feasibility study
Trail Program: Use of Recycled Pavements

prepared for
City of San José
Departments of:
Environmental Services
Parks, Recreation, and Neighborhood Services
Public Works

July 11, 2007

Callander Associates
Landscape Architecture, Inc.
park and recreation design
trails master planning
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>2</td>
</tr>
<tr>
<td>Report Summary</td>
<td>3</td>
</tr>
<tr>
<td>• Background</td>
<td>4</td>
</tr>
<tr>
<td>• Purpose</td>
<td>4</td>
</tr>
<tr>
<td>• Process</td>
<td>4</td>
</tr>
<tr>
<td>• Findings</td>
<td>4</td>
</tr>
<tr>
<td>• For Further Study</td>
<td>5</td>
</tr>
<tr>
<td>Legislative Background</td>
<td>6</td>
</tr>
<tr>
<td>• State Laws and Programs</td>
<td>6</td>
</tr>
<tr>
<td>• City Ordinances and Programs</td>
<td>7</td>
</tr>
<tr>
<td>Recycled Asphalt</td>
<td>8</td>
</tr>
<tr>
<td>• Types of Recycled Asphalt</td>
<td>8</td>
</tr>
<tr>
<td>• Summary of Findings</td>
<td>10</td>
</tr>
<tr>
<td>Environmental Implications</td>
<td>12</td>
</tr>
<tr>
<td>• California Department of Fish and Game</td>
<td>12</td>
</tr>
<tr>
<td>• Regional Water Quality Control Board</td>
<td>12</td>
</tr>
<tr>
<td>• Santa Clara Valley Water District</td>
<td>13</td>
</tr>
<tr>
<td>Appendix</td>
<td></td>
</tr>
<tr>
<td>• List of Abbreviations</td>
<td>i</td>
</tr>
<tr>
<td>• Bay Area Suppliers of Recycled Materials</td>
<td>ii</td>
</tr>
<tr>
<td>• Bay Area Contractors of Recycled Materials</td>
<td>iv</td>
</tr>
<tr>
<td>• Bay Area Agencies That Use Recycled Materials</td>
<td>v</td>
</tr>
<tr>
<td>• Bay Area Projects That Used Recycled Materials</td>
<td>vi</td>
</tr>
<tr>
<td>• Planned San Jose Roadway Projects That Will Use Rubberized AC</td>
<td>viii</td>
</tr>
<tr>
<td>• San José City Trails Program</td>
<td>x</td>
</tr>
<tr>
<td>• Material Comparison Matrixes</td>
<td>xi</td>
</tr>
<tr>
<td>• Sample Specifications</td>
<td>xiii</td>
</tr>
<tr>
<td>• Sample Construction Detail</td>
<td>xxvii</td>
</tr>
<tr>
<td>• References</td>
<td>xxviii</td>
</tr>
<tr>
<td>• Persons Contacted</td>
<td>xxx</td>
</tr>
</tbody>
</table>
Executive Summary

This study was prepared on behalf of the City of San José to explore the feasibility of using recycled pavements in the construction or resurfacing of trails. The report concludes that the use of recycled materials is both financially and environmentally feasible, and the use of recycled materials in trail construction is warranted.

Three types of recycled material were evaluated: recycled base aggregate, rubberized asphalt, and recycled hot-mix asphalt.

1. Recycled base aggregate is a cost effective material that is readily available and may have performance advantages over virgin base aggregate.
2. Rubberized asphalt is more costly than conventional asphalt and current availability for small scale projects is limited, but it does have performance advantages.
3. Recycled hot-mix asphalt is also currently difficult to procure but may in time become a more readily available material. It is more costly and appears to perform similarly to conventional asphalt.

There are possible negative environmental impacts associated with these recycled materials, primarily with regard to water quality. Potential mitigation measures are suggested in this study.
Report Summary

Background
The City of San José (City) has for years been developing and approving policies that support efforts to ‘go green’. In one of its more recent actions to improve energy efficiency and reduce impacts on the environment, the City has adopted the United Nations Environmental Accords’ goal of implementing a “Zero Waste Policy”. This policy seeks to reduce and eventually eliminate the City’s waste production. One important means of improving the ultimate success of this policy is to encourage recycling of materials that would otherwise be deemed as waste. To divert waste as a recyclable material, consumption markets must be created for the material. This report focuses on the feasibility of using recycled pavements in the construction or resurfacing of the City’s trails as a means of contributing to such a market. The consumption market addressed in this report includes recycled asphalt, recycled rubber, recycled concrete, and recycled aggregate products, as they relate to trail construction.

Beyond the broader interest in encouraging recycling, there is a specific need to find an alternative to the use of virgin mineral aggregates. Current projections estimate that California’s supply of virgin mineral aggregate will be outstripped by demand within the next four to five decades. Mineral aggregate is a primary ingredient in the manufacture of asphalt concrete (AC) and Portland cement concrete (PCC). According to the State of California’s Department of Conservation report (Department of Conservation, 2006) the fifty year projected needs of the state are greater than the permitted mining of aggregates. The report divides California into separate “Production-Consumer” zones according to the location of various aggregate production sites and the markets they serve. San Jose is part of the South Bay Zone which includes Alameda, Contra Costa, San Francisco, and San Mateo counties as well as the northern portion of Santa Clara County. The report states that the South Bay Area’s fifty year aggregate requirements are projected to be at 1,244,000,000 tons. The region’s permitted aggregate resources are projected to provide 458,000,000 tons. This represents a deficit of over 780,000,000 tons over the next 50 years.

As sources of virgin aggregate become scarcer and more costly, alternative sources will be required. The State and the City have already begun multiple programs implementing the use of alternative materials.

1. The State Department of Transportation (Caltrans) has adopted provisions for the use of recycled asphalt aggregates, crumb rubber, and recycled base aggregates into its standard specifications.
2. The City has established a model Construction and Demolition Recycling Program. Even with these efforts, more is needed to decrease the State and City’s use of virgin aggregates.
Purpose
Given the use of asphalt concrete and base rock in the construction of City trails, the trail network provides a potentially significant consumption market for recycled materials.

This study analyzes:
1. The feasibility of using recycled AC, PCC, crumb rubber, and base aggregate in the construction of the City’s trail network, including a consideration of the following factors:
   b. Types of recycled materials.
   c. Performance of recycled materials.
   d. Potential effects on the local recycled materials market.
   e. Regulatory agency policies regarding the use of recycled materials near riparian corridors.
2. The trail network’s potential contribution to meeting the goals of the City’s Construction and Demolition Recycling Program.

This study is intended to:
1. Help encourage the market growth of recycled materials production and consumption in San Jose.
2. Encourage City programs to participate in the City’s goal of creating zero waste within the City of San José.
3. Inform Public Works (PW) and Park, Recreation, and Neighborhood Services (PRNS) Department Project Managers of the feasibility of using recycled materials for trails.
4. Act as a supporting document to grant applications that require demonstrations of “green” policies by PW and PRNS.
5. Support PW and PRNS efforts to use recycled materials for trails.

Process
Information for this study was collected from a variety of sources. Several phone interviews were conducted with various South Bay Area regulatory agencies, municipalities, contractors, and suppliers. Much of the information they provided has been directly incorporated into this study. Some of them also provided references to other sources of information, both published and online. These sources of information are referenced in the appendix.

Findings
The use of recycled AC, PCC, crumb rubber, and base aggregate for construction of the City trail network is feasible, but with some qualifications. These materials must be
evaluated independently because they are used differently; vary in cost, availability, and in levels of performance; and have different potential environmental impacts.

Benefits to the Trail Program from the use of recycled materials include:
1. Potentially lower construction costs, depending on type and proportion of recycled material used.
2. A positive contribution to the environment through the reduction of materials transferred to landfills.
3. A positive contribution to the City’s goal of eliminating waste by providing demand for recycled materials.

Benefits to the City’s Construction and Demolition Recycling Program would be derived from the Trail Program’s participation as a recycled material consumer. In this capacity, the Trail Program would help support the consumption market for these recycled materials.

For Further Study
Two of the broader environmental issues not addressed in this report but which warrant further study include:
1. Additional negative impacts of using virgin base aggregates.
2. Additional benefits of rubberized AC. Negative impacts of using virgin base aggregates that are not addressed in this study include: mining-related energy consumption, increased runoff, scarring of the landscape, and other disturbances. An additional benefit of rubberized AC that is not specifically addressed in this study is its role in the partial diversion of over 32 million scrap tires produced each year in California alone. The stockpiles of tires take up landfill space and create breeding grounds for mosquitoes which are sources of diseases that endanger public health such as West Nile Virus.
Legislative Background

There are several laws, ordinances, and programs at the State and municipal level related to the City’s potential use of recycled asphalt in the trail system.

State Laws and Programs

State Assembly Bill 939 (AB 939)
Passed in 1989, this bill mandated that all cities and counties divert a minimum of 50% of solid waste from landfills by January 1, 2000. The means of diversion were to include source reduction, recycling, and composting. If a local government failed to meet this requirement, it would be fined $10,000 a day. The City of San José’s diversion rates as of 2004 (the most current information available) was 62%.

AB 939 also established the California Integrated Waste Management Board (CIWMB). The CIWMB has, since its establishment, created several resources for use by local governments to achieve the required 50% diversion. These resources include:

1. A statewide database of Construction and Demolition (C&D) Recycling Facilities, including facilities located within Santa Clara County,
2. An online “Recycled Content Product Directory”, and

Senate Bill 1322 (SB 1322)
SB 1322 was passed alongside AB 939 in 1989. The bill created the “Market Development Zone Program”. These zones, of which San Jose is a designated zone, were created to help foster the recycling of post-consumer waste materials. The San Jose Recycling Market Development Zone encourages recycling by attracting businesses which manufacture recycled products or process material to be used in recycled products.

There are over 132 miles of trail in the proposed City trail network (see City Trail Program Map in Appendix). Over 37 miles are already built, and over 3 miles are currently under construction. There are over 89 miles of future trails that could potentially use recycled materials as part of their construction.

The standard trail cross-section is 12 feet wide. Assuming the typical trail profile contains a 3 inch layer of AC and a 6 inch layer of base aggregate and that profile is extruded over the 89 miles of trail, there is a potential need of over 52,200 cubic yards of asphalt concrete and 104,400 cubic yards of base aggregate. This demand for aggregate and asphalt concrete to build trails could help support a consumption market for
recycled base aggregate and recycled AC within the San Jose Recycling Market Development Zone.

**Senate Bill 1374 (SB 1374)**
One of the CIWMB’s goals is to divert waste from California landfills. SB 1374, passed in 2003, recognized that a significant part of the state’s waste was generated from construction and demolition (C&D). SB 1374 mandated that the CIWMB develop a model C&D recycling ordinance to help reduce the amount of C&D waste entering California’s landfills. The CIWMB adopted such an ordinance in March of 2004. This ordinance can voluntarily be used by local California governments to establish and maintain C&D recycling programs.

**State Assembly Bill 338 (AB 338)**
Passed in 2005, AB 338 mandates a staged increase in Caltrans’ use of rubberized asphalt paving and the minimum amounts of crumb rubber (CRM) to be used in rubberized asphalt paving constructed by Caltrans:

1. January 1, 2007: CRM must constitute 6.62lbs/1 metric ton of rubberized asphalt’s total weight. That is approximately 0.30% of total weight.
2. January 1, 2010: CRM must constitute 8.27lbs/1 metric ton of rubberized asphalt’s total weight. That is approximately 0.37% of total weight.
3. January 1, 2013: CRM must constitute 11.58lbs/1 metric ton of rubberized asphalt’s total weight. That is approximately 0.52% of total weight.
4. January 1, 2007: 50% of asphalt used by Caltrans must be rubberized asphalt.
5. January 1, 2015: 100% of asphalt used by Caltrans must be rubberized asphalt.
6. The Secretary of Business, Transportation, and Housing shall annually produce, beginning no later than January 1, 2009, a report analyzing the cost differential between using conventional asphalt and asphalt containing CRM. If rubberized asphalt is not cost-effective in comparison to conventional asphalt, Caltrans will not have to comply with the 100% CRM requirement slated to begin in 2015.

**City Ordinances and Programs**
The City passed Ordinance No. 26566 in 2001 to help divert C&D waste from landfills. The ordinance establishes a C&D Recycling Program within the City’s jurisdiction. Deposits collected from the program are used to fund the program. All C&D projects conducted in San Jose are subject to this program except those listed in Chapter 9, Part 15, Section 9.10.2430 of Title 9 of the City’s Municipal Code. The C&D Recycling Program is a three step process for those who participate:

1. A project applies for a project permit. The project is assessed a refundable deposit based on project square footage and project type.
2. Materials from the project are diverted from a landfill by either being reused, donated, or taken to a recycling center.
3. Projects apply for a full refund of the assessed deposit by submitting a refund request form and all paperwork proving the above methods of recycling/reuse were implemented.
Types of Recycled Asphalt

“Recycled asphalt” refers to a variety of materials and methods, all of which contain some portion of recycled content derived from the re-processing of AC or PCC paving. These materials and methods are appropriate for two categories of work: rehabilitation and new construction.

Rehabilitation

Materials and methods used to rehabilitate existing projects, such as cold-in-place recycling or full depth reclamation, are best suited to roadway projects. On trails, the narrower pavement widths, sharper turning radii, steeper inclines, and proximity to sensitive habitats preclude the use of rehabilitation machinery; however, there are several types of recycled asphalt that can be implemented in new trail construction.

New Construction

1. Recycled Base aggregate
   Recycled base aggregate uses reclaimed materials from demolition jobs as the base layer in an asphalt pour. The reclaimed materials are either PCC or AC. The PCC and AC are pulverized and sifted by size.

   Base aggregate can be completely virgin material, completely recycled materials, or a blend of the two. Caltrans currently specifies that a maximum of 50% of the base aggregates be recycled aggregate (Caltrans, 2006).

   a. Costs
      Virgin base material: $14/ton.
      50/50 blend: $12.50/ton.
      100% recycled base material: $11.50/ton.

   b. Availability
      It is becoming more and more difficult to find virgin material in the South Bay region and as such, suppliers are selling increasing amounts of recycled base aggregates.

   c. Performance
      There is a perception that recycled aggregate may contain unknown impurities which will compromise the performance of the material. A study by the University of California, Berkeley’s Pavement Research Center shows that recycled base aggregate is stronger and stiffer than virgin material (Caltrans, 2001). This resulted in asphalt concrete paving constructed using
the recycled aggregate as its base layer to have reduced elastic deflections, which helped to reduce fatigue cracking in the paving. The same study also found that the recycled base had a slightly higher shear resistance than Class II base, providing a more stable base for the asphalt paving.

d. Special Requirements
There are no special requirements for installing recycled base aggregate.

2. Recycled Hot-Mix Asphalt Concrete
Recycled hot-mix asphalt incorporates recycled AC with virgin AC at an asphalt plant. Typically the mixture uses a maximum of 30% (Calkins, 2006) recycled material.

The incorporation of the recycled AC creates a considerable amount of air pollution. The more recycled content that is incorporated, the more air pollutants are released. As such, asphalt plants within the South Bay Area keep their mixes at a maximum of 15% of total weight as recycled content. Some plants prefer to keep even lower thresholds so they are not penalized for air pollution. Raisch Products typically keeps their mix at 8% recycled content.

a. Costs
There are generally increased energy costs when producing recycled hot-mix asphalt because it requires more heat to incorporate the recycled material (Calkins, 2006).

b. Availability
It is becoming more available, but is still not a common material on the market. Because air quality around the plant is reduced when high percentages of recycled content are mixed, significant production of hot-mix asphalt is unlikely to occur until this problem can be effectively addressed.

c. Performance
No information available.

d. Special Requirements
No information available.

3. Rubberized Asphalt Concrete
Rubberized asphalt incorporates rubber crumbs into the AC layer of the pavement. These rubber crumbs can be manufactured from recycled car tires. The rubberized asphalt is created in one of two different processes:
• Wet Process – The tire crumbs are blended with hot asphalt cement before the cement is mixed with the aggregates.
• Dry Process – The tire crumbs are blended with the aggregates before they are mixed with the hot asphalt cement.

a. Costs
Costs are dependent on the amount of rubberized asphalt being ordered. The small amounts required by a trail project would mean higher material costs.

b. Availability
Rubberized AC has been used successfully in the Bay Area; however, it is not yet used frequently enough to warrant local asphalt plants to produce a readily available supply. An asphalt plant could produce rubberized AC if a project’s demand was large enough to make the production feasible for the plant. An individual City trail project would not create a large enough demand to make production feasible; however, if a separate construction project created enough demand, trail construction could be timed to occur simultaneously and the asphalt plant could produce rubberized AC for both projects. This method of timing has already been implemented by the City’s Department of Transportation for a road project, Toyon Road from Penitencia to McKee.

c. Performance
Many studies indicate that rubberized AC lasts significantly longer than conventional AC. There is also agreement that it takes less rubberized AC to perform equally well as conventional AC. The Caltrans Highway Design Manual states that, for their construction projects, maximum thickness of rubberized AC is 2.5” and at minimum should be 1”.

d. Special Requirements
There are several roadway projects around the South Bay Area which have installed rubberized AC. Contractors who have worked on these projects note that working with rubberized AC is different than conventional AC. The incorporated rubber increases the viscosity of the material making it “gummier”. This “gummy” quality makes it more difficult to work with than conventional AC.

Summary of Findings
Recycled Base Aggregate
Cost: $14/ton
Availability: Readily available and increasing in availability
Performance: At least as well as virgin base aggregate
Special Requirements: There are no special requirements for installation.

Reycled Hot-Mix Asphalt:
Cost: No information available
Availability: Not readily available, but is increasing in availability.
Performance: Similar to conventional AC.
Special Requirements: There are no special requirements for installation.

Rubberized AC
Cost: $29 more per ton than conventional asphalt
Availability: Not readily available, but is increasing in availability.
Performance: Many studies have indicated that rubberized AC lasts significantly longer than conventional AC. AC layers do not need to be as thick as conventional AC.
Special Requirements: Difficult to install by hand because of the gummy nature of the material.
Environmental Implications

Most of the trails within the City’s network will occur near streams and other waterways. Both the California’s Department of Fish and Game (CDFG) and the Regional Water Quality Control Board (RWQCB) regulate development near bodies of water. In general, neither agency takes exception to the use of recycled material provided that appropriate Best Management Practices are implemented during construction.

California Department of Fish and Game (CDFG)
The CDFG is charged, by Section 1601-1607 of the California Fish and Game Code, to protect and conserve state fish and wildlife. Any projects that impact riparian corridors or wetlands must notify CDFG. The use of recycled materials in lieu of virgin material may have environmental impacts which concern CDFG.

The agency has no official policy regarding the use of recycled asphalt concrete or recycled base aggregate in lieu of virgin materials. It has general concerns about AC paving, specifically concerning the entry of particulate asphalt into bodies of water. CDFG recommends the use of permanent borders to contain the AC, regardless of whether it is recycled or virgin.

Findings: Permanent borders should be installed to contain the AC and prevent it from eroding into a nearby body of water.

Regional Water Quality Control Board (RWQCB)
The RWQCB protects the State’s water supply quality. One task the agency performs to ensure water quality is managing construction-related discharge of stormwater runoff. In phone discussions, the RWQCB, noted its concern that a change from virgin material to recycled material may have water quality impacts.

The RWQCB has no official policy regarding the use of recycled asphalt or recycled base material. It does recognize that these materials have the potential to negatively impact environmental quality.

Recycled base aggregate (which is placed beneath the asphalt pavement) can contain pulverized PCC. Pulverized PCC may negatively impact aquatic life by leaching lime into the water. The leached lime increases the pH of the water, threatening aquatic life.

This potential impact may be mitigated using soil filtration. If the PCC is placed far enough from the body of water, the soil can filter out any lime that may negatively impact water quality. Further contaminants can be kept from the water by treating any...
surface flow with a vegetative swale or bio-strip before it enters the water body. The vegetation in the swale or bio-strip could capture contaminants before they enter the water. Another option is to specify that recycled material contain no PCC.

Findings: The technical specifications for recycled base aggregate to be used in the construction of creek-side trails should specifically note that no pulverized PCC is allowed in the mix.

If the recycled base aggregate contains pulverized PCC, soil and vegetation should be placed so as to allow any runoff from the pulverized PCC to be filtered before entering any adjacent body of water.

Santa Clara Valley Water District (District)
The District owns much of the land adjacent to and through which the City trail network runs. Like the RWQCB, it is concerned with impacts to the water quality of waterways adjacent to the trails.

The District does not have an official policy regarding the use of recycled materials. It believes recycled materials do not contain contaminants different from traditional pavement. As such, it does not expect recycled materials to impact water quality any differently than might virgin materials.

The District does believe that each trail project must be reviewed on a case by case basis. Improvements, including the use of recycled materials, would be reviewed by the District.

Findings: Recycled materials do not pose any more concern than virgin materials. Each trail project, and its specified materials, will be evaluated on a case by case basis.
Appendix

List of Abbreviations

AB  Assembly Bill
AC  asphalt concrete
C&D  Construction and Demolition
CIWMB  California Integrated Waste Management Board
CRM  crumb rubber
CDFG  California Department of Fish and Game
PCC  Portland cement concrete
PRNS  Parks, Recreation, and Neighborhood Services Department
RWQCB  Regional Water Quality Control Board
SB  Senate Bill
Appendix

Bay Area Suppliers of Recycled Materials

Brisbane Recycling
5 Beatty Road
Brisbane, CA 94005
415.467.5050
Products: Recycled Base Aggregate

Curtner Quarry
2000 Scott Creek Road
Milpitas, CA 95035
510.908.1986
Products: Recycled Base Aggregate, Virgin Base Aggregate

Dumbarton Quarry
9600 Quarry Road
Fremont, CA 94555
510.908.1986
Products: Recycled Base Aggregate, Virgin Base Aggregate, Virgin AC, Rubberized AC

Gallager & Burke
344 High Street
Oakland, CA 94601
510.908.1986
Products: Virgin AC, Recycled Hot-Mix Asphalt, Rubberized Asphalt

Granite Construction
Felton Aggregate & Hot Mix Facility
End of San Lorenzo Avenue
Felton, CA 95060
831.335.3445
Products: Recycled Base Aggregate, Virgin Base Aggregate, Virgin AC

Raisch Products
99 Pullman Way
San Jose, CA 95111
408.227.9222
Products: Recycled Base Aggregate, Virgin Base Aggregate, Virgin AC, Hot-Mix AC, Rubberized AC
Reed & Graham
690 Sunol Street
San Jose, CA 95126
408.287.1400
Products: Recycled Base Aggregate, Virgin AC

Star Concrete
1510 S. Seventh Street
San Jose, CA 95112
408.947.0669
Products: Recycled Base Aggregate
Note: This plant is not currently operational, but will be in the near future

Zanker Materials Processing Facility
675 Los Esteros Road
San Jose, CA 95134
408.263.2384
Products: Recycled Base Aggregate
Bay Area Contractors of Recycled Materials

Graniterock Pavex Construction
120 Granite Rock Way
San Jose, CA 95136
408.574.1400
Products installed: Virgin Base Aggregate, Recycled Base Aggregate, Virgin AC, Recycled Hot-Mix AC, Rubberized AC

McGuire & Hester Contractors
9009 Railroad Avenue
Oakland, CA 94603
510.632.7676
Products installed: Virgin Base Aggregate, Recycled Base Aggregate

O'Grady Paving
2513 Wyandotte Street
Mountain View, CA 94043
650.966.1926
Products installed: Virgin base aggregate, Recycled Base Aggregate
Appendix

Bay Area Agencies That Use Recycled Materials

Recycled Base Aggregate

State of California, Department of Transportation (Caltrans)
111 Avenida Grande
San Jose, CA 95139
415.286.5830

City of Milpitas
1265 N. Milpitas Boulevard
Milpitas, CA 95035
408.586.2600

City of Mountain View
500 Castro Street
Mountain View, CA 94039-7540
Phone: 650-903-6311

The City of San Jose
Department of Transportation
200 East Santa Clara Street
8th Floor
San Jose, CA 95113
408.535.3850
Rubberized Asphalt

The City of Fremont
Engineering Division
39550 Liberty Street
Fremont, CA 94537
510.494.4700

The City of Oakland
250 Frank H. Ogawa Plaza Suite 4314
Oakland, Ca 94612
510.238.2233

The City of San Jose
Department of Transportation
200 East Santa Clara Street
8th Floor
San Jose, CA 95113
408.535.3850
Bay Area Projects That Used Recycled Materials

Roadway Projects:

Recycled Base Aggregate

San Jose, CA - Sierra Road

Rubberized Asphalt

San Jose, CA - 10th Street from I-280 to Keyes Street
San Jose, CA - Toyon Street from Penitencia Creek Road to McKee Road
San Jose, CA - South 7th Street from Margaret Street to Reed Street
Santa Clara, CA - Highway 101
Highway 680 from the City of Sunol and the City of Pleasanton

Trail Projects:

Recycled Base Aggregate

Milpitas, CA – Coyote Creek Trail Reach One. Ranch Drive to Dixon Landing Road
Mountain View – Stevens Creek Trail Reach Four, Segment One.
Planned San Jose Roadway Projects That Will Use Rubberized AC

Note: Projects will use rubber chip seal with rubber AC on top.
City of San Jose Department of Transportation Project Manager: Amanda Lei

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<td>OCALA AV</td>
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Appendix
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<th>STREET NAME</th>
<th>FROM</th>
<th>TO</th>
<th>L (FT)</th>
<th>W (FT)</th>
<th>AREA (SF)</th>
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<td>LOCKHAVEN WY</td>
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<td>BRIDGE</td>
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<td>TOPEKA AV</td>
<td>HADLEY AV</td>
<td>FOREST AV</td>
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Trail Program: Use of Recycled Pavements Feasibility Study
Callander Associates Landscape Architecture, Inc.
July 11, 2007
## Material Comparison Matrixes

<table>
<thead>
<tr>
<th>Material</th>
<th>Availability</th>
<th>Cost (per ton)</th>
<th>Potential Toxicity</th>
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</thead>
<tbody>
<tr>
<td>Virgin Base Aggregate</td>
<td>Available (becoming less common)</td>
<td>$14</td>
<td>No</td>
</tr>
<tr>
<td>Recycled Base Aggregate</td>
<td>Available (becoming more common)</td>
<td>$11.50</td>
<td>Yes (^{(1)})</td>
</tr>
<tr>
<td>Virgin AC</td>
<td>Available</td>
<td>$90</td>
<td>Yes (^{(2)})</td>
</tr>
<tr>
<td>Hot-Mix Recycled AC</td>
<td>Not readily available</td>
<td>Not available</td>
<td>Yes (^{(2)})</td>
</tr>
<tr>
<td>Rubberized AC</td>
<td>Not readily available (becoming more common)</td>
<td>$120</td>
<td>Yes (^{(2)})</td>
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<table>
<thead>
<tr>
<th>Material</th>
<th>Additional Contractor Labor</th>
<th>Special Installation Equipment</th>
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<tr>
<td>Virgin Base Aggregate</td>
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<tr>
<td>Recycled Base Aggregate</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Virgin AC</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Hot-Mix Recycled AC</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Rubberized AC</td>
<td>Some (especially hand)</td>
<td>None</td>
</tr>
</tbody>
</table>

Notes:
- \(^{(1)}\) Potential toxicity if aggregate mix contains PCC
- \(^{(2)}\) Potential toxicity due to presence of particulate asphalt
### Appendix

<table>
<thead>
<tr>
<th>Material</th>
<th>Benefits</th>
<th>Negatives</th>
</tr>
</thead>
</table>
| Virgin Base Aggregate     | 1. Readily available  
2. Reliable performance  
3. Cost effective  
4. Can be recycled | 1. Decreasing availability  
2. Does not divert any material from landfill |
| Recycled Base Aggregate   | 1. Readily available  
2. Increasing availability  
3. Reliable performance  
4. Diverts material from landfill  
5. Cost effective  
6. Can be recycled | 1. Possible water toxins |
| Virgin AC                 | 1. Readily available  
2. Reliable performance  
3. Cost effective  
4. Can be recycled | 1. Decreasing availability  
2. Does not divert any material from landfill |
| Hot-Mix Recycled AC       | 1. Diverts material from landfill  
2. Increasing availability  
3. Can be recycled | 1. Not readily available  
2. Possible water toxins |
| Rubberized AC             | 1. Increasing availability  
2. Less material needed than conventional AC  
3. Reliable performance  
4. Diverts material from landfill  
5. Can be recycled | 1. Not readily available  
2. Significantly more expensive than conventional AC  
3. Possible water toxins |
Sample Specifications

1. Recycled Base Aggregate
   a. Caltrans

   25-1.02A  Class 1, Class 2, and Class 3 Aggregate Subbases
   Aggregate for Class 1, Class 2 and Class 3 aggregate subbases shall be
   clean and free from organic matter and other deleterious substances, and
   shall be of such nature that it can be compacted readily under watering
   and rolling to form a firm, stable base. Aggregate may include material
   processed from reclaimed asphalt concrete, portland cement concrete, lean
   concrete base, cement treated base or a combination of any of these
   materials. The amount of reclaimed material shall not exceed 50 percent
   of the total volume of the aggregate used.

   b. Greenbook

   See “Greenbook” Standard Specifications for Public Works Construction

2. Recycled Hot-Mix AC
   a. Greenbook

   See “Greenbook” Standard Specifications for Public Works Construction
   2006 Edition Section 203-7, “Recycled Asphalt Concrete – Hot Mixed”

3. Rubberized AC
   a. City of San Jose, Department of Transportation

   SECTION 38A. RUBBERIZED ASPHALT CONCRETE (TYPE G) GAP
   GRADED

   GENERAL – Gap Graded Rubberized Asphalt Concrete (Type G) shall consist
   of furnishing and mixing gap graded aggregate and asphalt-rubber binder and
   spreading and compacting the mixture. Type G rubberized asphalt concrete shall
   conform, except as otherwise provided, to the provisions for Type A asphalt
   concrete in Section 39, "Asphalt Concrete," of the Standard Specifications and
   these special provisions.
General – The Contractor shall furnish samples of aggregate to the Engineer in conformance with the provisions in Section 39-3.03, "Proportioning," of the State Standard Specifications.

Aggregate for Type G rubberized asphalt concrete shall be of such quality that the optimum amount of asphalt-rubber binder to be mixed with the aggregate, as determined by the Engineer in conformance with the requirements in California Test 367 (as amended below), shall be a minimum of 7.0 percent by mass of dry aggregate and a maximum of 9.0 percent by mass of dry aggregate. Aggregates which result in an optimum asphalt-rubber binder content of less than 7.0 percent or more than 9.0 percent by mass of dry aggregate shall not be used. The Engineer will determine the exact amount of asphalt-rubber binder to be mixed with the aggregate in conformance with the requirements in California Test 367, except as follows:

A. The specific gravity used in California Test 367, Section "B. Voids Content of Specimen," will be determined using California Test 308, Method A.

B. California Test 367, Section "C. Optimum Bitumen Content," is revised as follows:

1. Plot asphalt-rubber binder content versus void content for each specimen on Form TL-306 (Figure 3), and connect adjacent points with straight lines.
2. From Figure 3 select the theoretical asphalt-rubber binder content that has 3.0 percent voids.
3. Record the asphalt-rubber binder content in Step 2 as the Optimum Bitumen Content (OBC).
4. To establish a recommended range, use the Optimum Bitumen Content (OBC) as the high value and 0.3 percent less as the low value. Notwithstanding, the recommended range shall not extend below 7.0 percent nor shall the high value to establish the recommended range be above 9.0 percent. If the OBC is 7.0 percent, then there shall be no recommended range, and 7.0 percent shall be the recommended value.

C. Laboratory mixing and compaction shall be in conformance with the requirements of California Test 304, except that the mixing temperature of the aggregate shall be between 300°F and 325°F. The compaction temperature of the combined mixture shall be between 290°F and 300°F.

The rubberized asphalt concrete mixture, composed of the aggregate proposed for use and the optimum amount of asphalt-rubber binder as determined in conformance with the requirements in California Test 367 modified above, shall conform to the following quality requirements:
RUBBERIZED ASPHALT CONCRETE MIXTURE

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>California Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilometer Value, Minimum</td>
<td>304 and 366</td>
<td>23</td>
</tr>
<tr>
<td>Voids in Mineral Aggregate, Percent, Minimum</td>
<td>See Note</td>
<td>18</td>
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</table>

Note: Voids in mineral aggregate test shall be determined as described in Asphalt Institute Mix Design Methods for Asphalt Concrete (MS-2).

The asphalt-rubber binder content of the rubberized asphalt concrete (Gap Graded) will be determined by extraction tests in conformance with the requirements in California Test 362, or will be determined in conformance with the requirements in California Test 379.

The Contractor shall furnish a Certificate of Compliance to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the State Standard Specifications for each material used in asphalt-rubber binder and the asphalt-rubber binder mixture. The Certificate of Compliance shall certify that the material conforms to the provisions in these special provisions. When requested by the Engineer, the Contractor shall submit samples with the Certificate of Compliance. The Contractor shall provide the Engineer a Material Safety Data Sheet (MSDS) for each of the constituent components of the asphalt-rubber binder, for the completed mixture of asphalt-rubber binder and for the Type G, gap graded, rubberized asphalt concrete.

The Contractor shall provide a Certificate of Compliance for each truckload of crumb rubber modifier (CRM), paving asphalt, and asphalt modifier delivered to the project. The Quality Control Program used by the manufacturer of each ingredient shall include a sampling and testing frequency as shown below:

A. CRM shall be tested, except for the grading requirement, at least once for every 250 tons of production, with a minimum of once for each project. CRM shall be tested for grading for every truckload delivered to the project.
B. Paving asphalt shall be tested at least once for every 200 tons of production with a minimum of once for each project.
C. Asphalt modifier shall be tested at least once for every 25 tons of production with a minimum of once for each project.
D. A copy of the laboratory test results for the test parameters specified in these Technical Specifications for CRM, paving asphalt, and asphalt modifier shall be submitted to the Engineer with the Certificate of Compliance for each truckload of individual material delivered to the project.
Certified volume or weight slips shall be delivered to the Engineer for the materials supplied.

**Paving Asphalt** – The grade of paving asphalt to be used in the asphalt-rubber binder shall be AR-4000 (or PG equivalent) and shall conform to the provisions in Section 92, "Asphalts," of the State Standard Specifications and these Specifications.

The paving asphalt for use in asphalt-rubber binder shall be modified with an asphalt modifier.

**Asphalt Modifier** – The asphalt modifier shall be a resinous, high flash point, aromatic hydrocarbon compound and shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, m²/s (x10−6) at 100°C</td>
<td>D 445</td>
<td>X ± 3*</td>
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<tr>
<td>Flash Point, CL.O.C., °F</td>
<td>D 92</td>
<td>207 min.</td>
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**Molecular Analysis:**

<table>
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<tr>
<th></th>
<th>ASTM Test Designation</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Asphaltenes, percent by mass</td>
<td>D 2007</td>
<td>0.1 max.</td>
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<tr>
<td>Aromatics, percent by mass</td>
<td>D 2007</td>
<td>55 min.</td>
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* The symbol "X" is the viscosity of the asphalt modifier the Contractor proposes to furnish. The value "X" which the Contractor proposes shall be between the limits 19 and 36 and shall be submitted in writing to the Engineer. A proposed change, requested by the Contractor, in the value "X" shall require a new asphalt-rubber binder design.

The asphalt modifier shall be proportionately added to the paving asphalt at the production site where the asphalt-rubber binder is blended and reacted. Asphalt modifier shall be added in an amount of 2.5 percent to 6.0 percent by mass of the paving asphalt based on the recommendation of the asphalt-rubber binder supplier. The paving asphalt shall be at a temperature of not less than 375°F or more than 440°F when the asphalt modifier is added. If the asphalt modifier is...
combined with the paving asphalt, before being blended with the CRM, the combined paving asphalt and asphalt modifier shall be mixed by circulation for a period of not less than 20 minutes. Premixing of asphalt modifier and paving asphalt will not be required when the ingredients of the asphalt-rubber binder are proportioned and mixed simultaneously. Asphalt modifier and paving asphalt shall be measured for proportioning with meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the State Standard Specifications.

**Crumb Rubber Modifier (CRM)** – Crumb rubber modifier (CRM) shall consist of a combination of scrap tire CRM and high natural CRM. The scrap tire CRM shall consist of ground or granulated rubber derived from a combination of automobile tires, truck tires or tire buffings. The high natural CRM shall consist of ground or granulated rubber derived from materials that utilize high natural rubber sources.

Steel and fiber separation may be accomplished by any method. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating.

CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles which can pass through the grinder or granulator without being ground or granulated respectively shall not be used.

CRM shall not contain more than 0.01-percent wire (by mass of CRM) and shall be free of other contaminants, except fabric. Fabric shall not exceed 0.05-percent by mass of CRM. The test and method for determining the percent by mass of wire and fabric is available at the Transportation Laboratory, Pavement Branch, Telephone 916-227-7300, and will be furnished to interested persons upon request. A Certificate of Compliance certifying these percentages shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the State Standard Specifications.

The length of an individual CRM particle shall not exceed 3/16”.

The CRM shall be sufficiently dry so that the CRM will be free flowing and not produce foaming when combined with the blended paving asphalt and asphalt modifier mixture. Calcium carbonate or talc may be added at a maximum amount of 3 percent by mass of CRM to prevent CRM particles from sticking together. The CRM shall have a specific gravity between 1.1 and 1.2 as determined by California Test 208. Scrap tire CRM and high natural CRM shall be delivered to the production site in separate bags and shall be sampled and tested separately. CRM material shall conform to the following requirements of ASTM Designation: D 297:
SCRAP TIRE CRUMB RUBBER MODIFIER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Percent</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>6.0</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Ash Content</td>
<td>—</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>28.0</td>
<td>38.0</td>
<td></td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>42.0</td>
<td>65.0</td>
<td></td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>22.0</td>
<td>39.0</td>
<td></td>
</tr>
</tbody>
</table>

HIGH NATURAL CRUMB RUBBER MODIFIER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Percent</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td></td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>4.0</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>50.0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>40.0</td>
<td>48.0</td>
<td></td>
</tr>
</tbody>
</table>

The CRM for asphalt-rubber binder shall conform to the gradations specified below when tested in conformance with the requirements in ASTM Designation: C 136, except as follows:

A. Split or quarter 100 g ± 5 g from the CRM sample and dry to a constant mass at a temperature of not less than 57°C or more than 63°C and record the dry sample mass. Place the CRM sample and 5.0 g of talc in a 0.5-L jar. Seal the jar, and then shake it by hand for a minimum of one minute to mix the CRM and the talc. Continue shaking or open the jar and stir until particle agglomerates and clumps are broken and the talc is uniformly mixed.

B. Place one rubber ball on each sieve. Each ball shall have a mass of 8.5 g ± 0.5 g, have a diameter of 24.5 mm ± 0.5 mm, and shall have a Shore Durometer "A" hardness of 50 ± 5 in conformance with the requirements in ASTM Designation: D 2240. After sieving the combined material for 10 minutes ± 1 minute, disassemble the sieves. Material adhering to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the mass of the material retained on the 2.36-mm sieve and leave this material (do not discard) on the scale or balance. Observed fabric balls shall remain on the scale or balance and shall be placed together on the side of the scale or balance to prevent the fabric balls from being covered or disturbed when placing the material from finer
sieves onto the scale or balance. The material retained on the next finer sieve (2.00-mm sieve) shall be added to the scale or balance. Weigh and record that mass as the accumulative mass retained on that sieve (2.00-mm sieve). Continue weighing and recording the accumulated masses retained on the remaining sieves until the accumulated mass retained in the pan has been determined. Prior to discarding the CRM sample, separately weigh and record the total mass of fabric balls in the sample.

C. Determine the mass of material passing the 75-µm sieve (or mass retained in the pan) by subtracting the accumulated mass retained on the 75-µm sieve from the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass of 5 g or less, cross out the recorded number for the accumulated mass retained in the pan and copy the number recorded for the accumulated mass retained on the 75-µm sieve and record that number (next to the crossed out number) as the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass greater than 5 g, cross out the recorded number for the accumulated mass retained in the pan, subtract 5 g from that number and record the difference next to the crossed out number. The adjustment to the accumulated mass retained in the pan is made to account for the 5 g of talc added to the sample. For calculation purposes, the adjusted total sample mass is the same as the adjusted accumulated mass retained in the pan. Determine the percent passing based on the adjusted total sample mass and record to the nearest 0.1 percent.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Scrap Tire CRM Percent Passing</th>
<th>High Natural CRM Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 10</td>
<td>98-100</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>45-75</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 30</td>
<td>2-20</td>
<td>35-85</td>
</tr>
<tr>
<td>No. 50</td>
<td>0-6</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-2</td>
<td>0-4</td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
<td>0-1</td>
</tr>
</tbody>
</table>

**Asphalt-Rubber Binder**

Asphalt-rubber binder shall consist of a mixture of paving asphalt, asphalt modifier, and crumb rubber modifier.
At least 2 weeks before the binder's intended use, the Contractor shall furnish the Engineer 4 one-quart cans filled with the asphalt-rubber binder proposed for use on the project. The Contractor shall supply the Engineer, for approval, a binder formulation and samples of the materials to be used in the asphalt-rubber binder at least 2 weeks before construction is scheduled to begin. The binder formulations shall consist of the following information:

A. Paving Asphalt and Modifiers:

1. Source and grade of paving asphalt.
2. Source and identification (or type) of modifiers used.
3. Percentage of asphalt modifier by mass of paving asphalt.
4. Percentage of the combined blend of paving asphalt and asphalt modifier by total mass of asphalt-rubber binder to be used.
5. Laboratory test results for test parameters shown in these special provisions.

B. Crumb Rubber Modifier (CRM):

1. Source and identification (or type) of scrap tire and high natural CRM.
2. Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend.
3. If CRM from more than one source is used, the above information will be required for each CRM source used.
4. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt-Rubber Binder:

1. Laboratory test results of the proposed blend for test parameters shown in these special provisions.
2. The minimum reaction time and temperature.

The method and equipment for combining paving asphalt, asphalt modifier, and CRM shall be so designed and accessible that the Engineer can readily determine the percentages by mass for each material being incorporated into the mixture.

The proportions of the materials, by total mass of asphalt-rubber binder, shall be 80 percent ± 2 percent combined paving asphalt and asphalt modifier, and 20 percent ± 2 percent CRM. However, the minimum amount of CRM shall not be less than 18.0 percent. Lower values which are rounded up shall not be allowed. The CRM shall be combined at the production site and shall contain 75 percent ± 2 percent scrap tire CRM and 25 percent ± 2 percent high natural CRM, by mass.
The paving asphalt and asphalt modifier shall be combined into a blended mixture that is chemically compatible with the crumb rubber modifier to be used. The blended mixture is considered to be chemically compatible when it meets the provisions for asphalt-rubber binder (after reacting) found in these Technical Specifications.

The blended paving asphalt and asphalt modifier mixture, and the CRM shall be combined and mixed together at the production site in a blender unit to produce a homogeneous mixture.

The temperature of the blended paving asphalt and asphalt modifier mixture shall be not less than 375°F or more than 440°F when the CRM is added. The combined materials shall be reacted for a minimum of 45 minutes after incorporation of the CRM at a temperature of not less than 375°F or more than 425°F. The temperature shall not be higher than 10°F below the actual flash point of the asphalt-rubber binder.

After reacting, the asphalt-rubber binder shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 77°F, 1/10 mm</td>
<td>D 217</td>
<td>25</td>
</tr>
<tr>
<td>Resilience @ 77°F, Percent rebound</td>
<td>D 3407</td>
<td>18</td>
</tr>
<tr>
<td>Field Softening Point, °F</td>
<td>D 36</td>
<td>125</td>
</tr>
<tr>
<td>Viscosity @ 375°F, Centipoise</td>
<td>See Note</td>
<td>1500</td>
</tr>
</tbody>
</table>

NOTE: The viscosity test shall be conducted using a hand held Haake Viscometer Model VT-02 with Rotor 1, 24 mm in depth x 53 mm in height, or equivalent, as determined by the Engineer. The accuracy of the viscometer shall be verified by comparing the viscosity results obtained with the hand held viscometer to 3 separate calibration fluids of known viscosities ranging from 1000 to 5000 Pa • s (x10^-3). The viscometer will be considered accurate if the values obtained are within 300 Pa • s (x10^-3) of the known viscosity. The known viscosity value shall be based on the fluid manufacturers standard test temperature or the test temperature versus viscosity correlation table provided by the fluid manufacturer. Viscometers used on the project shall be verified to be accurate. The test method for determining the viscosity of asphalt-rubber binder using a hand held viscometer is available at the Transportation Laboratory, Pavement Branch, Telephone (916) 227-7300. The accuracy verification results shall be provided to the Engineer and shall be certified by a Certificate of Compliance.
The Certificate of Compliance shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the State Standard Specifications.

The Contractor shall provide a Haake Viscometer, or equivalent, at the production site during combining of asphalt-rubber binder materials. The Contractor shall take viscosity readings of asphalt-rubber binder from samples taken from the feed line connecting the storage and reaction tank to the asphalt concrete plant. Readings shall be taken at least every hour with not less than one reading for each batch of asphalt-rubber binder. The Contractor shall log these results, including time and asphalt-rubber binder temperature, and a copy of the log shall be submitted to the Engineer on a daily basis. As determined by the Engineer, the Contractor shall either notify the Engineer at least 15 minutes prior to each test or provide the Engineer a schedule of testing times.

The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 375°F or more than 425°F.

If any of the material in a batch of asphalt-rubber binder is not used within 4 hours after the 45-minute reaction period, heating of the material shall be discontinued. Any time the asphalt-rubber binder cools below 375°F and is reheated shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 375°F or more than 425°F prior to use. Additional scrap tire CRM may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder mass. Reheated asphalt-rubber binder shall conform to the provisions for asphalt-rubber binder.

**Equipment For Production of Asphalt-Rubber Binder**

The Contractor shall utilize the following equipment for production of asphalt-rubber binder:

A. An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ± 5°F and shall be of the recording type.

B. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the State Standard Specifications.
blending system shall be capable of varying the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ± 25°F. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery and re-settable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device capable of delivering a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests.

C. An asphalt-rubber binder storage tank equipped with a heating system furnished with a temperature reading device to maintain the proper temperature of the asphalt-rubber binder and an internal mixing unit capable of maintaining a homogeneous mixture of paving asphalt, asphalt modifier, and CRM.

The equipment shall be approved by the Engineer prior to use.

Aggregate

The aggregate for gap graded asphalt rubber concrete (Type G) shall conform to the following grading and shall meet the quality provisions specified for Type A asphalt concrete in Section 39-2.02, "Aggregate," of the State Standard Specifications, except as follows:

A. California Test 211, Los Angeles Rattler loss at 500 revolutions shall be 40 percent maximum.

B. California Test 205, Section D, definition of a crushed particle is revised as follows: "A particle having 2 or more fresh mechanically fractured faces shall be considered a crushed particle."

C. The swell and moisture vapor susceptibility requirements shall not apply.
### Aggregate Grading Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Limits of Proposed Gradation</th>
<th>Operating Range</th>
<th>Contract Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>—</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>—</td>
<td>90 - 100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>83 - 87</td>
<td>X ±5</td>
<td>X ±7</td>
</tr>
<tr>
<td>No 4</td>
<td>33 - 37</td>
<td>X ±5</td>
<td>X ±7</td>
</tr>
<tr>
<td>No 8</td>
<td>18 - 22</td>
<td>X ±4</td>
<td>X ±5</td>
</tr>
<tr>
<td>No 30</td>
<td>8 - 12</td>
<td>X ±4</td>
<td>X ±5</td>
</tr>
<tr>
<td>No 200</td>
<td>—</td>
<td>2 - 7</td>
<td>0 - 8</td>
</tr>
</tbody>
</table>

The symbol "X" in the following table is the gradation which the Contractor proposes to furnish for the specific sieve.

### Proportioning, Spreading and Compacting

When batch type asphalt concrete plants are used to produce Type G rubberized asphalt concrete, the asphalt-rubber binder and mineral aggregate shall be proportioned by mass.

When continuous mixing type asphalt concrete plants are used to produce Type G rubberized asphalt concrete, the asphalt-rubber binder shall be proportioned by an asphalt meter of the mass flow, Coriolis effect type. The meter shall have been Type-approved by the Division of Measurement Standards prior to the start of production. The meter shall be calibrated in conformance with the requirements in California Test 109. The meter shall be interfaced with the existing continuous mixing plant controller in use on the asphalt concrete plant.

Type G rubberized asphalt concrete shall be placed only when the atmospheric and pavement surface temperatures are 55°F or above and rising.

When the atmospheric and pavement surface temperature is 65°F or higher, the following shall apply:

A. The temperature of the aggregate shall not be greater than 325°F at the time the asphalt-rubber binder is added to the aggregate.
B. Type G rubberized asphalt concrete shall be spread at a temperature of not less than 280°F or more than 325°F, measured in the mat directly behind the paving machine.

C. The first coverage of initial or breakdown compaction shall be performed when the temperature of the Type G rubberized asphalt concrete is not less than 275°F. Breakdown compaction shall be completed before the temperature of the Type G rubberized asphalt concrete drops below 250°F.

When the atmospheric or pavement surface temperature is below 65°F, the following shall apply:

A. The temperature of the aggregate shall not be less than 300°F nor more than 325°F at the time the asphalt-rubber binder is added to the aggregate.

B. The Contractor shall cover the loads of Type G rubberized asphalt concrete with tarpaulins. The tarpaulins shall completely cover the exposed Type G rubberized asphalt concrete until the Type G rubberized asphalt concrete has been completely transferred into the asphalt concrete paver hopper or deposited on the roadbed.

C. Type G rubberized asphalt concrete shall be spread at a temperature of not less than 290°F nor more than 325°F, measured in the mat directly behind the paving machine.

D. The first coverage of initial or breakdown compaction shall be performed when the temperature of the Type G rubberized asphalt concrete is not less than 280°F. Breakdown compaction shall be completed before the temperature of the Type G rubberized asphalt concrete drops below 260°F.

Pneumatic tired rollers shall not be used to compact Type G rubberized asphalt concrete.

Alternative compacting equipment conforming to the provisions in Section 39-6.03, "Compacting," of the State Standard Specifications shall be used to compact the Type G rubberized asphalt concrete.

Traffic shall not be allowed on the Type G rubberized asphalt concrete until final rolling operations have been completed and sand has been applied to the surface.

Sand shall be spread on the surface of Type G rubberized asphalt concrete at a rate of 1-2 lbs/square yard. The exact rate will be determined by the Engineer. When ordered by the Engineer excess sand shall be removed from the pavement surface by sweeping. Sand shall be free from clay or organic material. Sand shall conform to the fine aggregate grading provisions in Section 90-3.03, "Fine
Aggregate Grading,” of the State Standard Specifications. Alternatively, the Contractor may spread a suitable lime-water solution on the surface of Type G rubberized asphalt concrete at a rate to be determined by the Engineer.

The contract price paid per ton for Type G asphalt rubber concrete shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in placing Type G asphalt rubber concrete for roadways, complete in place, including bituminous seals, aggregate, and compaction as shown on the plans, as specified in the Standard Specifications and these Specifications, and as directed by the Engineer.

Payment will be made under:

Type G Asphalt Rubber Concrete Surface Course - Per Ton
Sample Construction Detail

ASPHALT PAVEMENT

SUBGRADE, COMPACT TO 95% OF MAXIMUM DRY DENSITY (MDD) PER ASTM D-1557 AND PER CSJ SPECS SECT. 2I CLASS A SUBGRADE

HEADERBOARD

PRIME COAT
TACK COAT
FOG SEAL COAT

FINISH GRADE ASPHALT

AGGREGATE BASE COURSE,
CLASS III, COMPACT TO 95%

ASPHALT BASE COURSE

ASPHALT SURFACE COURSE

REFER TO GEO TECH. REPORT
REFER TO GEO TECH. REPORT
Appendix

References


http://www.ciwmb.ca.gov/condemo/shingles/Pavement.htm

http://www.concreterecycling.org/links.html
http://www.dkrivit.com/


http://www.epa.gov/epaoswer/osw/conserve/priorities/bene-use.htm


http://shinglerecycling.org/
Appendix

Persons Contacted

Paul Amato, San Francisco Regional Water Quality Control Board

Stephen Bantillo, City of San Jose, Department of Environmental Services

Bob Beatty, Raisch Products

Rick Best, Reed and Graham

Chi-Wai Chung, City of Alameda, Department of Public Works

Rusty Gainor, Dunbarton Quarry Associates

Mark Gross, Zanker Materials Processing Facility

Tawfic Halaby, Public Works, Engineering, City of Oakland

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Mark Idemoto, Raisch Products

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Dave Nelson, Caltrans

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Gayle Seeds, City of Milpitas

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Brian Wines, San Francisco Regional Water Quality Control Board

Yves Zsutty, City of San Jose, Department of Parks, Recreation, and Neighborhood Services