Waste Tire Market Development Program Evaluation Project

Working Paper #1: Market Penetration Report

California Department of Resources Recycling and Recovery

September 2010

Contractor's Report

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Section 1
Introduction

The Tire Market Penetration Project is one of several sector wide projects under the Department of Resources Recycling and Recovery[1] (CalRecycle) Tire-Derived Product Business Assistance Program (TBAP). The purpose of the project is to gather information on the uses for products made from waste tires generated in California, and more specifically the extent to which products from tires have penetrated into, and are used in, different market segments. The information contained in this report is meant to inform the other TBAP sector wide projects and support the analysis and conclusions of those projects, specifically the program evaluation project which recommends CalRecycle tire market development strategies and prioritizes diversion opportunities by market segment.

This report includes information on the extent to which tires are used in certain market segments,[2] an analysis of trends that are currently impacting the disposition of tires, a discussion of market opportunities, and market penetration information. The report also summarizes the most critical barriers impeding market growth. This report is based on research conducted in late 2009 and early 2010. Appendix C provides a brief addendum on market trends subsequent to this time. Market trends are constantly changing and projections are subject to considerable uncertainty. However, the overall conclusions regarding market expansion and diversification opportunities, barriers, threats, and diversion rates achievable are thought to be sound as of the time of publication.

[1] CalRecycle was formed by merging the California Integrated Waste Management Board (CIWMB) and the Division of Recycling at the beginning of 2010. In this report "CalRecycle" refer to the organization in both its current and past CIWMB organizations.

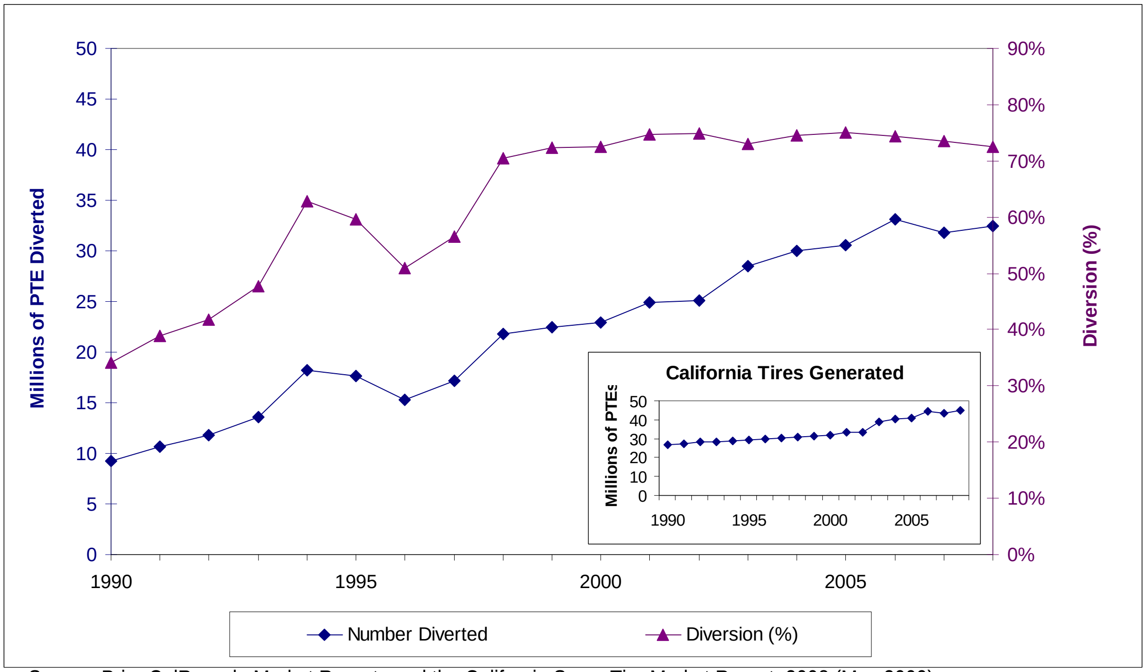
[2] Existing market information is based on the most recent data available at the time of this report, which covered calendar year 2008.

Section 2
California Tire Markets and Trends Influencing Demand

Summary

Since 1990 CalRecycle has worked to expand markets for waste tires and promote diversion from landfills. Figure 2-1 shows that the number of tires diverted has increased steadily over the years. In the 1990s the growth in diversion resulted in a rapidly increasing diversion rate. However, beginning in the late 1990s, annual increases in the quantity of tires diverted only matched the increases in tire generation, resulting in a plateau for the diversion rate of a little more than 70 percent.

Figure 2-1
Scrap Tire Diversion and Diversion Rate Trends



Source: Prior CalRecycle Market Reports and the California Scrap Tire Market Report: 2008 (May 2009)

Figure 2-1 shows a top-level overview of diversion. What it does not show is that ongoing efforts by CalRecycle to expand and diversify the waste tire marketplace in the 2000s have resulted in what is now one of the most balanced portfolios of tire markets of any U.S. state. In the mid 1990s a large percentage of diverted tires either went to fuel uses or were used as landfill alternative daily cover. By 2008 the share of tires that went to those two markets had fallen to approximately 30 percent of all tires diverted, as markets were diversified and increasing quantities of tires went into other applications including rubberized asphalt concrete (RAC), tire-derived products made from ground rubber, and tire-derived aggregate (TDA) used in civil engineering applications.

Although 2009 recycling and diversion data were not available for this report, preliminary conversations with operators of cement kilns, which are the primary consumer of waste tires for fuel use, indicated that production of cement had fallen by approximately 40 percent or more due to the economic recession that began in fall 2008 and lasted into 2010[3]. As a result, demand for tires from cement kilns was reduced. Because California's marketplace for tires is more diversified than that of the United States in general, California was better able to weather the downturn in this one market compared to the rest of the country.

Table 2-1 shows how California's marketplace for used and waste tires is structured. Each of the market categories/subcategories and their trends is discussed in detail following the table.

[3] Appendix C provides a brief addendum to market trends. One cement plant closed in early 2010 and reportedly, a second one may be closing soon as well.

Table 2-1 Markets and Market Trends for Used and Waste California Tires

Category	Sub-Category	2008	
		Million PTE	Percent of Total
Export	Waste Tires	2.19	4.9%
	Used Tires (Exported)	1.51	3.4%
	Subtotal	**3.69**	**8.2%**
Reuse	Retread	4.42	9.9%
	Used Tires (Domestic)	1.85	4.1%
	Subtotal	**6.27**	**14.0%**
Ground Rubber	RAC & Other Paving	4.32	9.7%
	Turf & Athletic Fields	2.44	5.5%
	Loose-Fill Playground/Bark/Mulch	1.15	2.5%
	Pour-in-Place Playground	0.45	1.0%
	Molded & Extruded	1.15	2.6%
	Other	0.54	1.2%
	Subtotal	**10.05**	**22.4%**
Civil Engineering	Landfill Applications	2.06[1]	4.6%
	Non-Landfill Applications	0.73	1.6%
	Subtotal	**2.79**	**6.2%**
Alternative Daily Cover (ADC)		**2.06**	**4.6%**
Other Recycling		**0.08**	**0.2%**
Tire-Derived Fuel (TDF)	Cement	6.67	14.9%
	Co-Generation	0.83	1.9%
	Subtotal	**7.50**	**16.7%**
Landfill Disposal		**12.35**	**27.6%**
Total Generated		**44.79**	**100.0%**
Total Diverted from Landfill		**32.44**	**72.4%**

Source: California Scrap Tire Market Report: 2008 (May 2009)

[1] This 2008 landfill civil engineering use estimate should not be used as a benchmark for evaluating future progress as it was necessarily based on reported usage that could not be validated by CalRecycle, and which in some cases may not be consistent with CalRecycle defined civil engineering applications. CalRecycle intends to define specific landfill civil engineering applications for TDA and establish a confirmed baseline when conducting the 2010 market analysis in early 2011.

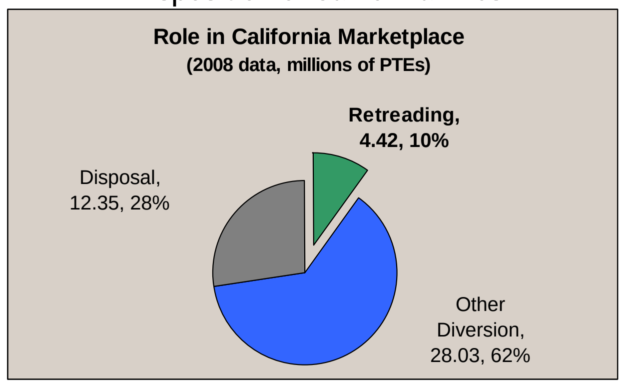
A discussion of the tire marketplace and trends influencing demand for the categories and sub-categories shown in Table 2-1 follows in the sections below. Appendix C provides a brief addendum with select market trends based on research conducted subsequent to this report.

Reuse

Reuse of tires in California includes: (1) culling, grading, and reselling of tires that are suitable for reuse as-is; and (2) retreading of tires. Sale of whole used tires for reuse outside of California is discussed near the end of this report because the up-front discussion has been reserved for categories and subcategories where the State of California can impact the market penetration within the state as opposed to where it is limited by policy, statute, or ability to influence external markets.

Retread

Figure 2-2
Role of Retreading in
Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Tire retreading is generally considered a mature and stable industry with approximately 40 California locations that are engaged in the production of retread tires. Market size is believed to be generally stable at approximately 4.4 million passenger tire equivalents (PTE), or 9.9 percent of California tires generated. Retreading is only performed on truck tires in California, not passenger car tires. However, unlike other market flow estimates in this report which are based on detailed analysis of survey results, the retread estimate is a "placeholder" that CalRecycle has held constant since 2003 pending better information. For the 2010 Market Analysis report, to be published in early 2011, CalRecycle will apply an expanded and refined methodology to better document this market segment.

Retreading of large commercial tires has a high market penetration according to conversations with staff from the Tire Retread and Repair Information Bureau (TRIB). Nearly half of all replacement truck tires are retreads. Most major trucking and transportation companies like FedEx and UPS utilize retread tires and the market is generally considered saturated. However, when compared to other states, California has less retreading company employment on an equivalent population basis, which may indicate some modest room for additional growth and diversion to this market.

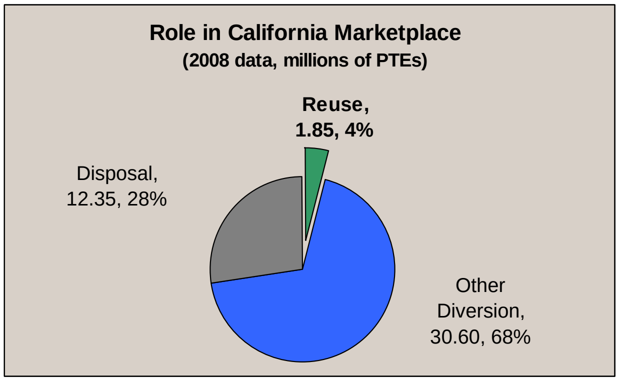
TRIB staff believes there are three areas of opportunity to expand the market beyond the large commercial sector:

1) Small commercial companies. These are companies whose primary industry is something other than trucking, but which own a small fleet to conduct their business.
2) Public sector. This includes any size city or county government that could utilize retreads on their work trucks, especially for large vehicles.
3) Passenger. This is the least tapped market and the market with potentially the greatest opportunity for growth. (Several stakeholders disagree with this TRIB assessment and feel passenger tire retreading is essentially "dead," with the possible exception of some specialty markets. There has been little or no passenger tire retreading for some time in California.)

TRIB staff believes that recent import duties on new tires from China will likely allow for higher new tire prices for the domestic tire market, which in turn will cause the commercial and retail sectors to more strongly consider utilizing retread tires. There are opportunities for CalRecycle to also work to promote retreading to the public sector and small commercial companies.

Domestic Used Tires

Figure 2-3
Role of Reuse of Used Tires
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May, 2009)

Like retreading, the reuse market is also considered to be stable and utilizes approximately 1.8-1.9 million PTE per year. There presently exists a large and well-established network of dealers who purchase used tires for wholesale distribution to lower-tier retail establishments that sell directly to consumers. Because the number of tires that are in good condition is limited, R. W. Beck does not believe that this market has the potential to grow significantly past its current level. There is a threat to this market that can come from legislation to require tire dealers to notify customers of the age of tires that are sold. If tires are regulated such that the sale of tires past a certain age is prohibited, or if age notification is required and results in lower sales of used tires, this market has the potential to contract.

Ground Rubber

Introduction

Although lack of supply of ground crumb rubber has been a barrier in the past to recycled rubber product manufacturing, a number of processors are gearing up to, or already have begun to, produce ground rubber for sale, so this may no longer be an issue in the future. As of the date of this report the number of California producers of ground rubber had grown to nine companies and interest by other companies could further expand this number in the future. Ground rubber is produced in various sizes including:

- Coarse ground rubber of ¼ to ¾ inch chips, which is used in applications such as loose-fill playground, mulch, and equestrian arenas;
- Ground rubber of 4-30 mesh, normally referred to as crumb rubber, which is used in rubberized asphalt concrete, turf, and some coarse molded products applications; and
- Fine ground rubber, which would be used in coatings and molded rubber and plastic products.

Fine ground rubber is currently only produced in small amounts in California, and is not generally considered to be a standard grade that is produced by processors. This is limiting the market applications into which California tires can go. In general, the ground rubber market is growing and some industry insiders believe the next big wave will be use of crumb rubber and fine ground rubber powders in consumer products. Threats include overproduction of ground rubber by processors compared to product manufacturer demand and imports of ground rubber, some of which is subsidized, from other states and Canadian provinces.

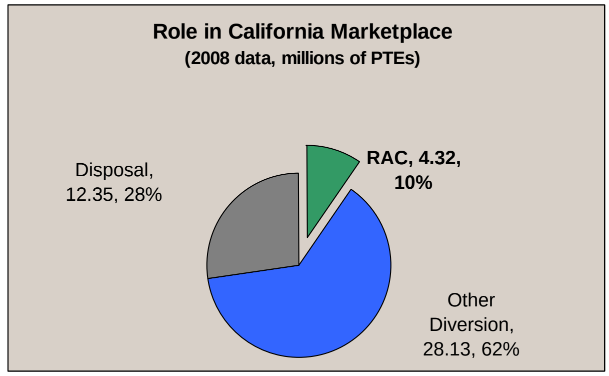
Following is a brief discussion of the various sub-categories of ground rubber uses.

RAC & Other Paving

The use of Rubberized Asphalt Concrete (RAC) continues to grow. Rubber from California tires going into this market grew from approximately 3.9 million to 4.3 million PTE from 2007 to 2008.

RAC paving projects are divided between state road paving projects contracted by Caltrans and local paving projects contracted by county and municipal governments.

Figure 2-4
Role of Rubberized Asphalt Paving in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

The relative split between California tires used for RAC paving contracted by Caltrans compared to RAC paving contracted by county and local governments is not known, largely because Caltrans is not required to only use California tire rubber in its projects and it does not track the origin of the ground rubber used in its projects. Information is also lacking on the amount of RAC paving performed by local governments that is not associated with state grants, and how much of the rubber used for non-CalRecycle grant paving projects comes from California tires versus how much is imported from out-of-state.

Caltrans is required by SB 876 to use RAC in 25 percent of state projects by 2010 and in 35 percent of state projects by 2013. Caltrans surpassed the 2010 goal when it reached 29 percent of projects in 2007 and it forecasted exceeding 40 percent in 2009.[4]

In order to assist the development of RAC markets in California, CalRecycle offers three different types of grants targeted to local governments:

- The **Targeted Rubberized Asphalt Concrete Incentive (Targeted) Grant Program** is for those eligible applicants that have received three or fewer RAC grants from CalRecycle. Project funding depends on the number of previous grants that the applying local government has previously received from CalRecycle.
- The **Rubberized Asphalt Concrete Use (Use) Grant Program** is for those eligible applicants that have received four or more RAC grants from CalRecycle. Project funding is limited to a maximum reimbursement of $5 per ton of RAC used.
- The **Rubberized Asphalt Concrete Chip Seal (Chip Seal) Grant Program** is for those eligible applicants wanting to extend the service life of a road before major maintenance is required by installing a rubberized chip seal layer on top of the road. Project funding depends on the number of previous CalRecycle Chip Seal grants received. This is a fairly new grant program that was begun in 2007.

CalRecycle has also promoted RAC through a wide variety of technical assistance and promotional efforts over the past two decades. Besides the state law requiring state road paving with RAC and local grants, recent pricing of crumb and asphalt and RAC performance

[4] Caltrans, "2009 Annual Report to the Legislature and the California Integrated Waste Management Board Senate Bill 876 Waste and Used Tires."

advantages that allow for thinner RAC pavement overlay layers compared to non-RAC asphalt paving materials, and/or longer service life before major maintenance is required, typically resulting in an economic advantage to projects that use RAC.

In addition to being able to save on materials costs and extend pavement life, RAC pavements also are quieter compared to roads paved with traditional materials. The quieter roads that result are preferred by the general public, and also may reduce the cost of noise mitigation measures, such as the size/cost of sound walls. Some stakeholders state that research shows the sound dampening qualities of RAC degrade over time to a degree.

There are limitations to RAC that keep it from being suitable for all asphalt paving applications. RAC is generally cost-effective when used as thin gap- or open-graded surface courses or overlays of 1.2 to 2.4 inches (30 to 60 mm) compacted thickness, chip seals, and interlayer applications. RAC is not suited for use in dense-graded hot mix asphalt because there is not enough void space in the dense-graded aggregate matrix to accommodate sufficient asphalt rubber binder content to enhance performance of dense-graded mixes enough to justify the added cost of the asphalt rubber binder. RAC is best suited for roads that are showing signs of reflective cracking. It is not suitable for thin overlays of roads experiencing major failure, such as where sever cracking is occurring with cracks more than 0.5 inch (12.5 mm) wide. Environmental conditions and project types can also limit when and where RAC paving can be performed. For example, asphalt rubber paving materials should not be placed:

- During cold or rainy weather with ambient or surface temperatures <55°F (13°C). This is because the rubber increases the viscosity of the asphalt binder, making it more difficult to place the asphalt under the temperatures needed to ensure good flow and compaction.
- Areas where considerable handwork is required.
- Where haul distances between the asphalt concrete plant and job site are too long to maintain mixture temperature as required for placement and compaction.
- Where traffic and deflection data are not known.[5]

RAC paving requires the use of special equipment by the asphalt mix plant. A blending unit is needed to mix and react the crumb rubber with the asphalt binder at a specified temperature for a specific period of time. This blending step adds cost and there are fewer than 20 of these units in all of California. Because of the cost of adding this step, RAC projects are only cost-effective where project the size is large, such as 2,500 tons of RAC (although CalRecycle grants have included a minimum project size of 1,250 tons of RAC), or where more than one paving project can be scheduled to be performed concurrently. CalRecycle has assisted small municipalities and those that are remotely located to find project partners to make RAC paving justifiable in their local areas.

Although not yet a commercial application in California, CalRecycle is researching terminal blend rubberized asphalt. In this application, which is used in several other states such as Illinois, powdered rubber particles that pass through a 50 mesh screen are blended into the asphalt binder, often at the original asphalt binder production plant terminal (hence the term “terminal” blend). The one California supplier of the blends (Paramount Petroleum) superheats the asphalt rubber blend so that most of the rubber particles begin to break down (depolymerize and/or pyrolyze) to the point at which there are either few or extremely small particles left, which means there is no need for agitation/dispersion of particles to keep them in suspension. Furthermore, the

[5] NOTE: Traffic and deflection data are basic requirements for Caltrans structural pavement design and rehabilitation. In some cases it may be necessary to add a layer of dense-graded hot mix asphalt before overlaying with RAC to provide sufficient pavement structure.

asphalt that is produced is not more viscous than traditional binders (the more viscous asphalt binder of traditional RAC is preferred, but comes with the disadvantages and limitations of workability, especially under cold weather, that were mentioned previously.) The finished product therefore is an asphalt rubber binder that does not require agitation or special mixing, blending, or special field application equipment and little or no modification of paving practices compared to traditional hot mix asphalt paving. The asphalt that is produced is comparable to a polymer modified performance grade of asphalt. This asphalt binder can therefore be used in a much wider range of applications than traditional RAC, including all forms of asphalt paving under all weather conditions.

Terminal blend asphalt is still developmental in California and R. W. Beck is aware of only one supplier in California. The methods of production and mixture of additives included in producing a terminal blend asphalt mean that each supplier's product is a unique and different brand name product and not a generic commodity. R. W. Beck also understands that product pricing for terminal blend has not yet been set by the market and current pricing for research and demonstration projects may be underwritten in part by the supplier because it is not yet a commercial product. For these reasons, conclusions have not yet been reached on the cost-effectiveness of terminal blends and performance compared to alternatives and the market opportunity is not yet certain. Because terminal blends need fine rubber powders, this market application may create sufficient demand for California processors to begin producing fine powders, which are not currently available. The fine rubber powders that would be produced would then also be available for plastics and rubber molding applications, which are discussed later in this section.

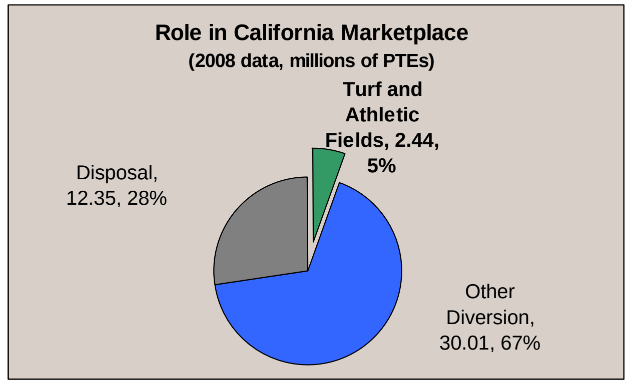
Another paving application that offers promise is to incorporate crumb rubber into Portland cement concrete. Research on this application is occurring in Arizona and Caltrans is investigating it as well. Reportedly, Cemex, a major cement producer, has experimented with this and has decided not to pursue it at this time. The crumb rubber serves as a lightweight aggregate substitute. Although the compressive strength of the concrete falls as increasing amounts of rubber are added, it may offer some benefits at relatively low concentrations (in comparison to other aggregate materials) of a few pounds per cubic yard of concrete.

The vast majority of RAC projects have been highly successful. However, according to CalRecycle staff, there have been a few instances in which CalRecycle was not involved where RAC paving projects failed. The program offers training and technical assistance to help avoid such failures.

Turf & Athletic Fields

Ground waste tire rubber is used as a component of infill in artificial turf installations as illustrated in Figure 2-6. The use of ground rubber in artificial turf and athletic field development has been increasing for several years, but some suggest it may now be slowing as alternative materials are found to replace rubber infill. According to the Synthetic Turf Council, there were approximately 1,000 field installations nationally in 2008, up 20 percent from 2007. The growing national sales pace was expected to continue in 2009; however, California tires recycled for this market showed an apparent slight decrease from 2007 to 2008, dropping from 2.5 million PTE to 2.4 million PTE. This apparent decrease may not directly correlate to field installations, since ground rubber for this application crosses state borders. Nationally, it is estimated that fewer than 10 percent of the approximately 45,000 college, high school, and middle school fields have installed this new generation of synthetic turf[6] and R. W. Beck does not believe that California differs significantly from the rest of the nation in this respect.

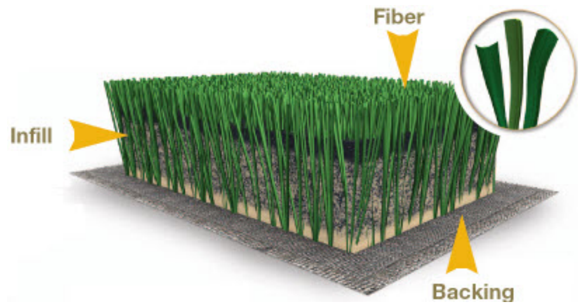
Figure 2-5
Role of Turf and Athletic Fields
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

[6] Based on a compilation of information by R. W. Beck from the Synthetic Turf Council.

Figure 2-6
Structure of Artificial Turf



Source: Field Turf

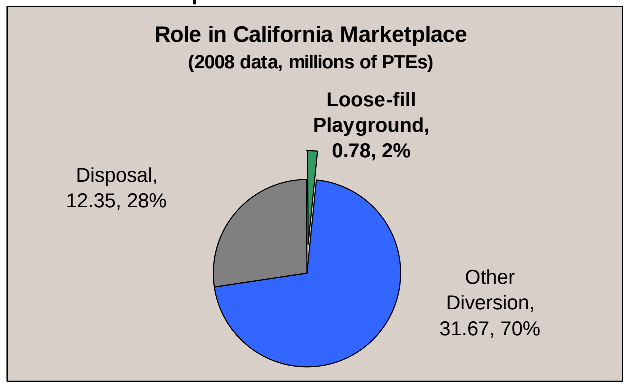
Growth of turf and athletic field installations may be being impacted by environment and health concerns raised in the media. In order to investigate the validity of these concerns, CalRecycle is funding a thorough investigation of the concerns by the California Office of Environmental Health Hazard Assessment (OEHHA). Initial investigations by OEHHA are favorable for using tire crumb rubber in this application. The final report for health impacts from ground rubber in artificial turf fields study is expected to be completed by December 2010. Other reports issued by New York State, New York City, the State of Connecticut, and University of California, Berkeley have suggested that concerns over health impacts are not justified; however, the topic continues to get occasional media attention.

Synthetic turf fields offer advantages to the natural grass alternative, including excellent playability, all-weather availability, and the ability to sustain increased playing hours. They are initially more expensive than natural turf, but their maintenance cost is less because they don't require the level of maintenance that natural turf does. They also conserve irrigation water, negating the need for fertilizers and pesticides, and negating the need for mowing.

Because of the advantages of artificial turf, apparent favorable environment and health study results, and relatively low market penetration, R. W. Beck believes that this application has the theoretical potential for significant market growth, especially over the next several years. On the other hand, there are reports that the market may already be declining as the industry experiments with alternatives to rubber infill. Even if this does not occur, over longer periods the market may eventually begin to decline as the market becomes saturated. CalRecycle has provided grant funds from 2006-2009 for 10 field installations where crumb rubber was used for infill. The great majority of fields that have been installed in California were done without grant fund support, for the benefits that were described above.

Loose-Fill Playground

Figure 2-7
Role of Loose-Fill Playground
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Loose-fill playground material is essentially the same material as rubber bark used in landscaping applications, which is discussed later in this section. (Because of the reporting challenges caused by the same material specification used for loose-fill playground and bark/mulch, these two market uses have been combined into a single market segment in this project's conclusions, and will be managed this way in subsequent CalRecycle Market Analysis reports.) This coarse ground rubber is often colored, and typically purchased by local governments for use on school playgrounds or community parks and recreation areas. California production of ground rubber for loose-fill playground material grew slightly in California from 0.6 million PTE in 2007 to 0.8 million PTE in 2008. CalRecycle grants have supported this market.

There are numerous advantages to this use of ground rubber as compared to typical playground surfaces. These advantages include:

- Improved fall safety;
- Lower maintenance costs compared to natural alternatives; and
- Long life.

Similar to the turf and athletic field market segment, certain groups oppose the use of loose-fill ground rubber for playgrounds, believing that such materials have environmental and health risks. While studies completed to date have not proven this to be the case, media articles have criticized the U.S. EPA for failure to conduct a comprehensive study of potential health impacts. Ongoing public concern and uncertainty over health risks could further deter growth in this market sector.

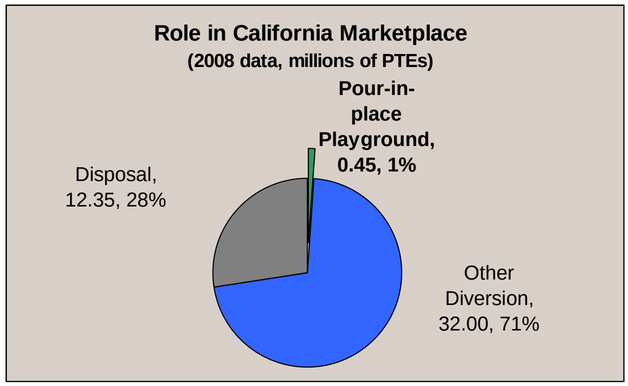
The Americans with Disabilities Act (ADA) requires that playground surfacing materials allow people in wheelchairs to maneuver through the playground without exerting too much effort or getting stuck. Materials that may have been used in playgrounds up until now may no longer be compliant today. There is a standard for accessibility: ASTM F1951-09b Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment. Surfacing materials are currently tested in a laboratory using an actual wheelchair and force measuring equipment. However, playgrounds may initially be compliant when installed, but may go out of compliance with use or weathering of the playground material. This issue would not impact sales to private residences, which some suggest is a growing market for loose-fill material.

Since 2005 an ASTM committee has been working on the "Standard Test Method for Measuring the Firmness and Stability of Surface Systems Using a Rotational Penetrometer." It is believed that using this standard rotational penetrometer device will allow for better and more repeatable testing, and allow for field testing of playground surfaces as installed over time. Work toward developing the standard has been slow because "manufacturers of some play surfaces do not support the rotational penetrometer (field test) for fear that their surfaces will not pass."[7] There is a threat that loose-fill surfacing materials from some or perhaps a majority of suppliers will not pass the proposed test method, in which case this market application will lose market share to pour-in-place, rubber tiles, or engineered wood surfacing materials. Because of this threat and the uncertainty of whether the standard test method will be passed and the compliance with suppliers' products, R. W. Beck cannot forecast whether this market subcategory has the potential to grow or decline. For the purposes of this report, we have assumed that this market application will remain constant for the next several years at current use levels.

Pour-in-Place Playground

Pour-in-place playgrounds are primarily made from buffings from retreading of used truck tires and, to a lesser degree, buffings produced by processors from waste truck tires that otherwise were headed to disposal (in which the casing may still be landfilled). Pour-in-place playgrounds are constructed by installing a layer of black recycled tire rubber (normally buffings), which is then topped with a high-quality aesthetically pleasing top virgin layer of varying colors. Pour-in-place playgrounds can be poured into an unlimited amount of designs and shapes.

Figure 2-8
Role of Pour-in-Place Playgrounds in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May, 2009)

The target market for this use is the same as that for loose-fill material – local governments for school playgrounds or community parks and recreation areas. Pour-in-place playgrounds are more expensive than loose-fill playgrounds; however, they have better aesthetics and easily comply with the ADA accessibility requirements discussed under loose-fill. CalRecycle grants can support pour-in-place playgrounds, but only if the tire rubber comes from waste tires and not retread tires. Buffings from tire retreading have a very healthy market demand and tire retreading and buffing markets do not need CalRecycle grant support to grow or sustain their markets.

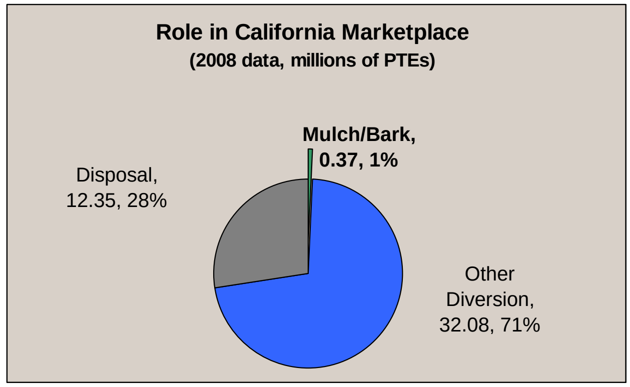
The production by processors of buffings and ground rubber from waste tires for use in pour-in-place playgrounds grew from 0.3 million PTE in 2007 to 0.5 million PTE in 2008 – an approximate growth rate of 70 percent. At least three California processors are producing buffings directly from waste truck tires, and two California producers are performing product development research so that ground rubber can substitute for a portion of the buffings typically used for the pour-in-place market, which could allow for greatly increased production in the future.

Potentially limiting factors to the growth of this market, in addition to the amount of material that processors are able to supply, are environmental and health concerns. Because the tire rubber is sealed underneath a virgin top layer, those concerns are less when compared to athletic field and loose-fill applications because of lower potential for skin exposure and opportunity to inhale or inject loose particles.

[7] ASTM Interlaboratory Study Program quote.

Mulch/Bark

Figure 2-9
Role of Mulch/Bark
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

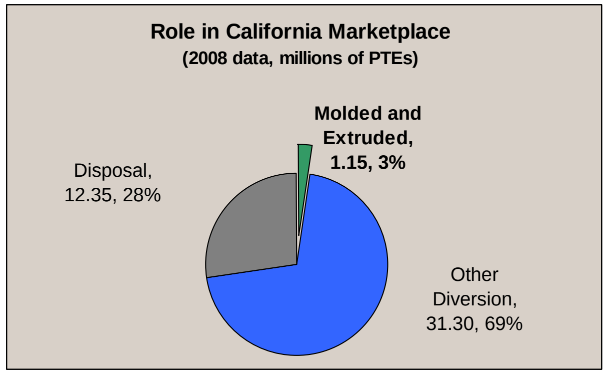
The production of ground rubber for use as a decorative and protective mulch or bark decreased slightly in California from 2007 to 2008, but generally revolved around 0.4 million PTE. (As noted above, the mulch/bark market segment has been combined with the loose-fill playground segment in this project's final report and in this report's summary conclusions below. This is because the same specifications used for the two markets complicate reporting.) This material is sold at national retailers like Walmart Stores, Home Depot, and Lowe's, and also sold in bulk through distributors or directly to landscapers and contractors. Unlike other markets for tire rubber, which are based almost entirely on government or industrial purchasing, this application also has the potential for a much broader market through retail sales to individual consumers.

The primary advantage to this material is its long life, and consequently its potential long-term cost savings and reduction of labor needed compared to annual replacement of natural mulch materials. The primary disadvantage to this material is its cost relative to natural alternatives. It is typically three times as expensive as natural mulch or bark. Additionally, similar health and environmental concerns arise related to this material as with other ground rubber applications. R. W. Beck estimates that the market penetration for this TDP application is currently less than one percent compared to other ground cover alternatives.

Production and sales of mulch/bark on the West Coast has lagged behind the East Coast, and many stakeholders feel there is high potential for growth.

Molded & Extruded Products

Figure 2-10
Role of Molded & Extruded
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Molded and extruded products are those where recycled tire crumb rubber is incorporated into new rubber or plastic products. A very wide range of products are produced in California, including flooring, mats, wheelchair transition ramps, drainage channels, erosion control devices, wheel stops, and others.

Molded and extruded products can be further segmented into rubber product manufacturing and plastic product manufacturing (incorporating rubber as an additive). The majority of ground rubber currently used for molded and extruded products is believed to go into bonded rubber products, with relatively little going into plastics at this time. Table 2-2 shows 2007 estimated demand for ground rubber in bonded rubber products for the United States, with estimated annual growth rates.

Table 2-2 Estimated U.S. Demand for Ground Rubber in Bonded Rubber Products

Category	2007 U.S. Estimated Ground Rubber Demand (million pounds)	Estimated Annual Growth
Agriculture Stall/bed mats, pavers, trailer liners	150	4-6%
Automotive/Transportation Miscellaneous components, load securement, bed mats, car mats	60	3-5%
Construction/Indoor Sports/commercial flooring, mats, acoustics, underlayments, ballistics	85	6-8%
Construction/Outdoor Commercial surfacing, safety surfacing, roofing, marine, pour-in-place products	120	4-6%
Consumer Floor and door mats, bulletin boards, interlocking tile, mouse pads, shoes, etc.	28	12-14%
Total	**443**	

Source: Presentation by Art Dodge, President and CEO, ECore. Presented at the April 2009 conference of the Institute of Scrap Recycling Industries.

As the table shows, national growth rates are believed to vary from 3-14 percent, depending on the market category. According to estimated California production from 2007 to 2008, there was a slight increase of 0.1 million passenger tire equivalents (increase from 2.3-2.6 percent of all estimated end uses), or 13 percent annual growth.

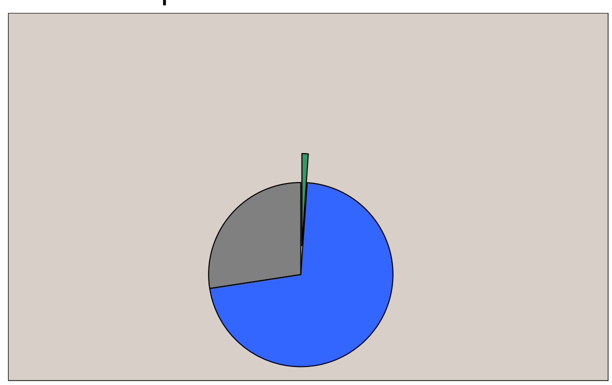
In 2008 approximately 22 percent of California scrap tires (just over 10 million passenger tire equivalents) were used to produce more than 130 million pounds of ground rubber. Of this amount, about 11 percent (approximately 14 million pounds of crumb rubber) was used to produce molded and extruded products. The potential market size for molded and extruded products is estimated to be 52 million pounds per year based on potential demand from California plastics and rubber product manufacturing companies. This represents a 26 percent market penetration into the estimated California market. These market size and penetration estimates are for existing rubber and plastic products that are made. If new products are developed that are not currently made in the state, such as roofing tiles/shakes, the market potential could be even higher.

Previous discussions above alluded to environmental and health concerns with ground rubber in turf and playground applications. There are also concerns with products made from ground rubber that may be used in indoor applications such as flooring made from tires. There are two assessments under way by the Office of Environmental Health Hazard Assessment with respect to environment and health effects from tire rubber. The first assessment, on ground rubber in artificial turf fields, was discussed previously and is due for release in late 2010. The second assessment is on indoor air quality when tire rubber is used in flooring materials – a draft final report has been produced and is undergoing peer review, and is expected to be released in fall 2010. Reportedly, research in Europe has concluded that concerns over indoor air quality and tire-derived products are unfounded; however, this research was not reviewed for this study.

Other Ground Rubber Applications

In 2008 0.54 million PTE were used to make a variety of products, slightly less than the amount classified in the "other" category for 2007. Examples of products in this category include very coarse 1-inch "ground rubber" used in ballistics applications, production of buffings from truck tires sent to products other than pour-in-place, fine powder rubber blended into coatings, and miscellaneous other applications that were not specified by processors in surveys.

Figure 2-11
Role of Other Ground Rubber Applications in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Another product is weed mats as reportedly used by the Texas Department of Transportation. This category also includes ground rubber that is similar to loose-fill playground and mulch that is used in equestrian arenas, although some mats and even pour-in-place products are sold to equestrian markets. Equestrian loose fill materials are typically colored and sold directly by manufacturers to horse arena owners.

R. W. Beck believes the assistance CalRecycle is providing through the Tire Derived Product Business Assistance Program (TBAP) will help to increase the size of this market category in the future. Because of the general nature of this category, which crosses many types of products and markets, it is difficult if not impossible to evaluate the potential market size or "market penetration" for this general ground rubber category.

Civil Engineering

Introduction

Tire-derived aggregate (TDA) made from shredded waste tires competes against other aggregate and lightweight fill materials in civil engineering applications. It can have advantages that allow it to be a preferred material in a number of civil engineering applications. Civil engineering uses can generally be segmented into three primary areas:

1) Landfill uses;
2) Transportation-related road and railway uses; and
3) All other uses, which can include drainage related applications such as septic system leach fields.

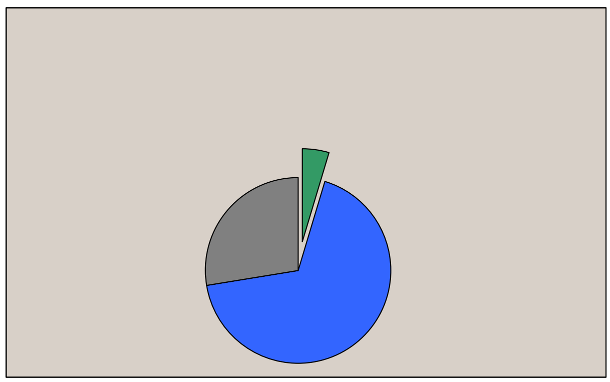
In California, landfill uses have dominated transportation-related and other uses to date. The three segments and specific civil engineering uses under each will be further discussed in the paragraphs that follow.

Landfill Applications

Landfill uses for TDA include:

- Landfill gas collection systems;
  - Extraction wells and trenches;
  - Gas collection layers;
  - Gas pipe and header protection;
- Leachate collection and removal system;
- Leachate recirculation beds/layers;
- Operations layer (for initial protective layer for new cell construction);
- Final cover drainage layer; and
- Alternative daily and intermediate covers (note that these uses are considered by CalRecycle to be a separate category of use apart from TDA used in civil engineering applications).

Figure 2-12
Role of Landfill TDA Use
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009). This 2008 landfill civil engineering use estimate should not be used as a benchmark for evaluating future progress as it was necessarily based on reported usage that could not be validated by CalRecycle, and which in some cases may not be consistent with CalRecycle defined civil engineering applications. CalRecycle intends to define specific landfill civil engineering applications for TDA and establish a confirmed baseline when conducting the 2010 market analysis in early 2011.

Tire shreds mixed with soil can also be used for landfill road construction, although that is not a common use in California.

Although California has more than 130 landfills, only 75 are of a suitable size, type, and distance (within 100 miles) of tire processors to be considered candidates for the use of TDA according to Kennec, CalRecycle's technical contractor for civil engineering use of TDA. Based on a review of information from nine landfill TDA projects, Kennec estimated that landfills could use TDA approximately every other year for landfill gas projects (meaning 37 to 38 landfills could use TDA each year), and could consume on average 0.06 million PTEs of tires, resulting in an annual landfill TDA market of approximately 1.9 million PTEs.[8]

Data on the quantity of TDA used by landfills has been collected by CalRecycle (and R. W. Beck for 2007 and 2008 as reported in the 2008 Market Report, the most recent data available at the time of this report). The data reported to R. W. Beck indicated that slightly more than 2 million PTEs of TDA was used annually at landfills, and that nine or fewer California landfills use TDA for civil engineering uses on a sporadic basis as projects come up. Subsequent to publication of the 2008 Market Report it was learned that data from one landfill, which had used TDA in the past, may have been mischaracterized in 2008 and perhaps in 2007 as well. That landfill received very large quantities of shredded tires that, instead of being used in a civil engineering application, instead may have been landfilled. The landfill stopped taking waste in 2008 and is now undergoing closure and it was not possible to verify the exact disposition of tires by that landfill for this study. Assuming material was misclassified, the historical quantity of tires used in landfill civil engineering uses in recent years may be closer to 1 million PTEs rather than 2 million.

Conversations with the landfills that use TDA indicate that some use much greater quantities of TDA than the average usage estimated by Kennec. These landfills typically have a waste tire processor collocated at the landfill so TDA is inexpensive and readily available. They also are either very large, use bed designs rather than the efficient trench design for gas collection, and/or they recirculate leachate, which provides an additional application likely not included by Kennec in its estimate. R. W. Beck is aware of only three California landfills that have the necessary permits to recirculate leachate, so this application cannot be considered to present a significant additional market opportunity.

Very large quantities of tires can be used in constructing leachate collection and removal systems and as operations layers as part of new cell commissioning and a single landfill can use 1.5 million PTEs.[9] R. W. Beck is aware of only one California landfill that has used TDA for this application. Similarly, final cover drainage layers can also use large quantities of tires. The infrequent nature of these applications and processor difficulties in supplying the quantity of material needed result in these applications not being commonly used and CalRecycle's technical contractor Kennec does not believe that these applications are feasible, at least in the immediate future.

The landfills that have used and/or continue to use TDA, generally organized from north to south, include the Yolo Landfill in Yolo County, the Kiefer Landfill in Sacramento County, the Bosco Landfill in Contra Costa County, the Altamont Landfill in Alameda County, the Crazy Horse Landfill in San Benito County, the Chiquita Landfill in Los Angeles County, and the El Sobrante, Badlands, and Lamb Canyon Landfills in Riverside County.

There may be potential for some landfills to establish a simple shredding capacity, even in remote areas where transportation costs to other facilities are high. In summary, use of TDA at landfills is growing, but significantly more TDA can be used as only a small number of California landfills

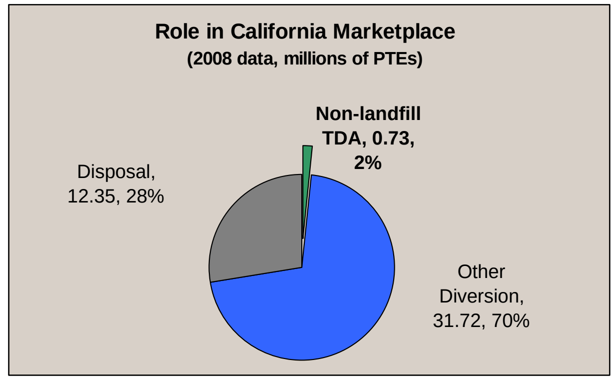
[8] Kennec Inc. drawing (FIG06 - LEGENDS.dwg) dated Sept. 8, 2009, as provided to CalRecycle.

[9] Estimate is derived from the CIWMB guidance manual "Tire Shreds as Operations Layer Material at Municipal Solid Waste Landfills" and is based on two 45,000 cubic feet tire shred stockpiles (3,300 cubic yards) to produce a 24-inch thick operations layer over an area of one acre. The thickness of 24 inches allows for tire shreds compressibility since a typical operations layer thickness is 12 to 18 inches thick. Conversion to PTEs is based on one cubic yard of shreds, compacted and compressed to their final in-place volume, is produced from approximately 60 to 70 whole passenger tires. Estimate therefore is 215,000 tires per acre. Assuming an average cell size of 7 acres, one landfill could use approximately 1.5 million PTEs for new cell commissioning. This assumes TDA is used for either the operations layer or the LCRS, but not both.

have used TDA. R. W. Beck estimates the market size at 3.6 million PTEs per year.[10] Landfill users of TDA can be either publicly or privately owned landfills.

Transportation-Related Applications

Figure 2-13
Role of Transportation-Related TDA Use in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Transportation-related applications include lightweight fill for embankments, roadway landslide repairs, and highway retaining wall backfill, and vibration dampening bed material for light rail train lines. In 2008 some 0.73 million PTE were reported used in these non-landfill civil engineering applications in California, down from about 0.98 million PTE in 2007. Based on a review of information from nine past non-landfill TDA projects the average number of tires used per project was 180,000 tires.

As with landfill civil engineering projects, transportation-related applications historically have involved a small number of very large projects, only one or two per year, and abrupt annual increases or decreases in use are likely to occur as projects begin and end.

The California Department of Transportation (Caltrans) is the state agency responsible for developing technical standards for highway construction, and local governments, especially those in Northern California, often use the same standard plans and specifications published by Caltrans for their own projects. In Southern California many local governments rely on the "Greenbook" Standard Specifications for Public Works Construction and the Standard Plans for Public Works Construction for their projects. Until CalRecycle staff worked with Caltrans to get shredded tires accepted as a lightweight fill material option, it was not considered for road applications in the state. The first road project in California to use TDA was a 2001 Caltrans project, and the use of TDA is still fairly new and novel today. However, Caltrans "now considers TDA as the first option whenever lightweight fill is required for a project."[11] Lightweight fill projects have typically required large quantities of TDA, which has varied from 130,000 to 600,000 tires per project.

Road projects where TDA can serve as lightweight fill are primarily in 30 counties, mostly along the coast, where mountainous geography and soil conditions lead to landslides that can cause road failures. Lightweight fill applications also include areas where the soil is not able to support a road, such as weak San Francisco Bay mud areas. One stakeholder cites the Southern California border area with Mexico as a good candidate for TDA use given the weak, sandy soil structure. When TDA is used in these applications, it substitutes for other lightweight fill materials such as shale and expanded polystyrene to provide a stable base with good drainage properties on which to build or repair a failed road. Owners of projects that are candidates to use TDA for lightweight fill include Caltrans and county road departments. Kennec estimates the market size for this

[10] Based on the existing landfill use estimated to average 1.6 million PTEs per year from nine landfills that have tried the material, plus Kennec's estimate of 0.06 million PTEs per landfill multiplied by 66 landfills that have not tried the material to date, and assuming a landfill gas project every other year.

[11] Caltrans "2009 Annual Report to the Legislature and the California Integrated Waste Management Board Senate Bill 876 Waste and Used Tires."

application at up to 30 projects per year and 2,500 tons per project, or up to 7.5 million PTEs per year.

Through its technical contractor Kennec, CalRecycle is also working closely with Caltrans to have an alternative design for a Type 1 retaining wall with TDA approved and included in Caltrans Standard Plans. This will open new opportunities to use TDA as a backfill behind retaining walls and bridge abutments, where the reduced pressure behind the walls provided by TDA compared to alternative materials should allow less concrete and steel to be used in the wall design, reducing construction costs. Only a couple of research and demonstration retaining walls have been constructed to date in cooperation with Caltrans. Once testing is completed and this application is accepted by Caltrans, Kennec estimates that 700 PTEs can be utilized per linear foot of transportation-related retaining wall constructed. Most projects would likely be in 19 counties where wall projects are numerous due to population density around major highways. Much of the use is expected to be by Caltrans, with some use also by county road departments. Kennec estimates the market size for this application at up to 18,750 tons per year, or up to 1.9 million PTEs per year.

Another transportation use in California is as an underlay material for expansion of light rail systems. This application takes advantage of the vibration attenuation properties of TDA to reduce the transmission of vibrations from passing trains to nearby structures. One project has used TDA in this application. The project was constructed in 2001 by the Santa Clara Valley Transportation Authority (VTA) and involved using TDA as an underlayment material for 2,000 feet of light rail track on the Vasona line expansion – 100,000 tires were used for the project.

Tests have confirmed that the use of a one-foot-thick layer of tire shreds beneath the sub-ballast and ballast layers of ballast and tie track is an effective vibration mitigation measure. The performance of the TDA was better than that that of a ballast mat but less than that of a floating slab trackbed, which are other methods by which to attenuate vibrations. Using TDA is less costly than either of the alternative methods. Providing vibration attenuation of any type adds costs compared to track that does not have attenuation, so vibration attenuation is only added to those track sections where it is needed. The most costly method of adding attenuation, at an additional cost of $500 per track foot, is floating slab track. The next most costly method is the installation of ballast mat, at an additional cost of approximately $200 per track foot. The least costly method is the installation of the TDA underlayment, at an additional cost of approximately $50 per track foot.[12] TDA was being considered for use in a BART system expansion at the time this report was prepared and CalRecycle has provided research assistance to support this review.

Light rail expansions are not frequent, which limits the amount of TDA that can go to this use. Approximately 50 tires per linear foot of track are used in this application. There are 10 rail systems within 19 counties that can use TDA in this application according to Kennec; however, the infrequent projects result in a small market potential of 1,500 tons per year, or 150,000 PTEs.

The costs and benefits of using TDA in other transportation applications, such as highway sound barrier and sound wall applications and water drainage structures have not yet been investigated in California and performance compared to alternatives or market size potential is not yet known. These applications are currently being evaluated elsewhere (e.g., in Maryland and Virginia).

In summary, the potential market size for transportation-related applications totals 11.5 million PTEs per year.

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[12] Wilson, Ihrig & Associates Inc., "Evaluation Of Tire Derived Aggregate as Installed Beneath Ballast and Tie Light Rail Track," June 2009.

Other Applications

R. W. Beck is not aware of TDA being used on an ongoing basis in any other application in California other than the applications discussed above and we do not foresee any change to this in the immediate future.

In other states, TDA is used in other applications. These applications include septic tank leach fields, as thermal insulating layers (where ground freezes), and as drainage medium behind basement walls. The use of TDA in septic applications normally must be approved by both state and local health departments and water quality agencies in order to be used. The use of TDA in California leach fields has not been approved by the State Water Resources Control Board (SWRCB), although it is allowed in a number of Eastern states including Arkansas, Florida, Georgia, New York, North Carolina, South Carolina, and Virginia. In some of these states it is a large part of the market for tires diverted from landfill disposal.

Although the SWRCB was devising revised regulations for septic systems in 2010, CalRecycle staff did not considered it likely at the time of this report that SWRCB would consider approving the use of TDA in septic systems. CalRecycle funded one research and demonstration project for this application, which included installing TDA at an I-5 rest stop in Stanislaus County in 1998 where 20,000 tires were used. Although performance in this application has not been formally evaluated, the results indicated that TDA performed well as a replacement for conventional aggregate in this application. Unlike the other TDA applications discussed in this section, which require 60,000 to a few hundred thousand tires per project, R. W. Beck estimates that residential septic applications would only take approximately 1,700 tires per residential home, with a potential 3,600 installations per year, for a total potential market size of 6 million PTEs per year. The very large, yet infrequent, civil engineering projects discussed previously are difficult for processors to supply, and supplying TDA to smaller but more frequent projects with steady demand, such as septic installations, would help to develop more suppliers of TDA in California.

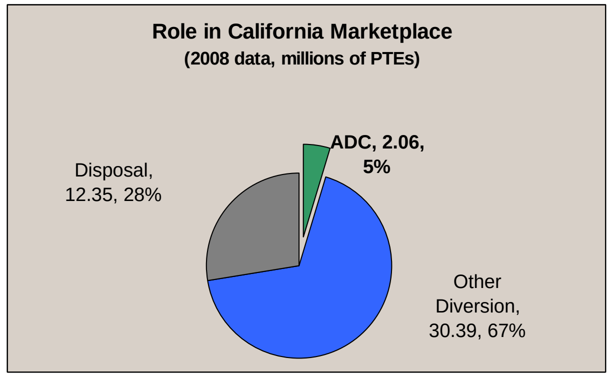
Previously it was noted that TDA use as backfill for retaining walls for road construction was being evaluated. Similarly, there is the potential to use TDA as part of the retaining wall backfill in residential and commercial development. There is no anticipated use of TDA for this application in California at this time, but the potential could be large.

CalRecycle conducted one project where TDA was used for an underground slurry cutoff wall on a Department of Water Resources levee between the Sutter-Colusa canal and the Feather River in Gridley, CA. Using TDA compared to the standard method of construction added an additional cost of $0.51 pre linear foot over the average cost of $6 per linear foot for construction without the TDA according to the U.S. Army Corps of Engineers, with no enhancement to performance. Some 45,000 PTEs were used for the project. Although projects of this type have the potential to use up to 6.4 million tires per year, the lack of cost and performance benefits mean that there is little potential for this application without ongoing state subsidies.

In summary, for the other civil engineering uses segment, only septic uses is a potential market, estimated at 6 million PTEs. However, this potential market cannot go forward without a change to state regulations.

Alternative Daily Cover

Figure 2-14
Role of Alternative Daily Cover in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Tire shreds are used as alternative daily cover to replace dirt and other materials such as green waste or wood waste, and can provide landfills with a cost advantage if they would be required to purchase other materials for use as cover. Landfills that want to use tires as ADC need regulatory permission to do so. The tires must be processed so that no tire material is longer than 12 inches long and at least half must be less than 6 inches long.

This specification is more stringent than the size reduction needed to process tires for landfilling – specifically, the less than 12 inch requirement will normally require most processors to screen and re-shred some of the tire material to ensure the ADC specification is met, whereas these steps are omitted for landfilling of tire shreds.

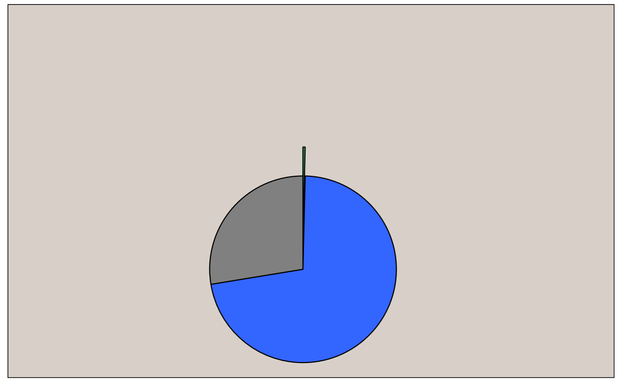
Processors typically must pay a tip fee or at best may be provided with a zero cost for delivering tire shreds to landfills for use as ADC. R. W. Beck believes that this is because of the relative abundance of other ADC materials such as green waste, for which landfills charge a tip fee and often shred themselves on site.

Since 2003, when ADC began to be tracked separately from other diversion uses, use of tires as ADC has steadily declined. In 2008, approximately 2.06 million PTE were shredded and used as alternative daily cover, a 27 percent decline from the amount in 2007. Only three landfills reported using tire shreds as ADC in 2008 and in 2009, so any change in use for this application by a single landfill can cause significant swings in annual quantities for this use.

There are 75 California landfills within 100 miles of the locations of the processors of California tires, so the market penetration for tires as ADC is small – 4 percent of California landfills that could feasibly use the material – and seemingly the potential for increased use is significant. However, the added cost of ensuring rough-shredded tires meet the ADC specification and the relative abundance of soil and other ADC materials mean that the trend of tires going to ADC is expected to continue to decline. Because of CalRecycle resource allocation constraints and other project priorities, financial incentives by CalRecycle to promote this use are not expected. Furthermore, this application will likely continue to decline if TDA use in civil engineering applications increases and material that otherwise would have been used for ADC is diverted to those civil engineering projects.

Other Recycling

Figure 2-15
Role of Other Recycling
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May, 2009)

Other recycling includes small niche markets for cut and stamped products from tires. It also includes technologies with the potential to become large markets for waste tires that are still under development or are not currently economically competitive, and that do not currently exist in California on a production scale. These developmental technologies include:

- **Pyrolysis**—Pyrolysis is the process of decomposing tires into basic materials/ chemicals in a high-temperature low-oxygen environment. At the time of this report, R. W. Beck was aware of only one pyrolysis plants for tires operating commercially in the United States, by Carbolytic Materials Co LLC, that began production in Missouri in fall 2009. Historically, plants such as these have struggled financially because the revenue from the sale of the pyrolysis products (oil, gas, carbon black, and steel) plus tipping fees often does not cover the capital and operating cost of the process. As the price of petrochemicals increases, this technology may become more cost-effective and enable more commercial plants in the future.

- **Devulcanization**—Devulcanization is the ability to take rubber and break the sulfur (curing agent) bond that prevents rubber from being reprocessed (melted and/or blended on the molecular level) after being cured. Devulcanization technologies typically require that waste tires be ground and that wire and fiber be removed prior to devulcanization. This pre-processing step adds significant cost and the materials produced by the technologies have not proven to be economically competitive compared to virgin rubber compounds to allow the process to be used for waste tire recycling.

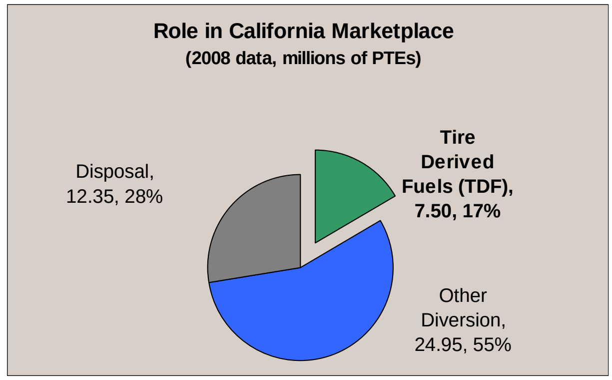
- **Gasification**—Gasification can crack plastics and rubber to gaseous feedstock materials that can be refined and then used as a feedstock for new materials manufacturing. Because of the high cost of production, there is currently no commercially viable market for this product.

For the next several years R. W. Beck believes that the market demand for tires in this category will remain low and that growth will be essentially zero. Over the long term, there is market growth potential. However, this would likely require a sustained return to the record high petrochemical prices that were reached in 2007.

Tire-Derived Fuel

Tire-derived fuel (TDF) includes the combustion of whole or shredded tires in an oxygenated environment for: (1) industrial processes; (2) to generate electricity; or (3) combined generating electricity and industrial processes at one location (referred to as a cogeneration facility).

Figure 2-16
Role of Tire-Derived Fuel
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

For air quality reasons, use of TDF is regulated and only facilities that have a permit to combust TDF may do so in accordance with the limitations of their permits. The only industrial facilities in California that have permits to use TDF are cement kilns. Although paper mills and steel mills in other states may use TDF in their industrial processes, there are no paper or steel mills in California that are believed to be able to benefit from using TDF and no opportunity for market penetration is believed to exist for those types of mills.

At the time of this report U.S. EPA had drafted a proposed rule for "Identification of Non-Hazardous Secondary Materials That Are Solid Waste" that would make combustion of waste tires more costly than in the past, which could result in more tires being landfilled instead of diverted for combustion. The impact of the draft rule is that facilities that combust "solid waste" would be regulated under Section 129 of the Clean Air Act (CAA) and facilities that combust "fuels" would be regulated under CAA Section 112, which pertains to industrial boilers. Regulation under Section 129 is much more stringent and costly to facilities than regulation under CAA Section 112, and may require equipment upgrades for emissions controls. The alternative is to process waste materials to the point that they become a "fuel" and are no longer considered to be waste.

EPA's draft rule would define whole used tires as "solid waste" because they are initially abandoned and thus meet the plain meaning of discard. To be processed into a "fuel," whole used tires would need to be shredded/chipped with steel belts removed so that the tire material is "relatively wire free." Used tires that have been shredded/chipped without the removal of the metal belts or wire would not be considered to have been sufficiently processed, and any TDF that is generated in such a fashion would be considered a waste-derived fuel. Removing the metal belts or wire will help reduce metal contaminants in the emissions and ash, and may improve the burning characteristics for some uses of the TDF. EPA acknowledges that whole tires can be legitimately burned as fuel, as is current practice in most California cement kilns that combust California waste tires, but because they have been discarded and not suitably processed, whole tires and large shreds (with wire) would be considered solid wastes and subject to the CAA section 129 requirements.

U.S. EPA recognizes that the wire in tires is beneficially used by cement kilns and becomes a desired ingredient in the cement clinker that is produced; however, it is not beneficially used by other types of combustion facilities and is not a desired material for them. Therefore, before finalizing the rule, EPA solicited comment on whether to adopt an additional definition for processing that would not require the metal belts or wire to be removed for certain combustion units, such as cement kilns where the metals serve a useful purpose in the process of making clinker.

In its draft rule U.S. EPA also plans to allow a petition method by which companies that burn tires can directly buy tires from generators (tire dealerships and automotive shops), in which case the whole tires would never be "disposed" and therefore would be exempt from the determination that they are "waste." Whole tires that originate from tire dealerships and automotive shops that are overseen by state tire collection oversight programs would be considered to be discarded, unless and until they are processed into TDF that has removed the steel belts and wire, or a case-specific non-waste determination petition is granted.

EPA's proposed rule will definitely impact California's cement kilns if it is finalized in the form as written in May 2010, in which case cement kilns will see their TDF fuel costs increase, unless they decide to cease using TDF for cost or other reasons. Because California's cogeneration facilities already use TDF that is believed to be relatively wire-free, the proposed rule change is not expected to impact them. The following subsections provide additional discussion of TDF use by cement and cogeneration facilities in California.

Cement

Cement kilns are the only type of industrial furnaces (without concurrent generation of electricity) that have obtained permits to combust tires in California. Only some of California's cement kilns have used TDF. The complete list of cement kilns in California is 11, as follows:

- **Northern California (three):**
  - Lehigh Hanson Cement, Inc.—Cupertino
  - Lehigh Southwest—Redding
  - Lone Star Cement (Cemex)[13]—Davenport
- **Southern California (eight):**
  - California Portland Cement Co.[14] —Colton
  - California Portland Cement Co.—Mojave
  - Cemex – California Cement, LLC—Victorville
  - Lehigh Southwest—Tehachapi
  - Mitsubishi Cement—Lucerne Valley
  - National Cement Co.—Lebec
  - TXI Oro Grand—Oro Grande
  - TXI Crestmore—Riverside

Figure 2-17 shows the locations of the cement plants listed above.

[13] Indefinitely shut down, spring 2009.

[14] Indefinitely shut down, November 2009.

Figure 2-17
Locations of California Cement Kilns

Seven of the above kilns are allowed to combust TDF by their air permits; however, in 2007 and 2008 only five actually did so (California Portland Cement, Colton; CEMEX, Victorville; Lehigh Southwest, Redding; Mitsubishi Cement, Lucerne Valley; and National Cement Co. of CA, Lebec).

TDF is a cleaner burning fuel than coal and petroleum coke, the most common fuels used by cement kilns in California, and is used by cement kilns as a supplemental fuel to reduce their emissions so that they can purchase dirtier (and therefore lower cost) coal and petroleum coke primary fuels. Decisions by cement kiln operators on how much TDF to use, if any, depends largely on the California Air Resources Board zone in which they are located, which sets emissions limits. Other factors include whether coal is the primary fuel used (which favors the use of TDF), and whether kilns have equipment that allows them to feed and combust whole tires, which are less expensive than tire shreds. If they can only accept shreds, the cost of the TDF is impacted by the distance to tire processors, which impacts the cost of freight for the TDF, and the cost of shredding.

Table 2-3 shows the mix of fuels used in California cement kilns in 2006.

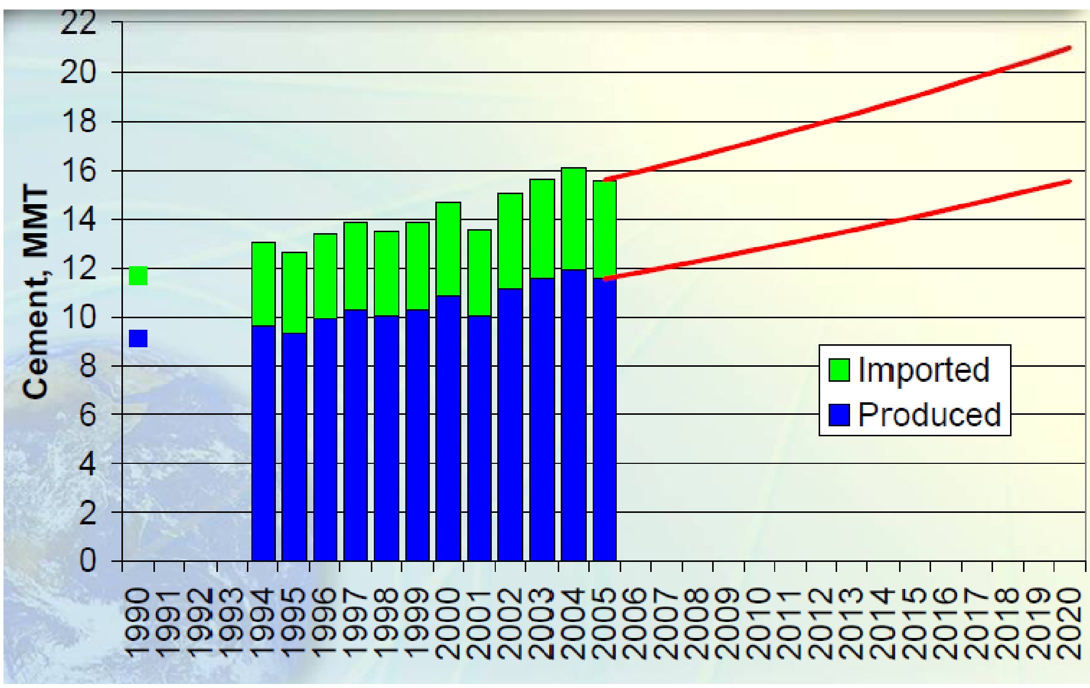
Table 2-3 2006 Fuel Output (California Cement Kilns Statewide)

Fuels	Total Energy (%)
Coal	67
Petroleum Coke	20
Natural Gas	6
Tires	5
Residual Oil	2
Biomass	< 1

Source: CalRecycle – "AB 32: The California Global Warming Solutions Act of 2006" PowerPoint 041008presentations-cement.pdf

In addition to the influence of air permit and fuel cost factors on demand for TDF by cement kilns, construction activity has a tremendous impact as well. At the time of this report, cement kiln production was averaging 60 to 70 percent, or less, of their production before the economic recession of 2008-2009, which resulted in less construction activity. Because fuel consumption by cement kilns is directly proportion to production, TDF demand had been scaled back along with demand for other fuels. As a result, we project that TDF consumed by cement kilns will have declined in 2009 compared to 2007 and 2008 levels, which were 6.6 million and 6.7 million PTE's respectively, or about 15 percent of California tires generated. Figure 2-18 shows projections of cement production in California, which could lead to future TDF demand. However, it is more likely that the proposed EPA rule that would require shredding and wire removal from tires in order to qualify as a "fuel," if it is implemented as drafted in May 2010, will result in a permanent drop in demand for TDF due to the additional cost of the material.

Figure 2-18
California Cement Production, Imports, and Projections



Source: CalRecycle – "AB 32: The California Global Warming Solutions Act of 2006" PowerPoint 041008presentations-cement.pdf

Many cement kilns can accept up to 10 percent TDF as a supplemental fuel without requiring significant changes to their facilities. There is the potential for TDF to increase as a percentage of the fuel mix, particularly if the cost of coal increases in the future. Based on the information presented in this section, it is reasonable to expect the demand for tire-derived fuel from cement facilities in California to be from 3 to 5 million tires in 2009 and 2010. While it has the potential to grow to 13 million PTEs if its percentage of the fuel mix increases to 10 percent, that scenario is unlikely due to changes by the U.S. EPA rule to define which non-hazardous secondary materials are solid waste.

As a result of the economic downturn, and especially its impact on the California construction industry, one cement plant closed in early 2010 and, reportedly, one other plant may be closing soon. During surveys in early 2010, several plants expressed the expectation that they would expand production when the economy rebounds. As of fall 2010 the future of the California TDF market in cement plants is uncertain at best, given these plant slowdowns, closures and the prospect of the U.S. EPA's new TDF rule being implemented.

Cogeneration

Up until 2006, three cogeneration facilities used TDF as a supplemental fuel in their furnaces, although as many as six have operating permits that allowed use of the material. In 2009 the Port of Stockton shut down its facility, leaving only two facilities to use TDF: the Mt. Poso cogeneration facility in Colton and the Stockton cogeneration facility in Stockton. In September 2009 the Mt. Poso facility announced that it would convert from using coal and TDF to exclusive use of biomass. Once the retrofit of the plant is complete in 2011, the only cogeneration facility to remain that will use TDF will be the Stockton cogeneration facility. Even that facility has announced that it plans to supplement its reliance of coal with biomass from local agriculture (i.e., nut shells and peach pits).

The clear trend for cogeneration facilities is that other fuels are being favored over TDF. Specifically, California state policy to generate more electricity from renewable sources means that qualifying "renewable" fuels will be favored compared to tire-derived fuel, which does not qualify. For this reason we expect the use of tires in cogeneration facilities to decline in the future and not grow. Furthermore, on Sept. 15, 2009. Governor Schwarzenegger signed an Executive Order directing the California Air Resources Board to adopt regulations increasing California's Renewable Portfolio Standard (RPS) to 33 percent by 2020. This push for renewables has had the unintended consequence of providing financial incentives for using biomass in the boilers of cogeneration facilities. The result is that cogeneration facility interest and activity is on increasing the use of biomass and the portion of solid waste that counts as "renewable" in California rather than increasing the use of TDF.

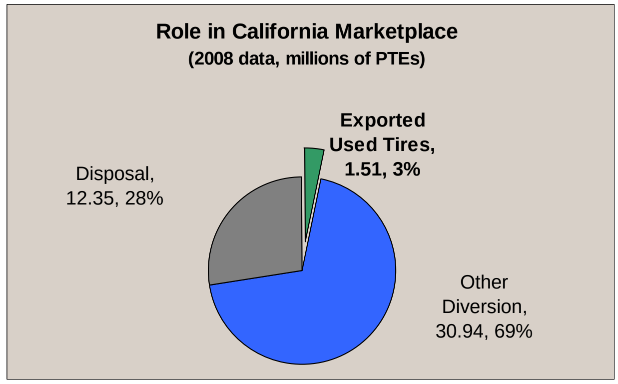
R. W. Beck estimates that these trends will result in the quantity of tires going to cogeneration markets declining from 1.3 million PTEs in 2006 to an estimated 0.6 million PTEs by 2011. At some point it may decline to zero. The U.S. EPA rule is not expected to impact cogeneration because TDF that goes to California cogeneration plants is already processed to the point where it would meet the EPA's proposed definition.

Export

Export markets to surrounding states and other countries can be segmented into two subcategories: (1) that of exporting usable whole tires for reuse as tires, and (2) export of whole tires or tire shreds for recycling into other products or use as fuel. There is a steady demand for export of tires for reuse, especially to Mexico. However, because much of the trends are the same as were discussed previously under California reuse, our discussion will not repeat those trends here.

Furthermore, there is little that California can do to control international and interstate commerce.

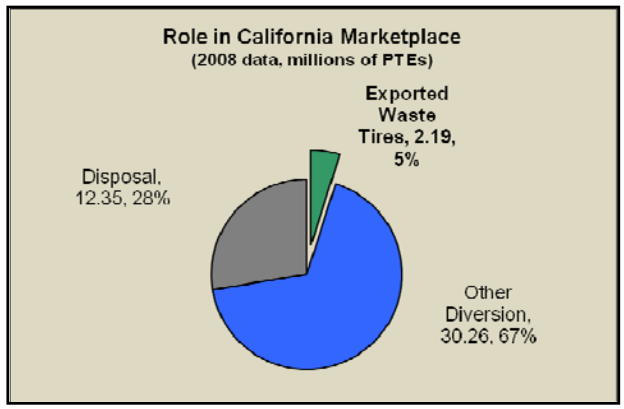
Figure 2-19
Role of Exported Used Tires
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

Export markets are less stable and inconsistent due to currency fluctuations, political and economic trends in other states and countries, and the cost and availability of shipping containers for ocean freight. A recent trend is a very strong and growing market for the export of waste tires to China and to a lesser extent to other Asian countries. China's industrial demand is growing and outstripping their domestic supply of both energy sources and raw materials for the manufacture of products. For this reason, Chinese demand for waste tires from California is growing and their demand is expected to continue growing for a number of years, barring Chinese governmental restrictions on the imports of raw materials from tires. Because of the complexity of the Chinese economy and demand from other countries, including Japan, it is difficult to predict what the future demand for tires from California may be into the future. Recent trends have shown a strong increase from 2007-2008 from 0.65-2.19 million PTEs.

Figure 2-20
Role of Exported Waste Tires
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

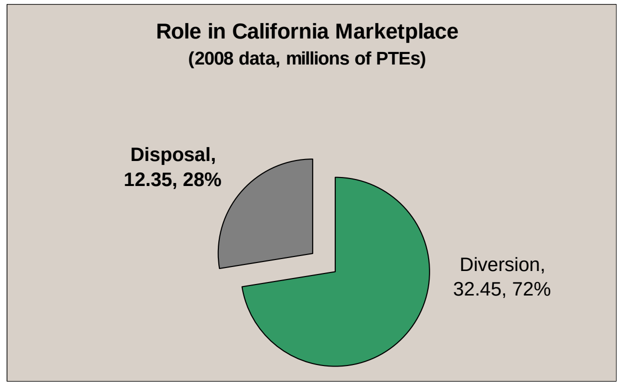
Anecdotal reports in mid-2010 indicate the growth in waste tire exports to Asia is continuing to grow at a rapid pace.

Landfill Disposal

Landfill disposal is the least preferred “market option” of last resort and represents the loss of a resource to disposal. In California, landfilling of whole tires is prohibited, so unless a landfill has invested in shredding equipment, which only a couple have, tire processors are part of the supply chain that delivers tire material for disposal. This fact is important to CalRecycle’s tire market development efforts. The number of landfills that dispose of shredded tires is relatively small, less than 15.

Of those, only five account for the vast majority of tires that are landfilled.

Figure 2-21
Role of Landfill Disposal
in Disposition of California Tires



Source: California Scrap Tire Market Report: 2008 (May 2009)

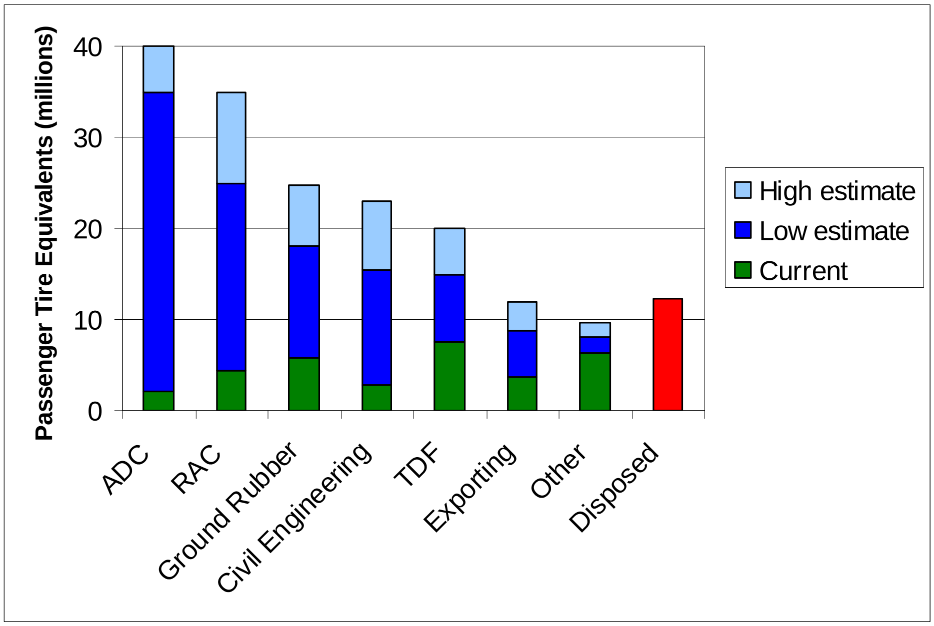
The largest disposal site for tires is the Azusa Landfill, which is owned by Waste Management, Inc., which takes about two-thirds of the 12 million PTEs landfilled in California each year. Although the amount and percentage of California tires landfilled has grown slightly in the last few years, R. W. Beck is confident that growth trends in other market areas as discussed previously, when combined with continuing CalRecycle market develop efforts, can reverse this trend and help California meet its diversion goal.

Section 3
Potential Market Size and Growth Projections

Potential Market Size and Current Penetration Estimates

Figure 3-1 provides a graphical depiction of high and low estimates for theoretical annual market size and penetration for the major categories of tires marketed in 2008.

Figure 3-1
Market Size Estimates and 2008 Market Penetration



The green bars of Figure 3-1 represent the quantity of tires (PTEs) that went into each category in 2008. The dark blue portion of each bar represents an estimate of the additional quantity of tires that could be accommodated in a low estimate for that category, assuming that any barrier to further penetration is removed. The light blue portion of the bars represents a higher level annual estimate for each category. The red bar is the quantity of tires disposed in 2008 that could be diverted into one or more of the blue shaded market areas shown.

The information depicted in Figure 3-1 is presented in more detail in Table 3-1, which also provides the basis for the potential market size estimates. The first column presents data on tires diverted to each market as reported in “California Scrap Tire Market Report: 2008,” May 2009. The 2008 market penetration percentages were calculated by dividing the quantities that went into each market by the high and low estimates for the theoretical market size, the basis of which is explained in the last column of the table.

Table 3-1 Estimated Market Size, Current Penetration, and Potential Penetration by 2015

Category	2008 Marketed (Million PTEs)	Estimated Theoretical Market Size (Million PTEs)		2008 Penetration (%)		Basis of Market Size Estimate
		Low	High	Low	High	
Ground Rubber	10.05	43.0	59.7	17	23	Sum of subcategories
Rubberized Asphalt Concrete (RAC)	4.32	25	35	12	17	California city and county centerline road miles total 138,661 per Table J-1, 2008 California Statistical Abstract. Assuming 2.75 lane miles per centerline mile, would estimate a total of 381,000 city/county lane miles. California state highway (Caltrans maintained) lane miles are 50,773 per Table J-2. Assuming Caltrans' 2008 RAC use rate of 3.5 million PTEs can be extended to city and county roads on the basis of lane miles, would result in a combined potential of 30 million PTEs. Used a range of 25-35 million PTEs due to estimating uncertainty.
Turf and Athletic Fields	2.44	4.0	5.0	49	61	The Synthetic Turf Council (STC) reports a potential market size of 45,000 fields nationally, of which 3,500 installations had been made nationally by 2008 (8 percent market penetration). The annual pace of installations has been growing with STC reporting a 20 percent industry growth in 2008. R. W. Beck has no basis for believing that California has significant differences from the rest of the nation. Taking California current market of 2.44 million PTEs and increasing it by 10 percent each year would result in a market size of 4.75 million PTEs by 2015. Used a range of 4-5 million PTEs due to estimating uncertainty.
Loose-fill Playground/Bark/Mulch	1.15	4.5	7.5	15	26	As noted in the previous section, these market segments have been combined because their common specification complicates separate reporting of market flows. Specific information on market size and share of both playground surfacing and bark/mulch materials is lacking. Engineered wood fiber appears to be the leading playground surfacing material at about half the cost of loose-fill based on initial costs. R. W.

Category	2008 Marketed (Million PTEs)	Estimated Theoretical Market Size (Million PTEs)		2008 Penetration (%)		Basis of Market Size Estimate
		Low	High	Low	High	
						Beck estimated the market size for loose-fill material could be 3-4 times its current size, assuming proposed ADA compliance test methods do not result in this being a non-complying material for commercial and public space applications (residential applications would still be possible). Estimating the size of the bark/mulch market is complicated by a number of factors, including a significant but unquantified volume of imports, the use of retreader buffing in some product applications (which are tracked separately from "nuggets" produced from whole tires), and the vast range of customers and product placement applications. Based on feedback from stakeholders and the relatively larger East Coast market, R.W. Beck estimates that bark/mulch has a potential market size of at least 4-5 times current estimated volumes. The combined market size estimate indicates high potential growth and justifies identification of this segment as a priority; however, additional research is merited to better document the market size.
Pour-in-place Playground	0.45	5.0	7.0	6	9	Information on market share of playground surfacing materials is lacking. Due to the newness of using waste tires for this application, R. W. Beck estimates the potential to be from 10 to 15 times the current market as these other materials replace buffings from retreaders.
Molded and Extruded	1.15	4.0	5.0	23	29	"Feedstock Conversion Project Report," May 2009, estimated the market potential at 52 million pounds of crumb rubber, or approximately 4.3 million PTEs. Used a range of 4-5 million PTEs due to estimating uncertainty.
Other Ground Rubber	0.54	1.5	2.2	25	36	Estimating market size for this general category is difficult because it represents no single market. R. W. Beck estimated the potential could grow from 3 to 4 times current levels.

Category	2008 Marketed (Million PTEs)	Estimated Theoretical Market Size (Million PTEs)		2008 Penetration (%)		Basis of Market Size Estimate
		Low	High	Low	High	
Alternative Daily Cover (ADC)	2.06	35	40	5	6	4.2 million tons of ADC of various types was used in California in 2008, of which tire ADC was approximately one-half of 1 percent. If tire ADC were to grow to 9 to 10 percent of ADC used in the state, the market size of tire ADC would be 35-40 million PTEs per year.
Civil Engineering	2.79	15.5	23.0	11	16	Sum of subcategories
Transportation – lightweight fill[1]	0.73	7.0	8.0	9	10	Kennec estimate of 30 counties with landslide conditions, one project per county per year, and 2,500 tons per project, or 7.5 million PTEs per year. Used a range of 7-8 million PTEs due to estimating uncertainty.
Transportation - retaining wall[1]	0.00	3.0	4.5	0	0	Kennec estimate of 19 counties where wall projects are numerous due to population density and major highways, a total of 1 mile of wall statewide, and 7 tons of TDA per linear foot, or 3.7 million PTEs per year. Used a range of 3-4.5 million PTEs due to estimating uncertainty.
Landfill use[1]	2.06[3]	3.0	4.0	52	69	Based on existing usage levels by nine landfills that have tried the material, plus Kennec estimate of 600 tons per project at 66 other landfills suitable in size and location around processors, and one landfill gas project every other year, for a total of 4 million PTEs. Provided a lower level of 3 million PTEs to account for landfills that are very liberally using the material due to lack of demand by other applications.
Septic use[2]	0.00	4.0	8.0	0	0	Assumes 180,000 new residential homes in California per year based on average of new housing starts from 2003-2007 as reported in Table I-3 of the 2008 California Statistical Abstract, and an estimate that 10 percent of which are in rural areas with septic systems, and 20 percent of septic installations use TDA. Assumes each installation uses 1,700 PTEs (Zicar -i New York State estimating factor), for a statewide market potential of 6 million PTEs. Used a range of 4-8 million PTEs due to estimating uncertainty.

Category	2008 Marketed (Million PTEs)	Estimated Theoretical Market Size (Million PTEs)		2008 Penetration (%)		Basis of Market Size Estimate
		Low	High	Low	High	
Tire Derived Fuels (TDF)	7.50	15	20	*38*	*50*	"Tire Shreds as a Fuel Supplement," 1992, which estimated that cement kilns can use from 15 to 20 percent TDF depending on the type of kiln. Steering committee members for this project suggested the level could be as low as 10 percent. R. W. Beck used the more conservative 10 percent of fuel. TDF use was 5 percent of fuel in 2006 (at 8.3 million PTEs), so the potential market size would be approximately 17 million PTEs. Used a range of 15-20 million PTEs due to estimating uncertainty. The economic downturn and especially the moribund state of the California construction industry have taken a heavy toll on the state's cement industry, with one plant closure in early 2010 and reports of a possible second closure in late 2010. Moreover, the impending U.S. EPA rule that would redefine TDF as municipal solid waste could severely reduce or even eliminate this market. Nevertheless, in surveys in early 2010, several plants expressed a strong desire and ability to use increasing quantities of TDF when the economy rebounds. Overall, the California TDF market potential is currently uncertain and should be re-evaluated in 2011.
Exported Waste Tires	2.19	7	10	*22*	*31*	Estimating market size for this category is difficult because of the complexity of Asian markets and other factors that impact demand. Because of China's high economic growth rate, R. W. Beck estimated the potential could grow from 3 to 4 times current levels.
Exported Used Tires	1.51	1.8	1.9	*79*	*84*	Growth of this category is limited by the number of used tires that are of suitable condition for reuse. R. W. Beck allowed for 20-30 percent larger market size to account for growth of tires generated over the next few years, and to account for tires that may be reusable but are currently going to other uses or disposal.

Category	2008 Marketed (Million PTEs)	Estimated Theoretical Market Size (Million PTEs)		2008 Penetration (%)		Basis of Market Size Estimate
		Low	High	Low	High	
Retreading	4.42	4.8	5.2	*85*	*92*	The majority of truck tires are believed to be retreaded but industry data on the quantity of tires in good enough condition to be retreaded but which are disposed is lacking. We have allowed for 10-20 percent growth as a conservative yet reasonable estimate of additional market potential.
Reuse	1.85	2.2	2.4	*77*	*84*	Growth of this category is limited by the number of used tires that are of suitable condition for reuse. R. W. Beck allowed for 20-30 percent larger market size to account for growth of tires generated over the next few years, and to account for tires that may be reusable but are currently going to other uses or disposal.
Other Uses (incl. Agriculture)	0.08	1	2	*4*	*8*	Estimating market size for this general category is difficult because it represents no single market. R. W. Beck assumed the market size for this category could grow to 1 to 2 million PTEs per year.
Total	**32.44**	**127**	**166**	***20***	***26***	

[1] One very large landfill regularly reports using a large quantity of TDA for its landfill gas collection system, more than is typical than the design basis used by Kennec to form its estimate. It is not certain whether this landfill uses more than the minimum amount of TDA it needs, or if it misclassified tire shreds disposed or used as ADC as used for TDA. Regardless, R. W. Beck, Kennec, and CalRecycle agree that market penetration for landfill use is low and that there is potential for much more TDA to go to this application.

[2] This application is listed because it has achieved wide acceptance in some other states; however, it is not currently approved in the State Water Resources Control Board regulations.

[3] This 2008 landfill civil engineering use estimate should not be used as a benchmark for evaluating future progress as it was necessarily based on reported usage that could not be validated by CalRecycle, and which in some cases may not be consistent with CalRecycle defined civil engineering applications. CalRecycle intends to define specific landfill civil engineering applications for TDA and establish a confirmed baseline when conducting the 2010 market analysis in early 2011.

Market Growth Rate Forecasts

Section 2 discussed markets and trends for California tires and the prior subsection discussed potential market size. In addition to the influence of outside factors on markets, CalRecycle has also been actively involved in influencing and expanding markets and its efforts are ongoing. Table 3-2 shows how California's marketplace for used and waste tires was structured in 2008, including the percent of tires generated that went to each market subcategory. It also includes a summary of market growth rates projected by R. W. Beck, based on a compilation of the trends discussed previously and expected changes due to CalRecycle's market development efforts.

Table 3-2 2008 Market Size and Growth Rate Estimates for Used and Waste California Tires

Category	Sub-Category	2008		Estimated Future Growth (annual number of PTEs)[1]
		Million PTE	Percent of Total	
Export	Waste Tires	2.19	4.9%	Growing at approximately 6% per year
	Used Tires (Exported)	1.51	3.4%	Stable
	Subtotal	**3.69**	**8.2%**	Growing at approximately 4% per year
Reuse	Retread	4.42	9.9%	Stable
	Used Tires (Domestic)	1.85	4.1%	Stable
	Subtotal	**6.27**	**14.0%**	Stable
Ground Rubber	RAC & Other Paving	4.32	9.7%	Growing at approximately 9%
	Turf & Athletic Fields	2.44	5.5%	Growing at up to 10% per year
	Loose-Fill Playground/Bark/Mulch	1.15	2.5%	Assume Bark/Mulch segment experiences growth based on current CA trends, stakeholder perspectives and relatively higher growth on the East Coast. Anticipate new test protocols will not favor loose-fill playground material.
	Pour-in-Place Playground	0.45	1.0%	Growth up to 10% per year
	Molded & Extruded	1.15	2.6%	Growing at approximately 8% per year
	Other	0.54	1.2%	Growing at approximately 8% per year
	Subtotal	**10.05**	**22.4%**	Growing at approximately 9% per year
Civil Engineering	Landfill Applications	2.06	4.6%	Growing at approximately 2% per year although there is a need to confirm baseline valid uses
	Non-Landfill Applications	0.73	1.6%	Growth of over 20% per year[2]
	Subtotal	**2.79**	**6.2%**	Growth of over 10% per year[2]
Alternative Daily Cover (ADC)		**2.06**	**4.6%**	Stable to declining
Other Recycling		**0.08**	**0.2%**	Stable to modest growth

Category	Sub-Category	2008		Estimated Future Growth (annual number of PTEs)[1]
		Million PTE	Percent of Total	
Tire-Derived Fuel (TDF)	Cement	6.67	14.9%	Stable to declining
	Co-Generation	0.83	1.9%	Declining
	Subtotal	**7.50**	**16.7%**	Stable to declining
Landfill Disposal		**12.35**	**27.6%**	Slightly declining
Total Generated		**44.79**	**100.0%**	
Total Diverted from Landfill		**32.44**	**72.4%**	

[1] The projected future growth rates shown are based on a regression analysis of California tire market data from 2003 to 2008. For many categories, growth rates predicted by the regression analysis were adjusted by R. W. Beck to account more heavily for near-term changes in the marketplace, and in anticipation that recent CalRecycle programs will prove effective in increasing diversion.

[2] Growth is not consistent from year-to-year due to sporadic use based on individual large project needs. CalRecycle continues to focus on growing this market segment and while there is great potential for significantly more use, concerted effort by CalRecycle to grow this market is required to achieve the projected growth rate shown.

The growth forecasts shown in Table 3-2 are based on a regression analysis of tire market data from 2003 to 2008 to produce predictive formulae for future market place changes. For many subcategories, R. W. Beck made adjustments to the formulae produced by the regression analysis to account more heavily for near-term changes in the marketplace, or to account for anticipated results from current CalRecycle programs that would not have been fully reflected in past data. Care has also been taken in an attempt to ensure the trends are not obscured by short-term changes from the economic recession of 2008-2009, which we believe to be temporary.

Listed below is a short summary of why R. W. Beck adjusted projections based on past trend data for certain categories. A listing of the growth rates forecasted by the regression analysis and a more in depth discussion of specific R. W. Beck adjustments to the growth factors can be found in Appendix B. The projected future growth rates shown in Table 3-2 form the basis of future diversion estimates produced by R. W. Beck out to the year 2015, which are presented later in this report.

It should be noted that the growth rate estimates are subject to high levels of uncertainty, and are presented here as a best available estimate at this time for planning purposes.

- **Exports**—Exports of waste tires to China are increasing, where they are used as an energy source or for materials in manufacturing. There was a large jump in this category from 2007 to 2008, so R. W. Beck adjusted the projected growth to a lower and more moderate rate suitable for longer term forecasting.
- **Ground Rubber**—CalRecycle continues to invest in market development and stimulate market demand for ground rubber products through grants, which are expected to continue to lead to growth in ground rubber in general.
    - **Rubberized Asphalt Concrete (RAC)**—R. W. Beck increased the growth estimate upward to account for municipal governments that were introduced to RAC through grants that only now seem to be increasingly using the product on their own without ongoing CalRecycle grant support.

- **Turf and Athletic Fields**—Use of crumb rubber from tires as infill between the blades of artificial turf in athletic field installations continues to grow. R. W. Beck adjusted the apparent California market growth upward to be more in line with national growth trends.
- **Playgrounds**—There is the potential for new testing methods currently under review for disability access and fall safety to cause changes in how certain materials qualify compared to alternatives. Specifically, there is the potential that pour-in-place may become more sought-after than loose-fill ground rubber, and that the demand for tire products in general may outpace non-tire materials. The statistical data for pour-in-place playgrounds is only based on a short two-year period in which playground data were collected as separate subcategories, and likely reflected the results of higher than average CalRecycle TDP grant funds going to playground applications. Because the higher growth levels are not sustainable, and because TDP grants are planned to decrease in the future, R. W. Beck chose to use a more moderate growth rate, focused on the pour-in-place category.
- **Loose-Fill Playground/Bark/Mulch**—Bark and mulch have grown steadily in recent years, including significant amounts of imports. (Some retreader buffing are also used as mulch, but are not included in market statistics focused on use of whole tires.) Some stakeholders feel there is significant potential for growth in this segment as West Coast use is much lower than levels on the East Coast. Loose-fill playground surfacing has appeared to hold steady in recent years, with some alluding to growth in residential uses. A new specification under development in relation to the Americans with Disability Act could reduce use of loose-fill rubber in playgrounds.
- **Molded and Extruded**—Molded and extruded products made from recycled tire rubber are expected to grow, but their potential is limited by the lack of suppliers of ultra-fine mesh rubber in California. R. W. Beck adjusted the growth rate downward to reflect this.

- **Civil Engineering**—CalRecycle continues to focus on growing this market segment. While there is great potential for significantly more use, concerted effort by CalRecycle to grow this market is required. R. W. Beck adjusted civil engineering applications significantly upward, assuming that CalRecycle's market development efforts show results in the future. Note, too, that the 2008 estimate cannot be used as a confirmed baseline because some of the reported uses could not be validated by CalRecycle as constituting civil engineering uses as defined by CalRecycle. However, there is clearly room for growth consistent with the projection provided. CalRecycle intends to document a confirmed baseline for landfill civil engineering uses for 2010, as part of the market analysis report to be prepared in early 2011.
- **Tire Derived Fuel**—R. W. Beck adjusted TDF to show a small increase in future years. The steep declines in the past several years are believed to be related to short-term factors. This category has the potential for significant future declines due to a proposed U.S. EPA rule change and the continuing economic downturn which has already resulted in one plant closure. Because of potential outcome of the proposed EPA rule is not known, it has not been reflected in the estimated growth rate at this time. And, despite the current reduction in capacity, industry representatives have indicated that they are interested in increasing use of TDF if conditions warrant. Consequently, this market should be watched closely in coming months and reevaluated in the next CalRecycle market analysis report scheduled for spring 2011.

Future Market Size and Potential Penetration Estimates

Table 3-3 shows an estimate of future market size growth and market penetration that, in R. W. Beck's opinion, is very optimistic yet achievable by 2015 if CalRecycle continues to work aggressively to remove barriers and support market development as spelled out in its 2009 Five-

Year Plan. The 2015 market potential size estimates were calculated from the 2008 data, using the estimated future growth rates discussed in the prior subsection.

Table 3-3 Estimated Market Size, 2008 Penetration, and Potential Penetration by 2015

Category	Estimated Theoretical Market Size (Million PTEs)		2008 Marketed (Million PTEs)	2008 Penetration (%)		2015 Market Potential (Million PTEs)	2015 Potential Penetration (%)	
	Low	High		Low	High		Low	High
Ground Rubber	44.0	61.7	10.05	16	23	16.1	26	38
Rubberized Asphalt Concrete (RAC)	*25*	*35*	*4.32*	*12*	*17*	*6.1*	*17*	*24*
Turf and Athletic Fields	*4.0*	*5.0*	*2.44*	*49*	*61*	*3.9*	*77*	*97*
Loose-fill Playground/Bark/Mulch	*4.5*	*7.5*	*1.15*	*15*	*26*	*2.0*	*27*	*44*
Pour-in-place Playground	*5.0*	*7.0*	*0.45*	*6*	*9*	*1.2*	*18*	*25*
Molded and Extruded	*4.0*	*5.0*	*1.15*	*23*	*29*	*2.0*	*39*	*49*
Other Ground Rubber	*1.5*	*2.2*	*0.54*	*25*	*36*	*0.9*	*42*	*62*
Alternative Daily Cover (ADC)	35	40	2.06	5	6	2.1	5	6
Civil Engineering	15.5	23.0	2.79	12	18	5.0	22	32
Transportation - lightweight fill[1]	*7.0*	*8.0*	*0.73*	*9*	*10*	*1.9*	*24*	*27*
Transportation - retaining wall[1]	*3.0*	*4.5*	*0.00*	*0*	*0*	*1.0*	*22*	*33*
Transportation - light rail	*0.1*	*0.2*	*0.00*	*0*	*0*	*0.1*	*50*	*100*
Landfill use[1, 2]	*3.0*	*4.0*	*2.06*	*52*	*69*	*2.0*	*52*	*69*
Other uses - septic[3]	*4.0*	*8.0*	*0.00*	*0*	*0*	*0.0*	*0*	*0*
Tire Derived Fuels (TDF)	15	20	7.50	38	50	7.7	38	51
Exported Waste Tires	7	10	2.19	22	31	3.7	37	52
Exported Used Tires	1.8	1.9	1.51	79	84	1.6	84	89
Retreading	4.8	5.2	4.42	85	92	4.5	87	94
Domestic Used Tires	2.2	2.4	1.85	77	84	2.0	85	93
Other Uses (incl. Agriculture)	1	2	0.08	4	8	0.1	5	10
Subtotal Diversion	128	168	32.44	19	25	42.8	26	34
Landfill Disposal	n/a	n/a	12.35	n/a	n/a	10.9	n/a	n/a
Total Generation	n/a	n/a	44.79	n/a	n/a	52.9	n/a	n/a

1 Estimated market size derived from Kennec estimates.

2 Landfill uses market size estimate is for landfill gas and leachate recirculation applications only. The 2008 estimate should not be used as a benchmark to evaluate future effort as it was necessarily based on reported use that in some cases could not be validated by CalRecycle and may not comprise CalRecycle defined civil engineering uses. Regardless of the uncertainty, R. W. Beck, Kennec, and CalRecycle agree that market penetration for landfill use is relatively low and that there is potential for more TDA to go to landfill gas applications. Landfill applications also include use of significant potential quantities TDA in operational layers; however, this use is not listed separately because of significant regulatory and supply barriers. Despite the barriers, CalRecycle should be open to opportunities to expand such uses and this potential contributes to listing landfill TDA as a priority market segment.

[3] This application is listed because it has achieved wide acceptance in some other states; however, it not currently included in the State Water Resources Control Board regulations.

Table 3-1 shows that more than 12 million California waste tires were landfilled in 2008. A 90 percent diversion rate in 2008 would have required that approximately 8 million of those 12 million tires go into the markets shown in Table 3-2. Due to population growth, market consumption of tires may need to grow by up to 5.9 million tires by 2015 just to keep the diversion rate equal to what it was in 2008. Furthermore, market demand and diversion for an additional 9.3 million tires (for an overall increase of 15.2 million tires by 2015 compared to 2008) would be required to achieve a 90 percent diversion rate by 2015. Figure 3-2 and Table 3-2 show that several general upper-level market categories on their own could accommodate the additional 16.6 million PTEs diversion from landfill that would be required, including Ground Rubber (collectively of all subcategories), ADC, and potentially Civil Engineering under high theoretical market size estimates. Alternatively, the additional tires that need to be diverted to achieve 90 percent can be distributed among several or all of the categories and subcategories. Even certain categories that have a relatively high market penetration, such as the Turf and Athletic Field category, can continue to expand and take significantly more tires to help the state achieve its landfill diversion goal.

CalRecycle's existing market development program is focused on increasing ground rubber use (RAC and other TDPs) and civil engineering projects that use TDA, and the 2009 Five-Year Plan is structured and funded to move California toward 90 percent diversion through those specific market segments. Based on the 2008 market category size and market category growth trend estimates listed in Table 3-2, and assuming CalRecycle's current programs and funding as laid out in the Five-Year Plan result in additional diversion, R. W. Beck forecasts that market consumption may increase by an additional 10.2 million PTEs compared to 2008 levels, to a total diversion of 42.8 million PTEs by 2015. At this diversion level, and assuming tire generation grows to 52.9 million PTEs by 2015, California may be on track to achieve an 81 percent diversion rate for waste tires by 2015. This analysis assumes that the upward trend in many markets continues and that potential significant barriers to market growth (such as to TDF or loose-fill playgrounds) do not adversely impact current markets. While an 81 percent diversion rate would be an improvement over the 72 percent diversion rate of 2008, it still falls short of the CalRecycle's 90 percent diversion rate goal. In presenting the forecasts of this section, there is risk that past trends and/or our adjustments to trend data may not accurately predict growth over the next few years. There is also risk that current market softening may result in long-term changes to the marketplace, which cannot be readily predicted.

Based on research results presented herein, CalRecycle will need to apply more resources to its market development program, building on existing strategies and including new ones as well, or consider other measures, in order to reach its diversion goal. For each market segment there are market expansion barriers and threats that stand in the way of CalRecycle achieving its goal. These barriers and threats are discussed briefly in the next section.

Section 4
Market Barriers and Threats

The apparent opportunities shown in the prior section where market penetration is a low percentage often have very real obstacles to achieving higher penetration levels. Key barriers to market expansion are presented in Table 4-1, which lists market segments generally in order of the largest theoretical market expansion potential, along with the key barriers related to each segment. At the bottom of the table, barriers related to multiple segments are listed. Table 4-1 just provides a summary of key barriers and a more detailed discussion of these barriers, additional barriers or nuances, as well as options for overcoming the barriers are included in a companion document to this report "Tire Market Development Program Evaluation," May 2010.

Table 4-1 Key Barriers to Additional Market Penetration

Market Category/Sub-Categories	Barriers
Ground Rubber	
▪ RAC and Other Paving	**Financial**—Specialized heating and blending equipment is needed by batch plants and chip seal contractors to use RAC, limiting use to larger project sizes and contractors with the required equipment.
▪ RAC and Other Paving ▪ Turf and Athletic Fields ▪ Molded and Extruded	**Financial**—Some crumb rubber from outside of California is subsidized, reducing its cost compared to California tire crumb, placing California processors at a disadvantage.
▪ RAC and Other Paving ▪ Turf and Athletic Fields ▪ Loose-Fill Playground ▪ Pour-in-Place Playground ▪ Mulch/Bark ▪ Molded and Extruded ▪ Other	**Technical**—Lack of consistency in composition of tires/feedstock.
▪ Turf and Athletic Fields ▪ Loose-Fill Playground ▪ Pour-in-Place Playground ▪ Mulch/Bark ▪ Molded and Extruded ▪ Other	**Technical**—Lack of industry standards and specifications (though they are currently under development by ASTM), testing protocols, and accessibility of testing equipment.
▪ Turf and Athletic Fields ▪ Loose-Fill Playground ▪ Pour-in-Place Playground ▪ Mulch/Bark	**Financial/Research**—High up-front costs are more than for alternative non-tire products; long-term product performance and life cycle costs have not been documented by independent agencies
▪ Molded and Extruded ▪ Other	**Technical**—Inherent material limitations that hinders its use as a feedstock.
▪ Molded and Extruded ▪ Other	**Financial**—Inconsistent financial benefit to feedstock conversion due to price fluctuations of other materials, e.g., oil, etc.; processors have not invested in production capacity for ultra-fine rubber due to unproven demand.

Market Category/Sub-Categories	Barriers
Alternative Daily Cover	
	Financial/Policy—Other ADC materials are readily available but tire ADC needs to be trucked in at a cost, unless a processor happens to be co-located at a landfill, and used in greater amounts than alternatives; requires prior CalRecycle and Local Enforcement Agency approval and modification of landfill operating permit.
Civil Engineering	
▪ Transportation-Related Applications	**Financial/Policy—**At this point in time individual project sizes are relatively large and irregular in timing, and as a result are disruptive to their routine business operations, so that processors are hesitant to enter marketplace as a supplier or invest in equipment to produce Type A and B TDA. Regulatory issues related to storage of tires for large jobs are also a barrier.
▪ Other Applications	**Policy**—Currently the State Water Resources Control Board does not include in its regulations the use of TDA in septic system applications; the use is approved in a large number of other states.
Other Recycling	
	Research/Technical—Other technologies remain unproven.
	Policy—Unresolved regulatory issues with newer technologies.
	Outreach/Financial—Lack of information about newer technologies makes them difficult to implement/fund.
Export	
	Educational—Lack of information/knowledge regarding export regulations and how to export, especially when broker not used.
Cross Category	
▪ All	**Financial**—Tire processor and TDP product manufacturing businesses are at an economic disadvantage when competing against older, larger, and more established incumbent products and materials and low margins leave little funds for improving business capitalization or extensive marketing campaigns.
▪ RAC ▪ Civil Engineering	**Financial**—There are a relatively small number of tire processors and they are concentrated in population centers where tires are generated. However, many project locations are in remote unpopulated areas where freight costs are a disincentive to using materials from tires. This is especially the case for TDA and RAC.
▪ All	**Informational/Research/Outreach/Technical—**Some potential consumers of tire-derived products have concerns regarding the health, safety, and environmental impacts of tire-derived products and feedstocks. There is a lack of information/awareness regarding best management practices to mitigate potential impacts.
▪ RAC and Other Paving ▪ Landfill Applications ▪ Transportation-Related Applications	**Educational/Technical**—Local government specifiers and engineers with are not familiar with advantages of products and how to design/specify projects.

Market Category/Sub-Categories	Barriers
▪ All	**Financial/Technical/Educational—**Some businesses lack expertise regarding how to market their products, streamline operations, and otherwise improve and expand their business.

The above table lists barriers to expanding demand over and above current levels in key market segments. It is also important to recognize that markets are fluid and there are threats that could potentially reduce current demand in some segments over time. Some key threats that could potentially impact diversion levels over the next three years or more are listed below:

- U.S. EPA has proposed a new regulation that could potentially have the effect of reducing the use of TDF in cement kilns. TDF demand could be reduced by as much as 5.4 million PTE (or 12 percent of total generation). The rule would define whole tires and processed tires larger than 2 inches consumed as fuel as municipal solid waste, thereby requiring cement kilns to secure new permits and abide by operating procedures. Industry experts caution that these plans would likely switch to other fuels rather than comply with these requirements and costs. Using 2-inch TDF chips would result in a new cost compared with the current tip fee revenues derived from acceptance of whole tires;
- In addition to the regulatory threat to TDF, contraction of the California cement industry due to the current economic downturn, which is assumed to be temporary, combined with a shift by cogeneration facilities to renewable power sources triggered by California's Climate Change Act (AB 32, Núñez, Chapter 488, Statutes of 2006) and other state policies could further reduce demand for TDF;
- The current economic downturn, which has resulted in hopefully a short-term reduced demand for several tire-derived products, and perhaps most notably for TDF in cement kilns, could be prolonged or even intensify, resulting in the potential long-term loss of demand and/or processor closures, putting added pressure on the need for market development;
- The recent significant increase in ground rubber production capacity combined with the possibility of significantly reduced demand could potentially result in a glut of ground rubber, with price reductions, reduced profitability, and possibly plant closures. Should this situation arise, low-cost ground rubber from subsidized producers in other states and in Canada could potentially out-compete California-produced ground rubber in some markets;
- Perceived health concerns and sustained media coverage could reduce demand for certain ground rubber products and/or spur installers and distributors to pursue alternatives to tire rubber, especially turf products and potentially bark/mulch and loose-fill playground surfacing products;
- While not currently under discussion, California is currently experiencing a severe budget crunch and if it were to occur, a significant reduction in tire program funding could reduce grants, other financial assistance, technical assistance and promotional efforts, potentially triggering a reduction in demand and/or production capacity;
- Strong demand for waste tires by Asian nations, especially China, could grow and then stall as waste tire collection volumes grow in China and other Asian nations, potentially causing a sudden glut of waste tires in California; and
- Some developing countries are considering legislation that could impose bans or duties on the importation of used tires and/or waste tires.

Section 5
Prioritization of Market Expansion Opportunities

This subsection provides a summary of where R. W. Beck believes market expansion opportunities exist, organized into top, medium, low, and no priority groupings. These priority assignments are based on the market growth trends, market penetration estimates, and barriers discussions of this report, as well as consideration of CalRecycle's legislative authority. It should be noted that these priorities are essentially in alignment with current CalRecycle market development focus areas.

Top Priority Market Expansion Opportunities

Growth in these market segments is critical to achieving 90 percent diversion, and expansion is in synch with CalRecycle goals and market development principles. CalRecycle should focus resources on these markets to as great an extent possible to support maximum market expansion.

- Ground Rubber:
    - **RAC**—RAC still offers significant growth opportunities, especially for local agency use and with potential for expanded use by Caltrans in new areas (e.g., terminal blend). There are also opportunities to increase the percentage of material used that is California-generated versus imported from other states and provinces, which is extensive.
    - **Loose-Fill Playground Surfacing/Bark/Mulch**—Loose fill is well-established and a large user of ground rubber, although it is threatened by a potential change in performance test methods related to the Americans with Disability Act. Bark/mulch is one of the few TDPs to achieve sales in retail stores; there is still potential growth for bark both at retail and at commercial and government properties. Production of bark/mulch on the West Coast trails the East Coast where the market is much larger, implying significant growth potential.
    - **Molded and extruded products**—This category includes a range of flooring and outdoor surfacing products with high growth potential, including as consumer products. While challenging and probably a long-term effort, feedstock conversion holds the promise of significant growth within established industries and product lines.
- Civil Engineering:
    - **Landfill applications**—This proven application has only been tried by 10 of the state's landfills for landfill gas collection and leachate recirculation systems and the smaller but recurring projects are easier for processors to supply compared to transportation civil engineering projects. There are higher-volume uses related to leachate collection and operations layers that also have high potential, but they have significant supply, cost, and possibly regulatory barriers that inhibit their potential.
    - **Transportation retaining wall and lightweight fill**—These applications are proven uses for which Caltrans has adopted supporting policies for use either currently (lightweight fill) or anticipated in the near future (retaining wall). There is a large potential to expand use in both state- and local agency-sponsored projects. Important supply and other barriers must be addressed.

Medium Priority Market Expansion Opportunities

These market segments already use large quantities of California tires, and sustained use is critical to achieving and maintaining the 90 percent diversion goal. CalRecycle should focus resources on these market segments to ensure continued strong sales and also, to the extent possible, continued growth. CalRecycle should be wary of threats that may reduce volumes flowing to these. Also included are civil engineering market segments that have high potential growth in the long term, but low potential in the short term.

- Ground Rubber:
  - **Pour-in-Place Playground Surfacing**—Pour-in-place playgrounds are currently primarily made from buffings from truck tire retreading/reuse applications, which is not a waste tire diversion application. There is room for expansion of pour-in-place playgrounds made from waste truck tire buffings and/or from developing product designs where ground tire material is incorporated into the structure. There is some concern that playground surfacing may be slowing due to market penetration and/or perceived environment or (for loose fill) health concerns. However, sustained use with the possibility of significant growth is likely for some time.
  - **Athletic Fields—**Athletic field installations continue to grow mostly on their own merits. CalRecycle can best support this market with independent cost-benefit assessments and by addressing environment and health concerns with fact-based research. While there is plenty of short-term potential left in this market, it will begin to moderate over the long term due to market saturation. Some California stakeholders suggest the market is already beginning to decline as substitutes for rubber infill are growing.
- Civil Engineering:
  - **Other uses (residential septic and residential retaining walls)**—These uses have significant potential, but will require a long period of time to demonstrate, overcome policy and institutional barriers, and develop supply chains for local distribution.

Low Priority Market Expansion Opportunities

These market segments are either not viewed as a highly desirable end use, or are already near their maximum market potential. CalRecycle should monitor their use and as needed and possible, continue to take actions to allow the uses to continue, while not impeding their use.

- **Reuse (used tires and retreading**)—These are highly mature and stable, economic uses that are likely to continue to be a staple of California tire markets. They have reached their near maximum potential already.
- **ADC**—While this use is not perceived as a high priority, it is does have the potential to use additional quantities of tires. Also, it may have a role in helping to address the civil engineering supply barrier by providing a market use from which flows may be able to be diverted to civil engineering projects as those projects arise.

No Priority

These are market segments that CalRecycle should take no action to promote at this time.

- **TDF**—TDF is a very important, sustainable and economic market to support diversion, which has the potential to use additional tires (especially as the economy rebounds), and which is subject to threats in the near term that could reduce its use from policy action on the national and state levels. Ideally, if not for the current legislatively mandated moratorium on CalRecycle promotion of TDF, R.W. Beck would recommend this as a high priority market segment.

- **Export**—While export market demand is currently growing and diverts significant quantities of tires from California landfills, there is very little information about how tires are used in export markets. There is also a risk over the long term that export markets may suddenly collapse, leaving the state without sufficient diversion options to handle the resulting increase in flows.

Appendix A
Glossary of Key Terms and Acronyms

Alternative Daily Cover (ADC)—The U.S. Resource Conservation and Recovery Act Subtitle D underwent a major revision in 1991 to ensure human health and the environment were protected. A major change was the requirement to cover disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals if necessary. Materials other than, or in combination with, earthen materials, referred to as Alternative Daily Cover, may be used to achieve the same function, including shredded tires. Permission must be granted by the Local Enforcement Agency for the landfill with concurrence by the CalRecycle.

Asphalt-Rubber—A blend of asphalt cement, ground tire rubber, and additives in which the rubber component is at least 15 percent by weight and has reacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles.

Buffings—High-quality scrap tire rubber, often elongated, that is a byproduct from the conditioning of tire carcasses to remove worn/used tread from a tire in preparation for re-treading. Buffings contain essentially no metal or fiber.

Chip Seal—A pavement surface treatment formed by evenly distributing a thin base of hot asphalt or asphalt-rubber onto an existing pavement and then embedding finely graded aggregate into it.

Civil Engineering (CE)—Use applications for shredded tires in public works construction applications where defined properties are needed, including use in roadways and transportation systems, landfill systems, as lightweight fill, in retaining wall applications, or levee projects.

Cogeneration—The process of combusting a fuel and using the heat for both an industrial process and for generating electricity. Waste tires and/or other fuels may be the fuel that is combusted.

Crumb Rubber—Rubber granules derived from a waste tire that are less than or equal to one-quarter inch or six millimeters in size. (30 Public Resources Code (PRC) §42801.7).

Passenger Tire Equivalent (PTE)—Historically, measurement of the quantities of scrap tires were based on number of tires and not weight. Because scrap tires come in a variety of sizes and weights (especially when passenger and light truck tires are compared to heavy commercial tires), it is useful to use a standard unit of measure to convert numbers of tires to weight and number of large tires to equivalent number of small tires, and vice versa. This factor is called the Passenger Tire Equivalent. The average scrap passenger tire historically has been commonly held to weigh 20.0 pounds. Furthermore, 14 CCR §17225.770 defines a "passenger tire equivalent" (PTE) as the total weight of altered waste tires, in pounds, divided by 20 pounds. 1 PTE = 1 Waste Tire.

Rubberized Asphalt Concrete (RAC)—A pavement material that consists of crumb rubber mixed into regular asphalt concrete (a mixture of asphalt binder and mineral aggregate). Since 2007 the California Department of Transportation (Caltrans) has superseded using the term Rubberized Asphalt Concrete with the term Rubber Hot Mix Asphalt, which is an equivalent term that Caltrans feels is more consistent with industry usage.

Rubber Hot Mix Asphalt (RHMA)—See the definition of Rubberized Asphalt Concrete.

Scrap Tire—A worn, damaged or defective tire that is not a repairable tire. (30 PRC §42805.6).

Tire Business Assistance Program (TBAP)—A California program that provides services and resources for businesses who either process used tires or produce tire-derived products using California waste tires.

Tire-Derived Aggregate (TDA)—Pieces of scrap tires that have a basic geometrical shape and are generally between 12 mm and 305 mm in size and are intended for use in civil engineering applications.

Tire-Derived Fuel (TDF)—The combustion of whole or shredded tires in an oxygenated environment to extract the energy value embodied in the tire for use in an industrial process or to generate electricity.

Tire-Derived Product(s) (TDP)—Material that meets both of the following requirements (30 PRC §42805.7):

1) Is derived from a process using whole tires as a feedstock. A process using whole tires includes, but is not limited to, shredding, crumbing, or chipping.

2) Has been sold and removed from the processing facility.

Used Tire—A tire that meets both of the following requirements:

1) The tire is no longer mounted on a vehicle but is still suitable for use as a vehicle tire.

2) The tire meets the applicable requirements of the Vehicle Code and of Title 13 of the California Code of Regulations.

Waste Tire—A tire that is no longer mounted on a vehicle and is no longer suitable for use as a vehicle tire due to wear, damage, or deviation from the manufacturer's original specifications. A waste tire includes a repairable tire, scrap tire, and altered waste tire, but does not include a tire-derived product, crumb rubber, or a used tire. (30 PRC §42807)

Appendix B
Basis for Market Growth Estimates to 2015

Table B-1 shows the formulae that were developed through a regression analysis of market data from 2003-2008. In many cases, data for subcategories were only available for 2007 and 2008, which is insufficient for regression analysis or for confidence in making future projections. Furthermore, historical trend data for certain categories were not believed to be good indicators of future growth potential for those categories due to recent market changes or CalRecycle initiatives in the marketplace. For those reasons, R. W. Beck made adjustments to the growth rates to be used for projecting the future number of tires to be diverted by 2015. These adjusted growth rate figures, and R. W. Beck's reason for making the adjustments, are also shown in the table and further discussed in the text that follows it.

Table B-1 Basis for Market Growth Estimates to 2015

Category	Sub-Category	Regression Formula or 2007-2008 change, Growth Rate %, r^2 [1]	R. W. Beck Adjusted Growth Rate	Reason for R. W. Beck Adjustment
Export	Waste Tires	237%	6%	Growing Chinese demand, more reasonable growth rate
	Used Tires (Exported)	-6%	1%	Understood to be stable and not declining
	Subtotal	-0.1871*(year)-372.81 5.1%, 0.22	4%	
Reuse	Retread	0.0029*(year)-1.3267 0.1%, 0.43	regression [2]	
	Used Tires (Domestic)	0.0483*(year)-95.115 2.3%, 0.09	regression [2]	
Ground Rubber	RAC & Other Paving	0.4046*(year)-808.13 6.8%, 0.67	9.4%	Growing municipal use has only recently become significant and is obscured in past data
	Turf & Athletic Fields	-2%	10%	Industry trend information (insufficient California data)
	Loose-Fill Playground/Bark/Mulch	NA	8.3%	Assume Bark/Mulch segment experiences growth based on current CA trends, stakeholder perspectives and relatively higher growth on the East Coast. Anticipate new test protocols will not favor loose-fill playground material.

Category	Sub-Category	Regression Formula or 2007-2008 change, Growth Rate %, r^2 [1]	R. W. Beck Adjusted Growth Rate	Reason for R. W. Beck Adjustment
	Pour-in-Place Playground	73%	10%	Anticipate new test protocols will favor pour-in-place; adjusted to a more reasonable long term growth rate
	Molded & Extruded	13%	8%	Industry trend information (insufficient California data)
	Other	-5%	8%	Industry trend information (insufficient California data)
	Subtotal	0.472*(year)-942.63 6.7%, 0.51 [3]	8%	
Civil Engineering	Landfill Applications	-19%	1%	Assumed CalRecycle success in growing this category
	Non-Landfill Applications	-26%	26%	Assumed CalRecycle success in growing this category
	Subtotal	0.3783*(year)-756.22 7.7%, 0.60	14%	
Alternative Daily Cover (ADC)		-0.5554*(year)+1117.8 -27%, 0.78	0%	Assumed outlet for material when civil engineering projects are not ongoing (no growth, no loss)
Other Recycling		-20%	0%	Industry trend information (California data not useful due to category definition changes)
Tire-Derived Fuel (TDF)	Cement	1%	regression [2]	
	Co-Generation	-25%	-4%	Another facility ceasing the use of TDF in 2010, adjusted to a more reasonable decline rate
	Subtotal	0.0017*(year)+4.532 0.0%, 0.00		
Total Generated		1.15, 2.6% (0.86)	2.3% [4]	Assumes tire growth parallels that of population

[1] Where a regression analysis could be performed, the formula derived from the regression analysis is presented as a linear equation (y=mx+b), where x, or "year," equals the calendar year (e.g., 2012). Also presented is an annual growth rate figure in percent, and an r^2 value. For a number of subcategories, specifically the ground rubber subcategories (except for RAC) and export subcategories, subcategory breakout data were only available for 2007 and 2008. For those subcategories a regression analysis was not performed and only a simple one year percent change value was calculated (from 2007 to 2008). The average growth rate percentage was calculated by dividing the forecasted annual growth from the regression analysis by the estimated market size value in 2012 (derived using the regression formula) to present an "average" rate figure for the period from 2009-2015. r^2 is an indicator of how well the regression formula that was produced fits the data for each subcategory. A value near 1 denotes an extremely good fit, whereas the quality of the formula as a predictor of data falls as r^2 approaches zero.

[2] R. W. Beck used the regression value for future projections.

[3] Includes all ground rubber subcategories except for RAC, which has had a longer term during which data have been gathered compared to the other ground rubber subcategories.

[4] Based on forecasted population growth.

Listed below are categories where R. W. Beck adjusted predictive formulae to better reflect forward looking trends, and our assumptions that resulted in us making our adjustments.

- **Exports**—Exports of waste tires can fluctuate wildly from year-to-year, making it difficult to model long-term trends. R. W. Beck is aware that the export of waste tires to China is increasing, where they are used either as an energy source or for materials in manufacturing. Unlike much of the world, China's economy slowed but did not go into recession in 2008-2009, and we expect China's economic growth rate to return to the high levels seen before the worldwide economic slowdown, result in increasing demand for imports of resources into China. Because the waste tire export growth from 2007-2008 is not sustainable over a longer period of time, R. W. Beck adjusted the growth rate to a strong yet moderate annual increase of 6 percent per year. We assumed used tire exports will grow slowly at 1 percent per year.

- **Ground Rubber**—A regression analysis of ground rubber markets in the aggregate projects that they will grow by an average of 6.7 percent for the next five years. R. W. Beck believes that local government use of crumb rubber in RAC did not become apparent in market figures until very recently and is not well-reflected in past historical data, so we adjusted the expected growth of that subcategory upward. Furthermore, CalRecycle continues to invest in market development and stimulate market demand for ground rubber products through grants, which are expected to continue to lead to growth in ground rubber markets in general. We adjusted growth among the subcategories of ground rubber as further described below, in order to more closely align subcategory growth with where it is expected.

    - **Rubberized Asphalt Concrete (RAC)**—Local governments that were introduced to RAC through grants now seem to be increasingly using the product on their own without the need for ongoing grant support and their use is estimated by R. W. Beck to be growing at nearly 12 percent per year.[‡‡‡‡] The impact of this is only now being felt, although it is muted by imports of crumb rubber from outside of California because municipal government RAC paving contracts do not typically specify that the crumb rubber must come from California tires. For future projections R. W. Beck assumed that Caltrans consumption will have reached its peak by 2009 and will remain flat after that year. We also assumed that crumb rubber imports for RAC will remain flat into the future as well. The weighted average of these assumptions resulted in an estimated average annual growth rate for California tires going to RAC of 9.4 percent, which R. W. Beck used for future estimates. No increase has been assumed for the potential of terminal blends at this time.

    - **Turf and Athletic Fields**—Use of crumb rubber from tires as infill between the blades of artificial turf in athletic field installations continues to grow. This growth is not well shown in the statistical data due to the short two-year period in which data were collected separately for this subcategory, which seemed to indicate a downward trend. Nationally, synthetic turf installations grew by 20 percent in 2008. Because the market is still growing, and estimated at 10 percent penetration of potential fields, we believe that growth will increase significantly in the next couple of years, and then begin to decline in the long term as the market becomes more fully penetrated. Furthermore, we have assumed that research funded by CalRecycle and conducted by the California Office of Environmental Health Hazard Assessment (OEHHA) will

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[‡‡‡‡] Based on a communication with Doug Carlson, executive director of the Rubber Pavements Association, of his estimate of the total amount of RAC paving in California. This estimate exceeded the amount of California rubber that goes into RAC by approximately 2.8 million PTEs, which R. W. Beck attributes to imports of crumb rubber from outside of California (only CalRecycle grants require the use of California-origin rubber). R. W. Beck subtracted RAC paving reported by Caltrans from Mr. Carlson's estimate in order to arrive at a local government use estimate and calculate an estimated growth rate.

counter safety myths so that further penetration in this market is not adversely affected in the next few years. For these reasons we have adjusted the growth of this subcategory upward over the short term to an average annual rate of 10 percent.

- **Playgrounds**—There is the potential for new testing methods currently under review for disability access to cause changes in how certain materials qualify compared to alternatives. Specifically, there is the potential that pour-in-place may become more sought after than loose-fill ground rubber, and that the demand for tire products in general may outpace non-tire materials. The statistical data for the two playgrounds subcategories are only based on a short two-year period in which playground data were collected as separate subcategories, and likely reflected the results of higher than average CalRecycle TDP grant funds going to playground applications. Because the higher growth levels are not sustainable, and because TDP grants are planned to decrease in the future, R. W. Beck chose to use a more moderate growth rate of 10 percent for the pour-in-place category, and a zero growth assumption for loose-fill, due to the threat that many processors' material may not be ADA-compliant in the future. The loose-fill category has the potential to significantly decline, or continue to grow, depending on the outcome of potential test method changes.
- **Loose-Fill Playground/Bark/Mulch**—Bark and mulch has grown steadily in recent years, including significant amounts of imports. (Some retreader buffing are also used as mulch, but are not included in market statistics focused on use of whole tires.) Some stakeholders feel there is significant potential for growth in this segment as West Coast use is much lower than levels on the East Coast. Loose-fill playground surfacing has appeared to hold steady in recent years, with some alluding to growth in residential uses. A new specification under development in relation to the Americans with Disability Act could reduce use of loose-fill rubber in playgrounds.
- **Molded and Extruded**—Molded and extruded products made from recycled tire rubber are expected to grow, but their potential is limited by the lack of suppliers of ultra-fine mesh rubber in California. The statistical data for this subcategory is only based on a short two-year period in which data were collected separately, so we adjusted the growth rate downward to a more modest level of 8 percent given supply limitations.

- **Civil Engineering**— CalRecycle continues to focus on growing this market segment and has funded large projects in recent years. However, there are obstacles that can limit growth, including large yet sporadic transportation-related projects. While there is great potential for significantly more use, concerted effort by CalRecycle to grow this market is required. We adjusted the apparent growth upward under the assumption that CalRecycle is effective in stimulating demand in large lightweight fill projects (non-landfill applications). We estimated that landfill uses will experience only a modest increase because CalRecycle has been less aggressive in promoting landfill applications compared to other civil engineering uses. Also, there is a need to confirm the baseline level of landfill civil engineering uses. As noted above, the 2008 estimate includes some reported uses that could not be validated as constituting civil engineering applications. Despite uncertainty over the 2008 baseline, there is agreement among CalRecycle, R.W. Beck, and CalRecycle's TDA technical assistance contractor, Kennec, that there is significant room for growth.
- **Alternative Daily Cover**—The expansion of the ground rubber and civil engineering uses markets in Northern California has contributed to a steep decline in the use of tires for alternative daily cover. In R. W. Beck's opinion this trend will level off shortly, and we made adjustments to reflect this assumption, assuming zero growth.

- **Tire-Derived Fuel**—Cement kilns are believed by R. W. Beck to continue to supplement their primary fuels with tires at the same growth rate as predicted by the regression analysis (approximately 1 percent per year). Although a reduction in the use of tires by cement kilns was believed to have occurred in 2009 and 2010 due to the economic recession, this long-term analysis assumes that any such reduction was temporary, and that cement industry usage will grow back to 7.3 million PTEs by 2011, after which we assume it will grow at a slow and stable rate of 1.5 percent per year. There is a very real threat that an U.S. EPA rule proposed in May 2010 will result in a fall-off in demand. The uncertain impact of this proposed rule could not be determined for this report and is not reflected in future projections. However, use of TDF in cogeneration facilities is declining because those facilities are converting to using renewable fuel such as biomass in response to California's renewable energy portfolio standard, which does not include TDF as a qualifying renewable material. Because plant shutdowns made the demand fall-off from 2007-2008 appear worse than would be the case in a typical year, we adjusted the overall annual decline to a more reasonable and steady decrease of 4 percent per year.

Appendix C
Market Analysis Addendum

The market estimates and projections discussed in this working paper and in the Program Evaluation Project main report are subject to much uncertainty. The analysis was conducted in late 2009, while the project and this report were finalized in September 2010. Following are several key trends that have affected markets, as documented in CalRecycle's "Tire Market Analysis Report: 2009," also released in September 2010.

Waste Tire Generation—Waste tire generation in 2009 was estimated at 41.3 million PTE, nearly 8 percent lower than in 2008, and anecdotally, this trend may have intensified in 2010. However, the Rubber Manufacturers Association reports that tire sales are rebounding, indicating that waste tire generation may again begin to increase. However, it remains to be seen whether the 2015 base projection used in this report of 52.9 million PTE will hold true. It appears at this time that this projection may be high.

Diversion—Tire diversion in 2009 was estimated to be 30.0 million PTE. While this represent a decline of more than 7 percent from 2008, the fact that waste tire generation was also down resulted in the diversion rate holding steady at about 73 percent.

Export—Export of waste tires continued to grow rapidly in 2009 to an estimated 3.3 million PTE, with anecdotal reports of even more rapid growth in exports during 2010. If this trend continues it could increase the tire diversion rate higher than the projected levels discussed above. However, this category was assigned no priority in this report indicating that it is not a segment CalRecycle or stakeholders have expressed an interest in fostering.

Ground Rubber—Overall, ground rubber production was down about 15 percent; however, RAC increased by 7 percent and loose-fill playground/bark/mulch increased by 12 percent. Moreover, new ground rubber capacity equal to about 40 percent of 2008 production also came online. These trends indicate that ground rubber may continue to grow rapidly in coming years, unless some threats identified above materialize.

Civil Engineering—Overall, civil engineering declined by 37 percent compared to 2008. However, some of this is a result of changes to reporting procedures. In the next market study CalRecycle intends to adjust and clarify guidelines for what "counts" as civil engineering.

Tire-Derived Fuel—Tire-derived fuel was down 6.8 percent in 2009 compared to 2008, a surprisingly positive result given that cement production was down substantially as a result of the economic downturn. In 2010, one plant has closed, and there are reports that a second plant may soon be closing. Moreover, a proposed U.S. EPA rule that would classify TDF as municipal solid waste, which appears likely to be adopted, would significantly raise the compliance costs for cement plants using TDF and may well result in this market being vastly reduced or even eliminated in coming years. This could affect up to 5.4 million PTE of market diversion based on the 2008 market analysis.

Given the uncertainties in the market place, it is not surprising that the above trends run counter to the overall 2015 projections presented in this report section. However, it is quite possible that many of the projections may still prove to be on target. And, in any event, it is the opinion of the report authors that the overall conclusions and recommendation of this report as presented in Section 7 remain justified.