Draft California Waste Tire Market Report: 2023

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Acknowledgments

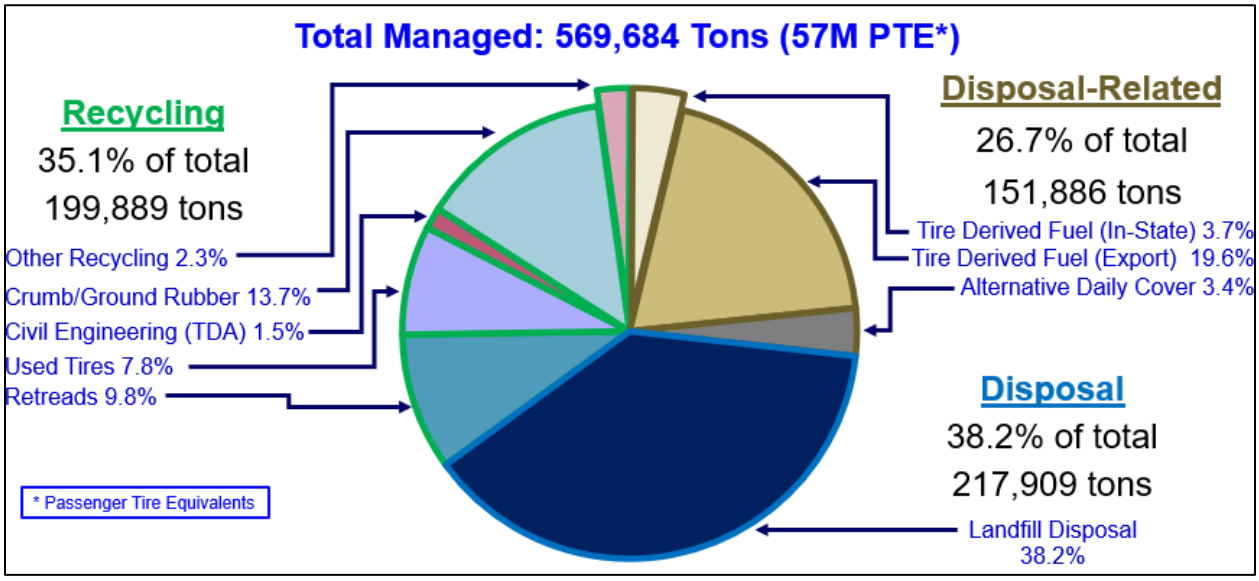
This report was prepared by GHD Inc. in partnership with subcontractors DKE Enterprises, Inc. (dba DK Enterprises) (tire recycling industry expert and liaison), Boisson Consulting (tire recycling industry expert) and WEC LLC (research support). We thank the many industry stakeholders who contributed their information, data, and insights as well as the CalRecycle staff who coordinated access to department databases and clarified program policies and trends.

Executive Summary

This report describes California waste tire flows in 2023 and trends as of Fall 2024, based on analysis of data from industry surveys, interviews, CalRecycle databases, and other sources.

As shown in Figure 1, in 2023, an estimated 569,683 tons (57 million PTEs[1]) of California-generated waste tires were managed. California waste tires flowed to nine different market segments. These segments are grouped into three subtotal categories; Recycled, Disposal Related, and Disposal. Factors such as federal interest rate increases, which rose four percent from June 2022 to July 2023, and were used to tame inflation, increased transportation and business costs and fueled fears of a 2023 recession. These factors along with overseas TDM markets impacted disposal related export markets and disposal tonnage in California. As well the Crumb Rubber and TDP markets stagnated or slightly decreased in 2023.

Figure 1 California-Generated Waste Tire Flows in 2023*



*See source data for Figure 1 in Appendix C.

CalRecycle has adopted a 75 percent waste tire recycling goal, consistent with a statewide 75 percent recycling goal covering all waste materials mandated by AB 341 (Chesbro, Chapter 476, Statutes of 2011). As Figure 2 shows, the California waste tire recycling rate increased in 2023 to 35.1 percent, a .4 percent increase from 2022. Recycled tons decreased by 4.4 percent to 199,889 tons (20 million PTEs); however,

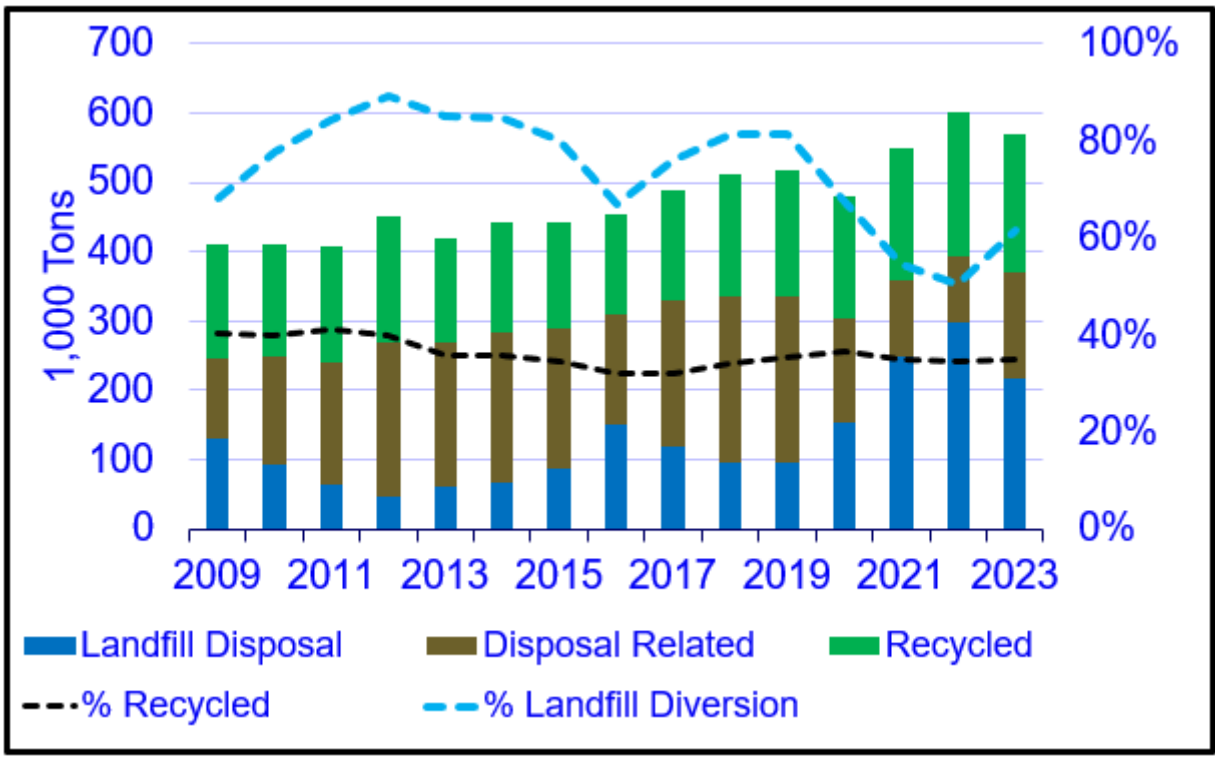
[1] PTE means Passenger Tire Equivalent, defined by CalRecycle (14 CCR § 17225.770) as 20 pounds. The PTE is a useful standardized reporting metric; but actual tire weights vary significantly by type, and passenger tires typically weigh more than 20 pounds.

this was accompanied by a 5.5 percent decrease in total generation. Retreading declined by 3 percent in 2023 from 2022, driven by market supply of imported inexpensive tires.

The following are some key trends by market segment:

- Crumb/ground rubber production remained stable into 2023, driven by a stable paving segment, the molded/other product, and crumb rubber market segments.
- Turf infill and playground surfacing in the state have declined since June 2015 with the announcement of the California Office of Environmental Health Hazzard Assessment (OEHHA) report committed under contract with CalRecycle to conduct a new study on synthetic turf and potential human health impacts. TIP and TDP Fiscal Year (FY) 2022-2023 grants excluded multiple high-volume uses of crumb rubber anticipating a report determination. The use of crumb rubber for roofing and flooring increased slightly. The turf infill market demonstrated it was stable from 2022 with a 75 percent use rate in southern California and 25 use in northern California. In 2023, turf infill use increased in the United States.
- Retread sales declined slightly by 3 percent from 2022.
- Used tire sales declined in 2023 by 10 percent, as reported by industry.
- The use of tire-derived aggregate (TDA) in civil engineering increased slightly but overall tonnage remains low compared to historical values.
- Landfill disposal decreased in 2023 to 217,909 tons, a 26.9 percent decrease from 2022 and is continuing a downward trend into 2024.
- Exported tire-derived fuel (TDF) increased in 2023 by 111,721 tons or 2.7 times the 2022 value. This change is based mostly on increased demand by Japan and India.
- In-state TDF shipments continued to decline in 2023 by 55.6 percent because two of the four cement kilns stopped taking tires as a fuel source. One of the two kilns changed their tire-derived fuel specification to where it was not economical for the TDF suppliers. The second kiln, though not accepting TDF, is still accepting tire fluff/fiber as a fuel source. In 2024, cement kilns are now taking tire fluff as a less expensive fuel source.

Figure 2 California-Generated Waste Tire Recycling, Disposal Related and Landfill Disposal Trends, 2009-2023



See source data for Figure 2 in Appendix C.

In 2024 and 2025, there is potential for further growth in recycling in the retreading, paving, and molded/other market segments. Recent changes in the Tire Incentive Program (TIP) may contribute to increased growth. Exports of Tire-Derived Material (TDM) increased in 2023 and continues in 2024. Continued expansion and diversification programs focusing on TDP markets are essential for increasing the recycled category tonnage.

TDM is considered a feedstock material derived from waste tires. Tires are processed to meet market specifications, for example, crumb rubber, ground rubber, Tire-Derived Products (TDP)'s, and Tire-Derived Fuel (TDF) or for use as a civil engineering material. Robust performance in TDM markets indicates that there are businesses effectively managing California waste tires. In 2023 overseas demand resulted in increased TDM usage through exports and decreased disposal amounts in California.

1. Introduction

The Department of Resources Recycling and Recovery (CalRecycle) oversees management of waste tires in California as authorized by Senate Bill 876 (Escutia, Statutes of 2000, Chapter 838).[2] CalRecycle's long-term, informal goal is to achieve a 75 percent waste tire recycling rate, consistent with the requirements of AB 341 (Chesbro, Chapter 476, Statutes of 2011) which established a 75 percent statewide recycling rate goal for all materials by 2020.

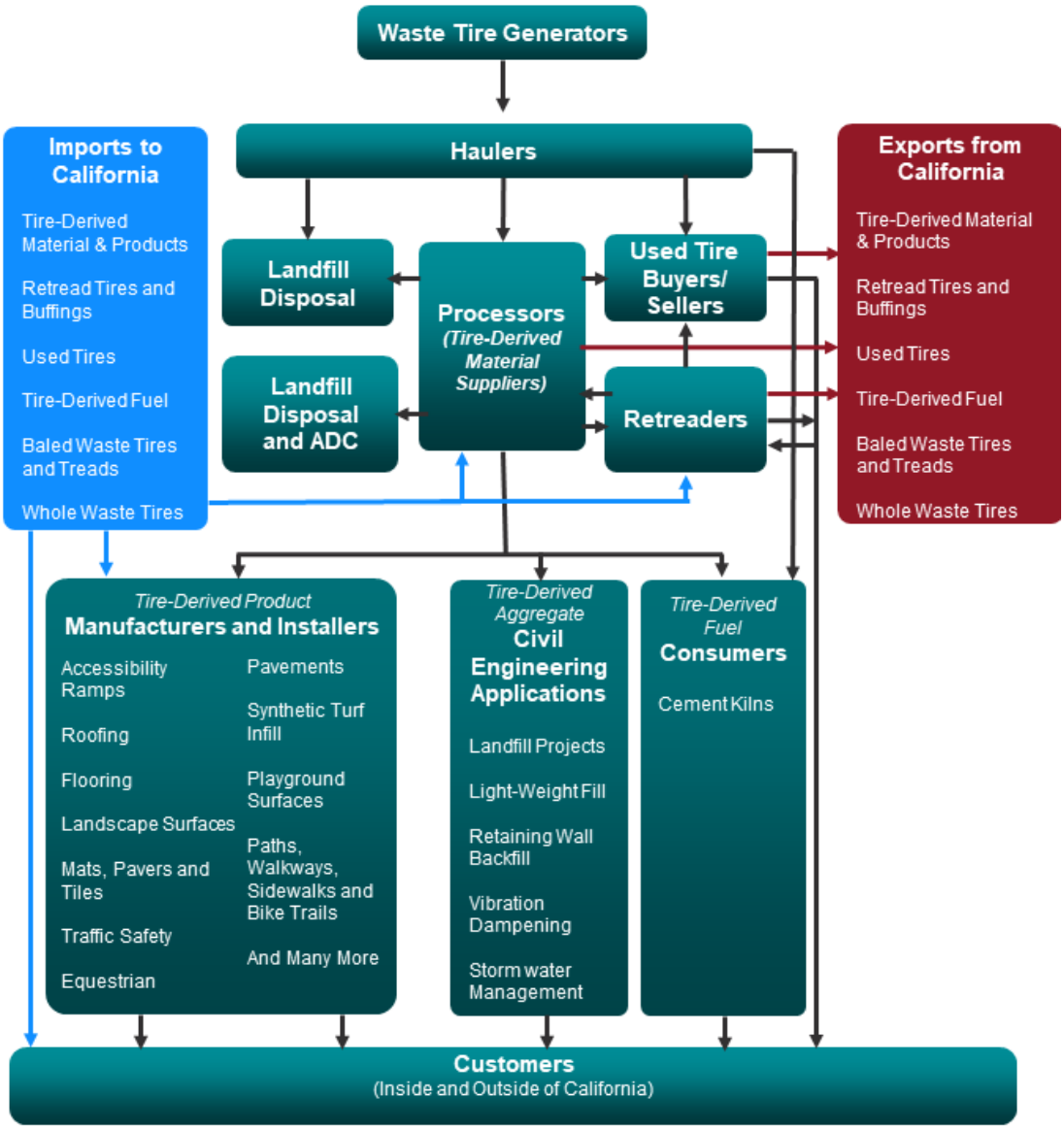
This report estimates the 2023 California tire recycling rate and describes current and historical trends in the flow of California-generated waste tires and TDM to different market segments including TDPs, TDF and Civil Engineering. GHD Inc. prepared the report, in partnership with industry specialists DK Enterprises and Boisson Consulting, and with research support from WEC LLC. Findings are based on detailed analysis of data and information provided by California waste tire management companies, CalRecycle staff and databases, and other sources.

Following this introduction, Section 2 summarizes California waste tire management infrastructure. Section 3 identifies broad trends influencing waste tire markets, while Section 4 provides detailed findings by market segment. The main report concludes with Section 5, discussing the outlook for increased tire recycling. Appendix A is a glossary of key terms and acronyms, while Appendix B covers the report methodology. Appendix C provides notes and source data for graphs and charts to ensure accessibility in compliance with the American Disabilities Act, Government Code sections 11546.7, 7405, and 11135, and Web Content Accessibility Guidelines 2.0. Finally, the End Notes section at the end of the report lists cited information sources.

2. California Waste Tire Management Infrastructure

Figure 3 illustrates flows of California-generated waste tires and tire-derived materials (TDM). Table 1 lists the number of distinct types of facilities and companies by category serving California. Waste tire collection and processing companies serve all areas of the state. CalRecycle's California Tire-Derived Product Catalog provides detailed product information, maps, and directories with company contacts. The TDP Catalog is available online.

Figure 3 California Waste Tire Recycling Industry Flow Chart



See detailed description of Figure 3 in Appendix C.

Table 1 California Waste Tire Management: Active Facilities and Companies by Catagory in 2023

Category	Counts
Registered Waste Tire Haulers	> 1,300[1]
Registered Waste Tire Generators	> 23,000[2]
Number of 2023 Waste Tire Shipments (Each Documented with a Comprehensive Trip Log in CalRecycle's Waste Tire Manifest System)	> 538,000[3]
Retreaders	37[4]
Facilities with a Major Waste Tire Facility Permit (Specified onsite maximums range from 9,960 to 336,300 PTEs)	15[5]
Facilities with a Minor Waste Tire Facility Permit (Allowing up to 4,999 PTEs onsite)	17[6]
Processors Reporting Crumb Rubber or Ground Rubber Shipments	4
Processors Reporting TDA Shipments	2
Processors Reporting In-State TDF Shipments (Includes size-reduced TDF, whole tire TDF and residual fluff from crumb rubber production)	4
Processors Reporting Exported TDF (e.g., chips, shreds) and/or Baled and Cut Waste Truck Tire Tread Shipments	5
Tire-Derived Product Manufacturers Listed in the California TDP Catalog	13[7]
Tire-Derived Product Installers Listed in the California TDP Catalog	7[8]
California Cement Kilns Consuming TDF	2
California Landfills Disposing Size Reduced Waste Tire Material On-Site	29

3. Broad Trends Influencing Markets

As in 2022, important trends continued to create uncertainty and disrupt business operations and markets to varying degrees in 2023 and into 2024. These trends include:

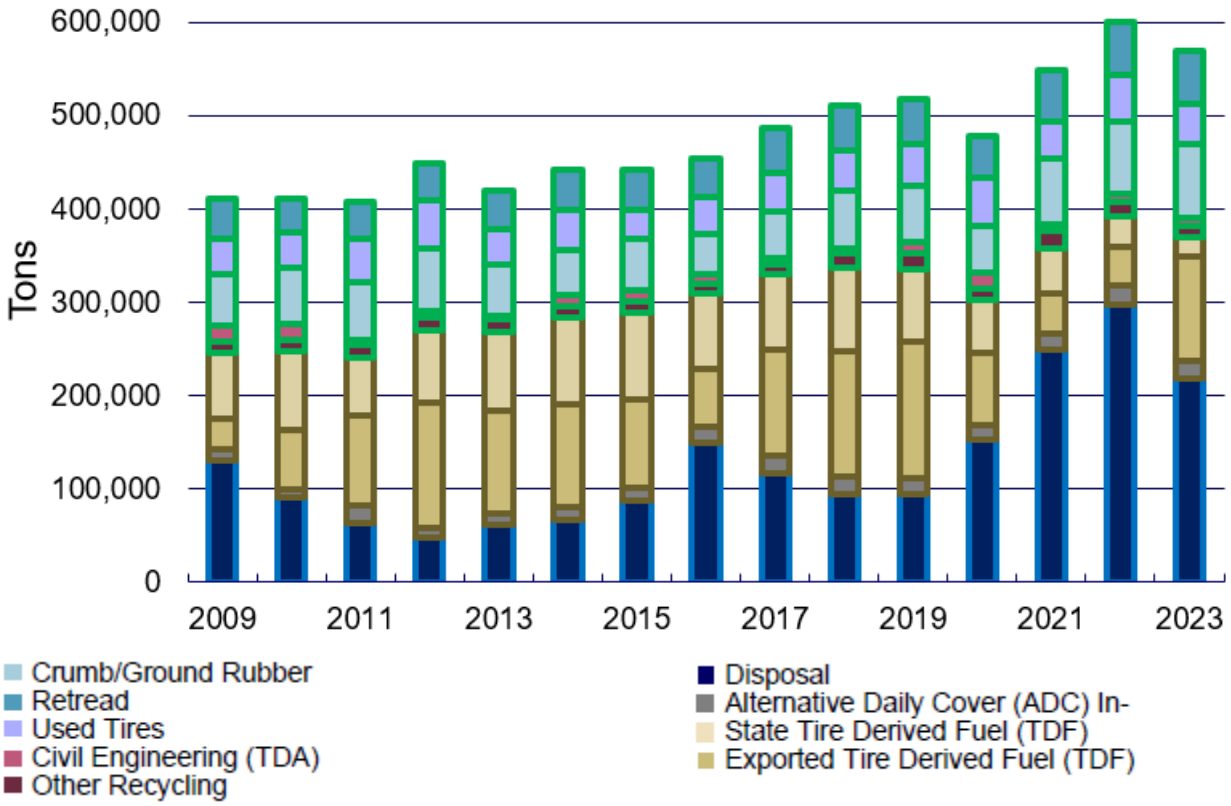
- **Shifting economic outlook**. Inflation persisted in 2023, albeit at a decelerating rate compared with 2022. Over the year, the Consumer Price Index (CPI) grew by the third largest over-the-year rate since 2007.
- **Federal Interest rate increase**. The rate increased by .25 percentage points four times in 2023.
- **Decreased vehicle miles.** Gasoline expenditures were down 12.7 percent reflecting a decrease in miles traveled, and potential replacement tire purchases.
- **Staffing challenges**. With continuing low unemployment and increased inflation rates, waste tire management companies (like other industries) have dealt with persistent staffing and hiring challenges, along with rising wages. This is a widely cited issue for companies in all market segments covered in this report.
- **Trucking and ocean shipping costs and challenges.** The staffing shortage of 2022 continued in 2023 and is particularly an issue in the trucking industry, and costs have skyrocketed in recent years. In 2023, ports continued to be severely disrupted by worker disruptions and other factors. Exports of TDM material increased in 2023 as demand increased in use for cement, chemical, pulp and paper and pyrolysis facilities. During 2023 both the Oakland and Long Beach Ports had an average of six-days of vessel dwell time for imports. Vessel dwell times are the amount of time that vessels spend in port actively loading or unloading cargo, which contributes to both port capacity and throughput performance.
- **Potential global marketplace changes.** Disruptions and uncertainty are poised to continue to affect the waste tire industry in 2024 and 2025. International demand for TDM is continuing to increase in 2024. Increased imports of inexpensive truck tires slightly decreased the national retread market in 2023. Imported rubber products sold online and at big box stores compete with products manufactured in California and the US. Some of the imported products are produced using chemicals that cannot be used in the manufacturing process in the US. International politics can, and often do, change our local and world marketplace. International politics can shift the focus of economic activity through the world's growing connectedness and movements in capital, people, and information, and the acceleration in the scope, scale, and economic impact of technology. The impact of these dynamics is felt worldwide, in the nation, in California, and in our local markets.

4. Trends by Market Segment

4.1 Historic Trends

Figure 4 shows the long-term trend in uses of California-generated waste tires and TDM, while Table 2 (on the next page) provides additional detail for the past three years. These findings are based exclusively on California-generated waste tires, excluding imports. Similarly, the flow estimates do not include buffing materials from retread operations. Appendix B describes the report methodology. The remainder of Section 4 describes trends within each market segment.

Figure 4 Historical Market Trends for California-Generated Waste Tires and TDM by Segment, 2009-2023*



*See Figure 4 source data in Appendix C.

Table 2 summarizes the estimated end uses of California ELTs in tons, by category, and shows the respective percentage of total managed for years 2020-2023, along with the percentage change from 2022 to 2023.

As shown in Table 2, the Crumb/Ground Rubber, Retread, Used Tire, Civil Engineering/Tire Derived Aggregate (TDA), and Other Recycling categories are combined as the Sub-total, Recycled. Disposal is the tonnage of altered ELTs without a

committed use going directly to the landfill. Landfill Alternative Daily Cover, and Tire-Derived Fuel are combined and referred to as Sub-total, Disposal Related.

As shown in Table 2, the subtotal Recycled category decreased tonnage from 2022 to 2023 by 4.3 percent. The Total Managed tonnage decreased from 2022 to 2023 by 5.2 percent. Although the Total Managed and Recycled tonnage decreased, the percentage recycled for 2023 increased by .4 percent over 2022. This resulted in the subtotal Recycled category being 35.1 percent of the Total Managed for 2023, a .4 percent increase on the previous year's value of 34.7 percent. The Disposal Related subtotal increased by 61.3 percent from 2022 to 2023. While the Landfill Disposal subcategory decreased by 26.9 percent from 2022 to 2023. It is likely to be a direct result of increased TDM exporting overseas.

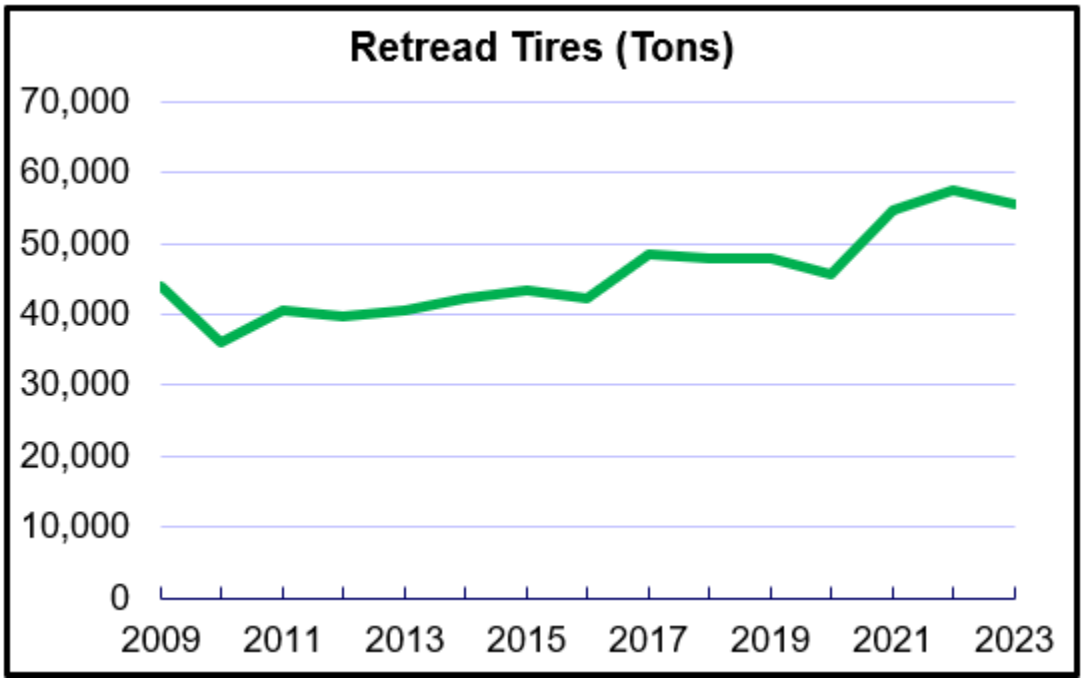
Table 2 Estimated End-Uses for California-Generated Waste Tires, 2019 – 2023

Category	2020 Tons	2020 M PTEs	2020 % Total	2021 Tons	2021 M PTEs	2021 %Total	2022 Tons	2022 M PTEs	2022 %Total	2023 Tons	2023 M PTEs	2023 %Total	% Tons Change 2022 - 2023
Retreads	45,500	4.6	9.5%	54,600	5.5	9.9%	57,366	5.7	9.5%	55,645	5.6	9.8%	-3.0%
Used Tires	51,000	5.1	10.7%	40,900	4.1	7.4%	49,112	5.0	8.2%	44,203	4.4	7.8%	-10.0%
Crumb Rubber and Ground Rubber	50,500	5.1	10.5%	70,900	7.1	12.9%	78,341	7.8	13.0%	78,159	7.8	13.7%	-0.2%
Civil Engineering (TDA)	16,900	1.7	3.5%	6,600	0.7	1.2%	7,371	0.7	1.2%	8,682	0.9	1.5%	17.8%
Other Recycling	11,900	1.2	2.5%	18,100	1.8	3.3%	16,587	1.4	2.8%	13,200	1.3	2.3%	-20.4%
Sub-Total, Recycled	175,900	17.6	36.7%	191,000	19.1	34.7%	208,777	20.7	34.7%	199,889	20.0	35.1%	-4.3%
Tire-Derived Fuel (In-State)	57,600	5.8	12.0%	48,200	4.8	8.8%	32,457	4.1	5.4%	20,858	2.1	3.7%	-35.7%
Tire-Derived Fuel (Export)	73,400	7.3	15.3%	40,100	4.0	7.3%	37,037	5.3	6.2%	105,091	10.5	18.4%	183.7%
Baled Waste Tires and Treads (Export)	3,200	0.3	0.7%	3,500	0.4	0.6%	3,500	0.4	0.6%	6,630	0.7	1.2%	89.4%
Landfill Alternative Daily Cover	14,900	1.5	3.1%	17,400	1.7	3.2%	21,169	2.1	3.5%	19,307	1.9	3.4%	-8.8%
Sub-Total, Disposal Related	149,100	14.9	31.1%	109,300	10.9	19.9%	94,163	12.3	15.7%	151,886	15.2	26.7%	61.3%
Landfill Disposal	154,000	15.4	32.2%	249,400	24.9	45.4%	298,084	29.5	49.6%	217,909	21.8	38.2%	-26.9%
Total Managed	479,000	47.9	100.0%	549,800	55.0	100.0%	601,024	62.5	100.0%	569,684	57.0	100.0%	-5.2%
Whole Waste Tire Imports	26,800	2.7	5.6%	29,500	3.0	5.4%	61,874	6.2	9.9%	63,334	6.3	11.1%	2.4%

4.2 Retreading

Retread companies experienced a stable year in 2023, with a minor decrease of 3 percent. The market indicators show stabilization and slight growth extending into 2024. Figure 5 shows an estimated 3 percent decrease in the quantity of retread tires in 2023 compared to 2022, totaling 55,645 tons (5.6 million PTEs, or 9.8 percent of all waste tires managed). This data, based on interviews with California and national industry professionals, was caused by significant supply chain disruptions that affected new tire supplies and increased new tire pricing. Retread businesses capitalized on this trend by fortifying their inventory, enabling them to seize the growth opportunity. The Retread industry appears to be stable with slight growth into 2024. CalRecycle's Retread Tire Services (RTS) Contract (2020 – 2022), contracted to DK Enterprises and supported by the Tire & Retread Information Bureau (TRIB) continued to gain interest and offered recommendations for furthering CalRecycle's support of the Retread. The RTS Contract resulted in producing a series of seven virtual Retread Plant Tour Workshops, a video and marketing material. The education materials are available on CalRecycle's website.

Figure 5 Estimated California-Generated Retread Tire Shipments, 2009-2023*



*See Figure 5 Source Data in Appendix C.

4.3 Used Tires

In 2023, an estimated 44,203 tons of used tires (4.4 million PTEs, or 7.8 percent of all waste tires managed) were culled from the waste tire stream. California Vehicle Code 27465(b) VC is the law that makes it a traffic offense for someone to drive a motor vehicle with tires that have overly worn tire treads. This statute imposes a minimum tread depth of at least 1/8th inch for front tires and 1/16th inch for rear tires.

Waste tires that are no longer mounted on a vehicle but are still suitable for use on a vehicle in California are considered used tires. The used tires are distributed for resale in tire shops throughout California. Similarly, importers of used tires in Mexico purchase a small portion of used tires managed in California, to be resold at tire shops in Mexico. Tires purchased by importers in Mexico are subject to an import quota enacted by the Government of Mexico, limiting importation of used tires to approximately an average of 760,000 used tires per year. Further, regulations in Mexico also require importers of used tires into Mexico to be registered as an importer and to pay an import fee for each tire. The market for used tires within California proves to be profitable and is expected to remain consistent in 2024. This market is difficult to track and is likely under reported.

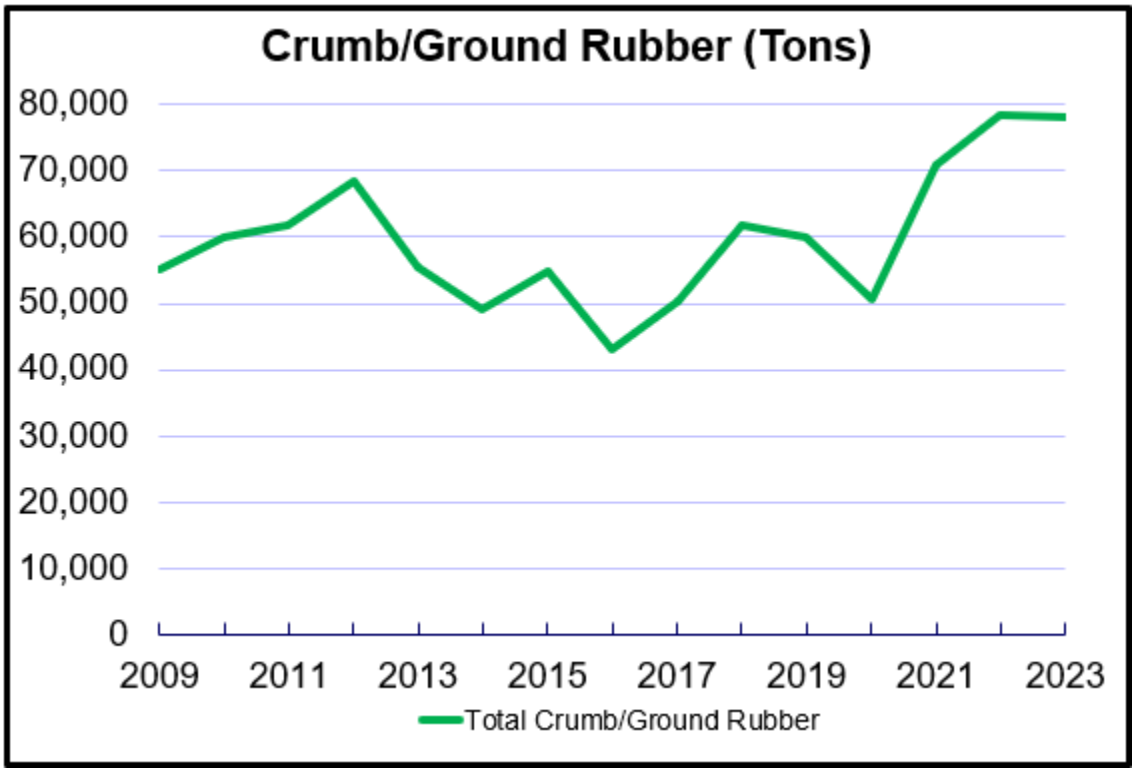
4.4 Crumb Rubber and Ground Rubber

In this report, crumb rubber and ground rubber are combined into a single category to report total quantities shipped, as shown in Figure 6 below and Table 2 above. However, there is some differentiation of four sub-categories of crumb/ground rubber uses. The categories are:

- Paving and chip seal surface treatments.
- Infill used on synthetic turf athletic fields and sport and playground surfacing applications.
- Molded and other products (e.g., flooring, roofing, ADA transition ramps, traffic safety devices, mats, and tiles, etc.).
- Miscellaneous products and uses made with ground rubber, including landscape surfaces, loose-fill playgrounds, and some ballistics applications, among others.

As illustrated in Figure 6, estimated shipments of California-generated crumb rubber and ground rubber decreased by 0.2 percent in 2023, totaling 78,159 tons (156.3 million pounds, 7.8 million PTE, or 13.7 percent of all waste tires managed). 2023's stable tonnage (very slight decline) follows an upward trend in 2021 and 2022.

Figure 6 Shipments of California-Generated Crumb Rubber and Ground Rubber, 2009-2023



See Figure 6 source data in Appendix C.

In addition to crumb rubber and ground rubber, raw and screened buffing's of different specifications are also used in certain TDPs (e.g., molded products, playground surfacing, and landscape mulch). Buffing's are removed from the tread of a retreaded tire and are produced as a by-product of the retreading process. We estimate that well over 15 million pounds of buffing were shipped to users by California retread businesses in 2023. It is important to note that, to avoid double counting, buffing materials are not included in recycling tonnage because the retreaded tires they originated from are already counted. As of 2024, buffing's continue to be in high demand. If the number of retreads declines, so does the amount of buffing used in the manufacture of TDPs.

Paving

California producers shipped 49 thousand tons of crumb rubber for use in asphalt paving projects in 2023, the same number of tons shipped in 2022. About half of all road projects are completed by municipalities and not Caltrans. Many industry representatives mentioned they had expected greater increases in demand by Caltrans due to enactment of SB1, the Road Repair and Accountability Act of 2017. However, SB1 funds are allocated to both state and local jurisdictions and are used for a wide variety of infrastructure improvements, many that do not involve rubberized asphalt

placement or use. That along with environmental concerns have resulted in an increase in bids for materials and services other than rubberized asphalt paving.

Caltrans has a statutory minimum requirement of 11.58 pounds of crumb rubber modifier per metric ton of the total asphalt paving materials used. In 2022 they used 12.63 pounds of crumb rubber per metric ton of asphalt paving used. In 2023 the draft values show a continued decrease to 11.7 pounds per metric ton of asphalt paving, which is still above the statutory minimum. It is expected to stabilize at just above the minimum for future years.

In 2023, they used about 2.6 million metric tons of Hot Mix Asphalt, a decrease from the 2022 value of 2.7 million. Of the Hot Mix Asphalt used by Caltrans in 2023, 35 percent was rubberized and reflects the 33 million lbs. of crumb rubber used, a slight decrease from the previous year's 34 million lbs. used in Rubberized Hot Mix Asphalt (RHMA) placement by Caltrans.

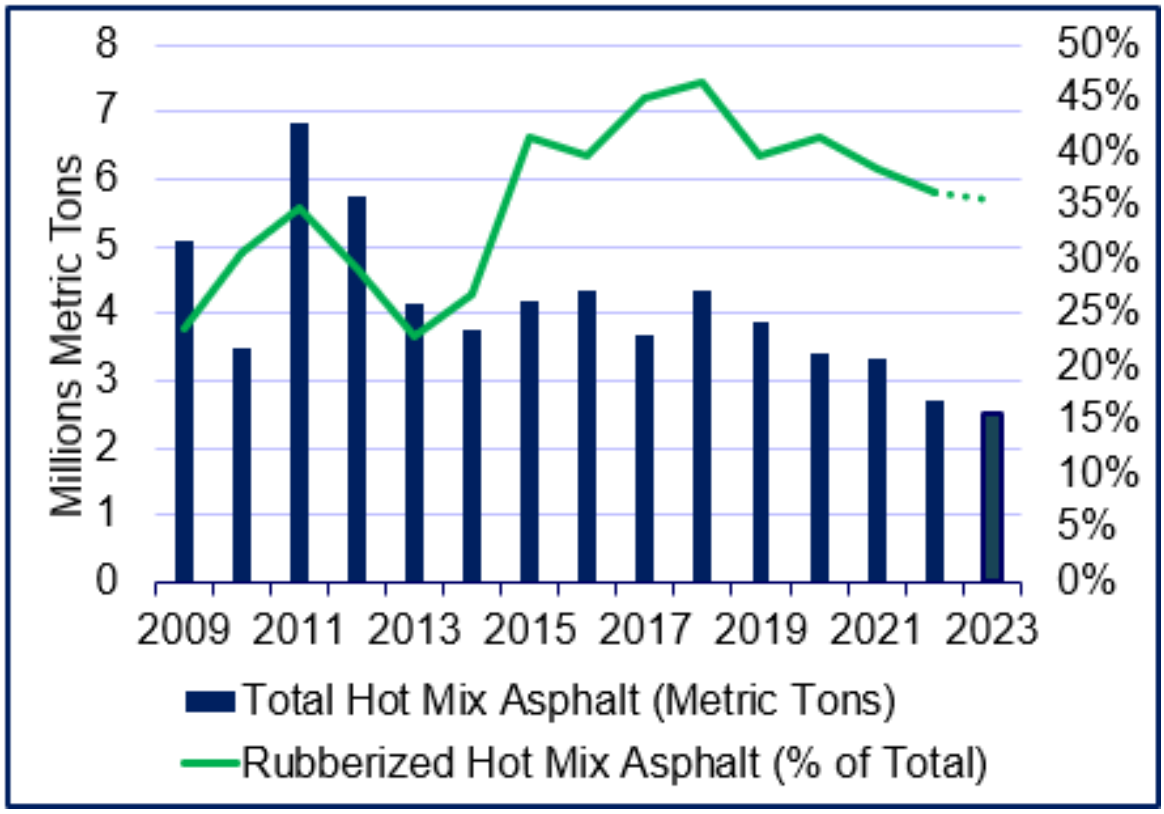
Figure 7 illustrates this trend, showing reductions in the total amount of asphalt placed over each of the last four years. While Caltrans has satisfied the mandate of minimum pounds per metric ton of asphalt, the actual percentage has declined in recent years.

Caltrans tracks crumb rubber use in four pavement categories, Pavement Preservation, Capitol Preventative Maintenance, Rehabilitation, and New Capacity. Annual rubber usage for Capitol Preventative maintenance and Pavement Preservation were reported to decline from 2022 to 2023 by Approximately .4 million Metric Tonnes (.44092 million US Tons), while Rehabilitation and New Capacity categories were reported to increase by approximately .1 million Metric Tons (.11 US million Tons).

Since 2018 the RHMA percentage decrease has a general correlation to the total hot mix asphalt placed. However, in the future, Caltrans is expected to meet their mandated percentage of rubber usage in hot mix asphalt therefore we would expect to see the Rubberized Asphalt percentage to remain at 35 percent or greater regardless of the amount of total placed. CalRecycle outreach and training has been ongoing for multiple years and the current grant program for RHMA installation sees repeat local government usage and is oversubscribed, reflecting that areas are embracing the use of RHMA. CalRecycle has also previously published a basic introduction to RHMA Usage to accompany the outreach and training efforts. The Public Works Standards Greenbook has published standards for Asphalt Rubber Hot Mix and continues to update based on new proven technologies and methods.

For smaller areas with smaller size projects, the current method of RHMA installation is slightly more costly than traditional asphalt and has specific technical placement requirements that can reduce its attractiveness.

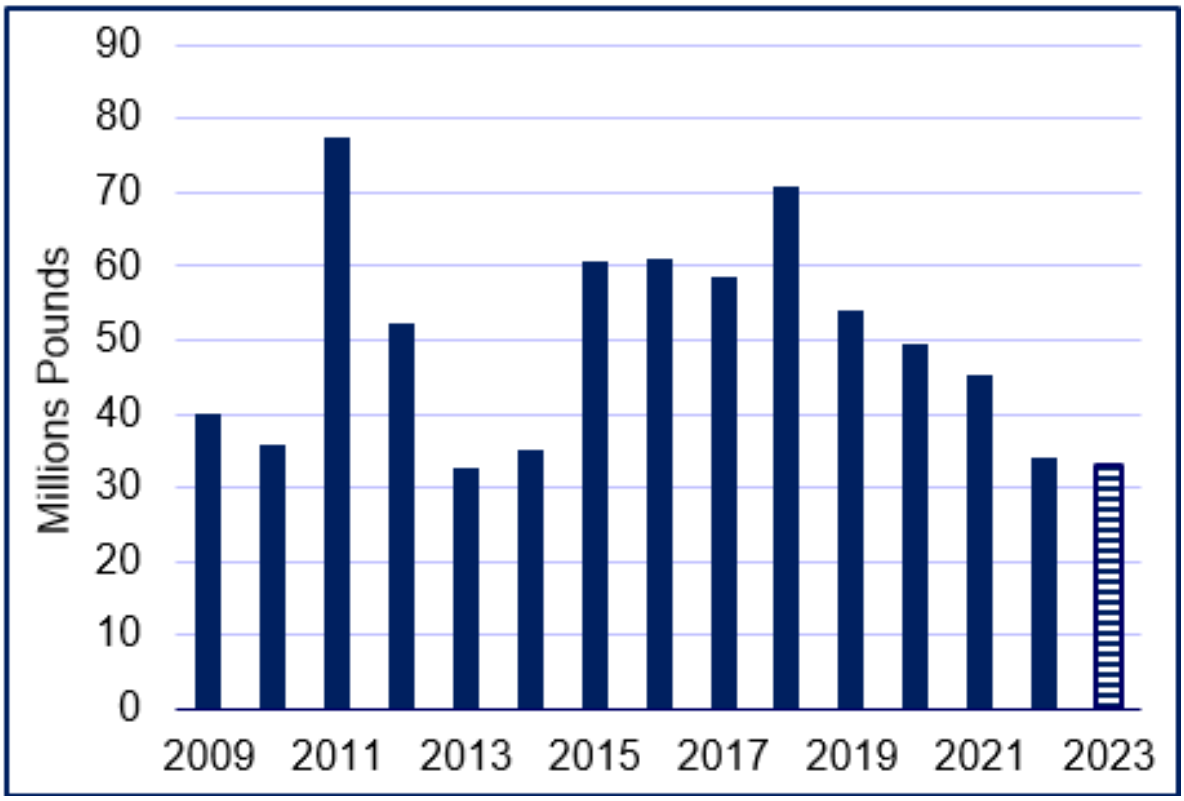
Figure 7 Caltrans Asphalt Placement and Rubberized Asphalt Percent of Total, 2009-2023 [9]



See Figure 7 source data in Appendix C.

The net pounds of crumb rubber used is depicted in Figure 8, indicating a reduction in estimated annual Caltrans crumb rubber use to about 33 million pounds in 2023. Since 2009, with removal of the 2011 and 2018 outlier points, Caltrans has used an average of 46.5 million pounds of crumb rubber each year.

Figure 8 Caltrans Annual Use of Crumb Rubber in Paving Applications, 2009-2023*[10]



*See Figure 8 source data in Appendix C.

Many California local governments use crumb rubber in paving projects. CalRecycle supports a portion of this use through the Rubberized Pavement Grant Program (TRP). In the most recent grant cycle for the 2023-24 fiscal year, 29 projects were approved with a combined projected total use of 12.2 million pounds of crumb rubber, intended for use in projects through the end of the grant cycle in April 2024. Historically, the program has funded an average annual use of 8.8 million pounds of crumb rubber each year. This average is based on the analysis of eight years of completed grants, culminating in the 2021-22 fiscal year. Data from the most recent grant cycles are not used because, historically, the actual use is typically less than the amount estimated in grant applications due to changes or cancelations of some projects.

Molded and Other Products

California producers shipped over 9,711 tons of crumb rubber to manufacturers and installers of molded and other products in 2023, based on received survey responses. This diverse category includes a variety of applications such as roofing, flooring, tiles, traffic sign bases, ADA transition ramps, and more. The quantity of crumb rubber feedstock consumed by firms in this category ranges widely, with some using less than 50,000 pounds per year, while a few commonly use at least five million pounds annually.

CalRecycle's Tire Incentive Program (TIP) plays a crucial role in supporting most of the crumb rubber used in this category. The program offers direct payments to tire-derived product (TDP) manufacturers, providing 10 cents per pound for new and existing products that use a minimum of 5 percent crumb rubber in the product; 40 cents per pound for new feedstock conversion products using a minimum of 5 percent crumb rubber in the replacement of other raw materials (e.g., plastics, virgin rubber, other materials) or devulcanized TDM; and, 50 cents per pound for 50 mesh or finer crumb rubber used in the manufacturer of a new or existing product.

In the most recent TIP grant cycle for the 2023-24 fiscal year, seven companies were awarded grants, with combined projected use of 16.0 million pounds of crumb rubber through April 2024. Based on the analysis of six years of completed grants culminating in FY 2019-20, the TIP program supported an average of 12.9 million pounds per year. It is important to note that data from the most recent grant cycles are not used because, historically, actual TDM use is typically less than the amount estimated in grant applications due to changes, postponement, or cancelation of some projects. TDM purchases and use can occur at any time within the three-year grant cycle.

CalRecycle's Feedstock Conversion Technical Assistance and Material Testing Services Contracts (FCS) (2017 – 2022) aimed to increase sales and expand demand for different and higher-value TDPs, supporting the Tire Incentive Program (TIP). DK Enterprises, as part of its role, supported the TIP by performing particle size testing as per ASTM International Standards D5603 (Classification) and D5644 (Test Methods) for material provided by the TDM suppliers and used by the TDP manufacturers. Support was also provided to encourage participation in TIP. Additionally, the contractor produced an educational video tutorial and user guide titled "Test and Classify the Source of Recycled Rubber Video Tutorial and User Guide" to encourage closer collaboration between the TDM suppliers and new/existing TDP manufacturers.

Turf Infill

California producers shipped 20 million pounds of crumb rubber for use as infill in new and replacement synthetic turf athletic fields in 2023, with some sold out of state. The long-term trend since 2015 has been downward. This decline is attributed to the cautious approach of California feedstock suppliers and potential users awaiting the results of the Office of Environment Health Hazard Assessment (OEHHA study on potential health concerns.

For a small portion of replacement fields in California, the End-of-Life (ELT) crumb rubber sand mixture extracted from the dismantled fields was reused in new replacement fields. Although, this practice is reportedly more common in the northeast and other U.S. regions and is currently not a widespread practice in California.

Other Ground Rubber Applications

Tire-derived materials (TDM) are used in other applications (e.g., playgrounds, landscape, other). As California feedstock suppliers and potential TDP grant users of

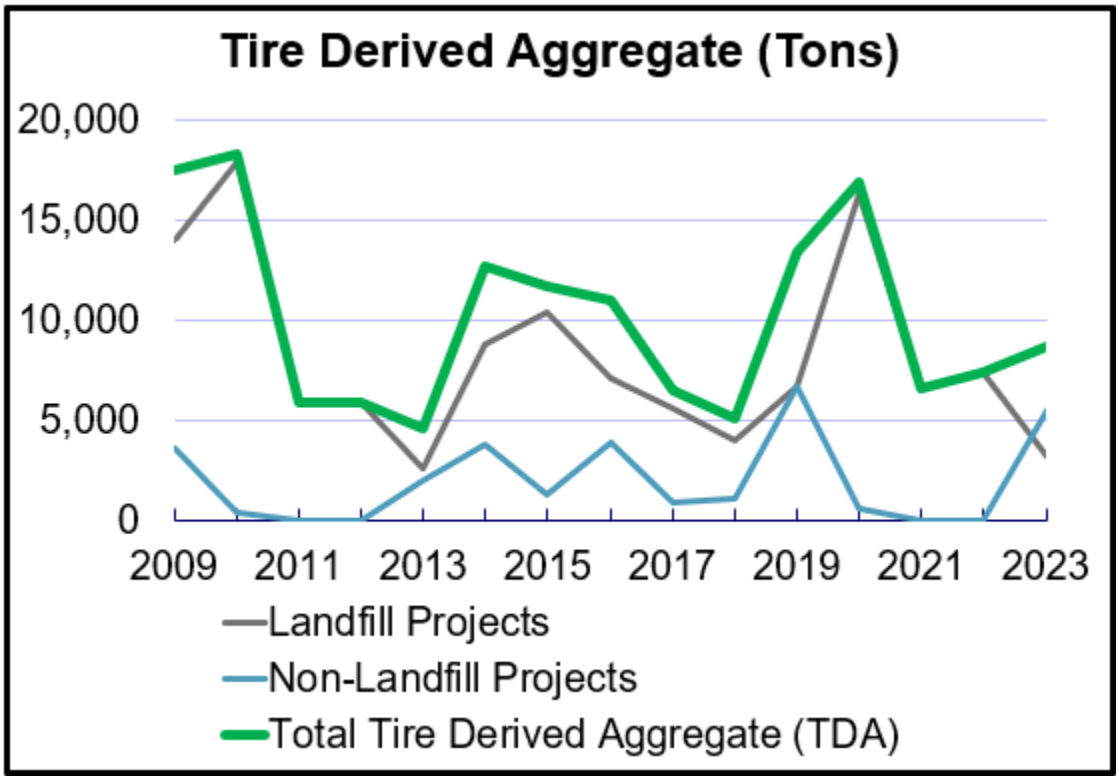
playground surfacing await the OEHHA study on potential health concerns, we expect to see the in-state market continue to be low through 2024.

4.5 Civil Engineering

Figure 9 shows how use of California-generated TDA in civil engineering projects has varied in recent years. In 2023, TDA use increased by 17.8 percent, totaling 8,682 tons (.87 million PTEs or 1.5 percent of all waste tires managed), compared to the 2022 usage of 7,371 tons (0.7 million PTEs or 1.2 percent of all waste tires managed). Notably, TDA was utilized in vibration mitigation projects and at landfills, primarily related to landfill gas collection systems, although some of those uses also involved road construction. Since 2011 non landfill TDA use has historically been between ~1500-4500 tons. There was one non-landfill use in 2023 as vibration mitigation material.

Outside of landfills, common TDA applications involve roadside repair, retaining wall backfill, embankment fill, stormwater infiltration galleries, and light rail vibration dampening projects, among others. Although recent environmental concerns have decreased the use of TDA in civil engineering applications, CalRecycle's TDA Grant Program support for these uses can lead to ongoing usage.

Figure 9 California-Generated Tire-Derived Aggregate Shipped for Use in Civil Engineering Projects, 2009-2023*



*See Figure 9 source data in Appendix C.

According to CalRecycle's TDA technical assistance team, a major contributing factor to the reduced demand for TDA is a 2020 study[11] linking a chemical known as 6PPD derived from tire wear particles to urban runoff mortality syndrome in coho salmon. The California Department of Toxic Substances Control's (DTSC) Safer Consumer Product Program has proposed to list motor vehicle tires containing 6PPD as a priority product and is anticipated to be listed in 2023 Adopted Priority Product: Motor Vehicle Tires Containing 6PPD | Department of Toxic Substances Control (ca.gov). CalRecycle is currently developing investigative research to understand how 6PPD-q may relate to TDA uses and projects, and how the project design can incorporate soil layer elements that will mitigate the potential release of 6PPD-q from TDA leachate to surface water or groundwater.

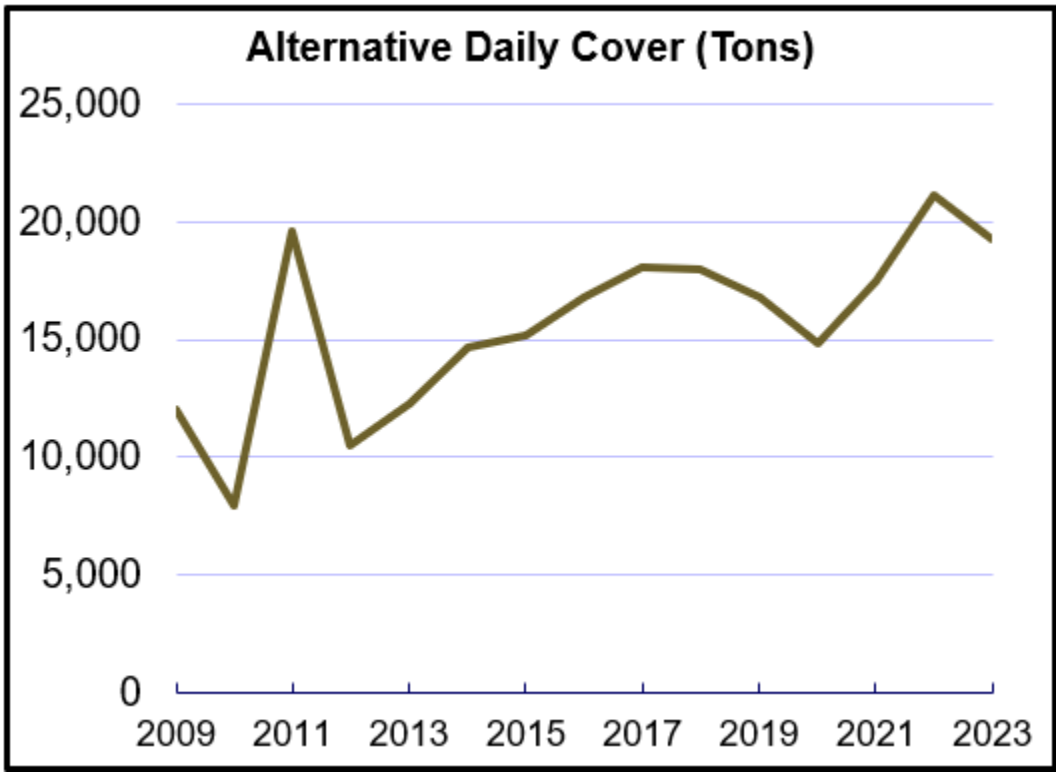
Separately, DTSC has also listed motor vehicle tires containing zinc as a priority product under the Safer Consumer Products Program. A recent CalRecycle sponsored Humboldt State University study[12] found that "use of rubberized hot mix asphalt pavement plays a minor role in the zinc concentration in runoff from road surfaces. Leaching of zinc from tire wear particles generated by vehicles on the roadway and from galvanized materials along the roadway are the largest sources of zinc in the runoff from roads identified in this work, and both deserve additional study."

Historically, based on an analysis of eight years of completed grants culminating in the 2022-23 fiscal year, the TDA Grant Program has supported 5,000 tons per year of TDA use. Data from the most recent grant cycles are not used because actual TDM use is typically less than the amount estimated in grant applications due to changes, postponements, or cancelations of some projects.

4.6 Landfill Alternative Daily Cover

The use of ADC is a disposal related activity as shown in Table 2. California landfills must apply an approved type of daily cover to the top of active landfill faces at the end of operations each day, and all landfill permits allow alternative materials, such as tire shreds. As Figure 10 shows, a significant quantity of tire shreds was used as alternative daily cover (ADC) in California. In 2023, 19,307 tons (1.9 million PTEs or 3.4 percent of all waste tires managed) were used as ADC. There are a few landfills that have consistently used tire shreds for ADC in the past, therefore we expect this amount to remain stable in the coming years.

Figure 10 California-Generated Tire-Derived Material Used as Landfill Alternative Daily Cover, 2009-2023*



*See Figure 10 source data in Appendix C.

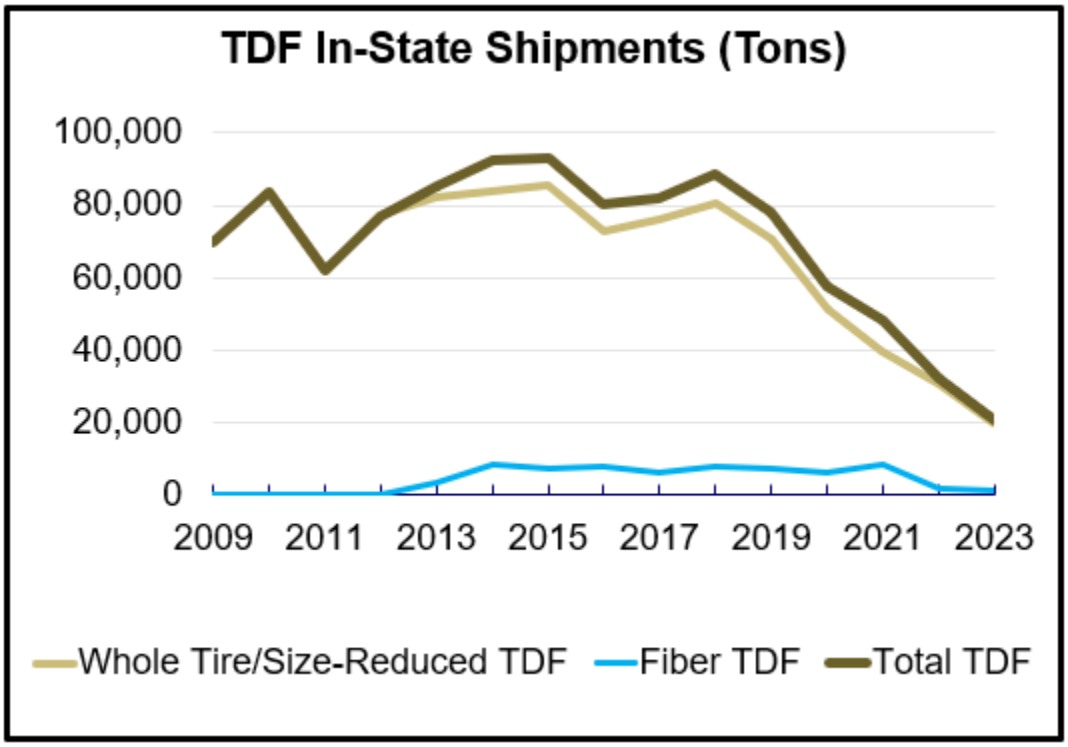
4.7 Tire-Derived Fuel (In-State)

Two California cement kilns continued to consume TDF in 2023. A third company stopped using waste tires as a fuel supply and the fourth cement company is now only using the fluff/fiber derived from waste tire processing as a fuel source based on its low cost and BTU value. At least one of the two cement companies was also not operating during its month-long maintenance period when the kiln was shut down. The cement companies dictate whether to accept material based on their volume requirements, particle specification, competitive fuel feedstocks, and their Green House Gas (GHG) emission values. Cement plants consistently seek the most economical and high BTU value feedstock and may change their preferred fuel at any time.

As illustrated in Figure 11, reported shipments of California-generated TDF declined in 2023 by 35.7 percent, totaling 20,858 tons (2.1 million PTEs, or 3.7 percent of all waste tires managed). This amount includes 19,558 tons (1.39 million PTEs) of whole waste tires and size reduced TDF, as well as 1,300 tons of tire fluff/fiber generated as residual by processors. Despite a national increase of 10 percent TDF use in cement, pulp and paper and industrial boilers its utilization in California has declined. In 2021 SB 596 was signed by Governor Newsom, which required the California Air Resource Board (CARB) to develop a comprehensive strategy for the cement sector to achieve a greenhouse gas emission intensity 40 percent below baseline levels by 2035 and net zero by 2045.

During 2022, CARB sponsored workshops were held to identify actions to overcome barriers to achieve the net zero goals.

Figure 11 California-Generated Whole Waste Tires, TDF and Residual Fluff/Fiber Consumed at California Cement Kilns, 2009-2023*



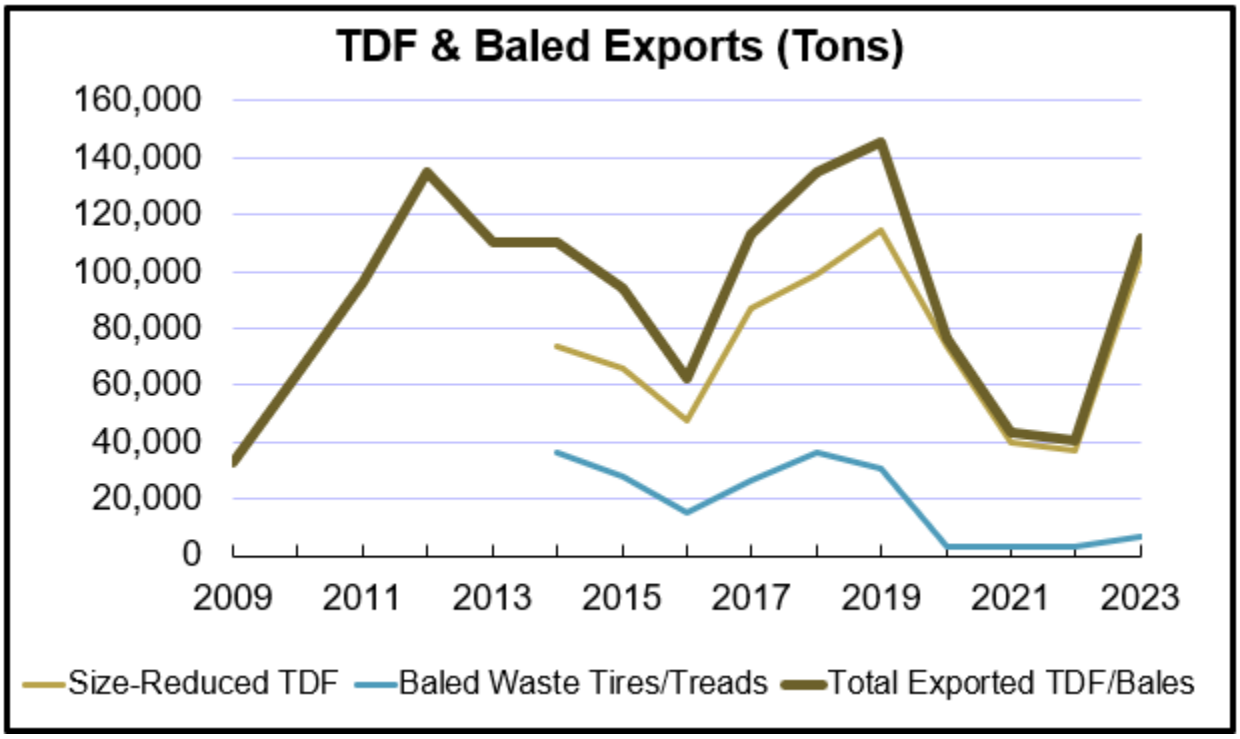
*See Figure 11 source data in Appendix C.

4.8 Tire-Derived Fuel and Baled Waste Tires and Truck Tire Treads (Export)

As Figure 12 shows, the export of California-generated TDF (e.g., size-reduced TDF, baled waste tires, baled truck tire treads) peaked in 2019 and continued to decline through 2022. In 2023 the exported TDM, including TDF, increased by 183.7 percent, totaling 105,091 tons (10.0 million PTEs, or 18.4 percent of all waste tires managed) in 2023. Japan and India were the largest users of TDM in 2023.

In 2023 the international demand for TDF resulted in large increases in exported altered waste tire rubber (e.g. shreds, baled), along with improved economic returns for California processors. The exported waste tire rubber is reportedly used for TDF and in some cases a source of material to produce crumb rubber in India. It is expected that the exported waste tire rubber tonnage will continue to increase in 2024.

Figure 12 California-Generated Exported TDF and Baled Waste Tires and Truck Tire Treads, 2009-2023*

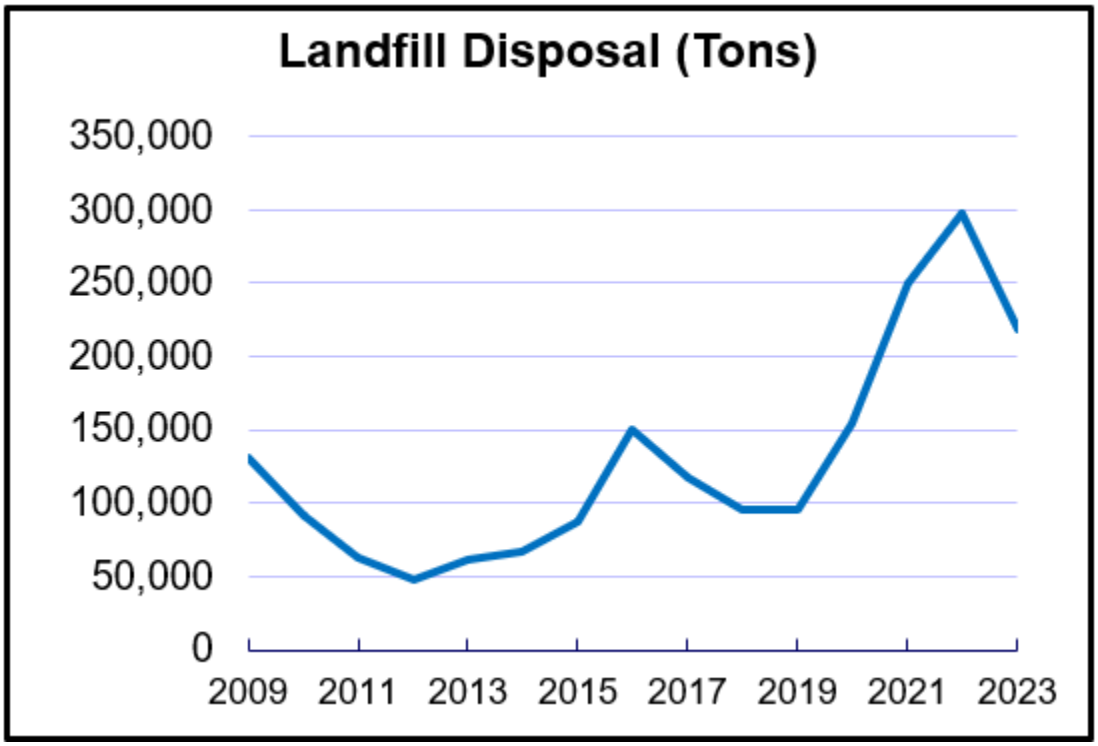


*See Figure 12 source data in Appendix C.

4.9 Landfill Disposal

As shown in Figure 13, following a 62 percent rise in 2021, the landfill disposal of California-generated waste tires increased again in 2022 by a 19.5 percent rise. The 2023 rate decreased by 26.5 percent, reaching 217,909 tons (21.7 million PTEs or 38.3 percent of all waste tires managed). In 2021 and 2022, the main contributing cause of the landfill disposal spikes was the disrupted export economics, logistical feasibility, and bans of imported TDM from previously accepting countries, leaving companies that typically export with limited options. In 2023 export demand increased dramatically, especially from India, and the exporting activities resulted in decreased landfill disposal. Landfill disposal is expected to continue to decrease in 2024, based on continued demand from overseas markets. The reason India is aggressively looking at receiving altered waste tires from the U.S. is that other countries have stopped the export of their tires or in the process of developing regulations to stop the export of waste tires.

Figure 13 California-Generated Waste Tires Disposed in Landfills, 2009-2023*



*See Figure 13 source data in Appendix C.

4.10 Waste Tire Imports

In 2023, an estimated 63,334 tons (6.3 million PTEs or 11 percent of all waste tires managed) were imported from out-of-state and flowed to a limited number of California processors. Most of the out-of-state inbound waste tires originated from Utah, Arizona and Oregon. The waste tire import tonnages are subtracted from the total managed tonnages for the respective processors and are not included in the recycling rate calculation.

5. The Outlook for Increased Waste Tire Recycling

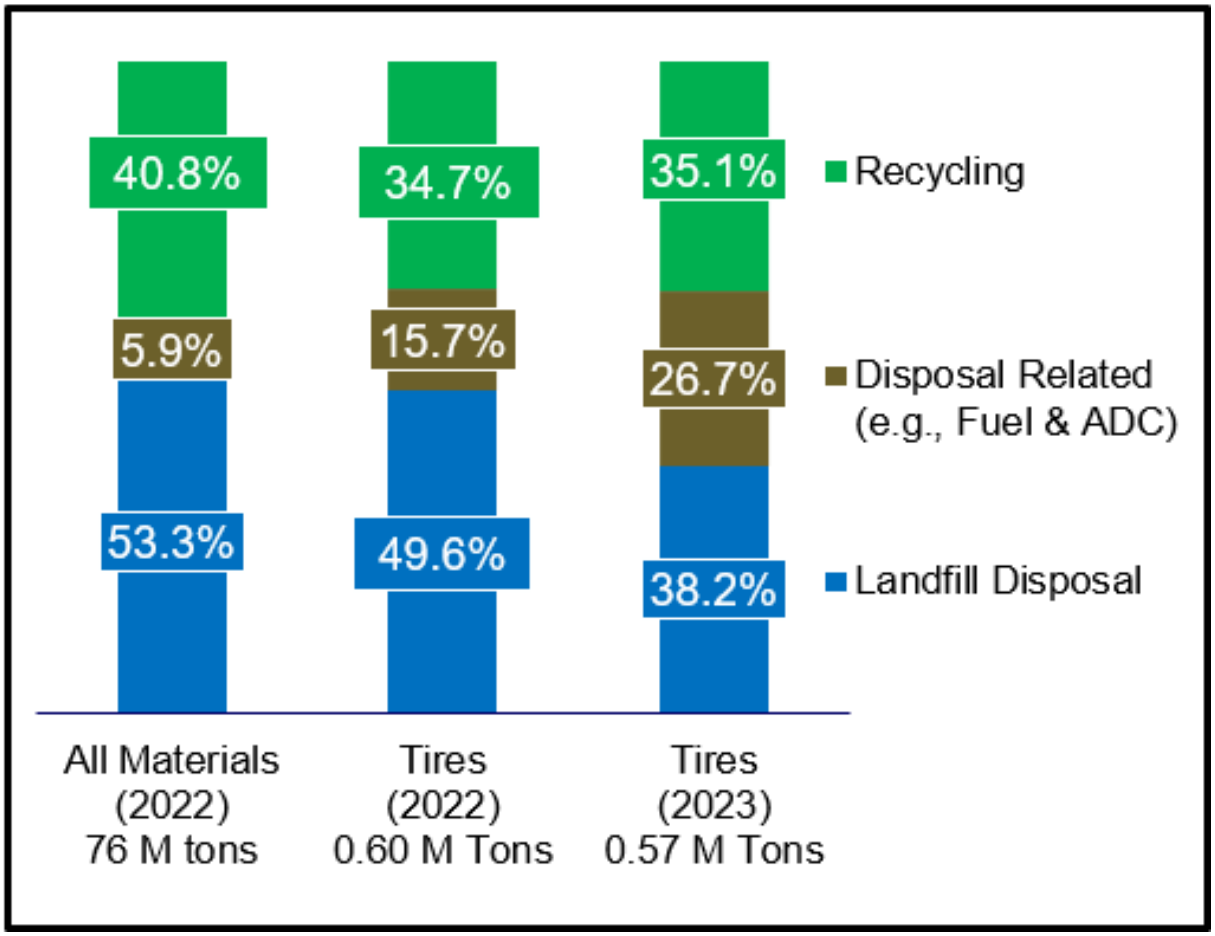
The following sections examine California waste tire management and recycling in the context of all types of waste, historical trends in waste tire recycling, and the outlook for increasing California waste tire recycling.

5.1 Waste Tire Recycling in the California Context

California has a mandatory statewide 75 percent recycling rate goal by 2020 for all waste types per AB 341 (Chesbro, Chapter 476, Statutes of 2011). While not codified in statute, CalRecycle has also informally adopted a 75 percent recycling goal specifically for waste tires. Consistent with AB 341, the recycling rate measurement excludes landfill ADC and fuel related uses, including TDF (included in the “disposal related” category to distinguish them from recycling (broadly defined to include reuse) and landfill disposal.

Figure 14 illustrates how California waste tire management compares to management of the entire waste stream. The figure shows the 2021 to 2023 breakdown for all waste materials

Figure 14 Comparison of All California Waste Materials and California Waste Tires Management*

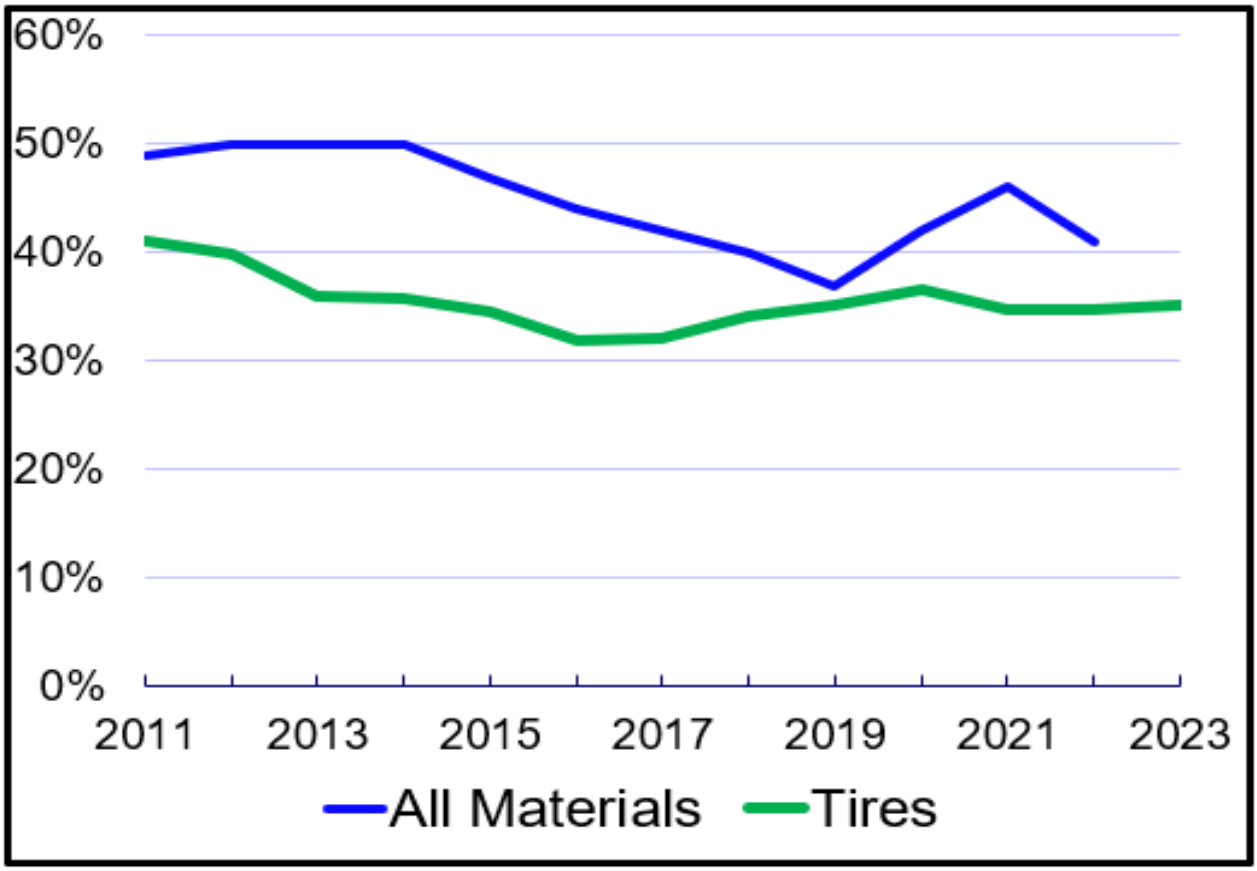


*See Figure 14 source data in Appendix C. Source for all materials: State of Disposal and Recycling in California

Figure 15 shows historical recycling percentage rates for All Materials compared to waste tire recycling percentage rates. The recycled groups used in CalRecycle's waste characterization studies are divided by material types, and then grouped into nine different commodity categories. In general, these categories contain types made from the same base material, such as paper, glass, or organics.

Traditionally, waste tire recycling rates have been lower than All Materials recycling rates, and recent years have seen similar trends in the change of rates for both All Materials and Tires. Based on interviews with industry experts, changes that affect the overall state recycling market are reflected in both rates simultaneously.

Figure 15 California All Waste Materials and California Waste Tires Recycling Rates, 2011-2023*

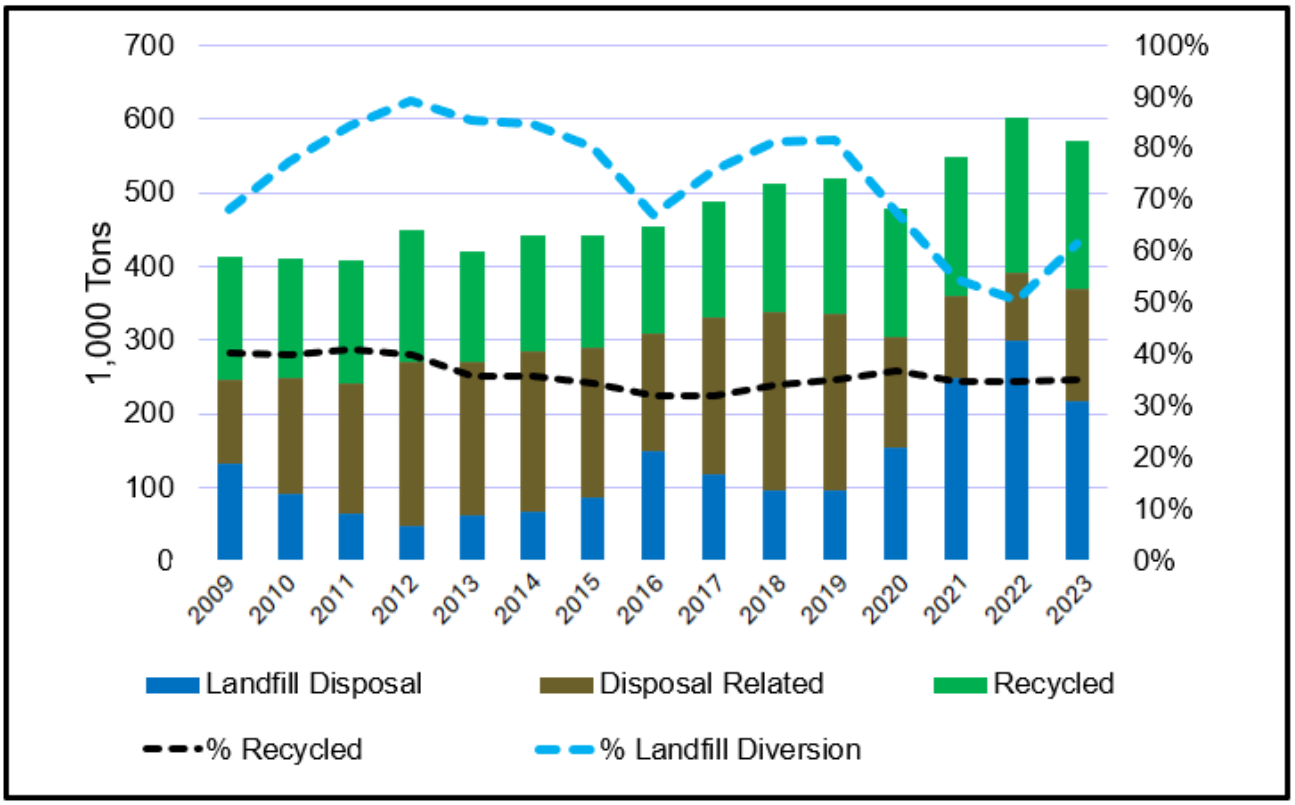


*See Figure 15 source data in Appendix C.

5.2 Historic Recycling, Disposal Related and Landfill Disposal Trend

As shown in Figure 16, the California waste tire recycled percentage fluctuated within a narrow range over the past 12 years. The rate reached a low point in 2016 of 32 percent, but has inched up slowly since then, reaching 35.1 percent in 2023. Export demand continues to change the dynamics in landfill disposal.

Figure 16 California Waste Tire Recycling, Disposal Related and Landfill Disposal Trend, 2009-2023*



*See Figure 16 source data in Appendix C.

5.3 Future Tire Recycling Trends and Considerations

Table 3 summarizes the short-term outlook for each market segment in 2023, building on the trends identified earlier in this report. Predicting growth in 2024 presents challenges, but here are several considerations:

- **Sustainability of 2023 Recycling.** The report highlights a 3 percent decrease in retreading and a .2 percent decrease in the crumb rubber/ground rubber market segment in 2023. Initial feedback suggests retreading is on track for stability and potential slight growth in 2024, industry has reported enthusiasm for continued CalRecycle support for the retreading market. The crumb rubber markets, especially in the local government paving and molded/other segments appear stable with the potential for slight growth.
- **Emergence of new products and markets.** The Tire Incentive Program in 2023 supports manufacturers utilizing crumb rubber in tire-derived products. Industry professionals recognize new markets and applications need to be developed for all sizes of TDM, not just for crumb rubber uses. Growth and investment in tire recycling is constrained by economic forecasts in California and increased regulatory and environmental concerns surrounding TDM use.

- **Continuation of Disruptions.** Persistent challenges in 2023 include staffing shortages, staffing benefits, elevated trucking and ocean shipping costs, and inflation. These challenges are likely to continue to constrain business operations and market expansion in most waste tire management and recycling industry segments through 2024 by adding complications and costs.
- **Impact of Business Ownership Changes and Investments.** In 2023, the industry witnessed continued changes and consolidations in TDP manufacturers, retread, and other market segments, that had started in 2022. The long-term impact is yet to be fully realized and will continue to change the markets into 2024. Investments that align with customer needs, especially in high-volume applications, have the potential to drive tire recycling expansion.

Table 3 The Outlook for California Waste Tire Recycling

Category	2023 Tons	2023 M PTEs	2023 % Total	Outlook Toward 2024
Retreads	55,645	5.6	9.8%	Stability and slight growth
Used Tires	44,203	4.4	7.8%	Stable, increase, related to total managed
Crumb Rubber and Ground Rubber	78,159	7.8	13.7%	Stable with reports of slight increase
Civil Engineering (TDA)	8,682	0.9	1.5%	Relatively steady landfill use, environmental concerns continue to restrict non landfill projects
Other Recycling	13,200	1.3	2.3%	Stable usage expected, 2023 saw some businesses closed or changed ownership
Total Recycling	**199,889**	**20.0**	**35.1%**	**Stable percentage of total managed**
TDF (In-State)	20,858	2.1	3.7%	Continued decrease toward stability
TDM (Export)	111,721	11.2	19.6%	Expected increases in exported TDM, including TDF due to international demand
Landfill Alternative Daily Cover	19,307	1.9	3.4%	Slight decrease overall, steady use at a few landfills
Total Disposal Related	**151,886**	**15.2**	**26.7%**	**Increase, related to TDF export demand**
Landfill Disposal	217,909	21.8	38.2%	Continued decrease, total tonnage managed and TDM export have strong influence on landfill disposal
Overall Diversion	351,775	35.2	61.7%	Increase related to export market
Waste Tires Managed	569,684	57.0	100.0%	slight increase based on economics and increasing passenger tire size and EV tire wear rate

5.4 Concluding Remarks

California has a robust and diverse waste tire management infrastructure. In the upcoming years there is potential for growth in recycled tire tonnages, especially within the retread, paving, and molded/other market segments. Continued changes and consolidations in business ownership and investments aimed at expanding or enhancing waste tire recycling operations may further bolster this positive trajectory. To sustain growth, there is a crucial need for ongoing expansion and diversification in TDP markets. Developing and expanding CalRecycle programs that promote existing and new markets would be advantageous.

CalRecycle has multiple ongoing programs aimed at improving recycling. They include, the Rubberized Pavement (TRP) Grant Program, the Tire Incentive Program (TIP), and the Tire Derived Aggregate Program (TDA).

With added waste tire volume from the expansion of EVs and production of new larger OEM tires, it is expected to see future increases in Waste tire generation. Heavier vehicles, which include EVs use tires up to 30 percent faster and the annual sales of EVs are projected to increase by 50 percent by the end of 2023[13]. This along with the trend of new OEM tires being larger and therefore comprised of more rubber material, is contributing to the yearly waste tire tonnage of California and the nation.

With the continued increase in demand for exported TDM we will continue to see declines in landfilling through 2024 and beyond.

With the potential increases in waste tire tonnage on the horizon, it may be beneficial for the tire program to explore developing new ways to promote source reduction. Source reduction activities can include promoting proper tire maintenance and methods for tires to last longer on a vehicle, carpooling, public transportation use, and bicycle and pedestrian pathway use.

While the conditions for a transformative leap in tire recycling might not be fully established, there is promising potential for incremental progress. CalRecycle communication with industry and stakeholder involvement are critical to the success of the CalRecycle's programs. California's waste tire management programs remain strong, ensuring effective management of the state's generated waste tires.

Appendix A, Glossary of Key Terms and Acronyms

6PPD: An organic chemical widely used as stabilizing additive (or anti-degradant) in rubbers; all of which are common in vehicle tires. Although it is an effective antioxidant it is primarily used because of its excellent antiozonant performance. It is one of several antiozonants based around p-phenylenediamine.

6PPD-q: 6PPD-quinone is an oxidation product of 6PPD, an additive intended to prevent damage to tire rubber from ozone.

ADC: Alternative Daily Cover used at landfills instead of soil.

Buffings: Tire rubber produced as a by-product of the tire retreading process and use.

California-Generated: As used in this report, this term refers to waste tires generated in California and/or tire-derived materials or products made from waste tires generated in California, excluding any amounts derived from waste tires imported into California.

Caltrans: California Department of Transportation.

CARB: California Air Resources Board.

Circular Economy: An economic system where products and services are traded in closed loops or cycles. It tackles global challenges like climate change, loss of biodiversity, waste, and pollution. Circular Economy aims to redefine growth, focusing on positive society-wide benefits. It is based on three principles: Design out waste and pollution; keep products and materials in use; regenerate natural systems.

Comprehensive trip log (CTL): Paper or electronic forms used by haulers and waste tire facilities to document waste and used tire pickup or delivery transactions. Forms are submitted to CalRecycle and entered in the Waste Tire Manifest System database.

Crumb rubber: Tire-derived material equal to or less than ¼ inch in size, free of wire and fiber. In this report the broad category Crumb Rubber and Ground Rubber is defined to include the following three sub-categories of products made from crumb rubber:

- Paving, including rubberized hot mix asphalt and chip seal surface treatments.
- Infill used on synthetic turf athletic fields and other sports surfacing applications.
- Molded and other products that use crumb rubber include flooring mats and tiles, ADA transition ramps, traffic safety related products, plumbing coupling fittings, and roofing.

Disposal-Related Activities: As defined in CalRecycle's annual State of Disposal and Recycling Reports, a set of activities considered as part of overall disposal: alternative daily cover, alternative intermediate cover, other beneficial reuse at landfills (such as

construction activities, landscaping, and erosion control), transformation, engineered municipal solid waste, and waste-tire derived fuel.

DTSC: California Department of Toxic Substances Control.

EVs: Electric Vehicles.

End-of-Life Tire (ELT): Refers to tire products that have reached the end of their useful life and are ready to be discarded and managed, whether through reuse, recycling, landfill disposal, or another means.

Feedstock conversion: The process whereby a manufacturer converts a portion of the raw materials (e.g., virgin rubber, EPDM, plastic, aggregate, or other raw material) used to make a product with recycled tire rubber.

Ground Rubber: The tire-derived material is larger than ¼ inch and up to one inch in size. For some applications the material is referred to as landscape nuggets. It is also used in walkways, playground applications, and ballistic walls. In this report Ground Rubber is also a sub-category of products within the broader Crumb Rubber and Ground Rubber category that includes any product made with ground rubber.

Landfill Disposal: Disposal of waste materials at a landfill, excluding materials disposed of as part of LFG and ADC activities.

Landfill Gas (LFG): LFG can be captured, converted, and used as a renewable energy resource.

OEHHA: California Office of Environmental Health Hazard Assessment.

OEM: Original Equipment Manufacturer.

Passenger tire equivalent (PTE): 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.)

Retread tire: A quality casing satisfying established standards to which a new tread has been affixed to extend the usable life of the tire.

Tire-derived aggregate (TDA): Tire-derived material used to replace conventional aggregates like rock in civil engineering applications.

Tire-derived fuel (TDF): Whole waste tires or tire-derived material consumed as fuel (referred to as size reduced TDF in this report). Residual tire fiber from crumb rubber operations sent used as fuel in California cement kilns is also categorized as tire-derived fuel in this report.

Tire-derived material (TDM): Tires processed to meet market specifications, for example, crumb rubber, ground rubber, tire-derived aggregate, road infrastructure projects and tire-derived fuel.

Tire-derived product (TDP): Product made entirely or in part from tire-derived material.

Tire Incentive Program (TIP): A CalRecycle program launched in June 2015 to promote feedstock conversion and the use of crumb rubber as feedstock by California manufacturers.

Used Tire: 30 PRC § 42806.5 defines "used tire" as a tire that: a) is no longer mounted on a vehicle but is still suitable for use as a vehicle tire; b) meets applicable requirements of the Vehicle Code and Title 13 of the California Code of Regulations; and c) meets specified storage requirements.

Waste Tire Manifest System (WTMS): Waste Tire Management System. A CalRecycle database containing information on waste tire management firms, permits, and submitted comprehensive trip log data.

Waste Tire: 30 Public Resources Code (PRC) § 42807 defines a "waste tire" as a tire that is not mounted on a vehicle and is no longer suitable for use as a vehicle tire due to wear, damage, or deviation from manufacturer original specifications.

Appendix B Methodology

The main goal of the annual Waste Tire Market Report series is to document California waste tire recycling trends, the recycling rate and the quantity of California-generated waste tires managed (including used tires and retread tires) along with trends in each segment they ultimately flow to.

Conducting the annual market analysis involves the following steps:

- Update a list of currently operating California facilities and companies waste tire management, including processors, TDP manufacturers and installers, asphalt rubber blender operators, brokers, retreaders, cement kilns, and landfills that dispose waste tires. Sources include CalRecycle databases, industry networking, online searching.
- Compile information on these facilities through surveys, interviews, CalRecycle databases (e.g., Waste Tire Manifest System) and online searches.
- Enter facility specific data into a customized flow model spreadsheet and systematically analyze flows, with emphasis on flows to and from waste tire facilities to end-use market segments. This is an iterative process in which researchers identify issues and follow up with facilities repeatedly to refine and validate the analysis. The process continues until researchers conclude the findings are as complete and accurate as possible, while avoiding double-counting.
- Where data is unavailable or contradictory, estimations are made based on the information available, and perspectives offered by industry representatives.

Readers should keep the following in mind when interpreting and using findings:

- Findings reported in the main body of the report are rounded to the nearest one hundred tons, reflecting a reasonable level of accuracy. However, the underlying source data used to generate charts, as presented in Appendix C, lists the exact numerical estimates generated through the customized flow model.
- The findings quantify California-generated waste tires and TDM/TDPs made from waste tires. Imported waste tires and TDM/TDPs made from them are excluded from the California-generated findings, as are buffing's from retread operations, since the rubber has already been “counted” as part of the retreading process.
- The findings do not represent estimates of California’s total market for TDM or TDPs.

- The waste tire market report series employs a consistent methodology that the authors strive to refine and improve over time. This includes extensive data gathering and validation through multiple sources wherever possible, as well as rigorous and systematic data analysis. Because of this, despite the need to address data gaps and inconsistencies, the authors believe the findings provide reasonably accurate information that can be used to evaluate trends over time.

Appendix C Accessibility Notes and Source Data

The following is the source data used for charts and figures in this report. Note that in the body of the report, findings are rounded to the nearest one hundred, reflecting a reasonable level of accuracy. However, in this appendix we present the exact estimates as generated in the waste tire flow model used by the study team to produce charts that reflect the best information available.

Supporting data for Figure 7 and 8 is derived from Caltrans annual Crumb Rubber Reports. (2023 data are draft estimates.)

Table C-1 Source Data for Figure 1 California Waste Tire Flows in 2023

Category	2023 Tons	2023 %
Retreads	55,645	9.8%
Used Tires	44,203	7.8%
Crumb/Ground Rubber	78,159	13.7%
Civil Engineering (Tire-Derived Aggregate)	8,682	1.5%
Other Recycling	13,200	2.3%
Tire-Derived Fuel (In-State)	20,858	3.7%
Tire-Derived Fuel (Export)	105,091	18.4%
Exported Baled and Cut Waste Tires	6,630	1.2%
Alternative Daily Cover	19,307	3.4%
Landfill Disposal	217,909	38.3%
Total Managed	**569,684**	**100.00%**
Total Recycled	**199,889**	**35.1%**
Total Disposal Related	**151,886**	**26.7%**

Table C-2 Source Data for Figure 2 California Waste Tire Recycling, Disposal Related and Disposal Trends, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770	87,170
Disposal Related	114,968	155,603	177,500	222,695	207,754	217,043	202,382
Recycled	165,997	164,206	167,516	179,768	150,741	158,094	152,767
% Recycled	40.3%	39.9%	41.0%	39.9%	35.9%	35.8%	34.5%
% Landfill Diversion	68.2%	77.7%	84.5%	89.4%	85.3%	84.9%	80.3%

Category	2016	2017	2018	2019	2020	2021	2022	2023
Landfill Disposal	150,226	117,448	95,401	95,412	154,050	249,377	298,084	217,909
Disposal Related	159,654	213,707	241,597	240,503	149,099	109,347	94,163	151,886
Recycled	145,288	156,994	174,264	182,438	175,868	193,197	208,777	199,889
% Recycled	31.9%	32.2%	34.1%	35.2%	36.7%	35.0%	34.7%	35.1%
% Landfill Diversion	67.0%	75.9%	81.3%	81.6%	67.8%	54.8%	50.4%	61.7%

Accessibility Notes for Figure 3, California Waste Tire Recycling Industry Flow Chart

This chart illustrates how California waste tires, tire-derived material (TDM) and tire-derived products (TDPs) flow between various entities. Haulers pick up waste tires from generators and may deliver them to either a landfill for disposal; a processor (who may produce TDM); a used tire buyer or seller; or a TDF consumer (i.e., one of four California cement kilns). Processors may dispose of whole tires or size-reduced material at a landfill or divert the size-reduced TDM for use in the following: civil engineering projects and other beneficial uses; for sale as used tires; for use as a compound mix in the manufacture of TDPs and installed applications; and TDF use at cement plants in the production of cement. Imports into California and exports from California include Whole waste tires, TDM and TDPs, retread tires and buffings, used tires, tire-derived fuel (size-reduced tires, baled waste tires and truck tire treads). Such imports may flow to California processors, TDP manufacturers and installers, TDF consumers, or directly to customers. Such exports may flow from California processors, TDP manufacturers, used tire buyers and sellers, and retreaders.

Categories of manufacturers and installers include:

- Accessibility ramps
- Flooring
- Landscape surfaces
- Mats, pavers, and tiles
- Paths, walkways, and sidewalks
- Pavements
- Playground surfaces
- Sport surfaces
- Synthetic turf infill
- Retreading
- Roofing
- Traffic related products

Types of civil engineering applications include:

- Landfill projects
- Light-weight fill
- Retaining wall backfill

- Vibration dampening
- Storm water management

Finally, TDP manufacturers and installers, civil engineering project leads, and TDF consumers sell products directly to their customers, inside and outside of California.

Table C-3 Source Data for Figure 4
Historical Market Trends by Segment, 2009-2023

Category	2009	2010	2011	2012	2013
Landfill Disposal	131,152	92,033	63,444	47,908	61,682
ADC	12,042	7,928	19,589	10,486	12,316
Exported TDF & Bales	33,000	64,000	96,000	135,000	110,144
In-State TDF	69,926	83,675	61,911	77,209	85,295
Other Recycling	12,221	12,121	13,427	14,059	12,166
Civil Engineering	17,510	18,274	5,915	5,844	4,557
Crumb/Ground Rubber	55,000	59,850	61,700	68,350	55,350
Used Tires	37,266	37,942	45,823	51,678	38,033
Retread	44,000	36,018	40,651	39,838	40,635
Total Managed	**412,117**	**411,842**	**408,459**	**450,372**	**420,177**

Category	2014	2015	2016	2017	2018
Landfill Disposal	66,770	87,170	150,226	117,448	95,401
ADC	14,691	15,217	16,798	18,108	17,975
Exported TDF & Bales	110,000	94,000	62,476	113,405	135,236
In-State TDF	92,352	93,165	80,380	82,194	88,386
Other Recycling	11,643	12,114	9,790	10,433	16,791
Civil Engineering	12,632	11,668	10,961	6,431	5,127
Crumb/Ground Rubber	49,200	54,700	43,165	50,345	61,728
Used Tires	42,278	30,927	39,032	41,375	42,692
Retread	42,341	43,358	42,341	48,409	47,925
Total Managed	**441,907**	**442,318**	**455,168**	**488,149**	**511,262**

Category	2019	2020	2021	2022	2023
Landfill Disposal	95,412	154,050	249,377	298,084	217,909
ADC	16,784	14,876	17,440	21,169	19,307
Exported TDF & Bales	145,412	76,612	43,664	40,537	6,630
In-State TDF	78,307	57,611	48,243	32,457	20,858
Other Recycling	16,442	11,862	18,082	16,587	13,200
Civil Engineering	13,330	16,911	6,575	7,371	8,682
Crumb/Ground Rubber	59,985	50,530	70,862	78,341	78,159
Used Tires	44,757	51,036	43,044	49,112	44,203
Retread	47,925	45,529	54,635	57,366	55,645
Total Managed	**518,353**	**479,017**	**551,921**	**601,204**	**569,684**

Table C-4 Source Data for Figure 5 Estimated California-Generated Retread Tire Shipments, 2009-2022

Category	2009	2010	2011	2012	2013	2014	2015	2016
Retreads	44,000	36,018	40,651	39,838	40,635	42,341	43,358	42,341

Category	2017	2018	2019	2020	2021	2022	2023
Retreads	48,409	47,925	47,925	45,529	54,635	57,366	55,645

Table C-5 Source Data for Figure 6 Shipments of California-Generated Crumb Rubber and Ground Rubber, 2009-2022

Category	2009	2010	2011	2012	2013	2014	2015
Paving	30,160	35,206	34,043	30,793	24,806	23,429	27,808
Turf Infill	8,723	9,605	11,871	15,089	14,034	11,355	13,415
Molded / Other	7,733	7,308	8,357	10,076	6,583	6,719	4,759
Ground Rubber	8,383	7,731	7,428	12,392	9,927	7,698	8,718
Total Crumb/Ground Rubber	**55,000**	**59,850**	**61,700**	**68,350**	**55,350**	**49,200**	**54,700**

Category	2016	2017	2018	2019	2020	2021	2022	2023
Paving	NA	NA	NA	NA	NA	NA	NA	NA
Turf Infill	NA	NA	NA	NA	NA	NA	NA	NA
Molded / Other	NA	NA	NA	NA	NA	NA	NA	NA
Ground Rubber	NA	NA	NA	NA	NA	NA	NA	NA
Total Crumb/Ground Rubber	**43,165**	**50,345**	**61,728**	**59,985**	**50,530**	**70,862**	**78,341**	**78,159**

Table C-6 Source Data for Figure 7, Caltrans Total Asphalt Placement and Rubberized Asphalt Percent of Total, 2009-2023, (2023 numbers are draft estimates)

Year	Total Asphalt Placed (MetricTons)	RHMA % Total
2009	5,589,914	23.60%
2010	3,860,646	30.60%
2011	7,522,354	34.70%
2012	6,333,678	29.20%
2013	4,578,258	22.90%
2014	4,120,457	26.70%
2015	4,602,421	41.30%
2016	4,785,160	39.80%
2017	4,056,991	45.03%
2018	4,767,951	46.43%
2019	3,860,363	39.75%
2020	3,405,088	41.31%
2021	3,280,000	38.00%
2022	2,695,298	35.79%
2023	2,695,298	35.50%

Table C-7 Source Data for Figure 8 Caltrans Use of Crumb Rubber in Paving Projects, 2009-2023, (2023 numbers are draft estimates)

Year	Crumb Rubber Used (Million Pounds)
2009	40,103,331
2010	35,919,690
2011	77,543,629
2012	52,286,289
2013	32,514,454
2014	35,220,943
2015	60,775,793
2016	60,892,762
2017	58,456,877
2018	70,839,587
2019	54,133,231
2020	49,611,420
2021	45,000,000
2022	34,030,984
2023	33,000,000

Table C-8 Source Data for Figure 9 California-Generated Tire-Derived Aggregate Shipped for Use in Civil Engineering Projects, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015
Landfill Projects	13,975	17,924	5,915	5,844	2,612	8,806	10,374
Non-Landfill Projects	3,535	350	0	0	1,945	3,826	1,294
Total TDA	**17,510**	**18,274**	**5,915**	**5,844**	**4,557**	**12,632**	**11,668**

Category	2016	2017	2018	2019	2020	2021	2022	2023
Landfill Projects	7,083	5,583	4,021	6,682	16,311	6,575	7,371	3,200
Non-Landfill Projects	3,878	853	1,106	6,648	600	0	0	5,482
Total TDA	**10,961**	**6,431**	**5,127**	**13,330**	**16,911**	**6,575**	**7,371**	**8,682**

Table C-9 Source Data for Figure 10 California-Generated Tire-Derived Material Used as Landfill Alternative Daily Cover or in Beneficial Reuse Applications, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015	2016
ADC	12,042	7,928	19,589	10,486	12,316	14,691	15,217	16,798

Category	2017	2018	2019	2020	2021	2022	2023
ADC	18,108	17,975	16,784	14,876	17,440	21,169	19,307

Table C-10 Source Data for Figure 11 California Whole Waste Tires and TDF Consumed at California Cement Kilns, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015	2016
Whole Tire/Size-Reduced TDF	69,926	83,675	61,911	77,209	81,982	83,934	85,721	72,723
Fiber TDF	0	0	0	0	3,313	8,418	7,443	7,656
Total TDF	**69,926**	**83,675**	**61,911**	**77,209**	**85,295**	**92,352**	**93,165**	**80,380**

Category	2017	2018	2019	2020	2021	2022	2023
Whole Tire/Size-Reduced TDF	75,989	80,603	70,807	51,315	39,704	30,915	19,558
Fiber TDF	6,205	7,783	7,500	6,297	8,539	1,542	1,300
Total TDF	**82,194**	**88,386**	**78,307**	**57,611**	**48,243**	**32,457**	**20,858**

Table C-11 Source Data for Figure 12 California-Generated Exported TDF and Bales of Waste Tires and Truck Tire Treads, 2008-2023

Category	2008	2009	2010	2011	2012
Size-Reduced TDF	NA	NA	NA	NA	NA
Baled and Cut Waste Tires	NA	NA	NA	NA	NA
Total Exported TDF/Bales	**22,000**	**33,000**	**64,000**	**96,000**	**135,000**

Category	2013	2014	2015	2016	2017
Size-Reduced TDF	NA	74,000	66,000	47,476	87,317
Baled and Cut Waste Tires	NA	36,000	28,000	15,000	26,089
Total Exported TDF/Bales	**110,144**	**110,000**	**94,000**	**62,476**	**113,405**

Category	2018	2019	2020	2021	2022	2023
Size-Reduced TDF	99,197	114,427	73,412	40,148	37,037	105,091
Baled and Cut Waste Tires	36,039	30,985	3,200	3,516	3,500	6,630
Total Exported TDF/Bales	**135,236**	**145,412**	**76,612**	**43,664**	**40,537**	**111,721**

Table C-12 Source Data for Figure 13 California-Generated Waste Tires Disposed in Landfills, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770	87,170

Category	2016	2017	2018	2019	2020	2021	2022	2023
Landfill Disposal	150,226	117,448	95,401	95,412	154,050	249,377	298,084	217,909

Table C-13 Source Data for Figure 14 Comparison of California All Materials and Waste Tires Management

Category	All Materials (2022) 76 M Tons	Tires (2022) 0.60 M Tons	Tires (2023) 0.57 M Tons
Landfill Disposal	53%	34.7%	35.1%
Disposal Related (e.g., Fuel & ADC)	6%	15.7%	26.7%
Recycling	41%	49.6%	38.2%

Table C-14 Source Data for Figure 15 Historic California All Materials and Waste Tires Recycling Rates

Year	All Materials	Tires
2011	49.0%	41.0%
2012	50.0%	39.9%
2013	50.0%	35.9%
2014	50.0%	35.8%
2015	47.0%	34.5%
2016	44.0%	31.9%
2017	42.0%	32.2%
2018	40.0%	34.1%
2019	37.0%	35.2%
2020	42.0%	36.7%
2021	40.0%	35.0%
2022	41.0%	34.7%
2023	N/A	35.1%

Table C-15 Source Data for Figure 16 California Waste Tire Recycling, Disposal Related and Disposal Trends, 2009-2023

Category	2009	2010	2011	2012	2013	2014	2015	2016
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770	87,170	150,226
Disposal Related	114,968	155,603	177,500	222,695	207,754	217,043	202,382	159,654
Recycled	165,997	164,206	167,516	179,768	150,741	158,094	152,767	145,288
% Recycled	40.3%	39.9%	41.0%	39.9%	35.9%	35.8%	34.5%	31.9%
% Landfill Diversion	68.2%	77.7%	84.5%	89.4%	85.3%	84.9%	80.3%	67.0%

Category	2017	2018	2019	2020	2021	2022	2023
Landfill Disposal	117,448	95,401	95,412	154,050	249,377	298,084	217,909
Disposal Related	213,707	241,597	240,503	149,099	109,347	94,163	151,886
Recycled	156,994	174,264	182,438	175,868	193,197	208,777	199,889
% Recycled	32.2%	34.1%	35.2%	36.7%	35.0%	34.7%	35.1%
% Landfill Diversion	75.9%	81.3%	81.6%	67.8%	54.8%	50.4%	61.7%

Appendix D End Notes

[1] CalRecycle, Waste Tire Program, Facilities Search Web Page.

[2] See end note 1.

[3] Analysis of Waste Tire Manifest Data as provided by CalRecycle to GHD5/15/ 2023.

[4] CalRecycle, California Tire-Derived Product Catalog, October 2021 Revision, Appendix A, Business Directories.

[5] Updated list of permitted waste tire facilities as provided to Boisson Consulting by CalRecycle on April 25, 2022.

[6] See end note 5.

[7] See end note 4.

[8] See end note 4.

[9] Chart data is based on Caltrans annual Crumb Rubber Reports available online in various locations. The 2020 report is available here. 2021 data are unpublished estimates based on verbal discussion with Caltrans representatives.

[10] See end note 12.

[11] "A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon." The Journal Science, Vol 371, Issue 6525. December 3, 2020.

[12] "Contribution of Leachate from Rubberized Hot Mix Asphalt to Zinc Loading in Roadway Stormwater Runoff." Prepared by Humboldt State University under contract to CalRecycle. May 2021. Page 6.

[13] RRC EV White Paper (squarespace.com)