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February 10, 2011

The Honorable J. Kalani English, Chair
and Members
Transportation and International Affairs Committee
State Capitol
Honolulu, Hawaii 96813

Dear Chair English and Members:

Subject: Senate Bill No. 698, Relating to Roadway Materials

The Department of Design and Construction (DDC) respectfully **opposes** the use of glass cullet in roadway surface and base course pavements for the following reasons:

1. Glass cullet can be detrimental to [hot mix] asphalt concrete (AC), because asphalt does not adhere to glass as well as it does to rock aggregate.

2. Glass cullet in hot mix asphalt limits the asphalt recycling options. Glass cullet is not allowed in the surface layer of AC pavement by either the State Department of Transportation or the City and County of Honolulu. Thus, pavement materials containing glass cullet cannot be used in the production of recycled asphalt pavement (RAP) when the mix is intended for a surface course application. Currently, the RAP that is allowed in the surface mix contains incidental glass from previous AC base mixes that allowed glass cullet. This incidental glass can be seen in many of the recent projects in the surface paving layer.

3. The City has received complaints about glass cullet showing up in gutters and along the edge of roadways during resurfacing projects. The paving construction method most efficiently employed by most contractors in rehabilitating roads has been to mill and place the AC base course layer first and then open the road to traffic at the end of the day. The final AC surface lift may be placed much later so that a longer stretch of roadway can be paved at once, resulting in minimal joints and a smoother riding surface. As glass cullet is currently allowed in the AC base course layers, traffic running on this AC layer has resulted in glass breaking free, as glass does not bind well to the asphalt, and showing up in the gutters and along the roadway. This presents a significant public safety concern.

4. If glass is continued to be allowed in the AC pavement structure during the use of RAP, the further breakdown of the glass, which is a silica product, may pose a health concern.

5. The best use of glass cullet is for making new glass products. A study referenced by Muench (see below) determined that recycling glass as a feedstock for new glass saved 315 kg of CO2 for every tonne of recycled glass, while using glass as an aggregate replacement required an additional 2 kg of CO2 for every tonne of recycled glass. Even though glass must be shipped to North America and sorted and cleaned to be recycled into new glass containers, the benefits far outweigh the disadvantages of using glass in pavement materials.

Reasons 1, 2, and 5, above, are documented in a report prepared for the Hawaii Community Foundation by Professor Steve Muench of the University of Washington ("Sustainable Pavement Solutions for O'ahu," February 2, 2011). An excerpt of the report that addresses glass cullet in AC paving is enclosed for your reference. The entire report with appendices can be provided upon request. Accordingly, we respectfully **oppose** the use of glass cullet in roadway surface and base course pavements.

Thank you for the opportunity to testify.

Very truly yours,

Collins D. Lam, P.E.
Director

CDL:WB:hm

Enclosure

Sustainable Pavement Solutions for O'ahu

An Exploration into the Use of Reclaimed Asphalt Pavement (RAP),
Warm Mix Asphalt (WMA) and other Sustainable Strategies
for O'ahu's Hot Mix Asphalt (HMA) Pavements

Warm mix asphalt
paved on Farrington Highway for HDOT, 5 October 2006

Steve Muench
with assistance from Denise Muramoto

2 February 2011

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Executive Summary

This report was prepared at the request of the Hawai'i Community Foundation and for the purpose of exploring and recommending sustainable solutions for the hot mix asphalt (HMA) pavement industry on O'ahu. Principal findings are as follows:

The O'ahu Hot Mix Asphalt (HMA) Industry

About 750,000 tons of HMA will be produced on O'ahu in 2010, primarily by two contractors: Grace Pacific Corp. (70%) and Jas. W. Glover, Ltd. (30%). The majority of work on O'ahu is for the City & County of Honolulu (60%), HDOT (15%), the military (15%) and others (10%). This can change from year-to-year based on individual agency funding and contracting.

Reclaimed Asphalt Pavement (RAP)

- About 100,000 tons of RAP will be used in new HMA mixtures on O'ahu in 2010
- Current RAP inventory in stockpiles is around 800,000 tons and growing
- Update the 1986 City & County of Honolulu specifications and make them consistent with HDOT specifications
- Allow the use of RAP in unbound aggregate base layers up to 50%, which is consistent with UH research findings.

Warm Mix Asphalt (WMA)

- Implement a permissive WMA specification for HDOT and Honolulu.
- Equip all Hawai'i (and O'ahu) HMA plants with WMA technology. Likely this means the widespread adoption of plant foaming technologies.
- Advertise Hawai'i as the first 100% WMA state in the U.S.

Other Sustainable Options for HMA on O'ahu

- **Use local materials.** Especially avoid importing aggregate from long distances. The energy use and CO_2 emissions associated with an HMA pavement constructed using aggregate from British Columbia is *4-5 times more* than a pavement constructed using local aggregate.
- **Rescind the mandate to include glass cullet in HMA.** Its impact on HMA quality is neutral to slightly negative and its highest and best use is in the making of glass.
- **Develop and use stone matrix asphalt (SMA), a long-lasting HMA surfacing.** HDOT paved a test section of SMA in 2004 but nothing has been paved since.
- **Adopt a standard accounting practice that accurately reflects all sustainability efforts put into O'ahu roadways.** A rating system like Greenroads could provide a means of (1) quantifying what is being done, (2) setting goals for improvement, and (3) effectively communicating sustainability efforts to the public and their benefits.

Potential Impacts of Sustainability Options for O'ahu

- In 2010 O'ahu HMA paving will use about 465 TJ (terrajoules) of energy and produce about 50,000 tonnes (metric tons) of greenhouse gases. This is equivalent to the energy use and greenhouse gas output for all households in Kailua town (pop. 36,000).

- Figure 1 shows a general estimate of the reduction in energy use associated with the sustainable solutions investigated in this report. Greenhouse gas reductions are similar.

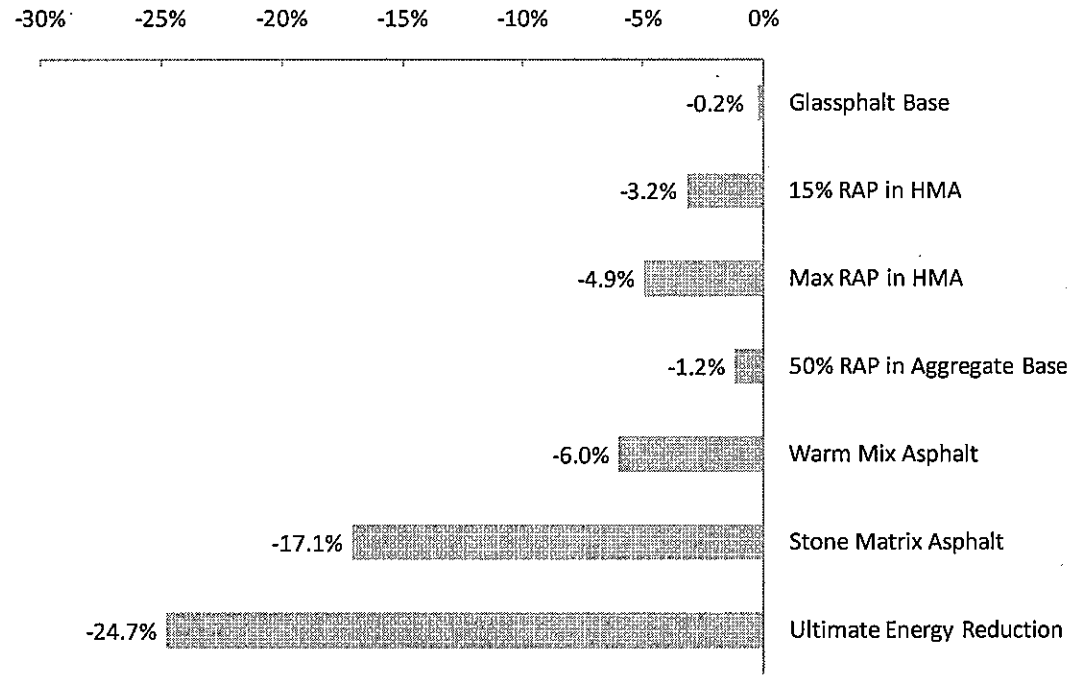

Figure 1. Average yearly energy reduction for HMA paving on O'ahu when compared to the baseline "all virgin materials" option. "Ultimate Energy Reduction" is a combination of these strategies: SMA surface course, 40% RAP in HMA base course, 50% RAP in aggregate base course and WMA used in all instances.

It is clear that the sustainable solutions examined in this report have significantly varying impacts in energy use and greenhouse gas emissions. Decisions regarding which ones to pursue should consider this. Current practice is most nearly reflected by the "15% RAP in HMA" option in Figure 1.

Sustainability Plan

There are many options for making HMA pavements more sustainable in the long-run; far more than can reasonably be implemented given Hawai'i's isolated location and limited resources. Given this, a coherent strategy to evaluate options and implementing a limited number of the most promising ones would be beneficial. This plan could, as a minimum, include:

- A written strategy for making pavements more sustainable in the State of Hawai'i.
- Identified metrics that will best indicate the extent to which this plan is being executed.
- Clearly defined goals and desired end results based on key metrics.
- A means to update and maintain the plan current and in compliance with higher-level plans and directives.

HDOT. The current specification, dated 2005, and special provisions allow the following amounts of RAP:

- 20% in "hot mix asphalt (HMA) pavement" – usually used as the surface course (generally the top two inches of a pavement structure.
- 40% in "hot mix asphalt base (HMAB)" – usually used as the base course. The specification actually allows 30% for batch plants and 40% for drum mix plants, however there are currently no batch plants on O'ahu.
- 20% in "hot mix glassphalt base (HMGB)" – required to be used as base material in lieu of HMAB if (1) glass cullet is available, and (2) the market price is equal to or less than aggregate. HMGB also includes 10% glass cullet as an aggregate substitute.

Honolulu. The current specification, dated 1986, does not allow the use of RAP in HMA. However, special provisions can, and typically are, added to allow 20% RAP in the surface course and 40% RAP in the base course similar to HDOT. Overall, RAP use is inconsistent through-out the City and County of Honolulu: sometimes the RAP special provision can be left out, purposefully or not, which causes some confusion amongst contractors bidding Honolulu work and can result in Honolulu jobs being paved with 100% virgin mix (no RAP) even when RAP would be an appropriate addition. The core issue is that the current standard specifications are now over 24 years old and need to be updated. Based on their comments, HAPI and Honolulu both favor an update. HAPI favors an update that would closely replicate HDOT specifications where appropriate.

Federal Aviation Administration (FAA). While HDOT administers Hawai'i airports, specifications are largely dictated by the FAA. FAA specifications (found as FAA Advisory Circular AC 150/5370-10), issued in 2009, do not allow RAP in surface mixes (usually the top 2-3 inches) except for shoulders, but allows 30% in other mixtures.

Military. Unified Facilities Guide Specification (UFGS) Section 32 12 15, dated May 2010, does not allow RAP in surface mixes (usually the top 2-3 inches) except for shoulders, but allows 30% in other mixtures. This is the same as FAA specification.

4.3 RAP on O'ahu

The amount of available RAP on O'ahu is large (800,000 tons) and growing in size. It is difficult to estimate the total quantity of RAP generated on O'ahu each year or in any specific year since RAP is typically inventoried only as it is used in new HMA and not as it is generated. For 2010, its use in new HMA on O'ahu is on the order of about 100,000 tons (based on estimates from Grace and Glover). Newcomb and Jones (2008) report that actual RAP use as a percentage in Hawai'i is about 15% for surface courses and 20% for base courses. It is important to note that there are two main RAP material streams on O'ahu:

- **Pure or "Clean" RAP.** Comes directly from milling up old HMA pavement. Contractors usually store this RAP on site at the HMA plant and use it when allowed. Current industry estimates are on the order of 400,000 tons of clean RAP stockpiled on O'ahu.

that would allow WMA to be used at the contractor's discretion. Of course, such a specification would likely involve a pre-approved product list.

5.5 WMA Recommendations for O'ahu

- Implement a permissive WMA specification for HDOT and Honolulu. This would likely tip the balance in favor of using WMA on most all HDOT and Honolulu projects. Appendix C is a sample specification from the WMA TWG and Appendix D is TxDOT Special Provision 341-020.
- Establish a pre-approved WMA technology list based on the same methods TxDOT uses.
- Equip all Hawai'i (and O'ahu) HMA plants with WMA technology. This likely means adoption of plant foaming technologies.
- Advertise Hawai'i as the first 100% WMA state in the U.S.

As with RAP recommended changes, WMA change should only be made through close consultation between HDOT, Honolulu and industry. The recommended general schedule for RAP could also be used for WMA.

6 Other Sustainable Options for HMA on O'ahu

Beyond RAP and WMA, there are other viable sustainable HMA options for O'ahu.

6.1 Use Local Materials

Use local materials to the extent possible in HMA. Importing aggregate results in an especially high energy and emissions cost that should not be tolerated. Specifying agencies should carefully consider the effects of existing specifications that essentially dictate the import of sand for HMA. These effects should be weighed against the possible negative effects on HMA quality of relaxing those specifications.

6.2 No Glass Cullet in Pavement Materials

The mandate to use glass cullet in HMGB is not practical and should be rescinded. HAPI, HDOT and Honolulu have all expressed this sentiment and are in relative agreement. Reasons are:

1. **Glass cullet is rarely used.** HMGB need only be used if the price of glass cullet is equal to or less than aggregate. This is rarely the case.
2. **Glass cullet can make HMA worse.** Its effect on HMA qualities is generally neutral to slightly negative (West et al. 1993). In rather simplistic terms, the problem is that asphalt does not stick to glass. Therefore, asphalt properties that rely on this "sticking" are generally not as good. Some of this can be overcome using an anti-strip additive but there may still be some negative consequences.
3. **The best use of glass cullet is in making new glass containers.** In a 2003 study, Enviros (an environmental consultant) calculated that recycling glass as a feedstock for new glass saved 315 kg of CO_2 for every tonne of recycled glass, while using glass as an aggregate replacement *required an additional* 2 kg of CO_2 for every tonne of recycled glass. Even though glass must be shipped to North America, sorted and cleaned to be

recycled into new glass containers, the benefits still far outweigh its use in pavement materials.

4. **Glass cullet in HMA limits recycling options.** Glass cullet is not allowed in the surface course of HDOT or Honolulu mixes. This can effectively prevent RAP use at all in the surface course unless the exclusion of glass cullet in the surface course is relaxed. Currently, this exclusion is not always relaxed. What this amounts to is a specification that requires including a waste product in new material that effectively excludes that material from being recycled.

6.3 Develop and Use Stone Matrix Asphalt

Stone matrix asphalt (SMA) is a specialty surface course mixture that was developed some 30 years ago in Europe to combat the effects of studded tire wear and provide a longer-lasting HMA pavement surface. Since then, SMA has been used all over the world and is in regular use in many states. As a premium mix, it tends to cost more initially, but its extended life more than compensates for this initial premium. Using SMA has the potential to reduce the overall amount of paving materials consumed on O'ahu because SMA-surfaced roadways would have to be resurfaced less often. As with most new material ventures, industry requires a commitment from agencies to pave substantial tonnage of the material before they are likely to invest in material supply lines and equipment to support the effort. Otherwise, they stand to lose money. SMA is likely to require a modified asphalt binder, which is not currently supplied on O'ahu.

One trial project to date. HDOT paved an initial trial section of SMA on the Moanalua Freeway in 2004, which appears to be performing adequately. To date, however, no other SMA has been paved on O'ahu roads and development of SMA is not a current priority within HDOT.

7 Impacts of Sustainable Options for O'ahu

So far, sustainable solutions have been discussed without regard to their impact on sustainability. However, impact is an important quality to consider when determining which solutions to pursue given limited resources. This section describes the relative impact of the sustainable solutions previously discussed *in regards to energy and greenhouse gases only*. Ideally, impact addresses all three principles of sustainability (ecology, equity and economy), however in principle this is difficult to do entirely objectively without an agreed upon metric. The issue of a more universal metric and its use is addressed in Section 7.4.

7.1 Method of Quantifying Impacts: Life Cycle Inventory

The Excel-based software program PaLATE (Consortium on Green Design and Manufacturing. 2007), as modified by the University of Washington (UW) was used to evaluate the energy use and CO_2 emissions associated with different sustainable solutions. It must be stressed that the version modified by the University UW (available for free at www.greenroads.us) must be used. It is a complete rebuild of the original version, which had numerous defects rendering it essentially useless. PaLATE uses a method called "life cycle assessment" (LCA) to determine these numbers. The U.S. Environmental Protection Agency (EPA 2010) describes LCA as, "...a

9 Recommendations Summary

The following is a short list of the most impactful recommendations from this exploration:

- Update the 1986 City & County of Honolulu Standard Specifications.
- Allow RAP to be included in unbound aggregate base layers up to 50% (Ooi et al. 2010).
- Implement a permissive WMA specification for HDOT and Honolulu.
- Equip all Hawai'i (and O'ahu) HMA plants with WMA technology.
- Advertise Hawai'i as the first 100% WMA state in the U.S.
- Use local materials.
- Do not require glass cullet to be included in roadway materials.
- Develop expertise in and use stone matrix asphalt (SMA) as a surface course.
- Try out and consider adopting the Greenroads sustainability rating system.
- Develop and implement a pavement sustainability plan.

GracePacific CORPORATION
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Hawaii State Senate
Committee on Transportation and International Affairs

February 10, 2011

Subject: **Support for SB 698, Relating to Roadway Materials**
Hearing Scheduled for 1:15 PM, Monday, February 14, 2011, Conference Room 224

I am writing today in support of **SB 698**.

Currently, HRS 103D-407 requires State highway officials to purchase roadway materials with minimum recycled glass content of 10% for basecourse and 100% for nonstructural capital improvement applications. This requirement (sometimes referred to as the "glassphalt mandate") has the following negative impacts:

1. It reduces the quality of roads in Hawaii.
2. It impairs the paving industry's ability to recycle asphalt pavements.
3. It results in a higher carbon footprint than if glass were shipped to the mainland to be recycled into new glass products.

The proposed bill **SB 698** would end the *requirement* that State agencies must use recycled glass in roadway materials, but would still *allow* State agencies to use recycled glass if desired. The following is a brief explanation of each of the negative impacts listed above.

1. Glass reduces the quality of roads in Hawaii.

Quite simply, asphalt does not stick to glass. The smooth surfaces of glass result in a higher stripping potential than natural aggregates, which causes the asphalt to "strip" from the aggregate, thereby causing premature failure. Glass can also reduce the skid resistance of the road, which is unsafe for drivers. For these reasons, glassphalt is not used in surface courses.

2. Glass impairs the paving industry's ability to recycle asphalt pavements.

Reclaimed asphalt pavement (RAP) is one of the most recycled materials in Hawaii, and throughout the country. It can be recycled into unbound aggregate basecourse, as well as new hot-mix asphalt pavements. Adding RAP to new hot-mix asphalt is considered the *highest and best use* since both the aggregate *and* the liquid asphalt are utilized in the new pavement. Unlike glass, RAP is used in the surface course (up to 20%) as well as the basecourse (up to 40%). In 2010, more than 50,000 tons of RAP were used in hot-mix asphalt produced by Grace Pacific.

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The presence of glass in the asphalt treated basecourse makes it difficult to use RAP in surface pavements. When existing roads are resurfaced or reconstructed, RAP from the surface course and the basecourse are comingled during the milling process. RAP is then brought to a facility for processing prior to recycling back into new hot-mix asphalt. Due to the limited space availability for stockpiling RAP, it is difficult – and sometimes impossible – to separate RAP that has glass in it with RAP that does not.

RAP that has glass in it may not be used in surface pavements. The asphalt paving industry has seen a complete lack of cooperation from State and County highway agencies with regards to allowing even an incidental amount of glass in the surface course (i.e., less than 1%). Thus, the presence of glass in the asphalt treated basecourse impairs the paving industry's ability to recycle asphalt pavements.

3. **Using glass in roadway materials results in a higher carbon footprint than if glass were shipped to the mainland to be recycled into new glass products.**

   The process of manufacturing virgin glass from silica sand is extremely energy intensive. Adding recycled glass to the manufacturing process significantly reduces the amount of energy required to produce glass products.

   I have done a simple life-cycle carbon footprint analysis of glass recycling that includes the carbon savings associated with recycling glass, as well as the carbon emissions associated with shipping glass to the mainland for recycling. For this analysis, I assumed a shipping distance from Honolulu to Los Angeles of 2,550 miles, and a trucking distance from Los Angeles to a glass recycler of 100 miles. Using these assumptions, *each 20-ton shipping container sent to the mainland for recycling results in a net decrease of CO_2 emissions by 3.6 tons*.

   In contrast, adding 20 tons of glass to hot-mix asphalt basecourse would result in a net decrease of CO_2 emissions by 0.4 tons. In other words, *the CO_2 emissions reduction associated with shipping glass to the mainland for recycling is 10 times greater than the CO_2 emissions reduction associated with adding glass to asphalt pavement.*

In summary, **SB 698** will allow for better quality roads, enable more cost-effective recycling of asphalt pavements, and reduce Hawaii's overall greenhouse gas emissions. I strongly support this bill.

Please do not hesitate to contact me at 674-8383 if there are any questions regarding this submittal.

With regards,

Joseph Shacat
Environmental Compliance Manager, Grace Pacific Corporation

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GREEN MIX HAWAII Contractors Lic. No. C-12094

February 11, 2011

Subject: Support for SB-698, Relating to Roadway Materials

I am writing today in strong support of SB 698.

Currently, HRS 103D-407 requires State highway officials to purchase roadway materials with minimum recycled glass content of 10% for base course and 100% for nonstructural capital improvement applications. This requirement (sometimes referred to as the "glassphalt mandate") has the following negative impacts:

1. It impairs the paving industry's ability to recycle asphalt pavements.
2. It reduces the quality of roads in Hawaii.

The proposed bill **SB 698** would end the *requirement* that State agencies must use recycled glass in roadway materials, but would still *allow* State agencies to use recycled glass if desired. The following is a brief explanation of each of the negative impacts listed above.

1. **Glass impairs the paving industry's ability to recycle asphalt pavements.**

   Reclaimed asphalt pavement (RAP) is one of the most recycled materials in Hawaii, and throughout the country. It can be recycled into unbound aggregate base course, as well as new hot-mix asphalt pavements. Adding RAP to new hot-mix asphalt is considered the *highest and best use* since both the aggregate *and* the liquid asphalt are utilized in the new pavement. Unlike glass, RAP is used in the surface course (up to 20%) as well as the base course (up to 40%). The presence of glass in the asphalt treated base course makes it difficult to use RAP in surface pavements. When existing roads are resurfaced or reconstructed, the roadway is milled down to the desired depth as specified by the highway engineer. RAP from the surface course and the base course are often comingled during this process. RAP is then brought to a facility for processing prior to recycling back into new hot-mix asphalt. Due to the limited space availability for stockpiling RAP, it is difficult – and sometimes impossible – to separate RAP containing glass from RAP that does not.

   State and county highway agencies have a zero tolerance policy for glass in the surface mix. Because of this, RAP that has glass in it cannot be used in the surface mix. Thus, the presence of glass in the asphalt treated base course impairs the paving industry's ability to recycle asphalt pavements.

   It will take some time to fully eliminate glass from RAP. Based on the original glassphalt specification of 10% glass cullet in base course mix and current specifications calling for a maximum of 20% RAP in our surface course; if we were to add the maximum 20% RAP to

surface course today, it is likely the amount of residual glass cullet in surface mix from existing RAP will be less than 2%. Although permitted by the specifications, surface course producers are unwilling to add RAP which includes this residual/incidental glass content to surface course and render the surface course potentially unacceptable to State and County inspectors. We could increase the recycling of RAP in surface mix if the State and Counties would accept, in surface mix, the residual glass cullet in RAP, an incidental amount (maximum 2%).

2. **Glass reduces the quality of roads in Hawaii.**

   Quite simply, asphalt does not stick to glass. The smooth surfaces of glass result in a higher stripping potential than natural aggregates, which causes the asphalt to "strip" from the aggregate, thereby causing premature failure. Glass can also reduce the skid resistance of the road, which is unsafe for drivers. For these reasons, glassphalt is not used in surface courses. Although glassphalt is only used in the base course, its use still has a negative impact on the road due to recycling of asphalt pavements as noted above.

Times have changed and the uses of recycled glass have increased along with the growth of the remanufactured glass business. It is no longer necessary to use recycled glass for the manufacture of asphalt as a means of disposing of the discarded glass. The Hawaii Deposit Beverage Container Program was launched in January 2005, making the recycling of glass containers much more attractive to individuals and business. Today there are many uses for this reclaimed glass and much of the recycled glass may be shipped to the mainland for remanufacture into new glass products.

In summary, **SB 698** will allow for better quality roads and enable more cost-effective recycling of asphalt pavements. I strongly support this bill.

Please do not hesitate to contact me at 478-8204 if there are any questions regarding this submittal.

With regards,

Elisabeth R. Wilson
President
Alakona Corp.