NCHRP 14-41: Permanent Vegetation Control Treatments for Roadsides

**INTERIM REPORT**

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CHAPTER 1   
  
INTRODUCTION

BACKGROUND

The Department of Transportations (DOTs) have historically incorporated a range of roadside

vegetation management operations (e.g., mowing, herbicide treatments, and permanent

vegetation control treatments) in the Right of Way (ROW) from boundary to boundary for fire

prevention, safety, cost, and aesthetic reasons. The American Association of State Highway and

Transportation Officials (AASHTO) published Guidelines for Vegetation Management in 2011 to assist DOTs with their vegetation management programs. Specifically, DOTs seek to minimize ROW maintenance without compromising safety and roadway infrastructure. The vision for the final products for National Cooperative Highway Research Program (NCHRP) 14-41 is user friendly guidance aimed at providing practitioners information that will be valuable when considering different permanent vegetation control treatments. The NCHRP 14-41 project aims to translate academic research and practical experience into user-friendly guidance.

OBJECTIVE

The NCHRP 14-41 project aims to produce up-to-date and user-friendly guidance for

transportation agencies to select appropriate permanent vegetation controls that will be effective

in preventing or significantly retarding the growth of unwanted vegetation around roadside

appurtenances and along roadsides.

This section of the proposal summarizes the research team’s work plan and deliverables to

achieve the NCHRP 14-41 project’s objective. The proposed plan also reflects the team’s

familiarity and current knowledge of roadside vegetation management practices. The research team will:

* Gather information on permanent vegetation controls through a detailed review of the literature, targeted interviews with technical experts, a web-based survey of transportation practitioners, and in-depth interviews with practitioners that have piloted or implemented additional methods, technologies, or applications.
* Develop guidance and an informed project selection process for effective permanent vegetation controls that also address traveler and highway worker safety and costs of construction and maintenance, as well as minimize adverse environmental impacts.
* Develop practical guidance that are broadly applicable to a wide range of conditions and appropriate for new construction and for existing facilities.

PURPOSE AND ORGANIZATION OF INTERIM REPORT

The Interim Report starts with the typical Introduction chapter to provide background information about this Interim Report along with the NCHRP 14-41 project. Chapter 2 summarizes current knowledge, practices, and relevant research pertaining to permanent vegetation controls for roadsides. It summarizes the findings of the American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Vegetation Management (Guidelines) with inclusion of newer approaches and methodologies. The third chapter provides overview on the state practices. Chapter 4 documents overall lessons learned about the state of the practice as well as suggestions for future research.

RESEARCH METHODOLOGY FOR NCHRP 14-41

The research was originally proposed to be conducted within five tasks. Each task listed is followed by the objectives of that task:

* **Task 1. Project Management.** The objectives of this task are to ensure that the research is conducted as defined in the detailed work plan within the agreed upon time and resources, and to effectively communicate with the NCHRP technical representative regarding the direction of the project along with the progress updates.
* **Task 2. Conduct Literature Review.** The objective of this task is to document the state-of-practice through a review of online documents and a review of the literature on the effectiveness, longevity, initial construction costs, maintenance requirements, site conditions, ecological and climate conditions, aesthetic value of permanent vegetation control treatments and their effect on the safety performance of highway appurtenances, such as guardrails, cable barriers, and signs.
* **Task 3. Conduct Web-Based Survey and Practitioner Interviews.** The objective of this task is to supplement the information gathered in Task 2. Specifically, the research team aims to collect information on current practices, institutional obstacles, issues and concerns agencies have regarding permanent vegetation control treatments. The research team will also identify additional methods and technologies that DOTs are piloting or experimenting with, additional guidance required, and how DOTs would utilize the findings from this research.
* **Task 4. Develop Interactive Selection Tool.** The objective of Task 4 is to develop an Interactive Selection Tool – a practical and user-friendly web-based tool – that will provide step-by-step guidance to transportation agencies to identify and select permanent vegetation controls. The development of the Interactive Selection Tool will be informed and based on the information collected in Tasks 2 and 3.
* **Task 5. Prepare Final Deliverables**. The objective of this task is to prepare the final project documentation, which will include a final research report documenting the conduct of research, web-based Interactive Selection Tool, and written/graphic presentation of permanent vegetation controls.

CHAPTER 2   
  
LITERATURE REVIEW

This chapter summarizes current knowledge, practices, and relevant research pertaining to permanent vegetation controls for roadside. While there is broad agreement on the common and most used permanent vegetation control methodologies, the usage and strategies vary throughout the literature. The American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Vegetation Management (Guidelines), published in 2011, compiled a range of permanent vegetation control countermeasures *(1).* This chapter provides a summary of the findings of the AASHTO Guideline. This chapter also documents additional countermeasures and strategies than are not included in the AASHTO Guideline.

COUNTERMEASURES LISTED IN 2011 AASHTO GUIDELINE

The 2011 AASHTO Guideline included the following countermeasures:

* Minor Concrete
* Minor Concrete Pavement
* Asphalt Concrete Pavement
* Asphalt Composite
* Stamped Asphalt Paving
* Patterned Concrete Pavement
* Rock Blanket
* Gravel Mulch
* Aggregate Base
* Rock Slope Protection
* Weed Control Mat (Fiber)
* Herbicidal Geofabric
* Rubber Weed Mat
* Irrigated Ornamental Vegetation
* Native and Non-Irrigated Vegetation
* Organic Mulch

*Minor Concrete Pavement*

Minor concrete is one of the roadside design treatments for vegetation control. It is generally installed before construction of guardrails and beam barriers *(2).* Beyond the gore area, it can also be designed and installed at side slopes and sign posts. Minor concrete is available in variety of colors to match the color of soil and can be stamped with pattern for texture (see Figure 1).



Figure 1. Minor Concrete treatment for vegetation management *(2)*

To design minor concrete, there are few base conditions to be checked. These are reinforcing fibers to be included, 28-day compressive strength to be tested and its thickness should be in between 2 inches to 3½ inches. There must be a blockout material installed under end treatments, of around 1½ inches to 3 inches in thickness *(3).*

There are several benefits and limitations attached to this treatment. It can be easily installed with standard equipment and life cycle cost is less if installed before the construction of guardrails and beam barriers. Limitations attached to minor concrete treatment are formation of leave-out section at guardrail system and it is not practical to install at an existing guardrail due to grading and excavation requirements.

*Minor Concrete Pavement*

Similar to minor concrete treatment, this measure is also applicable at the medians, gore areas and sign posts. The pavement can be colored or patterned during installation. One of the few disadvantages of this treatment is its high installation cost.

*Asphalt Composite*

Asphalt composite is a vegetation control treatment wherein asphalt emulsion is sprayed and reinforced with fiberglass strands. This method eliminates weed penetration into the systems. One of the best advantages of using this treatment is its performance under existing guardrails. It can be used in situations where minor concrete treatment is not feasible. Figure 2 shows a guardrail system using asphalt composite treatment.



Figure 2. Asphalt composite treatment at guardrail system *(4)*

This treatment is adherent to asphalt, concrete, wood and metal. To provide extra erosion protection, a coat of dilute emulsion and water is applied. One of the major advantages is low life cycle cost. In addition to that, this treatment can be simply and quickly installed at existing guardrails, easily repaired and allows minimal lane closure period. The limitation to this treatment is it cannot be installed at freezing climatic environment (4).

*Stamped asphalt paving*

Stamped asphalt paving is an economical alternative to other types of asphalt concretes. The pattern is formed by using standard compaction equipment which is pressed over the asphalt when it is warm. This process is repeated for the entire asphalt surface, and coloring is done as a final coat. Figure 3 shows the process of making stamped asphalt paving. It can be seen in the figure a wire is placed on asphalt paving and stamped using standard compaction equipment.



Figure 3. Process of making stamped asphalt paving *(5)*

Stamped asphalt concrete can be used for aesthetic value like crosswalks, median strips and ramp locations. This treatment is not suitable for entire intersections *(5).* The design pattern for stamped asphalt is to use red color in herringbone pattern of 12” wide in a stamped course pattern (5).

Some of the benefits are use of variety of colors and patterns and installation is less labor intensive. Even though this treatment is quicker, there are several limitations to it. This process can only proceed if temperature is above 50 def. F within 8 hours of application and there is no precipitation expected *(6).* Asphalts may bleed through in hot climatic condition. The life cycle of this treatment is unknown.

*Patterned Concrete Pavement*

Patterned concrete pavement is imprinted with patterns before curing and then colored to increase aesthetic value. The design mix should adhere to “2010 Caltrans Standard Specification section 90-2, Minor Concrete.” As stamped asphalt paving, patterned concrete pavement also offers aesthetic value to roadside in addition to control vegetation (see Figure 4). Main advantages of choosing concrete would be its “longevity, visual quality and context adaptability” *(7).* This treatment is more expensive and labor intensive than stamped asphalt, but it is better suited at some conditions like slopes.

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Figure 4. Patterned Concrete Pavement along roadside *(7)*

*Rock Blanket*

A ground surface covered with rock cobbles at the roadside is the description of rock blanket treatment. It is a multi-purpose treatment which can be used for aesthetical value, erosion control or weed suppression (8). Figure 5 shows an application of rock blanket along the roadside. There are no typical locations for installations. Several locations can include embankment paving, slopes under bridges, drainage outlets and roundabout designs.



Figure 5. Rock Blanket installation along roadside (8)

Rock blankets should not be placed near clear recovery zones or area near and at gore. The correct design specifications can lead to minimal maintenance for vegetation control. To increase the aesthetic value of the roadside, rock size should complement the plant material and geometric configurations of the roadway facility. The color of the rock also be considered to bring up the aesthetic value.  An important guideline to follow while placing the rock blanket would be to provide a physical barrier between the rock blanket and pedestrians or roadways. Physical barriers can include retaining walls, fences or concrete barriers *(8).* Some of the advantages of using rock are low maintenance cost, keeps weed out for a longer time and is wind resistant *(9).*

*Gravel Mulch*

A mulch is applied to the surface of soil which helps in reduction of weed growth and enhancement of the aesthetic value *(10).* Gravel mulch, one of the mulching techniques, is the placement of graded crushed or quarried rock above a geo-synthetic fabric. This treatment can only be used where disruption from errant vehicles is unlikely. Use of 4 inches of minimum depth of gravel is required at control measures site*.* Figure 6 shows the gravel mulch treatment at the roadside. It is one of the least expensive control treatments that can be achieved with use of any existing equipment *(11).* One of the biggest limitations to this treatment is that it can be easily disrupted by errant vehicles.



Figure 6. Gravel mulch treatment at the roadside (11)

*Aggregate Base*

A treatment appropriate for low traffic volume facilities, consists of compacted aggregate material to control roadside vegetation. This treatment should only contain aggregate and be free of organic matter and recycled asphalt (2). It is an easy to install, relocate and temporary measure. To extend the treatment’s effectiveness, compaction should be done on a regular basis.

*Rock Slope Protection*

Rock Slope Protection is a method to measure how root growth in plants are affected by rocks and soil on coastal slopes. The paper on rock slope talks about how roots are unpredictable and complex, and that there hasn’t been much technical research done on the topic *(12).* The paper suggests that the interconnectedness and depth of the root network among plants on coastal slopes is stable enough to be safe. Catallactic rock slopes are stable at lower angles but become unstable at higher angles. Rock slope protection can also be provided through single or double twist mesh. It would not unravel when wires are damaged because of double twist construction, which is considered as an advantage *(13).* Vegetation should not be placed directly on top of these areas, as it will have no effect. Surface vegetation will be able to protect loose rock structures from sea erosion and keep them from falling. The conclusion from this paper was that vegetation protection affects different types of rock formations on slopes differently.

*Organic Mulch*

This method is only effective temporarily. Since mulch is loose, it requires maintenance and replacement every 2-5 years. Organic mulches include grass clippings, wood chips or newspaper, providing thick layers of mulch help in control weed while it doesn’t interfere with plant growth *(14).* It is specified that 6 inches depth is required while providing organic mulches*.* This method should really only be used until another more permanent method can be put into place, or if the area using mulch will be worked on in the near future (see Figure 11). If a project is being planned in an area that is using mulch to prevent the growth of weeds, then a temporary solution works fine because the area will need to be treated again following the project. Wood chip and

bark mulch presents a costly alternative ($3,500/mile for wood chips plus labor and $4,300/mile for bark mulch plus labor) *(15).*



Figure 7. Organic Mulch

*Weed Control Fiber Mat*

Weed control fiber mats, composed of polyester fibers, work by blocking out sunlight so weeds die, but also having enough breathability so that water can get through and feed the plants. These mats need to be placed on a level surface without any debris (see Figure 7. ) It has many advantages over other treatment methods because of its easy installation at existing and new roadside location *(16).* It is affordable, easily repairable and effective temporary measure. Based on the findings, one of the major limitations it possesses is that cannot be used in areas where it snows. Washington State examined several weed barriers and found a need for annual cleaning to remove accumulation of organic/inorganic debris. Without this maintenance, the organic buildup starts to grow grass and weeds. Although prohibitively expensive for normal guardrail locations, on sites where herbicide use is restricted, weed barriers provide a viable option *(15).*



Figure 8. Weed Control Fiber Mat *(16)*

*Herbicidal Geofabric*

This fabric provides a continuous barrier between the soil and the road. The fabric contains time sensitive herbicide that activates to prevent new roots of weeds from growing. Since this method uses herbicide, it is not recommended to be used in areas with slopes or runoffs, as the herbicide may contaminate nearby bodies of water.

*Rubber Weed Mat*

The rubber weed mat blocks out the sunlight and keeps root and plant growth at bay. The tiles are great for level areas but are not suited for inclines or declines. High winds and severe weather may displace the mats *(17).* The mats have to be sealed properly or else plants might grow in their groves (see Figure 8).



Figure 9. Rubber Weed Mat *(17)*

*Irrigated Ornamental Vegetation*

The aim of this method is to avoid using tiles, mats, and other synthetically made barriers to prevent the spread of vegetation *(18).* This method aims to cover the ground with desirable vegetation that will not spread onto the roads and can suppress unwanted vegetation from growing (see Figure 9).



Figure 10. Irrigated Ornamental Vegetation *(18)*

*Non-irrigated Native Vegetation*

Like the previous method, the aim of this method is to suppress unwanted vegetation, with the replacement of more desirable vegetation *(19).* This method involves placing vegetation that is native to a region, especially a rural region, near the roadside (see Figure 10). The native vegetation will be well suited to the climate, and eventually will thrive on the side of the road, thus suffocating any weeds that may start to grow there *(20).*



Figure 11. Non-irrigated Native Vegetation *(19)*

**Table 1.Cost of installation, benefits and limitations to different countermeasures**

|  |  |  |  |
| --- | --- | --- | --- |
| **Countermeasures** | **Benefits** | **Limitations** | **Installation Cost[[1]](#footnote-1)** |
| Minor Concrete | - Effective life-cycle cost  - Easy installation at new construction zones | - Cannot be used at existing guardrail  - Rigid in nature, therefore a ‘leave out section must be left | $65/yd2 |
| Minor Concrete Pavement | - Most commonly used treatment  - Correct understanding of installation by most contractors | - Cannot be placed near guardrails  - Entire excavation process increases the cost | $50-$100/yd2 |
| Asphalt Composite | - Low life-cycle cost  - Easily installed and repaired  - Can be installed under existing guardrails | - Cannot withstand freezing climate environment while installation | $52/yd2 |
| Stamped Asphalt Paving | - Quick and easy installation  - Various colors and patterns available  - Great aesthetic value provided | - Because of rigidity, the paving should be 8” away from guard rails  - Asphalt may bleed during hot climate conditions | $40-$55 / yd2 |
| Patterned Concrete Pavement | - Concrete has high longevity, aesthetic value and low life-cycle cost  - More suitable for slopes than asphalt paving | - Repairing is difficult to do  - Due to rigid composure, a ‘leave out section’ is required | $100 - $125/yd2 |
| Rock Blanket | - Wind resistant, keeps weed out for longer time and easy to install | - Repairing cracked mortar is very difficult | $85-$120 /yd2 |
| Gravel Mulch | - It is low tech process, can be done with existing equipment  - Requires very little maintenance | - Easily displaced by errant vehicles  - Facilitate pore openings, can lead to weed growth | $10-$23 /yd2 |
| Aggregate Base | - Useful when additional widening is imminent  - Less expensive, can be used as temporary control | - During wet periods, rutting may occur which leads to disruption in vegetation | - |
| Rock Slope Protection | - Recommended for steeper slopes (3:1 or greater) | - Not suitable for flat slopes |  |

**Table 1. Cost of installation, benefits and limitations to different countermeasures**

|  |  |  |  |
| --- | --- | --- | --- |
| **Countermeasures** | **Benefits** | **Limitations** | **Installation Cost** |
| Weed Control Mat (Fiber) | - Easily available and long lasting -Easy installation at poles and landfills  - Allows infiltration | - Not recommended at windy areas, loose soils and snowfall areas  - Penetrations must be closed to ensure no weed growth | $50 /yd2 |
| Herbicidal Geofabric | - Provides a continuous barrier between soil and treatment | - Not recommended at places where pesticide is restricted  - Expensive method | - |
| Rubber Weed Mat | - Flexible and staking is not necessary which gives it an edge over other methods  - Specialized designs with specific requirements | - Many joints may cause problems  - Not recommended at windy areas, loose soils and snowfall regions | $53/yd2 |
| Irrigated Ornamental Vegetation | - Provides multiple benefits like controlling unwanted vegetation, slope protection  - Can assist in reducing headlight glare and reflect less noise | - Requires extensive capital and maintenance cost | $16-$24 /yd2 |
| Native and Non-irrigated Vegetation | - Provide aesthetic value and water quality  - Requires less maintenance | - Full establishment takes around 3-5 years  - May require assistance through herbicides or other control measures | $0.90-$9 /yd2 |
| Organic Mulch | - Retains soil moisture, enhance soil structure  - Provides erosion control | - Additional treatment required for steep slope  - Susceptible to burning | $40/yd3 |

NEW COUNTERMEASURES

In overarching theme expressed within the permanent vegetation management sector is the challenge for management is to comprehensively quantify and understand the role and values of roadside vegetation and manage roadsides to enhance their positive impacts and reduce their negative effects *(20).* An example of a new countermeasure developed since 2011 found in the literature review are tire-rubber anti-vegetation tiles *(21).*

*Anti-Vegetation (A/V) Tile (Recycled Tire Rubber)*

The work for this countermeasure had a two-fold purpose:

1. To develop and evaluate a new product for vegetation control especially around hard to mow areas like guardrail and base units for lighting.
2. To create reuse of rubber tires to minimize their impact on the solid waste industry.

After reading through the initial report, the researchers did not discover a full list of benefits or limitations of this countermeasure. The researchers plan to add questions regarding this countermeasure to the practitioner interviews.

**CABLE BARRIER AND ROADSIDE VEGETATION CONTROL**

One of the greatest areas of concern with cable barrier systems from a maintenance perspective is roadside vegetation. Current TxDOT guidance indicates that delineation should be at 100-foot spacing, unless otherwise approved by the project design engineer *(23).* The most commonly used solution is a mow strip, a narrow piece of pavement or other material placed directly beneath the barrier to prevent the growth of vegetation and facilitate mowing. Texas Department of Transportation (TxDOT) implemented several different mow strip designs (concrete, asphalt and rip rap) with typical installation cost per mile ranging from $45,000 to $55,000 for concrete and $75,000 to $90,000 for asphalt. Additionally, mow strip provides additional resistance to movement of socket foundations. Distance between the edge of a travel lane and cable barrier should consider mower widths *(22).*



Figure 12. Cable barrier and roadside vegetation (*22*)

The Delaware Department of Transportation funded a study to explore various methods of treating vegetation under guardrail *(23).* Four weed control barriers have been investigated in this study:

* U-TeckTM WeedEnder standard installation (a permeable recycled fiber material)
* U-TeckTM WeedEnder custom installation (a product designed to reach the road edge and accommodate variances in post width)
* Universal Weed Cover (a semi-rigid panel made of 100% recycled plastic)
* TrafFix (a rubber mat with 3 punched guardrail cutouts for flexible installation)

In the initial stage, two countermeasures were selected for testing including U-TeckTM WeedEnder and Universal Weed Cover. U-TeckTM’s WeedEnder is a permeable recycled fiber material. Universal Weed Cover is a semi-rigid panel made of 100% recycled plastic. Panels interlock around guardrail posts to form a weed barrier. U-TeckTM WeedEnder custom cut installation was more expensive than the UTeckTM WeedEnder standard cut installation. However, the costs are less when compared with hand trimming maintenance. The TrafFix weed barrier has a cost of $260.70 per 100 linear feet per year. The Universal Weed Cover barrier was the most expensive barrier in the Delaware study. This countermeasure is no longer in the market.

|  |  |
| --- | --- |
|  |  |
| U-TeckTM WeedEnder standard cut | U-TeckTM WeedEnder custom cut |
|  |  |
| Universal Weed Cover | TrafFix |

Figure 13. Weed control barriers (*23*)

**CONCLUSIONS**

The new work done by DOTs since the 2011 report is improving the best practices associated with the choices between mowing and applying herbicides and / or growth retardants. A few DOTs, like the Ohio DOT, have been able to identify times of the year that are best for planting, best for weed control applications and best for mowing *(24).* All three in concert help achieve the goals of maximizing worker safety, maximizing successful growth of vegetation to minimize erosion, and minimizing the use of herbicides along with minimizing the waste of herbicides to promote a healthier environment and save money. The current literature review is limited to the exiting literature on roadside vegetation control. The researchers plan to identify newer techniques implemented by DOTs during the practitioner interviews. Many times, vegetation management approaches are not always widely published. The researchers will use the practitioner interviews to identify new techniques not readily found with a literature review.

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