

**GEORGIA DEPARTMENT OF TRANSPORTATION  
OFFICE OF MATERIALS AND RESEARCH**

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**Evaluation of Recycled Rubber Mulch Products**

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16. Abstract <p>In this study, the Georgia Department of Transportation (GDOT) sought to confirm that recycled rubber mulch products provide greater service life, stability, and weed/grass control than conventional mulch materials at comparable or lower costs. Several rubber mulch products were used to replace conventional mulch materials used by GDOT for roadside enhancement and reduce or eliminate more labor-intensive forms of weed control such as repeated application of herbicides or manual (string) trimming. Five test sections were installed in GDOT District 1 (Gainesville) and four in GDOT District 7 (Metro Atlanta) in fall 1998 and monitored for 2-1/2-years. The following products were evaluated in District 1: loose mulch and preformed bench mats, trail mats, edging rolls, and tree ring mats. The following products were evaluated in District 7: pour-in-place mats, loose mulch, and preformed sign mats.</p> <p>Although rubber mulch products are expected to last 10 years and generally improve stability and weed/grass control, purchase of the products is generally not recommended in Districts 1 and 7 until prices may decrease, since rubber mulch use would be approximately 80% more expensive in District 1 and approximately 60% more expensive in District 7, all installation and maintenance costs considered. There is one exception to this recommendation, however. Some mulched areas may be extremely hard to reach or dangerous to maintain, hence higher costs would be justified due to convenience and to safety considerations.</p>			
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## EXECUTIVE SUMMARY

In this study, the Georgia Department of Transportation (GDOT) sought to confirm that recycled rubber mulch products provide greater service life, stability, and weed/grass control than conventional mulch materials at comparable or lower costs. Several rubber mulch products were used to replace conventional mulch materials used by GDOT for roadside enhancement and reduce or eliminate more labor-intensive forms of weed control such as repeated application of herbicides or manual (string) trimming. Five test sections were installed in GDOT District 1 (Gainesville) and four in GDOT District 7 (Metro Atlanta) in fall 1998 and monitored for 2-1/2-years. The following products were evaluated in District 1: loose mulch and preformed bench mats, trail mats, edging rolls, and tree ring mats. The following products were evaluated in District 7: pour-in-place mats, loose mulch, and preformed sign mats.

The pour-in-place mats held up well, but the degree of weed control provided seemed to depend on the type of slope underlying each mat. The mat installed on a concave slope experienced a large amount of weed penetration, but the mat installed on a convex slope almost none. The loose mulch stayed in place fairly well, but it did not appear to control underlying grass and weeds much better than wood mulch, and it seemed to absorb more heat. The tree ring and signs mats also stayed in place well and controlled underlying grass and weeds fairly well, except where there were placement slits in the mats. The edge rolls showed little utility, as shrubs and grass could easily overgrow them. The bench mats and trail mat controlled underlying grass and weeds well and held up to use at the Franklin County and Gwinnett County rest areas, respectively.

GDOT sought to confirm, via a cost comparison of rubber and wood mulch use, that (1) labor costs for mulch installation and maintenance were reduced by using rubber mulch, and (2) if so, the reduced labor costs offset the higher materials costs for rubber mulch. A 10-year service life was assumed for the rubber mulch, and it was assumed that wood mulch at a particular location would be replaced three times in the course of the 10-year period. The comparison indicated that the annual cost of rubber mulch use in Districts 1 and 7, respectively, would be approximately 80% (District 1) and 60% (District 7) higher than that of wood mulch use. The primary factors in these cost differences were (1) higher materials costs for the rubber mulch (both districts), and (2) high installation costs for the contractor placing the pour-in-place mats (District 7).

Although rubber mulch products are expected to last 10 years and generally improve stability and weed/grass control, purchase of the products is generally not recommended in Districts 1 and 7 until prices may decrease, since rubber mulch use would be significantly more expensive in both districts. There is an exception to this recommendation, however. Some mulched areas may be extremely hard to reach or dangerous to maintain, hence higher costs would be justified due to convenience and to safety considerations.

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# EVALUATION OF RECYLCED RUBBER MULCH PRODUCTS

## I. INTRODUCTION

In this study, the Georgia Department of Transportation (GDOT) sought to confirm that recycled rubber mulch products provide several advantages over conventional mulch products for roadside enhancement. These products, if implemented, could divert scrap tires from the solid waste stream, keeping them out of landfills and reusing them in a beneficial alternate form. Recycled rubber mulch products, hereafter referred to as rubber mulch products, are a near total reuse of scrap tires, and hence are an example of "closed loop recycling." The advantages of rubber mulch products which GDOT sought to confirm in this study are listed below:

- *Extended service life:* Rubber mulch has a projected 7-10 year service life, much longer than that of conventional wood mulches. Since the project duration was much shorter than the projected service life, GDOT opted to make a general deduction of the expected service life of the mulch based on observations of its integrity throughout the study.
- *Stability:* Rubber mulch is 3-4 times heavier than conventional wood mulch, and may be less likely to wash or blow away once applied.
- *Weed and grass control:* Rubber mulch can be used in applications such as preformed and pour-in-place mats that may offer weed and grass control not attainable with conventional mulches.
- *Cost savings:* All of the preceding advantages could contribute to reduced maintenance and, as a result, to reduced costs. Since wood mulch is generally obtained by GDOT at little or no cost, materials cost savings would probably not be realized from the use of rubber mulch, even if its extended service life is confirmed. GDOT, however, sought to confirm if labor costs were reduced by using rubber mulch, and if so, did the reduced costs offset the higher materials costs. This was to be done via a detailed cost comparison of rubber and wood mulch use.

To confirm these advantages, GDOT selected sites in which to assess the performance of rubber and wood mulches and, within the limits of the study, estimate the service lives and costs associated with use of these materials. Several forms of rubber mulch products were used at selected roadside locations in GDOT Districts One (Gainesville) and Seven (Metro Atlanta). At these locations, the rubber mulch was used to (1) replace conventional mulch materials such as pine straw, pine bark nuggets, and mixed wood mulch, and (2) reduce or eliminate more labor-intensive forms of weed control such as manual (string) trimming or repeated application of chemical herbicides. Descriptions of the various products tested, the test sites, and the test results are presented in Section II of this report.

Soil erosion control is another possible benefit of rubber mulch, but since it was only of secondary concern at the test sites selected, it was omitted from the list above. Also, as an

addendum to the product evaluations, GDOT sought to confirm with the products' manufacturer that the rubber mulch products evaluated were neither flammable nor toxic. A summary of this enquiry is provided at the end of Section II. The detailed cost comparison of rubber and wood mulch use is found in Section III, followed by conclusions and recommendations in Section IV.

## **II. TEST SITES AND RESULTS**

The paragraphs below describe the following items: (1) location of sites where rubber mulch and wood mulch materials were installed; (2) description of the product(s) evaluated at each site; (3) descriptions of the test and control section(s) at each site; and (4) overall results of quarterly evaluations at each site between December 1998 and June 2001. As an addendum, a summary of an enquiry to the rubber mulch manufacturer, concerning the flammability and toxicity of the rubber mulch, is included at the end of this section.

The following parameters were assessed for rubber and wood mulches at each site: (1) extent of displacement; (2) extent of deterioration, including fading, peeling, and cracking; (3) extent of soil erosion from underneath the mulches; and (4) extent of plant growth through the mulches.

### ***Test Site 1: I-75 southbound exit ramp onto I-285 westbound, Cobb County***

#### **Product Description**

*Pour-in-place mats* are used around irregularly shaped or spaced objects, as well as on terrain which is not level enough to accommodate a preformed mat without folding or buckling. They closely conform to the shape of the terrain on which they are placed. Pour-in-place mats can also be used on slopes or in gullies for erosion control purposes.

#### **Test and Control Section Descriptions**

A pour-in-place mat (2,000 sq. ft.) was installed adjacent to a gore area at this location, to prevent weed growth from obscuring the vision of motorists approaching the area. Installation of the mat was to reduce labor costs by eliminating herbicide application and string trimming.

To prepare the site, existing grass and weeds in the gore area were removed, landscape fabric was laid, and 1½" shredded tire chips (see Figure 1) were spread over the landscape fabric after being mixed with a pigmented polymer solution (see Figure 2). After curing, the chips had the appearance of pine bark nuggets and bonded together to form a continuous solid mat (see Figures 3 and 4). A control section was located on the grass shoulder immediately west of the gore, and received periodic herbicide application and string trimming.

#### **Results**

Numerous weeds appeared in the mat over the study duration (see Figure 5). Windblown seeds apparently germinated in the mat and sprouted upward. Also, some roots appeared to have penetrated downward into apparent gaps in the landscape fabric. Weed control may depend largely on how the underlying fabric was placed. The weeds observed did not obscure motorists' vision. The mat retained its color and integrity well, and no erosion of underlying soil was observed. The front tip of the mat was torn off at one point, likely due to an errant vehicle. The grass growth in the control section was normal and did not obstruct motorists' vision.



**FIGURE 1** Shredded tire chips used in pour-in-place mats



**FIGURE 2** Placement of pour-in-place mat



**FIGURE 3** Pour-in-place mat, I-75/I-285, upon placement (looking southwest)



**FIGURE 4 Pour-in-place mat, I-75/I-285, upon placement (looking northeast)**



**FIGURE 5 Pour-in-place mat, I-75/I-285, final evaluation**

***Test Site 2: I-20 Eastbound, Exit 29 (Maynard Terrace), Atlanta***

***Product Description***

Same as Test Site 1 above.

***Test and Control Section Descriptions***

A pour-in-place mat was installed around holly bushes in lieu of wood mulch at this exit ramp. A mat of approximately 1,364 sq. ft. was applied 1½" thick over landscape fabric (see Figure 6). Preparation of the site was essentially the same as that described under Test Site 1. A control application was located in a new shrub bed immediately adjacent to the test section, and consisted of approximately 5,000 sq. ft. of wood mulch placed 1½" thick.



**FIGURE 6 Pour-in-place mat, I-20 @  
Maynard Terrace, upon placement**

Results

The pour-in-place mat at this location performed well. Almost no weed penetration was observed nor erosion of underlying soil. The mat retained its color and integrity well, and no displacement of the mat occurred (see Figure 7). Weed penetration in the control section was slight to moderate, and no erosion of the underlying soil was observed. The wood mulch lost its color after a short time, but displacement was minimal (see Figure 8). At the close of the study, the holly bushes in the rubber mulch section were noticeably larger than those in the control section. The holly bushes in the wood mulch section may not have grown as well due to absorption of a significant amount of water by the wood mulch.



**FIGURE 7 Pour-in-place mat, I-20 @  
Maynard Terrace, final evaluation**



**FIGURE 8 Wood mulch, I-20 @ Maynard Terrace, final evaluation**

***Test Site 3: State Route (SR) 140 ("Buckhead") Loop @ SR 400, Atlanta***

**Product Description**

*Loose rubber mulch*, which is brown in color, has an appearance similar to pine bark mulch. It is used as a general purpose mulch around annuals, perennials, and shrubbery to minimize weed growth and retain soil moisture. It is normally applied 1½" - 2" deep.

**Test and Control Section Descriptions**

Loose rubber mulch (1/2" chips) was installed in two large juniper beds on SR 140 at Exit 2 of SR 400 to prevent weed growth and enhance the appearance of the beds (see Figures 9-10). Control sections of wood mulch were placed in the juniper beds adjacent to the rubber mulch. Approximately 1,080 cu. ft. of rubber mulch was placed in the two beds an average of 2" thick. Due to the large amount of rubber mulch, only about 100 cu. ft. of wood mulch was placed, and at a slightly lower thickness than the rubber mulch.



**FIGURE 9 Loose (1/2") rubber mulch, Buckhead Loop, upon placement (Bed #1)**



**FIGURE 10** Loose (1/2") rubber mulch, Buckhead Loop, upon placement (Bed #2)

Results

A large amount of rubber mulch displacement was observed in Bed #1, a sloped juniper bed on the east side of the exit, primarily in the midsection of the bed, where drainage from the pavement was concentrated (see Figure 11). The wood mulch in the adjacent control section was not in the drainage path, hence it was minimally displaced. The rubber mulch showed negligible deterioration, while the wood mulch had deteriorated moderately. The dark color of the rubber mulch seemed to absorb a great deal of heat in the bed but did not appear to have desiccated the junipers present. Per GDOT Maintenance, it quite possibly could have desiccated more moisture-sensitive shrubs.



**FIGURE 11** Loose (1/2") rubber mulch, Buckhead Loop, final evaluation (Bed #1)

Bed #2, a juniper bed on the west side of the exit, was flat, and no erosion or mulch displacement was observed. As with Bed #1, deterioration of the mulch was negligible, while deterioration of the wood mulch was moderate. In both beds, weed penetration was moderate, with the rubber mulch being slightly more effective, possibly due to its greater weight and thickness (see Figures 12-13).



**FIGURE 12 Wood and loose (1/2") rubber mulch, Buckhead Loop, final evaluation (Bed #1)**



**FIGURE 13 Loose (1/2") rubber mulch, Buckhead Loop, final evaluation (Bed #2)**

#### ***Test Section 4: Franklin County Rest Area, I-85 northbound***

##### **Product Description**

Preformed *bench mats* are used under benches to eliminate weed growth and soil erosion from the abrasive action of feet. Mats are typically 4' wide x 6' long x 1" thick and are formed to fit around rectangular bench supports. *Loose rubber mulch* is described under Test Section 3.

##### **Test and Control Section Descriptions**

Eight bench mats were used under concrete benches at the Franklin County Rest Area. Also, approximately 3,000 cu. ft. of loose mulch (1/2" chips) was installed about 1½" thick in shrub beds around the rest area. As a control application for the bench mats, wood mulch (600 cu. ft.) was placed around a picnic bench area. As a control application for the loose mulch, approximately 400 cu. ft. of wood mulch was placed 1½" thick in another shrub bed.

##### **Results**

The bench mats have retained their color, integrity, and position. Little weed penetration has been observed, and no erosion has occurred underneath the mats (see Figure 14). A small amount of loose rubber mulch slightly downhill from the rest area building washed away a number of times, since it is in the path of some drainage from the building. Minimal deterioration, underlying erosion, and weed penetration was observed in the rubber mulch, however (see Figure 15).

The wood mulch retained its color, integrity, and position as well, and few weeds were observed in it during the study (see Figures 16-17). It should be noted, however, that both the rubber mulch products and the wood mulch were in partially shaded areas, and this may have mitigated deterioration of them.



**FIGURE 14 Bench mat, Franklin County Rest Area, final evaluation**



**FIGURE 15** Loose (1/2") rubber mulch, Franklin County Rest Area, final evaluation



**FIGURE 16** Wood mulch, Franklin County Rest Area, final evaluation



**FIGURE 17** Wood mulch, Franklin County Rest Area, final evaluation

### ***Test Site 5: Gwinnett County Rest Area, I-85 northbound***

#### **Product Description**

A *walking mat* is a one piece, preformed mat which has the same general appearance as the pour-in-place mats described above. When rolled into place in the landscape, this mat has the appearance of pine bark mini-nuggets, makes an excellent walking surface, and is traversible by wheelchairs. When installing this trail mat, the soil is shaved 1" deep so that the mat can rest on the ground with its top surface flush with the ground.

#### **Test and Control Section Descriptions**

A 3' x 30' x 1" walking mat was installed in the at the Gwinnett County Rest Area on I-85 northbound to evaluate it as a pathway material in an area where repeated pedestrian traffic had worn a path in the grass and wheelchair access was not currently possible. No control application was done for the walking mat, since pedestrian traffic through grassed areas seemed to be concentrated in only one area.

#### **Results**

The mat has held up very well under a considerable amount of traffic. It has retained its color, integrity, and position, no erosion has occurred underneath it, and only minor weed penetration has been observed in it (see Figure 18).



**FIGURE 18 Trail mat, Gwinnett County Rest Area, final evaluation**

### ***Test Site 6: SR 365 (Jesse Jewel Parkway), Exit 7, Hall County***

#### **Product Description**

*Edging rolls* are preformed roll mats which are brown and have the appearance of pine bark mini-nuggets. These rolls can be used along the edges of mulched beds to (1) keep the loose mulch in place and away from mowers, (2) delineate mulched beds, and (3) keep grass and weeds out of mulched beds. The rolls were intended to eliminate the need for periodic manual trimming around mulched beds or the application of herbicides.

### Test and Control Section Descriptions

Thirty-one edging rolls, 5½" wide x 20' long x 1" thick, were used to delineate juniper beds on the embankments surrounding the SR 365 underpass at Exit 7 in Hall County (see Figure 19). The rolls were to prevent (1) encroachment of neighboring grasses into the beds, (2) weed growth around the beds, and (3) erosion of mulch during heavy rains. As a control section, one juniper bed at this location was left without edging.



**FIGURE 19** Edging roll, Jesse Jewel Parkway,  
upon placement

### Results

The edging rolls seem to have little utility in preventing the three problems listed above. Grass and weeds could easily overgrow the rolls because of the rolls' narrow width (see Figure 20). Little erosion of mulch from the beds was observed, but it is felt that the minimal thickness of the rolls could do little to prevent erosion if it occurred.



**FIGURE 20** Edging roll, Jesse Jewel Parkway,  
final evaluation

## ***Test Site 7: SR 11 (Limestone Parkway), Hall County***

### **Product Description**

*Tree ring mats* are circular mats 1" thick and are molded to slip around trees. The mats have a premolded center hole, and are slit from the center to the outside edge to facilitate placement. These mats are brown and have the appearance of pine bark mini-nuggets.

When used around trees, these mats are to provide weed control, possibly eliminating manual trimming and the need for periodic applications of herbicides to control grass and weed growth. These mats are heavy enough to remain in place when commercial maintenance equipment is used around them.

### **Test and Control Section Descriptions**

A total of 125 tree ring mulch mats (36" diameter) were placed around trees in the grassed median on SR 11 (see Figure 21). As a control application, a number of trees in the median were left without mulch around them.



**FIGURE 21 Tree ring mat, Limestone Parkway, upon placement**

### **Results**

The tree mats showed little deterioration, and no displacement or underlying erosion was observed. Weed control was good overall, but the slits cut in the mats to facilitate placement of them permitted weed growth through the slits (see Figure 22). The wood mulch placed around the street signs washed away over time, and only a small fraction of it remained around the sign posts (see Figure 23).



**FIGURE 22 Tree ring mat, Limestone Parkway,  
final evaluation**



**FIGURE 23 Wood mulch, Limestone Parkway,  
final evaluation**

***Test Site 8: (1) SR 11 (Limestone Parkway), Hall County***

***(2) I-20 Eastbound between I-75/85 and I-285, Fulton/Dekalb Counties***

**Product Description**

*Sign mats* are molded to slip around signs. These oval mats (4' at widest point) are 1" thick, have a premolded center hole, and are slit from the center to the outside edge of the mat to facilitate placement. The center hole can be square, "T" shaped, "I" shaped, circular, etc., to match the post with which the mat will be used. These mats have the same appearance as tree ring mats, serve the same purposes, and are heavy enough to remain in place when commercial maintenance equipment is used around them.

Test and Control Section Descriptions

Twenty-three 4' x 8' sign mats were installed along I-20 in Fulton County and twenty along SR 11 in Hall County for the same purposes as the tree mats described above (see Figure 24). As control section at the I-20 site, signs received periodic herbicide applications and string trimming in lieu of mulching, while at the SR 11 site, wood mulch was installed around a small number of street signs in the same corridor.



**FIGURE 24 Sign mat, Limestone Parkway, upon placement**

Results

The sign mats showed little if any deterioration, and no displacement or erosion underneath them was observed. Weed control was good overall, but the slits cut in the mats to facilitate placement of them permitted weed growth through the slits (see Figures 25-28). It is felt that the sign mats need to be enlarged to significantly facilitate mowing operations around the signs.



**FIGURE 25 Sign mat, Limestone Parkway, Final evaluation**



**FIGURE 26 Sign mat, Limestone Parkway, final evaluation**



**FIGURE 27 Sign mat, I-20, final evaluation**



**FIGURE 28 Sign mat, I-20, final evaluation**

### Toxicity and Flammability Enquiry

Per the Introduction to this report, GDOT sought to confirm that the rubber mulch products evaluated were neither flammable nor toxic, by enquiry to the manufacturer of the products. Per the manufacturer, the rubber mulch is not highly flammable, and waste tobacco products are unlikely to ignite it. The manufacturer cited the experience of South Carolina DOT, which has used rubber mulch products at selected rest areas for over three years, and no fire problems have occurred. Regarding toxicity, the manufacturer submitted a Materials Safety Data Sheet (see Appendix A), which affirmed that the rubber mulch products evaluated were non-toxic under normal conditions of use. Since vulcanized rubber is essentially an inert material, leaching of harmful substances is unlikely, with the possible exception of zinc, which is quite beneficial to some plants and harmless to others.

## **III. COST COMPARISON**

As stated in the Introduction, one of the potential benefits of rubber mulch which GDOT sought to confirm in this study was cost savings. The extended service life, stability, and weed/grass control provided by rubber mulch could contribute to reduced maintenance and, as a result, to reduced costs. Since wood mulch is generally obtained by GDOT at little or no cost, materials cost savings would probably not be realized from the use of rubber mulch, even if its extended service life was confirmed. GDOT, however, sought to confirm if labor costs were reduced by using rubber mulch, and if so, did the reduced costs offset the higher materials costs. This was to be done via a detailed cost comparison of rubber and wood mulch use. Separate cost comparisons were done for Districts 1 and 7, since the source of labor costs differed by district, as well as the degree of maintenance performed on rubber and wood mulch.

### **A. Costs for Rubber Mulch Installation**

The first element in the cost comparison was to compute the costs associated with installation of the various rubber mulch products, as shown in Table 1. Baseline cost data for the installation of the various products is shown in Appendix B. Materials costs, wage rates, and travel costs at the time the mulch was installed (fall 1998) were adjusted for inflation to 2001 levels.

In District 1, all of the rubber mulch products to be evaluated were installed by District 1 personnel. In District 7, the sign mats were installed by District 7 personnel, but the pour-in-place mats and loose mulch were installed by respective contractors. The square yard was chosen as the base unit of material for the entire cost comparison. The unit cost of materials for the pour-in-place mats was assumed to equal that for the loose mulch. A 10-year service life was assumed for the rubber mulch.

### **B. Costs for Wood Mulch Installation**

The next element in the cost comparison was to compute the costs associated with installation of wood mulch in lieu of rubber mulch. As stated above, wood mulch is generally obtained by GDOT at little or no cost, hence the materials costs of the wood mulch is assumed to be zero in this cost comparison. Unit costs of labor and travel for wood mulch installation are assumed to equal those for rubber mulch installation, except for the pour-in-place mats and the loose mulch, where a contractor labor rate (Contractor 2 in Appendix B) was assumed.

Per GDOT Maintenance, it was assumed that wood mulch at a particular site would be replaced by Contractor 2 three times every ten years, the projected service life of rubber mulch; hence, the costs per wood mulch installation shown in Table 2 are tripled to obtain 10-year totals.

**TABLE 1 Costs for Rubber Mulch Installation**

GDOT District	Material	Total Area (sq. yd.)	Costs per installation (\$)			10-year Total Cost (\$)	Annual Cost (\$)
			Total Materials	Total Labor	Total Travel		
1	Loose mulch	1,987	13,734.00	1,161.51	105.41	15,000.92	1,500.09
"	Bench mats	21	889.44	12.28	1.11	902.83	90.28
"	Walking mat	10	416.93	5.84	0.53	423.3	42.33
"	Edging rolls	32	1,022.86	18.71	1.70	1,043.27	104.33
"	Tree ring mats	98	3,474.38	57.29	5.20	3,536.87	353.69
"	Sign mats	71	2,158.20	41.50	3.77	2,203.47	220.35
<b>Totals</b>		2,219	21,695.81	1,297.13	117.72	23,110.66	2,311.07
7	Pour-in-place mats	767	3,950.05	8,776.79	26.16	12,753.00	1,275.30
"	Loose mulch	960	4,944.24	594.70	52.32	5,591.26	559.13
"	Sign mats	82	2,481.93	336.68	31.07	2,849.68	284.97
<b>Totals</b>		1,809	12,739.17	9,708.17	109.55	21,193.94	2,119.40

**TABLE 2 Costs for Wood Mulch Installation**

GDOT District	Material	Total Area (sq. yd.)	Costs per installation (\$)		10-year Tot. Cost (\$)	Annual Cost (\$)
			Total Labor	Total Travel		
1	Loose mulch	1,987	1,161.51	105.41	3,800.76	380.08
"	Bench mats	21	12.28	1.11	40.17	4.02
"	Walking mat	10	5.84	0.53	19.11	1.91
"	Edging rolls	32	18.71	1.70	61.23	6.12
"	Tree ring mats	98	57.29	5.20	187.47	18.75
"	Sign mats	71	41.50	3.77	135.81	13.58
<b>Totals</b>		2,219	1,297.13	117.72	4,244.55	424.46
7	Pour-in-place mats	767	475.14	26.16	1,503.90	150.39
"	Loose mulch	960	594.70	52.32	1,941.06	194.11
"	Sign mats	82	336.68	31.07	367.75	36.78
<b>Totals</b>		1,809	1,606.3	109.55	3,812.71	381.28

**C. Costs for Herbicide Application and String Trimming**

The next element in the cost comparison was to compute the costs associated with routine maintenance, namely herbicide application and string trimming, at sites where rubber mulch and wood mulch were used. These costs are shown in Table 3. Per GDOT Maintenance, (1) these costs were negligible for District 1 and were computed only for District 7; (2) the costs are for contractor (Contractor 2 in Appendix B) materials, labor, and travel (see Appendix B for labor

and travel rates); and (3) one herbicide application and one string trimming per year was estimated for sites where rubber mulch is used, while four herbicide applications and three string trimmings per year were assumed for sites where wood mulch is used.

Materials costs for herbicide applications pertained to the herbicide used, while materials costs for string trimming pertained to gasoline used to operate the trimming equipment. Total labor costs assume a two-man crew (no foreman) for herbicide applications and string trimmings, respectively. Travel costs were estimated from those associated with rubber and wood mulch installations by Contractor 2. Also per GDOT Maintenance, annual costs assume that a separate trip is made for each herbicide application and string trimming. Hence, a total of two trips per year are made for rubber mulch and seven trips per year for wood mulch.

**TABLE 3 Costs for Herbicide Application and String Trimming**

<b>GDOT District</b>	<b>Material</b>	<b>Total Area (sq. yd.)</b>	<b>Materials Cost/Herbicide (\$)</b>	<b>Materials Cost/Trimming (\$)</b>	<b>Labor Cost/Herbicide (\$)</b>	<b>Labor Cost/Trimming (\$)</b>	<b>Travel Cost/Trip (\$)</b>	<b>Annual Cost: Rubber (\$)</b>	<b>Annual Cost: Wood (\$)</b>
7	Pour-in-place mats	767	1.90	0.32	7.61	7.61	26.16	69.75	244.92
"	Loose mulch	960	2.38	0.40	9.52	9.52	13.08	47.98	168.92
"	Sign mats	82	0.20	0.03	0.81	0.81	13.08	28.02	98.17
<b>Totals</b>		1,809	4.49	0.75	17.94	17.94	52.32	145.75	512.01

**D. Total Annual Costs for Rubber Mulch and Wood Mulch Use**

The next element in the cost comparison was to compute the total annual costs for rubber and wood mulch use. The respective annual costs were computed by adding the annualized installation costs from Tables 1 and 2 and the annual herbicide/string trimming costs.

**TABLE 4 Total Annual Costs for Rubber Mulch and Wood Mulch Use**

<b>GDOT District</b>	<b>Material</b>	<b>Tot. Area (sq. yd.)</b>	<b>Annual Rubber Mulch Costs (\$)</b>	<b>Annual Wood Mulch Costs (\$)</b>
1	Loose mulch	1,987	1,500.09	380.08
"	Bench mats	21	90.28	4.02
"	Walking mat	10	42.33	1.91
"	Edging rolls	32	104.33	6.12
"	Tree ring mats	98	353.69	18.75
"	Sign mats	71	220.35	13.58
<b>Totals</b>		2,219	<b>2,311.07</b>	<b>424.46</b>
7	Pour-in-place mats	767	1,345.05	395.31
"	Loose mulch	960	607.11	363.03
"	Sign mats	82	312.99	134.95
<b>Totals</b>		1,809	<b>2,265.15</b>	<b>893.29</b>

### E. Average Unit Costs for Rubber Mulch and Wood Mulch Use

The final element in the cost comparison was to compute the average unit costs for rubber and wood mulch use. The total annual costs of rubber and wood mulch use by district (see Table 4) were divided by the total area of coverage per material to obtain an average unit cost per material for a 10-year period, and hence obtain a general estimate of the difference in costs. The average unit costs in Table 5, expressed in dollars per square yard, are derived from the figures in Table 4 by dividing the boldface figures in columns 4 and 5 of Table 4 by the "Total Area" totals in column 3 of Table 4 (2,219 sq. yd. and 1,809 sq. yd.).

**TABLE 5 Average Unit Costs for Rubber Mulch and Wood Mulch Use**

District	Average Unit Cost (\$/sq. yd.)	
	Rubber mulch	Wood mulch
1	1.04	0.19
7	1.25	0.49

### E. Comments on Cost Comparison

Per Table 1, the 10-year and annual costs for rubber mulch installation in Districts 1 and 7 were similar, although less rubber mulch was installed in District 7. The underlying reason for the higher installation costs in District 7 was contractor labor costs for the pour-in-place mats.

As shown in Table 2, the total costs for wood mulch installation were similar, since the costly labor for the pour-in-place contractor was removed, and the less expensive labor of Contractor 2 was substituted. Per Table 3, the differences in annual rubber and wood mulch maintenance costs were essentially due to the number of trips required for herbicide application and string trimming. Table 4 indicates that the total annual cost of wood mulch use is significantly less than that of rubber mulch use in both Districts 1 and 7. In District 1, this was due to the higher material costs of the rubber mulch. In District 7, this was due to higher material costs and primarily, to the high labor costs associated with the pour-in-place mats. Wood mulch use was more expensive in District 7, due to the herbicide and string trimming requirements. The average unit costs in Table 5 mirror the differences in total annual costs found in Table 4.

## IV. CONCLUSIONS AND RECOMMENDATIONS

In this special research study, GDOT sought to confirm that recycled rubber mulch products provide better service life, stability, weed and grass control than conventional mulch materials at comparable or lower costs. After a 2-1/2 year evaluation period, the following results were observed in the test sites selected for this study. The pour-in-place mats maintained their integrity well, but the degree of weed control provided seemed to depend on the type of slope underlying each mat. The mat installed on a concave slope experienced a large amount of weed penetration, but the mat installed on a convex slope almost none. Windblown seeds could germinate quite easily on top of the concave mat. The loose mulch stayed in place fairly well, but it did not appear to control underlying grass and weeds much better than wood mulch, and it seemed to absorb more heat. The tree ring and signs mats also stayed in place well and controlled

underlying grass and weeds fairly well, except where there were placement slits in the mats. Grass could penetrate the mats, apparently in weak points, and windblown seeds could germinate easily on top of the mats, as with the pour-in-place mats. The edge rolls showed little utility, as shrubs and grass could overgrow them easily. The bench mats controlled underlying grass and weeds well, as did the foot trail, and held up to use at Franklin and Gwinnett County Rest Areas, respectively. As an addendum to the product evaluations, GDOT sought to confirm that the rubber mulch products evaluated were neither flammable nor toxic, by enquiry to the manufacturer of the products. Per the manufacturer, the rubber mulch is not highly flammable and is non-toxic under normal conditions of use.

GDOT sought to confirm, via a cost comparison of rubber and wood mulch use, that (1) labor costs for mulch installation and maintenance were reduced by using rubber mulch, and (2) if so, the reduced labor costs offset the higher materials costs for rubber mulch. A 10-year service life was assumed for the rubber mulch, and it was assumed that wood mulch at a particular location would be replaced three times in the course of the 10-year period. The comparison indicated that the annual cost of rubber mulch use in Districts 1 and 7, respectively, would be approximately 80% (District 1) and 60% (District 7) higher than that of wood mulch use. The primary factors in these cost differences were (1) higher materials costs for the rubber mulch (both districts), and (2) high installation costs for the contractor placing the pour-in-place mats (District 7).

Although rubber mulch products are expected to last 10 years and generally improve stability and weed/grass control, purchase of the products is not recommended in Districts 1 and 7 until prices may decrease, since rubber mulch use would be significantly more expensive in both districts. There is an exception to this recommendation, however. Some mulched areas may be extremely hard to reach or dangerous to maintain, hence higher costs would be justified due to convenience and to safety considerations.

If GDOT should opt to purchase rubber mulch products in the future, the following recommendations on further use of the rubber mulch products evaluated are offered, by consensus of the Offices of Maintenance and Materials and Research:

- *Pour-in-place mats* may be useful in the following settings: (1) convex slopes where little windblown debris is likely to accumulate, (2) slopes which are difficult to access and maintain; and (3) gore areas where it may be less practical to use pavement.
- Use of *loose mulch* should not be pursued at this time, due to cost and, in some cases, excessive heat production.
- *Sign mats* would need to be enlarged to facilitate GDOT mowing operations, and the placement slits should be glued after placement to prevent grass and weed penetration.
- Use of *edge rolls* in their present form should not be pursued, as they can be overgrown easily and hence seem to have little utility for roadside enhancement applications.
- *Bench mats* might be used to control weeds around benches, but since benches in GDOT rest areas are typically surrounded by concrete, there may be little use for these mats.
- *Trail mats* are clearly useful for cut-through areas at rest areas, but very few such areas have been observed in the Georgia rest areas, hence there may not be a great need for the trail mats.

- As with the sign mats, the placement slits of the *tree ring mats* would need to be glued after placement to prevent grass and weed penetration. Also, as tree trunks expand, it may be necessary to cut larger holes in the mats.

## **APPENDICES**

**Appendix A:**  
**Materials Safety Data Sheet for Rubber Mulch**

**PHOENIX RECYCLED PRODUCTS  
MATERIAL SAFETY DATA SHEET**  
Product Name: Perm-A-Mulch Mulch Mats

Date Created/Revised: 08/09/01

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1.0 PRODUCT AND COMPANY INFORMATION	
<b>PRODUCT NAME</b>	Perm-A-Mulch Mulch Mats
<b>COMMON NAME</b>	Mulch Mats
<b>PRODUCT USE</b>	Phoenix Recycled Products 360 West Church Street
<b>MANUFACTURER</b>	Batesburg, SC (803) 532-4425
<b>EMERGENCY PHONE NUMBER</b>	(803) 532-4425

2.0 HAZARDOUS INGREDIENTS		
CHEMICAL NAME (CAS NUMBER)	WEIGHT %	1998 ACGIH TLV-TWA, OSHA - PEL
None		

3.0 HAZARD IDENTIFICATION	
<b>EMERGENCY OVERVIEW</b>	<p>This material is not expected to present a health or safety hazard under normal conditions of use. Hazardous vapors and fumes may be released if this material is burned. Irritating dust may be produced if this material is ground or cut with a saw.</p> <p>Eye and skin contact, inhalation of dust or combustion vapors.</p> <p>Eye irritation may occur as a result of exposure to dust from grinding or sawing or as a result of exposure to fumes/vapors released from burning or thermally decomposing material.</p> <p>Skin irritation is unlikely but may occur from exposure to the dust produced by grinding or sawing the material.</p> <p>Respiratory tract irritation may be caused by exposure to the dust from ground material or as a result of exposure to fumes/vapors released from burning or thermally decomposing material.</p> <p>Inhalation of dust, fumes, or vapors may aggravate asthma and inflammatory or fibrotic pulmonary disease. Sensitive individuals may experience an allergic response upon eye, skin, or inhalation exposure.</p> <p>None listed.</p>
<b>ROUTES OF EXPOSURE</b>	
<b>SYMPTOMS OF EXPOSURE</b>	
<b>Eyes</b>	
<b>Skin</b>	
<b>Inhalation</b>	
<b>MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE</b>	
<b>CARCINOGENICITY</b>	

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<b>4.0 EMERGENCY AND FIRST AID PROCEDURES</b>	
<b>FIRE FIGHTING</b>	Stable under normal conditions of usage and storage.
<b>Flash Point/Flammable Limits</b>	Not flammable
<b>Extinguishing Media</b>	Water, foam, or dry chemical. Use dry chemical extinguishers if fighting an electrical fire.
<b>Flammability Classification</b>	Class A - ordinary combustible
<b>Fire Fighting Instructions</b>	Use care to avoid spreading molten, burning material. Use a Self-Contained Breathing Apparatus (SCBA) and protective clothing if there is the potential for exposure to vapors or smoke from the burning product.
<b>FIRST AID</b>	
<b>Eye Contact</b>	Flush affected eye with water for at least 15 minutes to remove particulate matter. Consult a physician.
<b>Skin Contact</b>	Wash affected area with soap and water. Consult a physician in case of skin irritation or skin rash.
<b>Inhalation</b>	Remove to fresh air. Consult a physician if breathing is difficult.
<b>NOTE TO PHYSICIAN</b>	No specific treatment. Treatment should be directed at the control of the symptoms and the clinical condition.

<b>5.0 PHYSICAL AND CHEMICAL DATA</b>	
<b>APPEARANCE</b>	Rubber-like mat
<b>PHYSICAL STATE</b>	Solid
<b>VAPOR PRESSURE</b>	N/A
<b>SOLUBILITY IN WATER</b>	Insoluble

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<b>6.0 STABILITY AND REACTIVITY</b>	
<b>STABILITY</b>	Stable under normal conditions of usage and storage.
<b>INCOMPATIBILITY</b>	May react with strong oxidizers or acids.
<b>HAZARDOUS DECOMPOSITION PRODUCTS</b>	Thermal and electrical arc decomposition products may include toxic and/or corrosive vapors and aerosols.
<b>REACTIVITY</b>	Inert

<b>7.0 HANDLING AND STORAGE MEASURES</b>	
<b>HANDLING</b>	Special handling is not necessary under normal conditions of use. Use appropriate protective equipment when unusual conditions result in the generation of vapors, dust, or smoke.
<b>STORAGE</b>	Store at ambient temperature. Avoid contact with flame or high heat sources.

<b>8.0 ENGINEERING CONTROLS/PERSONAL PROTECTION/SPILL CONTROL</b>	
<b>ENGINEERING CONTROLS</b>	General mechanical ventilation usually is adequate to control potential exposure to vapors and dusts. Unusual situations involving the release of significant quantities of vapor or dust, or operation in an enclosed or confined space may require additional and/or local exhaust ventilation.
<b>PERSONAL PROTECTIVE EQUIPMENT</b>	
<b>Eye Protection</b>	Safety glasses
<b>Skin Protection</b>	Not necessary under normal conditions of use. If prolonged or repeated contact is necessary, protective gloves and clothing should be worn.
<b>Respiratory Protection</b>	Use a NIOSH approved respirator, selected in accordance with OSHA 29 CFR 1910.134, when exposed to dusts or vapors from the material.
<b>SPILL CONTROL</b>	No special procedures normally are required for clean up of spilled or waste material. Dispose of in accordance with applicable federal, state, and local regulations.

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<b>9.0</b>		<b>REGULATORY INFORMATION</b>
<b>TSCA</b>	All chemicals used to manufacture this product are listed on the TSCA inventory or are exempt from TSCA Inventory requirements.	

Phoenix Recycled Products believes that the preceding information and recommendations are accurate as of the indicated MSDS revision date. However, no warranty or representation, express or implied, is made concerning the accuracy or completeness of the information. This information relates only to the specific product designated and may not be valid where the product is used in combination with any other materials or in any process. Further, since the conditions and methods of use of the product and of the MSDS information are beyond the control of Phoenix Recycled Products, Phoenix Recycled Products expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.

**Appendix B:**  
**Baseline Cost Data for Rubber Mulch Installations**

## Baseline Cost Data for Single Rubber Mulch Installation

### Materials Costs

District	Material	Quantity	Unit	2001 Cost (\$)
1	Loose mulch	3000	cu. ft.	13,734.00
"	Bench mats	8	mat	889.44
"	Walking mat	1	mat	416.93
"	Edging rolls	31	roll	1,022.86
"	Tree ring mats	125	mat	3,474.38
"	Sign mats	20	mat	2,158.20
<b>Total</b>				<b>21,695.80</b>
7	Pour-in-place (gore)	900	sq. ft.	515.22*
"	Pour-in-place (slope)	6000	sq. ft.	3,434.83*
"	Loose mulch	1080	cu. ft.	4,944.24
"	Sign mats	23	mat	2,481.93
<b>Total</b>				<b>7,426.17</b>

\*Materials costs assessed by contractor.

### Labor Costs

District	Labor	Hours	Wage (\$)	2001 Cost (\$)
1	EOIII	24	18.48	483.44
"	EOII	24	13.51	353.42
"	Subtotal			836.86
"	Overhead*			460.27
<b>Total</b>				<b>1,297.13</b>
7	Foreman	8	24.91	217.22
"	Overhead*			119.47
<b>Total</b>				<b>336.68</b>
Contract. 1				<b>8,776.79</b>
Contract. 2	Foreman	8	20	174.40
"	Crew (2)	16	12	209.28
"	Subtotal			383.68
"	Overhead*			211.02
<b>Total</b>				<b>594.70</b>

\*All overhead rates are 55%.

### Travel Costs

District	Vehicle	Quantity (miles)	Unit Cost (\$/mile)	2001 Cost (\$)
1	Crew Cab	170	0.24	44.47
"	Pool Car	480	0.14	73.25
<b>Total</b>		650		<b>117.72</b>
7	Pickup	150	0.19	31.07
Contract. 1	Crew Cab	100	0.24	26.16
Contract. 2	Crew Cab	200	0.24	52.32