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TN TDOT Department of Transportation

2022 TENNESSEE STATEWIDE LITTER STUDY

February 13, 2023

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AAH	Adopt-A-Highway
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
GIS	Geographic Information System
Grand Division	Division of Tennessee into East, Middle and West areas
KAB	Keep America Beautiful
KTNB	Keep Tennessee Beautiful
PSA	Public Service Announcement
TDOT	Tennessee Department of Transportation
TDEC	Tennessee Department of Environment and Conservation

2022 TENNESSEE STATEWIDE LITTER STUDY
EXECUTIVE SUMMARY

The Tennessee Department of Transportation (TDOT) and Keep Tennessee Beautiful (KTNB) retained Burns & McDonnell to develop the 2022 Tennessee Statewide Litter Study (2022 Study) to evaluate progress on litter abatement and make the most effective use of future litter prevention and cleanup resources.

The objective of the 2022 Study is to provide a detailed comparison to the 2016 Tennessee Statewide Litter Study (2016 Study), measure the progress of abating litter statewide, and develop data-driven strategies to enhance the effectiveness of the Nobody Trashes Tennessee campaign. The 2022 Study leverages results from the 2020 Keep America Beautiful (KAB) Nationwide Litter Study (2020 KAB Study) to identify how litter has changed over time, determines the relationship between roadside litter and site characteristics, and assesses the impact of nearby infrastructure and socioeconomic factors to strengthen litter prevention and abatement programs on a statewide basis.

Throughout the Executive Summary there are key findings related to the analysis emphasized in call out boxes. This Executive Summary concludes with a series of key findings and recommendations related to litter abatement strategies.

Table ES-1 indicates how the 2022 Study is organized, listing each section with a brief description of the content included.

Table ES-1: Study Section Organization and Description

Section	Title	Description
1.0	**Introduction**	Presents the study objective, approach and key assumptions and limitations.
2.0	**Methodology**	Details the methodology of the 2022 Study including the sampling plan, material categories, field surveying, data analysis and compilation.
3.0	**Results**	Presents the results of the evaluation including comparisons of statewide total litter items by roadway classification, litter composition, and the results of the influencing factors statistical analysis to determine key location-based factors that contribute to greater or lesser rates of litter accumulation.
4.0	**Litter Abatement Strategies**	Evaluates the current litter abatement strategies and provides recommendations related to identify the best opportunities to strengthen litter prevention efforts.
Appendices		
A	**Sampling Site Locations**	Provides a detailed list of sampling sites including site location and roadway classification.
B	**Material Categories and Definitions**	Lists the detailed material categories and definitions.
C	**Litter Survey Form**	Includes images of the field survey form as part of the customized Survey123 data application.
D	**Composition Results**	Provides detailed composition tables by roadway classification and comparisons to the composition profiles from the 2016 Study.
E	**Regression Analysis Results**	Provides detailed results of the multiple regression and simple linear regression analyses evaluated for influencing factors and proximity to disposal, recycling, and rest stop facilities.

METHODOLOGY

Burns & McDonnell worked closely with TDOT and KTNB to develop a project approach to produce results that could be compared to the 2016 Study. The 2022 Study incorporates approaches based on the best practices consistent with more recent nationwide 2020 KAB Study. The following analysis is intended to be replicable for future KTNB or KAB studies to provide clear understanding of how the composition and quantity of litter may change over time.

The key differences between the 2016 and 2022 field work methodology include an increase in the number of material categories, conducting separate 4-inch-Plus and 4-inch-Minus surveys, and more streamlined evaluation of influencing factors.

Burns & McDonnell developed the sampling plan by coordinating with KTNB and TDOT to randomly select 120 roadway locations split equitably amongst the following four roadway classifications in both urban and rural areas of Tennessee: Interstate, U.S. Highway, State Highway and Local Roads. The sampling plan included designated litter hot spots provided by representatives from TDOT and KTNB in the cities of Memphis, Nashville, Knoxville, and Chattanooga, as well as at-risk and distressed locations. The sampling plan was finalized once the 120 survey sites were proportionally distributed based on the population among the Grand Divisions as shown in Table ES-2.

Table ES-2: Distribution of Survey Sites by Grand Division

Grand Division	Population (2020)	Population (%)	Survey Sites
West	1,557,649	23%	27
Middle	2,883,086	42%	50
East	2,470,105	36%	43
Total	6,910,840	100%	120

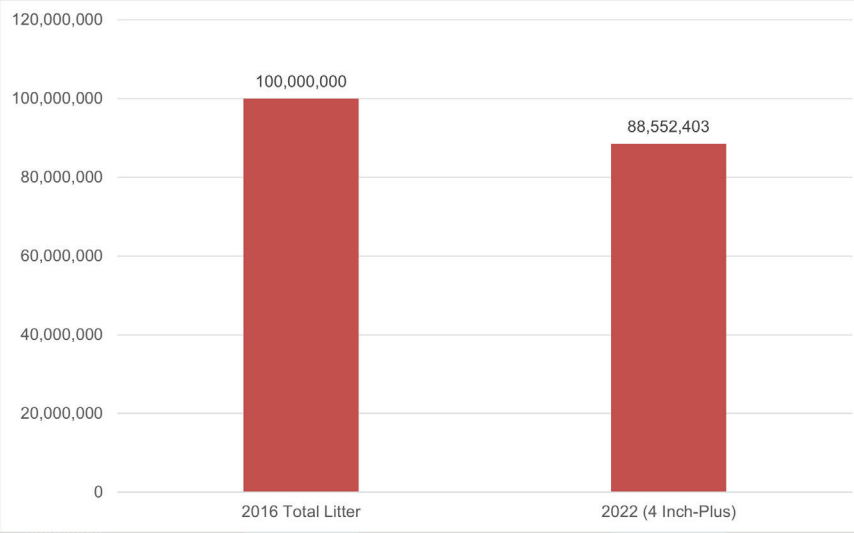
Reference Figure ES-2 for the map of approximate survey site locations and visual representation of the Grand Divisions. Burns & McDonnell determined the material categories to include in the 2022 Study by reviewing the more detailed categories included in 2020 KAB Study (about 70 material categories) and working with KTNB and TDOT to harmonize the material types with the categories included in the 2016 Study (30 material categories). Reference Table 2-3 for further detail regarding how material categories have been combined for the 2022 Study.

[1] Economic status designations are identified through a composite measure of each county's three-year average unemployment rate, per capita market income, and poverty rate. Based on these indicators, each county is then categorized as distressed, at-risk, transitional, competitive or attainment. Further information is available here: https://www.tn.gov/transparenttn/state-financial-overview/open-ecd.

STATEWIDE LITTER PREVALENCE AND COMPOSITION

The following shows the overall statewide litter prevalence and composition results as presented in Section 3.0. The total estimated litter items larger than 4 inches in the 2022 Study show a reduction of items this size along Tennessee roadways. Figure ES-1 compares the total estimated litter items from the 2016 Study to the 4-inch-Plus material from the 2022 Study.

Figure ES-1: Statewide Litter Prevalence Results



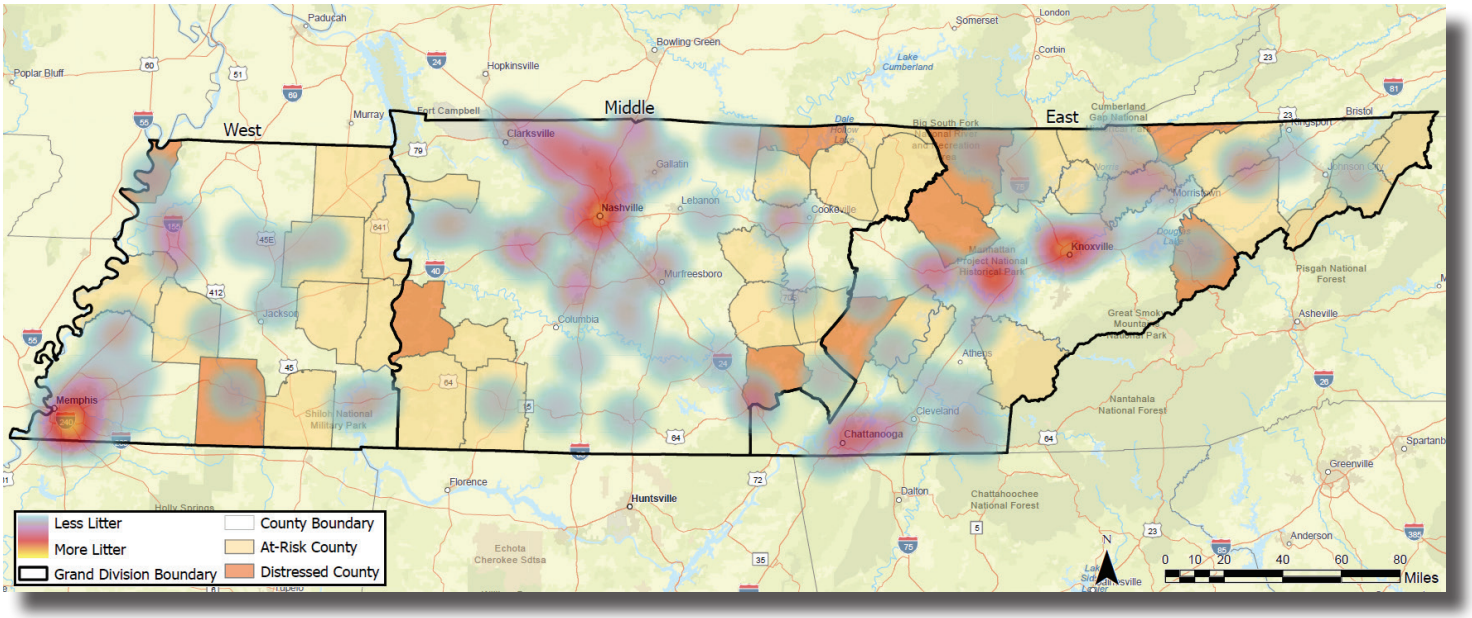
The total litter items estimated in 2016 include about 11.5million items, or about 12 percent more than the 4-inch-Plus items estimated in the 2022 Study.[2] The reduction in the comparable fraction of the items from the 2022 Study indicates that the efforts for litter abatement and prevention have been effective in reducing the prevalence of this material on Tennessee roadways.

Figure ES-2 presents a heatmap of the combined 4-inch-Plus and 4-inch-Minus litter items observed at 120 sample locations to provide a planning level indication of where litter is most prevalent across Tennessee. The visual representation of the results indicates that urban areas (e.g., Nashville, Memphis, Knoxville) have higher concentrations of observed litter compared to rural areas.

The heatmap represents combined 4-inch-plus and 4-inch-minus litter items ovserved at 120 sample locations. Adjacent sample locations are aggregated to indicate intensity of litter quantities within 20 miles. Litter count results represent a snapshot in time, and do not reflect absolute results for the amount of litter present or generated on an annual basis.

[2] Although the results of the 4-inch-Minus material are presented and evaluated, they are not directly compared to the 2016 Study in some cases because this aspect of the sampling methodology was not conducted in the 2016 Study.

Figure ES-2: Tennessee Statewide Litter Survey Visible Litter Heatmap[1]



1. Areas without coloring represent locations where no surveys took place within 20 miles.

Table ES-3 shows the Litter-per-mile by roadway classification results for the 2022 Study for both 4-inch-Plus and 4-inch-Minus survey results.

Table ES-3: 2022 Litter-per-mile by Roadway Classification[1]

Roadway Type	Average Items per Mile	Road Miles	Total Litter Items	Percent of Total Litter Items
Interstate	21,346	1,202	25,648,618	3%
U.S. Highway	7,386	8,849	65,359,820	9%
State Highway	15,497	3,975	61,604,466	8%
Local Roads	7,459	82,538	615,643,514	80%
Total	-	96,564	768,256,418	100%

1. Includes results from 4-inch-Plus and 4-inch-Minus survey.

U.S. Highways had the lowest litter-per-mile on a combined basis (7,386 litter items per mile on average including both 4-inch-Plus and 4-inch-Minus survey results); however, Local Roads account for the most road miles (82,538 miles) in the state. In aggregate, Local Roads had the highest percentage (80 percent) of total litter items by roadway type.

To provide context on the split between items under 4-inch-Plus and above 4-inch-Minus material, Table ES-4 compares the 4-inch-Plus and 4-inch-Minus survey results from the 2020 KAB and 2022 KTNB results.

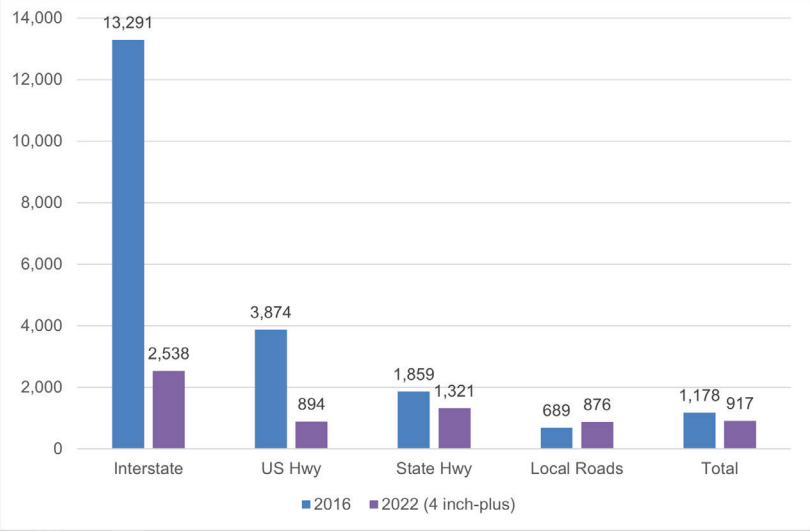
Table ES-4: Comparison of 4-inch-Plus and 4-Inch Minus Survey Total Litter Items

Material Size	2020 KAB		2022 KTNB	
	Total litter	Percentage	Total Litter	Percentage
4-Inch-Plus	2,956,539,100	12%	88,552,403	12%
4-Inch-Minus	20,721,487,400	88%	679,704,015	88%
Total	23,678,026,500	100%	768,256,418	100%

The majority of litter on Tennessee roadways is smaller than four inches. An estimated 679.7 million pieces, or 88 percent, items of litter were 4-inches or smaller in size; however, the 2022 Study estimates there is still a significant quantity (88.5 million pieces or 12 percent) of larger, and often more visible, litter on Tennessee roadways. The proportions of the 4-inch-Plus and 4-inch-Minus materials are similar between the 2020 KAB study and the 2022 Study.

Figure ES-3 provides a comparison on the Litter-per-mile for the 2016 Study and 2022 Study that reflects the results from the 4-inch-Plus survey.[3]

Figure ES-3: Comparison of Litter-per-mile[1]



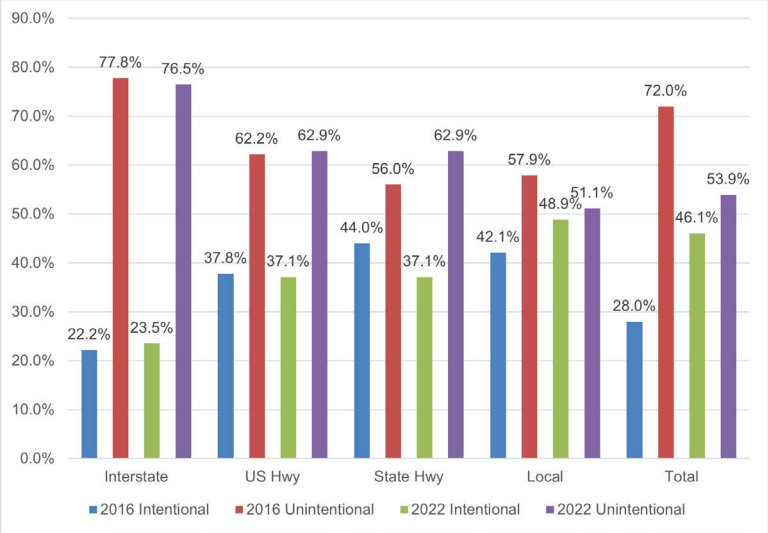
There was a significant reduction in the 4-inch-Plus litter items on Interstate and U.S. Highway roadway classifications. Other roadway classifications and the total litter items were comparable (e.g., within 300 litter items per mile). This indicates that litter prevention and abatement efforts may have had an impact on reducing Litter-per-mile on Interstate and U.S. Highway roadway classifications.

1. 2022 Study results based on 4-inch-Plus survey only for comparison purposes.

[3] Litter per mile, including 4 inch-plus and 4 inch-minus, can range between 500 to 50,000 depending on roadway classification, location, season, and local litter abatement programs activity.

Each material category was assigned as intentional or unintentional based on the designation of material categories from the 2016 Study with minor changes based on discussions with KTNB and TDOT staff. Figure ES-4 compares the amount of intentional and unintentional litter between 2016 and 2022 Studies.

Figure ES-4: Intentional and Unintentional Litter by Roadway Classification[1,2]

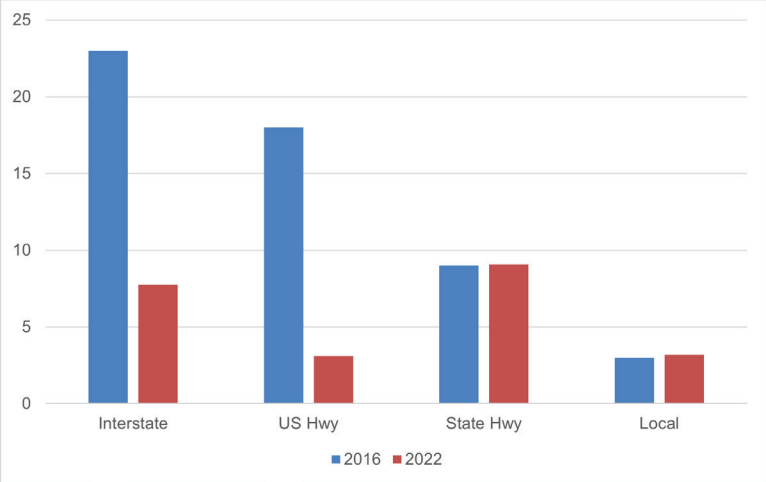


On an overall basis the intentional litter increased by about 18 percent due, in part, to changes in product packaging and classification differences between the 2016 Study and 2022 Study.

1. 2022 Study results based on 4-inch-Plus survey only for comparison purposes.
2. Designations were established prior to data collection, and were not inputted by field crews on an item-by-item basis.

Figure ES-5 compares the average number of cigarette butts by site and roadway classification, since cigarette butts have historically been one of the most littered items.

Figure ES-5: Average Cigarette Butt Count per Survey Site by Roadway Classification[1]

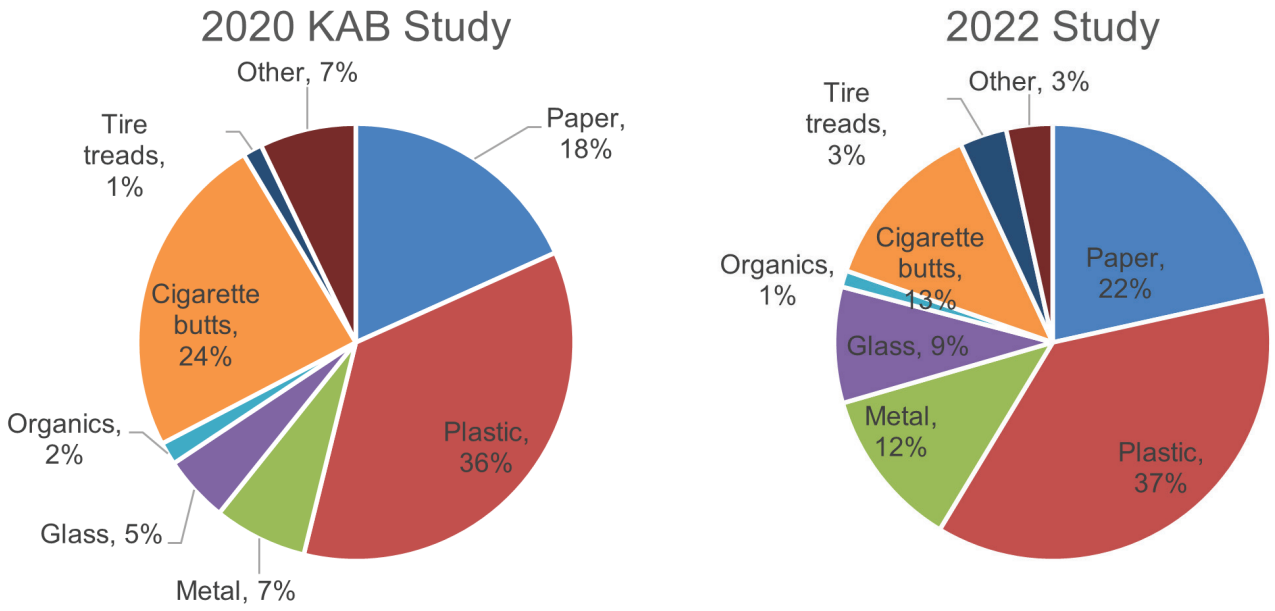


The amount of cigarette butts observed per site decreased for Interstate and U.S. Highway roadway classifications. This may be explained, in part, to the changes in tobacco usage over time (e.g., increase usage of vape pens) and less need to dispose of cigarette butts on the larger roadways.

1. Includes results from 4-inch-Plus and 4-inch-Minus survey, since majority of cigarette butts were identified as part of sub survey.

Figure ES-6 presents a comparison of the overall composition between the 2020 KAB Study and 2022 Study.

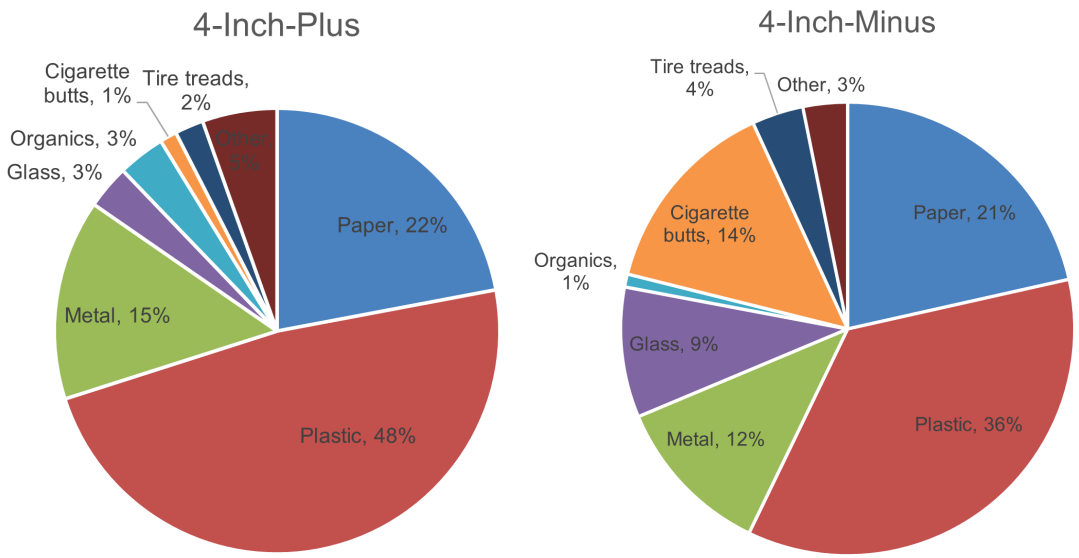
Figure ES-6: Aggregate Composition of Litter by Count, All Roadways



Plastic and paper items compose the majority of litter items. Litter on Tennessee roadways is composed of an estimated 285 million (37 percent) plastic items, followed by 165.5 million (22 percent) paper items. Since 2016, changes in plastic packaging and product types (e.g., increased prevalence of lightweighted materials and multi-layer film plastics) have impacted how plastic materials are handled. This may contribute to the high percentage of plastic litter items observed. From 2016 to 2022, cigarette butts decreased from 24 to 13 percent and glass items increased from 5 to 9 percent.

The material composition of litter varied by item size. As shown in Figure ES-7, plastic items composed the largest proportion by material category of both 4-inch-Plus and 4-inch-Minus litter.

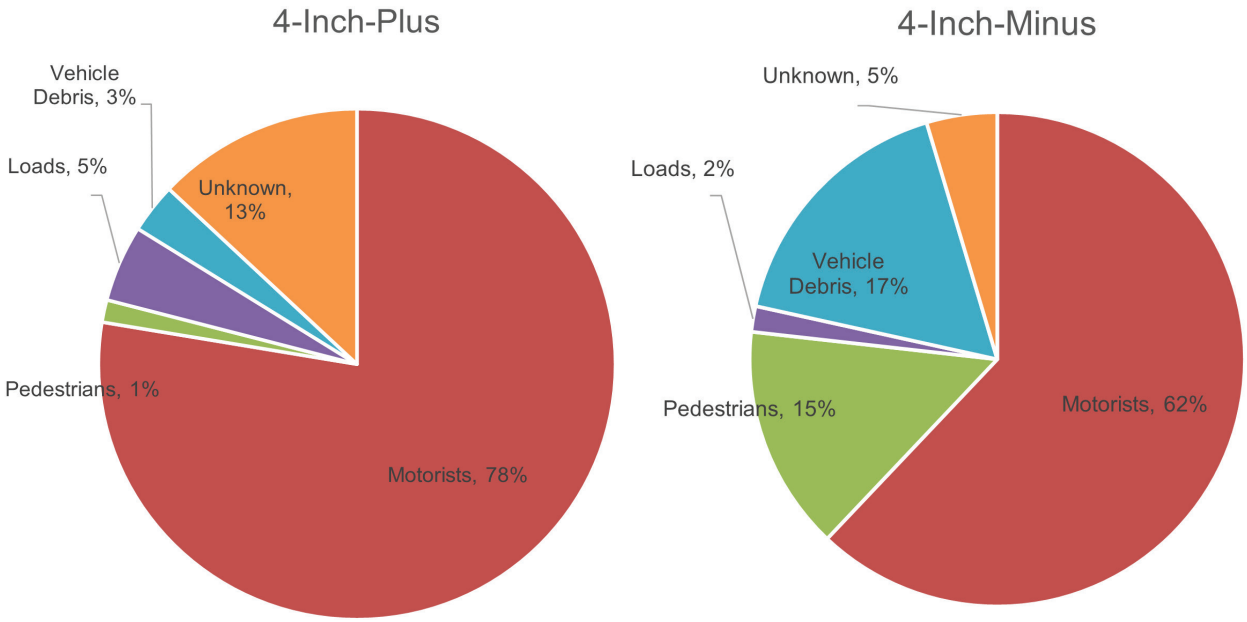
Figure ES-7: Aggregate Composition of Litter by Count, All Roadways



Cigarette butts, glass, and tire treads composed a larger portion of the smaller litter items representing a combined 27 percent compared to only six percent of the 4-inch-Plus items.

Figure ES-8 presents the sources of litter for 4-inch-Plus and 4-inch-Minus material types.

Figure ES-8: Source of Litter by Count, All Roadways



Motorists were determined to be the leading sources of litter on Tennessee roadways (78 percent) for the 4-inch plus material. The 4-inch-Minus material had fewer items from motorists compared to the 4-inch-Plus material and increased material from pedestrians and vehicle debris.

ECONOMETRIC ANALYSIS

The following summarizes the analysis of key drivers of litter-per-mile based on observations from the field crews and research conducted by Burns & McDonnell as presented in Section 3.0:

- **Scenic byway and Adopt-A-Highway (AAH) locations had much less litter observed on average compared to sites that were not on scenic byways or AAH locations.** This is consistent with the amount of litter observed on Local Roads (e.g., fewer items per mile than Interstates or U.S. and State highways) may be due, in part, to the additional litter cleanups and attention these stretches of roadway receive over time. This observation supports the continued focus on expanding the AAH program across the state.
- **Waterways are key considerations related to litter abatement, especially with the high levels of 4-inch-Minus materials present on Tennessee roadways.** At sites where waterways were observed, there was approximately 55 more litter items on average compared to sites where no waterways were observed. This finding indicates areas with waterways accumulate litter at higher rates.
- **Sites where bike paths were observed had about 41 fewer litter items on average, indicating areas with bike paths minimize litter generation.**
- **On average, there were fewer litter items observed at sites in at-risk and distressed counties.** This may be due to the fact that the majority of survey sites in these counties were in rural areas on local roads which, on average, also had fewer litter items.

Simple linear regression analysis was run on each of the counted observations (e.g., number of storm drains, number of bus stops) that showed statistical significance. Table ES-5 presents the R Square, P-value and coefficient of each linear regression to identify the strength and direction of each influencing factor that indicated statistical significance.

Table ES-5: Results of Simple Linear Regression Analysis[1]

Influencing Factor	R-Square	P-Value	Coefficient[2]
Bus	0.077	0.002	54,153
Convenience Store	0.149	0.00001	14,885
Construction Site	0.007	0.355	8,370

1. Simple linear regression analyses run at 95 percent confidence.
2. Represents the strength/direction of statistical correlation of influencing factor to Litter-per-mile (e.g., additional unit of influencing factor increases Litter-per-mile by coefficient value).

Based on the results of the simple linear regression analyses, the observations of bus stops and convenience stores were statistically valid (e.g., P-value below 0.05) and represent the influencing factors to have a statistical impact on the estimated litter-per-mile. While the fitness of data (e.g., R-Square values) are not high enough to run further modeling or prediction of the additional litter items these influencing factors might cause, they can become the focus of litter prevention and abatement strategies.

Additionally, the impact that distance from each survey site to the nearest disposal, recycling or rest stop facilities had on litter-per-mile items was evaluated, but was not shown to have a statistically significant effect at the locations surveyed. However, sites nearest to recycling facilities (including convenience centers) showed higher number of litter items on average compared to disposal or rest stop facilities.

LITTER ABATEMENT STRATEGIES

As a result of the 2016 Study, KTNB and TDOT implemented the current Nobody Trashes Tennessee campaign, which replaced the previous campaign related to litter abatement and prevention.[4] The previous effort had been focused on providing a website, generating educational materials, utilizing some traditional advertising (e.g., billboards), and developing public service announcements (PSAs). The new campaign focuses on building on the previous campaign by including digital and social media approaches to engaging with residents and businesses in the state.

The following summarizes key findings related to litter abatement strategies and recommendations that would increase the effectiveness of litter abatement programming and minimize the ongoing costs of litter abatement in Tennessee:

Key Findings

- **Grant funding supports counties and municipal police departments to abate litter and are critical to advancing litter abatement efforts at the local level.**
- **Digital media and traditional advertising could be targeted to roadway types where litter is most prevalent.**
- **Litter abatement and prevention approaches can be segmented by larger litter items (e.g., 4-inch-Plus) and smaller litter items (e.g., 4-inch-Minus).**

Recommendations

- **Target messaging to minimize juice and soft drink containers that become litter.**
- **Expand the AAH program so there are more communities or businesses engaged in litter cleanup events on an annual basis.**
- **Seek partnerships that make the most meaningful impact in litter prevention including entities that manage or operate bus, rest stops, and convenience stores.**
- **Develop litter prevention content for Tennessee waterways to increase engagement.**
- **Focus messaging on audiences that frequent rest stops.**
- **Conduct future litter research study to update the analysis in approximately five years to evaluate the success of strategies implemented.**

[4] More information regarding the Nobody Trashes Tennessee campaign can be found here: nobodytrashestennessee.com

1.0 INTRODUCTION

The Tennessee Department of Transportation (TDOT) and Keep Tennessee Beautiful (KTNB) retained Burns & McDonnell to develop the 2022 Tennessee Statewide Litter Study (2022 Study) to evaluate progress on litter abatement and make the most effective use of future litter prevention and cleanup resources. The 2022 Study provides a comparative analysis between the 2016 Tennessee Statewide Litter Study (2016 Study) and the recent 2020 Keep America Beautiful Nationwide Litter Study (2020 KAB Study) to develop data-driven strategies to enhance the effectiveness of the Nobody Trashes Tennessee campaign and supporting litter abatement programs.

1.1 Background and Study Objective

Roadside littering and illegal dumping are challenges that local governments and TDOT must address throughout Tennessee. To better understand the composition and sources of litter, the 2016 Tennessee Statewide Litter Study was prepared to evaluate the quantity, composition, and causes of litter found on Tennessee roadways in 2016.[5] As a result of the 2016 study, the Nobody Trashes Tennessee campaign was developed and is deployed to abate and prevent litter by establishing programs and messaging to increase awareness and minimize litter generation.

Since the development of the 2016 Study and deployment of the Nobody Trashes Tennessee campaign, the 2020 KAB Study was developed to evaluate observed litter, littering behavior, attitudes about litter, and the cost of litter on a nationwide basis.[6]

The objective of the 2022 Study is to provide a detailed comparison to the 2016 Study and measure the progress of abating litter statewide. The 2022 Study leverages results from the 2020 KAB Study to identify how litter has changed over time, determines the relationship between roadside litter and site characteristics, and assesses the impact of nearby infrastructure and socioeconomic factors to strengthen litter prevention and abatement programs on a statewide basis. Additionally, the 2022 Study reinforces the importance of providing approximately $5.5 million of annual support to county entities for roadway litter cleanup and litter abatement efforts.

1.2 Project Approach

Burns & McDonell worked closely with TDOT and KTNB to develop a project approach to produce results that could be compared to the 2016 Study. Further, the 2022 Study incorporates approaches based

[5] The 2016 Tennessee Statewide Litter Study is available at the following hyperlink: https://nobodytrashestennessee.com/about/#research

[6] The 2020 KAB Study report summary is available at the following hyperlink: https://kab.org/wp-content/uploads/2021/05/Litter-Study-Summary-Report-May-2021_final_05172021.pdf

on the best practices consistent with the more recent nationwide 2020 KAB Study. Detailed descriptions of differences are provided in Section 1.3.

To initiate the 2022 Study, Burns & McDonnell held a virtual meeting with TDOT and KTNB representatives to determine the project schedule, sampling plan approach, field survey procedures, and key topics for evaluation. Two, two-person field teams were deployed between October 17 – October 28, 2022 to count and characterize roadway litter using an electronic data collection tool specifically designed for the field data collection. Burns & McDonnell initiated the field surveying and data collection by hosting a hands-on training workshop. Field team leads and crews conducted several surveys together to provide teams with a thorough understanding of the material categories, survey procedure, data entry protocols, and safety requirements.

Field crews executed the field work (as described in Section 2.3) by performing field surveys at 120 roadway sites statewide. The data collected was reviewed through a series of quality control measures and analyzed through a combination of customized modeling tools to evaluate the Litter-per-mile, litter composition profile, and impacts of key influencing factors on observed litter.

The methodology was structured to align with the 2020 KAB Study to foster future replicability and program comparisons, while still providing valuable data that can be compared to the 2016 Study. The 2022 Study is intended to serve as a benchmark for future statewide studies. The results of the 2022 Study allow TDOT and KTNB to evaluate data-driven approaches to build on the existing Nobody Trashes Tennessee campaign and pursue programs that have the highest impact on litter reduction and prevention.

1.3 Key Assumptions

This section summarizes key assumptions and limitations of the 2022 Study, including differences between the 2016 and 2022 field work methodology and impacts on the data analysis and results.

- The 2022 Study methodology has been enhanced to align with the best practices (e.g., consistent with the 2020 KAB Study). The study results associated with litter-per-mile at the statewide and roadway classification level reflect extrapolative techniques based on total road miles. The results should be interpreted as planning level outcomes that represent a snapshot in time, and not as absolute results for the amount of litter present or generated on an annual basis.
- The 2022 Study methodology increased the number of material categories to include approximately 70 individual items to provide a more robust analysis and comparatively analyze the results against the 30 items considered in the 2016 Study. Material category definitions and terms have been updated in conjunction with TDOT and KTNB staff to reflect items that are consistent with products and packaging disposed as of 2022.

- The survey methodology is consistent with 2020 KAB study (e.g., including 4-inch-Plus and 4-inch-Minus surveys) compared to 2016 where the field crews conducted an "edge" survey, focusing on items within three feet of the edge of the pavement, and a "meander" survey counting items within 15 feet of the roadside.
- Material was categorized by type and no brand information was collected or evaluated.
- Each material type was designated as intentional or unintentional in conjunction with TDOT and KTNB staff. These terms have been updated from the terms "negligent" and "deliberate" used in the 2016 Study.
- The evaluation of influencing factors and proximity to facilities included only key variables identified as part of the 2016 Study. Based on discussions with TDOT and KTNB staff, the statistical analysis was streamlined to assess only the most critical variables to provide insights on the correlation to litter accumulation.

1.4 Report Organization

The following presents the report organization with a brief description of each section:

- **Executive Summary.** Presents the overall results of the 2022 Study, key findings, and summary of litter abatement strategies.
- **Section 1.0 – Introduction.** Presents the study objective, approach and key assumptions and limitations.
- **Section 2.0 – Methodology.** Details the methodology of the 2022 Study including the sampling plan, material categories, field surveying, data analysis and compilation.
- **Section 3.0 – Results.** Presents the results of the evaluation including comparisons of statewide total litter items by roadway classification, litter composition, and the results of the influencing factors statistical analysis to determine key location-based factors that contribute to greater or lesser rates of litter accumulation.
- **Section 4.0 – Litter Abatement Strategies.** Evaluates the current litter abatement strategies and provides recommendations related to abatement messaging optimizing the deployment of resources to identify the best opportunities to strengthen litter prevention efforts.
- **Appendix A – Sampling Site Locations.** Provides a detailed list of sampling sites including site location and roadway classification.
- **Appendix B – Material Categories and Definitions.** Lists the detailed material categories and definitions.

- **Appendix C – Litter Survey Form.** Includes images of the field survey form as part of the customized Survey123 data application.
- **Appendix D – Composition Results.** Provides detailed composition tables by roadway classification and comparisons to the composition profiles from the 2016 Study.
- **Appendix E – Regression Analysis Results.** Provides detailed results of the multiple regression and simple linear regression analyses evaluated for influencing factors and proximity to disposal, recycling, and rest stop facilities.

2.0 METHODOLOGY

This section describes the 2022 Study methodology that has been developed to provide a comparison to the 2016 Study and incorporate key enhancements for comparison to the 2020 KAB Study. The methodology described herein is intended to be replicable for future KTNB or KAB studies to provide clear understanding of how the composition and quantity of litter may change over time.

2.1 Sampling Plan

Burns & McDonnell developed the sampling plan by coordinating with KTNB and TDOT to randomly generate 120 roadway locations split equitably amongst the following four roadway classifications: Interstate, U.S. Highway, State Highway and Local Roads in both urban and rural areas of Tennessee.

Burns & McDonnell utilized ArcGIS to develop the sampling plan and determine the survey sites. Initially, the survey sites were randomly generated and equally distributed among roadway classification (e.g., 30 survey sites each) across Tennessee roadways and Grand Division (e.g., 40 survey sites per Grand Division). Refer to Figure 2-1 for depicting the Grand Division boundaries, which split Tennessee into the West, Middle, and East divisions. The sampling plan was further developed by including designated litter hot spots provided by representatives from TDOT and KTNB in the cities of Memphis, Nashville, Knoxville, and Chattanooga and to include locations in counties identified as at-risk and distressed.[7] The sampling plan was finalized once the 120 survey sites were proportionally distributed based on the population among the Grand Divisions. Table 2-1 presents the distribution of survey sites by Grand Division.

Table 2-1: Distribution of Survey Sites by Grand Division

Grand Division	Population (2020)	Population (%)	Survey Sites
West	1,557,649	23%	27
Middle	2,883,086	42%	50
East	2,470,105	36%	43
Total[1]	**6,910,840**	**100%**	**120**

1. Sum for population percentage does not total due to rounding.

[7]Economic status designations are identified through a composite measure of each county's three-year average unemployment rate, per capita market income, and poverty rate. Based on these indicators, each county is then categorized as distressed, at-risk, transitional, competitive or attainment. Further information is available at the following hyperlink: https://www.tn.gov/transparenttn/state-financial-overview/open-ecd/openecd/tnecd-performance-metrics/openecd-long-term-objectives-quick-stats/distressed-counties.html#:~:text=The%2010%20distressed%20counties%20in,counties%20to%2010%20by%202025.

Each site was reviewed to confirm that it was on an existing roadway and would not interfere with ongoing or planned construction. Figure 2-1 presents the site location and roadway classifications for the 2022 Study. A detailed listing of sample locations is provided in Appendix A.

Figure 2-1: Survey Site Location

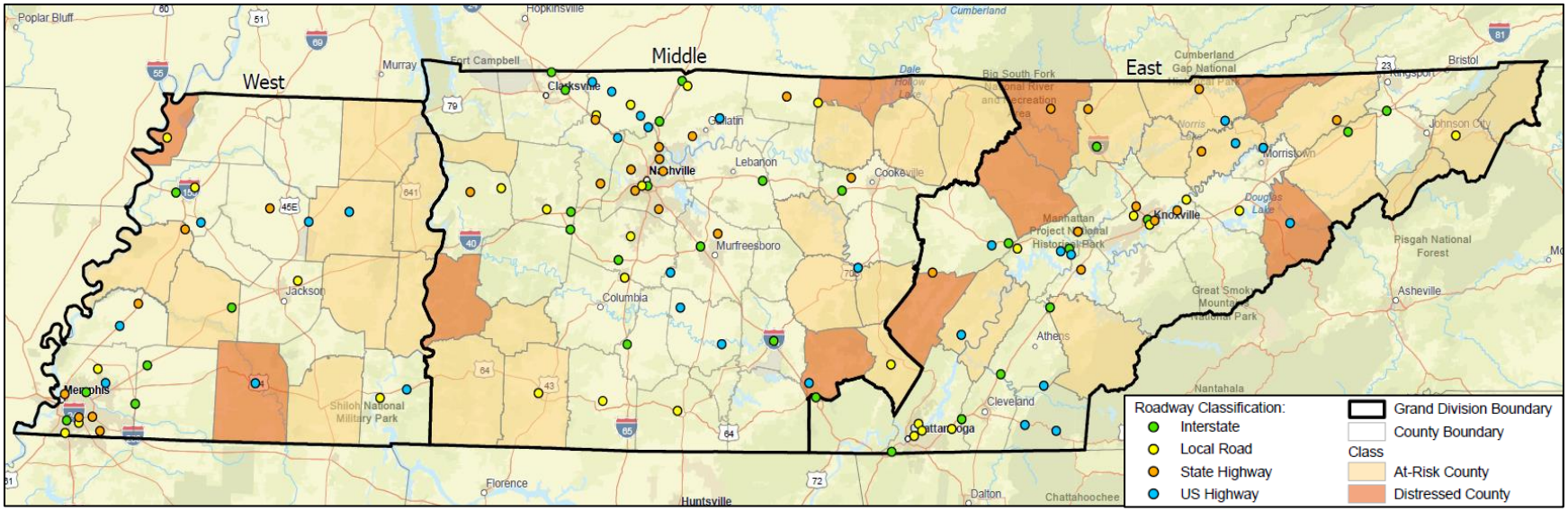


Table 2-2 presents the survey site locations identified by roadway classification and geography (urban or rural).

Table 2-2: Survey Site Locations by Roadway Classification and Geography[1]

Roadway Classification	Urban	Rural	Total[2]
Interstate	3	27	**30**
U.S. Highway	4	23	**27**
State Highway	12	21	**33**
Local Roads	13	17	**30**
Total	**32**	**88**	**120**

1. Geography is based on visual observations of the survey site by the field crews.
2. The survey sites are not split evenly among roadway classifications due to the addition predetermined litter hotspots provided by TDOT and KTNB.

2.2 Material Categories

Burns & McDonnell determined the material categories to include in the 2022 Study by reviewing the more detailed categories included in 2020 KAB Study (about 70 material categories) and working with KTNB and TDOT to harmonize the material types with the fewer number of categories included in the 2016 Study (30 material categories). This was intended to allow the flexibility to have the more robust list from the 2020 KAB Study correlated to the material types from the 2016 Study so they can be comparatively evaluated.

The material categories for the 2022 Study focus on updating material types (e.g., paper, plastic, glass, etc.). Some categories remain the same from the 2016 Study while others are split out to provide more detail, or omitted because they are no longer commonly in use (e.g., pull tabs). Table 2-3 provides a high-level overview of how the material categories from the 2022 Study are harmonized with the 2016 Study material categories and which categories are identified as intentional and unintentional. A more detailed listing of each material category definition and corresponding category from the 2016 Study is provided in Appendix B.

Table 2-3: 2016 and 2022 Study Material Categories Comparison Overview

	2016 Study[1]	2022 Study
Intentional	Juice and Soft Drink Containers	Plastic/Glass/Metal/Paper Beverage Containers[2]
	Beer, Wine & Liquor Containers	Plastic/Glass/Metal/Paper Beverage Containers
	Water Bottles	Plastic/Glass/Metal/Paper Beverage Containers
	Bottle caps/seals; pull tabs	Metal Other Beverage Packaging
	Beverage Containers and Cartons	Jugs
	Cups, Lids, Straws	Straws
	Snack Food Packaging (Candy, Gum, etc.)	Food Packaging Film
	Take-out Food Packaging	Paper/Plastic Fast-Food Service Items, Napkins and Paper Bags, EPS Fast Food Service Items
	Cigarette Packs, Lighters, Matches	Cigarette Butts, All Other Tabaco-related Products & Packaging, Electronic Cigarettes
	Plastic Bags	Plastic Bags, Other Film
	Toiletries, Toys, Drugs	Toiletries/Drug Bottles/Personal Hygiene Products, Tissues
Unintentional	Newspapers, Magazines, Books	Office Paper, Junk Mail, Newspapers, Inserts, Magazines, Books
	Advertising Signs & Cards	Advertising Signs/Cards
	Home Food Packaging (TV Dinners, etc.)	Paper/Plastic/Metal Home Food Packaging
	Vehicle Debris and Packaging	Vehicle Debris
	Tires	Whole Tires, Shredded Tires
	Construction Debris	Construction Debris
	Miscellaneous Paper	OCC, Brown Paper Bag, Receipts, Lottery Tickets, Aseptic/Gable-top Containers, Beverage Carriers/Cartons, Other Paper
	Miscellaneous Plastic	Plastic Other Beverage Packaging, Other Expanded Polystyrene, Other
	Miscellaneous Metal & Foil	Other Metal and Foil Packages
	Miscellaneous Glass & Ceramics	Broken Glass or Ceramic, Other Glass, Other
	Wood & Yard Debris	Wood & Yard Debris, Agricultural Debris
	Mattresses	Mattress/Box Spring
	White Goods	Household Appliances
	Entire 32 Gallon Trash bag	32-Gallon Trash Bags, 19-Gallon Trash Bgs
	Other	Personal Protective Equipment (PPE), Textiles/Small Rugs, Human Waste, Food Waste, Bulky Items, Other Hazardous, Entertainment Items, Electronics, Other Items, Gas Tanks

1. The following material categories included in the 2016 Study have been combined with material categories in the 2022 Study: pull tab, napkins, bags (paper only), tissues, gas tanks, tie down for trucks.
2. Beverage containers include the following beverage container types: soda, juice, tea, sports drinks, beer, wine, liquor, and water.

2.3 Litter Field Survey

Burns & McDonnell field crews were deployed between October 17 – 28, 2022 and utilized electronic tablets to enter litter counts and photograph data via a customized survey application. Prior to deploying, regional education coordinators from TDOT and KTNB were informed of the upcoming field surveying efforts and invited to observe surveys being performed. Field crews entered litter counts into the customized application as well as visual observations of potential influencing factors for each site.

2.3.1 Health & Safety Plan

Burns & McDonnell developed a comprehensive Health & Safety Plan for the 2022 Study to mitigate potential hazards, which included proximity to high-traffic roadways, exposure to heat and cold stress, exposure to biological threats, and conducting surveys at locations requiring access via private or semi-private roadways.

2.3.2 Sampling Procedure

Sampling sites include a full sample area and a smaller, sub-sample area consistent with the methodology from the 2020 KAB Study. Litter items greater than four inches were counted and characterized within the larger sample area and litter items smaller than four inches were counted and characterized in the sub-sample area.

Each field crew traveled in a single vehicle to a survey site and pulled over at a safe distance from the roadway and carried out the following procedure:

1. Pull over at a safe distance from the road with no barriers or hazards blocking the sample area, turn on vehicle hazard lights, and place cones or indicators around the vehicle.
2. Equip with all necessary personal protective equipment (PPE).
3. Retrieve the survey from the electronic data collection application.
4. Record site information in the survey site overview as completely as possible, noting weather, influencing factors and site condition.
5. Using the measuring wheel or similar device, measure out and demarcate the survey areas using stake flags or similar including the 300’ x 15’ for the full survey (4-inch-Plus) and the 15’ x 15’ for the sub survey (4-inch-Minus) area along the edge of the roadway. Figure 2-2 shows the full and sub survey area schematic.

Figure 2-2: Survey Area Schematic

6. Walking away from the car with the flow of traffic, continue past the sub survey area and demarcate the full 300'x15' survey by placing a flag at every 75' of length measured.
7. Photograph the site and litter items, as well as key influencing factors observed.
8. Once 300' is reached, perform the 4-inch-Plus litter survey by walking back towards the car and facing the flow of traffic, retrieving any demarcation objects (e.g., flags) as you go.
9. Perform a "meander count" of the 300' x 15' area to tabulate only 4-inch-Plus items.
10. As the meander count of 4-inch-Plus objects is in progress, the second field crew person performs a count of objects 4 inches-minus and under observed within the 15' x 15' sub survey area only, including cigarette butts 4-inch-Minus.
11. Collect all equipment (including traffic cones or similar), fill out and save all forms, and proceed to the next sample site.

The methodology presented above was implemented as the best practices for litter surveying, consistent with 2020 KAB study (e.g., including 4-inch-Plus and 4-inch minus surveys). In the 2016 Study, the field crews conducted an "edge" survey, focusing on items within three feet of the edge of the pavement, and a "meander" survey counting items within 15 feet of the roadside.

2.3.3 Data Collection

For each piece of litter counted during the survey, the field crew identified the source of the litter, as described in Table 2-4.

Table 2-4: Description of Sources of Litter[1]

Source	Description
Motorists	Litter from motorists is produced when a motorist discards trash while driving.
Pedestrians	Litter discarded by pedestrians walking on the sidewalk or another non-roadway area.
Improperly Secured Loads	Litter resulting from loads of material as they are hauled likely in a pick-up truck or roll-off container.
Overflowing Containers	Litter in the immediate vicinity of public litter containers or commercially collected garbage containers adjacent to businesses.
Vehicle Debris	Vehicle parts that have disengaged from an otherwise operational vehicle, as well as the range of materials that are generated during traffic accidents.
Unknown	Our field crew will use context clues as efficiently as possible to determine litter sources, but in some cases this may not be possible. In these cases, we will classify the source as unknown.

1. The estimated sources of litter are different than the identification of intentional and unintentional litter by material category.

The field crews assigned the condition of the sampling based on the KAB Litter Index. Table 2-5 provides descriptions of the specific evaluation criteria.

Table 2-5: Description of KAB Litter Index[1]

Litter Index	Description
No Litter	Virtually no litter is observed in the site being scored. The scorer has to look hard to see any litter, perhaps a very occasional litter item or two in a city block, or equivalent. Any litter seen could be collected quickly by one individual. The entire site has a generally neat and tidy appearance. Nothing grabs the eye as being littered or messy.
Slightly Littered	Upon careful inspection, a small amount of litter is obvious. The litter in the site could be collected by one or two individuals in a short period of time. While the site has a small amount of litter, the site is not distractingly littered.
Littered	Visible litter can readily be seen sporadically throughout the site, likely requiring an organized effort for removal. This area is "littered" and clearly needs to be addressed. One or two individuals could clean up the area within a few hours.
Extremely Littered	A large amount of litter is one of the most distinguishing features of the site. The site might include major illegal dumpsites. Equipment and/or extra manpower for removal are required. There is a strong impression of a lack of concern about litter in the site.

1. Scoring system is from Keep America Beautiful, Inc. Community Appearance Index: State of the Community.

The field crews indicated the observed condition of each survey site through a series of influencing factors categorized as Yes-No factors and quantified factors. Yes-No influencing factors identify if a survey site did or did not have a specific type of feature. Counted influencing factors reflect the number

of features visible at the survey site. Table 2-6 lists the Yes-No influencing factors and Table 2-7 presents the counted influencing factors.

Table 2-6: Yes-No Influencing Factors

Influencing Factor	Definition
Mowing	Identifies if the survey site has been mowed recently
Bike Path	Identifies if a bike path is visible
Landscaping	Identifies if the area around the survey site has been landscaped
Residential Area	Identifies if residential areas are visible
Waterway	Identifies if waterways are visible

Table 2-7: Counted Influencing Factors

Influencing Factor	Definition
Anti-Litter Messaging Signage	Anti-littering messaging signs visible
Litter Receptacle	Public litter receptacles
Recycling Receptacle	Public recycling receptacles
Storm Drains	Number of storm drains visible
Bus	Bus stops
Public Transportation	Public transportation stops (e.g., train station, etc.)
Fast Food	Fast food locations
Convenience Store	Convenience stores
Commercial Center	Commercial centers (e.g., mixed use development, etc.)
Commercial Business	Individual commercial businesses
Public Building	Public buildings (e.g., City Hall)
Recreational Area	Recreational areas (e.g., park, etc.)
Construction Sites	Construction sites (with and without fences)
Loading Dock	Buildings or areas with commercial loading docks
Vacant Lot	Vacant lots or unused paved areas

2.4 Data Analysis and Compilation

Following the field survey effort, Burns & McDonnell began the data analysis and compilation process to evaluate the litter counts, characterization, and influencing factors. The litter counts were used to develop a Litter-per-mile figure for each roadway classification. Each material category was extrapolated across the total miles of roadway for each roadway classification to calculate the litter composition on Tennessee roadways. Table 2-8 identifies the total miles of each roadway classification as identified by TDOT.

Table 2-8: Roadway Classifications[1]

Roadway Classification	Total Miles
Interstate	1,201
U.S. Highway	8,848
State Highway	3,975
Local Roads	82,538
Total	**96,562**

1. The mileage of roadways by roadway classification was provided by TDOT and only considers 1-way roadway miles for consistency with 2016 Study and 2020 KAB Study.

First the litter-per-mile and observations of influencing factors at each survey site were used as inputs to conduct multiple regression analyses to identify the strength and direction of relationships between litter items per mile and presence of influencing factors on a combined basis. Then, the influencing factors that showed a reasonable statistical fit were evaluated individually using a simple linear regression analysis.

Additionally, data from the Tennessee Department of Conservation (TDEC) and other sources was used to identify the location of disposal and recycling facilities and rest stops across Tennessee. Using the same approach as described for the influencing factors, Burns & McDonnell conducted multiple regression analyses on a combined basis to identify the strength and direction of relationships between litter items per mile and proximity to these designated facilities.

2.4.1 Quality Control

Burns & McDonnell included several quality control measures as part of the field survey, data analysis and compilation efforts. During the field survey, the customized data entry tool eliminated the need to manually enter handwritten data into spreadsheets, minimizing the potential for keystroke errors. Additionally, several of the survey fields of the (e.g., site location, roadway type) were pre-populated, further reducing the potential for human error.

2.5 Identification and Evaluation of Abatement Strategies

Burns & McDonnell submitted a request for information on the current programs including the Nobody Trashes Tennessee campaign, completed reports, and financial information and held a virtual meeting to discuss the current programs. Based on the results of the data evaluation and information provided by TDOT and KTNB, the project team analyzed current and planned litter abatement and reduction programs across Tennessee to identify opportunities to consider new or modified approaches and strategies.

3.0 LITTER SURVEY RESULTS

This section provides a comprehensive understanding of the quantity, composition, and sources of litter found across the state. Additionally, the results of the econometric analysis and a summary of key findings are presented.

Consistent with the 2016 Study, the total roadway miles in each roadway classification provided by TDOT has been used to generate the estimates for total statewide litter items. The methodology aligns with best practices in litter surveying established by the 2020 KAB Study and to compare the results to the 2016 Study to the extent possible. Supplemental comparisons are provided to the more recent 2020 KAB Study as appropriate.

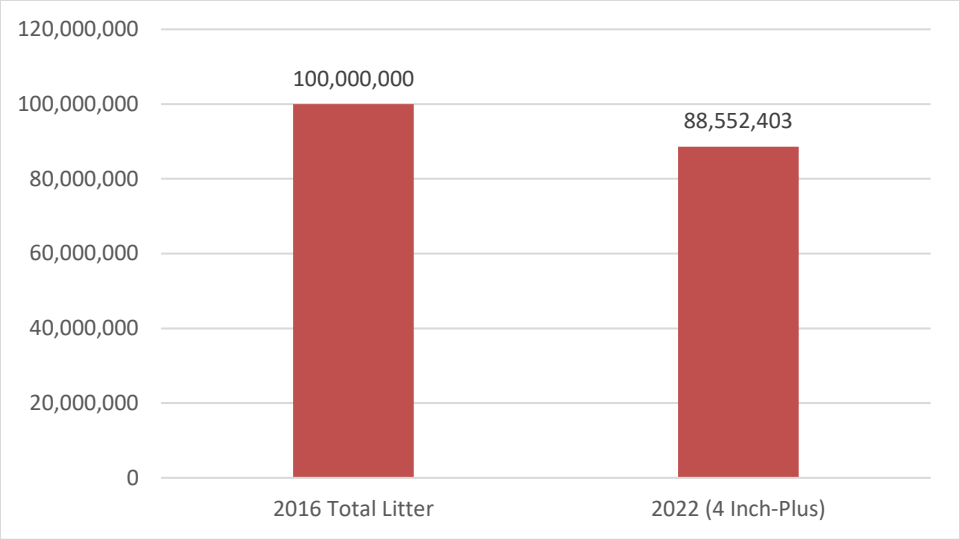
3.1 Statewide Litter Prevalence

On an overall basis, the total estimated litter items larger than 4 inches in the 2022 Study show a reduction of items this size along Tennessee roadways. This is due, in part, to the change in methodology between the 2016 and 2022 Studies to be consistent with the best practice for litter surveying. Further detail regarding the methodology of the 2022 Study is presented in Section 2.3.2. While illegal dumping may be a significant issue for solid waste management in Tennessee, this research effort focuses on roadside litter quantity and composition rather than illegal dumping hotspots.

The following analysis compares the estimated total litter items from the 2016 Study to the 4-inch-Plus material because the approach and resulting estimates are most comparable. The 2022 Study was more robust with the inclusion of a dedicated evaluation of the 4-inch-Minus material. Although the results of the 4-inch-Minus material are presented and evaluated, they are not directly compared to the 2016 Study in some cases because this aspect of the sampling methodology was not conducted in the 2016 Study.

Figure 3-1 compares the total estimated litter items from the 2016 Study to the 4-inch-Plus material from the 2022 Study.

Figure 3-1: Statewide Litter Prevalence Results



The total litter items estimated in 2016 include about 11.5 million items, or about 12 percent more than the 4-inch-Plus items estimated in Tennessee. The reduction in the comparable fraction of the items from the 2022 Study indicates that the efforts for litter abatement and prevention have been effective in reducing the prevalence of this material on Tennessee roadways. Further discussion on the litter abatement and prevention strategies is presented in Section 4.0.

To provide context on the split between items under 4-inch-Plus and above 4-inch-Minus material, Table 3-1 compares the 4-inch-Plus and 4-inch-Minus survey results from the 2020 KAB and 2022 KTNB results.

Table 3-1: Comparison of 4-inch-Plus and 4-Inch-Minus Survey Total Litter Items

Material Size	2020 KAB		2022 KTNB	
	Total litter	Percentage	Total Litter	Percentage
4-inch-Plus	2,956,539,100	12%	88,552,403	12%
4-inch-Minus	20,721,487,400	88%	679,704,015	88%
Total	23,678,026,500	100%	768,256,418	100%

The ratio of 4-inch-Minus to 4-inch-Plus items is 88/12 for both the 2020 KAB Study and the 2022 Study. This indicates that the results of litter items estimated on roadways in Tennessee is generally consistent with the 2020 KAB Study.

Table 3-2 shows the Litter-per-mile by roadway classification results for the 2022 Study for both 4-inch-Plus and 4-inch-Minus survey results.

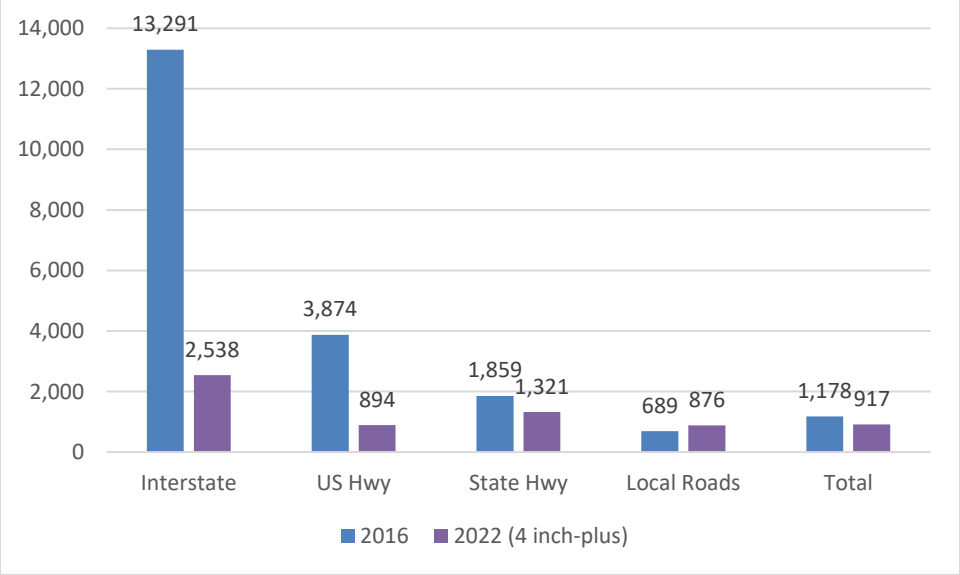
Table 3-2: 2022 Litter-per-mile by Roadway Classification[1]

Roadway Type	Average Items per Mile	Road Miles	Total Litter Items	Percent of Total Litter Items
Interstate	21,346	1,202	25,648,618	3%
U.S. Highway	7,386	8,849	65,359,820	9%
State Highway	15,497	3,975	61,604,466	8%
Local Roads	7,459	82,538	615,643,514	80%
Total	**-**	**96,564**	**768,256,418**	**100%**

1. Includes results from 4-inch-Plus and 4-inch-Minus survey.

The average items per mile may vary widely based on a number of factors, including seasonality, solid waste management facility regulations (e.g., permit required litter abatement), and truck tarping policies.[8] Figure 3-2 provides a comparison on the litter-per-mile for the 2016 Study and 2022 Study that reflects the results from the 4-inch-Plus survey.

Figure 3-2: Comparison of Litter-per-mile[1]



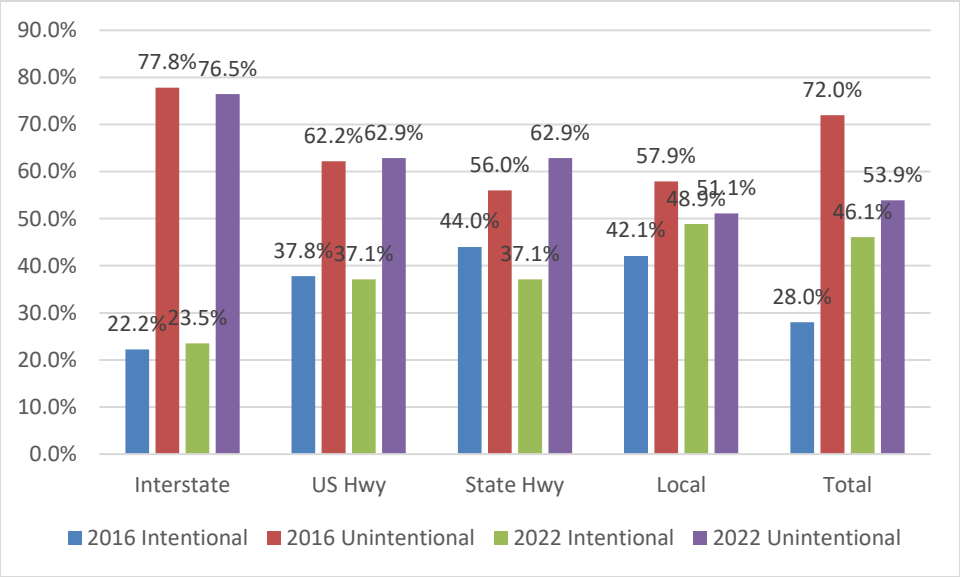
2. 2022 Study results based on 4-inch-Plus survey only for comparison purposes.

In the 2016 Study there was significantly more litter-per-mile compared to the 4-inch-Plus litter items on Interstate and U.S. Highway roadway classifications. Other roadway classifications and the total litter items were comparable (e.g., within 300 litter items per mile). This indicates that litter prevention and abatement efforts may have had a particular impact on reducing litter-per-mile on Interstate and U.S. Highway roadway classifications.

[8] Litter-per-mile, including 4-inch-Plus and 4-inch-Minus, can range between 500 to 50,000 depending on roadway classification, location, season, and local litter abatement programs activity.

Each material category was assigned as intentional or unintentional based on the designation of material categories from the 2016 Study with minor changes based on discussions with KTNB and TDOT staff. Designations were established prior to data collection and were not inputted by field crews on an item-by-item basis. Figure 3-3 compares the amount of intentional and unintentional litter between 2016 and 2022 Studies.

Figure 3-3: Intentional and Unintentional Litter by Roadway Classification[1]

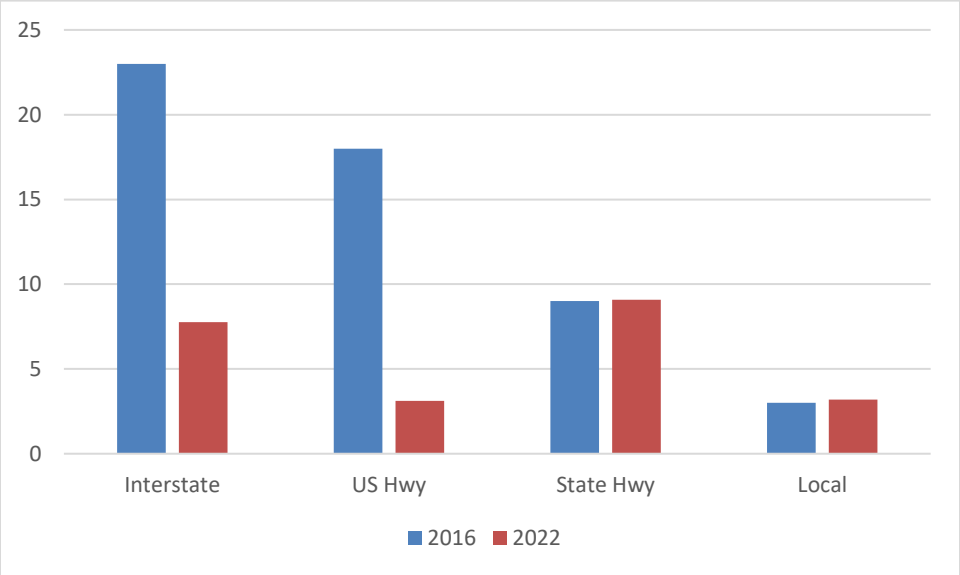


1. 2022 Study results based on 4-inch-Plus survey only for comparison purposes.

On an overall basis the intentional litter increased by about 18 percent due, in part, to changes in product packaging and classification differences between the 2016 Study and 2022 Study. However, by roadway type, the amount of intentional and unintentional litter remained fairly consistent between the 2016 and 2022 Studies, indicating that for the 4-inch-Plus material the reasons for litter occurring have not changed.

Cigarette butts have been consistently one of the most littered items and a major challenge for litter abatement. In the past few years, there have been significant changes in the usage of tobacco products with the deployment of e-cigarettes. Figure 3-4 compares the average number of cigarette butts by site and roadway classification (including both 4-inch-Plus and 4-inch-Minus surveys, since cigarette butts are mostly captured in the sub survey data).

Figure 3-4: Average Cigarette Butt Count per Survey Site by Roadway Classification[1]

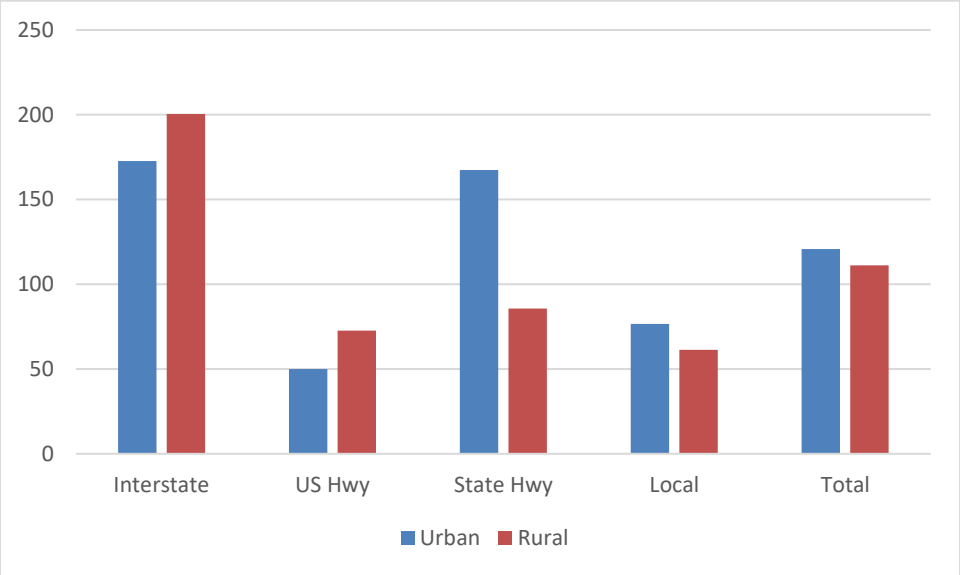


1. Includes results from 4-inch-Plus and 4-inch-Minus survey, since majority of cigarette butts were identified as part of sub survey.

Consistent with the results showing litter-per-mile by roadway classification, the results show that for Interstate and U.S. Highway roadways, the amount of cigarette butts observed per site has decreased compared to the 2016 Study, but has remained at similar levels on the State Highway and Local Roads. This may be explained, in part, to the changes in tobacco usage over time (e.g., increase usage of vape pens) and less need to dispose of cigarette butts on the larger roadways.

The following information is presented based on requests from KTNB and TDOT and included in the data collection and analysis effort for the 2022 Study. Each survey was categorized as urban or rural as part of the 2022 Study, consistent with the approach for from the 2020 KAB Study. Figure 3-5 presents the average litter items per survey for urban and rural site types.

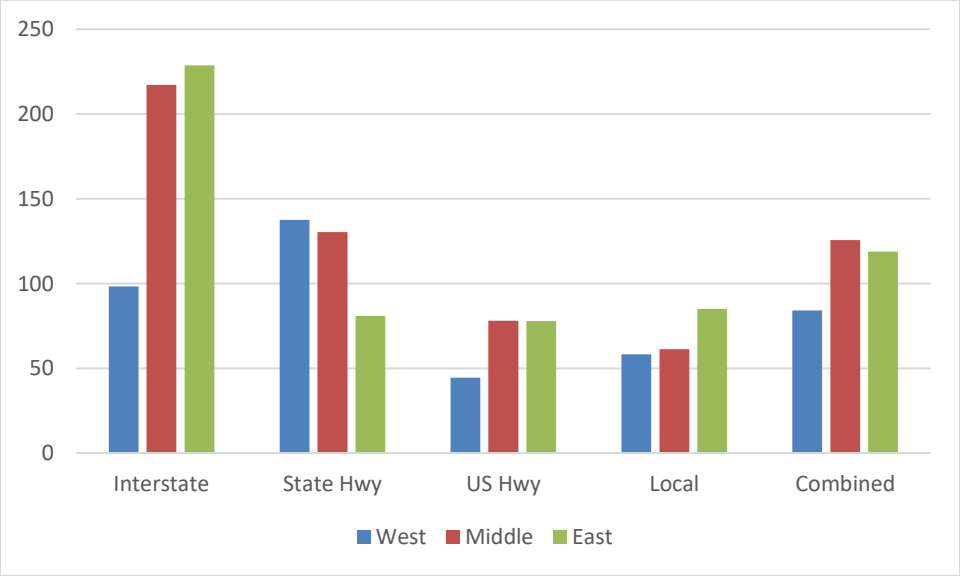
Figure 3-5: Average Litter Items per Survey by Site Type[1]



1. Includes results from 4-inch-Plus 4-inch-Minus survey.

The number of litter items for rural site types was higher on Interstate and U.S. Highway road classifications but lower on State Highway and Local Roads classifications. Overall, there were higher average litter items at sites in urban locations. Based on discussions with KTNB and TDOT, the average litter items split out by Grand Division have been evaluated. Figure 3-6 shows the average litter items per survey by Grand Division.

Figure 3-6: Average Litter Items per Survey by Grand Division[1]



1. Includes results from 4-inch-Plus and 4-inch-Minus survey.

Based on these results, the Middle and East Grand Divisions had the most litter per survey site on average.

3.2 Litter Composition

This section presents both the detailed litter profile and summary composition information. Table 3-3 presents the estimated statewide litter items by material category and percentage and provides a comparison to the 2020 KAB Study. Highlighted rows indicate select materials greater than two percent change between the 2020 KAB Study and the 2022 Study. OCC is highlighted because of its recent growth in the waste and recycling stream (e.g., the "Amazon Effect").

Table 3-3: Estimated Statewide Litter Items by Material Category

Group	Material Category	4-inch-Minus	4-inch-Plus	Total	Percentage	
					2022	2020[1]
Paper	Paper fast-food service items	2,539,555	437,725	2,977,280	0.4%	0.2%
	Napkins and Paper Bags	3,633,066	251,971	3,885,037	0.5%	0.2%
	OCC	16,541,258	2,645,529	19,186,787	2.5%	0.8%
	E-commerce OCC	-	-	-	0.0%	0.0%
	Brown paper bag	42,402	71,964	114,366	0.0%	0.0%
	Office paper/junk mail	2,379,641	66,319	2,445,961	0.3%	0.4%
	Newspaper/inserts	212,012	154,453	366,465	0.0%	1.1%
	Magazines/books	183,708	56,193	239,901	0.0%	0.0%
	Paper home food packaging	3,217,995	1,416,802	4,634,797	0.6%	0.2%
	Receipts	2,907,080	963,344	3,870,424	0.5%	0.4%
	Lottery tickets	-	-	-	0.0%	0.0%
	Aseptic/gable-top containers	-	48,422	48,422	0.0%	0.0%
	Beverage carriers/cartons	3,319,787	233,595	3,553,381	0.5%	0.1%
	Straws	-	-	-	0.0%	0.0%
	Other paper	111,045,880	13,147,384	124,193,264	16.2%	14.9%
	Wine and Liquor	-	6,473	6,473	0.0%	0.0%
	Water	14,098	9,298	23,396	0.0%	0.0%
	Subtotal Paper	**146,036,482**	**19,509,472**	**165,545,954**	**21.5%**	**18.3%**
Plastic	Soda	8,230,054	2,670,411	10,900,465	1.4%	0.3%
	Juice/Tea/Sports Drink	11,163,816	1,628,781	12,792,597	1.7%	0.3%
	Wine and Liquor	5,438,031	816,124	6,254,155	0.8%	1.1%
	Water	14,708,538	2,578,804	17,287,342	2.3%	0.5%
	Jugs	-	16,369	16,369	0.0%	0.0%
	Other beverage packaging	10,719,916	1,873,870	12,593,786	1.6%	1.8%
	Plastic Bags	1,498,143	626,480	2,124,624	0.3%	0.5%
	Other film	22,476,281	3,728,847	26,205,128	3.4%	5.0%
	Advertising/signs/cards	2,164,849	2,572,953	4,737,801	0.6%	0.0%
	Plastic home food packaging	18,649,147	4,513,947	23,163,094	3.0%	1.1%
	EPS fast food service items	18,839,307	776,380	19,615,688	2.6%	0.3%
	Other	58,198,344	9,722,359	67,920,703	8.8%	15.7%

Group	Material Category	4-inch-Minus	4-inch-Plus	Total	Percentage	
					2022	2020[1]
	Other expanded polystyrene	24,813,206	5,443,809	30,257,015	3.9%	2.1%
	Straws	6,564,139	798,910	7,363,050	1.0%	0.6%
	Food Packaging Film	21,518,252	2,348,357	23,866,609	3.1%	6.0%
	E-commerce Packaging	-	-	-	0.0%	0.0%
	Plastic fast-food service items	17,477,742	2,427,767	19,905,509	2.6%	0.4%
	Subtotal Plastic	**242,459,766**	**42,544,168**	**285,003,934**	**37.1%**	**35.6%**
Glass	Soda	115,365	52,663	168,027	0.0%	0.0%
	Juice/Tea/Sports Drink	-	101,085	101,085	0.0%	0.0%
	Water	-	705	705	0.0%	0.0%
	Beer	9,769,303	2,060,677	11,829,980	1.5%	0.5%
	Wine and liquor	4,158,774	201,552	4,360,326	0.6%	0.2%
	Broken glass or ceramic	44,929,136	194,029	45,123,165	5.9%	3.6%
	Other glass	-	-	-	0.0%	0.4%
	Other	4,174,899	212,174	4,387,073	0.6%	0.2%
	Subtotal Glass	**63,147,476**	**2,822,884**	**65,970,360**	**8.6%**	**4.9%**
Metal	Soda	16,453,209	2,112,759	18,565,968	2.4%	0.6%
	Juice/Tea/Sports Drink	12,595,979	702,436	13,298,416	1.7%	0.2%
	Beer	38,261,034	7,681,545	45,942,579	6.0%	1.7%
	Other Beverage Packaging	301,328	153,430	454,757	0.1%	0.4%
	Metal home food packaging	1,364,170	6,355	1,370,525	0.2%	0.0%
	Other metal and foil packages	9,354,571	2,230,562	11,585,134	1.5%	4.0%
	Subtotal Metal	**78,330,291**	**12,887,087**	**91,217,378**	**11.9%**	**6.9%**
Organics	Wood & Yard Debris	3,959,026	2,576,864	6,535,890	0.9%	0.2%
	Agricultural Debris	1,342,740	341,002	1,683,742	0.2%	0.0%
	Human Waste	-	-	-	0.0%	0.3%
	Food Waste	982,548	128,856	1,111,404	0.1%	1.2%
	Subtotal Organics	**6,284,314**	**3,046,722**	**9,331,036**	**1.2%**	**1.7%**
Other	Vehicle debris	4,028,242	715,659	4,743,901	0.6%	1.4%
	Whole Tires	1,161,418	335,489	1,496,907	0.2%	0.3%
	Shredded Tires	24,970,460	1,843,215	26,813,675	3.5%	1.4%
	Construction Debris	3,593,824	1,176,982	4,770,807	0.6%	1.6%
	Mattress/Box Spring	-	-	-	0.0%	0.0%
	Household Appliances	-	-	-	0.0%	0.0%
	32-gallon trash bags	-	633,733	633,733	0.1%	0.0%
	19-gallon trash bags	-	169,999	169,999	0.0%	0.0%
	Personal Protective Equipment (PPE)	127,099	197,054	324,153	0.0%	0.2%
	Textiles/small rugs	185,963	201,885	387,848	0.1%	1.7%
	Bulky Items	982,548	53,368	1,035,915	0.1%	0.0%
	Other Hazardous	-	-	-	0.0%	0.0%

Group	Material Category	4-inch-Minus	4-inch-Plus	Total	Percentage	
					2022	2020[1]
	Entertainment items	-	-	-	0.0%	0.0%
	Electronics	242,464	30,601	273,065	0.0%	0.1%
	Other Items	4,049,541	485,189	4,534,730	0.6%	0.7%
	Gas Tanks	-	-	-	0.0%	0.0%
	Toiletries/drug bottles/personal hygiene products	-	45,323	45,323	0.0%	0.1%
	Tissues	-	-	-	0.0%	0.0%
	Cigarette/Cigar butts	96,910,539	1,089,253	97,999,792	12.8%	24.1%
	All other tobacco-related products & packaging	7,078,221	700,833	7,779,054	1.0%	1.0%
	Electronic Cigarettes	115,365	63,489	178,853	0.0%	0.0%
	Subtotal Other	**143,445,686**	**7,742,070**	**151,187,755**	**19.7%**	**32.7%**
	Total[2]	**679,704,015**	**88,552,403**	**768,256,418**	**100.0%**	**100.0%**

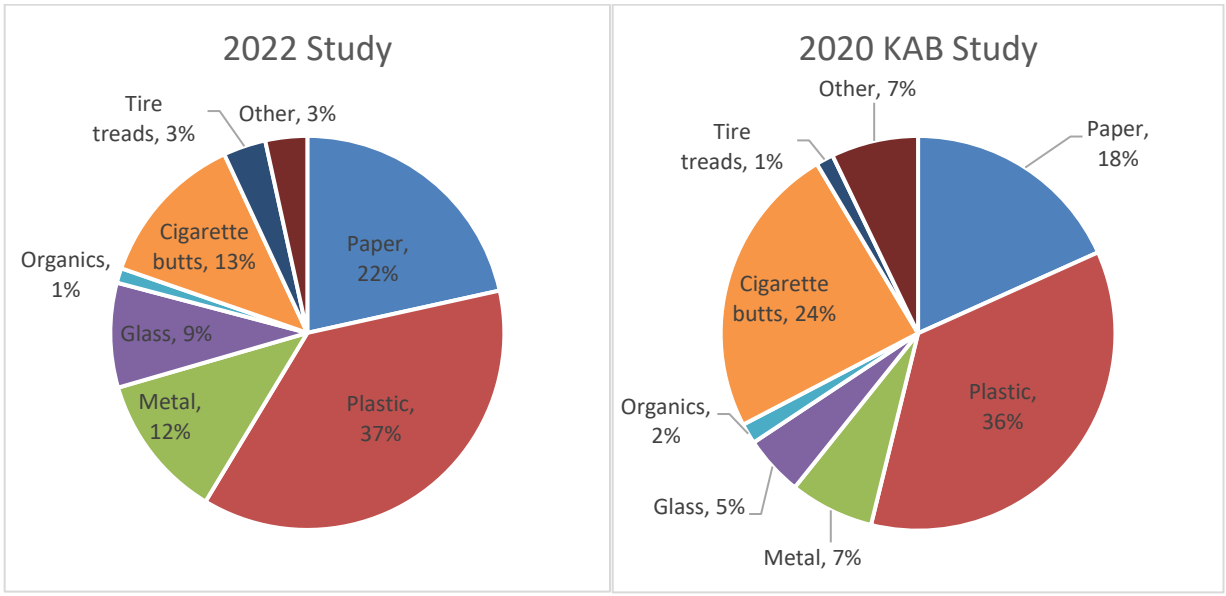
1. Reflects results from the 2020 KAB Study.
2. Totals may not sum due to rounding.

The litter on Tennessee roadways was composed of an estimated 285.0 million (37 percent) plastic items followed by 165.5 million (22 percent) paper items. The majority of litter on Tennessee roadways (679.7 million pieces or 88 percent) were 4 inches or smaller in size; however, the 2022 Study estimates there is still a significant quantity (88.5 million pieces or 12 percent) of larger, and often more visible, litter on Tennessee roadways. Comparing between the 2020 KAB Study and the 2022 Study, there was a moderate uptick in the percentage of OCC (e.g., cardboard), plastic fast food service items, metal containers and shredded tires. There was a decrease in the percentage of food packaging film and cigarette/cigar butts.

While illegal dumping may be a challenge for solid waste management across Tennessee, the roadside survey identified limited quantities of bulky items.

Figure 3-7 presents a comparison of the overall groups between the 2020 KAB Study and 2022 Study.

Figure 3-7: Aggregate Composition of Litter by Count, All Roadways



Overall, the 2022 Study indicated an increase in paper, glass and metal items compared to the 2020 KAB Study.

The material composition of litter varied by size of the litter item. As shown in Figure 3-8 and Figure 3-9, plastic items composed the majority of both 4-inch-Plus and 4-inch-Minus larger litter. Cigarette butts, glass, and tire treads composed a larger portion of the smaller litter items representing a combined 27 percent compared to only six percent of the 4-inch-Plus items.

Figure 3-8: Aggregate Composition of 4-inch-Plus Litter by Count, All Roadways

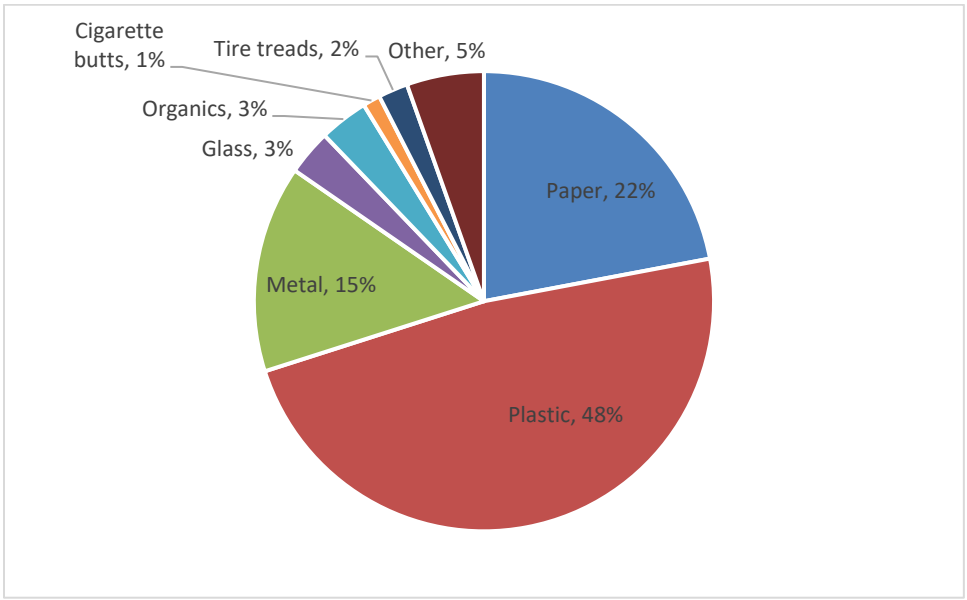
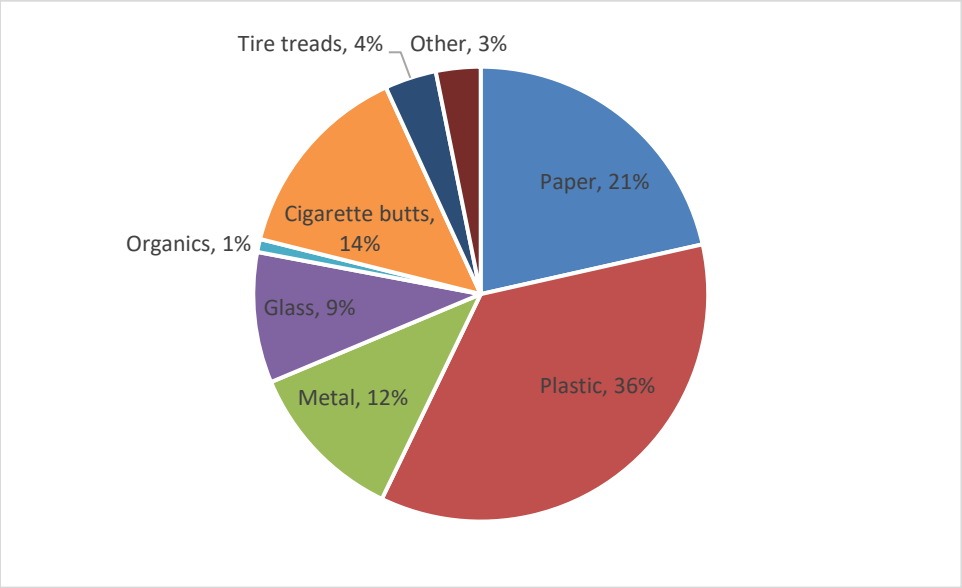


Figure 3-9: Aggregate Composition of 4-inch-Minus Litter by Count, All Roadways



Plastic product types, recycling processes and secondary market changes have significantly impacted how plastic materials are handled, both in Tennessee and nationally, since 2016. This may contribute to plastics composing more than one third of the total materials on Tennessee roadways.

Table 3-4 harmonizes the results into the appropriate material categories from the 2016 Study, organized by intentional or unintentional, and compares them on a percentage basis for both 4-inch-Plus and 4-inch-Minus surveys. Highlighted rows indicate select materials greater than a two percent change between the 2016 Study and the 2022 Study.

Table 3-4: Aggregate Composition of Litter by Material Category, All Roadways

	Material Category	2016 Study	2022 Study	Difference
Intentional	Juice and Soft Drink Containers[1]	2.1%	16.3%	14.2%
	Beer, Wine & Liquor Containers	1.3%	2.1%	0.8%
	Water Bottles	1.0%	0.0%	-1.0%
	Bottle caps/seals; pull tabs	1.9%	0.1%	-1.8%
	Pull Tabs	0.1%	0.0%	-0.1%
	Beverage Containers and Cartons	0.3%	0.0%	-0.3%
	Cups, Lids, Straws	5.0%	1.0%	-4.0%
	Snack Food Packaging (Candy, Gum, etc.)	5.9%	3.1%	-2.8%
	Take-out Food Packaging	3.0%	6.0%	3.0%
	Cigarette Packs, Lighters, Matches	1.6%	13.8%	12.2%
	Napkins, Bags (Paper Only), Tissues	4.6%	0.0%	-4.6%
	Plastic Bags	0.9%	3.7%	2.8%
	Toiletries, Toys, Drugs	0.3%	0.0%	-0.3%
Subtotal		**28.0%**	**46.1%**	**18.1%**
Unintentional	Newspapers, Magazines, Books	0.3%	0.4%	0.1%
	Advertising Signs & Cards	0.2%	0.6%	0.4%
	Home Food Packaging (TV Dinners, etc.)	0.2%	3.8%	3.6%
	Vehicle Debris and Packaging	41.8%	0.6%	-41.2%
	Tires	0.1%	3.7%	3.6%
	Construction Debris	0.5%	0.6%	0.1%
	Miscellaneous Paper	11.7%	19.7%	8.0%
	Miscellaneous Plastic	9.1%	14.4%	5.3%
	Gas Tanks	0.2%	0.0%	-0.2%
	Miscellaneous Metal & Foil	2.8%	1.5%	-1.3%
	Miscellaneous Glass & Ceramics	0.2%	6.4%	6.2%
	Wood & Yard Debris	3.5%	1.1%	-2.4%
	Mattresses	0.0%	0.0%	0.0%
	White Goods	0.0%	0.0%	0.0%
	Entire 32 Gallon Trash bag	0.1%	0.1%	0.0%
	Tie-downs for trucks	0.1%	0.0%	-0.1%
	Other	1.4%	1.0%	-0.4%
Subtotal		**72.2%**	**53.9%**	**-18.3**
Total[2]		**100%**	**100%**	

1. The 2022 Study categorized soda, juice/tea/sports drinks, water, and beer as separate categories for each applicable material type. Compiling them into a single category may have contributed to the increase from 2.1 percent to 16.3 percent.
2. Totals may not sum exactly due to rounding.

On an overall percentage basis, the largest changes in the composition shown are increases in juice and soft drink containers, cigarette packs, lighters and matches, and vehicle debris. The increase in juice and

soft drink containers should be a key focus for litter abatement and prevention in the future. In the 2016 Study, the juice and soft drink container category data was only considered a single category compared to the 2022 Study, which categorized soda, juice/tea/sports drinks, water, and beer as separate categories for each applicable material type. This may have contributed to the increase from 2.1 percent to 16.3 percent.

The increase in cigarette packs, lighters and matches and vehicle debris may be due, in part, to the inclusion of the sub survey categories and adjustments to the material categories used in the 2022 Study. The reduction in observation of vehicle debris may be reflective of TDOT's efforts to proactively remove vehicle debris caused by collisions and quickly collect loose debris reported on Tennessee roadways.

Appendix B of this Report provides composition results by roadway classification and across all samples for the 30 Study categories.

3.2.1 Sources of Litter

Motorists and vehicle debris were determined to be the leading sources of litter on Tennessee roadways (collectively 81 percent). Figure 3-10 presents the sources of litter items found on Tennessee roadways.

Figure 3-10: Source of Litter by Count, All Roadways

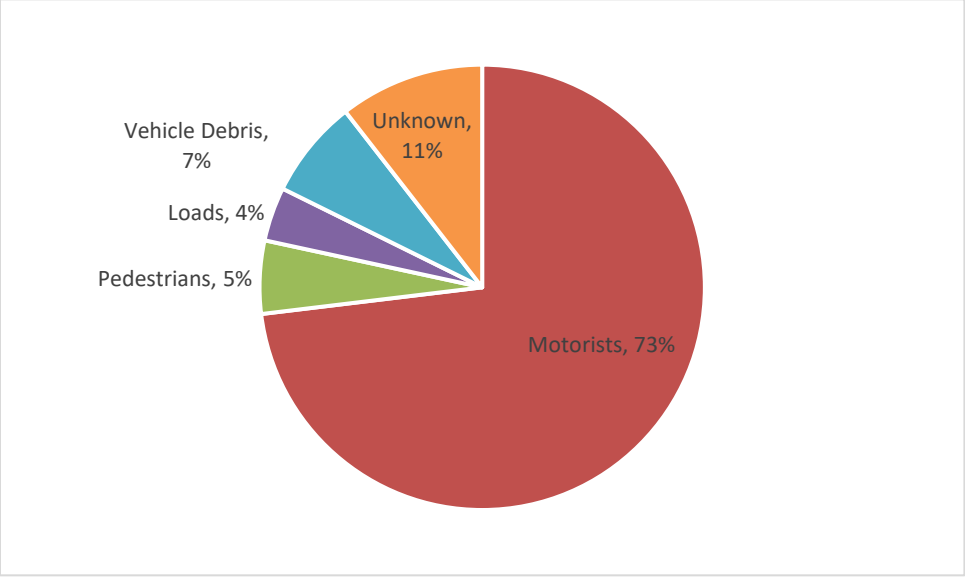


Figure 3-11 and Figure 3-12 present the sources of litter for 4-inch-Plus and 4-inch-Minus material types.

Figure 3-11: Source of 4-inch-Plus Litter by Count, All Roadways

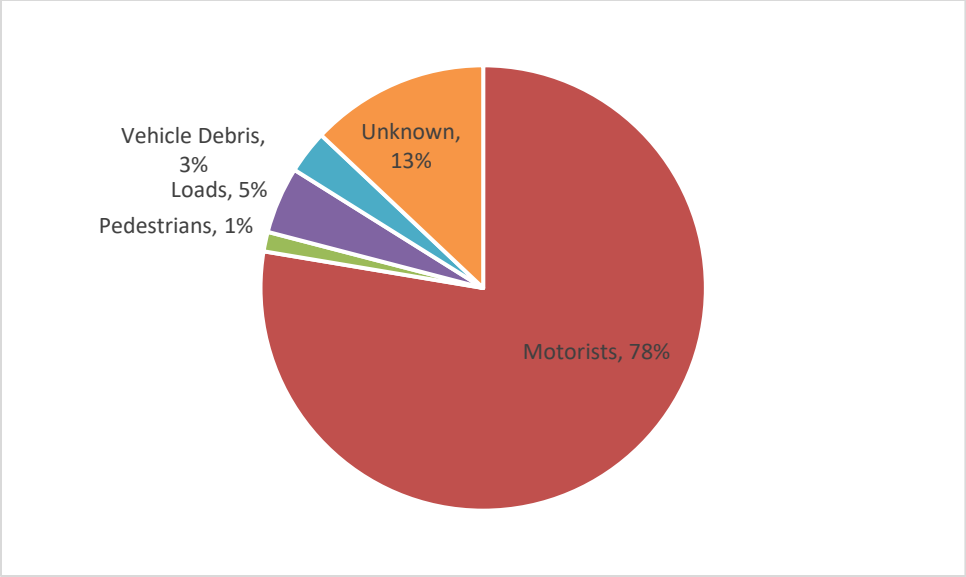
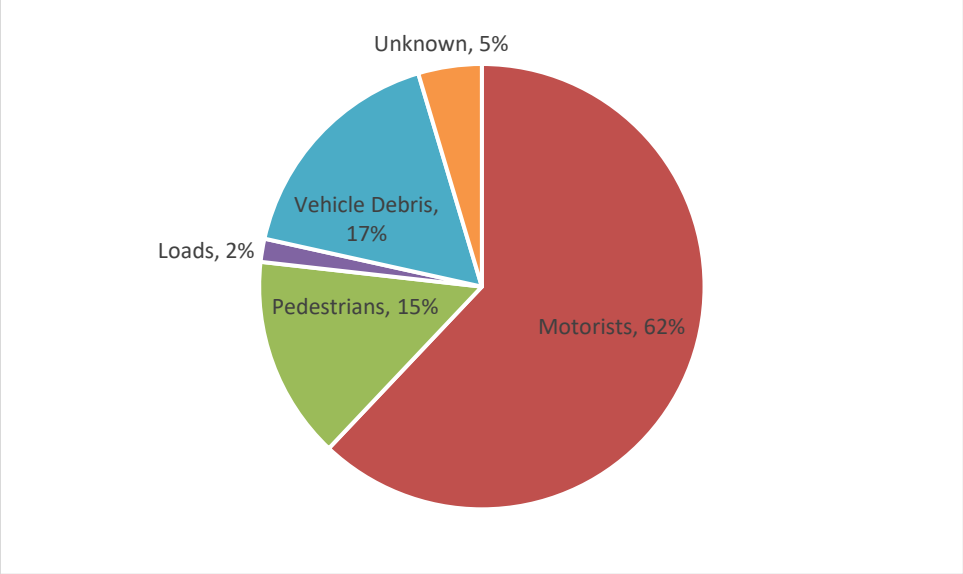


Figure 3-12: Source of 4-inch-Minus Litter by Count, All Roadways



The 4-inch-Minus material had fewer items from motorists compared to the 4-inch-Plus material and increased material from pedestrians and vehicle debris. The smaller material (e.g., 4-inch-Minus material) is a key consideration for the ongoing and future litter abatement efforts as this material is more easily swept into waterways.

3.3 Econometric Analysis

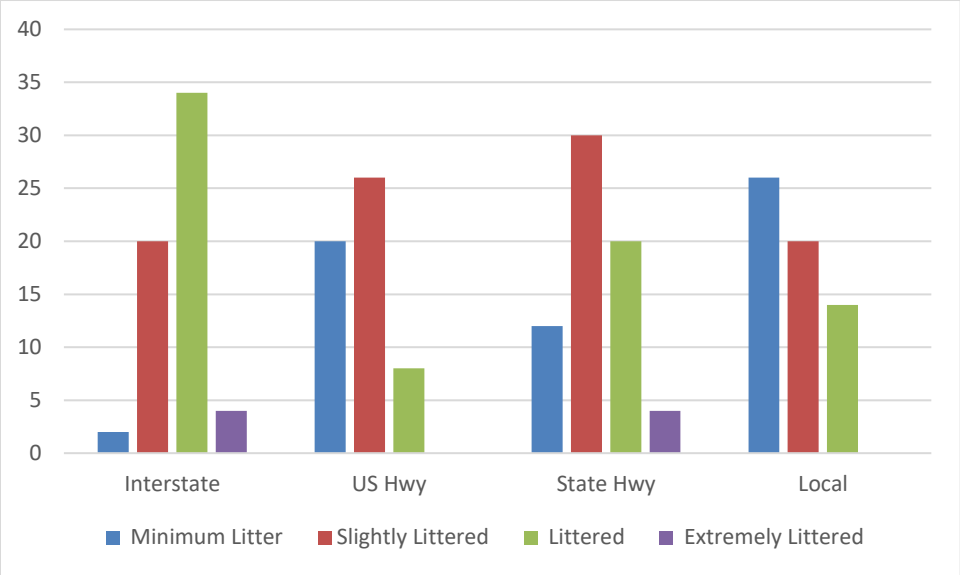
This section presents information in an effort to isolate the key drivers of litter-per-mile on TDOT roadways. There were multiple variables considered as part of the analysis based on observations from the field crews and research conducted by Burns & McDonnell. Influencing factors and distance to key site

types were evaluated independently and via regression analysis, as applicable. Some data is compared based on observed litter, rather than on litter-per-mile, to avoid presenting information that can be misleading when extrapolated across Tennessee due to small sample size (e.g., litter items at survey sites located on scenic byways, where waterways are visible, etc.).

3.3.1 Influencing Factors

Several influencing factor observations were noted during the field surveying effort as described in Section 2.3.3. One of the key observations was how littered a survey site was and ranked on the Litter Index. Figure 3-13 shows the Litter Index ranking by roadway classification.

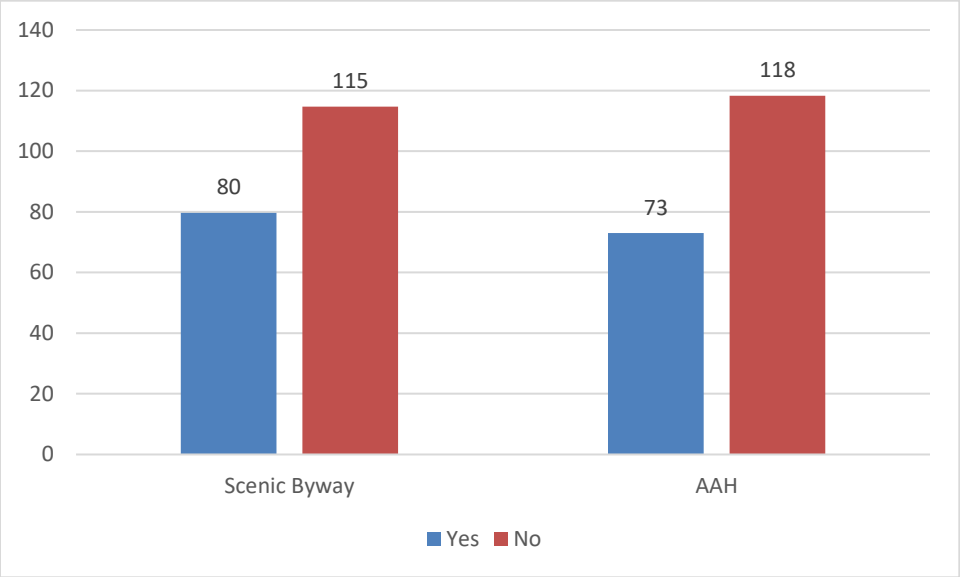
Figure 3-13: Number of Surveys by Litter Index and Roadway Classification



Based on the Litter Index observations by roadway classification, Local Roads have the highest number of sites with minimum litter, while Interstates had the highest number of littered and fewer with minimum litter. State Highways contain the highest number of sites that scored slightly littered or littered. This indicates that Local Roads were the least littered, while Interstates and State Highways were the most littered. Since the large majority of litter is discarded by motorists as shown in Figure 3-10, higher motorist traffic on Interstates and State Highways likely contributes to the comparatively higher litter counts at these sites.

Scenic byways and AAH locations are critical factors based on feedback from affiliate organizations as identified by KTNB and TDOT. Figure 3-14 presents the average litter items per site for 4-inch-Plus and 4-inch-Minus surveys.

Figure 3-14: Average Litter Items per Site at Scenic Byway and AAH Locations[1]

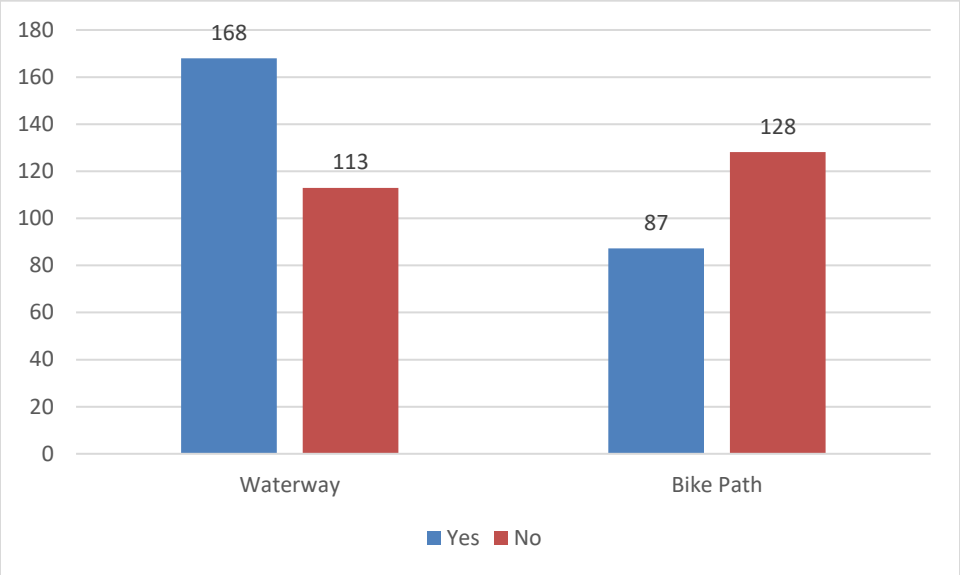


1. Results based on combined 4-inch-Plus and 4-inch-Minus survey data.

Scenic byway locations had much less litter observed on average compared to sites that were not on scenic byways in the state. This is consistent with the average litter per site on Local Roads compared to Interstates or U.S. and State Highways. Similarly, sites on AAH roadways also had fewer litter items observed. This may be based on the additional litter cleanups and attention these stretches of roadway receive over time and supports the continued focus on expanding the AAH program across the state.

Two other observations that are important to inform the understanding of where litter occurs are areas where waterways or bike paths are observed. Waterways are key considerations related to litter abatement, especially with the high levels of 4-inch-Minus materials present on Tennessee roadways. Figure 3-15 shows the average number of litter items for both 4-inch-Plus and 4-inch-Minus survey results at survey sites where a waterway or bike path was observed by field crews.

Figure 3-15: Average Litter Items per Site When Waterways and Bike Paths Observed[1]

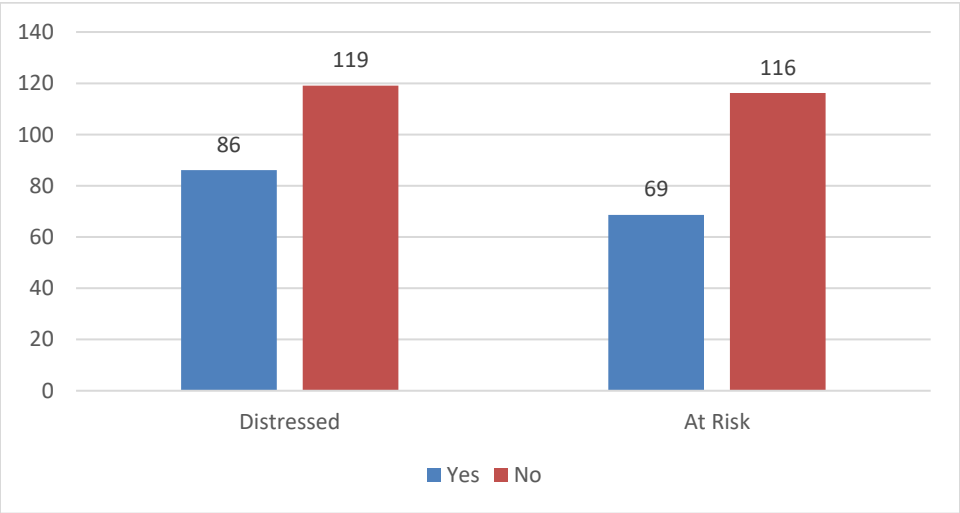


1. Results based on combined 4 inch plus and 4-inch-Minus survey data.

At sites where waterways were observed, there was about 55 more litter items on average compared to sites where no waterways were observed. Conversely, sites where bike paths were observed had about 41 fewer litter items on average. These findings indicate that waterways are an area where litter accumulates at higher rates, and areas with bike paths impact behavior where less litter is generated.

At-risk and distressed counties in Tennessee are areas of key focus to support litter abatement and prevention, since these counties may not have the same financial or staffing resources to combat litter. Figure 3-16 presents the average litter items at sites that were located within distressed and at-risk counties.

Figure 3-16: Average Litter Items per Site in Distressed and At-Risk Counties[1]



1. Results based on combined 4-inch-Plus and 4-inch-Minus survey data.

At sites within distressed and at-risk counties there were fewer litter items observed. This may be due to survey sites in these counties having a higher percentage of Local Roads which, on average, also had fewer litter items. Additionally, sites classified as urban had higher litter on average compared to rural sites (reference Figure 3-5). Figure ES-2 provides a heatmap of visible litter that shows a visual representation these results, indicating that urban areas (e.g., Nashville, Memphis, Knoxville) have higher concentrations of observed litter compared to rural areas.

While the sampling plan included some sites located in at-risk and distressed counties, the distribution of survey locations was based on population and Grand Division and included fewer sites in at-risk and distressed counties. On average, there were fewer litter items observed at sites in at-risk and distressed counties; however, this does not indicate that they have less need for resources to provide litter abatement and prevention services.

Regression analyses were run on the influencing factors that had numerical counts (e.g., number of bus stops, number of storm drains, etc.). Burns & McDonnell compiled the total litter items per mile for each survey site (including 4-inch-Plus and 4-inch-Minus survey data) and ran a multiple regression analysis to identify the influencing factors that had the best fit to the data. The multiple regression analysis was evaluated based on the statistical criteria described in Table 3-5.

Table 3-5: Regression Analysis Statistical Criteria

Statistical Metric	Criteria
R Square	Represents goodness of fit (e.g., percentage of variation of the dependent variable explained by the independent variable).
Adjusted R Square	R Square value adjusted for multiple regression analysis.
Significance F	Shows P-value for F-test, should be lower than 0.05.
Coefficients	Estimates derived by the least squares method. Every unit increase of independent variable causes the dependent variable to increase by the coefficient value and units.
P-value	Indicates the statistical relevance of the datasets if below 0.05 to reflect results within a 95 percent confidence interval.

Table 3-6 presents the P-value results of the multiple regression analysis on estimated litter-per-mile for each survey (including 4-inch-Plus and 4-inch-Minus survey). Further detailed results of the regression analyses are provided in Appendix E.

Table 3-6: Results of Influencing Factor Multiple Regression Analysis[1]

Influencing Factor	P-Value
Convenience Store	0.01
Bus	0.06
Construction Sites	0.08
Litter Receptacle	0.13
Recreational Area	0.23
Public Building	0.35
Commercial Center	0.42
Storm Drains	0.54
Recycle Receptacle	0.56
Vacant Lot	0.35
Anti-Litter Messaging Signage	0.79
Commercial Business	0.80
Public Transportation[2]	N/A
Fast Food[2]	N/A
Loading Dock[2]	N/A

1. Multiple regression run at a 95 percent confidence level.
2. N/A indicates that not enough non-zero observations were identified to calculate the P-value.

Based on the results of the multiple regression, the influencing factors that have P-values at or below 0.05 represent a meaningful fit of the data and indicate that visible bus stations, convenience stores and construction sites had an impact on the total number of litter items.

Simple linear regression analysis was run on each of the identified influencing factors. Table 3-7 presents the R Square, P-value and coefficient of each linear regression to identify the strength and direction of each influencing factor.

Table 3-7: Results of Simple Linear Regression Analysis[1]

Influencing Factor	R-Square	P-Value	Coefficient[2]
Bus	0.077	0.002	54,153
Convenience Store	0.149	0.00001	14,885
Construction Site	0.007	0.355	8,370

1. Simple linear regression analyses run at 95 percent confidence.
2. Represents the strength/direction of statistical correlation of influencing factor to litter-per-mile (e.g., additional unit of influencing factor increases litter-per-mile by coefficient value).

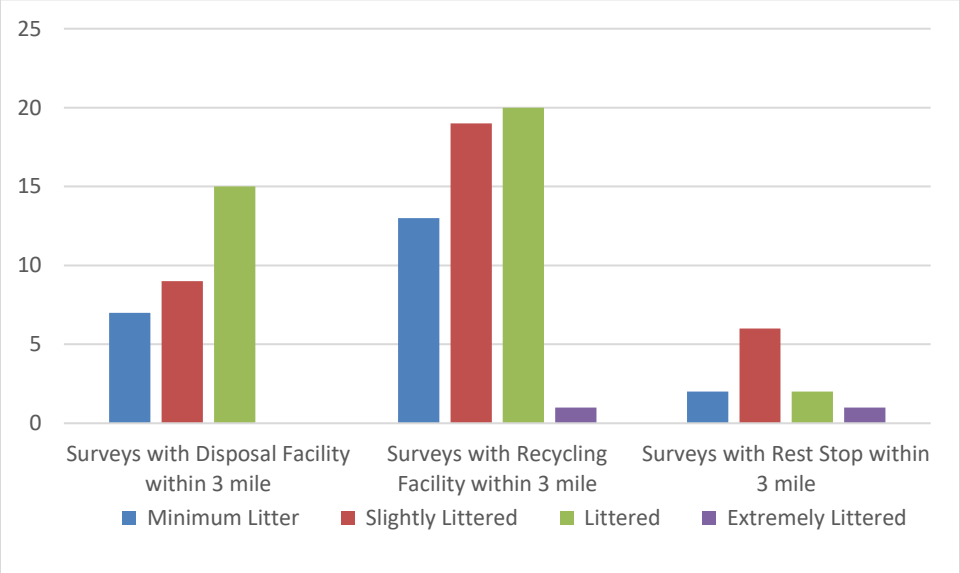
Based on the results of the simple linear regression analyses, the observations of bus stops and convenience stores were statistically valid (e.g., P-value below 0.05) and represent the influencing factors to have a statistical impact on the estimated litter-per-mile. The results of the analysis indicate that bus

stops have the highest impact on litter-per-mile followed by convenience stores and while the fitness of data (e.g., R-Square values) are not high enough to run further modeling or prediction of the additional litter items these influencing factors might cause, they can become the focus of litter prevention and abatement strategies.

3.3.2 Proximity Analysis

Burns & McDonnell evaluated the proximity of survey sites to disposal, recycling and rest stop facilities across the state. Disposal and recycling facility location information was compiled using the publicly available dataset from Tennessee Department of Environmental Conservation (TDEC) and supplemental research.[9] Disposal facilities include landfills and transfer stations, and recycling facilities include material recovery facilities and convenience centers. Rest stop information was compiled from publicly available location information.[10] Figure 3-17 presents the Litter Index of sites that had disposal, recycling or rest stop facilities within three miles.

Figure 3-17: Number of Surveys by Litter Index and Proximity to Facilities



Based on the results, survey sites with a recycling facility within three miles had the highest number of sites were identified as slightly littered or littered. These results related to recycling facilities may be explained by recycling material being more prone to being windblown and there may be fewer requirements to clean and abate litter compared to disposal sites. Additionally, recycling may not be bagged (depending on the solid waste management system) and can contribute to windblown litter.

[9] Information on solid waste facilities in Tennessee can be found at the following hyperlink: https://www.tn.gov/environment/program-areas/solid-waste/maps.html
[10] Information on rest stops in Tennessee can be found at the following hyperlink: https://www.tennesseerestareas.com/

Anecdotally, field crews observed rest stops with high numbers of trucks to have extremely littered environments.

Regression analyses were run on the proximity of facilities to the litter-per-mile (for 4-inch-Plus and 4-inch-Minus surveys) survey site locations factors that had numerical counts (e.g., number of bus stops, number of storm drains, etc.). Burns & McDonnell compiled the total litter items per mile for each survey site (including 4-inch-Plus and 4-inch-Minus survey data) and ran a multiple regression analysis to identify the statistical fit of proximity of disposal, recycling and rest stop facilities in the state. Table 3-8 presents the P-Value results of the multiple regression analysis on estimated litter-per-mile for each survey (including 4-inch-Plus and 4-inch-Minus survey).

Table 3-8: Results of Proximity Multiple Regression Analysis[1]

Facility	P-Value
Distance to Nearest facility	
Disposal	0.176
Recycling	0.156
Rest Stop	0.247
Number of Facilities within Three Miles	
Disposal	0.545
Recycling	0.625
Rest Stop	0.659

1. Multiple regression run at a 95 percent confidence level.

Detailed results of the proximity analysis are provided in Appendix E. Based on these results, the proximity (both straight-line miles and number of facilities within three mile radius) does not result in P-values near or below 0.05. This indicates that there is limited statistical correlation between these facility types and litter-per-mile. While there may be insights related to litter abatement and prevention strategies tied to the proximity to solid waste facilities, the estimated litter-per-mile is not impacted in a statistically meaningful way.

3.4 Key Findings

The following presents key findings related to the litter survey results:

- **Litter prevention and abatement efforts had an impact on Interstate and U.S. Highway roadway classifications** There was a significant reduction in the 4-inch-Plus litter items on Interstate and U.S. Highway roadway classifications. Other roadway classifications and the total litter items were comparable (e.g., within 300 litter items per mile). This indicates that litter prevention and abatement efforts may have had a particular impact on reducing litter-per-mile on Interstate and U.S. Highway roadway classifications.

- **The majority of litter on Tennessee roadways is smaller than four inches.** An estimated 679.7 million pieces, or 88 percent, items of litter were 4 inches or smaller in size; however, the 2022 Study estimates there is still a significant quantity (88.5 million pieces or 12 percent) of larger, and often more visible, litter on Tennessee roadways.
- **Local Roads had the most total litter items.** Local Roads had the second lowest litter-per-mile (7,459 litter items per mile on average including both 4-inch-Plus and 4-inch-Minus survey results). However, Local Roads account for the most road miles (82,538 miles) in the state. In aggregate, Local Roads had the highest percentage (80 percent) of total litter items by roadway type statewide.
- **Plastic and paper items collectively compose the majority of litter items.** Litter on Tennessee roadways is composed of an estimated 285 million (37 percent) plastic items, followed by 165.5 million (22 percent) paper items. Plastic product types, recycling processes and secondary market changes have significantly impacted how plastic materials are handled, both in Tennessee and nationally, since 2016. This may contribute to plastics composing more than one third of the total materials on Tennessee roadways. Glass items represented 9 percent of the total litter items.
- **Juice and soft drink items have increased 14.2 percent between 2016 and 2022.** The increase in juice and soft drink containers, largely composed of plastic and metal materials, should be a key focus for litter abatement and prevention programs.
- **The composition of litter varies by the size of the litter item.** Plastic items composed the majority of both 4-inch-Plus and 4-inch-Minus larger litter. Cigarette butts, glass, and tire treads composed a larger portion of the smaller litter items representing a combined 27 percent compared to only six percent of the 4-inch-Plus items.
- **The amount of cigarette butts observed per site decreased for Interstate and U.S. Highway roadway classifications.** Consistent with the results showing litter-per-mile by roadway classification, the amount of cigarette butts observed per site has decreased on Interstate and U.S. Highways compared to the 2016 Study, but has remained at similar levels on the State Highway and Local Roads. This may be explained, in part, to the changes in tobacco usage over time (e.g., increase usage of vape pens) and less need to dispose of cigarette butts on the larger roadways.
- **On an overall basis the intentional litter increased by about 18 percent due, in part, to changes in product packaging and classification differences between the 2016 Study and 2022 Study.** Comparing the 4-inch-Plus material, the motivations for litter occurring have not changed. However, on an overall basis, the intentional litter increased by about 18 percent due, in part, to changes in product packaging and classification differences between the 2016 Study and 2022 Study.

- **Motorists and vehicle debris were determined to be the leading sources of litter on Tennessee roadways (collectively 81 percent).** The 4-inch-Minus material had fewer items from motorists compared to the 4-inch-Plus material and increased material from pedestrians and vehicle debris. Targeting messaging based on material type generator (e.g., motorists for 4-inch-Plus material and pedestrians for 4-inch-Minus material) may support ongoing or future litter abatement programming.
- **Scenic byway and AAH locations had much less litter observed on average compared to sites that were not on scenic byways or AAH locations.** This is consistent with the amount of litter observed on Local Roads (e.g., fewer items per mile than Interstates or U.S. and State highways) may be due, in part, to the additional litter cleanups and attention these stretches of roadway receive over time. This observation supports the continued focus on expanding the AAH program across the state.
- **There is increased litter per site on average at waterways and fewer where bike baths were observed.** At sites where waterways were observed, there was about 55 more litter items on average compared to sites where no waterways were observed. Conversely, sites where bike paths were observed had about 41 fewer litter items on average. These findings indicate that waterways are an area where litter accumulates at higher rates, and areas with bike paths impact behavior where less litter is generated.
- **At sites within distressed and at-risk counties there were fewer litter items observed.** While the sampling plan included some sites located in at-risk and distressed counties, the distribution of survey locations was based on population and Grand Division and included fewer sites in at-risk and distressed counties. On average, there were fewer litter items observed at sites in at-risk and distressed counties. This may be due to (1) the majority of survey sites in these counties were in rural areas on local roads which, on average, had fewer litter items and (2) survey sites in these counties were in rural areas which, on average, had fewer litter items compared to urban locations.
- **Bus stops and convenience stores have a statistical impact on the prevalence of litter-per-mile.** Based on the regression analyses completed, these influencing factors can be shown to have a statistical impact on the estimated litter-per-mile and should be targeted for litter abatement and prevention efforts.
- **Proximity to disposal, recycling or rest stop facilities do not appear to have a statistical impact on the prevalence of litter-per-mile.** Based on the regression analysis, the presence of or distance to these facilities was not shown to increase or decrease litter at the locations surveyed. However, sites nearest to recycling facilities (including convenience centers) showed a higher

litter per survey on average compared to disposal or rest stop facilities. This may be caused by litter prevention policies at landfills (e.g., requirements to minimize windblown litter) and recyclables being more susceptible to becoming windblown litter if not tarped.

4.0 LITTER ABATEMENT STRATEGIES

As a result of the 2016 Study, KTNB and TDOT implemented the current Nobody Trashes Tennessee, which replaced the previous campaign related to litter abatement and prevention.[11] The previous effort had been focused on providing a website, generating educational materials, utilizing some traditional advertising (e.g., billboards), and developing public service announcements (PSAs). The new campaign focused on building on the previous campaign by including digital and social media approaches to engaging with residents and businesses in the state.

This section summarizes the ongoing litter abatement programs, future efforts and provides key findings to support the ongoing Nobody Trashes Tennessee campaign based on the results of the litter survey presented in Section 3.0.

4.1 Current Efforts

KTNB and TDOT manage several programs related to litter prevention, illegal dumping, education/outreach, and abatement. On December 2, 2022, Burns & McDonnell held a virtual meeting to review and discuss these initiatives with the KTNB and TDOT team. Table 4-1 summarizes the current litter abatement programs.

Table 4-1: Overview of Litter Abatement Programs

Program	Description
Litter Grants	Annual litter grants are distributed to counties and other entities in Tennessee based on population and roadway miles to support local litter abatement and prevention efforts. TDOT develops and submits a report on the state of litter to the Lieutenant Governor's office annually. The most recent report can be accessed at the following hyperlink: TDOT 2022 Litter Grant Annual Report
Adopt-A-Highway (AAH)	The program supports businesses, groups, or family volunteers to adopt two miles of roadway and conduct a total of four litter cleanups per year.
No Trash November	This month-long statewide cleanup effort coordinates litter cleanups and promotes litter abatement and prevention in the month of November.
Litter Hotline	The litter hotline is available for concerned citizens to take action by informing KTNB and TDOT when littering is observed.
Educational Content	Educational content is developed and deployed including videos, the mascot Trashquatch and a litter quiz.
Social Media	Social media content is deployed on a variety of platforms including campaign Twitter, Facebook, Instagram, TikTok, Youtube.
Partnerships	KTNB and TDOT partner with organizations to support the Nobody Trashes Tennessee campaign including key sponsors to build awareness.

[11] More information regarding the Nobody Trashes Tennessee campaign can be found here: https://nobodytrashestennessee.com/\

KTNB and TDOT distribute approximately $5.5 million to all counties in Tennessee annually as part of the litter grant program which supports their annual litter abatement and prevention efforts. The amount distributed to each County is based on population and roadway miles. Although tonnages from local litter pickup operations have decreased in recent years due to the COVID-19 pandemic and challenges staffing litter crews, ongoing litter abatement activities are critical to minimizing roadway litter.

Additionally, in 2021 KTNB started a law enforcement litter grant program for municipal police departments where grantees request funds for litter prevention initiatives based on specific needs for their community. Departments were required to participate in litter law training as part of their continuing education program to be eligible. To date, KTNB has engaged 26 police departments across Tennessee and a total of $80,000 has been devoted to the project over two years.

The Nobody Trashes Tennessee campaign supports several programs including the AAH program, No Trash November, and the Litter Hotline. As part of the campaign, KTNB and TDOT develop and deploy content in coordination with the Atkins Group.

Messaging related to litter abatement and prevention is currently segmented by urban, rural and suburban geographies and messaging is targeted to key audiences by generation/age range (e.g., Baby Boomer, Gen X, Gen Y, Gen Z). Based on discussions with KTNB and TDOT, the intent of the campaign is to make the most effective use of limited advertising resources. By focusing messaging to invigorate existing environmental advocates that can act as influencers, the campaign builds awareness and increases the number of early adopters and fast followers.

Partnerships and sponsors are a key component of the ongoing campaign and have increased the awareness and effectiveness of KTNB and TDOT's programming. Celebrities support messaging and cultivate beneficial partnerships with sports programs through radio spots, logos and signage displayed at sporting events. Two recent examples are Penny Hardaway and Eddie George, two prominent sports figures representing University of Memphis and Tennessee State University, respectively. The sponsorship levels associated with partnership range from $25,000 to $125,000.

4.2 Future Efforts

Based on discussions with KTNB and TDOT, the future efforts to build on the Nobody Trashes Tennessee Campaign will focus on increasing awareness of the campaign and key messaging via social media and partnerships. KTNB and TDOT are seeking to engage in partnerships with other sports programs (e.g., Nashville Predators, Nashville FC), the state university system, and other large businesses in the Tennessee (e.g., Volkswagon, Nissan).

Looking ahead, the campaign could focus on working with rising high school seniors as part of Tennessee Promise, or other similar scholarship programs. Audiences in high school are the target demographics that can become effective ambassadors for the Nobody Trashes Tennessee campaign and constructively communicate messaging as environmental advocates.

As the campaign continues to evolve, KTNB and TDOT will potentially require increased staffing and resources to strategically advance the programs including employees to streamline the processing of grant reimbursement requests, coordinate the growth of the AAH program, supporting the invoicing process and work more closely with grantees to provide support as a liaison.

Overall, future efforts will seek to minimize litter generation and increase the cost effectiveness of KTNB and TDOT's programming. Historically, collecting litter and addressing illegal dumping require more labor and costs than preventing it from being generated.

4.3 Key Findings and Recommendations

Burns & McDonnell has summarized key findings and recommendations to increase effectiveness of the Nobody Trashes Tennessee campaign and minimize the ongoing costs of litter abatement in Tennessee. The following presents key findings and recommendations based on the findings presented in Section 3.0 that KTNB and TDOT can integrate into the Nobody Trashes Tennessee campaign:

- **Grant funding supports counties and municipal police departments to abate litter.** These disbursements are critical to advancing litter abatement and prevention at the local level. One example that has previously been an effective grant approach is to support counties to purchase and distribute tarps to minimize windblown litter. This may be effective to reduce litter caused by local residents transporting material by pickup truck or self-load trailer.
- **Litter composition and quantity varies by roadway type.** Without causing confusion among audiences by differentiating between roadway type in messaging content, focusing the volume of digital media and traditional advertising along Interstates and State Highways, which have the highest average litter-per-mile.
- **Target messaging to minimize juice and soft drink containers products that become litter.** Based on the litter survey, there has been an increase of about 14 percent in the amount of juice and soft drink containers in the statewide litter profile. Targeting messaging to focus on proper management of juice and soft drinks could minimize the volume of these items that are littered.
- **Litter abatement and prevention approaches can be segmented by larger litter items (e.g., 4-inch-Plus) and smaller litter items (e.g., 4-inch-Minus).** Large litter (representing 12 percent of

litter) can be addressed via litter cleanups, but smaller litter items (representing 88 percent of litter) cannot easily be picked up and are more likely to be conveyed to waterways by stormwater runoff. Additionally, large litter items may degrade or otherwise become smaller litter items over time and are eventually conveyed to waterways. Prevention of litter items on Tennessee roadways will minimize the number of items that ultimately accumulate at Tennessee waterways.

- **Expand the AAH program so there are more communities or businesses engaged in litter cleanup events on an annual basis.** Although it may require increased staffing to expand the program, the results of the litter survey indicate that on average there were 45 fewer litter items observed at sites along AAH roadways. Increasing the roadways segments that are included in the program would scale the impact that AAH programs have on average litter items and minimize the average litter-per-mile.
- **Seek partnerships that can make the most meaningful impact in litter prevention.** Focusing partnership efforts on entities that manage, own or operate bus stops or convenience stores would have the greatest impact on litter prevention, as these influencing factors have been shown to result in increased litter-per-mile. This may include developing and deploying messaging directly to truckers and/or developing partnerships with trucking companies and truck stops.
- **Develop content on prevention of litter in Tennessee waterways to increase engagement.** Minimizing litter in waterways has been a key focus in the annual state of litter report. Additional, sites where waterways are visible has been shown to have an increased accumulation of litter on average. Smaller litter items are more easily conveyed by stormwater to waterways and the Nobody Trashes Tennessee campaign could consider leveraging litter and waterways as a key messaging component to drive audience engagement and awareness.
- **Focus messaging on audiences that frequent rest stops.** While the direct statistical analysis does not show a correlation between litter-per-mile and rest stops, anecdotal evidence supports higher levels of litter at rest stops with high truck traffic. Messaging targeting these geographic areas or audience types may have an increased impact on the occurrence of litter at these sites.
- **Conduct future litter research study.** The 2022 Study provided a comprehensive understanding of the current littering behavior and root causes in Tennessee. KTNB and TDOT should conduct a future litter research study in approximately five years to evaluate the success of strategies implemented and measure progress towards more cost effectively managing. Additionally, consistent with the 2020 KAB Study, KTNB and TDOT should consider opportunities to evaluate litter along waterways and other areas identified during the litter survey as accumulating high volumes of litter (e.g., rest stops).

APPENDIX A - SAMPLING SITE LOCATIONS

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
1	East	Chattanooga	I-24	Interstate	34.990479, -85.402129
2	East	Cleveland	I-75	Interstate	35.129275, -85.008861
3	East	Calhoun	I-75	Interstate	35.323182, -84.786853
4	East	Sweetwater	I-75	Interstate	35.610350, -84.504759
5	East	Monteagle	I-24	Interstate	35.229048, -85.825005
6	East	Knoxville	I-275	Interstate	35.983877, -83.944814
7	East	Caryville	BRUCE GAP RD.	Interstate	36.306080, -84.226467
8	East	Baileyton	I-81	Interstate	36.341376, -82.796425
9	East	Kingsport	I-81	Interstate	36.426214, -82.571914
10	East	Rockwood	I-40	Interstate	35.892782, -84.734125
11	East	Oak Ridge	ROBINETTE LN.	Interstate	35.864353, -84.390692
12	Middle	Murfreesboro	I-840	Interstate	35.884011, -86.476584
13	Middle	Manchester	I-24	Interstate	35.473891, -86.061242
14	Middle	Fairview	I-840	Interstate	35.952748, -87.212536
15	Middle	Thompson's Station	I-840	Interstate	35.822241, -86.939571
16	Middle	Burns	I-40	Interstate	36.029458, -87.210786
17	Middle	Nashville	I-65	Interstate	36.146160, -86.777056
18	Middle	Watertown	I-40	Interstate	36.170595, -86.125133
19	Middle	Baxter	I-40	Interstate	36.127082, -85.674676
20	Middle	Millersville	I-65	Interstate	36.426824, -86.712534

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
21	Middle	Portland	I-65	Interstate	36.603113, -86.585605
22	Middle	Clarksville	I-24	Interstate	36.635457, -87.330973
23	Middle	Lewisburg	I-65	Interstate	35.455729, -86.885179
24	Middle	Clarksville	I-24	Interstate	36.558117, -87.251252
25	West	Piperton	I-269	Interstate	35.145663, -89.638918
26	West	Memphis	I-40	Interstate	35.187321, -89.916402
27	West	Brownsville	I-40	Interstate	35.578722, -89.114749
28	West	Gallaway	I-40	Interstate	35.314602, -89.578644
29	West	Dyersburg	MCCULLOUGH CHAPEL RD.	Interstate	36.069967, -89.450681
30	West	Memphis	I-55	Interstate	35.060888, -90.019416
31	East	Rockwood	N. FRONT AVE.	Local Rd	35.869052, -84.685406
32	East	Dandridge	EVANS LN.	Local Rd	36.013408, -83.424939
33	East	Elizabethton	ARNOLD AVE.	Local Rd	36.307588, -82.184323
34	Middle	Fayetteville	BOONSHILL RD.	Local Rd	35.168346, -86.600737
35	Middle	Pulaski	RAGSDALE LN.	Local Rd	35.209072, -87.020085
36	Middle	Lawrenceburg	FRANKLIN DR.	Local Rd	35.239473, -87.380639
37	Middle	Dunlap	BUDDY SKYLES RD.	Local Rd	35.369659, -85.403617
38	Middle	Spring Hill	PORT ROYAL RD.	Local Rd	35.745426, -86.903287
39	Middle	Franklin	4TH AVE. N.	Local Rd	35.926193, -86.871179
40	Middle	Dickson	SPANISH CT.	Local Rd	36.039129, -87.347674

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
41	Middle	McEwen	OLD NASHVILLE HWY.	Local Rd	36.128071, -87.608058
42	Middle	Red Boiling Springs	BAKERTON RD.	Local Rd	36.510387, -85.810203
43	Middle	Springfield	E. 16TH AVE.	Local Rd	36.498150, -86.877745
44	Middle	Pleasant View	WANDALAND RD.	Local Rd	36.450658, -87.073140
45	Middle	Portland	CLUBS RD.	Local Rd	36.582172, -86.554310
46	West	Savannah	STADIUM DR.	Local Rd	35.205152, -88.268281
47	West	Bartlett	BROADMEADOWS DR.	Local Rd	35.290479, -89.855821
48	West	Jackson	NEW DEAL RD.	Local Rd	35.704379, -88.747449
49	West	Dyersburg	FORT HUDSON RD.	Local Rd	36.095120, -89.344644
50	West	Ridgely	MOORING RD.	Local Rd	36.306651, -89.511029
51	West	Memphis	ELVIS PRESLEY BLVD.	Local Rd	35.006416, -90.025166
52	West	Memphis	NEW TCHULAHOMA RD.	Local Rd	35.052138, -89.951583
53	Middle	Nashville	NATCHEZ TRCE.	Local Rd	36.146222, -86.809805
54	East	Chattanooga	MOUNTAIN VIEW RD.	Local Rd	35.088055, -85.065083
55	East	Chattanooga	N. ACCESS RD.	Local Rd	35.111944, -85.250861
56	East	Chattanooga	ADDISON RD.	Local Rd	35.081777, -85.232333
57	East	Chattanooga	WILCOX BLVD.	Local Rd	35.058611, -85.275583
58	East	Blaine	MASCOT PK.	Local Rd	36.066916, -83.723944
59	East	Knoxville	GRAND AVE.	Local Rd	35.962, -83.935
60	East	Knoxville	PLEASANT RIDGE RD.	Local Rd	36.002333, -84.023805
61	East	Pikeville	BELLVIEW RD.	State Hwy	35.768560, -85.165016

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
62	East	Loudon	SUGAR LIMB RD.	State Hwy	35.772702, -84.327115
63	East	Oak Ridge	WHIPP RD.	State Hwy	35.937793, -84.340536
64	East	Knoxville	N. BERTRAND ST.	State Hwy	35.979475, -83.905530
65	East	Rutledge	STATE HWY. 131	State Hwy	36.275117, -83.631895
66	East	Oneida	PAINT ROCK RD.	State Hwy	36.473953, -84.483882
67	East	Baileyton	BUREM PK.	State Hwy	36.393609, -82.857447
68	East	Harrogate	CUMBERLAND GAP PKWY.	State Hwy	36.545964, -83.637034
69	East	Caryville	STATE HWY. 297	State Hwy	36.470042, -84.272220
70	Middle	Pegram	SAMS CREEK RD.	State Hwy	36.153757, -87.045117
71	Middle	Baxter	GAINESBORO HWY.	State Hwy	36.183486, -85.622881
72	Middle	Waverly	N. CHURCH ST.	State Hwy	36.108566, -87.783164
73	Middle	Lafayette	GALEN RD.	State Hwy	36.536514, -85.988133
74	West	Covington	HWY. 51 N.	State Hwy	35.581596, -89.641363
75	West	Halls	OLD 51 HWY.	State Hwy	35.912186, -89.391769
76	West	Trenton	BRADFORD HWY.	State Hwy	36.015506, -88.915821
77	West	Memphis	THOMAS ST.	State Hwy	35.175111, -90.035805
78	West	Memphis	LAMAR AVE.	State Hwy	35.076722, -89.951527
79	West	Memphis	TN-385	State Hwy	35.081882, -89.876379
80	West	Memphis	RIVERDALE RD.	State Hwy	35.020444, -89.831027
81	Middle	Murfreesboro	LEBANON PK.	State Hwy	35.939529, -86.378331

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
82	Middle	Gallatin	VIETNAM VETERANS BLVD.	State Hwy	36.363283, -86.524904
83	Middle	Goodlettsville	RIVERGATE PKWY.	State Hwy	36.315055, -86.713583
84	Middle	Nashville	OLD HICKORY BLVD.	State Hwy	36.262972, -86.711888
85	Middle	Nashville	BRILEY PKWY.	State Hwy	36.210000, -86.690708
86	Middle	Nashville	BRILEY PKWY.	State Hwy	36.216588, -86.872214
87	Middle	Nashville	WHITE BRIDGE RD.	State Hwy	36.124888, -86.847861
88	Middle	Nashville	NOLENSVILLE PK.	State Hwy	36.045333, -86.713194
89	East	Knoxville	ASHEVILLE HWY.	State Hwy	36.021472, -83.776555
90	East	Knoxville	CENTRAL AVE. PK.	State Hwy	36.042333, -84.009249
91	East	Dayton	RICHLAND ST.	US Hwy	35.496207, -85.006599
92	East	Benton	US-HWY. 64	US Hwy	35.101365, -84.655015
93	East	Ducktown	US-HWY. 64	US Hwy	35.073664, -84.480185
94	East	Etowah	US-411	US Hwy	35.270663, -84.546272
95	East	Kingston	US-70	US Hwy	35.853836, -84.440075
96	East	Lenoir City	US-70	US Hwy	35.838898, -84.380942
97	East	Crab Orchard	US-70 E.	US Hwy	35.884473, -84.829150
98	East	Newport	US-HWY. 25W	US Hwy	35.952929, -83.139602
99	East	Bean Station	US-25E	US Hwy	36.283511, -83.280717
100	East	Rutledge	US-11W	US Hwy	36.306408, -83.437295
101	East	Tazewell	US-25E	US Hwy	36.405370, -83.493302

Site ID	Grand Division	City	Road Name	Roadway Classification	Latitude/Longitude
102	Middle	Monteagle	US-41	US Hwy	35.290988, -85.863668
103	Middle	Shelbyville	US-41A	US Hwy	35.459705, -86.353842
104	Middle	Chapel Hill	CONQUEST CT.	US Hwy	35.617762, -86.588317
105	Middle	Doyle	US-HWY. 70S	US Hwy	35.791732, -85.586070
106	Middle	Eagleville	US-41A	US Hwy	35.770109, -86.644864
107	Middle	Coopertown	US-41A	US Hwy	36.353071, -86.949873
108	Middle	Pleasant View	US-41A	US Hwy	36.430782, -87.078299
109	Middle	Ridgetop	US-41	US Hwy	36.401171, -86.776306
110	Middle	Gallatin	US-31E N.	US Hwy	36.441842, -86.369927
111	Middle	Springfield	US-41	US Hwy	36.450145, -86.820436
112	Middle	Cedar Hill	US-41	US Hwy	36.554084, -86.986310
113	Middle	Adams	US-41	US Hwy	36.596011, -87.097637
114	West	Savannah	OLD TOWN LOOP	US Hwy	35.244278, -88.120152
115	West	Bartlett	US-HWY. 70 / 79	US Hwy	35.230126, -89.809367
116	West	Bolivar	US-64	US Hwy	35.253343, -88.970283
117	West	Brighton	US-HWY. 51 S.	US Hwy	35.481225, -89.741030
118	West	Atwood	US-70A / 79	US Hwy	35.962204, -88.693798
119	West	Huntingdon	US-70A	US Hwy	36.010336, -88.466305
120	West	Friendship	US-412	US Hwy	35.944172, -89.303407

APPENDIX B – MATERIAL CATEGORIES AND DEFINITIONS

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Plastic Beverage Containers	Soda	Juice and Soft Drink Containers	Intentional	Plastic bottle or container of any size (excluding plastic cups) designed to contain soft drinks.
Plastic Beverage Containers	Juice/Tea/Sports Drink	Juice and Soft Drink Containers	Intentional	Plastic bottle or container of any size (excluding plastic cups) designed to contain juice, tea or sports and sports/health drinks.
Plastic Beverage Containers	Wine and Liquor	Juice and Soft Drink Containers	Intentional	Plastic bottles or containers (excluding plastic cups) designed to contain wine, wine coolers, vodka, gin, rum, and other liqueurs other than single serve wine & liquor plastic bottles or containers.
Plastic Beverage Containers	Water	Juice and Soft Drink Containers	Intentional	Plastic bottle or container of any size (excluding plastic cups) designed to contain water. Excludes plastic jugs.
Plastic Beverage Containers	Jugs	Beverage Containers and Cartons	Intentional	Plastic jugs used to contain milk, water, juice, etc.
Plastic Beverage Containers	Other beverage packaging	Miscellaneous Plastic	Unintentional	Plastic bottle or container that do not fit into other plastic categories. May be combined with minor amounts of other materials such as wax or glues.
Glass Beverage Containers	Soda	Juice and Soft Drink Containers	Intentional	Glass bottle or container of any size designed to contain soft drinks.
Glass Beverage Containers	Juice/Tea/Sports Drink	Juice and Soft Drink Containers	Intentional	Glass bottle or container of any size designed to contain juice, tea or sports and sports/health drinks.
Glass Beverage Containers	Water	Juice and Soft Drink Containers	Intentional	Glass bottle or container of any size designed to contain water.
Glass Beverage Containers	Beer	Beer, Wine & Liquor Containers	Intentional	Glass bottles or containers of any size designed to contain beer or other malt beverages.
Glass Beverage Containers	Wine and liquor	Beer, Wine & Liquor Containers	Intentional	Glass bottles or containers (excluding plastic cups) designed to contain wine, wine coolers, vodka, gin, rum, and other liqueurs other than single serve wine & liquor glass bottles or containers.
Metal Beverage Containers	Soda	Juice and Soft Drink Containers	Intentional	Aluminum cans of any size designed to contain soft drinks.

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Metal Beverage Containers	Juice/Tea/Sports Drink	Juice and Soft Drink Containers	Intentional	Aluminum cans of any size designed to contain sports and health drinks.
Metal Beverage Containers	Beer	Juice and Soft Drink Containers	Intentional	Aluminum cans of any size designed to contain beer or other malt beverages.
Metal Beverage Containers	Other Beverage Packaging	Bottle caps/seals; pull tabs	Intentional	Pull tabs, bottle caps, lids, and seals, made of metal, used in the packaging/sealing of beverage containers.
Paper Beverage Containers	Wine and Liquor	Beer, Wine & Liquor Containers	Intentional	Paper containers designed to contain plastic bags of wine.
Paper Beverage Containers	Water	Water Bottles	Intentional	Paper bottle or container of any size designed to contain water.
Paper Items	Paper fast-food service items	Take-out Food Packaging	Intentional	Paper items used to serve one-time or fast-food service items originating from restaurants, taverns, drive-ins, concessions, convenience stores, the fast-food section of a grocery store, and other such establishments. Examples include paper plates, bowls, wrappings, individual serving condiment packages, cup and beverage holders, napkins or towels, and pizza boxes known to be from such establishments.
Paper Items	Napkins and Paper Bags	Take-out Food Packaging	Intentional	Paper napkins or bags used as part of take-out food packaging.
Paper Items	OCC	Miscellaneous Paper	Unintentional	Cardboard usually has three layers consisting of a center wavy layer sandwiched between two outer layers. Cardboard may have a wax coating on the inside or outside. Examples include entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons.
Paper Items	E-commerce OCC	Miscellaneous Paper	Unintentional	Cardboard that has been used to ship materials ordered over the internet.
Paper Items	Brown paper bag	Miscellaneous Paper	Unintentional	Paper bags and sheets made from Kraft paper. Examples include paper grocery bags, department store bags, and heavyweight sheets of Kraft packing paper. Excludes fast food paper bags. Bags will not be opened for the study. Surveyor to record whether full or empty.

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Paper Items	Office paper/junk mail	Newspapers, Magazines, Books	Unintentional	Paper used in offices and mailings. Examples include manila folders, manila envelopes, index cards, white envelopes, white window envelopes, white or colored notebook paper, carbonless forms, junk mail, and other mail.
Paper Items	Newspaper/inserts	Newspapers, Magazines, Books	Unintentional	Printed groundwood newsprint, including glossy ads, inserts, and Sunday edition magazines that were delivered with the newspaper.
Paper Items	Magazines/books	Newspapers, Magazines, Books	Unintentional	Magazines, catalogs, and similar products with glossy paper and Paperback and hardback books.
Paper Items	Paper home food packaging	Home Food Packaging (TV Dinners, etc.)	Unintentional	Low-grade recyclable papers used in food packaging, including chipboard and other solid boxboard (not Polycoated). Examples include cereal, egg cartons (molded pulp), and other boxes and ice cream cartons and other frozen food boxes.
Paper Items	Receipts	Miscellaneous Paper	Unintentional	Paper items showing purchases or receipt of items or goods.
Paper Items	Lottery tickets	Miscellaneous Paper	Intentional	Used lottery game paper items such as scratch tickets or other discards
Paper Items	Aseptic/gable-top containers	Miscellaneous Paper	Unintentional	Gable-top containers. Examples include milk cartons, orange juice cartons, and soy milk aseptic containers.
Paper Items	Beverage carriers/cartons	Miscellaneous Paper	Unintentional	Paperboard boxes used to hold four or more individual soft drinks or beer bottles or cans.
Paper Items	Straws	Cups, Lids, Straws	Unintentional	Paper straws that are not contained in another item (e.g., standalone paper straws)
Paper Items	Other paper	Miscellaneous Paper	Unintentional	Items made mostly of paper that do not fit into other paper categories. May be combined with minor amounts of other materials such as wax or glues.
Plastic Items	Plastic Bags	Plastic Bags	Intentional	Plastic grocery and other merchandise shopping bags used to contain merchandise to transport from the place of purchase, given out by the store with the purchase (including dry cleaning bags). Bags will not be opened for the study. Surveyor to record whether full or empty.

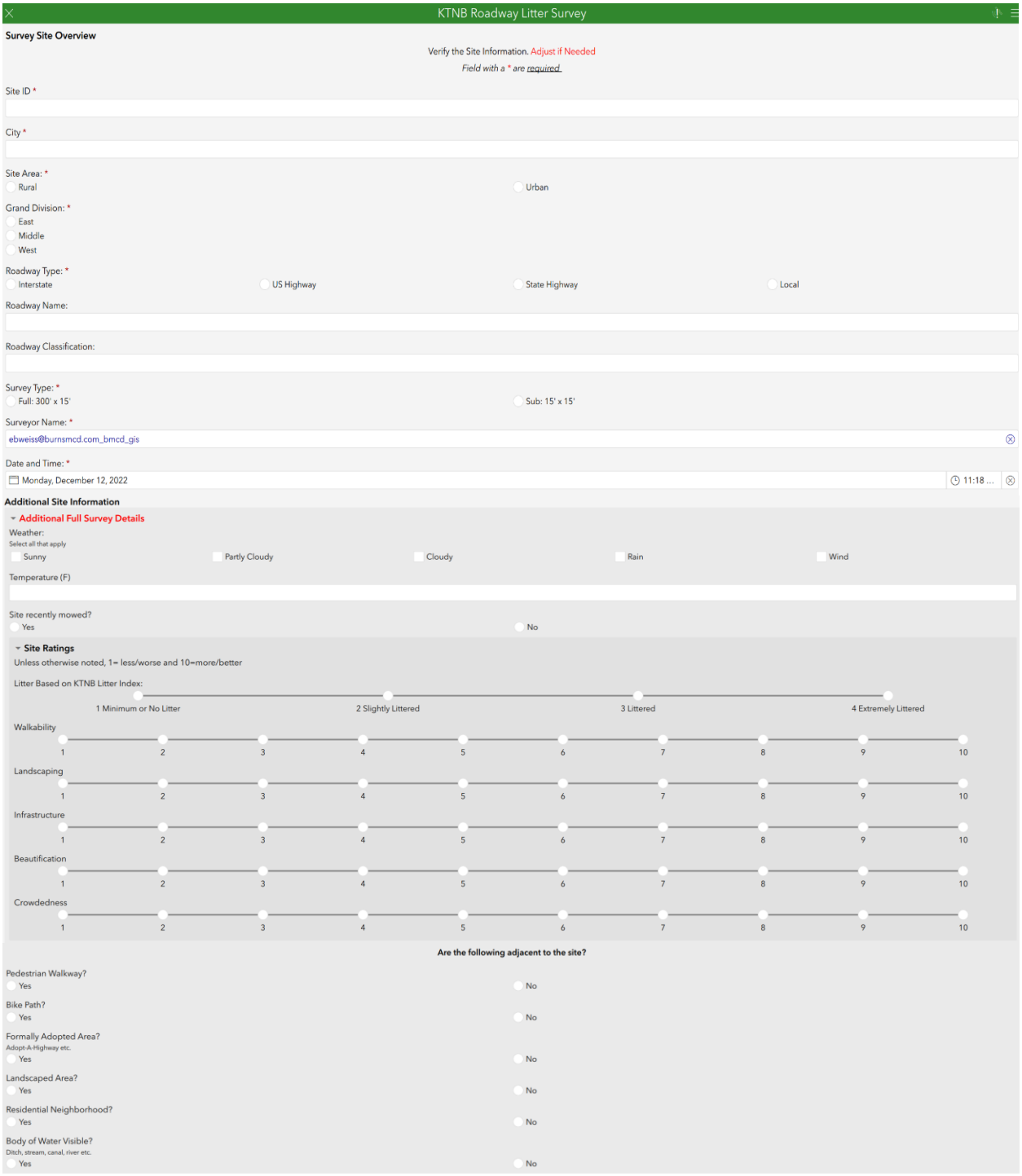
Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Plastic Items	Other film	Plastic Bags	Intentional	Plastic film used for purposes other than packaging. Examples include agricultural film (films used in various farming and growing applications, such as silage greenhouse films, mulch films, and wrap for hay bales), plastic sheeting used as drop cloths, and building wrap.
Plastic Items	Advertising/signs/cards	Advertising Signs & Cards	Unintentional	Examples include political yard signs and business advertising signs.
Plastic Items	Plastic home food packaging	Home Food Packaging (TV Dinners, etc.)	Unintentional	Low-grade plastic used in food packaging, including film and other multi-material plastics. Examples include shrink wrap and other multi-material flexible plastic packaging.
Plastic Items	EPS fast food service items	Take-out Food Packaging	Intentional	Polystyrene items used to serve one-time or fast food service items originating from restaurants, taverns, drive-ins, concessions, the fast food section of a grocery store, and other such establishments. Examples include Styrofoam platters, plates, bowls, cups, beverage holders, and clamshells. This does not include straws.
Plastic Items	Other	Miscellaneous Plastic	Unintentional	Other plastic items that do not otherwise fit into another material category.
Plastic Items	Other expanded polystyrene	Miscellaneous Plastic	Unintentional	Other expanded polystyrene (e.g., Styrofoam) that does not fit into another material category.
Plastic Items	Straws	Cups, Lids, Straws	Intentional	Plastic straws that are not contained in another item (e.g., standalone plastic straws)
Plastic Items	Food Packaging Film	Snack Food Packaging (Candy, Gum, etc.)	Intentional	Wrappings or bags used to package candy, gum, chips, or other food items generally sold at convenience stores.
Plastic Items	E-commerce Packaging	Miscellaneous Plastic	Unintentional	Plastic packaging used to protect items being shipped (e.g., plastic bubble wrap)

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Plastic Items	Plastic fast-food service items	Take-out Food Packaging	Intentional	Plastic items (excluding Styrofoam) used to serve one-time or fast food service items originating from restaurants, taverns, drive-ins, concessions, the fast food section of a grocery store, and other such establishments. Examples include plastic cups, lids, straws, utensils, plates, bowls, wrappings, individual serving condiment packages, cup and beverage holders, and plastic bags known to be from such establishments.
Metal Items	Metal home food packaging	Home Food Packaging (TV Dinners, etc.)	Unintentional	Steel/tin cans made mainly of steel, such as canned food containers, bimetal containers with steel sides and aluminum ends and aluminum foil.
Metal Items	Other metal and foil packages	Miscellaneous Metal & Foil	Unintentional	Items that are predominantly made of metal, but are combined with other material, and/or do not fit into other metal categories. Examples include ferrous metal (iron or steel) that is magnetic or any stainless-steel item, such as metal clothes hangers, metal pipes, small appliances comprised mainly of metal, and scrap ferrous items.
Glass Items	Broken glass or ceramic	Miscellaneous Glass & Ceramics	Unintentional	Broken glass pieces and ceramic products that do not fit into another category. Examples include broken glass beverage bottles, ceramic dishware, porcelain, China, garden pottery, and used toilets and sinks. Does not include automotive window glass.
Glass Items	Other glass	Miscellaneous Glass & Ceramics	Unintentional	Items that are predominantly made of glass, but are combined with other material, and/or do not fit into the other glass categories. Excludes automotive window glass.
Glass Items	Other	Miscellaneous Glass & Ceramics	Unintentional	Glass bottle or container of any size that is not distinguishable by type of beverage.
Other Items	Vehicle debris	Vehicle Debris and Packaging	Unintentional	Vehicle parts, debris from vehicle accidents, and other vehicle debris. Examples include hubcaps, tailpipes, tires, tire rims, vehicle molding, exterior light covers, rearview mirrors, or window glass known to be from an automobile, tie downs for trucks, bicycle, or other motorized vehicle. This does not include tire tread.
Other Items	Whole Tires	Tires	Unintentional	At least three-fourths of a full tire of any type (passenger vehicle, truck, tractor, etc.)

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Other Items	Shredded Tires	Tires	Unintentional	Shredded tire (e.g., found in numerous pieces) from any type of vehicle.
Other Items	Construction Debris	Construction Debris	Unintentional	Construction, renovation, and demolition debris Examples include rocks and brick, concrete, soil, fines, dirt, non-distinct fines, gypsum board, fiberglass insulation, other fiberglass, roofing waste, asphalt paving, asphalt roofing, lumber (non-treated), treated wood waste, pallets, and other C&D materials that did not fit into other categories.
Organic Items	Wood & Yard Debris	Wood & Yard Debris	Unintentional	Wood and yard debris including yard trimmings, brush, stumps, or dimensional lumber.
Organic Items	Agricultural Debris	Wood & Yard Debris	Unintentional	Agricultural debris such as hay bales, cotton picking scraps, etc.
Mattresses	Mattress/Box Spring	Mattresses	Unintentional	Mattresses including box springs
Other Items	Household Appliances	White Goods	Unintentional	Hope appliances including microwaves, washer dryer, refrigerator, dishwater, stove, hot water heater
Trash	32-gallon trash bags	Entire 32 Gallon Trash bag	Unintentional	32-gallon or larger industrial trash bags used to contain trash. Bags will not be opened for the study. Surveyor to record whether full or empty.
Trash	19-gallon trash bags	Entire 32 Gallon Trash bag	Unintentional	19-gallon household trash bags used to contain trash. Bags will not be opened for the study. Surveyor to record whether full or empty.
Household Waste	Personal Protective Equipment (PPE)	Other	Unintentional	Personal protective equipment including masks, gloves, and other equipment to prevent airborne illness.
Household Waste	Textiles/small rugs	Other	Unintentional	Items made of thread, yarn, fabric, or cloth. Examples include clothes, fabric trimmings, draperies, and bathroom rugs (flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material). This type does not include cloth-covered furniture, mattresses, or leather.
Organic Items	Human Waste	Other	Unintentional	Containers of any size or shape that contain human feces or urine. Examples include disposable baby diapers, protective undergarments for adults, and plastic beverage bottles filled with urine.
Organic Items	Food Waste	Other	Unintentional	Any item of food, excluding confection.

Material Category	Material Type	2016 Material Category	Intentional/ Unintentional	Definition
Other Items	Bulky Items	Other	Unintentional	Mixed material furniture, mattresses, box springs, appliances, refrigerators, and area rugs (flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material).
Other Items	Other Hazardous	Other	Unintentional	Other hazardous materials that cannot be otherwise identified.
Other Items	Entertainment items	Other	Unintentional	Examples include games, music cassettes, CDs, golf balls, frisbees, small cars, and other toys.
Other Items	Electronics	Other	Unintentional	Electronics including TVs computers, phones, iPad/tablets, etc; Cell phones and other portable electronics. This category also includes charging cords, headphones, adapters, power cords, and other cords
Other Items	Other Items	Other	Unintentional	Any other material not otherwise described.
Other Items	Gas Tanks	Other	Unintentional	Gas containers of any size including small campfire canisters, large grill tanks, oxygen tanks, and other gas tanks.
Other Items	Toiletries/drug bottles/personal hygiene products	Toiletries, Toys, Drugs	Intentional	Health care products. Examples include make-up sponges, gloves, and condoms.
Other Items	Tissues	Toiletries, Toys, Drugs	Intentional	Toilet tissues and other similar health care products.
Other Items	Cigarette/Cigar butts	Cigarette Packs, Lighters, Matches	Intentional	The discarded ends, pieces, or filters of fully or partially smoked cigarettes.
Other Items	All other tobacco-related products & packaging	Cigarette Packs, Lighters, Matches	Intentional	All other tobacco-related products that do not fit into other categories. Examples include unsmoked cigarettes, cigars, chewing tobacco, pipe tobacco, matches, matchbooks and packaging for tobacco products such as paper boxes, plastic or foil wrappings, or other materials used to package cigarettes, cigars, chewing or pipe tobacco, including individual cigarette packages and unused cigarette papers.
Other Items	Electronic Cigarettes	Cigarette Packs, Lighters, Matches	Intentional	Devices associated with the use of electronic cigarettes. Examples include electronic cigarette cartridges, disposable electronic cigarettes, and reusable electronic cigarettes.

APPENDIX C – LITTER SURVEY FORM



KTNB Roadway Litter Survey

Survey Site Overview

Verify the Site Information. Adjust if Needed

*Field with a * are required*

Site ID *

City *

Site Area: *
- Rural
- Urban

Grand Division: *
- East
- Middle
- West

Roadway Type: *
- Interstate
- US Highway
- State Highway
- Local

Roadway Name:

Roadway Classification:

Survey Type: *
- Full: 300' x 15'
- Sub: 15' x 15'

Surveyor Name: *

ebweiss@burnsmcd.com_bmcd_gis

Date and Time: *

Monday, December 12, 2022 11:18 ...

Additional Site Information

Additional Full Survey Details

Weather:

Select all that apply
- Sunny
- Partly Cloudy
- Cloudy
- Rain
- Wind

Temperature (F)

Site recently mowed?
- Yes
- No

Site Ratings

Unless otherwise noted, 1= less/worse and 10=more/better

Litter Based on KTNB Litter Index:

1 Minimum or No Litter | 2 Slightly Littered | 3 Littered | 4 Extremely Littered

Walkability: 1 2 3 4 5 6 7 8 9 10

Landscaping: 1 2 3 4 5 6 7 8 9 10

Infrastructure: 1 2 3 4 5 6 7 8 9 10

Beautification: 1 2 3 4 5 6 7 8 9 10

Crowdedness: 1 2 3 4 5 6 7 8 9 10

Are the following adjacent to the site?

Pedestrian Walkway?
- Yes
- No

Bike Path?
- Yes
- No

Formally Adopted Area?

Adopt-A-Highway etc.
- Yes
- No

Landscaped Area?
- Yes
- No

Residential Neighborhood?
- Yes
- No

Body of Water Visible?

Ditch, stream, canal, river etc.
- Yes
- No

How many of the following are visible from the Site?

Anti-littering Messaging? 0

Litter Receptacle? 0

Recycle Receptacle? 0

Storm Drain? 0

Bus Stop? 0

Other Public Transportation Stop?
Train, trolly etc. 0

Fast Food Restaurants? 0

Convenience Stores/Gas Stations? 0

Commerical Center?
Stripmall etc. 0

Standalone Commercial Businesses? 0

Public Buildings?
Schools, churches, libraries etc. 0

Recreational Area?
Pool, park etc. 0

Non-fenced Construction Site? 0

Fenced Construction Site? 0

Loading Dock? 0

Vacant Lot? 0

Is Solid Waste Drop Off Visible?
- Yes
- No

Is Solid Waste Disposal Facility Visible?
- Yes
- No

Other Site Notes:

Litter Collection

Paper Litter Items

Choose Item Type and Source

Paper Item Type

Fast food paper bag | Fast food paper cup | Fast food paper other | Cardboard | Kraft bag | Receipt | Political sign | Other advertising signs | Office paper/mail | Newspaper / inserts | Magazines | Books

Aseptic / gable-top containers | Beverage carriers / cartons | Home food packaging | Other paper

Item Source

Motorists | Pedestrians | Unsecure Loads | Vehicle Debris | Containers | Unknown

1 of 1

Paper Beverage Containers

Plastic Litter Items

Plastic Beverage Containers

Glass Litter Items

Glass Beverage Containers

Metal Litter Items

Metal Beverage Containers

Organic Litter Items

Trash Litter Items

Household Waste Items

Other Litter Items

Pictures

APPENDIX D – COMPOSITION RESULTS

Material	2022 Interstate						2016 Percentage
	4-inch-Plus Items	4-inch-Plus Percentage	4-inch-Minus Items	4-inch-Minus Percentage	Total Items	Total Percentage	
Juice and Soft Drink Containers	240,372	7.9%	1,029,159	4.6%	1,269,531	4.9%	1.5%
Beer, Wine & Liquor Containers	7,754	0.3%	0	0.0%	7,754	0.0%	0.9%
Water Bottles	1,410	0.0%	14,098	0.1%	15,508	0.1%	0.8%
Bottle caps/seals; pull tabs	2,115	0.1%	28,196	0.1%	30,311	0.1%	1.3%
Pull Tabs	0	0.0%	0	0.0%	0	0.0%	0.1%
Beverage Containers and Cartons	0	0.0%	0	0.0%	0	0.0%	0.3%
Cups, Lids, Straws	23,967	0.8%	98,686	0.4%	122,653	0.5%	4.5%
Snack Food Packaging (Candy, Gum, etc.)	83,179	2.7%	620,315	2.7%	703,494	2.7%	4.6%
Take-out Food Packaging	71,195	2.3%	380,648	1.7%	451,843	1.8%	2.5%
Cigarette Packs, Lighters, Matches	45,114	1.5%	2,594,045	11.5%	2,639,159	10.3%	1.0%
Napkins, Bags (Paper Only), Tissues	0	0.0%	0	0.0%	0	0.0%	3.6%
Plastic Bags	131,112	4.3%	662,609	2.9%	793,721	3.1%	0.8%
Toiletries, Toys, Drugs	705	0.0%	0	0.0%	705	0.0%	0.2%
Subtotal (Intentional)	**606,922**	**19.9%**	**5,427,757**	**24.0%**	**6,034,679**	**23.5%**	**22.1%**
Newspapers, Magazines, Books	2,115	0.1%	14,098	0.1%	16,213	0.1%	0.2%
Advertising Signs & Cards	40,179	1.3%	14,098	0.1%	54,278	0.2%	0.1%
Home Food Packaging (TV Dinners, etc.)	185,390	6.1%	437,040	1.9%	622,430	2.4%	0.1%
Vehicle Debris and Packaging	66,966	2.2%	944,571	4.2%	1,011,536	3.9%	52.0%
Tires	843,065	27.6%	8,867,686	39.2%	9,710,750	37.9%	0.1%
Construction Debris	69,081	2.3%	352,452	1.6%	421,532	1.6%	0.5%
Miscellaneous Paper	465,236	15.3%	2,185,201	9.7%	2,650,437	10.3%	9.8%
Miscellaneous Plastic	539,956	17.7%	2,509,456	11.1%	3,049,412	11.9%	7.6%
Gas Tanks	0	0.0%	0	0.0%	0	0.0%	0.2%
Miscellaneous Metal & Foil	62,032	2.0%	465,236	2.1%	527,268	2.1%	1.7%
Miscellaneous Glass & Ceramics	14,803	0.5%	874,080	3.9%	888,883	3.5%	0.1%
Wood & Yard Debris	102,916	3.4%	253,765	1.1%	356,681	1.4%	4.0%
Mattresses	0	0.0%	0	0.0%	0	0.0%	0.0%
White Goods	0	0.0%	0	0.0%	0	0.0%	0.0%
Entire 32 Gallon Trash bag	1,410	0.0%	0	0.0%	1,410	0.0%	0.1%
Tie-downs for trucks	0	0.0%	0	0.0%	0	0.0%	0.1%
Other	49,343	1.6%	253,765	1.1%	303,108	1.2%	1.2%
Subtotal (Unintentional)	**2,442,491**	**80.1%**	**17,171,448**	**76.0%**	**19,613,939**	**76.5%**	**77.8%**
Total[1]	**3,049,412**	**100.0%**	**22,599,205**	**100.0%**	**25,648,618**	**100.0%**	**99.9%**

1. Sum of 2016 percentage may not total to 100 percent due to rounding

Material	2022 U.S. Highway						
	4-inch-Plus Items	4-inch-Plus Percentage	4-inch-Minus Items	4-inch-Minus Percentage	Total Items	Total Percentage	2016 Percentage
Juice and Soft Drink Containers	905,612	11.5%	3,345,574	5.8%	4,251,186	6.5%	4.0%
Beer, Wine & Liquor Containers	51,914	0.7%	115,365	0.2%	167,279	0.3%	2.1%
Water Bottles	5,768	0.1%	0	0.0%	5,768	0.0%	1.4%
Bottle caps/seals; pull tabs	92,292	1.2%	230,729	0.4%	323,021	0.5%	2.8%
Pull Tabs	0	0.0%	0	0.0%	0	0.0%	0.1%
Beverage Containers and Cartons	5,768	0.1%	0	0.0%	5,768	0.0%	0.4%
Cups, Lids, Straws	46,146	0.6%	230,729	0.4%	276,875	0.4%	5.7%
Snack Food Packaging (Candy, Gum, etc.)	305,716	3.9%	2,653,386	4.6%	2,959,102	4.5%	7.7%
Take-out Food Packaging	224,961	2.8%	3,230,209	5.6%	3,455,170	5.3%	3.5%
Cigarette Packs, Lighters, Matches	121,133	1.5%	8,421,617	14.7%	8,542,749	13.1%	2.9%
Napkins, Bags (Paper Only), Tissues	0	0.0%	0	0.0%	0	0.0%	5.7%
Plastic Bags	317,253	4.0%	3,922,397	6.8%	4,239,649	6.5%	1.3%
Toiletries, Toys, Drugs	40,378	0.5%	0	0.0%	40,378	0.1%	0.1%
Subtotal (Intentional)	**2,116,941**	**26.8%**	**22,150,005**	**38.6%**	**24,266,946**	**37.1%**	**37.7%**
Newspapers, Magazines, Books	11,536	0.1%	230,729	0.4%	242,266	0.4%	0.4%
Advertising Signs & Cards	161,510	2.0%	461,458	0.8%	622,969	1.0%	0.3%
Home Food Packaging (TV Dinners, etc.)	709,492	9.0%	3,114,844	5.4%	3,824,337	5.9%	0.2%
Vehicle Debris and Packaging	115,365	1.5%	807,552	1.4%	922,917	1.4%	26.7%
Tires	559,518	7.1%	5,883,595	10.2%	6,443,113	9.9%	0.1%
Construction Debris	103,828	1.3%	576,823	1.0%	680,651	1.0%	0.5%
Miscellaneous Paper	1,568,959	19.8%	8,998,440	15.7%	10,567,398	16.2%	14.1%
Miscellaneous Plastic	1,909,284	24.1%	9,344,533	16.3%	11,253,818	17.2%	10.4%
Gas Tanks	0	0.0%	0	0.0%	0	0.0%	0.0%
Miscellaneous Metal & Foil	115,365	1.5%	922,917	1.6%	1,038,281	1.6%	4.7%
Miscellaneous Glass & Ceramics	115,365	1.5%	2,191,928	3.8%	2,307,292	3.5%	0.1%
Wood & Yard Debris	294,180	3.7%	1,845,834	3.2%	2,140,014	3.3%	3.1%
Mattresses	0	0.0%	0	0.0%	0	0.0%	0.0%
White Goods	0	0.0%	0	0.0%	0	0.0%	0.0%
Entire 32 Gallon Trash bag	0	0.0%	0	0.0%	0	0.0%	0.1%
Tie-downs for trucks	0	0.0%	0	0.0%	0	0.0%	0.1%
Other	126,901	1.6%	922,917	1.6%	1,049,818	1.6%	1.6%
Subtotal (Unintentional)	**5,791,303**	**73.2%**	**35,301,571**	**61.4%**	**41,092,874**	**62.9%**	**62.4%**
Total[1]	**7,908,244**	**100.0%**	**57,451,576**	**100.0%**	**65,359,820**	**100.0%**	**100.1%**

2. Sum of 2016 percentage may not total to 100 percent due to rounding

Material	2022 State Highway						2016 Percentage
	4-inch-Plus Items	4-inch-Plus Percentage	4-inch-Minus Items	4-inch-Minus Percentage	Total Items	Total Percentage	
Juice and Soft Drink Containers	735,683	14.0%	2,840,967	5.0%	3,576,651	5.8%	2.5%
Beer, Wine & Liquor Containers	78,445	1.5%	254,415	0.5%	332,860	0.5%	2.1%
Water Bottles	2,120	0.0%	0	0.0%	2,120	0.0%	1.2%
Bottle caps/seals; pull tabs	10,601	0.2%	42,402	0.1%	53,003	0.1%	3.3%
Pull Tabs	0	0.0%	0	0.0%	0	0.0%	0.2%
Beverage Containers and Cartons	10,601	0.2%	0	0.0%	10,601	0.0%	0.2%
Cups, Lids, Straws	50,883	1.0%	424,025	0.8%	474,908	0.8%	7.1%
Snack Food Packaging (Candy, Gum, etc.)	216,253	4.1%	1,780,905	3.2%	1,997,158	3.2%	9.5%
Take-out Food Packaging	256,535	4.9%	2,077,722	3.7%	2,334,257	3.8%	5.0%
Cigarette Packs, Lighters, Matches	137,808	2.6%	10,770,234	19.1%	10,908,042	17.7%	2.8%
Napkins, Bags (Paper Only), Tissues	0	0.0%	0	0.0%	0	0.0%	8.4%
Plastic Bags	226,853	4.3%	2,925,772	5.2%	3,152,626	5.1%	1.1%
Toiletries, Toys, Drugs	4,240	0.1%	0	0.0%	4,240	0.0%	0.4%
Subtotal (Intentional)	**1,730,022**	**32.9%**	**21,116,443**	**37.5%**	**22,846,465**	**37.1%**	**43.8%**
Newspapers, Magazines, Books	21,201	0.4%	593,635	1.1%	614,836	1.0%	0.2%
Advertising Signs & Cards	95,406	1.8%	720,842	1.3%	816,248	1.3%	0.3%
Home Food Packaging (TV Dinners, etc.)	296,817	5.7%	2,247,332	4.0%	2,544,150	4.1%	0.2%
Vehicle Debris and Packaging	97,526	1.9%	339,220	0.6%	436,746	0.7%	12.7%
Tires	195,051	3.7%	1,696,100	3.0%	1,891,151	3.1%	0.0%
Construction Debris	277,736	5.3%	1,696,100	3.0%	1,973,836	3.2%	0.6%
Miscellaneous Paper	1,178,789	22.4%	8,395,694	14.9%	9,574,484	15.5%	17.2%
Miscellaneous Plastic	1,032,501	19.7%	9,243,744	16.4%	10,276,245	16.7%	14.4%
Gas Tanks	0	0.0%	0	0.0%	0	0.0%	0.0%
Miscellaneous Metal & Foil	67,844	1.3%	1,187,270	2.1%	1,255,114	2.0%	6.4%
Miscellaneous Glass & Ceramics	33,922	0.6%	8,268,487	14.7%	8,302,409	13.5%	0.9%
Wood & Yard Debris	99,646	1.9%	296,817	0.5%	396,463	0.6%	1.6%
Mattresses	0	0.0%	0	0.0%	0	0.0%	0.0%
White Goods	0	0.0%	0	0.0%	0	0.0%	0.0%
Entire 32 Gallon Trash bag	27,562	0.5%	0	0.0%	27,562	0.0%	0.0%
Tie-downs for trucks	0	0.0%	0	0.0%	0	0.0%	0.1%
Other	97,526	1.9%	551,232	1.0%	648,758	1.1%	1.7%
Subtotal (Unintentional)	**3,521,527**	**67.1%**	**35,236,474**	**62.5%**	**38,758,001**	**62.9%**	**56.3%**
Total[1]	**5,251,549**	**100.0%**	**56,352,917**	**100.0%**	**61,604,466**	**100.0%**	**100.1%**

1. Sum of 2016 percentage may not total to 100 percent due to rounding

Material	2022 Local Roads						2016 Percentage
	4-inch-Plus Items	4-inch-Plus Percentage	4-inch-Minus Items	4-inch-Minus Percentage	Total Items	Total Percentage	
Juice and Soft Drink Containers	16,463,646	22.8%	99,750,325	18.4%	116,213,971	18.9%	3.5%
Beer, Wine & Liquor Containers	2,130,589	2.9%	13,558,297	2.5%	15,688,886	2.5%	2.6%
Water Bottles	0	0.0%	0	0.0%	0	0.0%	1.8%
Bottle caps/seals; pull tabs	48,422	0.1%	0	0.0%	48,422	0.0%	2.6%
Pull Tabs	0	0.0%	0	0.0%	0	0.0%	0.4%
Beverage Containers and Cartons	0	0.0%	0	0.0%	0	0.0%	0.1%
Cups, Lids, Straws	677,915	0.9%	5,810,699	1.1%	6,488,613	1.1%	5.8%
Snack Food Packaging (Candy, Gum, etc.)	1,743,210	2.4%	16,463,646	3.0%	18,206,856	3.0%	11.2%
Take-out Food Packaging	3,341,152	4.6%	36,801,091	6.8%	40,142,243	6.5%	4.0%
Cigarette Packs, Lighters, Matches	1,549,520	2.1%	82,318,230	15.2%	83,867,749	13.6%	2.0%
Napkins, Bags (Paper Only), Tissues	0	0.0%	0	0.0%	0	0.0%	6.3%
Plastic Bags	3,680,109	5.1%	16,463,646	3.0%	20,143,755	3.3%	0.6%
Toiletries, Toys, Drugs	0	0.0%	0	0.0%	0	0.0%	1.3%
Subtotal (Intentional)	**29,634,563**	**41.0%**	**271,165,933**	**49.9%**	**300,800,496**	**48.9%**	**42.2%**
Newspapers, Magazines, Books	242,112	0.3%	1,936,900	0.4%	2,179,012	0.4%	1.4%
Advertising Signs & Cards	2,275,857	3.1%	968,450	0.2%	3,244,307	0.5%	0.3%
Home Food Packaging (TV Dinners, etc.)	4,745,404	6.6%	17,432,096	3.2%	22,177,500	3.6%	0.4%
Vehicle Debris and Packaging	435,802	0.6%	1,936,900	0.4%	2,372,702	0.4%	7.4%
Tires	581,070	0.8%	9,684,498	1.8%	10,265,567	1.7%	0.2%
Construction Debris	726,337	1.0%	968,450	0.2%	1,694,787	0.3%	1.2%
Miscellaneous Paper	13,897,254	19.2%	114,277,072	21.0%	128,174,326	20.8%	18.8%
Miscellaneous Plastic	13,558,297	18.7%	72,633,732	13.4%	86,192,029	14.0%	15.8%
Gas Tanks	0	0.0%	0	0.0%	0	0.0%	0.0%
Miscellaneous Metal & Foil	1,985,322	2.7%	6,779,148	1.2%	8,764,470	1.4%	5.2%
Miscellaneous Glass & Ceramics	242,112	0.3%	37,769,541	7.0%	38,011,653	6.2%	0.6%
Wood & Yard Debris	2,421,124	3.3%	2,905,349	0.5%	5,326,474	0.9%	2.7%
Mattresses	0	0.0%	0	0.0%	0	0.0%	0.0%
White Goods	0	0.0%	0	0.0%	0	0.0%	0.0%
Entire 32 Gallon Trash bag	774,760	1.1%	0	0.0%	774,760	0.1%	0.2%
Tie-downs for trucks	0	0.0%	0	0.0%	0	0.0%	0.0%
Other	823,182	1.1%	4,842,249	0.9%	5,665,431	0.9%	3.7%
Subtotal (Unintentional)	**42,708,635**	**59.0%**	**272,134,383**	**50.1%**	**314,843,018**	**51.1%**	**57.9%**
Total[1]	**72,343,197**	**100.0%**	**543,300,317**	**100.0%**	**615,643,514**	**100.0%**	**100.1%**

1. Sum of 2016 percentage may not total to 100 percent due to rounding

Material	2022 Overall						
	4-inch-Plus Items	4-inch-Plus Percentage	4-inch-Minus Items	4-inch-Minus Percentage	Total Items	Total Percentage	2016 Percentage
Juice and Soft Drink Containers	18,345,314	20.7%	106,966,025	15.7%	125,311,339	16.3%	2.1%
Beer, Wine & Liquor Containers	2,268,702	2.6%	13,928,076	2.0%	16,196,778	2.1%	1.3%
Water Bottles	9,298	0.0%	14,098	0.0%	23,396	0.0%	1.0%
Bottle caps/seals; pull tabs	153,430	0.2%	301,328	0.0%	454,757	0.1%	1.9%
Pull Tabs	0	0.0%	0	0.0%	0	0.0%	0.1%
Beverage Containers and Cartons	16,369	0.0%	0	0.0%	16,369	0.0%	0.3%
Cups, Lids, Straws	798,910	0.9%	6,564,139	1.0%	7,363,050	1.0%	5.0%
Snack Food Packaging (Candy, Gum, etc.)	2,348,357	2.7%	21,518,252	3.2%	23,866,609	3.1%	5.9%
Take-out Food Packaging	3,893,843	4.4%	42,489,670	6.3%	46,383,513	6.0%	3.0%
Cigarette Packs, Lighters, Matches	1,853,574	2.1%	104,104,125	15.3%	105,957,699	13.8%	1.6%
Napkins, Bags (Paper Only), Tissues	0	0.0%	0	0.0%	0	0.0%	4.6%
Plastic Bags	4,355,327	4.9%	23,974,424	3.5%	28,329,751	3.7%	0.9%
Toiletries, Toys, Drugs	45,323	0.1%	0	0.0%	45,323	0.0%	0.3%
Subtotal (Intentional)	**34,088,447**	**38.5%**	**319,860,138**	**47.1%**	**353,948,585**	**46.1%**	**28.0%**
Newspapers, Magazines, Books	276,965	0.3%	2,775,362	0.4%	3,052,327	0.4%	0.3%
Advertising Signs & Cards	2,572,953	2.9%	2,164,849	0.3%	4,737,801	0.6%	0.2%
Home Food Packaging (TV Dinners, etc.)	5,937,103	6.7%	23,231,313	3.4%	29,168,416	3.8%	0.2%
Vehicle Debris and Packaging	715,659	0.8%	4,028,242	0.6%	4,743,901	0.6%	41.8%
Tires	2,178,704	2.5%	26,131,878	3.8%	28,310,582	3.7%	0.1%
Construction Debris	1,176,982	1.3%	3,593,824	0.5%	4,770,807	0.6%	0.5%
Miscellaneous Paper	17,110,238	19.3%	133,856,406	19.7%	150,966,645	19.7%	11.7%
Miscellaneous Plastic	17,040,038	19.2%	93,731,466	13.8%	110,771,504	14.4%	9.1%
Gas Tanks	0	0.0%	0	0.0%	0	0.0%	0.2%
Miscellaneous Metal & Foil	2,230,562	2.5%	9,354,571	1.4%	11,585,134	1.5%	2.8%
Miscellaneous Glass & Ceramics	406,202	0.5%	49,104,035	7.2%	49,510,237	6.4%	0.2%
Wood & Yard Debris	2,917,866	3.3%	5,301,766	0.8%	8,219,632	1.1%	3.5%
Mattresses	0	0.0%	0	0.0%	0	0.0%	0.0%
White Goods	0	0.0%	0	0.0%	0	0.0%	0.0%
Entire 32 Gallon Trash bag	803,731	0.9%	0	0.0%	803,731	0.1%	0.1%
Tie-downs for trucks	0	0.0%	0	0.0%	0	0.0%	0.1%
Other	1,096,952	1.2%	6,570,163	1.0%	7,667,116	1.0%	1.4%
Subtotal (Unintentional)	**54,463,956**	**61.5%**	**359,843,877**	**52.9%**	**414,307,832**	**53.9%**	**72.2%**
Total[1]	**88,552,403**	**100.0%**	**679,704,015**	**100.0%**	**768,256,418**	**100.0%**	**100.2%**

1. Sum of 2016 percentage may not total to 100 percent due to rounding

APPENDIX E – REGRESSION ANALYSIS RESULTS

Multiple Regression Analysis – Influencing Factors Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.565
R Square	0.319
Adjusted R Square	0.213
Standard Error	15,731
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	16	11,940,136,488	746,258,531	3.016	0.000
Residual	103	25,487,918,817	247,455,522		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	10,199	1,837	5.55	0.000	6,556	13,843
Anti Messaging	-3,127	11,445	-0.27	0.785	-25,826	19,573
Litter Receptacle	-3,623	2,383	-1.52	0.132	-8,349	1,103
Recycle Receptacle	1,970	3,337	0.59	0.556	-4,648	8,587
Storm Drain	705	1,146	0.62	0.540	-1,568	2,978
Bus	42,963	22,513	1.91	0.059	-1,687	87,612
Public Transportation	0	0	65535.00	#NUM!	0	0
Fast Food	1,788	2,668	0.67	#NUM!	-3,504	7,080
Convenience Store	10,976	4,268	2.57	0.012	2,512	19,440
Commercial Center	2,911	3,578	0.81	0.418	-4,186	10,008
Com Business	416	1,603	0.26	0.796	-2,762	3,595
Public Building	-3,835	4,121	-0.93	0.354	-12,007	4,337
Recreational Visible	-5,505	4,579	-1.20	0.232	-14,585	3,576
Construction No Fence	16,823	9,383	1.79	0.076	-1,787	35,433
Loading Dock	-24,470	18,235	-1.34	#NUM!	-60,635	11,694
Vacant Lot	1,392	3,151	0.441811774	0.660	-4,857	7,641

Simple Linear Regression – Bus Stop Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.279
R Square	0.078
Adjusted R Square	0.070
Standard Error	17,104
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	1	2,908,171,068	2,908,171,068	9.941	0.002
Residual	118	34,519,884,237	292,541,392		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	12,674	1,568	8.08	0.000	9,569	15,779
Bus	54,154	17,176	3.15	0.002	20,141	88,166

Simple Linear Regression – Convenience Store Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.387
R Square	0.150
Adjusted R Square	0.143
Standard Error	16,422
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	1	5,605,870,518	5,605,870,518	20.787	0.000
Residual	118	31,822,184,787	269,679,532		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	10,892	1,577	6.91	0.000	7,769	14,015
Convenience Store	14,885	3,265	4.56	0.000	8,420	21,351

Simple Linear Regression – Construction Site Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.085
R Square	0.007
Adjusted R Square	-0.001
Standard Error	17,745
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	1	270,946,501	270,946,501	0.860	0.356
Residual	118	37,157,108,804	314,890,753		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	12,846	1,648	7.80	0.000	9,583	16,109
Construction (No Fence)	8,371	9,024	0.93	0.356	-9,500	26,241

Multiple Regression – No. Disposal Facility within 3 and 5-mi Radius Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.164
R Square	0.027
Adjusted R Square	0.010
Standard Error	17,643
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	2	1,009,442,203	504,721,101	1.621	0.202
Residual	117	36,418,613,102	311,270,197		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	11,192	1,945	5.75	0.000	7,340	15,045
Disposal facilities within 3 mile radius	-1,618	2,670	-0.61	0.546	-6,906	3,670
Disposal facilities within 5 mile radius	2,522	1,739	1.45	0.150	-922	5,967

Multiple Regression – No. Recycling Facility within 3 and 5-mi Radius Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.058
R Square	0.003
Adjusted R Square	-0.014
Standard Error	17,855
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	2	127,081,298	63,540,649	0.199	0.820
Residual	117	37,300,974,007	318,811,744		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	13,926	2,490	5.59	0.000	8,993	18,858
Recycling facilities within 3 mile radius	-1,378	2,815	-0.49	0.625	-6,952	4,197
Recycling facilities within 5 mile radius	2	1,735	0.00	0.999	-3,434	3,438

Multiple Regression – No. Rest Stop Facilities within 3 and 5-mi Radius Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.053
R Square	0.003
Adjusted R Square	-0.014
Standard Error	17,860
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	2	105,620,365	52,810,182	0.166	0.848
Residual	117	37,322,434,940	318,995,170		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	12,910	1,745	7.40	0.000	9,454	16,366
Rest Stops within 3 mile radius	3,167	7,170	0.44	0.660	-11,033	17,367
Rest Stops within 5 mile radius	-886	6,106	-0.15	0.885	-12,979	11,208

Multiple Regression – Closest Facility Distance Impact on Combined Litter-per-mile

Regression Statistics	
Multiple R	0.224
R Square	0.050
Adjusted R Square	0.026
Standard Error	17,506
Observations	120

ANOVA

	df	SS	MS	F	Significance F
Regression	3	1,879,275,194	626,425,064.823	2.044	0.111548809
Residual	116	35,548,780,110	306455001		
Total	119	37,428,055,305			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	16,247	4,639	3.50	0.001	7,059	25,435
Distance to the nearest Disposal facility (Miles)	-540	397	-1.36	0.176	-1,327	246
Distance to the nearest Recycling facility (Miles)	846	594	1.43	0.157	-330	2,022
Distance to the nearest Rest Stop (Miles)	-168	145	-1.16	0.247	-454	118

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Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com