

BEACHED GLASS

by Phil Bresee

Facing significant hurdles, one county's attempt to control beach erosion could offer a sustainable outlet for recovered glass

"Can you make sand castles out of it?"

That is one of the common questions heard from people when first told of a Florida county's Beach Glass Renourishment Project. For the past three years, Broward County has been spearheading an innovative project to determine the feasibility of using pulverized glass from recycling programs blended with natural beach sand to help address erosion "hot spots" on local beaches. The project is a cooperative effort among the City of Hollywood and other partner cities from the county's Resource Recovery System (Fort Lauderdale, Florida), the county's Environmental Protection and Public Works and Transportation Departments (Plantation, Florida) and the State of Florida, primarily through the Florida Department of Environmental Protection (Tallahassee, Florida).

Results from the project's study areas have been positive to date, and Broward County is hopeful that the process of recycling glass back into its original state will yield a synergistic solution to combating beach erosion and

addressing poor markets for the county's recovered glass.

If the project is successful, Broward County will be the first U.S. community to utilize finely crushed glass blended with natural beach sand for erosion control (this type of sand/glass mix has been experimented with along resort beaches on the resort island of Curacao and in Wellington, New Zealand).

How does the county protect the beaches?

Beaches are big bucks in Broward County. A 1995 economic study determined that they help attract some seven million tourists per year who, in turn, contribute in excess of \$420 million into the local economy. Beaches also provide natural barriers between the sea and inland areas, providing protection to billions of dollars of infrastructure and real estate (note: given the tourism and real estate booms of the early 2000s, it stands to reason the economic value of Broward's beaches has appreciated con-

siderably beyond the values referenced in the 1995 study).

However, Broward County's beaches are in a constant state of erosion, with about 21 of the county's 24 miles of beaches considered critically eroded and requiring frequent infusions of new sand, or renourishment. The most recent beach renourishment effort restored 6.8 miles of Broward's southern shoreline and involved the placement of approximately two million cubic yards of sand at a cost of some \$45 million. This project is expected to provide erosion relief for about 10 years and involve the dredging of sand from offshore "borrow sites" and pumping it onto eroded beaches for spreading and grading. In addition to the use of dredged sand, renourishment efforts have begun to include the bypassing of sand at stabilized inlets and engineered erosion control structures that stabilize the most erosive stretches of the county's beaches.

But, these more traditional methods of erosion control and beach renourishment face challenges, including increasing costs for sand, rising construction costs and environmental resistance, due to the potential adverse effects of dredging offshore in proximity to coral reefs.

Broward County's recycling programs

The county's residential recycling programs expanded in the early 1990s, in part, to help the county comply with Florida statutes requiring large counties to achieve a 30-percent recy-

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cling rate. Local cities must provide recycling and solid waste collection services for residents, with approximately 95 percent of single-family style homes in the county at least having access to curbside recycling. Many cities also provide for recycling collection from multi-family residences (more than 40 percent of the county's housing stock) through direct pickup or through ordinances requiring properties to offer recycling services to residents.

Recycling collections are dual-stream throughout Broward County, with many cities providing households with two bins – one for commingled metal, plastic and glass food and beverage containers, and the other for mixed fiber. The county manages the materials recovery facility (MRF) contract on behalf of the 26 RRS partner cities (overall, the county has 31 cities).

RRS partner cities deliver an average of about 65,000 tons of residential recyclables to its MRF operator, WM Recycle America (Houston), each year, with glass accounting for about 13,000 tons. The county pays the company a per-ton fee to process and market collected recyclables and then shares revenues based on a formula. However, due to historically low end-market prices, the county ends up bearing a net cost of about \$130,000 per year to recycle its glass. Roughly 55 percent of the glass marketed by WM Recycle America is mixed broken glass and, in reality, does not get marketed at all, but rather is beneficially used as road base material at the company's large, regional landfill. While the cost per-ton to recover glass is far less than the cost of disposing of it (tipping fees at the county's two waste-to-energy plants exceed \$90 per ton), the negative value of the RRS' glass contrasts markedly with the continued robust market prices for other materials, especially aluminum, plastics and newspaper.

Through the years, the county has looked at ways to improve its glass processing and end-markets by reviewing optical sorting and additional intermediate processors, as well as examining alternative end-markets, such as using glass in the manufacture of asphalt shingles. A 2002 study by Malcolm Pirnie, Inc. (White Plains, New York) determined that securing an intermediate processor was the most cost-effective approach to managing the county's glass. Recognizing beach erosion and glass recycling issues, a committee of representatives from RRS cities recommended that additional evaluations be conducted to assess the viability of utilizing a local processor to process glass to sand-level quality.

Based on this direction, MPI conducted further analyses and issued a follow-up report in early 2003, which spoke to additional issues and challenges, including regulatory approvals, beach renourishment schedules, quantities of glass available and economics. It also included reviews of scientific studies performed in

Florida that recognized that glass and sand share very similar characteristics, and which concluded that the use of glass for beach erosion and renourishment is a potentially viable option, provided certain key concerns are addressed. The amount of glass generated within Broward County – even at 100-percent recovery levels – could never fully replace sand needed for beach erosion projects. However, it was hoped that glass could be processed and stored for use on smaller, highly-eroded areas when needed, possibly extending the beach renourishment schedule.

The promising results of the consultant studies allowed the project to move forward, and Florida DEP awarded a matching grant of \$570,000 (state and county split the costs 50-50) in late 2003.

Project approach

Based on the project's scope and consultations with staff from state regulatory agencies, the first phase of the project was organized into concurrent tasks to address the following questions:

- ◆ Is the project technically feasible?
- ◆ Is the project biologically and environmentally feasible?
- ◆ Will the public accept and support the project?

Project sub-consultants, Coastal Planning and Engineering (Boca Raton, Florida) and MARS Research (Coral Springs, Florida), were added to the project team to assist with these tasks.

Geotechnical feasibility

The first step in the technical feasibility phase involved identifying processors capable of producing glass that meets the same physical characteristics of sand that could be used for laboratory testing prior to actual beach applications. Glass cullet producers and glass crushing equipment manufacturers were sent specifications requesting them to produce samples that were similar in grain size (about 0.02 inches), angularity and roundness to natural beach sand. CPE sieve analyses determined the samples from the responding firms to be in the 0.01-inches to 0.04-inches range, and the levels of fines present in the samples were within state limits for beach compatible materials. The screening devices used by glass processors were those more typically associated with preparation of blasting medium, rather than cullet.

Environmental feasibility

Obtaining approvals from the various regulatory agencies for a beach application, including project co-sponsor FDEP, posed a challenge. First and foremost among the project team and agency concerns were the nesting habitats of endangered and threatened sea turtles. Sea turtles nest along Florida's beaches, including Broward's, so the project team had

to ensure that the majority of the project's eventual construction activities occurred outside of turtle nesting season.

Another element to the environmental investigation involved testing to determine contaminants in the recycled glass to be used in the project. Levels of lead, mercury, total coliform, fecal coliform, E. Coli and semi-volatile organics were measured, with results showing levels either undetectable or below residential exposure target ranges established by FDEP.

A final component of the environmental testing involved biological analyses of how marine organisms, including crustaceans, mollusks and various fish, might survive and colonize in the glass-sand mixes compared to 100-percent natural beach sand. A biological study ran for two-months and concluded that the glass-sand mixes did not adversely impact the marine organism habitation or their abilities to reproduce. In fact, mortality and colonization rates between the glass-sand mixes and the 100-percent sand samples showed no differences.

Public perception

From the outset, public and policy-makers' opinions of the project were considered vitally important. Additional sensitivities also were given to the tourism value that beaches provide to Broward County. To that end, the project team, working with MARS Research (Coral Springs, Florida), developed a public perception plan that included a full-fledged telephone public-opinion survey, as well as targeted focus groups.

The phone survey revealed widespread public acknowledgment that beach erosion is a critical issue in Broward County, and showed solid support for the project – especially the closed-loop approach to recycling glass. Some eight in 10 respondents considered the project "interesting" and more than 70-percent gauged the project as "appealing."

Two focus groups, with two very different groups of participants, also were conducted. A focus group made up of coastal engineers, marine biologists and scientists from Florida and across the southeast displayed a healthy skepticism, expressing concerns about the technical performance of the sand-glass mixture and the project team's ability to navigate the state's complicated regulatory approval process. However, the group showed overall support for the project, particularly when provided samples of the glass-sand blends and natural beach sand.

A second focus group consisting of county residents connected to tourism and economic development issues, including hoteliers and local chambers of commerce representatives, voiced similar concerns as the beach professionals. Overall though, the group felt that finding a viable solution to erosion on Broward's beaches was inherently connected

to the health of the tourism industry, and that the project would help achieve this objective.

But do the turtles like it?

Armed with the positive results from the technical, environmental and public perception phases of the project, the next step was to carry out an actual field demonstration of the glass-sand mixes in a beach environment. A field permit was issued in early 2006, allowing project consultants to construct test plots along a section of Hollywood Beach. The primary purpose of the test plots was to ascertain whether the glass-sand mixtures would exhibit the same abiotic characteristics (e.g., temperature, moisture content, gas exchanges and oxygen level) as natural beach sand. The development and survivability of nesting sea turtles could be impacted negatively if these parameters differ from those found in natural beach sand.

The overall plot dimensions were 40-feet long by 10-feet wide, with an excavated depth of about three feet – simulating a turtle nesting environment. The testing scheme used about 30 tons of glass pulverized to beach-sand specifications deposited into 16 five-foot by five-foot by three-foot sections (four each consisting of 100-percent Hollywood Beach sand; 25-percent glass and 75-percent sand; 50-percent glass and 50-percent sand; and 75-percent glass and 25-percent natural sand).

The test plots were constructed in early March 2006 and remained in place into September. A report issued in late 2006 showed little or no abiotic parameter differences between the glass-sand blends and the natural sand plots. The test plot studies concluded that an upland area of a beach renourished with glass and sand mixtures would offer nesting environments equal to natural beach sand.

Moving forward

With the first and second phases completed, the third phase of the project has begun. This phase involves the placement of substantially larger volumes of glass onto the seaward side of the beach (i.e. directly into the surf), which has always been the project's goal. Activities performed on this portion of the beach require a Joint Coastal Permit (JCP), which has been submitted to the U.S. Army Corp of Engineers (Washington) and Florida DEP.

The JCP calls for the placement of 1,000 cubic yards (note: one cubic-yard of pulverized glass is roughly equivalent to one ton) of pulverized glass as supplemental beach fill directly onto the shoreline, and will hopefully occur sometime during the fall of this year or winter of 2007-08. In this setting, the material will rapidly mix with natural sand, and the placement of glass will involve careful monitoring through surveys and beach samples

throughout its proposed year-long duration. If the initial seaward placement phase is deemed successful, a subsequent placement of 5,000 cubic yards and associated follow-up monitoring is planned.

Challenges and unanswered questions

The project passed some significant milestones

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in 2006, and the results to date support the technical feasibility and public acceptance of this project. The material produced is clean of contaminants, and has similar physical and chemical characteristics to natural sand. Broward County's unique concerns – specifically the nesting sea turtles and economic significance of the beaches – have been addressed throughout the project's testing phases.

Based on the fundamental results to date, manufacturing a sand product from recycled glass shows significant potential for communities around the U.S. and abroad where glass is a net cost to recycle. However, the project still faces some significant challenges.

Glass sourcing and processing

Commercial viability of the glass-to-sand process remains a significant concern. Production costs have been difficult to project, with some estimates indicating glass-to-sand production costs for the initial 1,000-ton seaward application could range as high as \$50,000.

Compounding matters is the fact that South Florida is home to no glass processors; the 30 tons of material used for the geotechnical and biological studies, and the test plots were purchased from Recycle America's former glass processing plant in Raleigh, North Carolina. Past efforts to stimulate private investment in the glass processing infrastructure failed to yield results. The cost of transporting Broward County glass to a processor and transporting it back would no doubt increase the production costs. Moreover, 1,000 cubic yards of glass represents nearly one-month's worth of glass collected by RRS partner cities and 5,000 cubic yards equates to more than four months worth. No storage facility has been identified for these amounts of materials.

Another challenge with glass processing includes the reality that Broward County does not own its recovered glass. Further complicating matters is the determination of which glass to use – only the mixed broken, or revenue-generating glass (e.g., clear glass) as well? The county's MRF operator has traditionally been responsible for marketing the county's glass and assumes ownership of the materials.

A negotiated side-agreement with WM Recycle America may be necessary in order for the county to use a large amount of glass for this project. However, the county's MRF contract expires in 2009, which may further cloud negotiations over glass ownership.

Project costs and funding

Overall project expenses through December 2006 totaled approximately \$517,000, which included funds spent on the various project related testing, construction of the

test pits on Hollywood Beach, materials costs, the public perception study and consultant services. Additional long-term costs, which would take the project through the completion of its third and final phase, are currently projected to be in the \$1.4 million range, with the majority of those monies being earmarked for consulting (engineering and permitting) services.

As part of the 2006 appropriations process, the Florida State Legislature awarded the county an additional \$100,000 in matching funds – effectively raising the project budget to \$770,000. These monies should fund the JCP, as well as any associated research and environmental studies. However, the current grant with FDEP is set to expire at the end of March 2007, and it is unclear whether DEP will extend the grant period. The project has been included in the county's 10-year beach renourishment plan, but potential limited support from FDEP for 2007-2008 may limit the availability of future funds from the federal and state levels.

While staff from the county's Public Works and Transportation and Environmental Protection Departments will continue to examine funding options, the possibility exists that the county, through the Resource Recovery System, may need to assume 100-percent funding of this project.

In spite of the challenges still ahead, the county continues seeking sustainable solutions for ongoing challenges of beach erosion and glass recycling. A dual-solution for beach erosion control and poor glass end-markets remains the goal.

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