CIVIL ENGINEERING STUDIES
Illinois Center for Transportation Series No. 15-014
UILU-ENG-2015-2019
ISSN: 0197-9191

ILLINOIS HIGHWAY MATERIALS SUSTAINABILITY EFFORTS OF 2014

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Research Report No. FHWA-ICT-15-014

The work described in this report was conducted under the general guidance and funding for R27-160, Sustainability Engineering and Support

Illinois Center for Transportation

August 2015

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-ICT-15-014		

4. Title and Subtitle

Illinois Highway Materials Sustainability Efforts of 2014

5. Report Date

August 2015

6. Performing Organization Code

7. Author(s)

David L. Lippert, Seung Gu Kang, and Hasan Ozer

8. Performing Organization Report No.

ICT-15-014
UILU-ENG-2015-2019

9. Performing Organization Name and Address

Illinois Center for Transportation
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10. Work Unit (TRAIS)

11. Contract or Grant No.

R27-160

12. Sponsoring Agency Name and Address

Illinois Department of Transportation (SPR)
Bureau of Materials and Physical Research
126 East Ash Street
Springfield, IL 26704-4766

13. Type of Report and Period Covered

Interim Report, CY 2014
July 1, 2013 – June 30, 2016

14. Sponsoring Agency Code

FHWA

15. Supplementary Notes

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

This report presents the 2014 sustainability efforts of the Illinois Department of Transportation (IDOT) in recycling reclaimed materials in highway construction. This report meets the requirements of Illinois Public Act 097-0314 by documenting IDOT's efforts to reduce the carbon footprint and achieve cost savings through the use of recycled materials in asphalt paving projects. Research efforts undertaken and those that will have a future impact on IDOT's sustainability efforts are highlighted.

17. Key Words	18. Distribution Statement
concrete aggregate, fly ash, HMA, hot-mix asphalt, Illinois Public Act 097-0314, RAP, RAS, RCM, reclaimed, reclaimed asphalt pavement, reclaimed asphalt shingles, recycled, recycled concrete material, recycled materials, sustainability	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price
Unclassified	Unclassified	37	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

ACKNOWLEDGMENTS AND DISCLAIMER

The authors of this report wish to thank the many people involved in developing specifications, conducting laboratory tests, constructing experimental sections, and collecting the data presented in this report:

- We are greatly indebted to the hot-mix asphalt contractors and their staff for providing information on use of reclaimed asphalt shingles.
- We thank Jody Meador and Tom Schutzbach of the Materials Integrated System for Test Information and Communication (MISTIC) Unit for assembling data on recycled material use.
- We thank Jan Yates for coordinating the survey on contractor use of shingles.

EXECUTIVE SUMMARY

The Illinois Department of Transportation (IDOT) continues to use a variety of reclaimed and recycled materials in highway construction. Recycled materials are used in highway construction to supplement aggregates, concrete, hot-mix asphalt (HMA), steel, and sealants, as well as for soil modification and pavement markings. This report presents the materials used in 2014, along with specific reporting on use of shingles, efforts to reduce the carbon footprint, and efforts to achieve cost savings through the use of recycled materials, as required by Illinois Public Act 097-0314.

The recycled materials currently tracked are summarized in four major groups related to uses of aggregate, HMA, concrete, and other. Aggregate use consists of recycled concrete material (RCM) and reclaimed asphalt pavement (RAP) used as an aggregate in lieu of natural aggregates. The HMA category includes slags used as friction aggregate, crumb rubber, RAP, and reclaimed asphalt shingles (RAS). Concrete-related materials include fly ash, ground granulated blast furnace slag, and microsilica used to replace cement or provide specific properties to the final concrete product. The "other" category is made up of by-product lime used for soil modification, glass beads used for pavement-marking retroreflectivity, and steel used for reinforcement.

In 2014, reclaimed and recycled materials totaling 1,643,948 tons were used in Illinois highways. This represents nearly a 70,000-ton or 4% reduction from 2013 quantities; however, funding for construction projects from FY 2013 to FY 2014 was reduced 36%. Funding level and the portfolio of project types are major factors influencing recycle levels. On a tons-per-mile basis, the amount of recycled materials used in 2014 slightly increased from 2013 levels, maintaining an approximately fourfold increase over the recycled content of 2009 construction. These materials were valued at more than $58 million, a very slight reduction resulting from reduced quantities and changes in value of the various materials in 2014.

The amount of RAS used in 2014 was 37,756 tons, which is a 5% decrease from 2013 use of 39,791 tons. It is important to note that the FY 2014 program contained 8% fewer miles of improvement compared with FY 2013. Another factor that reduced RAS use was the modification of district special provisions that reduced the maximum allowable asphalt binder replacement (ABR) when polymer-modified asphalts are used in the HMA mix. The number of IDOT districts for which contractors produced HMA containing RAS remained at seven in 2014.

While reporting tons of materials is an easy measure, it does not represent the true environmental benefit of recycling the various materials. This report estimates the equivalent carbon dioxide (CO_2EQ) emissions savings of the recycled materials used by IDOT. The use of fly ash resulted in the greatest environmental benefit by replacement of energy-intensive cement. It is estimated that IDOT's recycling efforts reduced CO_2EQ emissions by 114,719 tons in 2014. The use of fly ash accounted for approximately 50% of the reduction in emissions.

To better determine cost savings and possible performance impacts of ABR sources and amounts, a research project was initiated in 2014 to construct and monitor various combinations of RAP, RAS, and softer asphalt binder grades used to counter aged asphalt. The research is being conducted on five HMA overlay projects in the Joliet area by construction monitoring, sampling, testing, and performance monitoring.

In another effort to make the best use of recycled material in HMA mixes, an Illinois Center for Transportation research project has developed a Flexibility Index (FI) that will help prevent the use of HMA mixes prone to excessive premature cracking. The work has resulted in development of a new test specification and equipment to conduct the test. The testing specification protocol is currently in the ballot phase of being adopted by the American Association of State Highway and Transportation Officials (AASHTO)Subcommittee on Materials.

CONTENTS

CHAPTER 1: INTRODUCTION

This report is part of a series of annual reports published since 2010 to document recycling and sustainability efforts of the Illinois Department of Transportation (IDOT). This report also meets the reporting requirements of Illinois Public Act 097-0314 (Illinois General Assembly 2012).

Various past reports by IDOT and the Illinois Center for Transportation (ICT) provide excellent background information on reclaimed and recycled materials used in highway construction (Brownlee 2011, 2012; Brownlee and Burgdorfer 2011; Griffiths and Krstulovich 2002; IDOT 2013; Lippert and Brownlee 2012; Lippert et al. 2014; Rowden 2013).

In 2012, Illinois Public Act 097-0314 called on IDOT to report annually on efforts to reduce its carbon footprint and achieve cost savings through the use of recycled materials in asphalt paving projects (IDOT 2013; Lippert and Brownlee 2012; Rowden 2013). The act also required IDOT to allow the use of asphalt shingles in all hot-mix asphalt (HMA) mixes as long as such use does not cause negative impacts to life-cycle cost.

Illinois has many years of experience using various reclaimed materials in highway construction. These materials tend to be aggregates or materials that extend cement or asphalt. Fly ash and ground granulated blast furnace slag (GGBFS) have been added to concrete in Illinois for over 50 years. These additions reduce the amount of cement (a carbon-intensive material) required, while also lending other desirable properties to concrete. Reclaimed asphalt pavement (RAP) has been in use since the early 1980s, and its use is widely accepted.

Other materials, such as reclaimed asphalt shingles (RAS), have a much shorter history of use. Until 2011, IDOT was conducting experimental projects using asphalt shingles in HMA. With the passage of Public Act 097-0314, specifications were developed and adopted to allow RAS to be used on all IDOT projects if the contractor chose to do so (Lippert and Brownlee 2012).

This report is structured to first cover the use of all reclaimed and recycled materials. Then, IDOT's efforts in using RAS are presented. Following that, a life-cycle assessment based on available information is presented to better portray the environmental benefits of recycling the various materials. Finally, the report provides an overview of research projects that will provide long-term improvements to the life-cycle of pavements using recycled materials.

CHAPTER 2: USE OF RECLAIMED AND RECYCLED MATERIALS IN ILLINOIS HIGHWAY CONSTRUCTION IN 2014

2.1 REPORTING HISTORY

The first recycling report was published in 2002 to answer various inquiries on recycling (Griffiths and Krstulovich 2002). After this first effort to report on recycled materials, a follow-up report was not produced until 2010 construction information was available (Brownlee and Burgdorfer 2011). Reporting of recycled material use has since been on an annual basis Brownlee 2011, 2012; Lippert et al. 2014; Rowden 2013). The 2012 report on materials recycled provided the most in-depth overview of how each material is derived and used in highway construction (Rowden 2013). The 2013 report provided benchmark performance measures on recycled material use on a per-mile basis rather than total quantity (Lippert et al. 2014).

This report uses the same basic methodology for determining quantities as used in past reports from IDOT's Materials Integrated System for Test Information and Communication (MISTIC). Information from MISTIC is summarized to report quantities of each material recycled. There was no significant change in data collection methodology from the 2013 report on use (Lippert et al. 2014). New in this report is an estimate of the environmental benefit derived from use of the various recycled materials.

2.2 RECLAIMED AND RECYCLED MATERIALS ADDED OR DELETED IN 2014

During the 2014 reporting year, the same materials as in past years were recycled into Illinois highways. No new materials were added or old materials deleted in 2014.

2.3 MATERIALS RECLAIMED AND RECYCLED IN 2014

2.3.1 Determining Recycle Quantities

The manufacturing stream for each material listed in this report has been reviewed. The reported quantities pertain to the materials for which the amount of recycled material can be soundly documented through existing records. Items such as steel reinforcement and glass beads are composed of 100% recycled materials, as a result of how those materials are manufactured, and thus are simple to report. Many additional tons of recycled materials are used, but tracking quantities used is impractical. For example, recycled steel is used in large steel shapes for bridge construction; however, the amount of recycled material varies in each steel heat or batch. Information on the recycled content of such items is not available in the database and therefore not reported.

While MISTIC reports are the source of material quantities for most of the reported materials, there are two exceptions—namely, glass beads and RAS. The reported quantity for glass beads is based on quantities accepted for use in the State of Illinois. This quantity includes use by some local agencies that take part in statewide purchase agreements. The reported quantity of RAS is based on reviewing all HMA contracts for 2014 and requesting the contractors to report the amounts used on each contract.

2.3.2 Economic Values of Recycled Materials

Economic values for the various materials were updated to provide a reasonable comparison from year to year. For 2014 pricing, a statewide average was determined from supplier- and contractor-provided information. For items that have price indexes, such as steel, the monthly IDOT index was averaged for the year (IDOT 2015b). For RAP used in HMA, a combination of the annual index

average for the asphalt index price and statewide aggregate prices was used to determine the 2014 value. For RAP used as an aggregate, a typical value was determined.

2.3.3 Recycled and Reclaimed Material Use and Values for 2014

2.3.3.1 Data for 2014

Appendix A presents the 2014 recycled and reclaimed material quantities and values. In total, 1,643,948 tons of material were recycled in 2014, which is a 4% decrease in recycled tonnage from 2013. The value of 2014 recycled materials was $58,035,195, which is less than a 1% decrease from 2013. In 2014, the miles of roadway improvement, number of bridges constructed or rehabilitated, and value of projects awarded were all lower compared with 2013 and were the main drivers for changes in recycled quantities on an overall basis.

2.3.3.2 Data Analysis of 2014 Use

To present a more accurate picture of IDOT's recycling effort, a series of figures are presented that provide information on 2014 results as well as historical trends. As can be seen in Figure 1, three materials make up the bulk of the recycled tonnage: RAP in HMA mix; followed by recycled concrete material (RCM); and, finally, RAP as an aggregate.

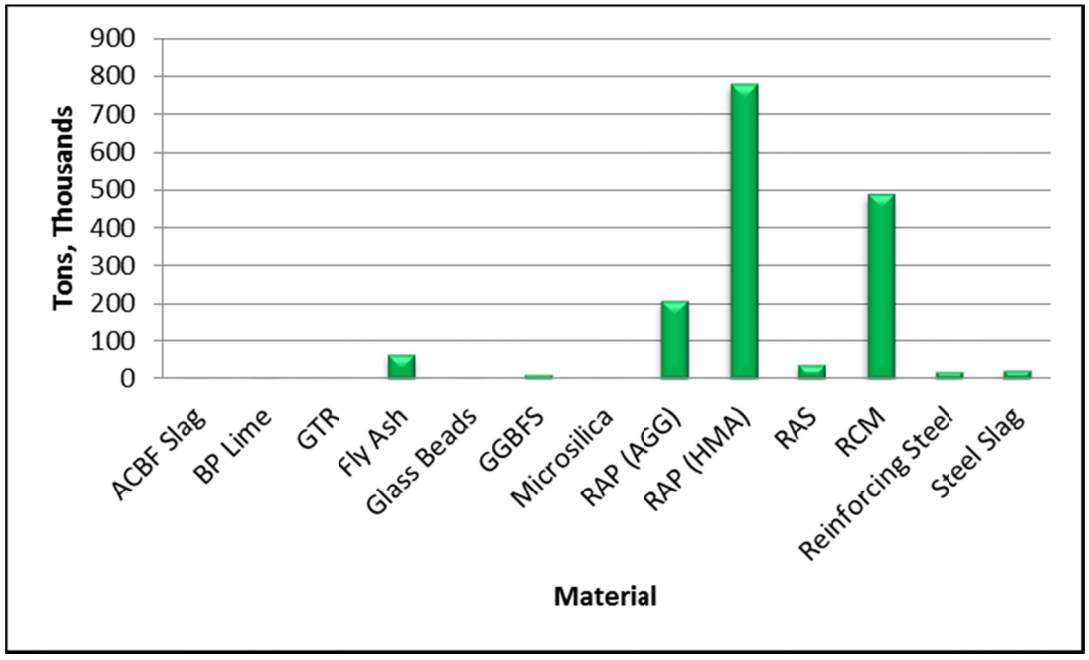

Figure 1. Reclaimed material use in 2014.

Figure 2 breaks out quantities by related uses for HMA, aggregate, concrete, and other. The latter category consists of by-product lime, glass beads, and steel. The HMA category includes slags used as friction aggregate (in HMA), crumb rubber, RAP, and RAS. Concrete-related materials include fly ash, ground granulated blast furnace slag (GGBFS), and microsilica used to replace cement or provide specific properties to the final concrete product. Aggregate use consists of RCM and RAP used as an aggregate in lieu of natural aggregates. From this breakout, one can see that the majority of recycled tonnage is related to HMA and aggregate uses.

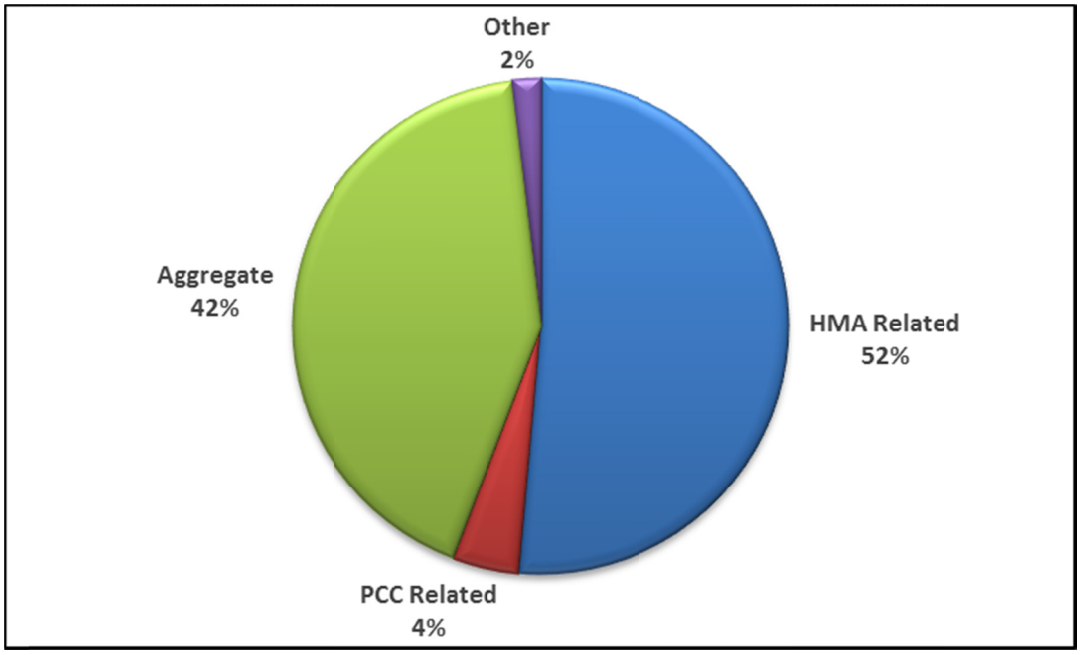

Figure 2. Reclaimed materials by related tons of use in 2014.

2.4 HISTORICAL RECYCLING TRENDS

2.4.1 Data Analysis

2.4.1.1 Recycling Relationship to Program Budget

Recycling quantities are highly correlated to the overall budget and portfolio of project types within that budget year. In general, resurfacing projects result in RAP both being produced and used. Major reconstruction or new alignment (greenfield) projects can use substantial amounts of recycled material. On the other hand, bridge projects tend to use limited amounts of materials because of the short lengths involved with those types of projects. Presented in Figure 3 are the total tons recycled from calendar years 2009 through 2014.

Also presented in the chart by fiscal year (FY; IDOT's FY is July 1 through June 30) are the values of projects awarded, centerline miles paved/improved, and number of bridges built/improved (IDOT 2014). Note that this is not the same time frame as the calendar year (CY) reported for recycled tonnage. However, the values tend to roughly align on a CY basis because of the delay between the award of contracts and use of materials in the project. For the purpose of this effort, it was considered reasonable to use all data as if they had been from the same time period by CY.

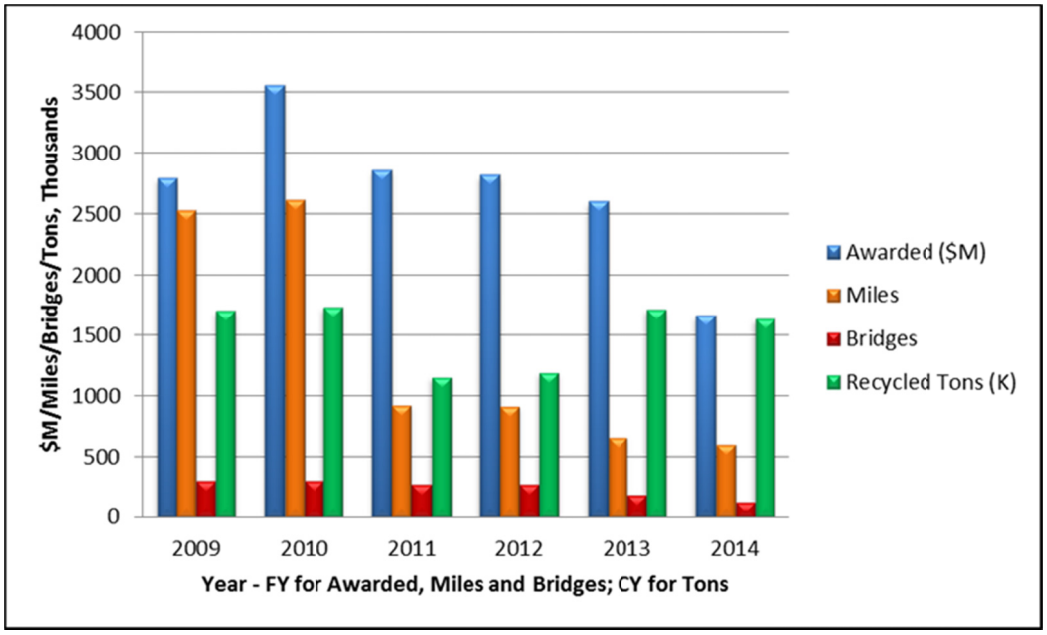

Figure 3. Annual projects awarded (FY), miles improved (FY), bridges built/improved (FY), and recycled tons (CY).

2.4.1.2 Determination of Recycled Content

To provide a more representative performance measurement of IDOT's recycling efforts, the previous report developed a method to determine the general recycle content by calendar year (Lippert et al. 2014). This approach is continued here. Figure 4 presents the results of determining the average tons of recycled material for each centerline mile of improvement since 2009. On a tons-per-mile basis, 2014 represents a 6% increase in recycle content from 2013 and an approximately fourfold increase in the use of recycled materials since 2009.

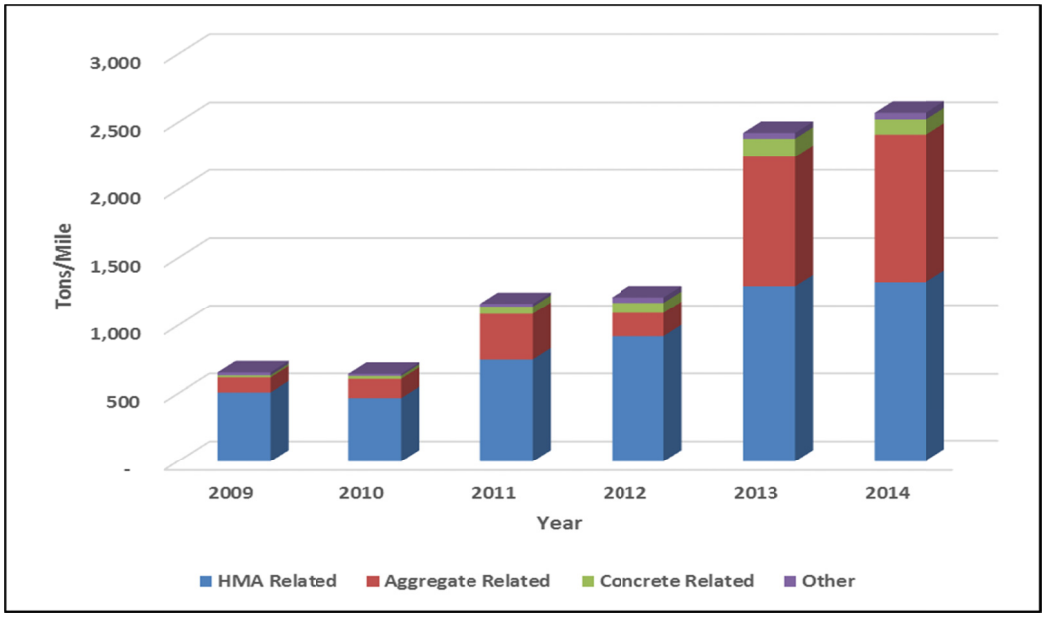

Figure 4. Historical recycle content

2.5 REGIONAL/DISTRICT RECYCLING EFFORTS

A few of the districts have developed their own special provisions to use resources unique to their area. The materials recycled under these special provisions are reported as part of normal materials acceptance and contribute to the quantities reported in Appendix A. The previous report described the special provisions in effect at the time (Lippert et al. 2014). This report provides a summary of changes from the 2013 report, as shown in Appendix B. Comments on provisions that were modified or changed are as follows.

2.5.1 Reclaimed Water (D-1)

This special provision was developed for use in 2014 and placed in contracts; however, the contracting community did not use the provision (Lippert et al. 2014). Therefore, it was not inserted into contracts after September 2014.

2.5.2 Aggregate Subgrade Improvement (D-1)

This special provision was revised starting November 2014. The revised version is provided in Appendix B.

2.5.3 Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (D-1).

The main change introduced with this special provision was alignment with the statewide Bureau of Design and Environment (BDE) specification for ABR content when polymer-modified asphalt is specified. High amounts of ABR counteract the desirable properties of polymer-modified asphalt and result in degradation of the elastic properties of the polymer.

CHAPTER 3: RECLAIMED ASPHALT SHINGLES

This chapter is a continuation of reporting on the specific status and use of RAS as required by Illinois Public Act 097-0314 (Illinois General Assembly 2012). Three previous reports provided details of RAS adoption (IDOT 2013; Lippert and Brownlee 2012; Lippert et al. 2014). Because of known under-reporting of RAS quantities in the MISTIC database, the contractor-provided information was deemed more accurate and reported herein. An update of where quantities of RAS are being used, along with specifications and policy changes, is presented to document activities for 2014.

3.1 RAS POLICIES AND SPECIFICATIONS IN EFFECT FOR 2014

3.1.1 RAS Policy for Sources

The BMPR Policy Memorandum, "Reclaimed Asphalt Shingle (RAS) Sources" (28-10.3), continued to be in effect for all 2014 RAS production and represents no change in policy since 2012. The policy can be found in the report on RAS use in 2012 (IDOT 2013). During 2014, IDOT added two new RAS suppliers and lost two suppliers, maintaining the count of listed suppliers at 13.

3.1.2 RAS Specifications

3.1.2.1 Statewide Specifications

The Bureau of Design and Environment (BDE) specification, "Reclaimed Asphalt Shingles (RAS) (BDE)," effective January 1, 2012, was revised on April 1, 2014, which resulted in different specifications being used in 2014 depending upon letting date. The 2012 specification can be found as previously reported (IDOT 2013). The revised specification effective April 1, 2014, is provided in Appendix B.

3.1.2.2 Regional/District Specifications

As noted in Section 2.5, during 2014, Region 1/District 1 used its own special provision for RAP and RAS. The modified district special provision is provided in Appendix B.

3.2 QUANTITY OF RAS USED IN CALENDAR YEAR 2014

As previously reported, the ability to perform a query of RAS tons used on state projects is limited by the MISTIC database (Lippert et al. 2014), which could lead to under-reporting RAS quantities. For that reason, contractor input was sought to confirm quantities on a project-by-project basis.

In 2014, IDOT experienced a 5% decrease in RAS use—to 37,756 tons from 39,791 tons in 2013 (Lippert et al. 2014). The decrease can be attributed to an 8% reduction in roadway improvement miles paved and a reduction in ABR rates when polymer asphalts are specified in district special provisions.

In 2014, seven of the districts reported use of RAS. Figure 5 presents the percentage of the 2014 statewide total RAS used by each IDOT district.

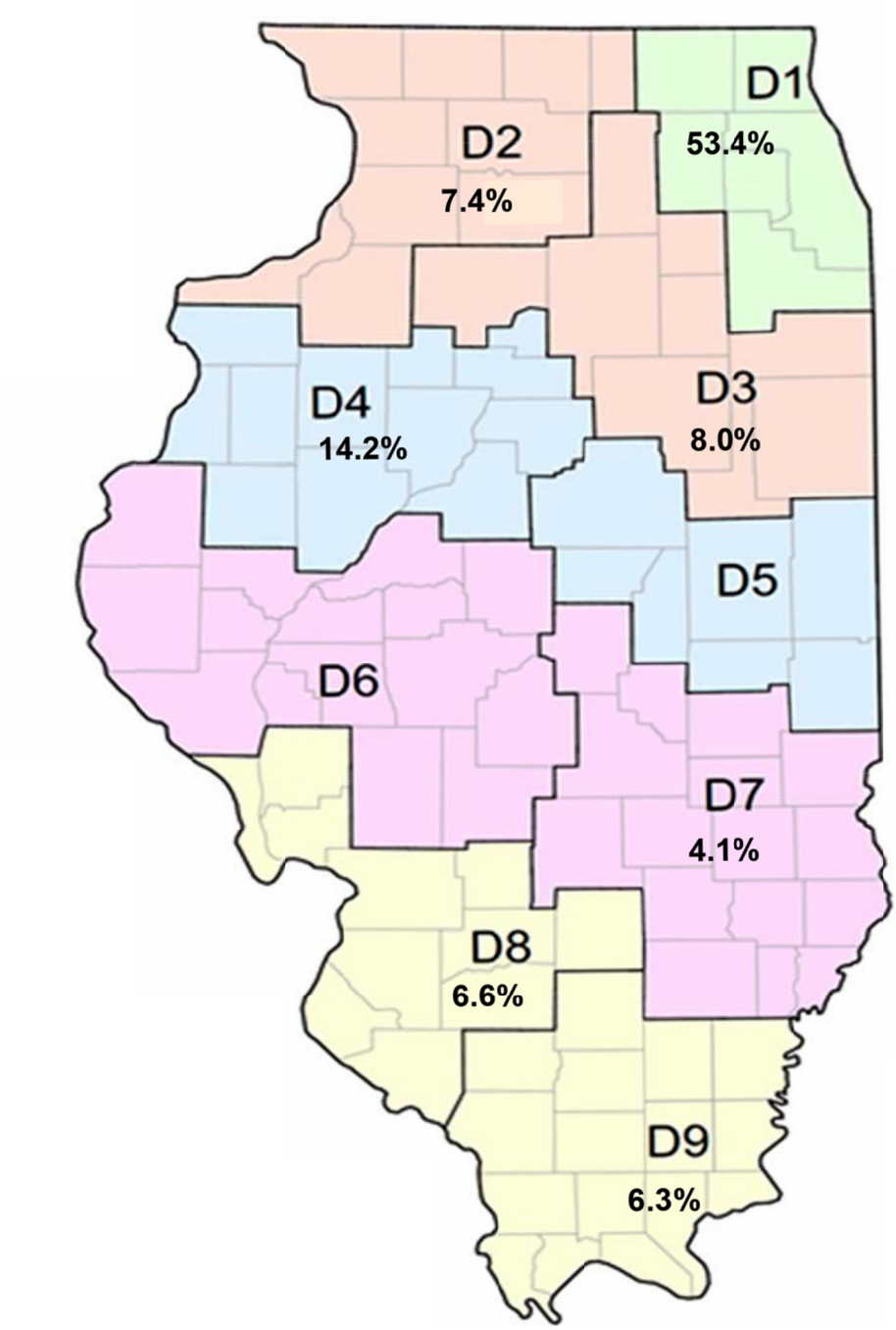

Figure 5. Percentage of RAS used by each district in calendar year 2014.

CHAPTER 4: ENVIRONMENTAL EVALUATION OF RECYCLED MATERIALS USED IN 2014

Over the years, the prime driver for use of recycled materials has been the initial cost savings of using these materials. Reclaimed materials typically have a low economical value because of oversupply or are considered a waste of the primary process from which the material is produced and in need of removal/disposal. Often these materials can be used to replace more costly virgin materials provided they are produced to a consistent quality standard. The ability to fully or partly replace virgin and/or manufactured materials with a product that otherwise would be landfilled or stockpiled as a waste can also greatly reduce the environmental burden of highway materials.

4.1 LIFE-CYCLE ASSESSMENT

An approach gaining favor in the evaluation of environmental burden of pavements and paving materials is life-cycle assessment (LCA). This approach attempts to document all aspects of a material used in a given application from cradle to grave of its life cycle. As part of the LCA process, each step of material production is analyzed in detail to determine a common and simple environmental burden measure. Typically, the measure used is carbon dioxide equivalents per ton of the material used, or CO_2EQ/ton.

For a simple example of aggregate production, fuel and electricity use can be assigned to each step. For virgin aggregate, the material must be mined, crushed, sized, transported to the site, placed, compacted, and used for the duration of the facility, then salvaged or wasted at the end of the facility's life. Recycled aggregates have an advantage in that they do not have the economic or environmental burden of mining, which is a major part of the environmental savings in recycled aggregate.

This report uses LCA values from the literature for both virgin materials and recycled materials used in Illinois to estimate a CO_2EQ/ton for each material recycled and the virgin material being replaced. The difference in CO_2EQ/ton between virgin and recycled material is the "savings" noted in Table 1 for each material, in kilograms equivalent of CO_2 for each ton of material recycled, for which information was available (Chen et al. 2010; EarthShift 2013; Prusinski 2003; Sunthonpagasit and Duffey 2004; World Steel Association 2011). For 2014, the total CO_2EQ savings in tons is also presented. This estimate includes typical transportation distances for Illinois. A main assumption is that the performance of the highway infrastructure item is equivalent for both virgin and recycled options.

Table 1. Estimated Environmental Burden Savings by Use of Recycled Material

Material	Savings per Ton of Use, CO_2EQ (kg)	2014 CO_2EQ Savings (Tons)
Air-Cooled Blast Furnace Slag	13	77
By-Product Lime	920	8,134
Crumb Rubber	1704	53
Fly Ash	894	62,336
Glass Beads	929	6,336
Ground Granulated Blast Furnace Slag	763	7,173
Microsilica	Not Available	Not Available
Reclaimed Asphalt Pavement Used For HMA	17	14,514
Reclaimed Asphalt Pavement Used For Aggregate	0.8	174
Reclaimed Asphalt Shingles	79	3,274
Recycled Concrete Material	0.8	409
Steel Reinforcement	640	11,821
Steel Slag	17	418
Wet-Bottom Boiler Slag	Not Available	Not Available

Materials that have low CO_2EQ, such as aggregate, have very low values of savings when recycled materials are used. On the other hand, when energy-intensive materials such as lime and cement are replaced with by-products such as fly ash, by-product lime, or GGBFS, very high savings of CO_2EQ can be realized.

From this simple analysis, it is estimated that a total of 114,719 tons of CO_2EQ were saved in 2014. Appendix A presents an accounting of CO_2EQ saved in 2014 for each of the materials used. As noted previously, using total tons of recycled material alone is limited as a performance measure for recycling. The environmental burden saved by material for 2014 is presented in Figure 6. This is a very different picture than tons of material as presented previously in Figure 1. Likewise, Figure 7 shows the distribution of CO_2EQ savings by related use, which differs greatly from the tonnage distribution presented previously in Figure 2.

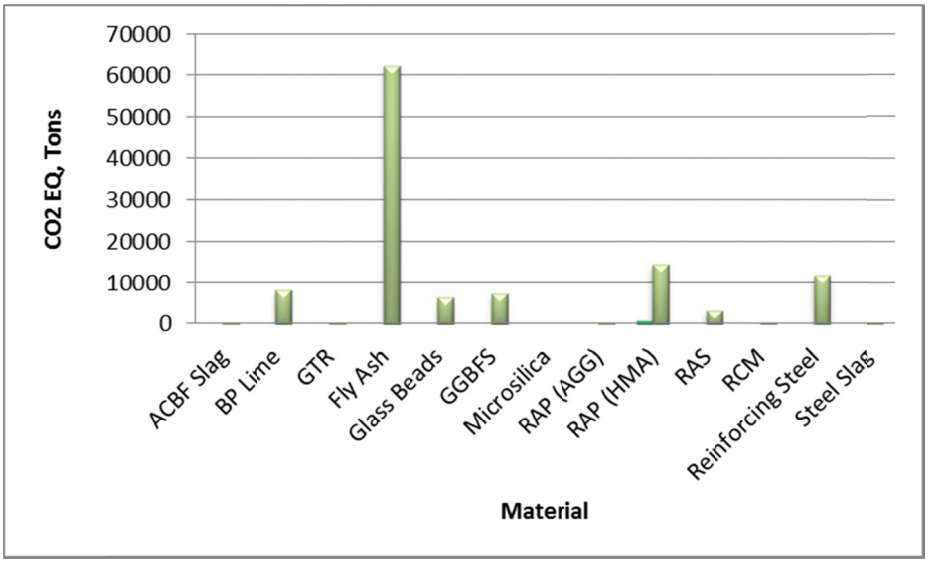

Figure 6. CO_2EQ saved by material in 2014.

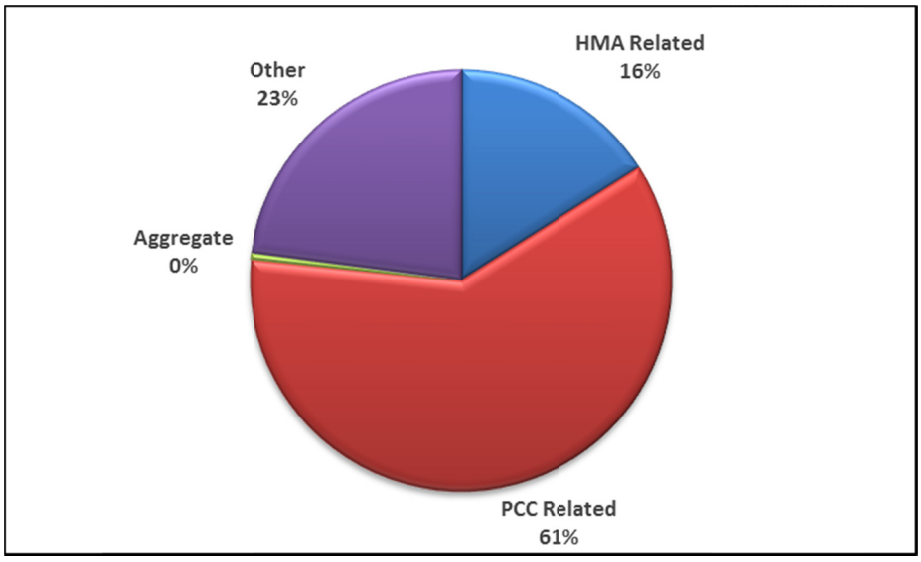

Figure 7. CO_2EQ saved by related use in 2014.

CHAPTER 5: NEW INITIATIVES

In 2014, IDOT initiated a new study (R27-161) with ICT related to sustainability and recycling. In addition, an existing study (R27-128) to develop testing protocols for determination of acceptable HMA properties made considerable progress in 2014 to the point that the results are on the path for implementation.

5.1 R27-161: CONSTRUCTION AND PERFORMANCE MONITORING OF VARIOUS ASPHALT MIXES

This 2014 study is based on five sites/locations in the Joliet area selected for evaluation of the field performance of various mixes that incorporate varying proportions of recycled materials. Tasks include a pre-construction pavement evaluation, construction survey and quality assurance, laboratory characterization of materials collected at the time of production, post-construction survey, and in-service field surveys over the life of the study. The basic experiment is presented in Table 2 and includes a variety of HMA mixes with and without RAS with different ABR percentages and different asphalt binders.

Table 2. Experimental Features of Project R27-161

June 13, 2014 Letting Projects										
Construction Year	Project	Letting Item[1]	Contract	Net Length	Mix	ABR %	RAS[3]	RAP[3]	Virgin PG	Surface Tons
2014	Crawford Ave/Pulaski Rd from 172nd to US Rt. 6	30	60Y03	1.5	N70-30% ABR	30	X	X	58-28	2,150
					N70-15% ABR	15	X	X	64-22	2,150
2014	US 52 From Chicago St. (IL 53) to Laraway Road	29	60Y02	3.3	N70-30% ABR	30	X	X	58-28	2,320
					N70-30% ABR	30		X	58-28	2,320
2015	US 52 from Laraway Road to Gouger Road	16	60N08	3.3	TRA[2]	48	5%[4]	X	52-34	5,236
2015	US 52 from Gouger Road to Second Street	15	60N07	1.5	TRA[2]	48	5%[4]	X	58-28	3,014
2015	Washington Street from Bridggs Street to US 30	31	60Y04	1.9	N70-30% ABR	30	X	X	58-34	1,580
					N70-30% ABR	30		X	58-34	1,580

[1]June 13, 2014, IDOT letting item number
[2]Total recycle asphalt (100% recycled aggregate with high ABR)
[3]"X" indicates whether RAP alone or RAP and RAS together contribute to the indicated ABR percentage
[4]Maximum percentage of RAS allowed in total mix by specification

The study projects were on the June 13, 2014, IDOT letting. All projects were awarded to the lowest bidder, "D" Construction, Inc. of Coal City, Illinois. Owing to the late-season award, only two of the five projects were completed in 2014: Crawford/Pulaski and the western leg of US 52 from IL 53 to Laraway Road. The remaining projects will be constructed in 2015. The findings and details of each project will be summarized in a final report. Results are expected to help determine the effectiveness of using softer asphalt binder grades to mitigate brittle recycled asphalt materials and how the recycled content of RAP and RAS impacts overlay life-cycle performance.

5.2 R27-128: TESTING PROTOCOLS TO ENSURE PERFORMANCE OF HIGH ASPHALT BINDER REPLACEMENT MIXES USING RAP AND RAS

The goal of this research project is to develop procedures that will help ensure that mixes using recycled materials are not prone to premature performance problems from excessive cracking. Started in 2013, the work has progressed to the point that by the end of 2014 a new test specification and equipment to conduct the test had been developed. The test protocols and equipment are based on fracture energy. Developed as part of this research is a new parameter, the Flexibility Index (FI). The FI has been shown to be a better screening parameter than fracture energy alone. The testing specification protocol is expected to be balloted by the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Materials in 2015.

The study is on schedule and expected to conclude with a final report planned for publication in December 2015 (ICT 2015).

CHAPTER 6: CONCLUSIONS

The goal of this report is to provide a single source document for 2014 sustainability efforts in highway materials that serves to meet the reporting requirement of Illinois Public Act 097-0314. On the basis of the 2014 efforts, the following conclusions can be made:

- The past efforts of the Illinois Department of Transportation that modified specifications, policies, and procedures continue to increase the recycled content of Illinois highways. This is evidenced by a 6% increase in recycled content from 2013 to 2014 for the average mile of highway improvement. When compared with 2009, 2014 represents approximately a fourfold increase in recycle content.

- In 2014, recycled materials used totaled 1,643,948 tons with a value of $58,035,195.

- Use of reclaimed asphalt shingles (RAS) in 2014 decreased 5% from 2013 levels. This was due to a corresponding 8% reduction in roadway improvement miles from 2013 to 2014 and reductions in maximum asphalt binder replacement levels allowed in polymer-modified asphalt mixes by district special provisions.

- Life-cycle assessment (LCA) can be used to provide a better picture of the true environmental savings of the various materials recycled. Using LCA and available information, it is estimated that carbon dioxide–equivalent emissions were reduced by 114,719 tons in 2014. The majority of the reduction is from the use of fly ash and ground granulated blast furnace slag to replace cement, followed by reclaimed asphalt pavement used in asphalt pavements.

- The department initiated an Illinois Center for Transportation research project (ICT R27-161) titled “Construction and Performance Monitoring of Various Asphalt Mixes.” This project will closely monitor the construction and field performance of various mixes that incorporate varying amounts of reclaimed asphalt pavement (RAP) and RAS. The results are intended to aid in better understanding the performance and maintenance impacts of recycled materials.

- A Flexibility Index (FI) test specification and protocols, which are expected to be adopted nationally, were developed in ICT R27-128, “Testing Protocols to Ensure Performance of High Asphalt Binder Replacement Mixes Using RAP and RAS.” The FI has been shown to be a better screening parameter than alternative testing schemes for determining hot-mix asphalt cracking potential.

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APPENDIX A: RECYCLED AND RECLAIMED MATERIALS QUANTITIES USED AND EQUIVALENT VALUES, 2014

Material	Unit Equivalent Value	Quantity[1] Tons	Total Equivalent Value to Department	CO_2 Equivalent Savings Tons[7]
Air-Cooled Blast Furnace Slag	$10.00	5,306	$53,060	77
By-Product Lime	$35.00	8,025	$280,875	8,134
Crumb Rubber[2]	$416.20	28	$11,654	53
Fly Ash	$20.00	63,297	$1,265,940	62,336
Glass Beads[3]	$626.00	6,188	$3,873,688	6,336
Ground Granulated Blast Furnace Slag	$85.00	8,531	$725,135	7,173
Microsilica	$500.00	3	$1,500	NA
Reclaimed Asphalt Pavement Used for HMA	$35.92	779,344	$27,994,036	14,514
Reclaimed Asphalt Pavement Used for Aggregate	$7.50	207,646	$1,557,345	174
Reclaimed Asphalt Shingles[4]	$40.00	37,756	$1,510,240	3,274
Recycled Concrete Material	$7.50	488,369	$3,662,768	409
Steel Reinforcement[5]	$993.47	16,766	$16,656,518	11,821
Steel Slag	$19.50	22,689	$442,436	418
Wet-Bottom Boiler Slag[6]	NA	NA	NA	

[1] Quantities were calculated from amounts assigned to projects in calendar year 2014. Prior to summation of values, metric values were converted to English values using factors located in Appendix B of the *Standard Specifications for Road and Bridge Construction.*

[2] Crumb rubber: This material quantity was calculated as 5% of the quantity of hot-poured joint sealant used in 2013.

[3] Glass beads use is based on tested and approved quantities and not projects assigned through MISTIC.

[4] Reclaimed asphalt shingle quantities are from survey of contractor records and not projects assigned through MISTIC.

[5] Steel reinforcement: For 2013 and this report, the IDOT monthly steel index was averaged for the year and used to represent the value of just the steel contained in these products. This approach does not include the epoxy coating value in the calculation of the material being recycled, which is a more accurate representation.

[6] Wet-bottom boiler slag: No records were found in MISTIC that indicated WBBS was used for any IDOT projects in 2014.

[7] Based on typical haul distances for Illinois and industrial averages between virgin material and recycled/reclaimed material found in the literature.

APPENDIX B: RECYCLING SPECIAL PROVISIONS

APPENDIX B1

AGGREGATE SUBGRADE IMPROVEMENT (D-1)
Effective: February 22, 2012
Revised: November 1, 2013~~3~~4

Add the following Section to the Standard Specifications:

"**SECTION 303. AGGREGATE SUBGRADE IMPROVEMENT**

303.01 Description. This work shall consist of constructing an aggregate subgrade improvement.

303.02 Materials. Materials shall be according to the following.

Item	Article/Section
(a) Coarse Aggregate	1004
(b) Reclaimed Asphalt Pavement (RAP) (Notes 1, 2 and 3)	1031

Note 1. Crushed RAP, from either full depth or single lift removal, may be mechanically blended with aggregate gradations CS 01 or CS 02 but shall not exceed 40 percent of the total product. The top size of the Coarse RAP shall be less than 4 in. (100 mm) and well graded.

Note 2. RAP having 100 percent passing the 1 1/2 in. (37.5 mm) sieve and being well graded, may be used as capping aggregate in the top 3 in. (75 mm) when aggregate gradations CS 01 or CS 02 are used in lower lifts. When RAP is blended with any of the coarse aggregates, the blending shall be done with mechanically calibrated feeders.

Note 3. The RAP used for aggregate subgrade improvement shall be according to the current Bureau of Materials and Physical Research Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications".

303.03 Equipment. The vibratory machine shall be according to Article 1101.01, or as approved by the Engineer.

303.04 Soil Preparation. The stability of the soil shall be according to the Department's Subgrade Stability Manual for the aggregate thickness specified.

303.05 Placing Aggregate. The maximum nominal lift thickness of aggregate gradations CS 01 or CS 02 shall be 24 in. (600 mm).

303.06 Capping Aggregate. The top surface of the aggregate subgrade shall consist of a minimum 3 in. (75 mm) of aggregate gradations CA 06 or CA 10. When Reclaimed Asphalt Pavement (RAP) is used, it shall be crushed and screened where 100 percent is passing the 1 1/2 in. (37.5 mm) sieve and being well graded. RAP that has been fractionated to size will not be permitted for use in capping. Capping aggregate will not be required when the aggregate subgrade improvement is used as a cubic yard pay item for undercut applications. When RAP is blended with any of the coarse aggregates, the blending shall be done with mechanically calibrated feeders.

303.07 Compaction. All aggregate lifts shall be compacted to the satisfaction of the Engineer. If the moisture content of the material is such that compaction cannot be obtained, sufficient water shall be added so that satisfactory compaction can be obtained.

303.08 Finishing and Maintenance of Aggregate Subgrade Improvement. The aggregate subgrade improvement shall be finished to the lines, grades, and cross sections shown on the plans, or as directed by the Engineer. The aggregate subgrade improvement shall be maintained in a smooth and compacted condition.

303.09 Method of Measurement. This work will be measured for payment according to Article 311.08.

303.10 Basis of Payment. This work will be paid for at the contract unit price per cubic yard (cubic meter) for AGGREGATE SUBGRADE IMPROVEMENT or at the contract unit price per square yard (square meter) for AGGREGATE SUBGRADE IMPROVEMENT, of the thickness specified.

Add the following to Section 1004 of the Standard Specifications:

"**1004.06 Coarse Aggregate for Aggregate Subgrade Improvement.** The aggregate shall be according to Article 1004.01 and the following.

(a) Description. The coarse aggregate shall be crushed gravel, crushed stone, or crushed concrete.

(b) Quality. The coarse aggregate shall consist of sound durable particles reasonably free of deleterious materials.

(c) Gradation.

(1) The coarse aggregate gradation for total subgrade thicknesses of 12 in. (300 mm) or greater shall be CS 01 or CS 02.

Grad No.	COARSE AGGREGATE SUBGRADE GRADATIONS Sieve Size and Percent Passing				
	8"	6"	4"	2"	#4
CS 01	100	97 ± 3	90 ± 10	45 ± 25	20 ± 20
CS 02		100	80 ± 10	25 ± 15	

Grad No.	COARSE AGGREGATE SUBGRADE GRADATIONS (Metric) Sieve Size and Percent Passing				
	200 mm	150 mm	100 mm	50 mm	4.75 mm
CS 01	100	97 ± 3	90 ± 10	45 ± 25	20 ± 20
CS 02		100	80 ± 10	25 ± 15	

(2) The 3 in. (75 mm) capping aggregate shall be gradation CA 6 or CA 10.

~~(3) Gradation deleterious count shall not exceed 10% of total RAP and 5% of other by total weight.~~

APPENDIX B2

RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES (D-1)
Effective: November 1, 2012
Revise: ~~November 1, 2013~~August 15, 2014

Revise Section 1031 of the Standard Specifications to read:

"**SECTION 1031. RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES**

1031.01 Description. Reclaimed asphalt pavement and reclaimed asphalt shingles shall be according to the following.

(a) Reclaimed Asphalt Pavement (RAP). RAP is the material resulting from cold milling or crushing an existing hot-mix asphalt (HMA) pavement. RAP will be considered processed FRAP after completion of both crushing and screening to size. The Contractor shall supply written documentation that the RAP originated from routes or airfields under federal, state, or local agency jurisdiction.

(b) Reclaimed Asphalt Shingles (RAS). Reclaimed asphalt shingles (RAS). RAS is from the processing and grinding of preconsumer or post-consumer shingles. RAS shall be a clean and uniform material with a maximum of 0.5 percent unacceptable material, as defined in Bureau of Materials and Physical Research Policy Memorandum "Reclaimed Asphalt Shingle (RAS) Sources", by weight of RAS. All RAS used shall come from a Bureau of Materials and Physical Research approved processing facility where it shall be ground and processed to 100 percent passing the 3/8 in. (9.5 mm) sieve and 90 percent passing the #4 (4.75 mm) sieve . RAS shall meet the testing requirements specified herein. In addition, RAS shall meet the following Type 1 or Type 2 requirements.

(1) Type 1. Type 1 RAS shall be processed, preconsumer asphalt shingles salvaged from the manufacture of residential asphalt roofing shingles.

(2) Type 2. Type 2 RAS shall be processed post-consumer shingles only, salvaged from residential, or four unit or less dwellings not subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP).

1031.02 Stockpiles. RAP and RAS stockpiles shall be according to the following.

(a) RAP Stockpiles. The Contractor shall construct individual, sealed RAP stockpiles meeting one of the following definitions. Additional processed RAP (FRAP) shall be stockpiled in a separate working pile, as designated in the QC Plan, and only added to the sealed stockpile when test results for the working pile are complete and are found to meet tolerances specified herein for the original sealed FRAP stockpile. Stockpiles shall be sufficiently separated to prevent intermingling at the base. All stockpiles (including unprocessed RAP and FRAP) shall be identified by signs indicating the type as listed below (i.e. "Non-Quality, FRAP -#4 or Type 2 RAS", etc…).

(1) Fractionated RAP (FRAP). FRAP shall consist of RAP from Class I, Superpave HMA (High and Low ESAL) or equivalent mixtures. The coarse aggregate in FRAP shall be crushed aggregate and may represent more than one aggregate type and/or quality but shall be at least C quality. All FRAP shall be processed prior to testing and sized into fractions with

the separation occurring on or between the #4 (4.75 mm) and 1/2 in. (12.5 mm) sieves. Agglomerations shall be minimized such that 100 percent of the RAP in the coarse fraction shall pass the maximum sieve size specified for the mix the FRAP will be used in.

(2) Restricted FRAP (B quality) stockpiles shall consist of RAP from Class I, Superpave (High ESAL), or HMA (High ESAL). If approved by the Engineer, the aggregate from a maximum 3.0 inch single combined pass of surface/binder milling will be classified as B quality. All millings from this application will be processed into FRAP as described previously.

(3) Conglomerate. Conglomerate RAP stockpiles shall consist of RAP from Class I, Superpave HMA (High and Low ESAL) or equivalent mixtures. The coarse aggregate in this RAP shall be crushed aggregate and may represent more than one aggregate type and/or quality but shall be at least C quality. This RAP may have an inconsistent gradation and/or asphalt binder content prior to processing. All conglomerate RAP shall be processed (FRAP) prior to testing. Conglomerate RAP stockpiles shall not contain steel slag or other expansive material as determined by the Department.

(4) Conglomerate “D” Quality (DQ). Conglomerate DQ RAP stockpiles shall consist of RAP from HMA shoulders, bituminous stabilized subbases or Superpave (Low ESAL)/HMA (Low ESAL) IL-19.0L binder mixture. The coarse aggregate in this RAP may be crushed or round but shall be at least D quality. This RAP may have an inconsistent gradation and/or asphalt binder content. Conglomerate DQ RAP stockpiles shall not contain steel slag or other expansive material as determined by the Department.

(5) Non-Quality. RAP stockpiles that do not meet the requirements of the stockpile categories listed above shall be classified as “Non-Quality”.

RAP or FRAP containing contaminants, such as earth, brick, sand, concrete, sheet asphalt, bituminous surface treatment (i.e. chip seal), pavement fabric, joint sealants, plant cleanout etc., will be unacceptable unless the contaminants are removed to the satisfaction of the Engineer. Sheet asphalt shall be stockpiled separately.

(b) RAS Stockpiles. Type 1 and Type 2 RAS shall be stockpiled separately and shall be sufficiently separated to prevent intermingling at the base. Each stockpile shall be signed indicating what type of RAS is present.

However, a RAS source may submit a written request to the Department for approval to blend mechanically a specified ratio of type 1 RAS with type 2 RAS. The source will not be permitted to change the ratio of the blend without the Department prior written approval. The Engineer’s written approval will be required, to mechanically blend RAS with any fine aggregate produced under the AGCS, up to an equal weight of RAS, to improve workability. The fine aggregate shall be “B Quality” or better from an approved Aggregate Gradation Control System source. The fine aggregate shall be one that is approved for use in the HMA mixture and accounted for in the mix design and during HMA production.

Records identifying the shingle processing facility supplying the RAS, RAS type and lot number shall be maintained by project contract number and kept for a minimum of three years.

1031.03 Testing. FRAP and RAS testing shall be according to the following.

(a) FRAP Testing. When used in HMA, the FRAP shall be sampled and tested either during processing or after stockpiling. It shall also be sampled during HMA production.

(1) During Stockpiling. For testing during stockpiling, washed extraction samples shall be run at the minimum frequency of one sample per 500 tons (450 metric tons) for the first 2000 tons (1800 metric tons) and one sample per 2000 tons (1800 metric tons) thereafter. A minimum of five tests shall be required for stockpiles less than 4000 tons (3600 metric tons).

(2) Incoming Material. For testing as incoming material, washed extraction samples shall be run at a minimum frequency of one sample per 2000 tons (1800 metric tons) or once per week, whichever comes first.

(3) After Stockpiling. For testing after stockpiling, the Contractor shall submit a plan for approval to the District proposing a satisfactory method of sampling and testing the RAP/FRAP pile either in-situ or by restockpiling. The sampling plan shall meet the minimum frequency required above and detail the procedure used to obtain representative samples throughout the pile for testing.

Before extraction, each field sample of FRAP, shall be split to obtain two samples of test sample size. One of the two test samples from the final split shall be labeled and stored for Department use. The Contractor shall extract the other test sample according to Department procedure. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

(b) RAS Testing. RAS shall be sampled and tested during stockpiling according to Bureau of Materials and Physical Research Policy Memorandum, “Reclaimed Asphalt Shingle (RAS) Sources”. The Contractor shall also sample as incoming material at the HMA plant.

(1) During Stockpiling. Washed extraction and testing for unacceptable materials shall be run at the minimum frequency of one sample per 200 tons (180 metric tons) for the first 1000 tons (900 metric tons) and one sample per 1000 tons (900 metric tons) thereafter. A minimum of five samples are required for stockpiles less than 1000 tons (900 metric tons). Once a ≤ 1000 ton (900 metric ton), five-sample/test stockpile has been established it shall be sealed. Additional incoming RAS shall be in a separate working pile as designated in the Quality Control plan and only added to the sealed stockpile when the test results of the working pile are complete and are found to meet the tolerances specified herein for the original sealed RAS stockpile.

(2) Incoming Material. For testing as incoming material at the HMA plant, washed extraction shall be run at the minimum frequency of one sample per 250 tons (227 metric tons). A minimum of five samples are required for stockpiles less than 1000 tons (900 metric tons). The incoming material test results shall meet the tolerances specified herein.

The Contractor shall obtain and make available all test results from start of the initial stockpile sampled and tested at the shingle processing facility in accordance with the facility’s QC Plan.

Before extraction, each field sample shall be split to obtain two samples of test sample size. One of the two test samples from the final split shall be labeled and stored for Department use.

The Contractor shall extract the other test sample according to Department procedures. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

1031.04 Evaluation of Tests. Evaluation of tests results shall be according to the following.

(a) Evaluation of FRAP Test Results. All test results shall be compiled to include asphalt binder content, gradation and, when applicable (for slag), G_{mm}. A five test average of results from the original pile will be used in the mix designs. Individual extraction test results run thereafter, shall be compared to the average used for the mix design, and will be accepted if within the tolerances listed below.

Parameter	FRAP
No. 4 (4.75 mm)	± 6 %
No. 8 (2.36 mm)	± 5 %
No. 30 (600 μm)	± 5 %
No. 200 (75 μm)	± 2.0 %
Asphalt Binder	± 0.3 %
G_{mm}	± 0.03 [1/]

1/ For stockpile with slag or steel slag present as determined in the current Manual of Test Procedures Appendix B 21, "Determination of Reclaimed Asphalt Pavement Aggregate Bulk Specific Gravity".

If any individual sieve and/or asphalt binder content tests are out of the above tolerances when compared to the average used for the mix design, the FRAP stockpile shall not be used in Hot-Mix Asphalt unless the FRAP representing those tests is removed from the stockpile. All test data and acceptance ranges shall be sent to the District for evaluation.

The Contractor shall maintain a representative moving average of five tests to be used for Hot-Mix Asphalt production.

With the approval of the Engineer, the ignition oven may be substituted for extractions according to the Illinois Test Procedure, "Calibration of the Ignition Oven for the Purpose of Characterizing Reclaimed Asphalt Pavement (RAP)" or Illinois Modified AASHTO T-164-11, Test Method A.

(b) Evaluation of RAS Test Results. All of the test results, with the exception of percent unacceptable materials, shall be compiled and averaged for asphalt binder content and gradation. A five test average of results from the original pile will be used in the mix designs. Individual test results run thereafter, when compared to the average used for the mix design, will be accepted if within the tolerances listed below.

Parameter	RAS
No. 8 (2.36 mm)	± 5 %
No. 16 (1.18 mm)	± 5 %
No. 30 (600 µm)	± 4 %
No. 200 (75 µm)	± 2.5 %
Asphalt Binder Content	± 2.0 %

If any individual sieve and/or asphalt binder content tests are out of the above tolerances when compared to the average used for the mix design, the RAS shall not be used in Hot-Mix Asphalt unless the RAS representing those tests is removed from the stockpile. All test data and acceptance ranges shall be sent to the District for evaluation.

(c) Quality Assurance by the Engineer. The Engineer may witness the sampling and splitting conduct assurance tests on split samples taken by the Contractor for quality control testing a minimum of once a month.

The overall testing frequency will be performed over the entire range of Contractor samples for asphalt binder content and gradation. The Engineer may select any or all split samples for assurance testing. The test results will be made available to the Contractor as soon as they become available.

The Engineer will notify the Contractor of observed deficiencies.

Differences between the Contractor's and the Engineer's split sample test results will be considered acceptable if within the following limits.

Test Parameter	Acceptable Limits of Precision	
% Passing:[1/]	FRAP	RAS
1 / 2 in.	5.0%	
No. 4	5.0%	
No. 8	3.0%	4.0%
No. 30	2.0%	3.0%
No. 200	2.2%	2.5%
Asphalt Binder Content	0.3%	1.0%
G_{mm}	0.030	

1/ Based on washed extraction.

In the event comparisons are outside the above acceptable limits of precision, the Engineer will immediately investigate.

(d) Acceptance by the Engineer. Acceptable of the material will be based on the validation of the Contractor's quality control by the assurance process.

1031.05 Quality Designation of Aggregate in RAP and FRAP.

(a) RAP. The aggregate quality of the RAP for homogenous, conglomerate, and conglomerate "D" quality stockpiles shall be set by the lowest quality of coarse aggregate in the RAP stockpile and are designated as follows.

(1) RAP from Class I, Superpave/HMA (High ESAL), or (Low ESAL) IL-9.5L surface mixtures are designated as containing Class B quality coarse aggregate.

(2) RAP from Superpave/HMA (Low ESAL) IL-19.0L binder mixture is designated as Class D quality coarse aggregate.

(3) RAP from Class I, Superpave/HMA (High ESAL) binder mixtures, bituminous base course mixtures, and bituminous base course widening mixtures are designated as containing Class C quality coarse aggregate.

(4) RAP from bituminous stabilized subbase and BAM shoulders are designated as containing Class D quality coarse aggregate.

(b) FRAP. If the Engineer has documentation of the quality of the FRAP aggregate, the Contractor shall use the assigned quality provided by the Engineer.

If the quality is not known, the quality shall be determined as follows. Fractionated RAP stockpiles containing plus #4 (4.75 mm) sieve coarse aggregate shall have a maximum tonnage of 5,000 tons (4,500 metric tons). The Contractor shall obtain a representative sample witnessed by the Engineer. The sample shall be a minimum of 50 lb (25 kg). The sample shall be extracted according to Illinois Modified AASHTO T 164 by a consultant prequalified by the Department for the specified testing. The consultant shall submit the test results along with the recovered aggregate to the District Office. The cost for this testing shall be paid by the Contractor. The District will forward the sample to the BMPR Aggregate Lab for MicroDeval Testing, according to Illinois Modified AASHTO T 327. A maximum loss of 15.0 percent will be applied for all HMA applications. The fine aggregate portion of the fractionated RAP shall not be used in any HMA mixtures that require a minimum of "B" quality aggregate or better, until the coarse aggregate fraction has been determined to be acceptable thru a MicroDeval Testing.

1031.06 Use of FRAP and/or RAS in HMA. The use of FRAP and/or RAS shall be a Contractor's option when constructing HMA in all contracts.

(a) FRAP. The use of FRAP in HMA shall be as follows.

(1) Coarse Aggregate Size (after extraction). The coarse aggregate in all FRAP shall be equal to or less than the nominal maximum size requirement for the HMA mixture to be produced.

(2) Steel Slag Stockpiles. FRAP stockpiles containing steel slag or other expansive material, as determined by the Department, shall be homogeneous and will be approved for use in HMA (High ESAL and Low ESAL) mixtures regardless of lift or mix type.

(3) Use in HMA Surface Mixtures (High and Low ESAL). FRAP stockpiles for use in HMA surface mixtures (High and Low ESAL) shall have coarse aggregate that is Class B quality

or better. FRAP shall be considered equivalent to limestone for frictional considerations unless produced/screened to minus 3/8 inch.

(4) Use in HMA Binder Mixtures (High and Low ESAL), HMA Base Course, and HMA Base Course Widening. FRAP stockpiles for use in HMA binder mixtures (High and Low ESAL), HMA base course, and HMA base course widening shall be FRAP in which the coarse aggregate is Class C quality or better.

(5) Use in Shoulders and Subbase. FRAP stockpiles for use in HMA shoulders and stabilized subbase (HMA) shall be FRAP, Restricted FRAP, conglomerate, or conglomerate DQ.

(b) RAS. RAS meeting Type 1 or Type 2 requirements will be permitted in all HMA applications as specified herein.

(c) FRAP and/or RAS Usage Limits. Type 1 or Type 2 RAS may be used alone or in conjunction with FRAP in HMA mixtures up to a maximum of 5.0% by weight of the total mix.

When FRAP~~, RAS~~ is used alone or FRAP is used in conjunction with RAS ~~is used~~, the percent of virgin asphalt binder replacement (ABR) shall not exceed the amounts indicated in the table below for a given N Design.

Max Asphalt Binder Replacement for FRAP with RAS Combination

HMA Mixtures 1/ 2/ ~~4/~~	Maximum % ABR		
Ndesign	Binder/Leveling Binder	Surface	Polymer Modified 3/
30L	50	40	~~3~~10
50	40	35	~~3~~10
70	40	30	~~3~~10
90	40	30	~~3~~10 4/
4.75 mm N-50			~~3~~40
SMA N-80			~~3~~20

1/ For HMA “All Other” (shoulder and stabilized subbase) N-30, the percent asphalt binder replacement shall not exceed 50% of the total asphalt binder in the mixture.

2/ When the binder replacement exceeds 15 percent for all mixes, except for SMA and IL-4.75, the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e. 25 percent binder replacement using a virgin asphalt binder grade of PG64-22 will be reduced to a PG58-28). When constructing full depth HMA and the ABR is less than 15 percent, the required virgin asphalt binder grade shall be PG64-28.

3/ When the ABR for SMA or IL-4.75 is 15 percent or less, the required virgin asphalt binder shall be SBS PG76-22 and the elastic recovery shall be a minimum of 80. When the ABR for SMA or IL-4.75 exceeds 15%, the virgin asphalt binder grade shall be SBS PG70-28 and the elastic recovery shall be a minimum of 80.

4/ ~~When FRAP or RAS is used alone, the maximum percent asphalt binder replacement designated on the table shall be reduced by 10%.~~ For polymerized surface mix used for overlays, with up to 10 percent ABR, a SBS PG70-22 will be required. However, if used in full depth HMA, a SBS PG70-28 will be required.

1031.07 HMA Mix Designs. At the Contractor's option, HMA mixtures may be constructed utilizing RAP/FRAP and/or RAS material meeting the detailed requirements specified herein.

(a) FRAP and/or RAS. FRAP and /or RAS mix designs shall be submitted for verification. If additional FRAP or RAS stockpiles are tested and found to be within tolerance, as defined under "Evaluation of Tests" herein, and meet all requirements herein, the additional FRAP or RAS stockpiles may be used in the original design at the percent previously verified.

(b) RAS. Type 1 and Type 2 RAS are not interchangeable in a mix design. A RAS stone bulk specific gravity (Gsb) of 2.500 shall be used for mix design purposes.

1031.08 HMA Production. HMA production utilizing FRAP and/or RAS shall be as follows.

To remove or reduce agglomerated material, a scalping screen, gator, crushing unit, or comparable sizing device approved by the Engineer shall be used in the RAS and FRAP feed system to remove or reduce oversized material. If material passing the sizing device adversely affects the mix production or quality of the mix, the sizing device shall be set at a size specified by the Engineer.

If during mix production, corrective actions fail to maintain FRAP, RAS or QC/QA test results within control tolerances or the requirements listed herein the Contractor shall cease production of the mixture containing FRAP or RAS and conduct an investigation that may require a new mix design.

(a) RAS. RAS shall be incorporated into the HMA mixture either by a separate weight depletion system or by using the RAP weigh belt. Either feed system shall be interlocked with the aggregate feed or weigh system to maintain correct proportions for all rates of production and batch sizes. The portion of RAS shall be controlled accurately to within ± 0.5 percent of the amount of RAS utilized. When using the weight depletion system, flow indicators or sensing devices shall be provided and interlocked with the plant controls such that the mixture production is halted when RAS flow is interrupted.

(b) HMA Plant Requirements. HMA plants utilizing FRAP and/or RAS shall be capable of automatically recording and printing the following information.

(1) Dryer Drum Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Accumulated weight of dry aggregate (combined or individual) in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

d. Accumulated dry weight of RAS and FRAP in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

e. Accumulated mineral filler in revolutions, tons (metric tons), etc. to the nearest 0.1 unit.

f. Accumulated asphalt binder in gallons (liters), tons (metric tons), etc. to the nearest 0.1 unit.

g. Residual asphalt binder in the RAS and FRAP material as a percent of the total mix to the nearest 0.1 percent.

h. Aggregate RAS and FRAP moisture compensators in percent as set on the control panel. (Required when accumulated or individual aggregate and RAS and FRAP are printed in wet condition.)

i. When producing mixtures with FRAP and/or RAS, a positive dust control system shall be utilized.

j. Accumulated mixture tonnage.

k. Dust Removed (accumulated to the nearest 0.1 ton).

(2) Batch Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Individual virgin aggregate hot bin batch weights to the nearest pound (kilogram).

d. Mineral filler weight to the nearest pound (kilogram).

f. RAS and FRAP weight to the nearest pound (kilogram).

g. Virgin asphalt binder weight to the nearest pound (kilogram).

h. Residual asphalt binder in the RAS and FRAP material as a percent of the total mix to the nearest 0.1 percent.

The printouts shall be maintained in a file at the plant for a minimum of one year or as directed by the Engineer and shall be made available upon request. The printing system will be inspected by the Engineer prior to production and verified at the beginning of each construction season thereafter.

1031.09 RAP in Aggregate Surface Course and Aggregate Shoulders. The use of RAP or FRAP in aggregate surface course and aggregate shoulders shall be as follows.

(a) Stockpiles and Testing. RAP stockpiles may be any of those listed in Article 1031.02, except "Non-Quality" and "FRAP". The testing requirements of Article 1031.03 shall not apply. RAP used to construct aggregate surface course and aggregate shoulders shall be according to the current Bureau of Materials and Physical Research's Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications"

(b) Gradation. One hundred percent of the RAP material shall pass the 1 1/2 in. (37.5mm) sieve. The RAP material shall be reasonably well graded from coarse to fine. RAP material that is gap-graded, FRAP, or single sized will not be accepted for use as Aggregate Surface Course and Aggregate Shoulders."

APPENDIX B3

RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES (BDE)

Effective: November 1, 2012
Revise: ~~November 1, 2013~~ April 1, 2014

Revise Section 1031 of the Standard Specifications to read:

"**SECTION 1031. RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES**

1031.01 Description. Reclaimed asphalt pavement and reclaimed asphalt shingles shall be according to the following.

(a) Reclaimed Asphalt Pavement (RAP). RAP is the material produced by cold milling or crushing an existing hot-mix asphalt (HMA) pavement. The Contractor shall supply written documentation that the RAP originated from routes or airfields under federal, state, or local agency jurisdiction.

(b) Reclaimed Asphalt Shingles (RAS). Reclaimed asphalt shingles (RAS). RAS is from the processing and grinding of preconsumer or post-consumer shingles. RAS shall be a clean and uniform material with a maximum of 0.5 percent unacceptable material, as defined in Bureau of Materials and Physical Research Policy Memorandum "Reclaimed Asphalt Shingle (RAS) Sources", by weight of RAS. All RAS used shall come from a Bureau of Materials and Physical Research approved processing facility where it shall be ground and processed to 100 percent passing the 3/8 in. (9.5 mm) sieve and 93 percent passing the #4 (4.75 mm) sieve based on a dry shake gradation. RAS shall be uniform in gradation and asphalt binder content and shall meet the testing requirements specified herein. In addition, RAS shall meet the following Type 1 or Type 2 requirements.

(1) Type 1. Type 1 RAS shall be processed, preconsumer asphalt shingles salvaged from the manufacture of residential asphalt roofing shingles.

(2) Type 2. Type 2 RAS shall be processed post-consumer shingles only, salvaged from residential, or four unit or less dwellings not subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP).

1031.02 Stockpiles. RAP and RAS stockpiles shall be according to the following.

(a) RAP Stockpiles. The Contractor shall construct individual, sealed RAP stockpiles meeting one of the following definitions. No additional RAP shall be added to the pile after the pile has been sealed. Stockpiles shall be sufficiently separated to prevent intermingling at the base. Stockpiles shall be identified by signs indicating the type as listed below (i.e. "Homogeneous Surface").

Prior to milling, the Contractor shall request the District provide documentation on the quality of the RAP to clarify the appropriate stockpile.

(1) Fractionated RAP (FRAP). FRAP shall consist of RAP from Class I, HMA (High and Low ESAL) mixtures. The coarse aggregate in FRAP shall be crushed aggregate and may represent more than one aggregate type and/or quality but shall be at least C quality. All

FRAP shall be fractionated prior to testing by screening into a minimum of two size fractions with the separation occurring on or between the #4 (4.75 mm) and 1/2 in. (12.5 mm) sieves. Agglomerations shall be minimized such that 100 percent of the RAP shall pass the sieve size specified below for the mix into which the FRAP will be incorporated.

Mixture FRAP will be used in:	Sieve Size that 100% of FRAP Shall Pass
IL-25.0	2 in. (50 mm)
IL-19.0	1 1/2 in. (40 mm)
IL-12.5	1 in. (25 mm)
IL-9.5	3/4 in. (20 mm)
IL-4.75	1/2 in. (13 mm)

(2) Homogeneous. Homogeneous RAP stockpiles shall consist of RAP from Class I, HMA (High and Low ESAL) mixtures and represent: 1) the same aggregate quality, but shall be at least C quality; 2) the same type of crushed aggregate (either crushed natural aggregate, ACBF slag, or steel slag); 3) similar gradation; and 4) similar asphalt binder content. If approved by the Engineer, combined single pass surface/binder millings may be considered "homogenous" with a quality rating dictated by the lowest coarse aggregate quality present in the mixture.

(3) Conglomerate. Conglomerate RAP stockpiles shall consist of RAP from Class I, HMA (High and Low ESAL) mixtures. The coarse aggregate in this RAP shall be crushed aggregate and may represent more than one aggregate type and/or quality but shall be at least C quality. This RAP may have an inconsistent gradation and/or asphalt binder content prior to processing. All conglomerate RAP shall be processed prior to testing by crushing to where all RAP shall pass the 5/8 in. (16 mm) or smaller screen. Conglomerate RAP stockpiles shall not contain steel slag.

(4) Conglomerate "D" Quality (DQ). Conglomerate DQ RAP stockpiles shall consist of RAP from Class I, HMA (High or Low ESAL), or "All Other" (as defined by Article 1030.04(a)(3)) mixtures. The coarse aggregate in this RAP may be crushed or round but shall be at least D quality. This RAP may have an inconsistent gradation and/or asphalt binder content. Conglomerate DQ RAP stockpiles shall not contain steel slag.

(5) Non-Quality. RAP stockpiles that do not meet the requirements of the stockpile categories listed above shall be classified as "Non-Quality".

RAP/FRAP containing contaminants, such as earth, brick, sand, concrete, sheet asphalt, bituminous surface treatment (i.e. chip seal), pavement fabric, joint sealants, etc., will be unacceptable unless the contaminants are removed to the satisfaction of the Engineer. Sheet asphalt shall be stockpiled separately.

(b) RAS Stockpiles. Type 1 and Type 2 RAS shall be stockpiled separately and shall not be intermingled. Each stockpile shall be signed indicating what type of RAS is present.

Unless otherwise specified by the Engineer, mechanically blending manufactured sand (FM 20 or FM 22) up to an equal weight of RAS with the processed RAS will be permitted to improve workability. The sand shall be "B Quality" or better from an approved Aggregate Gradation

Control System source. The sand shall be accounted for in the mix design and during HMA production.

Records identifying the shingle processing facility supplying the RAS, RAS type and lot number shall be maintained by project contract number and kept for a minimum of three years.

1031.03 Testing. RAP/FRAP and RAS testing shall be according to the following.

(a) RAP/FRAP Testing. When used in HMA, the RAP/FRAP shall be sampled and tested either during or after stockpiling.

(1) During Stockpiling. For testing during stockpiling, washed extraction samples shall be run at the minimum frequency of one sample per 500 tons (450 metric tons) for the first 2000 tons (1800 metric tons) and one sample per 2000 tons (1800 metric tons) thereafter. A minimum of five tests shall be required for stockpiles less than 4000 tons (3600 metric tons).

(2) After Stockpiling. For testing after stockpiling, the Contractor shall submit a plan for approval to the District proposing a satisfactory method of sampling and testing the RAP/FRAP pile either in-situ or by restockpiling. The sampling plan shall meet the minimum frequency required above and detail the procedure used to obtain representative samples throughout the pile for testing.

Each sample shall be split to obtain two equal samples of test sample size. One of the two test samples from the final split shall be labeled and stored for Department use. The Contractor shall extract the other test sample according to Department procedure. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

(b) RAS Testing. RAS or RAS blended with manufactured sand shall be sampled and tested during stockpiling according to Illinois Department of Transportation Policy Memorandum, “Reclaimed Asphalt Shingle (RAS) Source”.

Samples shall be collected during stockpiling at the minimum frequency of one sample per 200 tons (180 metric tons) for the first 1000 tons (900 metric tons) and one sample per 250 tons (225 metric tons) thereafter. A minimum of five samples are required for stockpiles less than 1000 tons (900 metric tons). Once a ≤ 1000 ton (900 metric ton), five-sample/test stockpile has been established it shall be sealed. Additional incoming RAS or RAS blended with manufactured sand shall be stockpiled in a separate working pile as designated in the Quality Control plan and only added to the sealed stockpile when the test results of the working pile are complete and are found to meet the tolerances specified herein for the original sealed RAS stockpile.

Before testing, each sample shall be split to obtain two test samples. One of the two test samples from the final split shall be labeled and stored for Department use. The Contractor shall perform a washed extraction and test for unacceptable materials on the other test sample according to Department procedures. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

If the sampling and testing was performed at the shingle processing facility in accordance with the QC Plan, the Contractor shall obtain and make available all of the test results from start of the initial stockpile.

1031.04 Evaluation of Tests. Evaluation of tests results shall be according to the following.

(a) Evaluation of RAP/FRAP Test Results. All of the extraction results shall be compiled and averaged for asphalt binder content and gradation and, when applicable G_{mm}. Individual extraction test results, when compared to the averages, will be accepted if within the tolerances listed below.

Parameter	FRAP/Homogeneous /Conglomerate	Conglomerate "D" Quality
1 in. (25 mm)		± 5 %
1/2 in. (12.5 mm)	± 8 %	± 15 %
No. 4 (4.75 mm)	± 6 %	± 13 %
No. 8 (2.36 mm)	± 5 %	
No. 16 (1.18 mm)		± 15 %
No. 30 (600 µm)	± 5 %	
No. 200 (75 µm)	± 2.0 %	± 4.0 %
Asphalt Binder	± 0.4 % 1/	± 0.5 %
G_{mm}	± 0.03	

1/ The tolerance for FRAP shall be ± 0.3 %.

If more than 20 percent of the individual sieves and/or asphalt binder content tests are out of the above tolerances, the RAP/FRAP shall not be used in HMA unless the RAP/FRAP representing the failing tests is removed from the stockpile. All test data and acceptance ranges shall be sent to the District for evaluation.

With the approval of the Engineer, the ignition oven may be substituted for extractions according to the Illinois Test Procedure, "Calibration of the Ignition Oven for the Purpose of Characterizing Reclaimed Asphalt Pavement (RAP)".

(b) Evaluation of RAS and RAS Blended with Manufactured Sand Test Results. All of the test results, with the exception of percent unacceptable materials, shall be compiled and averaged for asphalt binder content and gradation. Individual test results, when compared to the averages, will be accepted if within the tolerances listed below.

Parameter	RAS
No. 8 (2.36 mm)	± 5 %
No. 16 (1.18 mm)	± 5 %
No. 30 (600 µm)	± 4 %
No. 200 (75 µm)	± 2.0 %
Asphalt Binder Content	± 1.5 %

If more than 20 percent of the individual sieves and/or asphalt binder content tests are out of the above tolerances, or if the percent unacceptable material exceeds 0.5 percent by weight of material retained on the # 4 (4.75 mm) sieve, the RAS or RAS blend shall not be used in Department projects. All test data and acceptance ranges shall be sent to the District for evaluation.

1031.05 Quality Designation of Aggregate in RAP/FRAP.

(a) RAP. The aggregate quality of the RAP for homogenous, conglomerate, and conglomerate "D" quality stockpiles shall be set by the lowest quality of coarse aggregate in the RAP stockpile and are designated as follows.

(1) RAP from Class I, Superpave/HMA (High ESAL), or (Low ESAL) IL-9.5L surface mixtures are designated as containing Class B quality coarse aggregate.

(2) RAP from Superpave/HMA (Low ESAL) IL-19.0L binder mixture is designated as Class D quality coarse aggregate.

(3) RAP from Class I, Superpave/HMA (High ESAL) binder mixtures, bituminous base course mixtures, and bituminous base course widening mixtures are designated as containing Class C quality coarse aggregate.

(4) RAP from bituminous stabilized subbase and BAM shoulders are designated as containing Class D quality coarse aggregate.

(b) FRAP. If the Engineer has documentation of the quality of the FRAP aggregate, the Contractor shall use the assigned quality provided by the Engineer.

If the quality is not known, the quality shall be determined as follows. Coarse and fine FRAP stockpiles containing plus #4 (4.75 mm) sieve coarse aggregate shall have a maximum tonnage of 5,000 tons (4,500 metric tons). The Contractor shall obtain a representative sample witnessed by the Engineer. The sample shall be a minimum of 50 lb (25 kg). The sample shall be extracted according to Illinois Modified AASHTO T 164 by a consultant prequalified by the Department for the specified testing. The consultant shall submit the test results along with the recovered aggregate to the District Office. The cost for this testing shall be paid by the Contractor. The District will forward the sample to the BMPR Aggregate Lab for MicroDeval Testing, according to Illinois Modified AASHTO T 327. A maximum loss of 15.0 percent will be applied for all HMA applications.

1031.06 Use of RAP/FRAP and/or RAS in HMA. The use of RAP/FRAP and/or RAS shall be a Contractor's option when constructing HMA in all contracts.

(a) RAP/FRAP. The use of RAP/FRAP in HMA shall be as follows.

(1) Coarse Aggregate Size. The coarse aggregate in all RAP shall be equal to or less than the nominal maximum size requirement for the HMA mixture to be produced.

(2) Steel Slag Stockpiles. Homogeneous RAP stockpiles containing steel slag will be approved for use in all HMA (High ESAL and Low ESAL) Surface and Binder Mixture applications.

(3) Use in HMA Surface Mixtures (High and Low ESAL). RAP/FRAP stockpiles for use in HMA surface mixtures (High and Low ESAL) shall be FRAP or homogeneous in which the coarse aggregate is Class B quality or better. RAP/FRAP from Conglomerate stockpiles shall be considered equivalent to limestone for frictional considerations. Known frictional contributions from plus #4 (4.75 mm) homogeneous RAP and FRAP stockpiles will be accounted for in meeting frictional requirements in the specified mixture.

(4) Use in HMA Binder Mixtures (High and Low ESAL), HMA Base Course, and HMA Base Course Widening. RAP/FRAP stockpiles for use in HMA binder mixtures (High and Low ESAL), HMA base course, and HMA base course widening shall be FRAP, homogeneous, or conglomerate, in which the coarse aggregate is Class C quality or better.

(5) Use in Shoulders and Subbase. RAP/FRAP stockpiles for use in HMA shoulders and stabilized subbase (HMA) shall be FRAP, homogeneous, conglomerate, or conglomerate DQ.

(6) When the Contractor chooses the RAP option, the percentage of RAP shall not exceed the amounts indicated in Article 1031.06(c)(1) below for a given N Design.

(b) RAS. RAS meeting Type 1 or Type 2 requirements will be permitted in all HMA applications as specified herein.

(c) RAP/FRAP and/or RAS Usage Limits. Type 1 or Type 2 RAS may be used alone or in conjunction with RAP or FRAP in HMA mixtures up to a maximum of 5.0% by weight of the total mix.

(1) RAP/RAS. When RAP is used alone or RAP is used in conjunction with RAS, the percentage of virgin asphalt binder replacement shall not exceed the amounts listed in the Max RAP/RAS ABR table listed below for the given Ndesign.

RAP/RAS Maximum Asphalt Binder Replacement (ABR) Percentage

HMA Mixtures [1/, 2/]	RAP/RAS Maximum ABR %		
Ndesign	Binder/Leveling Binder	Surface	Polymer Modified
30	30	30	10
50	25	15	10
70	15	10	10
90	10	10	10
105	10	10	10

1/ For HMA “All Other” (shoulder and stabilized subbase) N-30, the RAP/RAS ABR shall not exceed 50 percent of the mixture.

2/ When RAP/RAS ABR exceeds 20 percent, the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e. 25 percent ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to a PG58-28). If warm mix asphalt (WMA) technology is utilized, and production temperatures do not exceed 275 °F (135 °C) the high and low virgin asphalt binder grades shall each be reduced by one grade when RAP/RAS ABR exceeds 25 percent (i.e. 26 percent RAP/RAS ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to a PG58-28).

(2) FRAP/RAS. When FRAP is used alone or FRAP is used in conjunction with RAS, the percentage of virgin asphalt binder replacement shall not exceed the amounts listed in the FRAP/RAS table listed below for the given N design.

FRAP/RAS Maximum Asphalt Binder Replacement (ABR) Percentage

HMA Mixtures [1/, 2/]	FRAP/RAS Maximum ABR %		
Ndesign	Binder/Leveling Binder	Surface	Polymer Modified [3/, 4/]
30	~~40~~50	40	10
50	40	~~30~~35	10
70	~~30~~40	~~20~~30	10
90	~~30~~40	~~20~~30	10
105	~~30~~40	~~15~~30	10

1/ For HMA "All Other" (shoulder and stabilized subbase) N30, the FRAP/RAS ABR shall not exceed 50 percent of the mixture.

2/ When FRAP/RAS ABR exceeds 20 percent for all mixes the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e. 25 percent ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to a PG58-28). If warm mix asphalt (WMA) technology is utilized, and production temperatures do not exceed 275 °F (135 °C) the high and low virgin asphalt binder grades shall each be reduced by one grade when FRAP/RAS ABR exceeds 25 percent (i.e. 26 percent ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to a PG58-28).

3/ For SMA the FRAP/RAS ABR shall not exceed 20 percent.

4/ For IL-4.75 mix the FRAP/RAS ABR shall not exceed 30 percent.

1031.07 HMA Mix Designs. At the Contractor's option, HMA mixtures may be constructed utilizing RAP/FRAP and/or RAS material meeting the detailed requirements specified herein.

(a) RAP/FRAP and/or RAS. RAP/FRAP and/or RAS mix designs shall be submitted for verification. If additional RAP/FRAP stockpiles are tested and found that no more than 20 percent of the results, as defined under "Testing" herein, are outside of the control tolerances set for the original RAP/FRAP stockpile and HMA mix design, and meets all of the requirements herein, the additional RAP/FRAP stockpiles may be used in the original mix design at the percent previously verified.

(b) RAS. Type 1 and Type 2 RAS are not interchangeable in a mix design. A RAS stone bulk specific gravity (Gsb) of 2.500 shall be used for mix design purposes.

1031.08 HMA Production. HMA production utilizing RAP/FRAP and/or RAS shall be as follows.

(a) RAP/FRAP. The coarse aggregate in all RAP/FRAP used shall be equal to or less than the nominal maximum size requirement for the HMA mixture being produced.

To remove or reduce agglomerated material, a scalping screen, gator, crushing unit, or comparable sizing device approved by the Engineer shall be used in the RAP feed system to remove or reduce oversized material. If material passing the sizing device adversely affects the mix production or quality of the mix, the sizing device shall be set at a size specified by the Engineer.

If the RAP/FRAP control tolerances or QC/QA test results require corrective action, the Contractor shall cease production of the mixture containing RAP/FRAP and either switch to the virgin aggregate design or submit a new RAP/FRAP design.

(b) RAS. RAS shall be incorporated into the HMA mixture either by a separate weight depletion system or by using the RAP weigh belt. Either feed system shall be interlocked with the aggregate feed or weigh system to maintain correct proportions for all rates of production and batch sizes. The portion of RAS shall be controlled accurately to within ± 0.5 percent of the amount of RAS utilized. When using the weight depletion system, flow indicators or sensing devices shall be provided and interlocked with the plant controls such that the mixture production is halted when RAS flow is interrupted.

~~When producing HMA containing RAS, a positive dust control system shall be utilized.~~

(c) RAP/FRAP and/or RAS. HMA plants utilizing RAP/FRAP and/or RAS shall be capable of automatically recording and printing the following information.

(1) Dryer Drum Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Accumulated weight of dry aggregate (combined or individual) in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

d. Accumulated dry weight of RAP/FRAP/RAS in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

e. Accumulated mineral filler in revolutions, tons (metric tons), etc. to the nearest 0.1 unit.

f. Accumulated asphalt binder in gallons (liters), tons (metric tons), etc. to the nearest 0.1 unit.

g. Residual asphalt binder in the RAP/FRAP material as a percent of the total mix to the nearest 0.1 percent.

h. Aggregate and RAP/FRAP moisture compensators in percent as set on the control panel. (Required when accumulated or individual aggregate and RAP/FRAP are printed in wet condition.)

(2) Batch Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Individual virgin aggregate hot bin batch weights to the nearest pound (kilogram).

d. Mineral filler weight to the nearest pound (kilogram).

~~f~~e. RAP/FRAP/RAS weight to the nearest pound (kilogram).

~~g~~f. Virgin asphalt binder weight to the nearest pound (kilogram).

~~h~~g. Residual asphalt binder in the RAP/FRAP/RAS material as a percent of the total mix to the nearest 0.1 percent.

The printouts shall be maintained in a file at the plant for a minimum of one year or as directed by the Engineer and shall be made available upon request. The printing system will be inspected by the Engineer prior to production and verified at the beginning of each construction season thereafter.

1031.09 RAP in Aggregate Surface Course and Aggregate Shoulders. The use of RAP in aggregate surface course (temporary access entrances only) and aggregate wedge shoulders Type B shall be as follows.

(a) Stockpiles and Testing. RAP stockpiles may be any of those listed in Article 1031.02, except "Non-Quality" and "FRAP". The testing requirements of Article 1031.03 shall not apply. RAP used to construct aggregate surface course and aggregate shoulders shall be according to the current Bureau of Materials and Physical Research's Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications".

(b) Gradation. One hundred percent of the RAP material shall pass the 1 1/2 in. (37.5 mm) sieve. The RAP material shall be reasonably well graded from coarse to fine. RAP material that is gap-graded or single sized will not be accepted."


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