Montpelier, VT, in conjunction with the Vermont Agency of Natural Resources, produced town maps of unpaved roads ranked as high, medium or low risk to water quality. Criteria influencing the risk assessment included hillslope, soil erodiblity, road grade, culvert width, river corridor buffer and distance to lakes, ponds or wetlands. I selected at least five high, five medium and five low risk road segments on each town's ranked road priority map. I then asked the town road foremen to validate the model's ranking, and to assign a new ranking if needed.

Additionally, I asked the road foreman to create a "wish list" of the most pressing road repairs needed in his town. In Corinth, the road foreman estimated the necessary length of road treatment to enable a cost estimate. In Huntington, Hyde Park and West Windsor, historic Category A Better Backroads reports provided an inventory of road repairs and associated costs needed to reduce erosion and improve water quality. Waitsfield had no recent road prioritization data or costs, nor was the town road foreman asked to identify road lengths in need of the highest priority repairs.

Results

BMP Age

Figure 8 below illustrates the condition of the projects as grouped into three age ranges divided over the eight-year study period. Twenty-nine BMPs at 11 projects were between one and two years old, 54 BMPs at 20 projects were between three and five years old, and 17 BMPs at 12 projects were between six and eight years old. The relatively low sample size of BMPs six-to-eight years old was due in part to the difficulty involved in obtaining complete project files from application years 2004, 2005 and 2006. Six BMPs at two projects constructed in 2013 were omitted from statistical analysis because they had yet to operate through a four seasons; as such, this report now refers only to the remaining 43 projects over one year old.

The percentage of intact BMPs decreased from 79% to 52% between sites one-to-two years old and sites three-to-five years old while the percentage of compromised BMPs rose from 17% to 39%. Only one BMP (3%), a one-year-old vegetative control, failed within the one-to-two year old age category, while five BMPs (9%) had failed in the three to five year old age category. The number of intact BMPs six-to-eight years old decreased to 47%, while the number of failed BMPs rose to 24%.

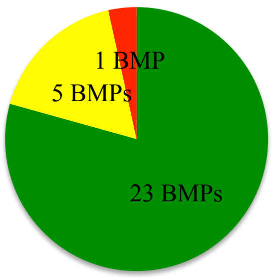
Thirteen of the 16 assessed culverts up to five years of age remained intact and only three had become compromised; none had failed. Three of the four culverts aged six-to-eight years were compromised. Culverts degraded where deposited sediment blocked the outlet or where erosion at the inlet altered stream flow away from the culvert and onto the bank or road.

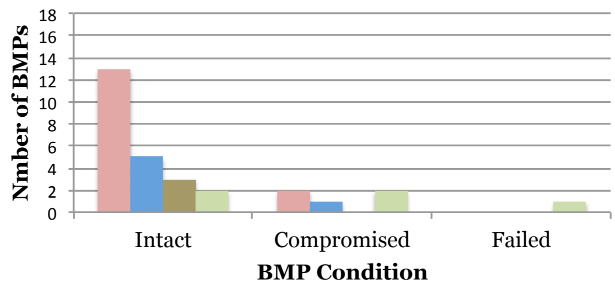
None of the 17 assessed revetments failed over the eight-year sample period. One revetment at a culvert inlet became compromised presumably after high water flow caused sedimentation and dislodged stones. Ten of the 17 revetments stabilized shoreline along Lake Champlain in the Champlain Islands or along Greenwood Lake in Woodbury. Five of the 17 revetments stabilized stream or river shorelines. The remaining two revetments stabilized dry slopes adjacent to road banks. Vegetated controls degraded quickly compared to all other types of BMPs. Within the projects up to two years of age, three of the five vegetation BMPs were compromised or had failed in projects one-to-two years old. Within projects between three and five years of age, only two had become compromised or failed, and seven remained intact. However, after six to eight years, no vegetative controls remained intact.

BMP Age

1-2 Years

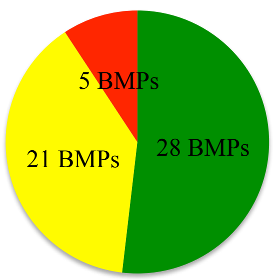
29 BMPs at 11 Projects
Average Age 1.4 Years, SD 0.5

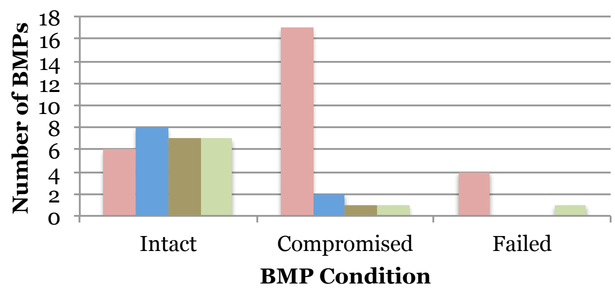




3-5 Years

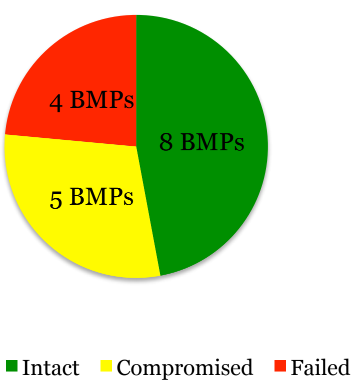
54 BMPs at 20 Projects
Average Age 4.0 Years, SD 0.7





6-8 Years

17 BMPs at 12 Projects
Average Age 7.2 Years, SD 0.9



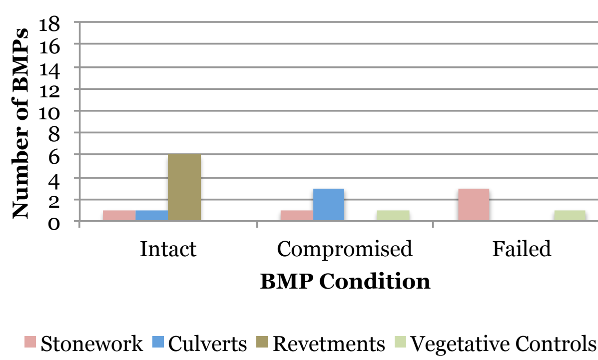


Figure 8: Condition of BMPs grouped by age.

Road Grade

Figure 9 below illustrates the condition of BMPs grouped by three categories of road grade: less than 5%, 5% - 9%, and greater than 9%. All 24 BMPs assessed on roads with less than 5% grade were intact. These BMPs had an average age of 4.9 years (SD 2.3) and included 10 revetments along lake shores, five culvert structures, four revetments along rivers, three vegetative controls and two stonework BMPs.

The distribution of the condition of BMPs on roads between 5% and 9% grade was roughly equivalent to that of roads of greater than 9% grade. Approximately half of all BMPs on roads greater than 5% grade were intact, three-eighths were compromised, and one-eighth had failed. The average age of BMPs was 4.0 years (SD 2.3) on roads with slopes between 5% and 9% and 3.4 years (SD 1.3) on roads with grades greater than 9%.

Stonework BMPs accounted for 18 of the 29 BMPs on roads with slopes between 5% and 9% and 27 of the 47 BMPs on roads with slopes greater than 9%. Of note were the 13 compromised and four failed stonework BMPs on roads with slopes greater than 9%. Reductions in the efficacy of stonework most often occurred when sediment deposition buried the stone itself.

Nine of the 15 culverts assessed on roads with slopes greater than 5% were intact. Compromised culverts ranged between two and eight years old.

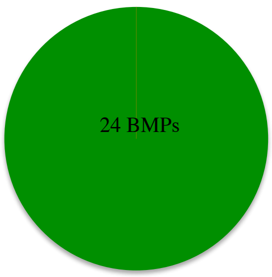
Three of the 17 assessed revetments were built to stabilize road cuts neighboring roads with grades greater than 9%. Two were intact but one was compromised after some rock had become dislodged from the slope. Not subject to the power of lake ice or river flow, revetments along road cuts were likely to remain intact barring poor construction or excessive downslope water flow.

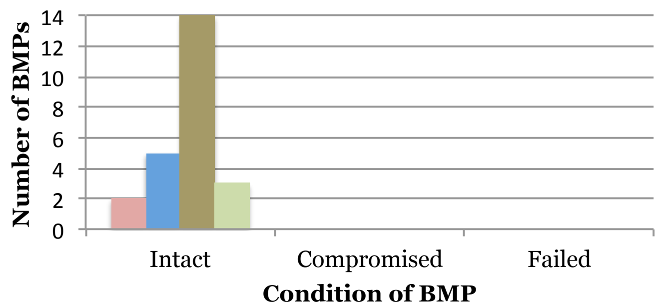
Seven of the 13 vegetative controls used on roads with slopes greater than 5% were compromised or failed. The success of this type of BMP on steep roads likely depends on the amount and flow of water, but also upon whether or not the vegetation had sufficient time and adequate weather conditions to establish itself before the first storm event.

Road Grade

<5%

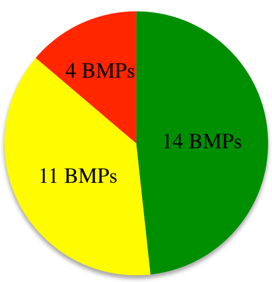
24 BMPs at 17 Projects
Average Age 4.9 Years, SD 2.3

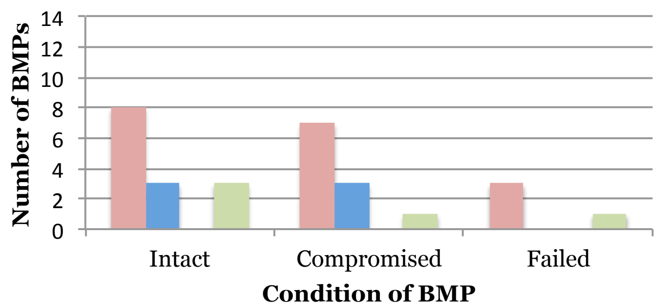




5% -9%

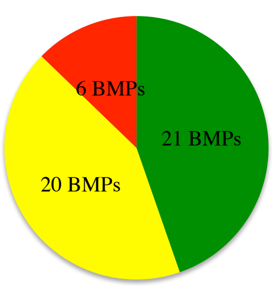
29 BMPs at 12 Projects
Average Age 4.0 Years, SD 2.6

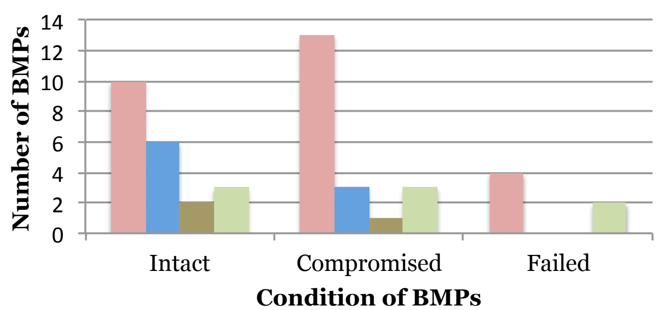




>9%

47 BMPs at 14 Projects
Average Age 3.4 Years, SD 1.3





Intact Compromised Failed

Stonework Culverts Revetments Vegetative Controls

Figure 9: Condition of BMPs grouped by road grade.

Road Placement on Slope

Figure 10 below illustrates the comparable distribution of intact, compromised and failed BMPs on parallel-slope and cross-slope roads. The average age of the BMPs on parallel-slope roads was 2.9 years (SD 1.5); none of the seven- or eight-year old projects in this study were built on parallel-slope roads. By contrast, the average age of the cross-slope BMPs was 5.2 years (SD 2.2) and included BMPs between one and eight years of age.

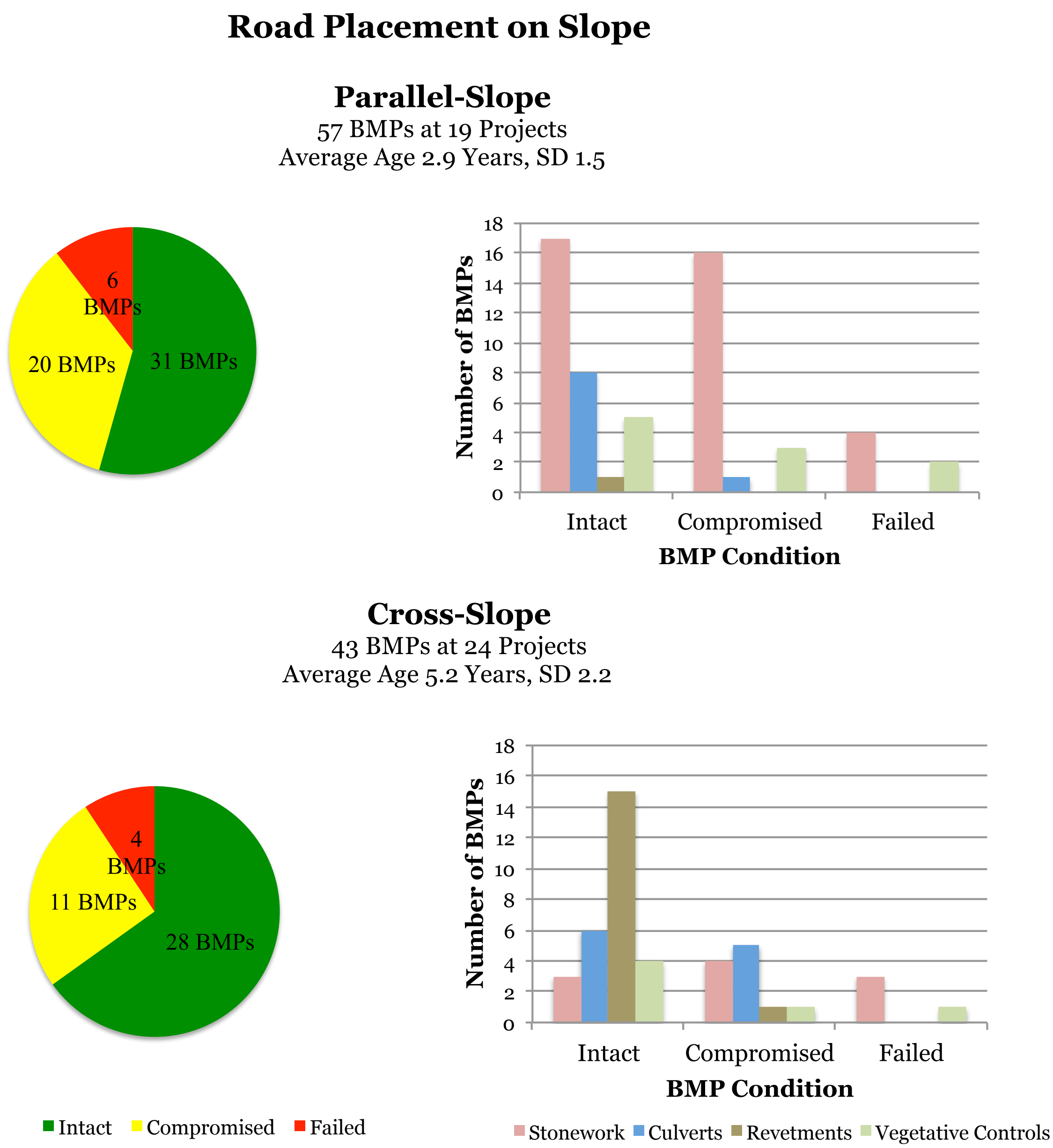


Figure 10: BMP condition grouped by road placement on the slope.

Culverts were more common on cross-slope roads than parallel-slope roads, but while only six of the 11 culverts on cross-slope roads were intact, eight of the nine were intact on parallel-slope roads. However, the average age of culverts on parallel-slope roads (2.5 years) was less than that of culverts on cross-slope roads (4.5 years).

Vegetative controls were more common on parallel-slope roads than on cross-slope roads. Five of the ten vegetative controls on parallel-slope roads were compromised or failed, while only two of six vegetative controls on cross-slope roads were compromised or failed.

Road Profile

Figure 11 below illustrates the condition of the 37 crowned, five outsloped and one insloped road profiles at the assessed projects. Fifty-one of the 83 BMPs evaluated on crowned roads were intact, 23 were compromised and nine had failed. The relatively small number of BMPs assessed on outsloped roads made comparisons of the effects of road profile difficult to assess. However, less than half of these BMPs (seven of 16 assessed) were intact. Eight of the 16 BMPs were compromised and one had failed. The average age of projects on crowned roads was 4.0 years (SD 2.3); the average age of projects on outsloped roads was comparable at 4.6 years (SD 0.8).

Stonework BMPs retained greater efficacy on crowned roads than on outsloped roads, although in both road profile conditions, more than half of the BMPs were compromised or failed. Culvert condition was not clearly affected by road profile; more culverts were intact than compromised in both conditions and none had failed. Fourteen of the 16 assessed vegetative controls bordered crowned roads; eight of these remained intact, three were compromised and three had failed.

All but one of the revetments on crowned roads were intact. None bordered outsloped roads and only one revetment, on Water Road in Northfield, bordered an insloped road. The uphill tilt directed water away from a revetment constructed on a riverbank and towards a stone-lined ditch on the opposite side of the road. This eight-year-old revetment was intact.

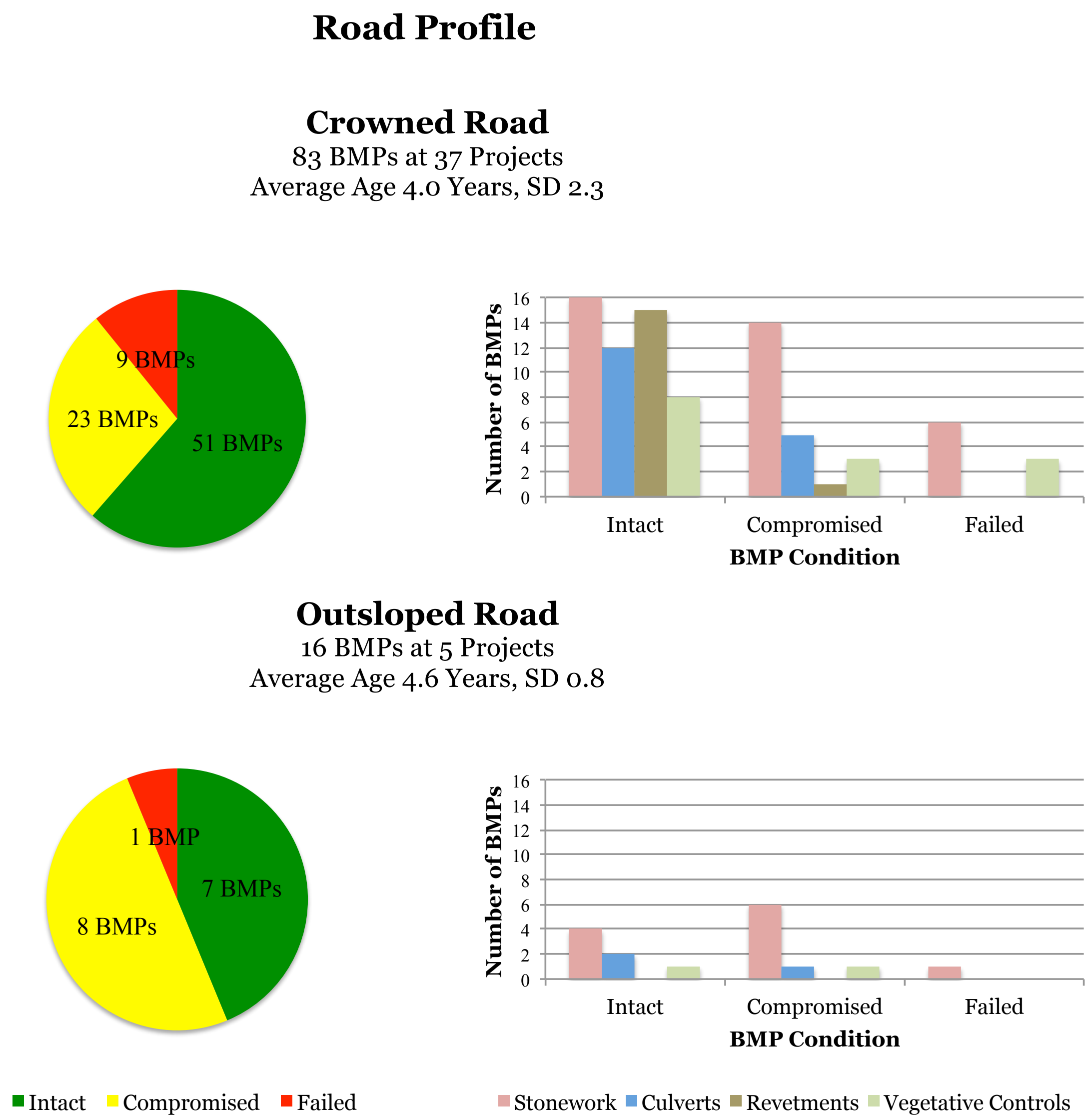


Figure 11: BMP condition grouped by road surface crown or tilt.

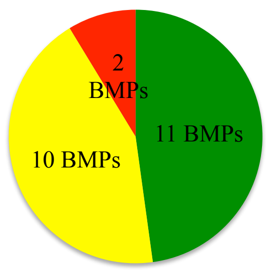
Vegetated Border

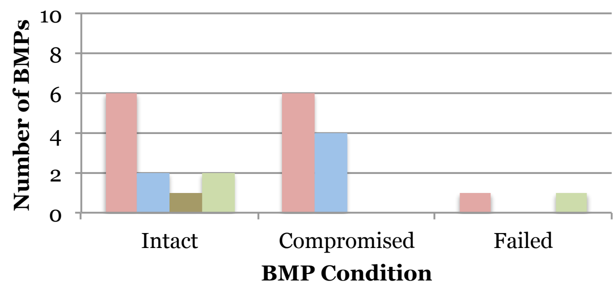
Figure 12 below illustrates projects grouped by the presence and amount of vegetated border. Projects displaying either no vegetated border or some vegetated border exhibited similar distributions of BMP longevity. In both cases, 48% of the BMPs were intact. Forty-three percent of BMPs with no vegetated border and 44% of BMPs with some vegetated border were compromised; the remaining BMPs (8% and 9%) had failed.

Vegetated Border

None

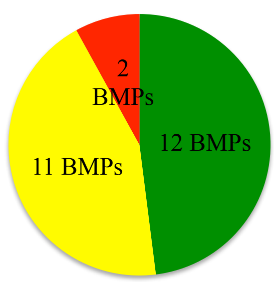
23 BMPs at 8 Projects
Average Age 4.1 Years, SD 2.2

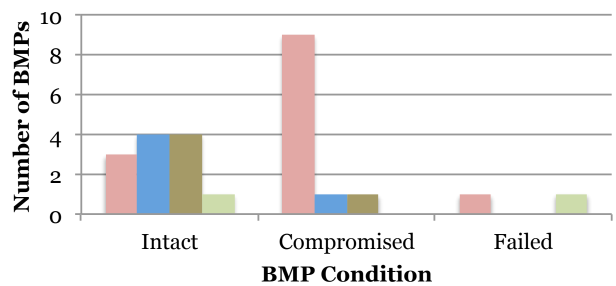




Some

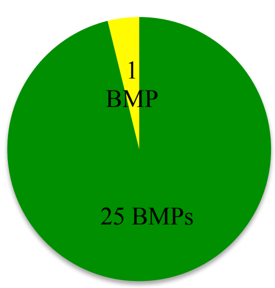
25 BMPs at 11 Projects
Average Age 4.0 Years, SD 1.7

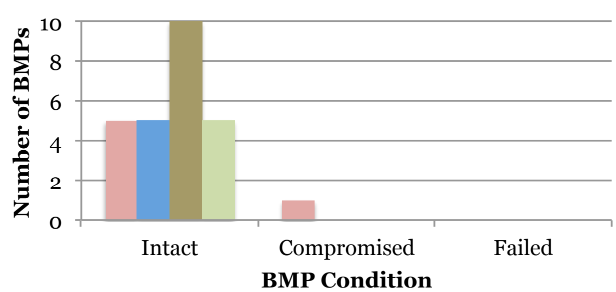




Extensive

26 BMPs at 15 Projects
Average Age 4.3 years, SD 2.4





Intact Compromised Failed

Stonework Culverts Revetments Vegetative Controls

Figure 12: BMP Condition grouped by the presence and extent of a vegetated border

In contrast, 25 of the 26 BMPs exhibiting an extensive vegetated border between the BMP and road were intact. The remaining BMP, a stone-lined ditch, was compromised. Ten of the 26 BMPs were revetments along Lake Champlain where grasses and herbaceous plants had adequate space to grow between the revetment and the road.

All three categories of the vegetated border variable contained projects between one and eight years old. The average age of projects with no, some and extensive vegetated border was 4.1 years, 4.0 years and 4.3 years, respectively.

Flood Events

Figure 13 below illustrates BMP condition in relation to two flood events recorded in the VT DEC database that occurred since 2005, the first from July 9-11, 2007, the second following Tropical Storm Irene on August 28, 2011. Only one project, the culvert and grass lined ditches on Weir Street in Williamstown, was impacted by both the 2007 and 2011 floods. Twenty-two projects were in zones affected by the 2011 flood only; 20 projects were reportedly unaffected by flood events. However, it is unknown if BMPs damaged during the 2007 or 2011 flood events were repaired before the 2013 field assessments. Similarly, it is unknown if any BMPs remained intact after a flood event but were subsequently damaged during a storm or flood event not documented in the VT ANR study.

Less than half of assessed BMPs (26 of 59 BMPs) impacted by a flood event were intact. A comparable portion (25 of 59 BMPs) of BMPs were compromised; the remaining 8 BMPs failed. Of these, only seven of the 31 stonework BMPs remained intact after a flood event; the remaining 24 may have acted to trap sediment but needed maintenance or rebuilding before being able to operate effectively again. In contrast, 13 of the 16 stonework BMPs not affected by flood events were intact, two were compromised and only one had failed.

The distribution of culvert condition was not distinctly different between the two flood exposure categories. Eight of the 12 assessed culvert BMPs impacted by a flood event were intact, four were compromised and none had failed. Six of the 8 assessed culvert BMPs not impacted by a flood event were intact and two were compromised. One revetment on Center Street in Middlesex was compromised, as evidenced by dislodged stones, but the remaining six revetments were intact.

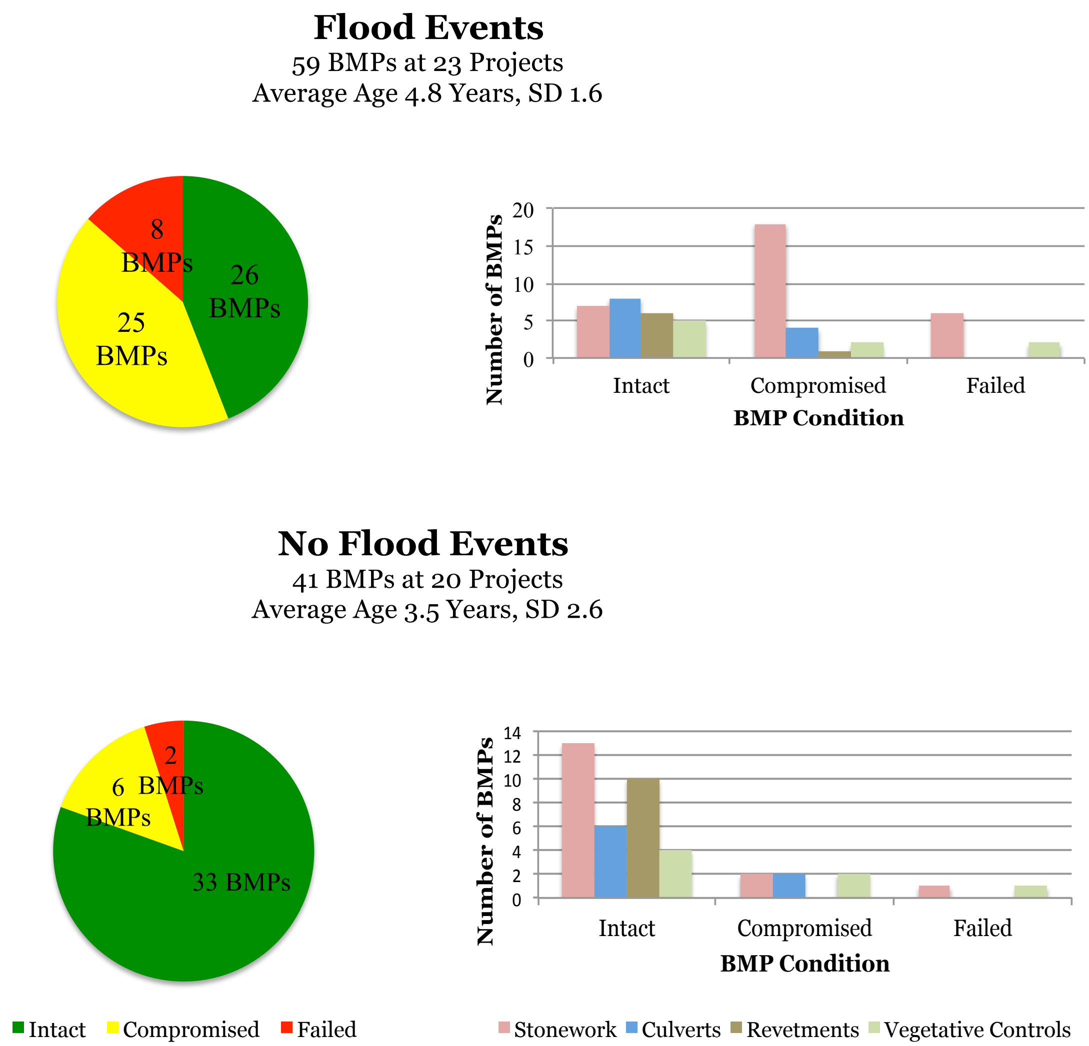


Figure 13: Impact of flood events documented by VT ANR, 2013, on BMP condition.

Although vegetative controls easily become compromised when inundated by fast-moving water, five of the nine vegetative control BMPs affected by a flood event were intact. Two vegetative controls were compromised and two had failed. A similar distribution of vegetative control BMP condition existed at projects not affected by floods; four were intact, two were compromised and one had failed.

Statistical Analysis

Statistical analysis of data by project showed that grade, exposure to flood events, the presence and extent of a vegetated border and the orientation of the road were factors that, individually, had a likelihood of predicting project condition (Table 1). Specifically, the likelihood of a projects to exhibit compromised or failed BMPs increased as grade increased, if a site was exposed to one or more floods, if no vegetated border existed between the BMP and the road, or if the road slope was parallel to the slope of the hill instead of across a the slope. When effects of project conditions were combined, project compromise or failure was most accurately predicted using only road grade, road orientation and flood exposure data.

Table 1: Table of variables tested using binary logistic regression for prediction of the likelihood that a project will exhibit compromised or failed stone-lined ditches. Analysis was conducted on a sample size of 25. Probability values (p) for statistically significant predictors of project condition are shown in bold.

Projects**, n = 43**			
X_i[1]	P	-2 log likelihood	Correctly classified
age	0.970	59.400	53.5%
grade	**0.000**	31.498	83.7%
road profile	0.254	56.540	59.5%
road orientation	**0.015**	51.889	69.0%
vegetated border[2]	**0.001**	35.397	75.7%
flood exp[3]	**0.001**	48.283	74.4%
grade, flood exp	0.000	24.264	93.0%
grade, flood exp, veg border	0.000	12.631	90.9%
grade, flood exp, orient	0.000	21.390	**97.6%**
grade, flood exp, orient, veg border	0.000	15.283	91.9%

[1] X_i is individual or set of explanatory variables in the model
[2] Vegetated border expressed as a binary variable indicating extensive border, or some or no border.
[3] Flood exposure expressed as a binary variable with "exposed" including any site exposed to one or more historical flood events since installation.

Logistic regression of individual BMP types was possible where adequate sample size and variation in condition existed; here, 25 stone-lined ditches and 18 culverts (both stream and ditch) were analyzed. Increased flood exposure and increased age were the most likely predictors of compromised or failed stone-lined ditches (Table 2). Grade, a significant predictor of BMP efficacy when grouped as a whole, was not a significant factor affecting stone-lined ditch condition. Degraded culvert condition, however, was correlated with increased road grade, although age remained the most significant variable (Table 3).

Table 2: Using a sample size of 25, a binary logistic regression analysis showed increased age and exposure to flood events to be the most significant predictors of stone-lined ditch compromise or failure.

Stone-lined ditch, **n = 25**			
X_i[1]	P	-2 Log likelihood	Correctly classified
age	**0.004**	25.226	**84.0%**
grade	0.854	33.617	60.0%
road profile	0.172	31.786	64.0%
road orientation	0.172	31.785	64.0%
vegetated border	0.569	33.326	60.0%
flood exp	**0.001**	21.872	84.0%
age, grade	0.039	16.417	83.3%
age, flood exp	**0.003**	21.867	**84.0%**
age, flood exp, grade	0.008	21.842	84.0%
age, flood exp, grade, veg border	0.019	21.802	84.0%

[1] X_i is individual or set of explanatory variables in the model

Table 3: Using a sample size of 18, the analysis showed increased age and increased road grade to be the most significant predictors of culvert compromise or failure.

Culverts, **n = 18**			
X_i[1]	P	-2 Log likelihood	Correctly classified
age	**0.029**	18.162	77.8%
grade	0.525	22.510	66.7%
road profile	0.368	22.105	66.7%
road orientation	0.368	22.103	66.7%
vegetated border	**0.104**	20.278	66.7%
flood exp	0.499	22.458	66.7%
age, veg border	**0.062**	17.367	**77.8%**
age, grade	**0.039**	16.417	**83.3%**
age, flood exp	0.086	18.002	77.8%
age, grade, flood exp	0.059	15.464	77.8%

[1] X_i is individual or set of explanatory variables in the model

Cost Analysis

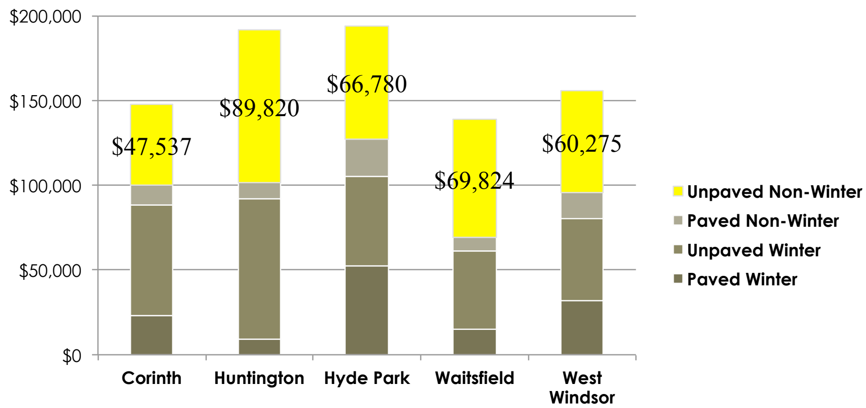
The five participating towns, all located in central Vermont, received funding from Better Backroads for at least one erosion control project in the past. As such, all road foremen were aware of BMP recommendations as described in the Better Backroads manual. Relevant town statistics are included in Table 4, including population as a proxy for tax base.

Table 4 Town statistics pertaining to unpaved road maintenance and funding.

Town	Corinth	Huntington	Hyde Park	Waitsfield	West Windsor
Total road miles	93.74	43.96	63.45	29.67	51.28
Unpaved miles	71.99	32.78	38.84	20.22	43.64
Population*	1,367	1,938	2,954	1,719	1,099
Road Budget (Year)	$1,076,891 (FY 2014)	$867,717 (FY 2013)	$677,707 (FY 2014)	$431,615 (CY 2013)	$876,088 (CY 2013)
Budget $ / mile	$11,488	$19,739	$10,680	$14,547	$17,084
Road Crew Salary	$147,628	$191,650	$194,153	$138,784	$155,745
Road Crew Employees	3 FT 1 PT	4 FT	4 FT 1 PT	3 FT	3 FT, 1 PT
* Data from Vermont 2010 Census of Population and Housing					

Road Crew Hours

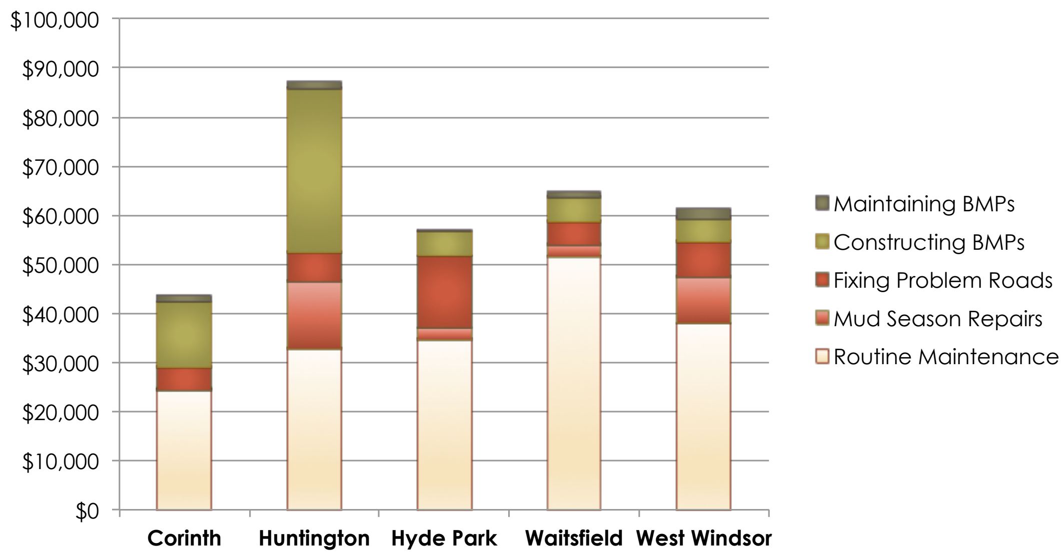
Road foremen initially estimated the seasonal time expenditure on paved and unpaved roads. The annual distribution of the road crew salaries in the five study towns is illustrated in Figure 14 and detailed in Table 5. Highlighted are the costs of non-winter, unpaved road maintenance that ranged from and estimated $47,534 in Corinth to $89,820 in Huntington.



Town	Corinth	Huntington	Hyde Park	Waitsfield	West Windsor
Unpaved non-winter salary	$47,537	$89,820	$66,780	$69,824	$60,275
Unpaved miles	71.99	32.78	38.84	20.22	43.64
Salary expenditure per mile	$660	$2,740	$1,719	$3,453	$1,381

Figure 14 and Table 5 Annual distribution of road crew salary by road type and seasonal task.

Monthly road crew hours spent on unpaved roads outside of the winter months were estimated for each of the five maintenance tasks. Results of salary distribution by town are illustrated in Figure 15 and Table 6. Vacation salary, normally taken during the summer months, was subtracted from the total road crew salary to improve accuracy of road crew time distribution. Of note are the salary costs associated with "fixing problem roads" – between $4,654 (Corinth) and $14,638 in one year, or between 10% and 30% of time dedicated to non-winter unpaved road maintenance, and between 3% and 11% of all road maintenance hours. Huntington and Corinth spent more time constructing BMPs than fixing repeated erosion-related problems. In all towns except Huntington, the largest percentage of time was spent on routine maintenance.

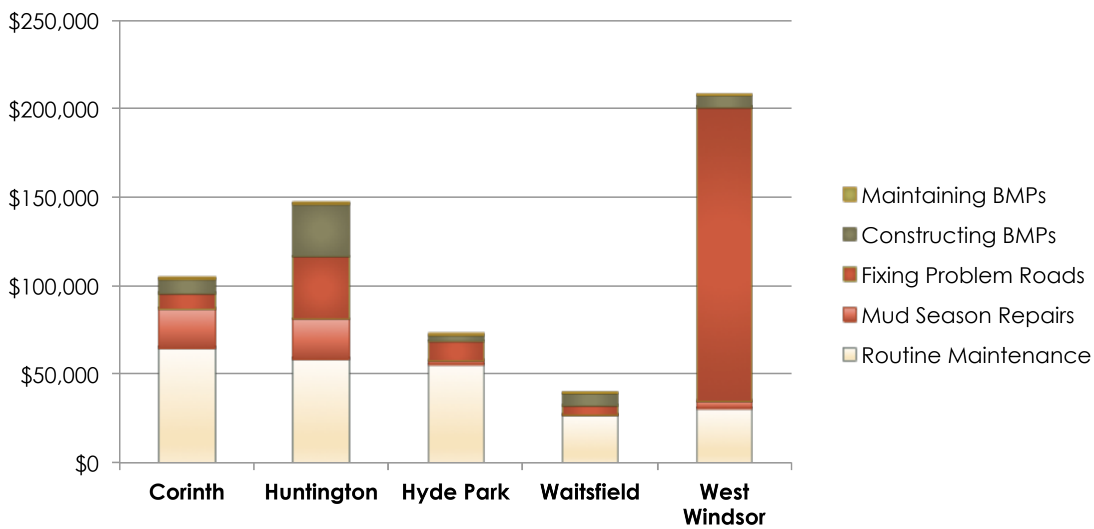


Town	Corinth	Huntington	Hyde Park	Waitsfield	West Windsor
Road crew salary	$147,628	$191,650	$194,153	$138,784	$155,745
Net unpaved non-winter salary	$43,570	$87,302	$56,758	$64,768	$61,288
Routine Maintenance	$24,480	$32,942	$34,682	$51,517	$38,057
Mud Season Repairs	$0	$13,640	$2,426	$2,448	$9,387
Fixing Problem Roads	$4,655	$5,908	$14,638	$4,896	$7,272
Constructing BMPs	$13,272	$33,512	$5,011	$4,896	$4,694
Maintaining BMPs	$1,164	$1,301	$0	$1,011	$1,877
Unpaved road miles	71.99	32,78	38.84	20.22	43.64
Cost per mile	$2,051	$4,465	$1,852	$1,955	$4,753

Figure 15 and Table 6 Distribution of annual road crew salary on non-winter, unpaved road maintenance tasks.

Road Materials

The road foreman was asked to distribute the use of pre-selected road materials over unpaved and paved roads. The distribution of these road materials used over the five maintenance tasks is illustrated in Figure 16 and Table 7. The highest town expenditure on materials, $207,412 in West Windsor, includes $55,687 of equipment rental, materials and trucking needed after a 2013 flood event. Although calculation of cost per mile (shown in Table 7 below) normalizes road material expenditure by town, it suggests an equal expenditure on all miles of road within a town. In fact, certain sections of road are heavily treated, while other road sections receive minimal maintenance, such as one-time grading.

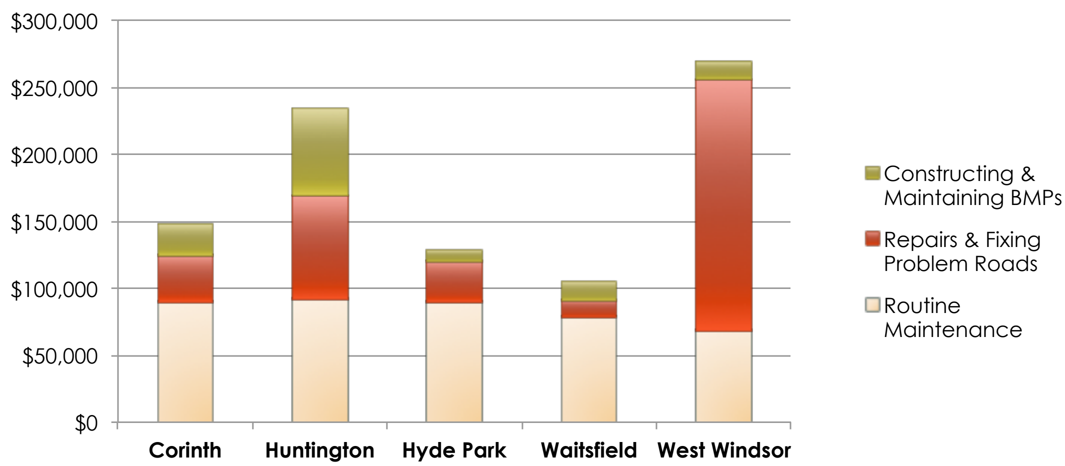


Town	Corinth	Huntington	Hyde Park	Waitsfield	West Windsor
Unpaved non-winter road materials	$104,083	$146,377	$71,941	$39,533	$207,412
Routine Maintenance	$65,134	$59,129	$55,696	$26,874	$30,932
Mud Season Repairs	$21,860	$22,347	$2,136	$459	$3,891
Fixing Problem Roads	$8,771	$35,186	$11,010	$4,947	$166,261
Constructing BMPs	$8,318.58	$29,714	$3,099	$6,794	$6,327
Maintaining BMPs	$0	$0	$0	$459	$0
Unpaved road miles	71.99	32.78	38.84	20.22	43.64
Cost per mile	$1,446	$4,465	$1,852	$1,955	$4,753

Figure 16 and Table 7 Distribution of annual road material costs on non-winter, unpaved road maintenance.

Annual Cost

Estimates of time and materials spent on non-winter, unpaved road maintenance are illustrated in Figure 17 and detailed in Table 8. The five tasks were grouped into three overarching categories to enable a comparison between routine maintenance, repeated maintenance of problem roads, and BMP construction and maintenance.



Town	Corinth	Huntington	Hyde Park	Waitsfield	West Windsor
Annual cost	$147,654	$233,680	$128,699	$104,301	$268,698
Routine Maintenance	$89,615	$92,071	$90,379	$78,390	$68,989
Repairs and Fixing Problems	$35,285	$77,082	$30,209	$12,751	$186,811
Constructing and Maintaining BMPs	$22,754	$64,527	$8,111	$13,160	$12,898
Unpaved road miles	71.99	32.78	38.84	20.22	43.64
Cost per mile	$2,051	$7,129	$3,314	$5,158	$6,157

Figure 17 and Table 8 Costs of non-winter, unpaved road maintenance (salary and materials) during one year. Cost per mile is a calculated average and does not necessarily reflect true expenditures on individual road miles.

Erosion-control prioritization

Eighty-one road sections were selected from the five town-wide erosion control prioritization maps created by Stone Environmental, Inc. Of those, 20 were awarded matching priority rankings by road foremen and town administrators. Table

9 displays all results from the comparison study. Of note are the 25 roads ranked as "No Priority" during the interviews. These roads were either paved, class 4 or private driveways not maintained by the town, or were no longer considered erosion control problems.

		GIS model ranking		
		High	Medium	Low
Town Ranking	High	8	8	8
	Medium	5	5	2
	Low	3	10	7
	No Priority	10	5	10

Table 9 Correlation of road prioritization rankings as designated in the GIS model created by Stone Environmental (horizontal) and by road foremen during town interviews (vertical). Yellow cells highlight matching rankings.

Discussion

Analysis of field results established the trend that BMP efficacy decreases with age, yet statistical analysis of the BMP sample group as a whole showed that age was not a statistically significant predictor of project outcome. Key predictors of the effectiveness of BMPs, as inferred from the analysis conducted here, include the grade and orientation of the road, the presence of a vegetated border on the roadside, and exposure to extreme flood events.

While the overall condition of BMPs over time did not differ considerably between parallel-slope and cross-slope roads, the study of BMP longevity according to road placement on the hill slope did demonstrate several logical but significant observations regarding the utility of each type of BMP.

Stone-lined ditches, stone turnouts and other stonework were primarily constructed on parallel-slope roads where fast-flowing water requires more intensive management. The difference in the average age of the two groups (5.2 years on cross-slope roads, 2.9 years on parallel-slope roads), while potentially an artifact of the sampling method, could suggest that BMPs on parallel-slope roads require repeated maintenance to sustain effectiveness or must be reconstructed with greater frequency than BMPs on cross-slope roads. The higher percentage of compromised BMPs on parallel-slope roads compared to cross-slope roads may also support this conclusion. Statistically, increased age and exposure to flood events were the most likely predictors of compromised or failed stone-lined ditches; however, when combined, exposure to flood events was more influential than age. In practice, many stone lined ditches effectively slowed water and captured sediment during storm events, resulting in the filling in of the stone lining with sediment until the ditches themselves became a source of sediment pollution. With routine maintenance of stonework by cleaning and replacing buried stones, these BMPs could retain their efficacy without the expense and disruption of rebuilding after road failure.

In contrast to the analysis of BMPs efficacy as a whole that indicated that age was not a significant environmental variable, analysis of the 18 assessed culverts alone revealed that increased age was the most likely predictor of a compromised or failed culvert condition. Increased grade also plays a smaller role in predicting comprised or failed culverts. In the field assessment, the number of compromised culverts increased with age, yet none of the assessed culverts had failed. This data suggests that culverts, when built correctly, are unlikely to fail under any normal site conditions. However, culverts completely blown out by large storm events are usually repaired or replaced immediately. Recording the number and age of culvert replacements would inform how often culverts are undersized for the anticipated volume of water runoff.

Revetments, by their nature, stabilize banks cut by roads. Compared to that of other forms of stonework, revetment longevity is high and is likely an effective way of stabilizing slopes where the need arises. Of the 17 revetments assessed in this study, 15 were constructed on cross-slope roads. Revetments on parallel-slope roads were restricted to locations where the road bank ran parallel to a river within a narrow valley or where the road was constructed in a historic valley bottom.

The longevity of vegetative control BMPs, such as grass-lined ditches, may be affected by road grade and storm events more than by surface water flow and velocity due to road orientation. Inherently, BMPs exposed to fast- flowing water in road ditches likely degrade more often than vegetative controls exposed to little or slow surface water. Assessment of vegetative control BMPs by age indicates that grass-lined ditches and restorative seeding and mulching can be effective up to five years after implementation. However, improper planting technique, slope instability, upslope debris slides or early washout of seed due to storms can render the efficacy of the BMP negligible. The road foreman in Huntington, VT stated during a town visit in November of 2013 that he prefers to utilize stone lined ditching wherever water is consistently flowing, even if the road grade is less than 5%. Seeps from hillsides often prevent grass seeds from taking root, undermining the ditches and the road banks. However, the high cost of stone and the associated labor for stone lining, when compared to grass seed and mulching labor, often prevents stone lining on wet but low-slope roadsides.

The success of BMPs that exhibit an established and extensive vegetated border between the road and the BMP suggests that allowing space and circumstances for this plant growth could be an integral part of BMP implementation. The webbed root and stem systems of plants, particularly low herbaceous plants, provide a free, renewable and biodegradable method to slow water and trap sediment. Alan May, the Better Backroads Technician, noted that the presence of vegetation on slopes, within revetments and along the perimeter of roadside ditches is a sign that erosion is minimal or absent and that proximal BMPs are stable. However, large shrubs and trees, while retaining sediment, can be detrimental to road maintenance. Tree crowns shade the road, resulting in ice patches during “mud season” while open road has thawed. During the winter, snow plows often hit trees, damaging the trunks and creating a safety hazard for the plow operator. However, the lack of vegetation between the road and any stonework BMPs appears to be a relevant factor in reducing stonework longevity – only 9 of the 26 stonework BMPs exhibiting no or some vegetated border remained intact within this study period.

Documenting the impact of large flood events on BMP condition established that exposure to these extreme events will likely lead to compromised or failed BMP installations. Achieving a greater understanding of the effects of other severe yet localized storms on all BMPs within a region or town may help town and state offices predict how much time and money should be reserved for maintenance of the most impacted sites, likely those on steep slopes or with no vegetative border. While almost half of the BMPs exposed to one or more flood events had become compromised, only eight of 59 BMPs had failed. With adequate maintenance, these BMPs could be restored to their initial efficacy.

Recent annual expenditures on BMPs in five sample towns ranged between approximately $13,000 and $64,000, small fractions of the total annual road budgets of between approximately $450,000 and over $1,000,000. Expenditures on erosion-related repairs in four towns ranged between $13,000 and $77,000 annually; outlier West Windsor spent an estimated $186,000 after 2013 flood damage. With the exception of West Windsor, these costs are of the same order of magnitude as the proactive maintenance approach achieved through BMP implementation. The West Windsor data highlights the costs of storm damage, but of note is that Huntington, which also experienced damage during July 2013 storm, did not expend similar costs during road repair. Although damage was perhaps a result of disparate environmental conditions such as slope, rainfall, or drainage obstructions, Huntington had invested greater funds in BMP construction, particularly after Tropical Storm Irene in 2011.

With the expectation that most BMPs can last at least eight years, especially when properly maintained, towns can expect to save increasing portions of their repeat expenditure on erosion-control. While towns perceive the Better Backroads grant application process as straightforward and accessible, they also note a need and desire to apply for further grants if such funding existed. Of particular importance may be recommendations and ensuing funding earmarked for BMP maintenance, especially as previously funded Better Backroads erosion-control projects surpass a decade in age.

Through GIS modeling, the Vermont Agency of Natural Resources can identify unpaved roads that pose the highest risk to water quality. However, state agencies will still need to rely on the local expertise of town road commissioners and foremen to allocate grant money accurately. The ground-truthing of GIS rankings indicates that both private roads and driveways pose threats to water quality, suggesting that Better Backroads consider private landowners as a target audience for erosion-control projects. If state water quality is to reap the rewards of BMPs on unpaved roads, towns will require continued training on the environmental and financial effects of unpaved road erosion and a future of increased technical and financial support for erosion control projects.

Conclusions

We retrospectively assessed 100 best management practices constructed in 43 road improvement projects included in the archives of projects funded by the Vermont Better Backroads program. BMP conditions were ranked as "intact" if installations showed no degradation in capacity to reduce on-site erosion, as "compromised" if evidence of degradation of the installation was visible, and "failed" if the installation was no longer functioning to provide water quality improvements as intended. Six independently measured or GIS-derived variables for each site were used to assess factors that might explain the efficacy of BMPs: the *age* of the BMP calculated since installation, the *grade* of the road on which BMPs were installed, the *orientation* of the road relative to the hill slope, the *profile* of the road surface, the presence of a *vegetated border* or the roadside, and exposure to one or more *floods* since installation. Statistically, road grade was the strongest predictor of overall project condition, with BMPs on steeper roads more likely to degrade. Exposure to extreme floods, the absence of a vegetated border between the BMP and road, and the construction of BMPs on slope-parallel roads also contributed to the compromised or failed condition of the assessed BMPs. Increased project age, while not a statistically significant predictor of overall project longevity, did predict a decline in stone-lined ditch and culvert condition.

Interviews of road foremen and town administrators in five small, mountainous towns in Vermont yielded estimates suggesting that towns are spending between 5% and 28% of their non-winter unpaved road maintenance budgets on BMP construction and maintenance. Four out of five towns were spending a greater percentage of their budgets on repeatedly fixing problem roads compared to construction of BMPs, suggesting that continued implementation of BMPs will reduce erosion-control costs, particularly over the eight or more year lifespan of BMPs. Statewide GIS models identifying unpaved roads posing high risk to water quality still require refinement and ground-truthing if they are to predict future road maintenance costs related to water quality; however, they provide an effective way for state programs to identify, and possibly incentivize, towns contributing heavily to non-point source water pollution through erosion of their unpaved roads.

This study is the first attempt to assess the effectiveness and longevity of low-cost management practice in reducing erosion and water quality degradation on Vermont's rural back roads. Our results show that BMPs assessed here remain intact or could be maintained when compromised to achieve long-term efficacy in water quality improvements.

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Appendix 1

Category B
Better Backroads Projects
2004 – September 2013

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
lamoille county nrcd	2004		REGIONAL HYDRO-SEEDER PROMOTION PROJECT	$7,000.00	$7,000.00	$6,230.00	$2,076.66	
south burlington dpw	2004		BEACON STREET STORM SEWER IMPROVEMENTS	$7,000.00	$7,000.00	$7,000.00	$13,854.26	
southeast newark pond assn (senpa)	2004		EROSION CONTROL/IMPROVED DRAINAGE AT NEWARK POND	$6,361.80	$6,362.00	$6,362.00	$5,518.00	
town of belvidere	2004		BOG ROAD/LAMOILLE RIVER STREAMBANK STABILIZATION	$2,625.00	$2,625.00	$2,509.50	$721.00	
town of benson	2004		SUNSET LAKE ROADBANK EROSION CONTROL PROJECT	$6,750.00	$6,750.00	$6,750.00	$2,250.00	
town of brattleboro dpw	2004		BLACK MOUNTAIN BROOK CULVERT HEADER	$4,800.00	$4,800.00	$4,800.00	$2,839.43	
town of calais	2004		WORCESTER ROAD (CALAIS) CULVERT REPLACEMENT	$2,026.16	$2,026.00	$2,026.00	$700.16	
town of colchester	2004		SHORE ACRES DRIVE DRAINAGE STABILIZATION	$7,000.00	$7,000.00	$7,000.00	$67,917.40	
town of danville	2004		WATER ANDRIC ROAD PROJECT - RIVERBANK EROSION	$5,547.00	$5,547.00	$5,547.00	$4,419.67	
town of east montpelier	2004		COBURN RD (TH30) & CATE FARM RD (TH31 BR#21) EROSI	$7,000.00	$7,000.00	$7,000.00	$41,925.00	
town of eden	2004		GIHON RIVER STREAMBANK STABILIZATION	$5,238.37	$5,238.00	$5,238.00	$1,761.20	
town of eden	2004		WHITE BRANCH EROSION CONTROL ON KNOWLES FLAT ROAD	$6,772.87	$6,773.00	$6,773.00	$2,165.71	
town of enosburg	2004		BOGUE ROAD (TH30) SITE 3 - ERODED STREAM	$5,085.00	$5,085.00	$1,793.72	$597.91	
town of enosburg	2004		HORSE SHOE CIRCLE ROAD	$3,483.00	$3,483.00	$1,004.76	$334.92	
town of enosburg	2004		TYLER BRANCH ROAD - STREAMBANK EROSION	$5,520.00	$4,123.00	$4,068.71	$1,356.24	
town of enosburg	2004		BOSTON POST ROAD (TH2) SITE 9 - SHOULDER EROSION	$7,000.00	$7,000.00	$7,000.00	$2,369.21	
town of fairfield	2004		JUAIRE ROAD (TH41) - EROSION TO ROAD SLOPE	$4,830.00	$4,830.00	$4,830.00	$22,866.30	
town of fairfield	2004		MITCHELL ROAD (TH35) - DITCH EROSION	$7,000.00	$7,000.00	$7,000.00	$17,539.00	
town of fairfield	2004		BRADLEY ROAD (TH57) - DITCH EROSION	$6,951.75	$6,952.00	$6,952.00	$4,910.30	
town of ferrisburgh	2004		SATTERLY ROAD - EROSION IN DITCH	$7,000.00	$7,000.00	$7,000.00	$5,403.25	
town of isle lamotte	2004		"1387 WEST SHORE ROAD" EROSION	$6,307.20	$6,307.00	$6,307.00	$3,776.74	
town of jericho highway dept.	2004		MILL BROOK STREAMBANK STABILIZATION	$10,000.00	$7,000.00	$6,123.00	$2,041.00	
town of middlebury	2004		MORSE ROAD DRAINAGE PROJECT	$7,000.00	$6,900.00	$6,900.00	$48,354.00	
town of middlesex	2004		GOVERNMENT HILL - ERODED CULVERTS	$6,866.00	$6,866.00	$6,866.00	$2,189.00	
town of newbury	2004		SCOTCH HOLLOW ROAD "2004" RECONSTRUCTION PROJECT	$5,747.33	$5,700.00	$5,700.00	$5,881.50	
town of north hero	2004		LAKEVIEW DRIVE BANK STABILIZATION	$5,790.00	$5,700.00	$5,700.00	$6,734.62	
town of norwich highway dept.	2004		GODDARD ROAD EROSION CONTROL PROJECT	$5,993.48	$5,900.00	$5,900.00	$4,527.96	
town of rochester	2004		WEST HILL ROAD CULVERT REPLACEMENT	$6,480.00	$6,480.00	$5,322.76	$1,774.25	
town of stowe	2004		UPPER PINNACLE ROAD DITCH LINING	$6,900.00	$6,900.00	$6,900.00	$4,909.74	
town of sudbury	2004		BURR POND BANK STABILIZATION	$7,000.00	$7,000.00	$7,000.00	$13,869.12	
barnard silver lake association	2005		GROVE ROAD EROSION PROJECT	$4,500.00	$ 4,500.00	$ 4,500.00	$ 2,643.01	
franklin watershed cmte/franklin selectmen	2005		DEWING SHORE ROAD STABILIZATION	$7,000.00	$ 7,000.00	$ 7,000.00	$ 16,723.92	$ 7,000.00
maidstone lake camp owners assn	2005		MAIDSTONE LAKE WEST SIDE ROAD IMPROVEMENT	$5,846.00	$ 5,846.00	$ 5,846.00	$ 2,385.63	
north bennington highway dept	2005		NORTH STREET DRAINAGE PROJECT - ERODING ROADSIDE	$4,500.00	$ 4,500.00	$ 4,500.00	$ 2,400.00	$ 4,500.00
southeast newark pond assn	2005		EROSION CONTROL/IMPROVED DRAINAGE AT NEWARK POND	$4,732.00	$ 4,732.00	$ 4,732.00	$ 3,026.00	
town of arlington	2005		EROSION CONTROL & BANK STAB AT BENEDICT BRK CULVER	$4,470.00	$ 4,470.00	$ 4,470.00	$ 109,722.95	$ 4,470.00
town of barnard	2005		LIME POND BANK SLIDE - SEVERE EROSION OF BANK	$6,900.00	$ 6,900.00	$ 6,900.00	$ 8,058.00	$ 6,900.00
town of barre	2005		STERLING HILL RD-EROSION CONTROL & BROOK BANK STAB	$7,000.00	$ 7,000.00	$ 6,848.95	$ 1,712.24	$ 6,848.95
town of belvidere	2005		SMITHVILLE ROAD DRAINAGE IMPROVEMENT	$3,120.00	$ 3,120.00	$ 2,164.00	$ 721.28	
town of benson	2005		SUNSET LAKE ROAD BANK EROSION CONTROL PROJECT	$7,000.00	$ 7,000.00	$ 7,000.00	$ 4,000.00	
town of calais	2005		NO. 10 POND ROAD DITCH PROJECT - EROSION	$2,233.95	$ 2,233.95	$ 2,233.95	$ 744.65	$ 2,233.95
town of cambridge	2005		BRYCE RD - ROAD BACKSLOPE, FILL DITCH	$2,016.00	$ 2,016.00	$ 2,016.00	$ 2,496.73	$ 2,016.00
town of cambridge	2005		EDWARDS RD - STREAM EROSION IS CAUSING ROADSLOPE	$7,000.00	$ 7,000.00	$ 7,000.00	$ 3,648.60	$ 7,000.00
town of cambridge	2005		RUSHFORD RD - EROSION & UNDERCUTTING IN RDSIDE DIT	$7,000.00	$ 7,000.00	$ 7,000.00	$ 4,478.30	$ 7,000.00
town of castleton	2005		BELGO ROAD - CULVERTS, SEDIMENT	$5,154.80	$ 5,154.80	$ 1,963.22	$ 490.80	$ 1,963.22
town of charlotte	2005		ROSCOE RD. BANK STABILIZATION PROJ.	$4,000.00	$ 4,000.00	$ 4,000.00	$ 1,546.93	$ 4,000.00
town of cornwall	2005		CLARK ROAD/BEAVER BROOK RUNOFF & EROSION	$5,625.00	$ 5,625.00	$ 5,625.00	$ 2,812.03	$ 5,625.00
town of cornwall	2005		CUTTING HILL RD - CORRECTION EROSION	$5,625.00	$ 5,625.00	$ 5,625.00	$ 2,719.33	$ 5,625.00
town of danby	2005		DANBY PAWLET ROAD CULVERT UPGRADE	$6,420.00	$ 6,420.00	$ 2,710.22	$ 677.55	$ 2,710.22
town of danville	2005		WATER ANDRIC BRK-PENNY LANE RD PROJ - EROSION RIVE	$6,500.00	$ 6,500.00	$ 6,500.00	$ 3,357.00	$ 6,500.00
town of eden	2005		BOOMHOWER BROOK DRAINAGE & EROSION CONTROL	$15,000.00	$ 15,000.00	$ 15,000.00	$ 12,699.29	$ 15,000.00
town of enosburg	2005		NICHOLS ROAD PROJECT - DITCH EROSION	$6,993.00	$ 6,993.00	$ 5,576.43	$ 1,394.11	$ 5,576.43
town of enosburg	2005		CHESTER ARTHUR RD PROJECT - STREAM RUNOFF, ERODING	$4,014.60	$ 4,014.60	$ 3,508.31	$ 877.08	$ 3,508.31
town of enosburg	2005		PERLEY ROAD PROJECT - DITCH EROSION & DITCHING	$7,000.00	$ 7,000.00	$ 7,000.00	$ 3,020.76	$ 7,000.00

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
lamoille county nrcd	1			
south burlington dpw	0			
southeast newark pond assn (senpa)	0			
town of belvidere	2			
town of benson	2			
town of brattleboro dpw	1			
town of calais	0			
town of colchester	0			
town of danville	0			
town of east montpelier	1			
town of eden	1			
town of eden	1			
town of enosburg	0			
town of enosburg	0			
town of enosburg	0			
town of enosburg	0			
town of fairfield	2			
town of fairfield	2			
town of fairfield	2			
town of ferrisburgh	1			
town of isle lamotte	0			
town of jericho highway dept.	1			
town of middlebury	0			
town of middlesex	0			
town of newbury	0			
town of north hero	0			
town of norwich highway dept.	1			
town of rochester	1			
town of stowe	3			
town of sudbury	0			
barnard silver lake association		2006	06GR002	
franklin watershed cmte/franklin selectmen		2006	06GR002	
maidstone lake camp owners assn		2006	06GR002	
north bennington highway dept		2006	06GR002	
southeast newark pond assn		2006	06GR002	
town of arlington		2006	06GR002	
town of barnard		2006	06GR002	
town of barre		2006	06GR002	
town of belvidere		2006	06GR002	
town of benson		2006	06GR002	
town of calais		2006	06GR002	
town of cambridge		2006	06GR002	
town of cambridge		2006	06GR002	
town of cambridge		2006	06GR002	
town of castleton		2006	06GR002	
town of charlotte		2006	06GR002	
town of cornwall		2006	06GR002	
town of cornwall		2006	06GR002	
town of danby		2006	06GR002	
town of danville		2006	06GR002	
town of eden		2006	06GR002	
town of enosburg		2006	06GR002	
town of enosburg		2006	06GR002	
town of enosburg		2006	06GR002	

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
town of fairfax	2005		Pilon Rd (TH46) Culvert Replacement	$ 5,597.00	$5,597.00	$5,597.00	$1,630.08	$ 5,597.00
town of fairfield	2005		BRADLEY ROAD - ROADWAY DITCH ERODING & ROAD SLOPE	$7,000.00	$ 7,000.00	$ 7,000.00	$ 5,442.85	$ 7,000.00
town of fairfield	2005		SHENANE ROAD - ROADWAY DITCH ERODING	$7,000.00	$ 7,000.00	$ 7,000.00	$ 8,879.60	$ 7,000.00
town of fairfield	2005		MOREY ROAD - EROSION TO ROADWAY SLOPES & DITCH	$4,185.00	$ 4,185.00	$ 3,227.02	$ 806.76	$ 3,227.02
town of glover & shadow lake assn	2005		TOWN HWY #40-INADEQUATE DRAINAGE & UNDERSIZED CULV	$7,000.00	$ 7,000.00	$ 7,000.00	$ 17,345.21	$ 7,000.00
town of grand isle, vermont	2005		ADAM LANDING TH7 BANK STABILIZATION APPROX 90' IN	$7,000.00	$ 7,000.00	$ 7,000.00	$ 4,475.77	
town of greensboro	2005		DITCH STABILIZATION PROJECT - EROSION INTO LAKE	$7,000.00	$ 7,000.00	$ 7,000.00	$ 13,817.29	$ 7,000.00
town of hardwick	2005		BUNKER HILLL DITCH STABILIZATION - EROSION OF ROAD	$3,980.00	$ 3,980.00	$ 3,980.00	$ 2,093.62	$ 3,980.00
town of holland	2005		TICE MILL & TWINBRIDGE BANK - BANK EROSION	$5,000.00	$ 5,000.00	$ 4,705.24	$ 1,568.41	
town of isle lamotte	2005		LAKE SHORE RD PROJ-LONGTERM LAKE EROSION ROADSLOPE	$6,825.00	$6,825.00	$6,825.00	$3,152.93	$6,825.00
town of johnson	2005		BANK STABILIZATION RIVER ROAD EAST	$7,000.00	$ 7,000.00	$ 7,000.00	$ 4,553.02	
town of lincoln	2005		LINCOLN GAP ROAD - CONSTANT FLOODING, DITCHING	$7,000.00	$ 7,000.00	$ 7,000.00	$ 2,394.24	$ 7,000.00
town of ludlow	2005		FISHING ACCESS ROAD/ROUND POND - IMPROVE DITCH	$1,605.00	$ 1,605.00	$ 1,605.00	$ 548.33	$ 1,605.00
town of mendon	2005		DEERMONT POND EROSION CONTROL	$3,750.00	$ 3,750.00	$ 3,750.00	$ 3,844.54	$ 3,750.00
town of moretown	2005		DICKERSON ROAD BANK STABILIZATION	$7,000.00	$ 7,000.00	$ 6,206.00	$ 1,274.85	
town of morristown	2005		MUD CITY LOOP ROAD EROSION CONTROL PROJECT	$6,666.00	$ 6,666.00	$ 2,991.09	$ 747.77	$ 2,991.09
town of morristown	2005		PATCH ROAD EROSION CONTROL PROJECT	$2,588.00	$ 2,588.00	$ 1,883.10	$ 470.78	$ 1,883.10
town of new haven	2005		DITCH ON EAST STREET/RIVER ROAD - EROSION	$2,000.00	$ 2,000.00	$ 2,000.00	$ 1,995.74	$ 2,000.00
town of northfield	2005		WATER ST - ROADWAY/STREAMBANK STABILIZATION	$5,250.00	$ 5,250.00	$ 3,158.00	$ 1,052.50	
town of pawlet	2005		BETTS BRIDGE ROAD DITCH RESTRUCTURING	$5,250.00	$ 5,250.00	$ 5,250.00	$ 9,196.14	$ 5,250.00
Town of Rochester, Vermont	2005		MARSH BROOK BRIDGE - REPLACE ERODED LOG HEADWALL	$15,000.00	$ 15,000.00	$ 15,000.00	$ 5,277.65	$ 15,000.00
town of shoreham	2005		DOOLITTLE RD-WATER EROSION, WASHING AWAY RD & SLOP	$7,000.00	$ 7,000.00	$ 7,000.00	$ 4,584.78	$ 7,000.00
town of topsham	2005		WILLEY HILL ROAD RIVERBANK EROSION PROJECT	$3,917.85	$ 3,917.85	$ 3,917.85	$ 2,210.18	$ 4,902.42
town of townshend	2005		PLUMB ROAD BANK - EROSION INTO DITCH	$7,000.00	$ 7,000.00	$ 7,000.00	$ 3,594.50	$ 7,000.00
town of walden	2005		FERGUSON HILL ROAD EROSION CONTROL PROJECT	$4,611.00	$ 6,409.00	$ 6,409.00	$ 3,451.80	$ 6,409.00
town of walden	2005		HOUSTON HILL ROAD EROSION CONTROL PROJECT	$7,000.00	$ 13,674.70	$ 7,000.00	$ 15,888.29	$ 7,000.00
town of walden	2005		COLES POND ROAD EROSION CONTROL PROJECT	$5,161.00	$ 7,023.00	$ 7,023.00	$ 2,800.63	$ 7,023.00
town of west windsor	2005		BANK STABILIZATION ON SHEDDSVILLE ROAD	$7,000.00	$ 7,000.00	$ 7,000.00	$ 10,751.47	$ 7,000.00
town of williamstown	2005		WIER ROAD - ROADSIDE WASHING INTO SMALL STREAM	$2,176.20	$ 2,176.20	$ 2,176.20	$ 2,901.80	$ 2,176.20
Maidstone Lake Camp Owners Assoc.	2006		West Side Road ditching, backslope stabilization, and repair/replacement of culverts	$7,000.00	$7,000.00	$7,000.00	$4,898.25	
Thatcher Pines Assn	2006		East Wind Dr - road erosion into watershed area	$2,400.00	$0.00	$0.00	$0.00	
Town of Barnard	2006		Lakota Rd - no room for culvert inlet basin	$3,845.00	$3,845.00	$1,852.80	$463.20	$1,852.80
Town of Belvidere	2006		Bog Road - Roadway Erosion Improvements	$7,000.00	$7,000.00	$6,384.04	$1,596.01	$6,384.04
Town of Benson	2006		Frazier Hill Road Drainage Improvement	$7,000.00	$7,000.00	$7,000.00	$6,000.00	$7,000.00
Town of Berlin	2006		Comstock Road - corroded culverts, ditches	$7,000.00	$7,000.00	$7,000.00	$13,345.82	$7,000.00
Town of Berlin	2006		Granger Road - culverts and ditches	$7,000.00	$7,000.00	$3,630.17	$907.54	$3,630.17
Town of Bridgewater	2006		Bridgewater Ctr Rd - road bank stabilization	$7,000.00	$7,000.00	$7,000.00	$4,220.00	$7,000.00
Town of Brownington	2006		Schoolhouse Rd. ditch installation	$3,517.50	$3,517.50	$3,517.50	$2,615.00	$3,517.50
Town of Cambridge	2006		Upper Bartlette Rd - road erosion	$7,000.00	$7,000.00	$7,000.00	$7,271.55	$7,000.00
Town of Cambridge	2006		Lower Bartlette Rd - road erosion	$7,000.00	$7,000.00	$7,000.00	$8,463.81	$7,000.00
Town of Cavendish	2006		20 Mile Stream Rd (Farrar) Culvert Repl, Realign &	$3,972.00	$3,972.00	$3,937.74	$984.43	$3,937.74
Town of Cavendish	2006		Howard Hill Rd Ditch & Bank Stab Proj	$5,776.00	$5,776.00	$5,776.00	$14,738.37	$5,776.00
Town of Chittenden	2006		Culvert near end of TH#10, slope ditch	$2,392.50	$2,392.50	$1,466.87	$488.96	
Town of Craftsbury	2006		Denton Hill TH#43 - culvert caused washout	$6,042.00	$6,042.00	$6,042.00	$2,317.29	$6,042.00
Town of Danville	2006		Water Andric River Bridge Erosion Proj	$7,000.00	$7,000.00	$7,000.00	$3,170.00	$7,000.00
Town of Enosburgh	2006		Woodward Neighborhood Proj - erosion of brook bank	$4,137.60	$4,137.60	$4,137.60	$1,257.75	$4,137.60
Town of Enosburgh	2006		Bogue Road Proj - ditch erosion along roadside	$5,851.65	$5,851.65	$5,258.40	$1,314.60	$5,258.40
Town of Fairfield	2006		Chester Arthur Road - erosion along road slope	$7,000.00	$7,000.00	$7,000.00	$29,367.54	$7,000.00
Town of Fairfield	2006		Callan Road - undersize culverts	$7,000.00	$7,000.00	$7,000.00	$11,216.94	$7,000.00
Town of Fairlee	2006		Terry Hill Road - Ditch Stab & Culvert Replacement	$5,236.50	$5,236.50	$5,236.50	$5,112.34	$5,236.50
Town of Fairlee	2006		Quinibeck Road - Ditch Stabilization	$7,000.00	$7,000.00	$7,000.00	$2,452.83	$7,000.00
Town of Georgia	2006		Georgia Mt Ditch Stabilization	$6,449.00	$6,449.00	$6,449.00	$3,132.00	$6,449.00

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
town of fairfax		2006	06GR002	
town of fairfield		2006	06GR002	
town of fairfield		2006	06GR002	
town of fairfield		2006	06GR002	
town of glover & shadow lake assn		2006	06GR002	
town of grand isle, vermont		2006	06GR002	
town of greensboro		2006	06GR002	
town of hardwick		2006	06GR002	
town of holland		2006	06GR002	
town of isle lamotte		2006	06GR002	
town of johnson		2006	06GR002	
town of lincoln		2006	06GR002	
town of ludlow		2006	06GR002	
town of mendon		2006	06GR002	
town of moretown		2006	06GR002	
town of morristown		2006	06GR002	
town of morristown		2006	06GR002	
town of new haven		2006	06GR002	
town of northfield		2006	06GR002	
town of pawlet		2006	06GR002	
Town of Rochester, Vermont		2006	06GR002	
town of shoreham		2006	06GR002	
town of topsham		2006	06GR002	
town of townshend		2006	06GR002	
town of walden		2006	06GR002	
town of walden		2006	06GR002	
town of walden		2006	06GR002	
town of west windsor		2006	06GR002	
town of williamstown		2006	06GR002	
Maidstone Lake Camp Owners Assoc.		2007	07GR011	
Thatcher Pines Assn		2007	07GR011	
Town of Barnard		2007 or 2008	07GR011 or 08GR012	
Town of Belvidere		2007	07GR011	
Town of Benson		2007 or 2008	07GR011 or 08GR012	
Town of Berlin		2007	07GR011	
Town of Berlin		2007	07GR011	
Town of Bridgewater		2007 or 2008	07GR011 or 08GR012	
Town of Brownington		2007	07GR011	
Town of Cambridge		2007	07GR011	
Town of Cambridge		2007	07GR011	
Town of Cavendish		2007	07GR011	
Town of Cavendish		2007	07GR011	
Town of Chittenden		2007	07GR011	
Town of Craftsbury		2007	07GR011	
Town of Danville		2007	07GR011	
Town of Enosburgh		2007	07GR011	
Town of Enosburgh		2007	07GR011	
Town of Fairfield		2007	07GR011	
Town of Fairfield		2007	07GR011	
Town of Fairlee		2007	07GR011	
Town of Fairlee		2007	07GR011	
Town of Georgia		2007	07GR011	

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Grafton	2006		Richard's Rd Project-road undermined severely	$6,420.00	$6,420.00	$5,304.29	$1,326.07	$5,304.36
Town of Hartford	2006		Hillside Rd & Allen Family Rd intersection-drainage	$7,000.00	$7,000.00	$7,000.00	$4,931.01	$7,000.00
Town of Hyde Park	2006		Brook Road Project - roadside ditch slope	$1,597.50	$1,597.50	$1,597.50	$738.10	$1,597.50
Town of Lincoln	2006		Lincoln/Ripton Rd. bank stabilization	$7,000.00	$7,000.00	$7,000.00	$3,083.84	$7,000.00
Town of Morristown	2006		Brook Road - road erosion	$6,000.00	$6,000.00	$6,000.00	$1,598.12	$6,000.00
Town of Morristown	2006		Mud City Loop - road erosion	$4,860.00	$4,860.00	$2,215.04	$553.76	$2,215.04
Town of North Hero	2006		Bank Stabilization-South End Road	$6,232.50	$6,232.50	$6,232.50	$5,302.20	$6,232.50
Town of Orange	2006		Upper Emery Rd - road washouts	$7,000.00	$7,000.00	$7,000.00	$6,282.38	$7,000.00
Town of Orange	2006		Lower Emery Rd - unlined ditches	$6,802.00	$6,802.00	$6,802.00	$4,802.32	$6,802.00
Town of Orwell	2006		Knox Hill - road washed out	$3,090.00	$3,090.00	$3,090.00	$2,609.32	$3,090.00
Town of Panton	2006		Slang Road (TH14) Culvert Replacement	$6,531.00	$6,531.00	$6,531.00	$2,381.00	
Town of Pawlet	2006		TH#14 Ditch Stabilization	$7,000.00	$7,000.00	$7,000.00	$12,536.80	
Town of Peacham	2006		Mack's Mt Erosion Control Proj	$7,000.00	$7,000.00	$7,000.00	$7,275.62	$7,000.00
Town of Pomfret	2006		Stage Road Reclamation - erosion of lower road slope	$7,000.00	$7,000.00	$7,000.00	$2,866.79	$7,000.00
Town of Ripton	2006		Wagon Wheel - bring road up to standards-ditch	$7,000.00	$7,000.00	$7,000.00	$3,242.09	$7,000.00
Town of Rochester	2006		Marsh Brook - Shady Rill Culvert - replace	$7,000.00	$7,000.00	$7,000.00	$9,495.74	
Town of Rupert	2006		Sandgate Rd Proj - stream erosion of roadway	$6,787.50	$6,787.50	$6,787.50	$2,244.50	$6,787.50
Town of Shoreham	2006		Quiet Valley Rd - Water erosion washing rd & slope	$7,000.00	$7,000.00	$7,000.00	$3,867.73	$7,000.00
Town of Stratton	2006		Penny Ave - fix ditch culverts and bank stab	$6,720.00	$6,720.00	$6,720.00	$5,403.68	$6,720.00
Town of Topsham	2006		Warsley Road Ditch Project - runoff	$2,795.10	$2,795.10	$2,795.10	$1,534.75	$2,795.10
Town of Underhill	2006		Westman Road Stabilization - roadside ditch	$1,585.00	$1,585.00	$1,585.00	$1,649.61	$1,585.00
Town of Victory	2006		River Roadbank - eroding riverbank	$7,000.00	$7,000.00	$7,000.00	$4,465.73	
Town of Walden	2006		Lower Coles Pond Rd - road erosion	$5,895.00	$5,895.00	$5,895.00	$3,844.10	$5,895.00
Town of Walden	2006		Middle Coles Pond Rd - road erosion	$7,000.00	$7,000.00	$7,000.00	$5,715.75	$7,000.00
Town of Wallingford	2006		Hartsboro Road Erosion	$4,525.43	$4,525.43	$4,525.43	$3,399.01	$4,525.43
Town of Warren	2006		West Hill Slide Erosion Storm Water Control, TH 16	$7,000.00	$7,000.00	$7,000.00	$69,241.00	
Town of Washington	2006		Poor Farm Rd - streambank instability	$7,000.00	$7,000.00	$6,671.83	$1,667.96	$6,671.83
Town of Washington	2006		Woodchuck Hollow Extension Rd.	$3,951.00	$3,951.00	$3,951.00	$4,117.20	$3,951.00
Town of West Windsor	2006		Continued Bank Stab on Sheddsville Rd	$13,116.00	$7,000.00	$7,000.00	$3,553.75	$7,000.00
Town of Whitingham Hwy Dept	2006		Goodnow/Kenfield Road Erosion Problem	$7,000.00	$7,000.00	$7,000.00	$8,310.24	$7,000.00
All Souls Unitarian Universalist Church	2007		All Souls Church/W Village Mtg House Rd Runoff Mitigation Proj	$4,300.00	$4,300.00	$4,300.00	$7,197.00	
Maistone Lake Campowners Assn	2007		West Side Rd. Projects	$7,000.00	$7,000.00	$7,000.00	$4,012.16	
Spring Lake Ranch Inc	2007		Spring Lake Rd Improvement Proj - road erosion	$4,750.00	$4,750.00	$4,750.00	$2,808.76	
Town of Belvidere	2007		Florence Rd - Rdway Erosion Improvement	$2,111.00	$2,111.00	$2,111.00	$934.46	$2,111.00
Town of Belvidere	2007		Bog Road (TH#8) Drainage Improvements	$2,647.00	$2,647.00	$2,647.00	$1,740.91	$2,647.00
Town of Benson	2007		North Lake Rd Erosion Proj-eroion in waterways that feed into Lake Champlain	$7,000.00	$7,000.00	$7,000.00	$6,972.40	$7,000.00
Town of Bloomfield	2007		Spencer Hill	$7,000.00	$7,000.00	$7,000.00	$49,983.15	$7,000.00
Town of Bridgewater	2007		Perkins Rd ditching - runoff that erodes the ditch and roadside	$3,769.00	$3,769.00	$3,769.00	$2,243.90	$3,769.00
Town of Bristol	2007		Upper Notch Rd Bank Stabilization-significant annual loss of road surface	$7,000.00	$7,000.00	$7,000.00	$21,991.00	$7,000.00
Town of Cambridge	2007		Bryce Rd (TH43) Proj #1-roadside ditch is undercutting & eroding	$7,000.00	$7,000.00	$7,000.00	$11,719.08	$7,000.00
Town of Corinth	2007		Brook Rd.	$7,000.00	$7,000.00	$7,000.00	$6,399.76	$7,000.00
Town of Cornwall	2007		West St - ditches	$4,650.00	$4,650.00	$4,650.00	$8,071.40	$4,650.00
Town of Danville	2007		Old Stagecoach Rd Culvert Erosion Proj - eroded road into stream	$4,000.00	$4,000.00	$4,000.00	$1,644.20	$4,000.00
Town of Danville	2007		Morrill Rd.	$7,000.00	$7,000.00	$2,533.30	$633.33	$2,533.30
Town of Dummerston	2007		Stickney Brook Rd-road eroding	$7,500.00	$7,000.00	$7,000.00	$17,145.06	$7,000.00
Town of Eden	2007		Paranto Rd Drainage & Erosion Control - little or no drainage	$7,000.00	$7,000.00	$7,000.00	$11,978.54	
Town of Eden	2007		Paronto Rd Drainage & Erosion Control	$7,000.00	$7,000.00	$7,000.00	$12,125.55	$7,000.00
Town of Enosburgh	2007		St. Pierre Rd. Site 1	$7,000.00	$7,000.00	$4,992.88	$1,248.22	$4,992.88
Town of Fairfield	2007		Fairfield - Ridge Rd-eording ditches	$7,000.00	$7,000.00	$7,000.00	$8,944.65	$7,000.00
Town of Fletcher	2007		Rugg Rd. - Excessive Runoff	$5,791.50	$5,791.50	$5,791.50	$6,026.20	
Town of Glover	2007		Daniels Pond Rd Erosion Control Proj - insufficient ditches, water runoff	$7,000.00	$7,000.00	$7,000.00	$23,301.00	

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Grafton		2007 or 2008	07GR011 or 08GR012	
Town of Hartford		2007 or 2008	07GR011 or 08GR012	
Town of Hyde Park		2007	07GR011	
Town of Lincoln		2007	07GR011	
Town of Morristown		2007	07GR011	
Town of Morristown		2007	07GR011	
Town of North Hero		2007	07GR011	
Town of Orange		2007	07GR011	
Town of Orange		2007	07GR011	
Town of Orwell		2007 or 2008	07GR011 or 08GR012	
Town of Panton		2007	07GR011	
Town of Pawlet		2007	07GR011	
Town of Peacham		2007 or 2008	07GR011 or 08GR012	
Town of Pomfret		2007 or 2008	07GR011 or 08GR012	
Town of Ripton		2007 or 2008	07GR011 or 08GR012	
Town of Rochester		2007	07GR011	
Town of Rupert		2007	07GR011	
Town of Shoreham		2007	07GR011	
Town of Stratton		2007	07GR011	
Town of Topsham		2007	07GR011	
Town of Underhill		2007	07GR011	
Town of Victory		2007	07GR011	
Town of Walden		2007	07GR011	
Town of Walden		2007	07GR011	
Town of Wallingford		2007 or 2008	07GR011 or 08GR012	
Town of Warren		2007	07GR011	
Town of Washington		2007	07GR011	
Town of Washington		2007	07GR011	
Town of West Windsor		2007 or 2008	07GR011 or 08GR012	
Town of Whitingham Hwy Dept		2007 or 2008	07GR011 or 08GR012	
All Souls Unitarian Universalist Church		2008	08GR012	
Maistone Lake Campowners Assn		2008	08GR012	
Spring Lake Ranch Inc		2008	08GR012	
Town of Belvidere		2008	08GR012	
Town of Belvidere		2008	08GR012	
Town of Benson		2008	08GR012	
Town of Bloomfield		2008	08GR012	
Town of Bridgewater		2008	08GR012	
Town of Bristol		2008	08GR012	
Town of Cambridge		2008	08GR012	
Town of Corinth		2008	08GR012	
Town of Cornwall		2008	08GR012	
Town of Danville		2008	08GR012	
Town of Danville		2008	08GR012	
Town of Dummerston		2008	08GR012	
Town of Eden		2008	08GR012	
Town of Eden		2008	08GR012	
Town of Enosburgh		2008	08GR012	
Town of Fairfield		2008	08GR012	
Town of Fletcher		2008	08GR012	
Town of Glover		2008	08GR012	

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Greensboro	2007		Ditch Stabilization Proj - inadequate ditches causing sediment to flow into Lake	$7,000.00	$7,000.00	$7,000.00	$2,081.74	$7,000.00
Town of Lincoln	2007		York Hill Road Ditching	$7,000.00	$7,000.00	$6,587.11	$1,646.78	$6,587.11
Town of Ludlow	2007		Lower East Lake Rd- rd runoff/shoreline	$5,237.50	$5,237.50	$5,237.50	$2,959.20	$5,237.50
Town of Ludlow	2007		Upper East Lake Road/eroding the road surface	$6,505.88	$6,505.88	$6,505.88	$2,496.72	$6,505.88
Town of Middletown Springs	2007		Coy Hill Rd - ditches filled & overgrown & rusted culverts	$7,000.00	$7,000.00	$7,000.00	$3,703.81	$7,000.00
Town of Moretown	2007		Dickerson Rd Bank Stabilization-bank erosion, cracked road	$6,930.00	$6,930.00	$5,507.20	$1,376.80	$5,507.20
Town of New Haven	2007		River Rd.	$7,000.00	$7,000.00	$7,000.00	$3,054.91	$7,000.00
Town of North Hero	2007		Pelot Pt Rd Proj - eroding road slope & embankment	$7,000.00	$7,000.00	$7,000.00	$7,635.68	$7,000.00
Town of North Hero	2007		Lake View Dr Proj-high water levels are eroding road slope & embankment	$7,000.00	$7,000.00	$7,000.00	$9,464.50	$7,000.00
Town of Norton	2007		Brousseau Mtn. Rd.	$7,000.00	$7,000.00	$7,000.00	$1,823.16	$7,000.00
Town of Panton	2007		Adams Ferry Rd. - Ditch erosion	$7,000.00	$7,000.00	$7,000.00	$10,316.75	$7,000.00
Town of Pawlet	2007		TH27 Stabilization Proj	$7,000.00	$7,000.00	$7,000.00	$8,803.60	$7,000.00
Town of Richford	2007		South Richford Road Ditch Stab Proj	$7,000.00	$7,000.00	$7,000.00	$14,950.41	$7,000.00
Town of Ripton	2007		Barker Rd Erosion control-ditched slurrped in & 2 culverts failing	$7,000.00	$7,000.00	$7,000.00	$6,446.83	$7,000.00
Town of Rochester	2007		Bingo Rd-road embankment	$7,000.00	$7,000.00	$4,681.48	$1,170.37	$4,681.48
Town of Rutland	2007		Sand Hill Ditch Proj - 500' eroded dtich along the road	$5,965.10	$5,965.10	$5,085.07	$1,271.27	$5,085.07
Town of Sheldon	2007		Kane Rd Ditch Proj - runoff from cornfield	$7,000.00	$7,000.00	$7,000.00	$24,536.00	
Town of Sheldon (SEP Funds)	2007		St. Marie's Hill	$7,000.00	$7,000.00	$7,000.00	$3,013.00	
Town of Shoreham	2007		Lake Street Ditch - water runoff is eroding ditch & rd	$7,000.00	$7,000.00	$7,000.00	$6,948.00	$7,000.00
Town of Sunderland	2007		Bentley Hill Ditch Stabilization-water runoff	$1,900.50	$1,900.50	$1,900.50	$4,982.16	$1,900.50
Town of Tinmouth	2007		Palmer Brook	$7,000.00	$7,000.00	$6,928.83	$1,732.21	$6,928.83
Town of Waitsfield	2007		Dana Hill Rd Erosion Restoration Proj	$6,946.00	$6,946.00	$6,073.27	$1,518.32	$6,073.27
Town of Walden	2007		Baily-Hazen Rd. Ditching and Culverts	$10,788.00	$7,000.00	$7,000.00	$2,329.19	$7,000.00
Town of Wardsboro	2007		South Wardsboro Rd Clay Slide - clay embankment sliding into roadside ditch	$3,750.00	$3,750.00	$3,750.00	$1,100.00	$3,750.00
Town of West Haven	2007		Replacing culverts on W Haven Main Rd East of Hubbardton River	$7,000.00	$7,000.00	$7,000.00	$3,640.26	
Town of Westford	2007		TH#30 Pettengill Rd, Proj 1 - backslope falls & plugs ditch	$7,000.00	$7,000.00	$5,953.60	$1,488.40	$5,953.60
Town of Woodbury	2007		Greenwood Lake	$4,367.00	$4,367.00	$3,428.73	$1,142.91	
UVM Extension	2007		Bishop Street	$6,816.00	$6,816.00	$6,816.00	$6,516.00	
West Shore Rd Assn-Lake Groton	2007		West Shore Rd Erosion Control Porj	$2,981.25	$2,981.25	$2,981.25	$1,176.25	
Winooski NRCD	2007		Williston Hills Stormwater Mitigation Proj - Gully Stabilization	$7,000.00	$7,000.00	$7,000.00	$172,934.82	
Maidstone Lake Campowners Assn	2008		West Side Rd. - Soil erosion from road & ditches	$7,000.00	$7,000.00	$7,000.00	$4,005.37	
Orleans County NRCD	2008		Seymour Tributaries	$10,000.00	$10,000.00	$10,000.00	$8,295.95	
Town of Barnard	2008		Chateauguay Rd. Bank slide 40-50' from Locust Creek (pristine class water), sm. 6" culvert, siltation & ponding at edge of road	$7,000.00	$7,000.00	$7,000.00	$4,052.94	$7,000.00
Town of Barre	2008		Taplin Rd. - Lower section of hill 15%+ grade on hill erosion along road shoulder & ditches w/unstsble culvert inlets & outlets	$8,094.00	$7,000.00	$7,000.00	$8,282.81	$7,000.00
Town of Barre	2008		Taplin Rd. - Upper section of hill 15%+ grade on hill erosion along road shoulder & ditches w/unstsble culvert inlets & outlets	$8,814.00	$7,000.00	$7,000.00	$7,759.00	$7,000.00
Town of Benson	2008		Sunset Lake Rd. - East roadside slope of Sunset Lake Road is silting into the cross culverts & then into Sunset Lake	$7,000.00	$7,000.00	$7,000.00	$5,389.65	$7,000.00
Town of Berlin	2008		Brookfield Rd. - Poor drainage & sediment control issues along Brookfield & Mirror Lake Roads	$7,000.00	$7,000.00	$7,000.00	$19,577.08	$7,000.00
Town of Bloomfield	2008		Spencer Hill Rd. - Narrow Roadway, very little ditches, storm runoff	$7,000.00	$7,000.00	$7,000.00	$14,881.57	$7,000.00
Town of Cambridge	2008		Junction Hill Rd - Ditch Work	$7,000.00	$7,000.00	$7,000.00	$7,178.91	
Town of Cambridge	2008		Junction Hill Rd. - Road Edge and ditch erosion	$7,000.00	$7,000.00	$7,000.00	$6,867.19	$7,000.00
Town of Dummerston	2008		East-West Rd. and Miller Rd. - Excessing washing or erosion of ditches along pavement on grades	$740.00	$740.00	$740.00	$703.03	
Town of Dummerston	2008		Miller Rd. and East-West Rd. Intersection - 2 culverts running under the intersection are poor rated on our inventory list	$3,900.00	$3,900.00	$3,900.00	$2,237.38	$3,900.00

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Greensboro		2008	08GR012	
Town of Lincoln		2008	08GR012	
Town of Ludlow		2008	08GR012	
Town of Ludlow		2008	08GR012	
Town of Middletown Springs		2008	08GR012	
Town of Moretown		2008	08GR012	
Town of New Haven		2008	08GR012	
Town of North Hero		2008	08GR012	
Town of North Hero		2008	08GR012	
Town of Norton		2008	08GR012	
Town of Panton		2008	08GR012	
Town of Pawlet		2008	08GR012	
Town of Richford		2008	08GR012	
Town of Ripton		2008	08GR012	
Town of Rochester		2008	08GR012	
Town of Rutland		2008	08GR012	
Town of Sheldon		2008	08GR012	
Town of Sheldon (SEP Funds)				
Town of Shoreham		2008	08GR012	
Town of Sunderland		2008	08GR012	
Town of Tinmouth		2008	08GR012	
Town of Waitsfield		2008	08GR012	
Town of Walden		2008	08GR012	
Town of Wardsboro		2008	08GR012	
Town of West Haven		2008	08GR012	
Town of Westford		2008	08GR012	
Town of Woodbury		2008	08GR012	
UVM Extension		2008	08GR012	
West Shore Rd Assn-Lake Groton		2008	08GR012	
Winooski NRCD		2008	08GR012	
Maidstone Lake Campowners Assn		2009		
Orleans County NRCD		2009		
Town of Barnard		2009		
Town of Barre		2009		
Town of Barre		2009		
Town of Benson		2009		
Town of Berlin		2009		
Town of Bloomfield		2009		
Town of Cambridge		2009		
Town of Cambridge		2009		
Town of Dummerston		2009		
Town of Dummerston		2009		

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Eden	2008		Warren Rd. - Heavy rain into culvert causing erosion of the roadway at the inlet & outelt depositing sediment into the White branch that flows in the Gihon River	$7,000.00	$7,000.00	$7,000.00	$17,339.28	$7,000.00
Town of Elmore	2008		Lacasse Rd. - runoff creates washouts, constant eorison & sediment flow into brook	$4,273.00	$4,273.00	$4,273.00	$4,727.33	
Town of Enosburgh	2008		St. Pierre Rd. - Ditch erosion on north side of road along a 5-8% grade	$7,000.00	$7,000.00	$6,379.30	$1,594.83	$6,379.30
Town of Fairfax	2008		River Road Bank Stabilization Proj-TH51-riverundermining TH51, runoof from the roads' surface, bank erosionof the bank	$7,000.00	$7,000.00	$7,000.00	$2,838.08	
Town of Fairfield	2008		Gilbert Hill Rd. - ditch & road edge erosion adding cross culverts to reduce volume is not feasible	$7,000.00	$7,000.00	2007 SEP Funds		
Town of Fairlee	2008		Quinibeck Rd. - Bank is completely undermined. Excessively deep banks & ditches	$7,000.00	$7,000.00	$6,723.13	$1,680.78	$6,723.13
Town of Fletcher	2008		Ellsworth Rd. - Ditch has disappeared, excessive erosion from hillside property	$7,000.00	$7,000.00	$7,000.00	$8,026.42	$7,000.00
Town of Fletcher	2008		Mayotte Rd. - Large drainage area uphill from road, during most large thunderstorms, runoff water picks up speed & washes out road	$7,000.00	$7,000.00	$7,000.00	$3,887.03	$7,000.00
Town of Glover	2008		Dexter Mountain Rd. - Insufficient ditches & plugged culverts causing road erosion to enter	$7,000.00	$7,000.00	$7,000.00	$42,047.56	$7,000.00
Town of Grafton	2008		Chester Hill - 3 culverts bank sliding into the inlet blocking the entrance of culvert	$2,934.00	$2,934.00	$2,934.00	$968.00	$2,934.00
Town of Hyde Park	2008		Cleveland Corners Rd. - Erosion of ditch. Insufficient to handle drainage	$7,000.00	$7,000.00	$7,000.00	$6,530.49	
Town of Isle LaMotte	2008		Quarry Rd. - Roadside ditch that is not functioning as required to support the road structure & provide adequate drainage	$7,000.00	$7,000.00	$4,433.90		
Town of Jericho	2008		Nashville Rd. - Not in capital severe scope erosion/instability resulting from culvert being too short & downstream road slope being too steep	$7,000.00	$7,000.00	$7,000.00	$21,960.70	$7,000.00
Town of Johnson	2008		Gould Hill Rd. - Earthen ditches have eroded	$7,000.00	$7,000.00	$7,000.00	$5,801.55	$7,000.00
Town of Lincoln	2008		Page Hill Rd. - Ditches have been washing out, causing silt & sand to fill ditches at base of hill & run into New Haven River	$7,000.00	$7,000.00	$6,784.81	$1,696.20	$6,784.81
Town of Ludlow	2008		Ellisons Lake Rd. - Road has become heavily traveled, traffic loosens & erodes road surface. Road runoff is eroding sides of road into lake	$4,083.00	$4,083.00	$4,083.00	$2,014.47	
Town of Lunenburg	2008		Tobyne Rd. - Water washes road bc of steep banks on road's sides & narrow road	$7,000.00	$7,000.00	$7,000.00	$6,679.76	$7,000.00
Town of Lunenburg	2008		East Concord Rd. - Water stands in ditch, cannot drain to culverts	$7,000.00	$7,000.00	$6,691.99	$1,673.00	$6,691.99
Town of Lyndon	2008		Brown Farm Rd. - Ongoing erosion of hwy due to steep incline& no ditch to carry waterinto wetland area downgrade	$4,870.00	$4,870.00	$4,870.00	$10,784.81	
Town of Lyndon	2008		Sheldon Brook Rd. - Ongoing washouts & erosion as Sheldon Brook is w/in 10' of edge of hwy	$3,486.50	$3,486.50	$3,486.50	$1,735.26	$3,486.50
Town of Middlesex	2008		Center Rd. - Steep grade, fast water flow, ditches have clay base, heavy erosion	$6,650.00	$6,650.00	$6,650.00	$3,594.84	$6,650.00
Town of Morgan	2008		Wayeeses Rd. - erosion of road surface & ditch along steep hill of road, eroding into stream	$7,000.00	$7,000.00	$7,000.00	$1,923.07	$7,000.00
Town of New Haven	2008		Sumner Rd. - Erosion along road shoulder on s side of road	$15,165.00	$7,000.00	$7,000.00	$2,769.19	$7,000.00
Town of New Haven	2008		Dog Team Rd. - erosion along road shoulder occurs during periods of heavy runoff	$23,190.00	$7,000.00	$7,000.00	$13,432.95	$7,000.00
Town of Pawlet	2008		Higo Rd. - runoffs into small brook	$7,000.00	$7,000.00	$7,000.00	$14,947.55	
Town of Plainfield	2008		Middle Rd. - Inadequate road drainage ditching resulting in increased road shoulder erosion & frequent washouts	$7,000.00	$7,000.00	$7,000.00	$4,123.45	$7,000.00
Town of Plainfield	2008		Lower Rd. - Inadequate road drainage ditching resulting in increased road shoulder erosion & frequent washouts	$7,000.00	$7,000.00	$7,000.00	$5,094.34	$7,000.00
Town of Richford	2008		Weightman Hill Rd. (TH 41) - constant ditch & road edge erosion	$7,000.00	$7,000.00	$7,000.00	$12,994.66	$7,000.00
Town of Ripton	2008		Wagon Wheel Rd. - Ditch is slumped in & 2 culverts are failing	$7,000.00	$7,000.00	$7,000.00	$2,909.40	$7,000.00

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Eden		2009		
Town of Elmore		2009		
Town of Enosburgh		2009		
Town of Fairfax		2009		
Town of Fairfield		2009		
Town of Fairlee		2009		
Town of Fletcher		2009		
Town of Fletcher		2009		
Town of Glover		2009		
Town of Grafton		2009		
Town of Hyde Park		2009		
Town of Isle LaMotte		2009		
Town of Jericho		2009		
Town of Johnson		2009		
Town of Lincoln		2009		
Town of Ludlow		2009		
Town of Lunenburg		2009		
Town of Lunenburg		2009		
Town of Lyndon		2009		
Town of Lyndon		2009		
Town of Middlesex		2009		
Town of Morgan		2009		
Town of New Haven		2009		
Town of New Haven		2009		
Town of Pawlet		2009		
Town of Plainfield		2009		
Town of Plainfield		2009		
Town of Richford		2009		
Town of Ripton		2009		

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Shaftsbury	2008		White Creek Rd. - Cold Spring Brook is washing streambank on White Creek road mainly under high water conditions	$4,695.00	$4,695.00	$2,749.44	$687.60	$2,749.44
Town of Sheldon	2008		Kittell Rd. - Runoff water washign out ditch	$7,000.00	$7,000.00	$7,000.00	$4,080.48	$7,000.00
Town of Underhill	2008		Stevensville Rd. - No drainage ditches but have culverts that are always plugged	$5,338.00	$5,338.00	$5,338.00	$4,341.00	$5,338.00
Town of Walden	2008		Bailey Hazen Rd. - poorly formed & unlined ditches on very steep road causes erosion, sedimentation, plugged culverts road washouts	$7,000.00	$7,000.00	$7,000.00	$7,841.95	
Town of Walden	2008		Cobb Rd.	$7,000.00	$7,000.00	$7,000.00	$3,208.62	$7,000.00
Town of Wallingford	2008		Seward Hill Rd. - road washes out 2-3 times/yr due to poor drainage	$924.21	$924.21	$924.21	$796.15	$924.21
Town of Wallingford	2008		Sugar Hill Rd. - Sediment erosion of roda due to poor drainage. Sediment is filling in pools in the river.	$4,017.60	$4,017.60	$4,017.60	$1,594.51	$4,017.60
Town of Warren	2008		Dump Rd has been a major erosin source w/associated mateiral loss & river siltation problem	$7,000.00	$7,000.00	$7,000.00	$3,280.00	
Town of Waterbury	2008		Ring Rd. - Inadequate culverts pone to clogging w/debris	$7,000.00	$7,000.00	$7,000.00	$3,452.65	$7,000.00
Town of West Haven	2008		Coggman Rd. - Eroded bank - 60 linear feet	$10,000.00	$7,000.00	$6,945.52	$1,736.38	$6,945.52
Town of West Windsor	2008		Sheddsville Rd. - Significant erosion of 120' section of roadbank on Sheddsville Road	$7,000.00	$7,000.00	$7,000.00	$8,428.47	$7,000.00
Town of Westford	2008		Seymour Rd. - stream cut away bank & washout road	$3,000.00	$3,000.00	$3,000.00	$838.21	$3,000.00
Town of Whitingham	2008		Fuller Hill Proj-9 culverts in need of replacement	$7,000.00	$7,000.00	$7,000.00	$9,613.60	
Town of Williamstown	2008		McGlynn Rd. - Stonefill & stabilize ditches, arour streambank, replace & increase diameter of culvert	$6,021.00	$6,021.00	$6,021.00	$3,233.19	$6,021.00
Town of Windsor	2008		Weeden Hill Rd. - Creek (brook) bank erosion encroaching into roadway	$7,000.00	$7,000.00	$7,000.00	$10,876.06	$7,000.00
UVM Extension Lake Champlain Sea Grant and Condo Association	2008		Milton Falls Court Condominium Rain Garden Project	$6,138.00	$6,138.00	$4,091.16	$1,363.72	
Woodford Lake Estates	2008		"Talking Tree Lane" - Stabilizing banks, ditch excavation, road resurfacing, culvert replacement	$7,000.00	$7,000.00	$7,000.00	$6,091.00	
Campers Lane Road Committee and Road Fund	2009		Campers Lane - Culverts	$10,000.00	$10,000.00	$10,000.00		$10,000.00
City of South Burlington	2009		National Guard Avenue Slope stabilization project	$7,000.00	$7,000.00	$7,000.00		$7,000.00
Maidstone Lake Association	2009		West Side Rd - Culverts, Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Belvidere	2009		Bog Project- priority #1	$9,445.00	$9,445.00	$7,320.38		$7,320.38
Town of Bloomfield	2009		Spencer Hill Rd. - Culvert, Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Calais	2009		Sadie Foss Rd. - Ditching	$6,100.00	$6,100.00	$6,100.00		$6,100.00
Town of Cambridge	2009		Burnor Road	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Charleston and Echo Lake Protective Assoc.	2009		Church Hill Rd. - Culverts, Ditching, Plunge Pools	$9,000.00	$9,000.00	$9,000.00		$9,000.00
Town of Corinth	2009		Cookeville Road Drainage Improvements	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Cornwall	2009		Sperry Road/ Beaver Brook	$3,600.00	$3,600.00	$3,600.00		$3,600.00
Town of Danville	2009		Kittridge Rd. - Streambank Stabilization and Culvert	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Eden	2009		Mary Deuso Road drainage and erosion control	$7,000.00	$7,000.00	$7,000.00		$7,000.00
Town of Enosburg	2009		Perley Road project	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Essex	2009		Osgood Hill Rd. - Ditching	$9,375.00	$9,375.00	$9,375.00		$9,375.00
Town of Franklin and Franklin Watershed Committee	2009		Swamp Rd. - Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Glover	2009		Shadow Lake, Mud Island culvert and ditching upgrade	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Grafton	2009		Anderson Road stone lined ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Hyde Park	2009		Garfield Rd. - Culverts	$8,802.00	$8,802.00	$8,802.00		$8,802.00
Town of Ira	2009		Cross Road brook erosion	$5,100.00	$5,100.00	$5,100.00		$5,100.00
Town of Ludlow	2009		East Lake Road- south side	$6,285.00	$6,285.00	$5,303.98		$5,303.98
Town of New Haven	2009		River Road ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Newport and Memphremagog Watershed Association	2009		Vance Hill road culvert and ditching project	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Orange	2009		Richardson Road- East priority #1	$10,000.00	$10,000.00	$10,000.00		$10,000.00

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Shaftsbury		2009		
Town of Sheldon		2009		
Town of Underhill		2009		
Town of Walden		2009		
Town of Walden		2009		
Town of Wallingford		2009		
Town of Wallingford		2009		
Town of Warren		2009		
Town of Waterbury		2009		
Town of West Haven		2009		
Town of West Windsor		2009		
Town of Westford		2009		
Town of Whitingham		2009		
Town of Williamstown		2009		
Town of Windsor		2009		
UVM Extension Lake Champlain Sea Grant and Condo Association		2009		
Woodford Lake Estates		2009		
Campers Lane Road Committee and Road Fund		2010		ANR Grant
City of South Burlington		2010		
Maidstone Lake Association		2010		ANR Grant
Town of Belvidere		2010		
Town of Bloomfield		2010		
Town of Calais		2010		
Town of Cambridge		2010		
Town of Charleston and Echo Lake Protective Assoc.		2010		
Town of Corinth		2010		
Town of Cornwall		2010		
Town of Danville		2010		
Town of Eden		2010		
Town of Enosburg		2010		
Town of Essex		2010		
Town of Franklin and Franklin Watershed Committee		2010		
Town of Glover		2010		
Town of Grafton		2010		
Town of Hyde Park		2010		
Town of Ira		2010		
Town of Ludlow		2010		
Town of New Haven		2010		
Town of Newport and Memphremagog Watershed Association		2010		
Town of Orange		2010		

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Orwell	2009		Chipmans Point	$9,000.00	$9,000.00	$9,000.00		$9,000.00
Town of Panton	2009		Panton Rd. - Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Pawlet	2009		Clark Road TH7	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Peacham	2009		Great Road Hill culverts	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Randolph	2009		North Randolph Road Bank Stabilization Phase 1	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Richford	2009		Prive Hill Rd. - Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Richmond	2009		Kenyon Road ditch stabilization project- priority 1	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Ripton	2009		Pearl Lee Road	$10,000.00	$10,000.00	$9,906.03		$9,906.03
Town of Rochester	2009		Jct. of Marine Hill Rd. and Maple Hill Rd. - Ditching	$10,000.00	$10,000.00	$5,118.22		$5,118.22
Town of Ryegate	2009		Ticklenaked Pond Road	$2,205.00	$2,205.00	$2,195.80		$2,195.80
Town of Sheldon	2009		Kittell Rd. - Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Shoreham	2009		Jenison Rd.	$6,990.00	$6,990.00	$6,990.00		$6,990.00
Town of St. Albans	2009		French Hill Rd. - Culvert	$6,244.00	$6,244.00	$5,940.32		$5,940.32
Town of Stamford	2009		Silt-free in Stamford! Priority 1	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Topsham	2009		Pike Hill Road ditch project	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Walden	2009		Upper Keene Road priority #1	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Wallingford	2009		Elfin Lake Beach Road erosion control	$2,150.39	$2,150.39	$2,150.39		$2,150.39
Town of Waterbury	2009		Lincoln Street construct/rehab retaining wall/riprap project	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Wells	2009		Endless Brook stabilization and wq improvement project	$10,000.00	$10,000.00	$8,554.75		$8,554.75
Town of West Windsor	2009		Brook Road bank stabilization	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Westford	2009		Pettengill Road 2010	$10,000.00	$10,000.00	$5,640.49		$5,640.49
Town of Westmore	2009		Long Pond Road TH15 erosion control project	$8,500.00	$8,500.00	$8,500.00		$8,500.00
Town of Wheelock	2009		Burroughs Rd. - Culvert, Ditching	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Williamstown	2009		Baptist Street erosion and sediment control	$10,000.00	$10,000.00	$10,000.00		$10,000.00
Town of Woodstock	2009		Peterkin Hill erosion prevention project	$9,000.00	$9,000.00	$9,000.00		$9,000.00
Unified Towns and Gores of Essex County	2009		Cottage Rd. - Raise Road Height and Ditching	$6,748.88	$6,748.88	$5,087.62		$5,087.62
Campers Lane Road Committee	2010		Campers Lane Road Committee and Fund	$10,000.00		$10,000.00	$10,000.00	
Lake Fairlee Association	2010		Robinson Hill Rd.	$1,909.75		$1,909.75	$1,909.75	
Lake Iroquois Association	2010		Lake Iroquois ErosionProblem Project	$8,350.00		$7,980.00	$7,980.00	
Old Cottage Lane,Inc	2010		Old Cottage Lane Erosion Control	$8,240.25		$8,240.25	$8,240.25	
Town of Arlington	2010		Maple Hill Ditch Job # 2	$4,094.10		$4,094.10	$4,449.61	
Town of Barre	2010		Lyman Rd /Cutler Corner	$10,000.00		Completed by 7/1/13		
Town of Benson	2010		Roadside Erosion/silting into waterways	$10,000.00		$10,000.00	$15,873.25	
Town of Bethel	2010		North Main Street Storm Outfall	$6,200		$4,767.28	$1,191.82	
Town of Brandon	2010		Wheeler Road (TH 15) Shoulder Stabbilization	$7,000.00		$7,000.00	$12,831.22	
Town of Bridport	2010		Middle Rd Ditch Project	$8,791.20		$6,888.16	$1,722.04	
Town of Brighton	2010		Lakeshore Drive Project	$9,723.80		$8,874.51	$2,218.63	
Town of Charlston-E. L. P. A	2010		Dane Hill Rd	$10,000.00		$10,000.00	$3,670.00	
Town of Chelsea	2010		Williamstown Rd	$2,450.00		$2,450.00	$1,613.71	
Town of Danville	2010		Walden Hill Rd-Chase Brook Erosion project	$10,000.00		$10,000.00	$26,700.00	
Town of Dorset	2010		Dorset Culvert Project	$6,427.20		$6,427.20	$4,511.59	
Town of Eden	2010		Boomhower Brook,Phase 2	$10,000.00		$10,000.00	$9,972.48	
Town of Fairfield	2010		Ryan Road-cross culvert-stone line ditch	$10,000.00		$10,000.00	$7,641.97	
Town of Franklin	2010		Dewing Shore Rd-stablization	$10,000.00		$10,000.00	$4,540.87	
Town of Greensboro	2010		Ditch Stabilization Project	$10,000.00		$10,000.00	$8,328.70	
Town of Hubbardton	2010		Black Pond Bank Stabilization	$8,250.00		$8,250.00	$4,929.12	
Town of Huntington #2 Priority	2010		Moody Road-Huntington	$10,000.00		$10,000.00	$5,170.28	
Town of Isle La Motte	2010		East Shore Road	$10,000.00		$3,694.98	$923.75	
Town of Lincoln	2010		Elder Hill Rd - Priority #1	$10,000.00		$10,000.00	$8,592.43	
Town of Ludlow	2010		Ellisons Lake Rd-South End	$8,810.00		$8,810.00	$2,447.04	
Town of North Hero	2010		South End Road embankment erosion	$9,896.00		$9,896.00	$2,589.14	
Town of Plainfield	2010		Middle Road-Road Drainage.	$10,000.00		$10,000.00	$5,455.48	
Town of Richmond	2010		Stage Rd Ditch and Siltration stabililzation	$9,356.66		$9,356.66	$8,073.36	
Town of Ryegate	2010		Whitehill Road Project	$8,643.75		$8,643.75	$5,155.56	

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Orwell		2010		
Town of Panton		2010		
Town of Pawlet		2010		
Town of Peacham		2010		
Town of Randolph		2010		
Town of Richford		2010		
Town of Richmond		2010		
Town of Ripton		2010		
Town of Rochester		2010		
Town of Ryegate		2010		
Town of Sheldon		2010		
Town of Shoreham		2010		
Town of St. Albans		2010		
Town of Stamford		2010		
Town of Topsham		2010		
Town of Walden		2010		
Town of Wallingford		2010		
Town of Waterbury		2010		
Town of Wells		2010		
Town of West Windsor		2010		
Town of Westford		2010		
Town of Westmore		2010		
Town of Wheelock		2010		
Town of Williamstown		2010		
Town of Woodstock		2010		
Unified Towns and Gores of Essex County		2010		
Campers Lane Road Committee		2011		$3,568.00
Lake Fairlee Association		2011		$1,946.43
Lake Iroquois Association		2011		$2,660.00
Old Cottage Lane,Inc		2011		$5,011.75
Town of Arlington		2011		Federal Highway Funded Project
Town of Barre		2011		Federal Highway Funded Project
Town of Benson		2011		State Funded Project
Town of Bethel		2011		Federal Highway Funded Project
Town of Brandon		2011		State Funded Project
Town of Bridport		2011		Federal Highway Funded Project
Town of Brighton		2011		Federal Highway Funded Project
Town of Charlston-E. L. P. A		2011		Federal Highway Funded Project
Town of Chelsea		2011		Federal Highway Funded Project
Town of Danville		2011		Federal Highway Funded Project
Town of Dorset		2011		Federal Highway Funded Project
Town of Eden		2011		Federal Highway Funded Project
Town of Fairfield		2011		State Funded Project
Town of Franklin		2011		Federal Highway Funded Project
Town of Greensboro		2011		Federal Highway Funded Project
Town of Hubbardton		2011		Federal Highway Funded Project
Town of Huntington #2 Priority		2011		Federal Highway Funded Project
Town of Isle La Motte		2011		State Funded Project
Town of Lincoln		2011		Federal Highway Funded Project
Town of Ludlow		2011		Federal Highway Funded Project
Town of North Hero		2011		State Funded Project
Town of Plainfield		2011		Federal Highway Funded Project
Town of Richmond		2011		Federal Highway Funded Project
Town of Ryegate		2011		State Funded Project

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Shoreham	2010		T H #1 Richville Road Ditch Project	$10,000.00		$10,000.00	$4,364.09	
Town of Stamford	2010		Water control on Bouldger	$9,480.00		$4,692.29	$1,173.07	
Town of Starksboro	2010		Russell Young Rd, Project	$10,000.00		$10,000.00	$5,111.02	
Town of Strafford	2010		Van Dyke TH#11 Erosion Control	$4,562.00		$4,562.00	$1,482.80	
Town of Underhill	2010		Stevensville Rd Project,Phase 2	$7,045.23		$7,045.23	$6,627.51	
Town of Walden	2010		Upper Cahoon Farm Road priority #2	$10,000.00		$10,000.00	$3,991.98	
Town of Warren	2010		Fuller Hill Road	$10,000.00		$10,000.00	$18,529.30	
Town of West Windsor	2010		Beaver Brook/Sheddsville Road Stabilization	$10,000.00		$10,000.00	$8,344.11	
Town of Westford	2010		Old #11 Road Ditch Stabilization	$10,000.00		$8,145.10	$2,036.28	
Town of Westmore	2010		Long Pond Road TH15 erosion control project	$10,000.00		$10,000.00	$21,666.99	
Town of Wheelock	2010		Blakely Road Ditch Project	$10,000.00		$10,000.00	$3,417.60	
Town of Whitingham	2010		Sadawga Lake Road Project	$10,000.00		$10,000.00	$4,661.80	
UTG of Essex County	2010		Cottage Rd.	$5,378.44		$5,296.42	$1,324.11	
UTG of Essex County	2010		Canaan Hill Rd.	$2,179.65		$2,179.65	$1,174.08	
Campers Lane	2011		Campers Lane	$10,000.00	$8,290.00	$8,290.00	$3,000.50	
Lake Fairlee Ass.	2011		Bank Stabilization, Robinson Hill Road	$10,000.00	$8,000.00	$8,000.00	$1,150.32	
Lake Rescue Assoc.	2011		Archibald Lane	$4,830.00	$4,830.00	$4,830.00	$2,195.48	
Town of Barre	2011		Taplin Road	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Benson	2011		Mill Pond Road	$10,000.00	$10,000.00	$10,000.00	$5,512.35	
Town of Bridport	2011		Town Line Ditch Erosion	$10,000.00	$10,000.00	$10,000.00	$3,710.16	
Town of Calais	2011		Ballantine Road	$8,120.00	$9,952.00	$9,952.00	$4,899.93	
Town of Cambridge	2011		Sunny Acres Road	$10,000.00	$10,000.00	$10,000.00	$3,353.85	
Town of Clarendon	2011		South Creek Road	$10,000.00	$10,000.00	$10,000.00	$9,053.18	
Town of Corinth	2011		Cookville Road Ditch	$10,000.00	$10,000.00	$10,000.00	$4,218.70	
Town of Eden	2011		Boomhover Brook,Phase 3	$10,000.00	$10,000.00	$10,000.00	$5,688.02	
Town of Enosburgh	2011		Duffy Hill Project	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Fairfield	2011		Pumkin Village Road	$10,000.00	$10,000.00	$10,000.00	$6,670.97	
Town of Fairlee	2011		Lake Morey Road Erosion	$7,477.50	$7,976.00	$4,299.66	$1,074.92	
Town of Georgia	2011		Mill River-Mass Failure	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Hubbardton	2011		Black Pond Bank Stabilization	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Johnson	2011		Drainage system replacement	$10,000.00	$10,000.00	Completed by 12/15/13		

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Shoreham		2011		State Funded Project
Town of Stamford		2011		Federal Highway Funded Project
Town of Starksboro		2011		Federal Highway Funded Project
Town of Strafford		2011		Federal Highway Funded Project
Town of Underhill		2011		Federal Highway Funded Project
Town of Walden		2011		Federal Highway Funded Project
Town of Warren		2011		State Funded Project
Town of West Windsor		2011		State Funded Project
Town of Westford		2011		Federal Highway Funded Project
Town of Westmore		2011		Federal Highway Funded Project
Town of Wheelock		2011		Federal Highway Funded Project
Town of Whitingham		2011		Federal Highway Funded Project
UTG of Essex County		2011		Federal Highway Funded Project
UTG of Essex County		2011		Federal Highway Funded Project
Campers Lane		2012		State DEC Funded - Private
Lake Fairlee Ass.		2012		State DEC Funded - Private
Lake Rescue Assoc.		2012		State DEC Funded - Private
Town of Barre		2012		Federal Funded
Town of Benson		2012		Federal Funded
Town of Bridport		2012		Federal Funded
Town of Calais		2012		Federal Funded
Town of Cambridge		2012		Federal Funded
Town of Clarendon		2012		State Funded
Town of Corinth		2012		State Funded
Town of Eden		2012		Federal Funded
Town of Enosburgh		2012		Federal Funded
Town of Fairfield		2012		State Funded
Town of Fairlee		2012		State Funded
Town of Georgia		2012		Federal Funded
Town of Hubbardton		2012		Federal Funded
Town of Johnson		2012		Federal Funded

Appendix 1
Category B Better Backroads Projects
2004 - September 2013

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Town of Kirby	2011		Mud Hollow-Stone Line Ditch	$6,326.74	$6,748.52	Completed by 12/15/13		
Town of Lyndon	2011		Vail Hill Drainage	$5,592.00	$5,965.60	$5,916.72	$1,479.18	
Town of North Hero	2011		South End Road	$10,000.00	$10,000.00	$10,000.00	$7,181.56	
Town of Orange	2011		Stone line Prechtl Road	$10,000.00	$10,000.00	$6,999.58	$1,749.90	
Town of Panton	2011		West Road TH.#14	$10,000.00	$10,000.00	$10,000.00	$6,218.81	
Town of Pawlet	2011		Rafter Road Stabilization Project	$10,000.00	$10,000.00	$10,000.00	$3,511.98	
Town of Ripton	2011		Culvert Replacement	$8,250.00	$8,800.00	$8,800.00	$4,587.22	
Town of Ryegate	2011		North Bay-Hazen Roadley	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Sheldon	2011		TH #17 Swamp Road	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Shoreham	2011		Lake Street Erosion Action	$3,535.00	$3,768.00	$3,768.00	$1,102.00	
Town of Topsham	2011		Lime Kiln Road	$4,000.00	$10,000.00	Completed by 12/15/13		
Town of Topsham	2011		Galusha Hill Road	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Topsham	2011		Kimball Hill Road	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Walden	2011		Upper Cahoon Road	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Wells	2011		Western Shore Road	$3,776.40	$4,028.17	$3,621.18	$905.29	
Town of West Windsor	2011		Beaver Brook/Shedsville RD Bank Stabilization	$10,000.00	$10,000.00	$10,000.00	$8,476.55	
Town of Westmore	2011		Long Pond Road Erosion	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Wheelock	2011		Vertical Mile Ditch Project	$10,000.00	$10,000.00	$10,000.00	$3,612.00	
Town of Williston	2011		Avenue C&D Bank Erosion	$10,000.00	$10,000.00	Completed by 12/15/13		
Town of Wolcott	2011		Sand Hill Road	$10,000.00	$10,000.00	$7,824.84	$1,956.21	
UTG of Essex County	2011		Erosion on Cannan Hill and Cottage Rd	$9,688.29	$10,000.00	Completed by 12/15/13		
Woodford Lake Assoc.	2011		Road Ditching Project	$7,380.00	$7,380.00	$7,380.00	$2,534.60	
Total Number of Sites	375				$2,273,677.48	$2,356,005.79	$2,176,396.39	
Total Number of Completed Projects 2004	30				$178,347.00	$169,603.45	$295,583.55	$0.00
Total Number of Forfeited Projects	2							
Total Number of Denied Projects	18							
Total Number of Completed Projects 2005	53				$ 317,547.10	$ 292,422.58	$ 329,107.72	$ 241,095.91
Total Number of Forfeited Projects 2005	5							
Total Number of Denied Projects 2005	3							
Total Number of Completed Projects 2006	53				$310,011.78	$298,391.81	$313,374.40	$255,394.01
Total Number of Forfeited Projects 2006	8							
Total Number of Denied Projects 2006	2							
Total Number of Completed Projects 2007	51				$314,417.73	$299,981.10	$519,380.78	$222,913.62
Total Number of Forfeited Projects 2007	4							
Total Number of Denied Projects 2007	0							
Total Number of Completed Projects 2008	58				$365,070.31	$350,036.56	$364,469.47	$254,545.50
Total Number of Forfeited Projects 2008	2							
Total Number of Denied Projects 2008	0							
Total Number of Completed Projects 2009	49				$432,545.27	$416,684.98	$0.00	$416,684.98
Total Number of Forfeited Projects 2009	4							
Total Number of Denied Projects 2009	0							
Total Number of Completed Projects 2010	42				$0.00	$329,203.33	$260,636.79	$0.00
Total Number of Forfeited Projects 2010	7							
Total Number of Denied Projects 2010	1							
Total Number of Completed Projects 2011	39				$355,738.29	$199,681.98	$93,843.68	$0.00
Total Number of Forfeited Projects 2011	4							
Total Number of Denied Projects 2011	0							
Total Number of Completed Projects	375				$2,273,677.48	$2,356,005.79	$2,176,396.39	$1,390,634.02
Total Number of Forfeited Projects	36							
Total Number of Denied Projects	24							

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Town of Kirby		2012		State Funded
Town of Lyndon		2012		State Funded
Town of North Hero		2012		State Funded
Town of Orange		2012		State Funded
Town of Panton		2012		Federal Funded
Town of Pawlet		2012		Federal Funded
Town of Ripton		2012		State Funded
Town of Ryegate		2012		Federal Funded
Town of Sheldon		2012		Federal Funded
Town of Shoreham		2012		State Funded
Town of Topsham		2012		Federal Funded
Town of Topsham		2012		Federal Funded
Town of Topsham		2012		Federal Funded
Town of Walden		2012		Federal Funded
Town of Wells		2012		State Funded
Town of West Windsor		2012		Federal Funded
Town of Westmore		2012		State Funded
Town of Wheelock		2012		Federal Funded
Town of Williston		2012		State Funded
Town of Wolcott		2012		Federal Funded
UTG of Essex County		2012		Federal Funded
Woodford Lake Assoc.		2012		State DEC Funded - Private
Total Number of Sites				
Total Number of Completed Projects 2004				
Total Number of Forfeited Projects				
Total Number of Denied Projects				
Total Number of Completed Projects 2005				
Total Number of Forfeited Projects 2005				
Total Number of Denied Projects 2005				
Total Number of Completed Projects 2006				
Total Number of Forfeited Projects 2006				
Total Number of Denied Projects 2006				
Total Number of Completed Projects 2007				
Total Number of Forfeited Projects 2007				
Total Number of Denied Projects 2007				
Total Number of Completed Projects 2008				
Total Number of Forfeited Projects 2008				
Total Number of Denied Projects 2008				
Total Number of Completed Projects 2009				
Total Number of Forfeited Projects 2009				
Total Number of Denied Projects 2009				
Total Number of Completed Projects 2010				
Total Number of Forfeited Projects 2010				
Total Number of Denied Projects 2010				
Total Number of Completed Projects 2011				
Total Number of Forfeited Projects 2011				
Total Number of Denied Projects 2011				
Total Number of Completed Projects				
Total Number of Forfeited Projects				
Total Number of Denied Projects				

Appendix 1
Category B Better Backroads Projects
2004 - September 2013

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
Forfeited	36							
town of topsham	2004		WILLEY HILL ROAD RIVERBANK EROSION	$3,750.00	Forfeit	Forfeit		1
Bradford Town Highway	2004		WRIGHTS MOUNTAIN ROAD - DITCH EROSION	$3,918.00	Forfeit	Forfeit		1
town of huntington	2005		LINCOLN HILL RD. (TH18) - CULVERT REPLACEMENT AND INCREASE NUMBER ALSO DITCH WORK.	$7,000.00	Forfeit	Forfeit		
town of plainfield	2005		COVEY SITE ON FOWLER RD - EROSION OF BANK	$ 4,000.00	Forfeit	Forfeit		
Town of Rockingham	2005		PARKER HILL BANK EROSION - DITCH	$ 7,000.00	Forfeit	Forfeit		
Town of Royalton	2005		SA6 ROYALTON HILL WATER TURNOUTS - DITCH EROSION	$ 3,000.00	Forfeit	Forfeit		
town of walden	2005		BAILEY HAZENS ROAD EROSION CONTROL PROJECT	$ 7,000.00	Forfeit	Forfeit		
City of Montpelier	2006		Hubbard Park Road	$6,305.00	Forfeit	Forfeit	Forfeit	
City of S. Burlington	2006		Airport Parkway Drainage Repair	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Bennington	2006		River Road Proj - streambank erosion	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Bolton	2006		Mountain View Drive Proj-bank & roadbed erosion	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Brandon	2006		Wheeler Road East Shoulder Ditching	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Danville	2006		Morrill Road Erosion Proj	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Greensboro	2006		Ditch Stabilization Proj - inadequate ditch	$7,000.00	Forfeit	Forfeit	Forfeit	
Town of Stowe	2006		Lower Sanborn Road Erosion Control Proj	$6,998.00	Forfeit	Forfeit	Forfeit	
Town of Leicester	2007		Old Jerusalem Rd Stab Proj - shoulders crumbling & falling into Otter Creek	$7,000.00	Forfeit	Forfeit		
Town of Randolph	2007		N Randolph Rd Bank tabilization - stream severely incised & the stream bank is eording in several areas	$7,000.00	Forfeit	Forfeit		
Town of Stratton	2007		Pike Falls Rd.	$4,540.12	Forfeit	Forfeit		
Town of Swanton (SEP Funds)	2007		Woods Hill Rd.	$7,000.00	Forfeit	Forfeit		
Campers Lane Rd. Fund	2008		Campers Lane - Road Maintenance Proj.	$7,000.00	Forfeit	Forfeit		
Seymour East Assn.	2008		Soil erosion on Seymour East & McCleay Rds due to rainfall making hill nearly impossible	$900.00	Forfeit	Forfeit		
Town of Brownington	2009		TH#4 culverts beaver problem prevention	$2,970.00	Forfeit			
Town of Georgia	2009		Mill River mass failure- Georgia Shore Road	$10,000.00	Forfeit			
Town of Moretown	2009		Lovers Lane slope failure- priority 1	$2,678.00	Forfeit			
Town of West Haven	2009		Upper River Road erosion project priority #1	$10,000.00	Forfeit			
Town of Belvidere	2010		Florence Road ,Erosion issues		Forfeited			
Town of Bolton	2010		Bolton Notch Road Project		Forfeited			
Town of Moretown	2010		Lovers Lane, Bank stabilization site #7	$4,879.80		Forfeited		
Town of Peacham	2010		Slack Street-Inventory/Capital Plan	$10,000.00		Forfeited		
Town of Randolph	2010		Tatro Hill and Seymour RD	$10,000.00		Forfeited		
Town of West Haven	2010		Lower River Road erosion project priority #2	$10,000.00		Forfeited		
Town of Windsor	2010		Brook Rd.Bank Stabilization	$9,996.00		Forfeited		
Town of Huntington	2011		Camels Hump Lane	$10,000.00	$10,000.00	Forfeit		
Town of New Haven	2011		Lime Kiln Drainage	$10,000.00	$10,000.00	Forfeit		
Town of New Haven	2011		Quarry Road Drainage	$10,000.00	$10,000.00	Forfeit		
Town of West Haven	2011		Lower River Road	$10,000.00	$10,000.00	Forfeit		
2004				$3,750.00				
2005				$24,918.00				
2006				$55,305.00				
2007				$25,538.12				
2008				$14,000.00				
2009				$16,548.00				
2011				$10,000.00				
2012								

Appendix 1
Category B Better Backroads Projects
2004 - September 2013

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
Forfeited				
town of topsham				
Bradford Town Highway				
town of huntington	2006	06GR002		
town of plainfield	2006	06GR002		
Town of Rockingham	2006	06GR002		
Town of Royalton	2006	06GR002		
town of walden	2006	06GR002		
City of Montpelier	2007 or 2008	07GR011 or 08GR012		
City of S. Burlington	2007 or 2008	07GR011 or 08GR012		
Town of Bennington	2007 or 2008	07GR011 or 08GR012		
Town of Bolton	2007 or 2008	07GR011 or 08GR012		
Town of Brandon	2007	07GR011		
Town of Danville	2007	07GR011		
Town of Greensboro	2007	07GR011		
Town of Stowe	2007 or 2008	07GR011 or 08GR012		
Town of Leicester	2008	08GR012		
Town of Randolph	2008	08GR012		
Town of Stratton	2008	08GR012		
Town of Swanton (SEP Funds)				
Campers Lane Rd. Fund	2009			
Seymour East Assn.	2009			
Town of Brownington	2010			
Town of Georgia	2010			
Town of Moretown	2010			
Town of West Haven	2010			
Town of Belvidere	2011		Federal Highway Funded Project	
Town of Bolton	2011		Federal Highway Funded Project	
Town of Moretown		2011		Federal Highway Funded Project
Town of Peacham		2011		Federal Highway Funded Project
Town of Randolph		2011		State Funded Project, Complete this Summer, ok
Town of West Haven		2011		State Funded Project
Town of Windsor		2011		State Funded Project
Town of Huntington		2012		Federal Funded
Town of New Haven		2012		Federal Funded
Town of New Haven		2012		Federal Funded
Town of West Haven		2012		Federal Funded
2004				
2005				
2006				
2007				
2008				
2009				
2011				
2012				

ORGANIZATION	APPLICATION YEAR	SENT DEINIED LETTER	PROJECT NAME & DESCRIPTION	AMOUNT REQ	Amount Awarded	Amount Paid	Match Provided	Reimb. VTrans
DENIED	24							
bragg road committee	2004	Y	BRAGG ROAD IMPROVEMENT - CULVERTS & DITCHING	$4,000.00	$0.00			
sunrise/sunset lake-perch pond assn	2004	Y	PERCH POND ROAD SHOTGUN COVE EROSION CONTROL	$3,000.00	$0.00			
town of barton highway dept.	2004	Y	BURTON HILL DRAINAGE	$1,347.68	$0.00			
town of brighton	2004	Y	MEADOW STREET REPLACE CULVERTS	$1,350.00	$0.00			
town of castleton	2004	Y	BELGO RD & GRANDPA'S KNOB SPLASH - ERODING CULVERT	$5,154.90	$0.00			
town of jay	2004	Y	JAY BETTER BACKRDS PROGRAM-ERODING ROADS & DITCHES	$7,000.00	$0.00			
town of northfield	2004		WATER STREET - ROADWAY/STREAMBANK STABILIZATION	$4,500.00	$0.00			
town of plainfield	2004	Y	COVEY SITE ON FOWLER ROAD - BANK EROSION	$7,000.00	$0.00			
town of pomfret	2004	Y	STAGE RD. SLOPE STABILIZATION	$5,000.00	$0.00			
town of stratton	2004	Y	CANEDY HILL ROAD - STONELINE DITCH AND SLOPE BANKS	$4,269.00	$0.00			
town of troy	2004	Y	RIVER ROAD EROSION	$18,750.00	$0.00			
town of wallingford	2004	Y	TOWN OF WALLINGFORD PROJECT #2 - DRAINGE, CULVERT	$7,000.00	$0.00			
town of wallingford	2004	Y	TOWN OF WALLINGFORD PROJECT #1 - REMOVAL OF LEDGE	$4,000.00	$0.00			
town of wardsboro	2004	Y	BOB LAT ROAD DITCH LINING	$1,875.00	$0.00			
town of west windsor	2004	Y	BANK STABILIZATION ON SHEDDSVILLE ROAD	$6,500.00	$0.00			
town of williamstown	2004	Y	WIER ROAD - REPLACE CULVERT	$2,176.00	$0.00			
town of williamstown	2004	Y	BAPTIST STREET CULVERT	$2,176.00	$0.00			
woodford lake estates, inc.	2004	Y	ENTRANCE CULVERT REPLACEMENT (EVERGREEN LANE)	$7,000.00	$0.00			
berlin conservation commission	2005		DARLING HILL & BLACK ROAD - EROSION	$1,775.00	$ -			
town of fairfax	2005		COMETTE ROAD/DITCH EROSION CONTROL	$7,000.00	$ -			
town of fletcher	2005		RUGG ROAD - RUN OFF - ERODING FIELDS	$7,000.00	$ -			
Barton Village Inc	2006		Barton Village Ballfield Erosion Control	$7,000.00	$0.00	$0.00	$0.00	
Town of Grand Isle	2006		Repair Cracked Cement TH9 Lakeshore Bank Stab	$7,000.00	$0.00	$0.00	$0.00	
Orleans County-NRCD	2010		Big Rock Road on Seymour Lake	$10,000.00				

Appendix 1
Category B Better Backroads Projects
2004 - September 2013

ORGANIZATION	# OF PREV AWARDS	Fiscal Year	Contract #	Notes
DENIED				
bragg road committee	1			
sunrise/sunset lake-perch pond assn	1			
town of barton highway dept.	0			
town of brighton	0			
town of castleton	1			
town of jay	0			
town of northfield	1			
town of plainfield	0			
town of pomfret	3			
town of stratton	0			
town of troy	0			
town of wallingford	1			
town of wallingford	1			
town of wardsboro	0			
town of west windsor	2			
town of williamstown	2			
town of williamstown	2			
woodford lake estates, inc.	4			
berlin conservation commission		2006	06GR002	
town of fairfax		2006	06GR002	
town of fletcher		2006	06GR002	
Barton Village Inc		2007	07GR011	
Town of Grand Isle		2007	07GR011	
Orleans County-NRCD		2011		

Appendix 2

Field Assessment Sheet

Date: ________ App. Year: _______ Applicant: ______________________________ Road Name: ___________________________

Project Summary	
	Costs

Remaining Drainage Problems

Site Characteristics			
GPS Waypoint			
Road Slope			
Road Crown/Tilt	Crowned	Downslope	Upslope
Angle of road slope	Parallel	Cross-slope	
Dominant Vegetation	Grasses	Herbaceous	Trees

Site/BMP Condition				Notes
Are BMPs visible?	Yes	Partially	No	
Do BMPs need maintenance?	Yes	Some	No	
Does **ditch** show signs of erosion?	None	Some	Extensive	
Does **ditch** show signs of deposition?	None	Some	Extensive	
Does **road** show signs of erosion?	None	Some	Extensive	
Does **road** show signs of deposition?	None	Some	Extensive	
Is there vegetation between road and BMP?	Yes	Some	No	

Culvert		
Erosion/Deposition at inlet?	Yes	No
Erosion/Deposition at outlet	Yes	No
Is culvert obstructed?	Yes	No
Is culvert damaged?	Yes	No
Is culvert 1.2 bankfull at stream crossing?	Yes	No
Are inlet and outlet vegetated?	Yes	No
Is headwall intact and correctly installed?	Yes	No
Notes:		

Date: ________ App. Year: _______ Applicant: ____________________________ Road Name: _________________________

Best Management Practices (BMPs)	1	2	3
	Intact	Compromised	Failed

	Ditches	Notes
	Grass-Lined	
	Stone-Lined	
	Stone Check Dam	
	Compost Sock	
	Silt Fence	
	Culvert (stream)	
	Culvert (ditch)	
	Headwall	

	Velocity Controls	Notes
	Stone Dike	
	Log and Bush Check Dam	

	Outlet Structures	Notes
	Turnout	
	Rock Apron	
	Riprap Conveyance Channel	
	Splash/Plunge Pool	
	Level Spreader	
	Waterbar	

	Bank Stabilization	Notes
	Seeding and Mulching	
	Grading	
	Terracing	
	Cut and Fill	

	Vegetation	Notes
	Live Wattle/Stake	
	Brush Layering	
	Sprig/Plug	

	Walls and Mats	Notes
	Gabion	
	Log or Timber Crib	
	Revetment	
	Vegetated Rock Wall	
	Vegetated Rip Rap	
	Geogrid	
	Erosion Control Mat	
	Buffer Zone	

Date: _________ App. Year: _______ Applicant: ______________________________ Road Name: ___________________________

Photo Log

Photo ID#	GPS Point	Description

Appendix 3

CD-ROM
Photos of Assessed Project Sites

Appendix 4

Sample Field Assessment Sheet
Distribution of Annual Road Crew Hours

	Material									Total
	Fuel*	Chloride	Crushed Gravel**	Stone (ditch)	Culverts**	Tools	Signs	Fabric	Cold Patch, Hay, Seed**	
Line Item	$27,356.00									
Winter	**$12,036.64**									
Non-Winter	**$15,319.36**	**$8,608.00**	**$8,058.50**	**$2,482.00**	**$1,829.00**	**$2,472.00**	**$2,382.00**	**$306.00**	**$1,507.00**	**$42,963.86**
% on Unpaved Roads*	90%	100%	100%	90%	100%	66%	66%	100%	100%	
$ on Unpaved Roads	**$13,787.42**	**$8,608.00**	**$8,058.50**	**$2,233.80**	**$1,829.00**	**$1,631.52**	**$1,572.12**	**$306.00**	**$1,507.00**	**$39,533.36**
NON-WINTER MAINTENANCE										
Routine Maintenance	80%	100%	50%			100%	100%			
Mud Season Repairs	3.33%									
NON-WINTER EROSION CONTROL										
Fixing "Problem Roads"	6.66%		50%							
Constructing BMPs	6.66%			100%	100%			100%	100%	
Maintaining BMPs	3.33%									
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	

* = Percentage of fuel use is equivalent to the percentage of time spent on tasks, e.g. 44% of time is spent on Winter Work, 56% on Non-Winter Work.

** = Half of the 2012 crushed gravel line item was used in 2013. Half of the 2012 culverts were used in 2013. Cold Patch costs $3000 for two years, the remainder of this line item is for hay and seed.

Appendix 5

Sample Field Assessment Sheet
Distribution of Annual Road Materials

Road Crew Salary $191,650.00 (2012-13 Fiscal Year) Net Salary after vacation $179,671.88

	July	August	September	October	November		December	January	February	March	April		May	June
Hours/per week	40	40	40	40	40	52.5	52.5	52.5	52.5	52.5	52.5	40	40	40
# of employees	4	4	4	4	4	4	4	4	4	4	4	4	4	4
WINTER WORK														
Winter Work				40%	75%	75%	100%	80%	80%	75%	25%			
NON-WINTER WORK														
Routine Maintenance		60%		20%	25%	25%						100%		100%
Mud season repairs								10%	10%	25%	75%			
EROSION CONTROL														
Fixing "Problem Roads"				20%				10%	10%					
Constructing BMPs	70%	15%	75%										100%	
Maintaining BMPs	5%	5%												
Vacation	25%	20%	25%	20%										
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

One member of the road crew takes 4 weeks of vacation a year and the other three members each take 3 weeks of vacation per year. Vacation hours largely occur between July and October.

In the winter and non-winter months, the road crew spends 10% of its time on paved roads and 90% of its time on unpaved roads. This is reflected in the calculations below.

On Becoming Better Stewards of America's Backroads

A literature review of management and maintenance practices on unpaved roads and a reflection on the role of roads in the environment

Joanne Garton, Masters Candidate
Rubenstein School of Environment and Natural Resources
University of Vermont
April 8, 2015

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On Becoming Better Stewards of America's Backroads

A literature review of management and maintenance practices on unpaved roads and a reflection on the role of roads in the environment

Joanne Garton
April 8, 2015

Almost a quarter of a million miles of interstate and major roads carry the majority of America's highway freight and traffic. Another 887,000 miles are located in urban areas, shuffling cars, buses, trucks and cyclists through the rigors of city travel. Yet more than 1.42 million miles, or over one-third of all 4.09 million road miles in the country, are unpaved gravel or dirt roads (ARTBA, 2014). Known affectionately as "backroads", these arteries connect smaller communities and rural residents in a time-honored fashion on roads that, while picturesque and relaxing, often succumb to the washouts and washboards that keep town road crews on their toes. While towns are increasingly reaping the benefits of following state-recommended best management practices for unpaved road construction and maintenance, the effects are piecemeal, resolving local transportation problems as perceived at the town level instead of at a watershed, state, or national scale.

The Vermont Agency of Transportation and Agency of Natural Resources are now examining the effects of unpaved roads on regional water quality. While point sources of water pollution are being targeted and controlled, many non-point sources of pollution, such as unpaved roads, do not lend themselves to conventional regulation. By definition, non-point source pollution stems from surface run-off that is not concentrated by man-made controls. With an eye to road management at a watershed level, state environmental and transportation planners are working with town select boards and road crews to find effective and affordable ways to mitigate the detrimental effects of unpaved roads on water quality. Such a process may require a re-vamping of the objectives of town road crews, not only as custodians of safe road travel, but also as environmental stewards of their unpaved roads.

A literature review of best management practices on unpaved roads uncovered ample studies on the management of temporary logging roads, presumably due to the controversial nature of the effect of logging on the environment and the desire of the research community to improve standards and reduce litigation. Research of the efficacy of recommendations and standards applied to permanent unpaved roads, normally categorized as town Class 3 or 4 roads, is sparse and limited to a small pool of authors. Their results, along with relevant research on logging roads, are summarized in the following discussion that addresses ways to mitigate erosion on unpaved roads.

The Elements of Road Stewardship: Management and Maintenance of Unpaved Roads

The struggle to keep unpaved roads in place was keenly emphasized on August 28, 2011 when over 7 inches of rainfall fell during Tropical Storm Irene. The rain affected 225 Vermont municipalities, causing flashfloods that turned roads into rivers and separated communities from clean water, food, and each other (Vermont Agency of Natural Resources, 2011). State and town governances, as well as private landowners and farmers, relied on aid from federal disaster relief funds to repair roads and bridges swept downstream. Costs of repairs to over 500 miles of road and approximately 200 bridges exceeded $175 million ("Planning for flood", 2014). As a result, towns are now planning for future road resilience as well as safety. Capital investments using best management practices (BMPs) to reduce erosion during storm events will yield long-term financial savings for towns while also preventing road sand, gravel and stone from settling in Vermont's streams, rivers and lakes.

Effective management and maintenance of unpaved roads requires that those that govern them make difficult decisions regarding the allocation of limited funds for seemingly illimitable roadwork. This can be effectively done by:

- *Prioritizing* roads that, when properly maintained, will have the greatest effect on habitat connectivity and water quality improvements;
- *Implementing* BMPs on these roads;
- *Maintaining* BMPs on these roads;
- Using *good training and communication* as methods to increase BMP longevity;
- *Fixing the problem*, not the symptoms;
- Holding towns and landowners more *legally responsible* for runoff from their roads;
- And, *closing roads* properly when they are too environmentally or financially costly.

By prioritizing **roads that, when properly maintained, will have the greatest effect on habitat, connectivity and water quality improvements**

In order to maintain safe and efficient travel, town road foremen constantly juggle limited time and resources to repair and rehabilitate problematic roads. At a town level, the road repair schedule is often fueled more by the need to resolve acute problems than by the anticipation of future environmental damage. Yet as state environmental agencies struggle to manage the multitude of forces affecting its natural resources, water quality managers no longer assume that these time and resource intensive roads are the same roads that pose the greatest threats to water quality, wildlife habitat and hillslope stability.

The sediment erosion causing road degradation depends on the interaction of a multitude of factors including, but not limited to, the road gradient[1], the slope of the surrounding banks cut for road work, the size of the road surface particles, the

[1] After studying 74 plots on forest roads in the Oregon coast range, (Luce & Black, 1999) correlated sediment production from these unpaved roads to the length of the road section multiplied by the *square* of the road slope.

[2] In Vermont, the town select board assigns class 3 designation to town highways. However, the minimum standards for a class 3 highway require that it is "negotiable under normal conditions all season of the year by a standard manufactured pleasure car" (Vermont Legislature, 2013) These roads must have a surface sufficient for vehicular travel, exhibit

frequency with which a road is maintained the inherent erodibility of the soil, and the weather at the site (Luce & Black, 1999). However, some of the most obvious factors, such as high road density, are not always the most influential when it comes to environmental degradation (Luce, Rieman, Dunham, Clayton, King, & Black, 2001). "Most [road] segments produce little sediment, while only a few produce a great deal." (Luce & Black, 1999). Prioritizing the implementation and regular maintenance of BMPs on these segments has a much greater effect on erosion reduction than blanket, low-level treatment, yet is often more expensive and controversial than continuing on with "business as usual".

Road repair prioritization requires information that may go beyond what is available to town road foreman. Transportation planners at both town and state levels should utilize interdisciplinary knowledge to plan road construction, repair, and closure, overlaying the requirements of wildlife habitat (particularly endangered habitat), water quality preservation, and the physical, social and financial constraints imposed by people. Sophisticated modeling methods, such as the Analytic Hierarchy Process (AHP), have already provided consistent approaches to ranking road repairs based on multiple criteria that weigh the costs and benefits of both economic and environmental investments (Coulter, 2006). First pioneered by Professor Thomas Saaty in 1971, AHP organizes and prioritizes factors of complex decisions. In the case of unpaved road maintenance, they include:

- physical aspects (grade, drainage, surface condition);
- traffic patterns (daily average volume, percentage of vehicles that are light, average or heavy);
- climatic conditions (rainfall, exposure to flood events, length of year when frozen);
- social importance (relevance to schools, hospitals, urban centers); and
- administrative aspects (power of, and funding from, municipal and state source (Moazami, Muni, Hamid, & Yusoff, 2011).

Broad-reaching methods of analysis such as AHP are often logistically or financially infeasible for the transportation official in an average small town.

However, with state aid, towns may identify the most serious problems by assessing roads at a watershed scale using geographic information systems (GIS), followed by field reconnaissance to verify GIS predictions. Such work is already underway in many states, including Vermont, where GIS analysis is aiding state agencies to locate potential road erosion sites near surface waters (Hoffman, 2014).

By *implementing* BMPs on these roads

BMPs on unpaved roads are recommendations, not strict regulations, allowing for towns to adapt BMP designs for variations in terrain, equipment, and the size of the road operation (Swift, 1988). It is now commonly accepted that BMPs on unpaved roads reduce the detrimental effects of this kind of land disturbance, particularly when it comes to the cumulative effects of unpaved roads and logging operations (Edwards & Williard, 2010). Controlled studies between undisturbed forested watersheds and logged watersheds showed that regardless of the type of logging conducted, BMPs that minimized bare soil, maintained streamside management zones, and controlled both water volume and speed on roads and skid trails all reduced negative water quality impacts (Martin & Hornbeck, 1994). Correct installation, however, is still vital to ensure that money spent on BMPs is invested for the long term. A study conducted on forested roads in New York found that 53% and 31% of culverts installed in Adirondack and Catskill regions, respectively, were installed incorrectly, often spaced too far apart to effectively capture and divert fast-moving water (Schuler & Briggs, 2000). Many granting agencies now require that grantees validate implementation techniques with specs and photographs of the project taken both before and after construction.

In addition to improving water quality, BMP implementation also reduces routine road maintenance requirements such as repeated road grading, crowning and minor ditch shaping. A 2006 study in the Stillwater Creek Watershed, Oklahoma monitored runoff from two unpaved roads subject to repeated re-grading "many times during a year" (Turton, Stebler, & Smolen, 2007, p.9). One section on each road remained untreated, while a second section on each road was treated according to road construction best practices recommended by the Local Technology Assistance Program in the Center for Local Government Technology at Oklahoma State University. Treatment included crowning, re-shaping of ditches, re-seeding, placing of geotextile, and the addition of limestone gravel in some ditches. The reduction in accumulated sediment from unpaved road after BMP application was 46% and 81% at the two sites (Turton, Smolen, & Stebler, 2009), and while untreated roads segments were re-graded twice in the year following treatment, treated roads were not re-graded at all (Turton et al., 2007).

The overarching principles of road design have always promoted road drainage patterns that allow for minimal disturbance of the natural drainage pattern of the land and dissipate water away from unstable areas. Some of the simplest and least expensive methods of slowing and dissipating water away from the road include landform alterations such as:

- outsloping, used to quickly drain water from roads to prevent loss of control of water;
- berms, used to restrict the length that water can travel down a road before being redirected to a cross drain
- broad-based dips and in-road waterbars; used when traffic is slow and culvert use is limited because of economic or environmental restrictions, such as within forests.

Although effective and inexpensive, reshaping the road surface impedes traffic flow, a characteristic often deemed too detrimental to the overall purpose of roads (Food and Agriculture Organization, 1998). As such, more permanent and relatively high-traffic roads, including most Class 3[2] unpaved roads, opt for less intrusive yet more expensive drainage methods that collect water into ditches and culverts. Once

[2] In Vermont, the town select board assigns class 3 designation to town highways. However, the minimum standards for a class 3 highway require that it is "negotiable under normal conditions all season of the year by a standard manufactured pleasure car" (Vermont Legislature, 2013) These roads must have a surface sufficient for vehicular travel, exhibit adequate drainage, and be of sufficient width to provide winter maintenance, except where the select board deems the road unsafe for winter travel.

installed, these drainage systems are effective and hidden – until they become clogged. Routine maintenance alleviates blockages and overflows, but this care is often neglected when both money and time run short.

By *maintaining* BMPs on these roads

Despite the publication of multiple articles on the overarching principles of road design and the positive effects of BMPs on unpaved roads, there is little evidence of a complete manual or database on the need for, and effects of, BMP maintenance (Food and Agriculture Organization, 1998). It seems possible that once implemented, BMPs often receive little or no further attention from road crews until the next road washout (which may be considerably delayed because of the BMP). However, ensuring that BMPs are properly constructed and maintained prolongs road integrity and delays routine road maintenance such as re-grading. The Center for Dirt and Gravel Roads Studies at the University of Pennsylvania, which grants money to assist municipalities in repairing their unpaved roads, recommends specific construction practices and BMPs that, while they will lengthen maintenance cycles, still require intermittent maintenance (Penn State University, 2005).

Lack of maintenance is often due to budgetary constraints, but ultimately, the cost that the public incurs from poorly maintained roads, especially in the form of ecosystem degradation, may far outweigh the cost of regular BMP maintenance (Gucinski & Furniss, 2001). As such, the responsibility of BMP maintenance may also need to extend beyond the road crew. Satellite imagery, particularly during the leafless months, could capture growing problems in streams and rivers and monitor the effectiveness of road deactivation and rehabilitation (Kliparchuk & Collins, 2003). The development efficient and low-cost methods for BMP monitoring, and the increased ability to share this knowledge, will enable a further return on investment of money spent on BMPs (Aust & Blinn, 2004).

The list of future directions of BMPs includes the need for BMP refinement specific to each site, the development efficient and low-cost methods for BMP monitoring, the need for BMP training of landowners, loggers and foresters (and by extension, road crews and select boards), the need for more research on how BMPs affect TMDL values, and to increase the ability to share knowledge (Aust & Blinn, 2004).

By using *good training and communication* as methods to increase BMP longevity.

Communication between road crew members, local officials, state agencies and granting agencies is an invaluable and attainable form of long-term road maintenance (Aust & Blinn, 2004). Although some communication can occur informally, required training workshops encourage more frequent and purposeful interactions between parties with vested interests in the longevity of road maintenance practices. For example, local county conservation district planners within the State of Pennsylvania's Conservation Commission have heard the opinions and observations of more than 2,000 local road crews and officials through a training program in Environmentally Sensitive Road Maintenance administered by the Dirt and Gravel Road Pollution Prevention Program (Colbert, 2003). Their input has helped shape the standards used to guide road management across the state.

Implementation of BMPs that result in successful resolution of severe road problems not only improve road crews expertise, but also train and educate those involved in, or affected by, its construction, including private citizens and landowners, land managers, field technicians, and even policymakers in government (Swift, 1988). The far-reaching effects of BMP training were tested on loggers from the piedmont region of Virginia in a 1997 study performed by Virginia Tech and the Champion International Corporation. One group of loggers received a two-day workshop on pre-harvest planning that outlined BMPs designed for deck, road and stream planning, while a second group received no training. Upon review of submitted written harvest operation plans, the trained group revealed higher rates of BMP compliance, improved landowner satisfaction and less weather-related downtime compared to the untrained group. Loggers also reported improved ability to plan logging operations early in the procedure and an increased sense of professionalism on the job when plans were well planned, followed and documented (Shaffer & Meade, 1997). Evaluating the efficacy of road crew training on BMP construction and maintenance is one further way to increase BMP longevity.

By fixing the *problem*, not the *symptoms*

Simply put, BMPs slow and divert unpaved road runoff after it has already formed. The procedures used on unpaved roads resemble those used on paved roads, namely, to remove water from the road as quickly as possible then dissipate the collected runoff. Such a procedure implies that having water on unpaved road is a problem; ultimately, road crews want to avoid the symptoms of water on the road including erosion in the form of gulleys, washouts, clogged ditches and culverts, all to resume normal traffic flow as quickly as possible.

In an effort to redefine the role of floodwater on unpaved road, Colbert (2003) explores a design in which the problem of road erosion is alleviated by eliminating its symptoms. The study recommends constructing a completely flat road next to a stream that is likely to flood its banks, essentially creating a floodplain for the stream on which sediment could settle. Post-storm maintenance would consist only of removing fine sedimentation using a grader. In addition, a ford, or stabilized gabion built at the downstream end of a flooded road, aids in draining water from the road via a small and controlled waterfall, but only after it has slowed over the road surface (Food and Agriculture Organization, 1998). Re-envisioning unpaved roads as sinks for sediments instead of sources may be the kinds of solutions that future road planning may embrace when "business as usual", including BMP implementation, becomes too costly. With this may come a renewed realization that roads close during flood events, edging out human priorities of convenience for the sake of improved water quality.

By *closing roads* properly when they are too environmentally or financially costly

Although road closure appears to reduce the effects of a seemingly inexhaustible source of erodible sediment laid down on unpaved roads each season, closure alone does not guarantee restoration of an ecosystem previously degraded by the installation and continued presence of a road. Concentrated runoff, erosion, risk of road-triggered landslides of saturated soil, and barriers to wildlife will persist until a road is ripped, recontoured, and re-vegetated along its length and in character with its native surroundings (Switalski, Bissonette, DeLuca, Luce, & Madej, 2004).

Ripping of the road, or decompaction of the road surface to depths of 30-90 cm using a specifically fitted plow, increases infiltration and provides an accessible soil depth for vegetation. Ripping may initially increase loose sediment available for short-term erosion, but it reduces chronic long-term erosion as vegetation takes root and slopes are stabilized. However, roads may re-compact or unintentionally be re-vegetated with invasive species after the soil has been aerated. Ripping alone cannot guarantee ecosystem restoration (Switalski, Bissonette, DeLuca, Luce, & Madej, 2004).

Full-road recontouring, which includes reconstruction of stream crossings altered by culverts, most effectively removes the physical evidence of the road bed. The addition of soil amendments (organic matter) and implementation of intentional and native planting schemes will also promote restoration of neighboring tree canopies, stream beds and pools, riparian zones and groundwater flow in a hillslope. In a 1997 study conducted in Redwood National Park, California, researchers found that 80% of the roads removed using ripping, full-road recontouring and re-vegetation had no detectable landslide erosion after 12 years. Untreated roads produced four times as much erosion as treated roads, mostly in the form of landslides (Switalski et al., 2004).

At present, there are no formal protocols in place for towns to use to select roads for removal, nor to monitor the effectiveness of their removal (Napper, 2005;

Switalski et al., 2004). Some state governments use the metric of "length of road treated" to measure the success of road closure initiatives; however, this encourages light treatment of long road segments instead of any heavy and necessary treatment of short road segments with particularly detrimental environmental effects. A 2006 study of a road network proximal to Lost Man Creek in the northern Coast Ranges of California, incorporated a "critical habitat weighting factor" into the prioritization scheme for road closure within the watershed basin. Rather than perform a uniform but minimal treatment on all roads being closed, treatment shifted to more intense treatment on the lower and steeper hillslopes where erosion was greatest, and less intensive treatment on upper and middle hillslope roads (Madej, Eschenbach, Diaz, Teasley, & Baker, 2006).

Although it is rare that unpaved town roads are permanently closed, such decommissioning may become necessary as road maintenance needs increase outside the bounds of road budgets in small towns. Prioritizing their influence should utilize interdisciplinary knowledge, overlaying the requirements of wildlife habitat (particularly endangered habitat), water quality preservation, and the physical, social and financial constraints imposed by people (Luce et al., 2001), including the desire to retain access to a location no matter what the environmental cost (Madej et al., 2006).

By holding towns and landowners more *legally responsible* for run off from their roads

When BMPs were first introduced through the 1972 Amendments to the Federal Water Pollution Control Act, the practices recommended removing stormwater at frequent intervals by outsloping rather than by consolidating runoff into ditches and culverts (Swift, 1988). However, the waterbars and broad-based dips necessary for this type of discharge required regular reshaping and impeded fast traffic flow, two qualities that most towns found hard to accept as part of normal travel on unpaved roads. Although more expensive than outsloped dips, grass-lined and stone-lined roadside ditches are now typical elements of unpaved road construction. When constructed on slopes, ditches re-route overland flow from road surfaces and intercept subsurface flow, increasing peak discharges into adjacent streams and reducing the amount of soil moisture downslope of the road (Buchanan, Falbo, Schneider, Easton, & Walter, 2013).

In light of broad, statewide efforts to delegate responsibility of water quality stewardship, the use of roadside ditches as a legally viable method to manage surface runoff has become controversial. By definition, non-point source pollution stems from surface run-off that is not concentrated by man-made controls. By inference, roadside ditches, which act to concentrate runoff, could be considered point sources of pollution. In a court case that began in 2006, *Northwest Environmental Defense Center (NEDC) v. Brown,* the Ninth Circuit Court of Appeals ruled that storm water ditches along forest roads that discharge into the waters of the United States are considered point sources of pollution and require an National Pollutant Discharge Elimination System (NPDES) permit (Boston, 2012).

If towns were held legally responsible for keeping sediment collected in ditches and culverts out of United States waters, proper construction and maintenance of BMPs would become imperative. Of course, the expense involved to monitor or enforce such regulations in small towns nationwide would be large and the ability of the towns to remedy violations would be challenging. But the shift of thinking of town road crews as merely construction workers to regarding them as road stewards responsible for preventing violations of pollutant production may be the new frontier of unpaved road management, one which requires collaboration between town, state and federal governance.

A Reflection on the Role of Roads in the Environment

To propel a vehicle over the landscape with any speed requires the re-engineering of a landscape, the taming of its curves and leveling of its bumps. But roads quickly become obsolete over generations when communities move away, over months when a logging or mining operation is complete, or, on a small scale, over minutes when traffic is absent. At these times, the road utility is absent, yet its *legacy* remains (Lugo & Gucinski, 2000). In America, our academic understanding of the environmental effects of roads came to the fore when landscape ecological Richard T.T. Forman published *Road* Ecology in 2003. Our vision to re-define these effects, however, has yet to begin.

This reflection imagines an investment in a road network that, when managed correctly, increases the resilience of the ecosystems it intersects. Instead of degrading surrounding natural resources, it enriches them. Instead of creating environmental problems, it helps solve them. And for the taxpayer, the monetary investment in road networks lasts for generations, restoring the environment that it initially altered and providing environmental benefit instead of detriment.

The Road Effect

Although the road surface may be the focal point of road safety and function, it is only one part of the road corridor, an area covered by the road surface itself as well as parallel ditches, turnouts, infrastructure and parallel vegetated strips. Quantitative research pioneered by Richard Forman and Alexander in the late 1990s began to show that the ecological influence of roads extends far beyond their actual footprint. Called the "road effect", this phenomenon of interaction between roads and ecosystems is largely negative, encompassing environmental damage such as wildlife habitat loss, altered hydrology, increased soil erosion and sedimentation in streams, altered plant and animal patterns, decrease in air quality and increased human disturbance in remote areas (Forman & Alexander, 1998). The road corridors surrounding the over four million miles of road in America cover an estimated 1% of the country, yet the area directly affected by the presence of roads is estimated at 20% (Forman & Deblinger, 2000).

And yet the Road Effect, particularly unpaved roads in rural settings, is often of little concern to town taxpayers. Safety and functionality come first, and today, even temporary road closures highly inconvenience drivers. After education, roads are the largest expenditure in town budgets. While taxpayers expect to reap the rewards of their education investments over a generation, they expect their road infrastructure to last only until the next storm or mud season and remain prepared, if not saddened, to continually reinvest in the same roads with the same problems. Additionally, taxpayers accept that even more money must be poured into righting the wrongs caused by roads, completing stream and aquatic habitat restoration, hillslope repair, roadkill removal, invasive species control and management of water quality.

Corridors for Conservation

Just as wildlife habitat requirements vary among species, so do the manifestations of conservation corridors. Although commonly thought of as linear swaths of forest cover, ecologically productive corridors also include continued open fields, riparian zones, wetlands, and even man-made amenities such as power lines and windbreaks (Gustafsson & Hannsson, 1997). These narrow forms of road-side habitats are often more suited to generalist species less influenced by the frequent changes in noise, light, soil pH and even temperature caused by the roads and abundant edge habitat they create. Species benefitting from road infrastructure include wolves that may travel on roads when traffic is absent, birds and bats that nest in underneath bridges and perch on overhead wires, and amphibians and insects that thrive in constructed runoff pools (Daigle, 2010) (Spellerberg, 1998). In Australia, considerable interest has developed in assigning a conservation label to roadside “verges”, or the linear habitat created by road edges. However, the terms “roadside verge” and “wildlife corridor” are often mis-used; the presence of wildlife habitat does not guarantee its connectivity to other wildlife refuges (Spellerberg & Gaywood, 1993).

Yet when engineered correctly, roads have ample opportunity to provide habitat in heavily disturbed landscapes. A road with a tree-lined border may be the most forested part of an agricultural landscape, providing wildlife with food and shelter and storing seed sources for future reforestation. Additionally, many populations of endangered plants are found primarily alongside roads, likely because they were accidentally transported alongside commercial goods (Hopper, van Leeuwen, Brown & Patrick, 1990). However, the use of corridors for conservation is still weakly supported in scientific research (Gustaffson & Hannsson, 1997); at this point, we may be more prudent to think of wildlife corridors as experiments rather than solutions.

Additionally, roads as cultural corridors fulfill a particularly American ideology that some of the country's history and freedom is rooted in the open road. The federally-endorsed "America's Scenic Byways" programs boosts some roads to elevated status through titles such as "All American Road," "National Forest Scenic Byways," and "BLM Back Country Byways" (byways.org). Highlighting anything from the vineyards along the Valley of the Moon Highway to the Cajun music of the Zydeco Prairie Scenic Byway, America thrives at making the journey actually become the destination where the experience on the road is just as important as the stops along the way.

Redefining Stewardship

With this freedom to drive already instilled in the American psyche, might the eco-tourists of the country be ready for the next innovation in road design? Could the value of a road rest now not in its history, but in its future? As environmental awareness plays a greater role in regional identity, the values associated with some roads, particularly backroads, may change from stressing history, tradition and beauty to creating wildlife habitat, promoting native plantings and engineering ecosystem regeneration.

Imagine a road design that increases vernal spring habitat, or one that collects and filters water for irrigation of adjacent agricultural fields. Could the friction from car tires on road surfaces release embedded native seeds that revegetate ditches and revetments? Could roads be biodegradable over several hundred years, tamed while we use them but wild when we are done? Perhaps once its useful life has been lived, a logging road could grow needed habitat that provides food and shelter for wildlife as well as natural resources for people. In urban areas, where waterside property once used for industry is increasingly becoming gentrified, roads could undergo a similar rebirth—might well-managed roadside corridors become an amenity to certain real estate, providing views of important wildlife, increased birdsong, and visual beauty?

Current research and public policy focuses on mitigating the problems posed by "the giant embracing us" (Forman, 1998, p.iii). But by considering roads as multi-faceted parts of the built environment, we may be able to turn the road effect on its head, constructing roads that provide for the environment instead of taking from it. While road innovation catches up with increasing demand for the transportation system to which we are accustomed, we must realize that serious reduction in erosion from unpaved roads will only come as towns, in conjunction with state funding agencies, make decisions about the necessity of their roads. Limited road budgets are already stretched thin to accommodate the demand for more miles of year-round roads. Until technology changes and the public accepts a proactive approach to road erosion control, roads will always run from where they were placed, rushing downhill into our streams, lakes and rivers.

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