

# California Waste Tire Market Report: 2015



California Department of Resources Recycling and Recovery

**July 2016**

Contractor's Report  
Produced Under Contract By:



**Louis Berger**

# State of California

**Jerry Brown**  
Governor


**Matthew Rodriguez**  
Secretary, California Environmental Protection Agency

## DEPARTMENT OF RESOURCES RECYCLING AND RECOVERY

**Scott Smithline**  
Director

Department of Resources Recycling and Recovery  
Public Affairs Office  
1001 I Street (MS 22-B)  
P.O. Box 4025  
Sacramento, CA 95812-4025  
[www.calrecycle.ca.gov/Publications/](http://www.calrecycle.ca.gov/Publications/)  
1-800-RECYCLE (California only) or (916) 341-6300

Publication # DRRR 2016-01567

 To conserve resources and reduce waste, CalRecycle reports are produced in electronic format only. If printing copies of this document, please consider use of recycled paper containing 100 percent postconsumer fiber and, where possible, please print images on both sides of the paper.

Copyright © 2016 by the California Department of Resources Recycling and Recovery (CalRecycle). All rights reserved. This publication, or parts thereof, may not be reproduced in any form without permission.

*Prepared as part of contract number DRR 13003 for \$1.5 million, including other services.*

*The Department of Resources Recycling and Recovery (CalRecycle) does not discriminate on the basis of disability in access to its programs. CalRecycle publications are available in accessible formats upon request by calling the Public Affairs Office at (916) 341-6300. Persons with hearing impairments can reach CalRecycle through the California Relay Service, 1-800-735-2929.*

**Disclaimer: This report was produced under contract by Louis Berger Group, Inc. The statements and conclusions contained in this report are those of the contractor and not necessarily those of the Department of Resources Recycling and Recovery (CalRecycle), its employees, or the State of California and should not be cited or quoted as official Department policy or direction.**

**The state makes no warranty, expressed or implied, and assumes no liability for the information contained in the succeeding text. Any mention of commercial products or processes shall not be construed as an endorsement of such products or processes.**

# Table of Contents

---

List of Tables .....	4
List of Figures .....	4
Section 1 Introduction .....	5
Background .....	5
Interpreting and Using Report Findings .....	5
Industry Overview .....	6
Section 2 Market Snapshot .....	9
2015 Diversion and Recycling Rates .....	9
Synopsis of Trends .....	9
Section 3 Key Trends by Market Segment .....	14
Supply and Demand Balance .....	14
Reuse .....	16
Crumb Rubber .....	18
Civil Engineering .....	23
Alternative Daily Cover .....	24
Other Diversion .....	24
Tire-Derived Fuel .....	24
Disposal .....	25
Imports and Exports .....	25
Section 4 Outlook for Increasing Waste Tire Diversion and Recycling .....	30
Historical Waste Tire Diversion and Recycling Trends .....	30
Diversion and Recycling Outlook .....	31
Section 5 Concluding Remarks: Implications for CalRecycle Market Development Efforts .....	35
Synopsis of Current Programs .....	35
Implications for Future Efforts .....	36
Appendix A Glossary .....	41
Appendix B Methodology and Data Limitations .....	42
General Approach .....	42
Conversion Factors .....	43
Conclusions .....	44

**List of Tables**

Table 1 Estimated End Uses for California-Generated Waste Tires, 2013–2015..... 12  
Table 2 Estimated Sales of Crumb Rubber Made from California-Generated Tires..... 19  
Table 3 Estimated Market Disposition of Waste Tires Imported to California Processing Facilities  
..... 27  
Table 4 Key Barriers to Expansion of Waste Tire Recycling..... 32  
Table 5 The Outlook for Diversion and Recycling..... 33  
Table 6 A Hypothetical Growth Scenario for California Tire Recycling ..... 34

**List of Figures**

Figure 1 California Waste Tire Recycling Industry Flow Chart..... 8  
Figure 2 Twelve-Year Trend in California Waste Tire End Uses..... 10  
Figure 3 Four-Year Trend in Total California Waste Tire Disposal (Million PTEs)..... 25  
Figure 4 Trends in Export of TDF, Baled Waste Tires, and Used Tires ..... 28  
Figure 5 Waste Tire Diversion and Disposal Trends ..... 30

# Section 1

## Introduction

---

### ***Background***

Under the California Tire Recycling Act of 1989 and subsequent amendments, the Department of Resources Recycling and Recovery (CalRecycle) has two main strategies: 1) provide a strong and fair regulatory framework to protect public health and safety and the environment while not stifling waste tire flow and processing; and 2) support expansion and diversification of recycling markets for waste tires. CalRecycle has long had a goal of diverting at least 90 percent of waste tires generated in California from landfills. CalRecycle is now also focused on implementing programs to achieve a statewide 75 percent recycling (as opposed to diversion) goal for all discarded materials, as required under AB 341 (Chesbro, Chapter 476, Statutes of 2011). Consequently, the Department is focusing mainly on recycling tires through reuse, civil engineering, and crumb rubber, as opposed to diversion through export, alternative daily cover (ADC), or tire-derived fuel (TDF). CalRecycle's Five-Year Plan for the Waste Tire Recycling Management Program, which is revised every two years, guides efforts to reach and maintain a 90 percent diversion goal and the 75 percent recycling goal. The latest version of the [five-year plan](#) was approved on May 1, 2015.

This report summarizes waste tire recycling and market trends in 2015, with additional information on trends in early 2016. The report was prepared under CalRecycle contract by Louis Berger Group, with research, analysis, and writing led by Boisson Consulting in collaboration with DK Enterprises.

Following this introduction, Section 2 provides a snapshot of key findings on diversion activities and markets for California waste tires. Section 3 describes detailed market trends by category. Section 4 analyzes the outlook for increased diversion and implications for CalRecycle's market development activities. Finally, Appendix A provides a glossary of key terms, and Appendix B summarizes the report methodology and limitations.

### ***Interpreting and Using Report Findings***

As detailed in Appendix B, findings in this report are based on detailed analysis of data and information from numerous sources, including: industry surveys and interviews; CalRecycle staff; CalRecycle's Waste Tire Manifest System (WTMS); and other sources. Following are a few key points to consider when interpreting and using the report's findings:

**Estimates Reported in PTEs<sup>1</sup> for Consistency with Prior Years:** The vast majority of data provided for this study is provided in units of tons, and all sources are converted to tons during the analysis using the most appropriate and accurate conversion factors available, as detailed in Appendix B. However, to facilitate comparison with earlier reports, final results are converted to passenger tire equivalents (, defined as 20 pounds).

**Reasonably Accurate Trend Information:** Estimating California waste tire flows is challenging due to data gaps, data quality issues, and conflicting sources of information. Nevertheless, this report provides data that can be used to evaluate trends over time. The authors strive to develop the most complete and accurate estimates for each market segment, while avoiding double counting, and they believe accuracy is generally well within plus or minus 10 percent. The reported volume of used tires is on the higher end of this range as, unlike other segments, it relies more on industry estimates of the typical percentage of tires culled for reuse in the study year (in addition to records of specific shipments made or received, which is the preferred and main information source used in this study). Other segments are based on direct data and reports of volumes, adjusted in detail to maximize completeness while avoiding double counting.

**Use of California-Generated Waste Tires, Not Total Market Size:** The report estimates the quantity of California-generated waste tires flowing into each market segment and does not include tire-derived material (TDM) or tire-derived products (TDP) entering California from outside the state. Buffings from retread operations are also not included in market estimates. Consequently, the market data presented does not estimate total market size. While not included in the market flow estimates, some findings on retreader buffings and imported TDM and TDP is presented.

**The Tire Recycling and Diversion Rates Are Not Adjusted for Residuals or Disposed TDPs:** As with other tire market studies, tire diversion and recycling rates are not adjusted for steel and fiber residuals generated by TDM producers. However, in 2015, the vast majority of tire wire and rims were recycled, and most tire fiber was combusted at California cement kilns.

## ***Industry Overview***

Figure 1 illustrates waste tire flows and identifies the types of firms involved in California waste tire management. To analyze 2015 waste tire flows, research focused on the following California facilities:

- Fifteen “processors” that received significant quantities of whole waste tires and shipped used tires and/or TDM to a variety of market segments;

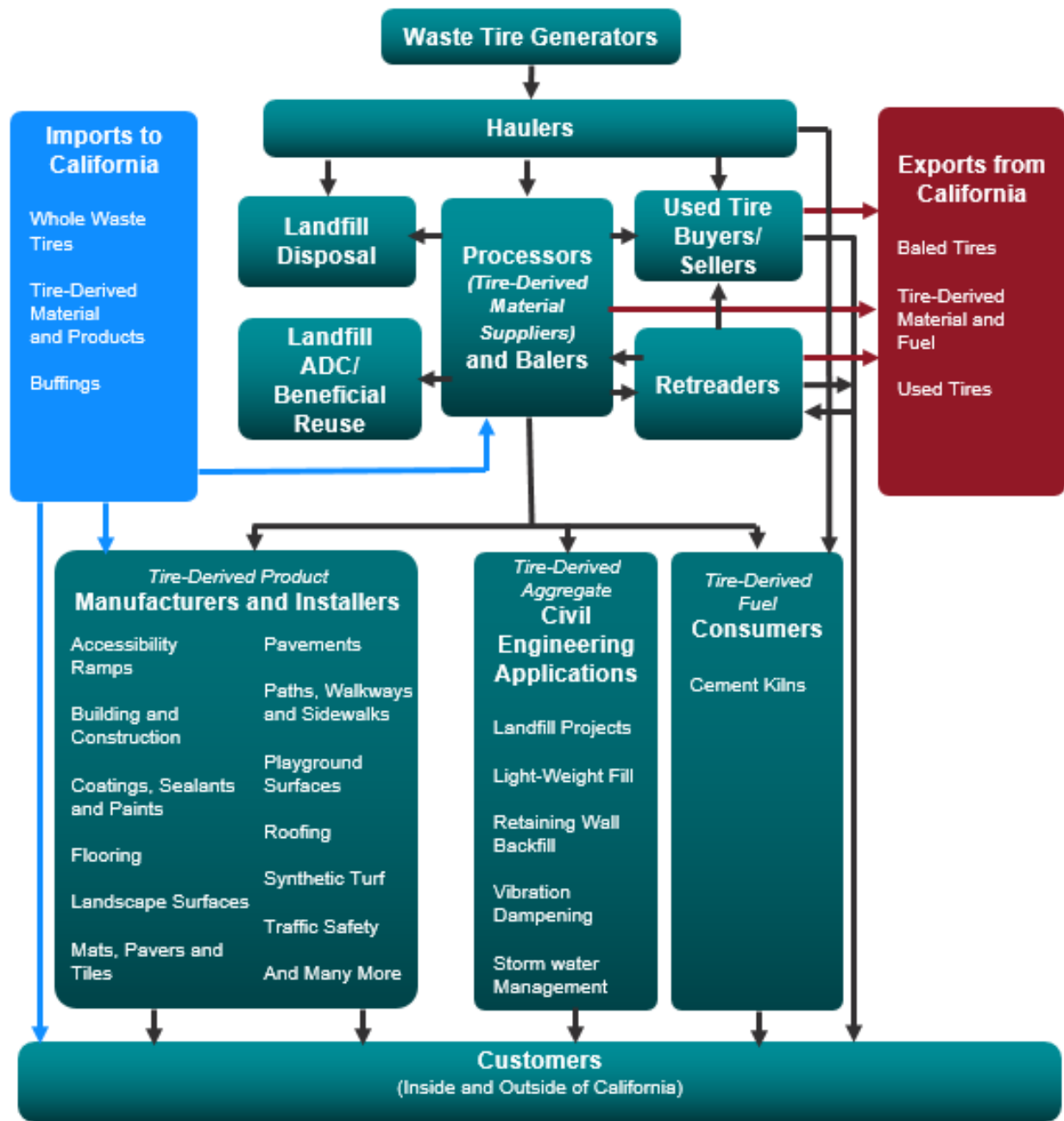
---

<sup>1</sup> PTE stands for passenger tire equivalent, defined by in regulations by CalRecycle (14 CCR § 17225.770) to equal 20 pounds of tire rubber.

- Six “balers” that received whole waste tires, primarily for the purpose of exporting baled waste tires and/or selling used tires;
- Twenty-six firms that manufacture, market, and/or install TDPs;
- Four cement kilns that combust processed tire-derived fuel (TDF) or baled waste tires;
- Thirty landfills that accept significant quantities of tires or tire-derived aggregate (TDA) for use in civil engineering projects, or as alternative daily cover (ADC), or for disposal in recent years; and
- Thirty-two retreaders that retread truck tires and generate buffings sold as TDM for use in a variety of products and end uses.

Detailed information on the many types of California-made TDPs is available in CalRecycle’s California Tire-Derived Product Catalog at [www.calrecycle.ca.gov/Tires/Products/Catalog/](http://www.calrecycle.ca.gov/Tires/Products/Catalog/).

Figure 1  
California Waste Tire Recycling Industry Flow Chart





## Section 2

# Market Snapshot

---

This section provides a snapshot of California waste tire markets in 2015 and key trends as of spring 2016. More detailed, segment-specific information is provided in Section 3.

### **2015 Diversion and Recycling Rates**

Table 1 lists the quantity of California-generated tires flowing to each market segment and the percentage of the total quantity for each market for 2013 through 2015. After reaching an all-time high of 92.9 percent waste tire diversion in 2012 (exceeding CalRecycle's 90 percent goal), the rate dipped to 80.9 percent in 2015. Since the adoption of AB 341 (Chesbro, Chapter 476, Statutes of 2011), which established a statewide recycling goal of 75 percent for all discarded materials, CalRecycle now focuses on achieving a 75 percent tire recycling goal. Consistent with AB 341, this report now separately reports waste tire diversion (including all uses outside of landfill disposal) and waste tire recycling excluding TDF, ADC, and exports of TDF and bales (assumed to be used as TDF abroad). Based on this definition, the 2015 waste tire recycling rate is estimated at 35.8 percent, less than the 2014 rate of 38.0 percent and significantly down from the 2012 recycling rate of 44.3 percent.

### **Synopsis of Trends**

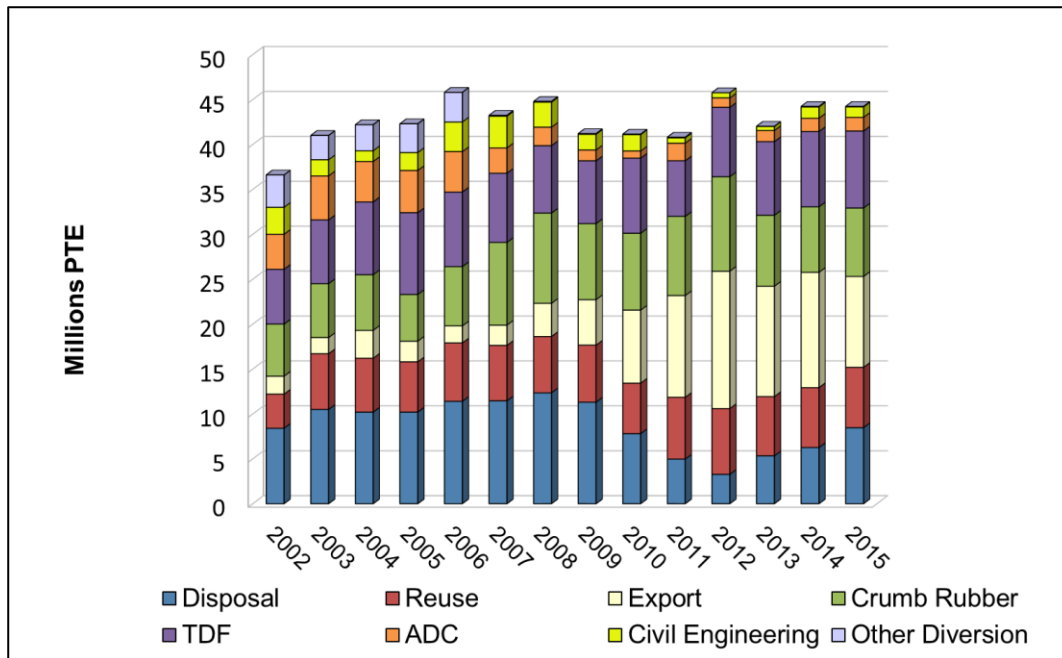
Figure 2 shows waste tire end use trends by broad market category since 2002. Taking all of the information below into account, there is a good chance that both tire diversion and recycling rates will increase, due to expected growth in civil engineering applications, the potential for growth in crumb rubber uses, and an uptick in exports of processed TDF in early 2016, which could further increase diversion, but not recycling.

**Exports:** After rising rapidly beginning in 2009, exports of processed TDF (typically 2- to 4-inch shreds) and baled waste tires peaked in 2012 at 13.5 million PTEs before dropping to 9.4 million PTEs in 2015. In 2015, 6.6 million PTE of processed TDF (down from 7.4 million PTEs in 2014) and 2.8 million PTEs of baled waste tires (down from 3.6 million PTEs in 2014) were exported to Asian countries. Prior to 2015 these categories were combined. An estimated 0.7 million PTEs of culled used tires were also exported in 2015. This is significantly less than the 1.8 million PTEs reported for 2014; however, this is most likely due to a refinement in the estimation methodology, which the authors believe now more accurately reflects exported used tires. Export of processed TDF is reportedly going strong in early 2016, and export of baled waste tires, which had waned in 2015 and early 2016, may be picking up as well.

**Reuse:** In addition to the exported used tires, in 2015 an estimated 2.4 million PTEs of used tires were culled from waste tire flows for sale domestically, for a total of 3.1 million PTEs used tires in 2015. Retreading in 2015 was estimated at 4.3 million PTEs, 2 percent higher than in 2014. Overall (including exported used tires), the tire reuse category as a whole was down by 12 percent at 7.4 million PTEs. Reuse is a

consistently strong and profitable market segment, but it is very mature and little growth is projected. Companies involved in the reuse segment (both used tires and retreading) report that the increasing quantities of lower-tier tires from China are often not suitable for reuse and have impacted their volume of used tires.

**Figure 2**  
**Twelve-Year Trend in California Waste Tire End Uses<sup>2</sup>**



**Crumb Rubber:**<sup>3</sup> Overall, use of California waste tires to produce crumb rubber increased by 5 percent in 2015, to 7.6 million PTEs. This comes after two consecutive annual declines. With relatively strong demand, use of California crumb rubber in the paving, turf infill, and ground rubber/nuggets segments was up by 12 percent, 11

<sup>2</sup> Data for 2002–2006 are from CalRecycle’s annual “California Waste Tire Generation, Markets, and Disposal” reports, prepared by CalRecycle Staff. Data for 2007–2015 are from the annual California Tire Market Reports prepared by the same consulting team responsible for this report, under several different CalRecycle contracts. In some cases, methodological differences complicate direct comparisons between earlier reports and post-2006 reports. Reports covering 2007 and beyond are available online at <http://www.calrecycle.ca.gov/Publications/PublicationsByCategory.aspx?CategoryID=25>.

<sup>3</sup> In this report, crumb rubber refers to tire-derived material ¼ inch or smaller, and is distinguished from ground rubber, which is ¼ to 1 inch in size, and nuggets, which may exceed 1 inch. For simplicity, crumb rubber is also used as the general market category, including crumb rubber, ground rubber, and nuggets.

percent, and 6 percent, respectively. The molded and extruded category was down by 26 percent in 2015, the third straight year of decline. Despite its promise, given continuing diversity and innovation in this sector, volumes remain relatively low. However, in addition to California-produced crumb rubber, some of these firms also use significant quantities of buffings and imported crumb rubber.

**Table 1**  
**Estimated End Uses for California-Generated Waste Tires, 2013–2015**

Category	Sub-Category	2013			2014			2015			Percent change '14 - '15
		Tons	Million PTEs	Percent of Total	Tons	Million PTEs	Percent of Total	Tons	Million PTEs	Percent of Total	
Export	Processed TDF	110,144	11.0	26.2%	73,958	7.4	16.7%	65,614	6.6	14.8%	-11%
	Baled Waste Tires				36,446	3.6	8.2%	28,426	2.8	6.4%	-22%
	Used Tires (Export)	12,678	1.3	3.0%	17,943	1.8	4.1%	7,128	0.7	1.6%	-60%
	<b>Subtotal</b>	<b>122,821</b>	<b>12.3</b>	<b>29.2%</b>	<b>128,346</b>	<b>12.8</b>	<b>29.0%</b>	<b>101,168</b>	<b>10.1</b>	<b>22.9%</b>	<b>-21%</b>
Reuse	Retread	40,635	4.1	9.7%	42,341	4.2	9.6%	43,358	4.3	9.8%	2%
	Used Tires (Domestic)	25,355	2.5	6.0%	24,336	2.4	5.5%	23,800	2.4	5.4%	-2%
	<b>Subtotal</b>	<b>65,990</b>	<b>6.6</b>	<b>15.7%</b>	<b>66,677</b>	<b>6.7</b>	<b>15.1%</b>	<b>67,158</b>	<b>6.7</b>	<b>15.2%</b>	<b>1%</b>
Crumb Rubber	Paving	35,422	3.5	8.4%	34,708	3.5	7.8%	38,736	3.9	8.8%	12%
	Turf Infill	20,040	2.0	4.8%	16,821	1.7	3.8%	18,686	1.9	4.2%	11%
	Ground Rubber/Nuggets	14,175	1.4	3.4%	11,404	1.1	2.6%	12,144	1.2	2.7%	6%
	Molded & Extruded	8,960	0.9	2.1%	7,855	0.8	1.8%	5,849	0.6	1.3%	-26%
	Other	441	0.0	0.1%	2,098	0.2	0.5%	780	0.1	0.2%	-63%
	<b>Subtotal</b>	<b>79,038</b>	<b>7.9</b>	<b>18.8%</b>	<b>72,887</b>	<b>7.3</b>	<b>16.5%</b>	<b>76,195</b>	<b>7.6</b>	<b>17.2%</b>	<b>5%</b>
Civil Engineering	Landfill Applications	2,612	0.3	0.6%	8,806	0.9	2.0%	10,374	1.0	2.3%	18%
	Non-Landfill Applications	1,945	0.2	0.5%	3,826	0.4	0.9%	1,294	0.1	0.3%	-66%
	<b>Subtotal</b>	<b>4,557</b>	<b>0.5</b>	<b>1.1%</b>	<b>12,632</b>	<b>1.3</b>	<b>2.9%</b>	<b>11,668</b>	<b>1.2</b>	<b>2.6%</b>	<b>-8%</b>
<b>Alternative Daily Cover</b>		<b>12,316</b>	<b>1.2</b>	<b>2.9%</b>	<b>14,691</b>	<b>1.5</b>	<b>3.3%</b>	<b>15,217</b>	<b>1.5</b>	<b>3.4%</b>	<b>4%</b>
<b>Other Diversion</b>		<b>152</b>	<b>0.0</b>	<b>0.0%</b>	<b>564</b>	<b>0.1</b>	<b>0.1%</b>	<b>533</b>	<b>0.1</b>	<b>0.1%</b>	<b>-6%</b>
<b>Tire-Derived Fuel</b>		<b>81,982</b>	<b>8.2</b>	<b>19.5%</b>	<b>83,934</b>	<b>8.4</b>	<b>19.0%</b>	<b>85,721</b>	<b>8.6</b>	<b>19.4%</b>	<b>2%</b>
<b>Landfill Disposal</b>		<b>53,320</b>	<b>5.3</b>	<b>12.7%</b>	<b>62,579</b>	<b>6.3</b>	<b>14.1%</b>	<b>84,699</b>	<b>8.5</b>	<b>19.1%</b>	<b>35%</b>
<b>Estimated Total Managed</b>		<b>420,177</b>	<b>42.0</b>	<b>100.0%</b>	<b>442,311</b>	<b>44.2</b>	<b>100.0%</b>	<b>442,358</b>	<b>44.2</b>	<b>100.0%</b>	<b>0%</b>
<b>Total Diverted from Landfill</b>		<b>366,857</b>	<b>36.7</b>	<b>87.3%</b>	<b>379,731</b>	<b>38.0</b>	<b>85.9%</b>	<b>357,659</b>	<b>35.8</b>	<b>80.9%</b>	<b>-6%</b>
<b>Total Recycled</b>		<b>162,263</b>	<b>16.2</b>	<b>38.6%</b>	<b>170,138</b>	<b>17.0</b>	<b>38.5%</b>	<b>162,680</b>	<b>16.3</b>	<b>36.8%</b>	<b>-4%</b>
Imports		12,431	1.2	3.0%	12,661	1.3	2.9%	23,382	2.3	5.3%	85%

Available data indicate that a total of up to 24 million pounds of all types of tire rubber may have been consumed in this segment in 2015. Overall, use of California tires to make crumb rubber has fluctuated within tight boundaries for the past decade and a half. To transcend this level, it appears that a quantum leap in customer demand for products or applications within existing markets, or a new high-volume innovation that satisfies customer requirements in a different market area, is needed. As described in the next section, Caltrans is investigating new policies that could more than double current use in the paving segment. In addition to crumb rubber, an estimated 17.5 million pounds of buffings flowed to California processors, who either brokered it to other firms or directly used it themselves in a variety of market applications, especially pour-in-place, molded, and landscape mulch applications.

**Civil Engineering:** Use of tire-derived aggregate (TDA) in civil engineering applications declined in 2015 by 8 percent to 1.2 million PTEs, with 1 million PTEs of this being used at seven landfills, and with the remaining TDA used largely in one project by Bay Area Rapid Transit (BART). An uptick in grant awards to both landfill and non-landfill projects is expected to result in an increase in this category in 2016.

**Alternative Daily Cover:** In 2015 three landfills reported use of a total of 1.5 million PTEs as ADC, the same level as in 2014. This amount is expected to stay flat into 2016, although the amount could increase if other landfills choose to use tire ADC in the future.

**Tire-Derived Fuel:** Consumption of California whole waste tires and processed TDF by four California cement kilns totaled 8.6 million PTEs in 2015, a 2 percent increase compared to 2014. In addition, these California cement plants consumed an estimated additional 1.1 million PTEs in TDF derived from waste tires imported from out-of-state to California-based processors serving these plants. TDF continues to provide a strong, stable market, but is approaching its maximum capacity given current permitting and operational infrastructure. Within the boundary of current capacity, demand is strongly dependent on changes in the construction industry, and is expected to remain flat in 2016.

**Disposal:** Waste tire disposal increased in 2015 by 35 percent to 8.5 million PTEs, the highest level since 2011. This was due in part to softening in the export market spurred by a strike at the ports, lower pricing for baled waste tires, and enforcement activities by CalRecycle.

## Section 3

# Key Trends by Market Segment

---

This section describes key market trends for each market segment in more detail, beginning with the current balance between supply and demand.

### ***Supply and Demand Balance***

As in any commodity market, the balance between supply and demand for waste tires, TDM and TDPs is constantly in flux, influencing pricing, competitive pressures, and generally, the profitability and resiliency of firms operating in the market. This section addresses two fairly distinct sets of supply-and-demand issues related to scrap tire recycling: those involving whole tires, and those involving tire-derived materials used to make products. Shifts in these supply-demand dynamics directly influence the ability to increase recycling and diversion levels.

### **Supply and Demand for Whole Tires**

Research for this report included analyzing 2015 waste tire deliveries to, and TDM/TDP shipments from, 15 processors serving a variety of recycling, diversion, and disposal markets, and six balers set up mainly to export baled waste tires only. To varying degrees, these firms, along with haulers that supply tires to them or deliver whole/used tires elsewhere, compete for the limited supply of California waste tires and the associated collection fee revenues.

Beginning in 2009 a rapid rise in exports of baled waste tires from California to Asian nations severely disrupted the supply-demand balance for whole waste tires. This trend was analyzed in detail in the 2011 California Waste Tire Market Report<sup>4</sup> and reached a peak in 2012. In brief, balers are relatively simple operations with low capital requirements (and in some cases have operated without permits). When pricing is favorable, balers can rapidly ramp up and compete aggressively to secure collection accounts. This in turn can reduce access to supply and lower collection-related revenues of established processors, which operate under a much different business model than that of the balers. When pricing of exported waste tire bales is not favorable, as in much of 2015 and early 2016, baler volumes can decline rapidly, and balers may have difficulty moving collected tires stored at their facilities. Baler-related disruptions have stabilized to a degree over the past year or two as a result of reduced pricing. Concurrently, waste tire collection revenues for established processors have reportedly rebounded to an extent, especially in Northern California. However, baled volumes are still significant (more than 2.8 million PTEs in 2015), and baling operations continue to ramp up, ramp down, and/or shift locations unpredictably, with reports of renewed strong pricing and activity in late spring 2016.

---

<sup>4</sup> Available online at: <http://www.calrecycle.ca.gov/publications/Detail.aspx?PublicationID=1425>.

In mid-2016 a new crumb rubber producer will start operations in Stockton. In addition, a large Northern California civil engineering project will require up to 4.2 million PTEs later in 2016 or 2017, and demand for processed TDF is strong. Processors interviewed for this study generally did not identify access to waste tire supplies and collection tip-fee revenue levels as major concerns; however, it is possible that these factors could significantly increase competition for waste tires generated in Northern California.

## **Supply and Demand for Tire-Derived Materials and Products**

**Crumb Rubber:** Production of crumb rubber was up by 5 percent in 2015, using 7.6 million California PTEs. The major crumb rubber markets (i.e., paving, turf infill, and ground rubber/nuggets) appear to be relatively strong, with potential for modest short-term growth in 2016, and potentially more significant long-term growth (especially due to potential new Caltrans paving specifications, as discussed in the crumb rubber section on the following pages). As noted above, California's already ample crumb rubber production capacity is increasing significantly with the opening of a new facility in Stockton in early 2016. Although demand for crumb rubber is strong, it is not expected to increase markedly in the short term, and therefore it is likely that crumb rubber production capacity will continue to be much higher than demand. Notwithstanding that, it is possible that California producers could win market share from crumb rubber producers in other states, an outcome that CalRecycle's Tire Incentive Program (TIP) is aimed in part at encouraging.

A new factor that could potentially impact crumb rubber supply and demand in coming years is the possibility of using calcium carbonate derived from recycled carpets to replace a portion of crumb rubber used as a filler in certain TDPs. The Carpet America Recovery Effort (CARE), the carpet industry organization charged with compliance with California's carpet extended producer responsibility law, has issued more than \$2.1 million in grants to companies involved in tire recycling in an effort to expand this market. Increasing demand for crumb rubber and recycled carpet components are both CalRecycle priorities, and the potential for calcium carbonate to reduce sales of crumb rubber is currently uncertain.

**Fine-Mesh Crumb Rubber:** Supply and demand for fine-mesh crumb rubber in California is a classic chicken-and-egg situation which has continued for several years. A number of current and potential manufacturers of diverse molded/extruded TDPs have a need for fine-mesh crumb rubber. California crumb rubber producers do have the capacity to supply limited quantities, but often place higher priority on the much larger and better-established markets like paving and turf infill. This has led to challenges in securing fine-mesh crumb rubber supplies for existing producers and new ones interested in participating in CalRecycle's TIP or receiving services under CalRecycle's Feedstock Conversion Services contract. Moreover, to supply much greater volumes of fine-mesh crumb rubber meeting exacting specifications, California's producers would need to invest in new equipment. Given current low volumes and relatively strong demand in established markets, none have yet indicated a plan to do so.

**Buffings:** Buffings from retreaders are used extensively in certain market segments, especially pour-in-place playground surfacing, molded products, and landscape mulch products. In 2015 California tire processors received approximately 17.5 million pounds of buffings, most but not all of which was produced by retreaders located in California. Demand for buffings currently exceeds supply, with some firms expressing concern about both the ability to secure ample supplies and increased pricing.

**Tire-Derived Products:** Generally, TDP production capacity appears to exceed demand for most of the well-established products, including paving, turf infill, ground rubber/nuggets, and tire-derived aggregate. The molded/extruded products segment is more nuanced, with a variety of diverse firms with established products making efforts to incorporate crumb rubber feedstocks and expand sales. Some of these firms are focused on developing their production capacity and refining TDM/product quality in order to meet customer needs. Expanded and enhanced California capacity to produce a wider variety of molded TDPs would be highly beneficial, and could potentially help spur investment by one or more California crumb rubber producers to boost fine-mesh crumb rubber production.

**Tire-Derived Aggregate:** Sales of TDA for use in civil engineering applications was down 8 percent to 1.2 million PTEs, but has the potential for significant gains in the coming year with continuing use at several landfills, a growing mix of non-landfill applications, and a very large lightweight fill/road fill project in Solano County that is projected to use more than 4.2 million PTEs within a short window of time. With several processors actively supplying TDA in recent years, potential supply is well in excess of demand, and Northern California processors indicate that supplying TDA to this project should not pose a difficulty. That said, managing the delivery and application of such large quantities of TDA in a relatively short time frame could pose logistical and compliance challenges at the job site. Strong technical support from CalRecycle will aid in ensuring TDA supply needs are satisfied as demand ramps up.

## **Reuse**

Reuse, including retreading and sale of partially worn used tires, remains strong in California. Overall, 7.4 million PTEs were estimated to be reused in 2015. Of this amount, 4.3 million were retread, and 3.1 million were culled, graded, and sold both domestically and internationally. (See “Export” in Table 1 in Section 2.)

Both retreading and sale of used tires are very strong, profitable market segments that are relatively mature and not expected to grow substantially. However, firms involved in tire reuse are concerned over the growing number of lower-tier tires made in China and sold at very low prices. These tires negatively impact reuse in several ways. First, some customers may be more likely to purchase low-price new tires rather than used or retread tires, even if they may be of lower quality. Second, according to many in the field, the lower-tier tires are produced to a lower standard than tier 1 or 2 tires, and consequently they may not be able to be reused or retread, or they may be able to be retread only a single time. Third, these issues could broadly damage consumer confidence in reused or retread tires over the long run. In response to formal complaints



filed by U.S. tire manufacturers, the U.S. International Trade Agency has determined that these imports are unfairly priced and are harming the U.S. market, and the Department of Commerce has developed a system of tariffs ranging from 14 to 100 percent of the price of imported tires. It remains to be seen whether and when these tariffs will be imposed and the impact they may have. While most firms expressed strong concerns over this issue, overall reused tire volumes remain high and do not appear to have been severely impacted to date, compared to previous years.

### **Retread Tires**

The quantity of truck and specialty tires retread in California was estimated to be up slightly to 4.3 million PTEs in 2015, compared to 4.2 million PTEs in 2013.

Overall, despite strong concerns over lower-tier Chinese tires (described above), retreading volumes appear to be fairly stable, with a mix of growth and contraction, often related to competitive developments within the industry. Responding retreaders reported operating at an average of 69 percent capacity. Ten reported their volumes were down in 2015 by an average of 14 percent, nine said their volumes were up by an average of 13 percent, and two said their 2015 volumes were flat. Looking ahead to 2016, seven predicted volumes would decline, by an average of 5.5 percent, while eight predicted growth, by an average of 5 percent. Four predicted flat volumes in 2016. (Respondents did not necessarily answer every survey question; consequently, the total number of responses for each question varies.)

### **Used Tires**

An estimated 3.1 million PTEs were culled and graded for reuse in 2015, a 12 percent decline from 2014. This includes 2.4 million PTE sold for sale domestically, flat with 2014. And, 0.7 million PTEs were estimated to have been exported for reuse, 60 percent less than the quantity previously estimated for 2014. This large drop in the estimate for used tire exports is mainly due to a change in methodology implemented for the first time this year, as described in Appendix B.

In addition, based on WTMS data and survey responses, more than 1 million PTEs were shipped by several firms from other U.S. western states into California, either for sale here or directly to ports for export to Mexico or elsewhere. One reason for shipping used tires to California for sale may be the fact that California regulations require a lower tread depth for used tires. For example, passenger tires require a depth of at least 1/32 inch, while federal regulations and those in some other states require 2/32 inch tread.<sup>5</sup> According to U.S. Census Bureau, a total of 1,038,633 used tire units were exported from California ports, with 871,700 of these to Mexico and the remainder,

---

<sup>5</sup> California Vehicle Code Section 605 and Section 27450-27503, <http://www.dot.ca.gov/hq/roadinfo/vctires.htm>. And Federal Motor Carrier Safety Administration, § 393.75: Tires. <https://www.fmcsa.dot.gov/regulations/title49/section/393.75>

166,933 units, to other countries.<sup>6</sup> These used tire “units” are of varying size and type, but based on an average weight of 22.5 to 32.8<sup>7</sup> pounds per tire for a mixed load, the total quantity exported would equate to 11,684 tons (1.2 million PTEs) to 17,033 tons (1.7 million PTEs), consistent with this report’s estimate of 0.7 million California-generated used tires being exported when additional quantities of used tire exports from out-of-state are considered.

## **Crumb Rubber**

### **Overview**

In 2015, approximately 7.6 million PTEs of California-generated tires were used to produce crumb rubber, a 5 percent increase over the amount in 2014, but 27 percent lower than the all-time high of 10.5 million PTEs used to make crumb rubber in 2012. These estimates exclude the portion of feedstock used by California crumb rubber producers that was derived from non-California tires imported from other states, which in 2015 was an estimated 198,300 PTEs. While a complete estimate is not available for the quantity of tire wire and fiber generated in 2015, the vast majority of both were diverted, with more than 16,000 tons of wire/metal recycled and 12,523 tons of fiber reported consumed as fuel at California cement kilns consuming TDF (this amount is excluded from the TDF estimates presented later in this report). Table 2 summarizes estimated volumes of crumb rubber shipped to each market segment in 2015. An estimated 109.4 million pounds of crumb rubber was shipped, up from 98.4 million pounds in 2014. (Note: These production estimates are not adjusted to exclude the portion produced from out-of-state tires.) More than half flowed to paving applications, including Caltrans, local government (some supported by CalRecycle grants), and privately sponsored projects. The second-largest crumb market is the turf infill segment, followed by the ground rubber/nuggets market segment (i.e., loose-fill playground, landscape mulch, and equestrian material) and Molded Products.

---

<sup>6</sup> U.S. Census Bureau, USA Trade Online. <https://usatrade.census.gov/index.php?do=login>

<sup>7</sup> According to the Rubber Manufacturers Association, on average light duty tires such as scrap passenger tires weigh 22.5 pounds, commercial tires such as scrap truck and bus tires weigh 120 pounds, and the average of all light duty and commercial scrap tires (excluding off-the-road tires) is 32.8 pounds. Source: “2013 U.S. Scrap Tire Management Summary.” Rubber Manufacturers Association, November 2014, page 4. <https://rma.org/publications/scrap-tire-publications/market-reports>

**Table 2**  
**Estimated Sales of Crumb Rubber Made from California-Generated Tires<sup>8</sup>**

Category	2014		2015	
	Millions of Pounds	Percent of Total	Millions of Pounds	Percent of Total
Paving	46.4	47%	56.7	52%
Turf Infill	22.5	23%	26.2	24%
Ground Rubber/Nuggets	15.5	16%	16.8	15%
Molded & Extruded	12.1	12%	8.6	8%
Other/Unidentified	2.8	3%	1.1	1%
<b>Total</b>	<b>98.4</b>	<b>100%</b>	<b>109.4</b>	<b>100%</b>

Buffings from retreaders are counted separately from crumb rubber and are not included in recycling rates (since the retread tires they originated from are already counted under retreads). Buffings are used extensively in certain market segments, especially pour-in-place playground surfacing, molded products, and landscape mulch products. In 2015 California processors received approximately 17.5 million pounds of buffings, most of which was produced by retreaders located in California. Buffings are currently in high demand, with relatively high pricing.

Overall, the crumb rubber market appears likely to grow modestly in 2016. Demand in the major segments of paving, turf infill, and ground rubber/nuggets was fairly strong in 2015, and processors report each of these may be up again in 2016. Despite growing diversity and innovation in the molded/extruded segment, volumes remain low and declined in 2015. California has ample crumb rubber production capacity that has not been fully utilized, especially with the permitting of a new facility in Stockton in January 2016. The crumb rubber industry is highly competitive, both among California-based producers and with out-of-state producers who also supply a portion of in-state demand. Production has fluctuated within tight boundaries since 2000, and absent a quantum leap in existing market demand or emergence of a new, high-volume application, California’s crumb rubber industry may not be able to grow substantially beyond its current size.

CalRecycle is supporting crumb rubber market development in a number of ways, including: funding and participation in Caltrans’ “PG+5” Committee investing new

---

<sup>8</sup> The number of PTEs flowing to each crumb market segment as listed in Table 1 may not correlate consistently with reported volumes of crumb rubber produced in Table 2. This is because the yield rate (i.e., the amount of crumb rubber produced per PTE) varies by producer. Also, Table 2 is not adjusted to account for imported tires from out-of-state used to produce crumb rubber. Lastly, in some cases discrepancies may also be caused by starting and ending inventories.

specifications that could boost crumb rubber use significantly (discussed in the following pages); the Tire Incentive Program (providing 5 to 40 cents per pound to manufacturers using crumb rubber); the Rubberized Pavement Grant Program and technical assistance program; the Tire-Derived Product Grant Program; the Tire Outreach and Market Analysis Program; and the Feedstock Conversion Services contract (providing product testing, technical support, and other services). Following are more details on each crumb rubber category.

## **Paving**

In 2015, use of California-produced crumb rubber in paving applications was up 12 percent to 3.9 million PTEs. Industry representatives indicate this was due to somewhat higher use by both Caltrans and local agencies, and that this trend toward somewhat higher use is continuing in early 2016.

Caltrans is responsible for a large portion of rubber pavement applications in California. The Department is required by statute (AB 338, Levine, Chapter 709, Statutes of 2005) to use tire rubber in 35 percent of its paving projects, for an average of 11.6 pounds per metric ton of total asphalt paving materials used. Prior to 2015 this statute specifically required use of rubber asphalt or “field blend,” (also referred to as the “wet process”). But as of January 2015, Caltrans may use any paving technology to achieve the required levels. To date, Caltrans has used other paving technologies incorporating crumb rubber, such as the “terminal blend” process, far less than field blend applications. However, terminal blend material containing crumb rubber can be used in a range of products, including hot mix, warm mix, slurry seals, and chip seals.

While Caltrans has not yet released its annual report on its use of waste tires in 2015, the previous report estimated that in 2014, 2.7 million PTEs were consumed, an amount that translates to 34.2 million pounds of crumb rubber (based on a standardized conversion of 12 pounds of crumb rubber per PTE used by Caltrans and CalRecycle), with rubberized asphalt used in 26.7 percent of projects.<sup>9</sup> This was up from 23 percent in 2013, but much lower than the 34 percent reported in 2011. This higher rate was based on approved rubber paving projects, but Caltrans now estimates crumb rubber use based on actual completed projects.

According to Caltrans representatives, the total amount of paving has been substantially reduced over the last few years as federal stimulus funding and special bond funding was exhausted. In 2011, for example, Caltrans representative report 2.6 million tons of rubber hot mix asphalt was applied, but this level fell to 1 million tons in 2013. This trend has continued and paving levels are not expected to rebound to the levels of 2011 in the foreseeable future. However, the paving that is occurring is mainly maintenance-related as opposed to new pavements, which favors the use of rubber asphalt products. A small

---

<sup>9</sup> “2014 Annual Report on Caltrans’ Use of Waste and Used Tires.” Available online at: <http://www.dot.ca.gov/hq/oppd/rescons/sb876.htm>.

portion of crumb rubber supplied to Caltrans may be imported from other states, as their procurement policies require U.S.-made, but not California-made, crumb rubber.

With CalRecycle support, Caltrans has formed the so-called “PG+5” Committee to investigate a range of proposed new policies that could greatly increase the amount of crumb rubber consumed in its paving operations. The group includes a variety of industry stakeholders, and is considering several distinct options. According to Caltrans representatives, the effort is currently on track to refine proposals and conduct testing that will allow new policies to be implemented in 2018. Caltrans estimated the original proposal—requiring use of performance-graded asphalt with 5 percent crumb rubber in all unmodified asphalt binder used in California—could result in the use of up to 8.3 million to 10 million PTE per year (compared to 3.5 million to 3.9 million PTEs per year from California crumb rubber producers used in both state and local paving over the past several years). Committee participants are vigorously debating the pros and cons of alternative policies and the potential quantity of tires that could be used. Some have suggested that Caltrans’ projection above is overly optimistic but have suggested other options that could achieve the same result. The Caltrans initiative appears to have the highest potential of any activity currently underway to boost demand for California-produced crumb rubber; however, a detailed analysis of the options is beyond the scope of this report.

### **Turf Infill**

Use of California crumb rubber as infill in synthetic turf athletic fields was up 11 percent in 2015 compared to 2013, to 1.9 million PTEs. In addition to drivers such as reduced maintenance costs and increased play time, this market segment is being driven in part by the ongoing and severe California drought, which increases the attractiveness of the significant water savings offered by synthetic turf fields compared to natural turf. Synthetic turf used in residential and some other landscaping applications seldom use crumb rubber infill.

Despite persistent media reports citing perceived concerns over health and safety related to the use of crumb rubber infill in synthetic turf athletic fields, crumb rubber continues to be the go-to infill in the vast majority of these applications. Based on industry interviews, approximately 100 to 150 fields were installed in California in 2015. Perhaps 10 to 15 percent of these were replacements for fields that had reached the end of their useful life. Only a very small portion of these installations used alternative infills other than crumb rubber.

A growing number of synthetic turf athletic fields are reaching their end of life (EOL) and will need to be removed and replaced. Interest is growing in reusing or recycling crumb rubber and other field components; however, reuse of crumb rubber from replacement fields is still very rare in California. When it does occur, reuse reduces to a degree the amount of newly produced crumb rubber used. Other than occasional reuse of crumb rubber infill in the same field from which it was removed, no examples of recycling of synthetic turf field components at EOL in California were identified. Challenges to recycling EOL infill and other turf system components include the need to clean and

separate the infill (whether on-site or off-site); testing and analysis of the recovered infill properties; owner and/or installer policies regarding material reuse or recycling; warranties; a lack of established on-site technologies or processing facilities able to clean the material; the costs associated with all of these steps; and a lack of precedents for using the material to make new products. CalRecycle intends to explore EOL management for turf crumb rubber infill and other TDPs over the next few years.

Indications are that 2016 may be equally strong or even stronger for the use of crumb rubber infill. Although negative media reports are concerning, major new research projects sponsored by CalRecycle (through a contract with OEHHA) and the U.S. EPA are underway that could help further inform these concerns.

### **Ground Rubber/Nuggets**

This segment mainly includes three very different markets with unique dynamics: loose-fill playground surfacing, landscape mulch, and equestrian surfacing. These market segments are grouped together because they all use ground rubber (i.e., tire-derived material of ¼ inch to ¾ inch in size) or nuggets (which may range in size to more than 1 inch). Grouping these products simplifies the surveys used to gather information for the purpose of this report. In 2015, this market category consumed approximately 1.2 million PTEs, 6 percent more than in 2014. One major producer of landscape mulch closed down in 2015, but research indicates demand in this segment is currently strong but extremely competitive. Buffings are not counted in the above estimates. Buffings are, however, most often used in landscape mulch applications, albeit with a much different specification than nuggets.

### **Molded and Extruded Products**

In 2015, use of California-produced crumb rubber by molded product manufacturers dropped by 26 percent, to 0.6 million PTEs, compared to 2014. This was on the heels of a 12 percent drop in 2014. This segment is by far the most diverse of all markets for California tire-derived materials. As detailed in CalRecycle's California Tire-Derived Product Catalog (available online at [www.calrecycle.ca.gov/Tires/Products/Catalog/](http://www.calrecycle.ca.gov/Tires/Products/Catalog/)), molded products include a variety of products used in the flooring, roofing, landscaping, building construction, transportation, cleaning supply, and agricultural industries, among others. This category also includes tiles used in playgrounds and other outdoor surfacing applications.

In 2015, about a dozen California firms produced molded or extruded products, including several involved in feedstock conversion (i.e., reformulating established products to use crumb rubber as part of the feedstock mix), and they continue to use relatively low volumes of crumb rubber as they work toward expanding production and sales. Reasons for low volumes in the molded category include historically low prices for oil and virgin raw materials and the challenges associated with commercializing and expanding sales for products newly incorporating crumb rubber raw materials. However, in addition to California-produced crumb rubber, some of these firms also use significant quantities of buffings and imported crumb rubber. Available data indicate that up to 24

million pounds of all types of tire rubber may have been consumed in this segment in 2015. It is recommended that future waste tire market reports analyze this segment in greater detail to better capture the range and quantity of feedstock types used.

As described above under Supply and Demand Balance, a new factor that could potentially impact crumb rubber supply and demand over the long-term is the possibility of using calcium carbonate derived from recycled carpets to replace a portion of crumb rubber used as a filler in certain TDPs. CARE, the carpet industry organization charged with compliance with California's carpet extended producer responsibility law, has issued more than \$2.1 million in grants to companies involved in tire recycling in an effort to expand this market. Increasing demand for crumb rubber and recycled carpet components are both CalRecycle priorities, and the potential for calcium carbonate to reduce sales of crumb rubber is currently uncertain.

### ***Civil Engineering***

The use of tire-derived aggregate in civil engineering applications was down by 8 percent in 2015 to 1.2 million PTEs. The decline was a function of the timing of non-landfill civil engineering project implementation, as a very large project is expected to begin in 2016. The outlook in 2016 is for increases in total use and in the number of projects using TDA, both for landfill civil engineering projects mainly involving gas collection systems and for non-landfill projects involving lightweight fill, vibration mitigation in light rail systems, storm water management, and other engineering projects. This trend is supported by CalRecycle's TDA grant program as well as ongoing outreach, research, and technical assistance activities.

#### **Landfill Civil Engineering Applications**

CalRecycle's TDA Grant Program helped to catalyze use of 1.0 million PTEs of TDA by seven landfills in 2015. While some are currently using low volumes, landfills as a category could potentially be established as a consistent market for TDA. California landfills generally report using TDA in connection with gas collection systems.

#### **Non-Landfill Civil Engineering Applications**

In 2015, about 129,000 PTEs of TDA were used in non-landfill civil engineering applications: in a vibration mitigation application related to the Bay Area Rapid Transit (BART) System outside of the grant program and a grant-funded storm water management project. While the storm water management project is relatively small, it could help fortify a trend toward a larger number of TDA projects using relatively small amounts that, combined, provide an ongoing, steady use of TDA. There is still a continued potential for very large projects on occasion. CalRecycle recently funded two non-landfill TDA projects that could use well over 4 million PTEs in 2016 and 2017: a landslide repair project in Santa Barbara and a very large lightweight fill/road fill project in Solano County that is projected to use more than 4.2 million PTEs. This will provide a major boost to use of TDA in civil engineering applications.

## ***Alternative Daily Cover***

Tire shreds are used as ADC at some landfills to cover disposed waste at the end of each day. In 2015, three landfills reported they used a total of 1.5 million PTEs (15,217 tons) of tire shreds as ADC, essentially the same amount used in 2014 at four landfills. This amount is expected to remain flat in 2016.

Tire ADC replaces dirt and can substitute for other ADC materials such as ground yard debris. The landfill's operating permit must allow for this use, the shreds must meet specifications, and use of ADC is limited to dry weather conditions. Tire ADC can sometimes provide landfills with a cost advantage if the landfill would be required to purchase other materials for use as cover; however, materials such as yard debris are readily available onsite at most landfills, while operational hurdles to using tires as ADC limit their use. (As of January 1, 2020, the use of yard debris and other "green material" as ADC does not constitute diversion through recycling and shall be considered disposal pursuant to PRC Section 41781.3. (2)(A)). Some landfills that do use tire ADC can potentially consume large quantities of waste tires. Processors typically must pay a tip fee or, at best, may have zero cost for disposing of the tire shreds to landfills for use as ADC, although they still must pay transportation costs.

## ***Other Diversion***

Products in the "Other Diversion" category may include rings cut from truck tires used to weigh down construction traffic barrels, weights for agricultural film plastic, or other uses. In 2015 100,000 PTE was reported as "Other Diversion," similar to the amount reported in 2014.

## ***Tire-Derived Fuel***

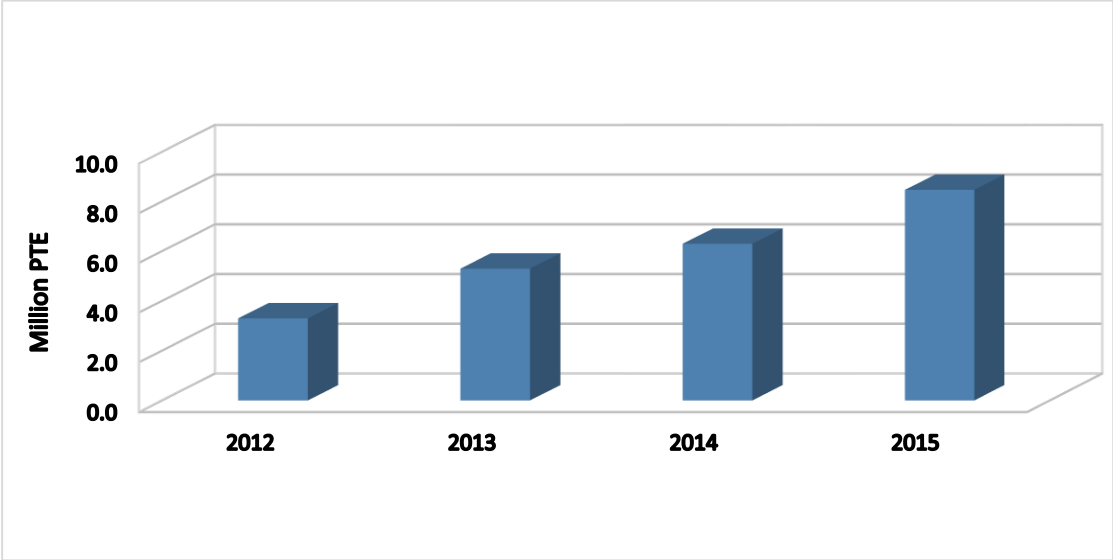
Four California cement kilns continue to use significant quantities of processed TDF or baled waste tires, providing a strong, steady market that thrives without government support. (CalRecycle is precluded from promoting TDF markets by statute.) In 2015, these plants consumed 8.6 million California PTEs, 2 percent more than in 2014. We estimate that these plants also used an additional 1.1 million PTEs that were supplied by California processors but were imported from outside the state (based on allocation of imports across the market segments served by California processors receiving imported tires). One plant reported that its TDF use increased by nearly 7 percent as a result of increased demand, while another plant indicated it is already using near the maximum allowable amount of TDF based on its permits. (The other two plants did not respond to this part of the survey.) In addition to these volumes, the plants also reported consuming a total of 12,523 tons of tire fiber, an increase over the 9,919 tons consumed in 2014, comprising the majority of fiber generated by California crumb rubber producers. The cement kilns reported no difficulty in obtaining adequate supplies of whole tires or TDF, with stable pricing. TDF and tire fluff use in 2016 is expected to be close to the 2015 level.



**Disposal**

As shown in Figure 3, waste tire disposal increased by 35 percent in 2015 compared to 2014, from 6.3 million PTEs to 8.5 million PTEs, the highest reported amount since 2011 and more than 250 percent higher than the all-time low of 3.3 million in 2012. It should be noted that an additional 456,000 imported PTEs were disposed in California landfills in 2015, based on a pro-rating of flows from processors reporting they imported a share of their tire supplies from out-of-state sources. (See the following “Imports and Exports” section for more details.)

**Figure 3**  
**Four-Year Trend in Total California Waste Tire Disposal (Million PTEs)**



As in the last two years, one factor leading to higher disposal in 2015 was declining export volumes. When exports decline and there are not profitable, attractive market alternatives, some processors tend to dispose an increased portion of their tires. Generally, tire disposal occurs when processors or haulers view it as the most profitable alternative compared to other market options, given their location and distance to alternative facilities, current pricing, their business model, and related considerations. In 2016 there is the potential for a decline in disposal, given projections for increases in California tires used in crumb rubber, civil engineering, and export market segments.

**Imports and Exports**

**Used Tire Imports and Exports**

Used tires that have been culled and graded depending on their type and quality have long been a staple export from California and other U.S. states. As was discussed in the “Reuse” section of this report, in 2015 an estimated 0.7 million PTEs of California tires were exported for reuse, 60 percent less than the quantity previously estimated for

2014. The authors believe this large decline is mainly a result of a refinement of the estimation methodology, as described in Appendix B. In addition, based on WTMS data and industry interviews, more than 1 million PTEs of already-culled used tires were shipped into or through California by a number of firms in other western U.S. states, either for direct sale or to a California port for shipment to Mexico or other countries. One reason for shipping used tires to California for sale may be that California regulations require a lower tread depth for used tires. For example, in California passenger tires require a depth of at least 1/32 inch, while federal regulations and those in some other states require 2/32-inch tread. According to the U.S. Census Bureau, a total of 1,038,633 used tire units were exported from California ports, with 871,700 of these to Mexico and the remainder, 166,933 units, to other countries, mainly in Central or South America but also to countries in other parts of the world.<sup>10</sup>

### **Waste Tire Imports**

In 2015, an estimated 2.3 million PTEs of waste tires were imported from out of state and flowed to several California processors. This estimate does not include already-culled used tires imported into California directly for the purpose of sale or export, as previously discussed. The processors importing these waste tires, in turn, shipped whole waste or used tires and TDM to a variety of market segments, and this share of their shipments was subtracted from the market segment estimates presented in Table 1 for California-generated tires. The amount subtracted from the flows from California processors to each market segment is shown in Table 3.

---

<sup>10</sup> U.S. Census Bureau, USA Trade Online. <https://usatrade.census.gov/index.php?do=login>

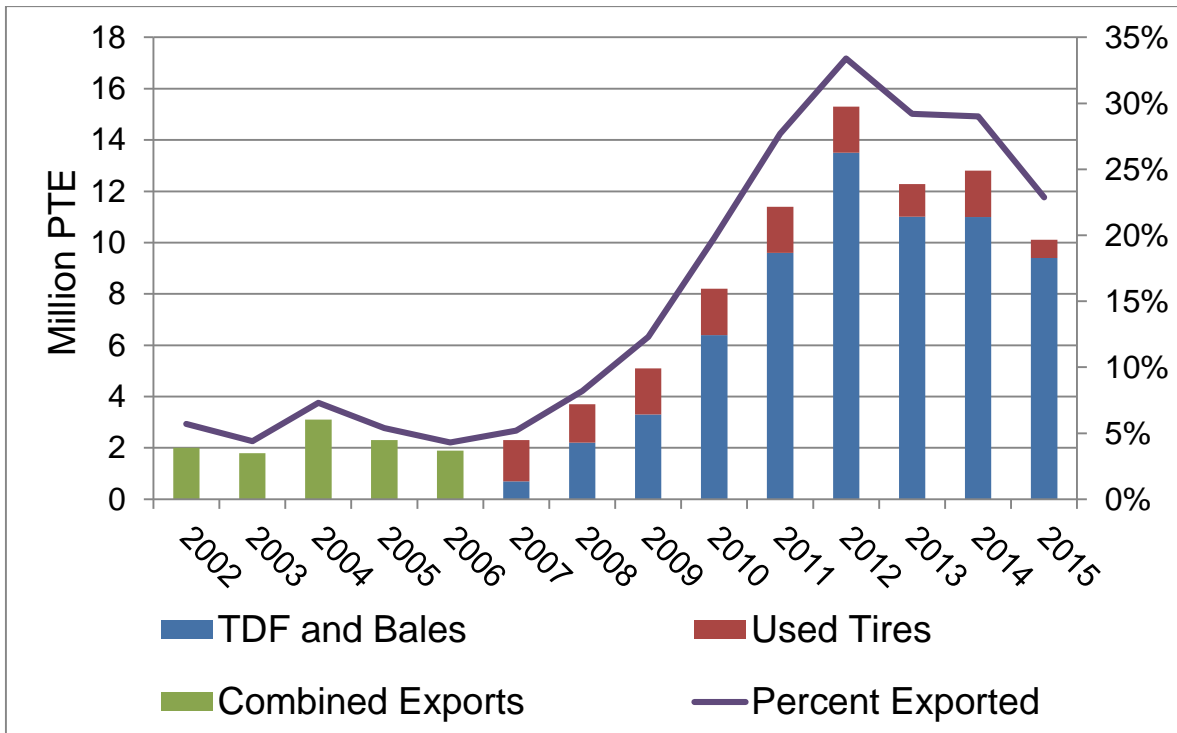
**Table 3**  
**Estimated Market Disposition of Waste Tires Imported to California Processing Facilities**

Category	Sub-Category	Adjustments Made to Shipments from California Processors to Account for Imported Tires (Tons)
<b>Export</b>	Processed TDF	2,632
	Baled Waste Tires	0
	Used Tires (Exported)	878
	<b>Subtotal</b>	<b>3,510</b>
<b>Reuse</b>	Retread	0
	Used Tires (Domestic)	1,843
	<b>Subtotal</b>	<b>1,843</b>
<b>Crumb Rubber</b>	Paving	1,826
	Turf Infill	88
	Loose-Fill Playground/Mulch/Equestrian	67
	Molded & Extruded	2
	Other	0
	<b>Subtotal</b>	<b>1,983</b>
<b>Civil Engineering</b>	Landfill Applications	125
	Non-Landfill Applications	0
	<b>Subtotal</b>	<b>125</b>
<b>Alternative Daily Cover</b>		0
<b>Other Diversion</b>		3
<b>Tire-Derived Fuel</b>		11,357
<b>Landfill Disposal</b>		4,561
<b>Total Imports</b>		<b>23,382</b>

### **Export of Processed TDF and Baled Waste Tires**

As shown in Figure 4 on the next page, after a rapid and consistent rise beginning in 2007, export of TDF and baled waste tires for purposes of TDF in Asian countries peaked in 2012 at an estimated 13.5 million PTEs. This amount then declined to 11.0 million PTEs in both 2013 and 2014. In 2015, an estimated 6.6 million PTEs of processed TDF were exported, primarily to Japan and Korea, and an estimated 2.8 million PTEs of baled waste tires was exported, primarily to Vietnam and Korea. Prior to 2014, this report did not separately break out exports of processed TDF and exports of baled waste tires. Also, as shown in Table 3 above, an additional 2,632 tons of exported, processed TDF was produced by California processors from tires imported from out of state.

**Figure 4  
Trends in Export of TDF, Baled Waste Tires, and Used Tires**



The drop in exports was driven by a number of factors. As in 2014, port strikes slowed movement of goods for a time. Also, in 2015 prices for fossil fuels declined markedly, which in turn pushed pricing and demand for imported waste tire bales and processed TDF downward. Moreover, according to one large producer of TDF for export, there is growing competition from other countries that export waste tires and TDF, especially Australia and India. Finally, CalRecycle enforcement actions and fines have reportedly had a detrimental impact on certain balers. As a result of these trends, several balers shut down, changed ownership and/or company names, and/or had greatly reduced volumes compared to recent years. However, export of processed TDF is going strong thus far in 2016, and some balers are reportedly picking up their volumes in mid-2016 as pricing for waste tire bales appears to be rebounding.

**Crumb Rubber and TDP Imports and Exports**

In 2015, crumb rubber from other states, Canadian provinces, and Europe was sold in California at competitive prices, despite transportation costs. This is in part possibly due to the incentive payment subsidies and/or favorable operating conditions in some of these jurisdictions. California crumb rubber producers have often complained of imported crumb rubber being offered at very low prices, reducing what they believe to be fair market prices. However, according to two crumb rubber producers, the glut of crumb rubber that had exacerbated this situation subsided somewhat during 2014 and

2015. Similarly, TDPs such as mats and tiles are sometimes imported into California from other states or Canadian provinces.

# Section 4

## Outlook for Increasing Waste Tire Diversion and Recycling

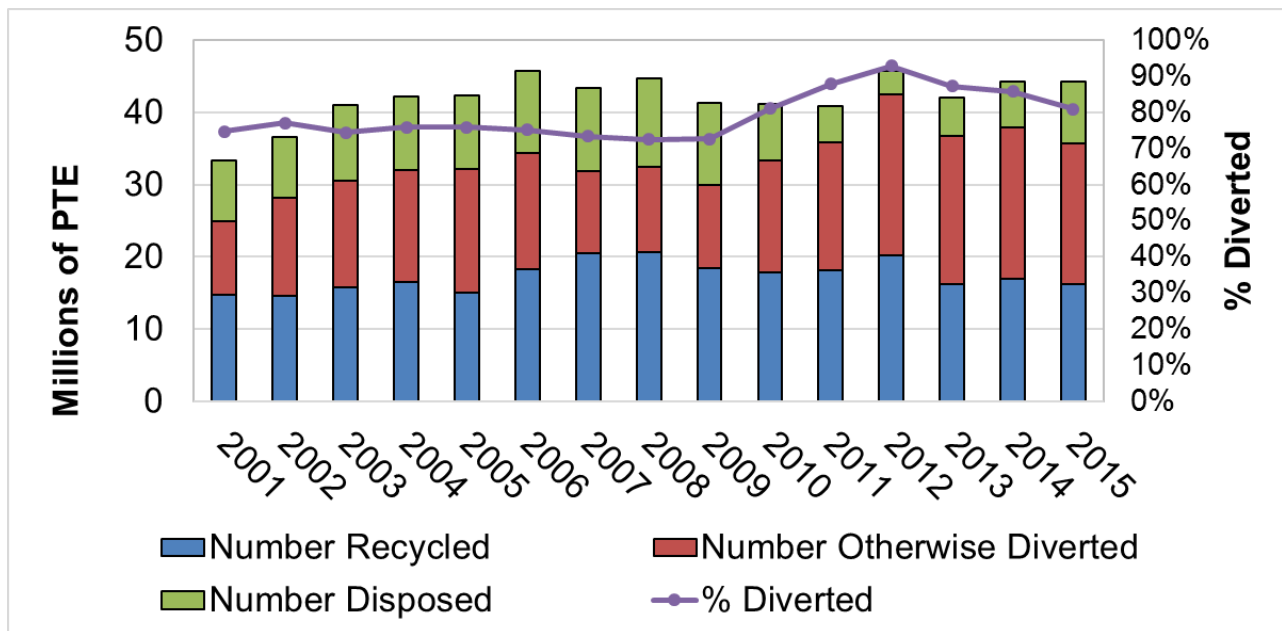
This section begins with a historical look at waste diversion and recycling trends and is followed by an overview of the short-term and long-term outlook for increasing levels in the future.

### Historical Waste Tire Diversion and Recycling Trends

As detailed in Section 2, CalRecycle has shifted its focus to achieving a 75 percent recycling rate for all waste materials including tires. This is in addition to CalRecycle’s long-standing 90 percent tire diversion goal. The recycling-based measurement is defined in this report to exclude waste tire and TDF exports (but not used tire exports), ADC, and TDF sold domestically. Excluding these segments, the 2015 recycling rate was 36.8 percent, down from 38.5 percent in 2014. The 2015 tire diversion rate is 80.9 percent, down from 85.9 percent in 2014.

As illustrated in Figure 5, over the past 15 years California waste tire recycling volumes have fluctuated within a narrow band of 14.6 million to 20.6 million PTEs per year. Diversion volumes have been more erratic, ranging from 10.1 million to 22.3 million PTEs over the same period, with large shifts occasionally occurring in exports and ADC.

**Figure 5**  
Waste Tire Diversion and Disposal Trends



## ***Diversion and Recycling Outlook***

Table 4 on the next page lists some of the key barriers impeding expansion of the waste tire recycling market segments. Current CalRecycle programs aim to help the industry overcome these barriers through a variety of funding, research, technical assistance, outreach, and direct business assistance activities.

Drawing on specific information gleaned during research for this report, Table 5 summarizes projections for short- and long-term recycling and diversion of California waste tires. In the short term, given projected increases in crumb rubber, use of TDA in civil engineering applications, and exports, with other diversion and recycling market segments expected to be stable, there is a strong potential for both diversion and recycling rates to increase moderately.

In the long term, given the diversity of diversion markets and their proven ability to sustain large volumes, it appears likely that diversion levels will continue to be high, in the 80 to 90 percent range, with occasional spikes above 90 percent and dips as markets grow and contract (especially export, ADC, and civil engineering, which can potentially increase or decrease significantly year to year). The potential for substantial, long-term growth in recycling volumes appears to rest mainly on whether large increases in customer demand for products made with crumb rubber and for TDA can occur and be sustained. There are some supply-related barriers to address (e.g., the need for a California producer of fine-mesh crumb rubber and demonstration models for job site logistics involving receipt of very large TDA quantities). However, production capacity for most non-fine-mesh crumb rubber and TDA currently exceed demand, and sustained strong demand would greatly reduce supply-side barriers.

Given these barriers and the overriding need for increased demand, a 75 percent tire recycling rate, as sought by CalRecycle, will be extremely challenging to achieve. To illustrate, Table 6 presents one hypothetical scenario that could result in a 75 percent tire recycling rate. Based on the estimated 2015 flows presented in this report, an additional 17 million PTEs would need to be recycled to achieve a 75 percent recycling rate. The scenarios presented in Table 6 would yield 16.4 million PTEs, very close to the target. However, as detailed in the table, achieving this level of growth for some market segments would require unprecedented increases in demand and production far beyond what past experience has indicated may be possible. It may be possible that some segments can exceed these growth levels, but again, this would depend on innovations and market conditions that have yet to be seen. The highest potential for substantial growth in demand would appear to be the paving market segment, since specific high-potential Caltrans policies are currently being investigated that could be implemented as soon as 2018.

That said, there is certainly room for growth in all of these recycling markets, with much riding on the manner in which California tire market development programs evolve in coming years, as described in the following section of this report.

**Table 4  
Key Barriers to Expansion of Waste Tire Recycling**

Barrier	Crumb Rubber Production	Reuse		Crumb Rubber Demand				Civil Engineering	
		Retread	Used Tires	Paving	Turf Infill	Play/Mulch	Molded/Extruded	Non-Landfill	Landfill
<b>Need for increased demand</b> for TDM by manufacturers and for TDPs by product consumers	X			X	X	X	X	X	X
<b>Concerns over insufficient quantity or quality of crumb rubber (including lack of fine-mesh material) and other TDM Supplies</b>							X	X	
<b>Tire storage regulations</b> and concerns impede ability to supply projects with tire-derived materials								X	
<b>Competition with conventional materials/products</b> with favorable pricing or performance	X	X	X	X	X	X	X	X	X
<b>Competition from out-of-state suppliers'</b> tire-derived materials and products, sometimes with subsidies or operational cost advantages	X			X	X	X	X		
<b>Insufficient quality standards and practices</b> , or inadequate implementation and adoption	X			X		X	X		
<b>Concerns over increasing imports of lower-tier tires from China at below-market prices</b> , which compete with retread/reused tires and have low potential retreading/reuse themselves		X	X						
<b>Lack of awareness</b> of tire-derived products, performance or pricing benefits, and past experience	X	X		X	X	X	X	X	X
<b>Perceived concerns over environmental, health, or safety risks</b>		X	X		X	X			
<b>Barriers to entry in use of TDM and TDPs</b> , which may include lack of prior experience or knowledge of sources and needed adjustments to current practices, and required time/monetary investments	X			X			X	X	X
<b>Long lead time and investment</b> needed for feedstock conversion and new product development				X			X		
<b>Inherent material characteristics</b> of tire rubber limit potential applications				X		X	X	X	
<b>California has a relatively small rubber product manufacturing industry</b> that may limit the potential for increasing demand through feedstock conversion							X		
<b>Most virgin rubber is used in tires but no California crumb rubber is used in tires</b> , resulting in the need for large volume, non-traditional markets for recycled tires	X								
<b>Government agency budget constraints</b> force them to rely solely on the alternatives with the lowest initial bid instead of basing purchases on life-cycle savings over time				X	X	X	X		



**Table 5  
The Outlook for Diversion and Recycling**

Category		2015 Volumes		Short-Term Outlook (2016-2017)	Long-Term Outlook (2018 – 2023 and Beyond)
		Million PTEs	Per-cent		
Recycling	Reuse (Inc. Used Tire Export)	7.4	16.8%	<b>Flat</b> Mature and relatively stable industries with little room for growth and relatively low fluctuations year to year.	<b>Flat or Possible Decline</b> Potentially threatened by competition with, and poor reuse potential of, imported lower-tier Chinese tires.
	Crumb Rubber	7.6	17.2%	<b>Modest Increase</b> Markets for main segments of paving, turf infill and ground rubber/nuggets appear strong to be strong and increasing somewhat in 2016.	<b>Possible Increase and Diversification</b> Caltrans is considering policies to greatly expand crumb rubber use; feedstock conversion could diversify and expand demand, despite current low volumes.
	Civil Engineering	1.2	2.6%	<b>Growth</b> CalRecycle-funded projects show potential to double use in 2016 and/or 2017, with some sustained TDA users.	<b>Modest Growth with Continued Intermittent Spikes</b> With continued CalRecycle funding, the number of projects and TDA specifiers seems likely to grow.
	Overall "Recycling"	16.3	36.8%	<b>Modest Growth</b> Growth in civil engineering and sustained strong markets for paving, turf infill, and ground rubber/nuggets may increase levels.	<b>Potential Growth but Much Higher Demand Needed</b> Growth depends on increased demand for crumb rubber and TDA, and addressing perceived concerns over turf infill.
Diversion	ADC	1.5	3.4%	<b>Flat</b> No major changes projected at consuming landfills.	<b>Flat</b> Historically at least one or two landfills use tire ADC.
	TDF	8.6	19.4%	<b>Flat</b> California cement kilns are near current capacity.	<b>Flat</b> Growth would require new permitting and kiln investments.
	TDF Export	6.6	14.8%	<b>Modest Growth</b> Rebounding fossil fuel prices are helping to spur increased demand and pricing for TDF in the international market.	<b>Sustained High Volume with Intermittent Fluctuations</b> Demand is strong but will likely suffer inevitable interruptions, spikes, and declines.
	Baled Waste Tire Export	2.8	6.4%	<b>Growth</b> Baling activity is picking up in early 2016.	<b>Erratic but Sustained High Volumes</b> Strong global demand, even with low fossil fuel prices; likely continuing abrupt changes in baler operations.
	Overall Diversion	35.8	80.9%	<b>Growth</b> Increasing export, TDA, and crumb rubber appear likely to boost total diversion by several percentage points.	<b>Continued 80+ Percent with Fluctuations</b> California market diversity and growth potential should maintain high diversion levels for foreseeable future.

**Table 6  
A Hypothetical Growth Scenario for California Tire Recycling**

<b>Recycling Market Segment</b>	<b>Hypothetical Growth Scenario<sup>11</sup> (Annual Increase Over and Above Current Levels)</b>	<b>Feasibility Assessment</b>
Reuse	Stable, No Growth	Likely scenario, with possibility of decline due to growing quantity of lower-tier imported tires.
Paving	6M+ PTEs/Year	Increase of 150 percent of current level. Feasible if new Caltrans policies are implemented consistently over time.
Turf Infill	1M PTEs/Year	Increase of 50 percent of current level. Very challenging but potentially doable. Requires that new studies reverse negative media attention, and that newly produced crumb rubber continues to be the primary infill of choice. Large-scale reuse of crumb rubber infill in replacement fields, while environmentally beneficial, would reduce growth potential for new crumb rubber.
Ground Rubber/ Nuggets	1.2M PTEs/Year	Increase of 100 percent of current level. Very challenging but potentially feasible. Requires that nuggets sustain and expand market share, potentially at the expense of landscape products made from buffings. If buffings shortage intensifies, it could support this scenario.
Molded/Extruded	4M PTEs/Year	Nearly a 7-fold increase over current level. Extremely challenging and most likely not possible. This volume would require several large-scale manufacturers to establish production of new or feedstock conversion products with sustained high-volume use of crumb rubber raw materials. Use of calcium carbonate from recycled carpets could reduce the potential for growth in this segment.
Civil Engineering	4.2M PTEs/Year	Increase of 350 percent of current level, and a 5-fold increase over the average annual use over the past 5 years. Very challenging to achieve. Would require sustained use in a variety of small- and large-scale projects in a greater diversity of market segments.
<b>Total</b>	<b>16.4M+ PTEs/Year</b>	

<sup>11</sup> These hypothetical scenarios are not projections. They are presented solely for the purpose of illustrating how challenging it will be to achieve a 75 percent tire recycling rate in California.

## Section 5

# Concluding Remarks: Implications for CalRecycle Market Development Efforts

---

This concluding section briefly summarizes CalRecycle's tire market development program and some implications of the preceding analysis.

### ***Synopsis of Current Programs***

CalRecycle's waste tire research and market development program is perhaps the best funded and most expansive in the nation. With an average annual budget of \$14,721,000 per year (not including program staffing),<sup>12</sup> the program has helped to spur the establishment of a strong waste tire collection and processing infrastructure. The program has been instrumental in the expansion of rubberized paving and playground applications, and is currently making progress in two additional priority areas: incorporating crumb rubber into new and existing products (i.e., feedstock conversion) and expanding use of TDA in civil engineering. Prior to a change in policy, CalRecycle also helped to spur expansion of TDF markets in the 1990s.

CalRecycle's current tire market development programs include:

- Grants to qualified purchasers (mainly government agencies) for rubber pavement;
- Grants to qualified purchasers of miscellaneous tire-derived products and direct payments to qualified manufacturers or compounders using recycled tire rubber, with funding allocations shared between the two programs;
- Technical assistance and educational services related to promoting rubber pavement products and use of TDA in civil engineering projects;
- Outreach activities to inform government agencies, architects, and private businesses about the range of California-made TDPs available and to track market trends through the Tire Outreach and Market Analysis Program;
- Provision of product testing, technical support, and other services to qualified manufacturers that add tire crumb rubber as a feedstock to replace plastic,

---

<sup>12</sup> The average, annual budget is based on figures presented in "Report to the Legislature: Five-Year Plan for the Waste Tire Recycling Management Program (Eighth Edition Covering Fiscal Years 2015/16-2019/20)," page 6.

<http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1528>

virgin rubber, or other materials in new or existing products through the Feedstock Conversion Services Program; and

- Provision of loans to qualified firms through the Recycling Market Development Zone Loan Program.

Additionally, CalRecycle's latest Five-Year Tire Plan, adopted on May 1, 2015, includes a vision statement outlining CalRecycle's intention to consider implementation of an expanded incentive payment system to drive expansion of tire recycling volumes, excluding TDF, landfill ADC, and exports. The vision statement also references other potential legislative changes, including stronger procurement policies and a phased-in ban on tire disposal and use of tire-related ADC. Proposed legislation is currently being considered (AB 1329, Gordon and Atkins) that would authorize an expanded incentive program compared to the current Tire Incentive Program, along with a variety of related policy changes.

### ***Implications for Future Efforts***

As described in Section 4, achieving a 75 percent tire recycling rate will be extremely challenging. There are some supply-related barriers that must be addressed, e.g., ensuring access to fine-mesh, customized compounds and other crumb rubber based raw material specifications needed by emerging TDP manufacturing ventures, and addressing logistical challenges related to delivery of large quantities of TDA in short time frames. However, the most critical need is for significantly increased customer demand for TDPs, made from both crumb rubber and TDA.

Stakeholders have expressed a variety of strongly held viewpoints regarding CalRecycle policies and programs. The following suggestions are based on the analysis presented in this report. CalRecycle and others may wish to consider as these as they debate alternative approaches:

- ***Focus on expanding rubberized paving applications.*** Paving appears to have the highest potential to significantly increase crumb rubber demand within a relatively short time frame. While participants in Caltrans' "PG+5" Committee do not necessarily agree on all of the details, a number of policies have been proposed that appear to have strong potential to increase crumb rubber volumes in a way that enhances product performance. Options to consider include accelerating research and testing to ensure new policies are adopted and implemented as soon as possible; tracking Caltrans procurement more closely and reviewing projects that do not use rubberized pavement but appear suitable to do so; and increasing grants, incentives, and/or mandates to promote use of rubberized paving materials and products in local government and private projects, in addition to Caltrans-sponsored projects.
- ***Refresh and strengthen TDP procurement policies.*** A number of state procurement policies exist to promote purchase of TDPs, some of which were

adopted in the mid-1990s. Since that time, the number and variety of TDPs available in California has greatly increased. While not analyzed in detail for this report, anecdotally there appears to be large potential for state and local agencies (including colleges and universities) to greatly increase use of a variety of TDPs. Decision makers could consider strengthening these policies to more strongly promote or require purchases of TDPs by certain state or local agencies.

- **Keep incentive payments simple, secure, and focused on increasing customer demand for TDPs.** With ample crumb rubber production capacity and TDP markets that have not seen large expansion in many years, there is a risk that incentives will spur additional crumb rubber or TDP production without sufficient markets. Therefore, incentive payments may be more effectively focused on expansion of TDP customer demand than on production of crumb rubber or TDPs. Options to consider include maintaining or expanding funding for TDP purchasers through existing grant programs or new incentive payment policies; and prioritizing incentives to TDP consumers over incentives to crumb rubber producers or TDP manufacturers. To the extent that TDM and/or TDP manufacturers receive payments, consider strictly requiring demonstration that the qualifying materials/products have already been sold to customers. Also, as concluded in a previous CalRecycle report on incentive payment systems, participation rules must be simple, transparent, and consistently applied, while also guarding against the high potential for fraud, to be effective. Decision makers may wish to consider studying some challenges experienced in other jurisdictions that have tire incentive payment systems to help anticipate potential pitfalls and to identify lessons learned, for example, in Colorado or Louisiana.<sup>13</sup>
- **Expand TDP research and development.** Basic research is a long-term endeavor with difficult-to-predict benefits. However, given the need for new high-volume tire recycling markets, CalRecycle could consider funding basic research to investigate and develop potential new applications. Options to consider include sponsoring state universities or colleges and/or research by private companies to identify potential commercial products and applications.
- **Fund production capacity for fine-mesh crumb rubber.** While demand for fine-mesh crumb rubber is still low, expansion of the molded and extruded market segment is stymied to a degree by the lack of supply. As manufacturers investigate how they can incorporate crumb rubber into the

---

<sup>13</sup> Audit reports have been prepared on tire incentive payment programs in both Colorado and Louisiana, among others. See for example: “Fee Collection in the Waste Tire Management Program, Louisiana Department of Environmental Quality.” Louisiana Legislative Auditor, Performance Audit, July 30, 2014; and, “Waste Tire Processors and End Users Program: Performance Audit.” Colorado Office of the State Auditor, 2014.

manufacture of established products, they require small quantities for testing, sometimes including experimentation with customized compounds that may combine rubber and plastics along with other specialized additives required to meet customer specifications. Because of the initially small volumes and the need to invest in equipment and adjust operations, crumb rubber producers have sometimes been reluctant to work with these firms to provide needed raw materials. In some cases, California manufacturers have chosen to use crumb rubber produced in other states as far away as Georgia. To address this, CalRecycle could consider a one-time change in its current policy of not providing grants for tire recycling equipment by soliciting proposals from crumb rubber producers for development of production capacity. Any funding provided could be tied to a binding commitment to supply California manufacturers in need of such material, and to participate in ongoing CalRecycle efforts to proactively work with compounders, manufacturers, product consumers, and CalRecycle to expand this diverse market segment.

- **Promote use of buffings and crumb rubber equally.** CalRecycle programs vary on whether the use of retreader buffings is eligible for funding. Buffings are initially thin slices of tire rubber produced as casings and prepared for retreading. These raw buffings are then often size-reduced to produce various grades of crumb rubber that is similar to, but also have distinct properties from, crumb rubber produced from waste tires at dedicated production facilities through an ambient, crambient, or cryogenic process. Both types of crumb rubber are used by manufacturers, compounders, and installers as a tire-derived recycled material feedstock in the production of molded rubber products, pour-in-place applications, or fillers in some product applications. Other buffing specifications are also used directly in landscaping mulch or playground surfacing applications. Each type of buffing and crumb rubber specification has its own beneficial properties and uses. Allowing buffings to “count” in all CalRecycle programs may help to streamline program administration and attract new manufacturers who otherwise may not consider use of recycled tire rubber, and who could help boost customer demand for recycled tire rubber overall.
- **Promote expanded retreading and recycling of off-the-road tires.** While a mature, highly competitive industry, retreaders may have room to expand operations in some cases or to use crumb rubber in the retreading process. Moreover, the trend of lower-tier Chinese tires could potentially damage their operations in coming years. Related to this, some have indicated that there may be an opportunity to expand diversion of off-the-road (OTR) tires through increased retreading and/or processing to produce crumb rubber/buffings. OTR tires have a very high disposal cost and contain a high percentage of natural rubber, which improves the economics of recycling them. CalRecycle could consider expressly including or targeting retreaders and OTR tires in all tire market development programs.

- **Allocate funding to promote recycling of TDPs at the end of their useful life.** CalRecycle already has approved a scope of work to investigate and promote best management practices for recycling turf infill, playground surfaces, and other TDPs at their end-of-life stage. CalRecycle could consider allocating a portion of funding to advance these efforts. Given the early stage of such efforts, funding may need to be focused on pilot projects, identifying potential customers, and/or demonstrating technologies needed to process TDPs to produce reusable or recyclable-grade materials. A portion of funding could also be allocated to demonstrate best management practices for the design of TDPs that maximize life-cycle benefits related to EOL management, greenhouse gas emissions, and other issues.
- **Step up monitoring and consideration of emerging technologies.** Private firms have sought to refine and commercialize a number of waste tire processing technologies over many years. While there have been many failed attempts, sustained efforts in the United States and globally have also seen some successes, and the landscape of alternative technologies and variants is ever-changing. Faced with insufficient customer demand for established crumb rubber products and civil engineering applications, CalRecycle may wish to update its assessment and policy treatment of certain technologies periodically.<sup>14</sup> In some cases, technologies may blur the line between recycling and transformation, but they may still offer attractive greenhouse gas reductions, which also need to be documented in the context of now-established guidelines developed by the California Air Resources Board. Examples of technologies to monitor include devulcanization (modifying the structure of vulcanized waste rubber to remove crosslink bonds, allowing it to potentially be used in a variety of applications); pyrolysis (thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen); and gasification (a process that utilizes a reactive agent such as air, oxygen, hydrogen, or steam to produce fuel primarily in the form of gas, as well as carbon black).<sup>15</sup>

---

<sup>14</sup> Examples of past CalRecycle-sponsored tire emerging technology evaluations include: 1) “Technology Evaluation and Economic Analysis of Waste Tire Pyrolysis, Gasification, and Liquefaction,” prepared by the University of California, Riverside. <http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1174>; 2) “Environmental Factors of Waste Tire Pyrolysis, Gasification, and Liquefaction,” prepared by Cal Recovery, Inc., 1995 <http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1134>; 3) “Evaluation of Waste Tire Devulcanization Technologies,” prepared by Cal Recovery, Inc., 2004 <http://www.calrecycle.ca.gov/Publications/Detail.aspx?PublicationID=1078>; and “New and Emerging Conversion Technologies, Report to the Legislature.” Prepared by RTI, 2007.

<sup>15</sup> Definitions are adapted from information in the CalRecycle reports listed in footnote 15.

While there is no “silver bullet” policy or program that is guaranteed to achieve and sustain CalRecycle’s 75 percent tire recycling goal, this report strongly indicates that the key to success lies in expanding customer demand, especially in profitable, high-volume products and applications. Given its resources, the state’s strong tire recycling infrastructure and growing focus, the state is well positioned to make progress in coming years.



# Appendix A Glossary

---

<b>ADC</b>	Alternative daily cover used at landfills instead of soil
<b>Buffings</b>	Tire rubber produced as a by-product of the tire retreading process.
<b>Caltrans</b>	California Department of Transportation
<b>CARB</b>	California Air Resources Board
<b>Crumb rubber</b>	Tire-derived material less than ¼ inch in size, free of wire and fiber.
<b>Feedstock conversion</b>	The process whereby a manufacturer of an existing, commercially proven product converts a portion of the raw materials used to make the product from existing one (e.g., virgin rubber, plastic, or other materials) to crumb rubber made from recycled tires
<b>Ground rubber</b>	Tire-derived material ¼ inch to 1 inch in size, free of wire and fiber
<b>OEHHA</b>	California Office of Environmental Health Hazard Assessment
<b>Passenger tire equivalent (PTE)</b>	Defined as 20 pounds of tire rubber for the purpose of making consistent comparisons in this and other reports (The actual weight of waste passenger tires may vary considerably.)
<b>Tire-derived aggregate (TDA)</b>	Tire-derived material used to replace conventional aggregates like rock in civil engineering applications
<b>Tire-derived fuel (TDF)</b>	Whole waste tires or tire-derived material consumed as fuel (referred to as processed TDF in this report)
<b>Tire-derived material (TDM)</b>	Tires processed to meet market specifications, for example, crumb rubber, ground rubber, tire-derived aggregate, and tire-derived fuel
<b>Tire-derived product (TDP)</b>	Product made entirely or in part from tire-derived material
<b>Tire Incentive Program (TIP)</b>	A CalRecycle program launched in June 2015 to promote feedstock conversion and the use of crumb rubber as feedstock by California manufacturers
<b>WTMS</b>	Waste Tire Manifest System

# Appendix B

## Methodology and Data Limitations

---

### *General Approach*

This appendix briefly summarizes the methodology used in this study to estimate the quantity of California-generated waste tires flowing to each market segment.

In short, the methodology involves:

- Gathering data and information through direct surveys and interviews of California-based waste tire processors, balers, landfills disposing waste tires or using TDA or ADC, cement kilns consuming TDF, retreaders, TDP manufacturers/installers/marketers, and select haulers;
- Compiling and analyzing CalRecycle data such as data on tire flows as reported by haulers and facilities in Comprehensive Trip Logs and entered into the Waste Tire Manifest System; the Disposal Reporting System; facility permitting activity; and grant program data available through CalRecycle monthly meeting agendas;
- Reviewing third-party information sources such as Caltrans' annual report to the Legislature on waste tire use; California Air Resources Board data on cement kiln tire use; the Rubber Manufacturers Association data on national scrap tire market trends; and a variety of other information sources identified each year, including information from other trade associations such as the Rubber Pavement Association and the Synthetic Turf Council; and
- Interviewing a variety of other individuals knowledgeable about waste tire industry and market trends.

Detailed data on flows of California tires from these sources is entered into a master flow model and scrutinized in an effort to identify all flows as completely and accurately as possible while avoiding double counting. This is an iterative process in which researchers frequently identify issues and follow up with facilities to refine the analysis.

For most market segments, survey responses are the preferred source, subject to validation if possible from other sources. If survey responses are not available for a given facility, analysts select the alternative approach deemed to be the most accurate, usually prior survey responses or WTMS data, which may be refined based on all available data and information.

Estimating the quantity of used tires is particularly challenging, as some facilities and haulers can only provide a rough estimate of the percentage of tires culled from waste tire streams they manage. These percentages can vary widely depending on the type of waste tire generators served, the extent to which tires may be culled prior to reaching the processor, proximity to ports, and general economic conditions. As a result, a

different methodology than that used for other market segments is employed to estimate used tire quantities. The preferred source of data is processor records of the specific tonnage shipped to domestic purchasers or exported. However, sometimes these are not available, usually because the facility operator provides only a rough estimate of the percentage of tires culled for reuse. In such cases, researchers apply a single industry average percentage estimate of the portion culled for reuse from all tire flows (excluding flows to facilities for which a processor has already provided specific tonnage of used tires culled). Finally, researchers then apply an estimate for the percentage of these used tires that is exported versus sold domestically. The specific percentages used are developed based on discussion with processors and haulers, and the quantity exported is validated to a degree based on U.S. Census data on exported used tires. In past years, processor-specific estimates were used for each facility, even when it was a rough percentage. And, the percentages used to estimate total and exported used tire quantities were based on anecdotal feedback from only a few firms. The authors believe this refined methodology is more accurate because it applies a single, industry-wide average culling estimate that takes into account activities throughout the chain from generator to processor; it recognizes that the flows of some processors may be more rich in used tires than others; and the percentage of used tire culling and the percent exported can be updated annually based on interviews with processors and haulers.

### ***Conversion Factors***

Following are some key notes regarding the use of conversion factors in this study.

- All calculations in the analysis are performed in tons, not PTEs. When the final analysis is complete, tons are then converted to PTEs using the standard definition of 20 pounds per PTE, and reported that way in this report, for consistency with past reports.<sup>16</sup>
- With the exception of retreaders, surveys request that flow data from companies be provided in tons, and it is nearly always provided that way. Retreaders report the number of different types of tires retreaded and are also asked to provide the average tire weight for each type. If not available, the average weight from other reporting companies is used. Occasionally, other facilities may provide flow data in terms of the number of tires, and the most accurate conversion factor available is used to convert to tons. For example, Caltrans' annual report to the Legislature and related documents report tire use in PTEs, defined as 20 pounds per tire or 12 pounds of crumb rubber per

---

<sup>16</sup> This approach is based on direction provided by CalRecycle to the contractor team and is consistent with CalRecycle practices in a number of programs and policies. For example, the California Code of Regulations defines a PTE as 20 pounds (14 CCR § 17225.770).

tire, consistent with CalRecycle regulations. Other conversion factors are available for other size/type of tires.<sup>17</sup>

- WTMS data are used to estimate the approximate magnitude of tires flowing to and from facilities in this study. This information helps to identify facilities and haulers handling large volumes of tires and to ask the right questions in surveys and interviews. In a very limited number of cases, if a survey response is not provided and there are no other options, WTMS data may be used to estimate deliveries to a particular facility.
- CalRecycle's WTMS database provides all data in PTEs (defined as 20 pounds), although companies may provide the data in Comprehensive Trip Logs (CTLs) as either tons, cubic yards, or the actual number of tires (regardless of the tire size or type). CalRecycle converts cubic yards to PTEs using 10 PTEs/cubic yard. CalRecycle converts the number of tires to PTEs using 20 pounds per tire, regardless of the type or size of tires (which is not identified in the CTL). These conversions are some of the main reasons why WTMS data can often differ markedly from survey responses, and why it is only used as an indicator or as a last-resort flow estimate when more reliable data are not available.

## **Conclusions**

As this methodology description illustrates, estimating California waste tire flows is challenging due to a variety of data gaps, data quality issues, and conflicting sources of information. Nevertheless, this report provides data that can be used to evaluate trends over time. The authors strive to provide estimates for each market segment that are as accurate as possible, and they generally believe the accuracy is well within plus or minus 10 percent.

The methodology used in previous California waste tire market reports covering 2007 to 2013 is very similar to that used in this report. These reports are available online at: <http://www.calrecycle.ca.gov/Publications/PublicationsByCategory.aspx?CategoryID=25>. Some changes are occasionally made to refine the methodology or clarify presentation of results, and these are generally documented in an appendix. In this report covering 2015, the used tire estimation methodology described above was modified, and the "Synthetic Turf and Athletic Fields" category was renamed as "Turf Infill" to better describe the use of crumb rubber in that market segment.

---

<sup>17</sup> According to the Rubber Manufacturers Association, on average light duty tires such as scrap passenger tires weigh 22.5 pounds, commercial tires such as scrap truck and bus tires weigh 120 pounds, and the average of all light duty and commercial scrap tires (excluding off-the-road tires) is 32.8 pounds. Source: "2013 U.S. Scrap Tire Management Summary." Rubber Manufacturers Association, November 2014, page 4. <https://rma.org/publications/scrap-tire-publications/market-reports>