REPORT OF THE
VIRGINIA DEPARTMENT OF TRANSPORTATION
IN RESPONSE TO SENATE BILL 469 (1992) ON

The Use of Recycled Materials in Highway Construction

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

SENATE DOCUMENT NO. 53

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PREFACE

The Virginia Department of Transportation (VDOT) under the direction of Ray D. Pethtel, Commonwealth Transportation Commissioner, was directed by the 1992 General Assembly through Senate Bill 469 to create a Committee to study the use of waste glass and other recycled waste materials in highway construction and make recommendations to VDOT on methods of using these recycled materials. VDOT was to develop specifications to use glass and other materials based on these recommendations.

The Committee was also to develop guidelines for a five year plan to encourage the use of recycled materials.

The Committee was to be composed of at least one member from each of the following organizations:

Va. Department of Transportation
Va. Road & Transportation Builders Assn.
Va. Aggregate Assn.
Va. Asphalt Assn.
Va. Waste Industries
Va. Dept. of Waste Management
Virginians for Recycling, Inc.
Local Government Organizations

A report of this effort was to be made to the 1994 General Assembly.

The Committee looked into the use of glass and other materials in the following categories:

1. Glass
2. Tires
3. Plastics
4. Yard Waste/Wood Waste, Concrete & Paper
5. Aggregate Fines
6. Roofing Materials
7. Bituminous Concrete

Recommendations were made for use of glass, tires, plastics, wood, concrete, paper and bituminous concrete.

VDOT has developed specifications in each of the categories.

A plan was proposed by the Committee to encourage the use of recycled materials. This plan consists of actions to

allow continuing efforts to identify, experiment with and write specifications for waste materials. It also provides for an educational process to increase the level of awareness of everybody involved in the beneficial use of recycled waste materials in highway construction. Many new processes and products are being developed using recyclable materials and VDOT has in place a New Products Committee to address the possible use of these products.

It is the intent of the Committee to remain in place for the next five years to provide a contact point for those interested in recycling. This Committee can also serve to encourage the use of recycled products that have proven value in highway construction.

EXECUTIVE SUMMARY

This report was prepared for the Recycled Materials in Highway Construction Advisory Committee by W. L. Hayden, State Materials Engineer for the Virginia Department of Transportation (VDOT), in response to Senate Bill 469 which requested VDOT to establish a committee to review and prepare methods to allow and encourage recycled products in highway construction.

The Committee reviewed many products and waste materials that are being reprocessed, or have a potential for being reprocessed, for use in highway construction. The final action of the Committee was to recommend that the VDOT prepare specifications for recycled products in the following areas:

- Recycled glass
- Recycled tire rubber
- Recycled plastics
- Recycled wood and paper
- Recycled concrete
- Recycled asphalt pavements

The Committee reviewed the availability of various waste materials and processes that have been developed before recommending these areas of use and determined that the processes exist and enough material is available to make specifications feasible. The Committee recommended that specifications be developed and introduced in such a way as to allow the recycled products to be competitively bid with other products and processes. VDOT conducted a literature review, tried experimental projects and developed specifications to accomplish the Committee's recommendations in each of the areas.

The Committee also recommended that the legislature direct the Committee to remain standing for a period of 5 years to serve as a reviewer of new recycled processes and recycled products in order that the industry, waste collection agencies and others having an interest in finding new markets for recycled products might have someone to contact. It is believed that this Committee could serve as a mechanism to investigate the potential for new recycled highway products that are being proposed to legislative committees.

INTRODUCTION

Senate Bill 469 (see Appendix I) directed the Virginia Department of Transportation to create a Recycled Materials in Highway Construction Advisory Committee to make recommendations to the VDOT regarding the use of recycled materials in highway construction. The Committee was composed of the following:

Members of Committee

Walton L. Hayden	Virginia Department of Transportation-(Materials Div.)
Earl Robb	Virginia Department of Transportation (Environmental Division)
Bill Maupin	Virginia Department of Transportation- (Research Council)
Bill Richards	Va. Road & Transp. Builders Assn.
Tom Carroll	Va. Aggregate Association
Richard Schreck	Va. Asphalt Association
Paul Gilbert	Va. Waste Industries
Allan Lassiter	Va. Dept. of Waste Management
Paul Hughes	Virginians for Recycling, Inc.
Scott St. Clair	Fairfax Dir. of Maint. & Constr.

PURPOSE

The purpose of this Committee was to identify waste products that can be recycled to become useful highway construction materials and recommend specifications to allow the use of these waste materials.

SCOPE

Because of the wide variety of materials that could possibly be used, the Committee's first effort was to enlist the aid of the Virginia Department of Transportation's Research Council to conduct a literature review to determine which waste products are presently being used by other states or agencies.

Based on this review, the Committee decided to list the waste materials that had the most potential for use in seven categories as follows:

1. Glass
2. Tires
3. Plastics
4. Yard Waste/Wood Waste, Concrete, Old Newspaper
5. Aggregate Fines
6. Roofing Materials
7. Bituminous Concrete

GLASS

Recycled glass has been used in several places around the country. The Committee made a concerted effort to find out how much glass is available for use in Virginia. VDOT's Research Council produced a technical assistance report on the use of glass in highway construction (see Appendix II).

The literature review identified that there were 140,000 tons of waste glass generated in Virginia annually. Of that about 15,000 to 40,000 tons were not presently being recycled. Some localities classify glass to remove the recyclable glass (clear waste glass and some specific type bottles) and then waste or landfill the broken and small pieces (under 2"). This colored, small, and broken glass could be made available for highway construction if specifications allow its use. The Committee identified two areas of possible use, in asphalt pavements and in highway embankments.

Inasmuch as asphalt concrete pavements are a very critical construction item and research has shown that asphalt pavement containing glass has durability problems, it was decided to consider only limited use of glass in asphalt pavements.

The use of glass in embankments did not pose the same problems and the amount of waste glass available (15,000 to 40,000 tons) could easily be used in embankment construction. The cost may be much higher than normal embankment materials depending on where the embankment is in relation to the glass collection source. The Committee decided to recommend that the Department of Transportation develop permissive specifications and let the market place decide if it is economically feasible to use. It may be that waste facilities will actually pay to have the material used by others rather than landfill it, thus, making it economically feasible.

It was recommended that the Department of Transportation develop specifications for embankments using waste glass.

TIRES

The next area studied was the use of waste tires. It is estimated that Virginia generates approximately 3 to 4 million waste tires a year. The ISTEA Bill requires Virginia to use 20# of waste tire rubber per ton of asphalt in 5% of all federal aid asphalt pavements in 1994 and to increase that use to 10% of the federal aid pavements in 1995, 15% in 1996 and 20% in 1997 and beyond. Virginia Department of Transportation has developed specifications and a plan to use the tire rubber in asphalt pavements as required.

It was determined that while this use is required and will be accomplished in accordance with the law, that more waste tires could be used if permissive specifications were developed to allow the use of waste tire rubber in embankment construction.

The Department of Transportation undertook an experimental project to use tire rubber in a 50% soil-tire blend to construct embankments. VDOT was able to satisfactorily construct a fill of approximately 930 feet in length, 4 lanes wide to a height of 20 feet using shredded tires and soil. The experimental project used 2.5 million tires and is performing well.

The cost of using tire rubber in embankment construction was more than using regular soil embankment but the Committee concluded that there may be some off sets in cost if those who are charged with disposing of waste tires were given the opportunity to support the construction activity by paying contractors to use the materials. The contractor could use the tires if the specifications were made permissive. It was, therefore, decided to recommend that VDOT develop permissive specifications to allow the use of shredded tires in embankment construction and let the economics of the situation be worked out in the market place.

The Committee recommended that the Department of Transportation develop specifications for tires in embankments. The Department of Transportation developed the specifications.

PLASTICS

The next area studied was the use of plastics. There are certain products available that use plastics and recycled plastics. Most notable are polymers in asphalts, posts and guardrail block outs.

The Committee recommended that the Department of Transportation continue to allow, and try to expand the use of recycle plastics.

The Department of Transportation is developing specifications for the guardrail blocks and is seeking an experimental project for the use of the posts.

YARD WASTE/WOOD PRODUCTS

The Committee looked into the use of yard waste and wood products. It was determined that the Department of Transportation already uses wood waste as brush barriers for

siltation control and wood chips as mulch. There are specifications that allow processed wood waste in Virginia Department of Transportation construction.

CONCRETE

The Committee looked into the use of recycled concrete. It was determined that the Virginia Department of Transportation already uses recycled concrete for fill material. VDOT also allows the use of crushed concrete for aggregate subbase materials and embankment construction.

The Committee recommended that VDOT consider the use of crush concrete pavements in new concrete construction. There are recognized problems with using recycled concrete in new structural grade concretes but it was thought that the problems may be solved through selective use.

The Virginia Department of Transportation agreed to experiment in this area and has developed specifications for one project and will continue to look at the process through its' Research Council.

NEWSPAPERS/WASTE PAPER

The Committee looked into the use of recycling waste paper into a useful highway construction material. It was determined that this is already allowed under VDOT specifications. Wasted recycled paper is used as mulch during the seeding of highway right-of-way.

AGGREGATE FINES

The Committee also looked at the possibility of using more aggregate fines from quarry waste. No use was found for an unclassified fine aggregate, however, one area of possible use would be as embankment materials if they are mixed with enough suitable material to create a stable fill with CBR values as high as or higher than the available borrow material. The Virginia Department of Transportation specifications already allow this use. The transportation cost may be prohibitive because the materials will be competing with local soil material.

The Committee made no recommendation on this area as it was thought that VDOT specifications would allow the use of the material if properly processed.

ROOFING MATERIALS

The Committee looked into the use of roofing materials for asphalt pavements. During the limited time this Committee had to work in this area, it was unable to

determine that this was a viable product for highway construction. No specifications or processes are known to already exist. Inasmuch as roofing materials are made up of asphalt and aggregates, it was deemed desirable to investigate further. There was concern that past consumer waste was contaminated with nails and other foreign material. The industrial waste may generate a more acceptable material.

The Committee recommended that the Department of Transportation have its Research Council conduct research in this area for possible future use if it is found that a reasonable supply of this material is available and a proper asphalt mixture can be developed.

There are patching materials in existence and the Department of Transportation purchases this type material.

RECYCLED BITUMINOUS CONCRETE

The Committee looked into the use of reclaimed asphalt pavement (RAP). It was determined that approximately 500,000 tons of asphalt pavement is removed from city streets and highways annually. It was noted that asphalt pavements are completely recyclable.

The Committee determined that the VDOT was presently recycling most of this material but had limits on the allowable percentages. The Committee recommended that the VDOT develop specifications to allow a greater use of reclaimed asphalt pavement.

VDOT is developing specifications to allow for an increased use of reclaimed asphalt pavements by allowing exceptions to maximum limits.

CONCLUSION

The Committee determined that there are many waste materials that have a potential for recycling, but products/processes have not been developed for them, as of yet. The Committee felt that it could only recommend those products outlined in this report. The Committee recommends that the Review Committee be continued for a period of five years to evaluate annually the Department's progress in utilizing recycled products. The Committee believes that it could serve as a contact point for producers of recycled products and a clearinghouse for new ideas that may or may not have highway construction application. The Committee could meet once a year to determine if the products have any highway construction application and if they are produced in enough quantity to make them a viable item. The make up

of the Committee is such that waste products would be evaluated objectively as state agencies, local governments, construction industry and recycling interest are all represented.

It was also decided that the most practical way to utilize recycled products was to make sure that specifications were made permissive where there were products that have proven performance. This is a constantly evolving area as more and more products are developed and produced. This evolutionary process must be constantly monitored in order to be kept current on products, specifications and research.

RECOMMENDATIONS/ACTION

RECOMMENDATION

The Review Committee recommended a specification for use of glass in highway embankments.

ACTION

The Department of Transportation developed a specification for recycled glass in embankment construction.

RECOMMENDATION

The Review Committee recommended a specification for the use of waste tire rubber in asphalt pavements in accordance with the ISTEA Bill. Under this bill Virginia will have a plan to use waste tire rubber in 10% of the federal-aid asphalt pavements in 1995, 15% in 1996 and 20% in 1997 and beyond in accordance with the law. If the law is changed, the plan will be reviewed to comply.

ACTION

The Department developed a specification for the use of waste tire rubber in asphalt pavements.

RECOMMENDATION

The Review Committee recommended a specification for waste tire rubber in highway embankments.

ACTION

The Department developed a specification for the use of waste tire rubber in highway embankments.

RECOMMENDATION

The Review Committee recommended that the Department allow recycled plastics in highway construction.

ACTION

The Department is developing specifications that allow recycled plastic in certain manufacturer's products such as polymers in asphalt cement.

ACTION

The Department is developing specifications that will allow use of recycling plastics in fence post and guardrail blockouts. The research is complete in these areas and draft specifications have been developed.

RECOMMENDATION

The Review Committee recommended that the Department of Transportation use wood waste where possible.

ACTION

The Department has specifications on wood cellouse products that will allow recycled wood in mulches.

RECOMMENDATION

The Review Committee recommended that the Department of Transportation conduct research on the use of recycled concrete in construction.

ACTION

The Department has set-up a project that will allow waste concrete to be reprocessed as an aggregate for new concrete. The Department is also conducting research to determine if a greater use of recycled concrete will be feasible from a performance standpoint.

RECOMMENDATION

The Review Committee recommended that the Department of Transportation make use of waste paper products.

ACTION

The Department has specifications to allow the use of recycled paper products as mulch.

RECOMMENDATION

The Review Committee recommended that the Department of Transportation conduct research on the use of recycled roofing materials.

ACTION

The Department will continue research in this area.

RECOMMENDATION

The Review Committee recommended that the Department develop specifications to allow the use of Recycled Asphalt Pavements in highway construction.

ACTION

The Department has specifications to allow Recycled Asphalt Pavements in highway construction.

RECOMMENDATIONS TO ENCOURAGE THE USE OF RECYCLED MATERIALS

The Advisory Committee was also charged with making recommendations to the Department on the components of a five-year plan for encouraging the increased use of recycled glass and other recyclable materials in highway construction.

The Advisory Committee makes the following recommendations:

1. Remove impediments against recycling from specifications where equal or better products exist.

2. Continue to conduct research and perform evaluations of recycled products that are presented by manufacturers and have creditable background test results.

3. Develop permissive specifications on recycled products that have proven records of performance.

4. Advise local governments who collect waste materials of VDOT specifications which allow the use of certain waste as recycled materials in highway construction.

5. Use the Technology Transfer courses conducted by the VDOT's Research Council to advise highway construction agencies of new developments in the use of recycled materials.

6. Advise DEQ of specifications that allow recycled materials as they are developed so they will be able to encourage the recycling industries of potential markets.

7. Use VDOT Research Advisory Committees to identify new recycled materials that have highway construction application.

8. Request cities and counties to provide VDOT or DEQ information on all waste materials being diverted from their waste streams that have potential highway construction application.

APPENDIX I

1992 SESSION

VIRGINIA ACTS OF ASSEMBLY - CHAPTER 255

An Act to amend the Code of Virginia by adding in Article 1.1 of Chapter 1 of Title 33.1 a section numbered 33.1-23.5:2, relating to use of certain recycled materials in highway construction.

[S 469]

Approved MAR 13 1992

Be it enacted by the General Assembly of Virginia:

1. That the Code of Virginia is amended by adding in Article 1.1 of Chapter 1 of Title 33.1 a section numbered 33.1-23.5:2 as follows:

§ 33.1-23.5:2. Use of recycled materials in highway construction.—The Department shall create a Recycled Materials in Highway Construction Advisory Committee which shall include, but not be limited to: one person representing the Department, one person representing the Virginia Roadbuilders Association, one person representing the Virginia Aggregates Association, one person representing the Virginia Asphalt Association, one person representing the Virginia Waste Industries Association, one person representing the Virginia Department of Waste Management, one person representing Virginians for Recycling, Inc., and one person representing a Virginia local government or authority which operates or contracts for the operation of a recycling facility. The Advisory Committee shall make recommendations to the Department on the specifications to be set by the Department pursuant to this section. The Advisory Committee shall also make recommendations to the Department on the components of a five-year plan for encouraging the increased use by the Department of recycled glass and other recyclable materials in Virginia highway projects. The Department shall report to the 1994 Session of the General Assembly actions taken to comply with the provisions of this section.

The Department, after receiving the recommendations of the Recycled Materials in Highway Construction Advisory Committee, shall (i) set specifications, in conjunction with its road and bridge specifications and in all of its similar publications and documents, which authorize and govern the use of recycled glass as construction material in highway-related construction in Virginia and (ii) adopt a five-year plan encouraging the increased use by the Department of recycled glass and other recycled materials in Virginia highway projects.

The Department shall maintain and make available to its contractors a list of the sites in Virginia from which they may obtain recycled glass and other recycled materials for use in Virginia highway construction projects.

APPENDIX II

ABSTRACT

Increasing pressures to recycle more wastes and minimize the amount of materials placed in landfills are forcing reconsideration of potential uses of waste glass in highway construction and maintenance operations. The federal government and many state legislatures are mandating studies to find such uses. Because the volume of aggregate needed for highway construction is so large, the use of waste glass in this manner offers a potential for utilizing most if not all glass unsuitable for other purposes.

This report provides the results of a literature search and telephone survey to determine current (1992) practices of selected state highway agencies regarding the use of crushed glass in highway construction. It is shown that similar viewpoints are held by most state highway agencies regarding such use:

1. Glass can be used as a component of unbound aggregates for embankments, trench backfills, backfills for walls, pipe bedding, gravel bases, ballast, etc., and in hot-mix asphalt base courses and surfaces.

2. Waste glass is not economically competitive with available sources of natural aggregates, nor is the available volume sufficient to reduce substantially the need for natural aggregates in a given geographical area.

3. No use has been made of glass in surfaces of main highways where high speeds and heavy truck traffic exist.

4. Cities and towns have successfully used glass in asphalt surface courses for construction and maintenance of their streets.

5. Use in highway construction can be cost-effective as an alternative means of disposing of waste glass collected in recycling programs where there is a need to avoid high landfill costs and conserve landfill space.

6. Cities and towns that have a public works department responsible for both waste management (including recycling) and street maintenance appear to be in the best position to use waste glass in a cost-effective manner. Cooperative efforts and mutually beneficial systems need to be worked out among waste management representatives, private recycling firms, highway construction agencies, and asphalt paving organizations.

Because local jurisdictions often have limited testing facilities, there is a recognized need among state highway agencies to provide specifications and guidelines for use by cities and counties in their state. The trend is to provide for optional use under established limitations.

Given a situation in which the use of waste glass is advantageous from an environmental viewpoint, highway engineers generally prefer that its use be in embankments or as a portion of the aggregate in base courses. Less restrictions are necessary for such applications. Larger glass particles and greater quantities can

be used. Upper permissible limits are not well established, but some states permit up to 25 percent in embankments, with stipulations that the top portions and sides of such embankments be all natural materials. Glass particles with a maximum size of 25 mm (1 in) have been used, and large particles may be acceptable. Similarly, when used for backfill of trenches, etc., less restriction on the size and amounts of glass is required.

Because street and road maintenance or rehabilitation is likely to offer greater opportunity to use waste glass in urban locations than in new construction, the use of waste glass as a portion of the aggregate in hot asphalt mixtures for these purposes is of considerable interest in such locations. Concerns that have not been fully evaluated include the following:

- long-term stripping
- effects on skid resistance
- degree to which pullout of glass particles from the surface may create hazards to tires or persons (especially for residential streets)
- effects of glass in pavements to be recycled
- effects of glass handling and additions of glass during the mixing process on compliance with the regulations of the Environmental Protection Agency or health
- effects of the use of glass on established production procedures and material supplies. If the portion of the aggregate being displaced by the glass is part of the normal production stream and must be removed and wasted in order for the glass to be used, nothing will have been accomplished except to change the identity of the waste material.

**Complete report "Use of Waste Glass in Highway Construction (Update - 1992) by Woodrow J. Halstead, Research Consultant may be obtained from the State Materials Engineer's office.