

**Mobile
Glass Processing
Equipment**

Feasibility Report

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This report is provided as opinion for discussion only and is **not** designed to replace qualified engineering, architectural or legal advice in any way. Municipalities are cautioned to obtain qualified advice and certified/approved drawings and plans prior to undertaking or adopting any recommendations that may affect their programs or facilities.



Background

- Glass Markets** Recycled glass generates the lowest revenue (in most cases negative revenue) of all blue box materials. Since the raw material for glass making is sand, recovered blue box glass can never command commodity revenues that will offset the cost of collection, transport and processing. Therefore, municipalities can only improve their effectiveness and efficiency of recycling glass by reducing costs as much as possible.
- Glass Transportation** A large percentage of Ontario municipalities are situated more than 100 km. from current Ontario based glass processors and markets. Most of these municipalities do not generate glass tonnage in quantities great enough to negotiate bulk shipping discount rates or preferential processing or revenue rates.
- With the continually escalating cost of transportation, municipalities that are far from markets and processing are facing significant financial challenges for recycling glass.

Challenge and Opportunity

- The Challenge** Remote municipalities are struggling to find a more cost effective solution for processing and marketing glass. The current paradigm of transporting low value glass over long distances for costly processing into a single end market is obsolete.
- The Opportunity** New technology now exists to address both the transportation issue and the limited end market issue. Mobile glass processing equipment is now available that is capable of travelling to the remote municipalities and processing stockpiled glass on site.
- This equipment can produce multiple products capable of being used within the local municipality as a replacement for costly landscaping materials, filter media and purchased aggregates. The material can also be high graded to produce increased revenue if marketed to a variety of end users. (see product list below)
- The concept for improved glass processing in remote municipalities consists of stockpiling glass until sufficient quantities are available to justify a processing session using mobile equipment. Provided the system is viable, over time, regularly scheduled processing runs could be established to service participating municipalities and maximize equipment utilization. Multiple municipalities may also be persuaded to pool resources to jointly acquire and operate the mobile equipment and thereby obtain the benefits of economies of scale and multi-municipal co-operation.
- Project Description** The Emerald Group was engaged to conduct a site visit to the equipment manufacturer in Richfield Springs, NY. USA, to investigate and report on the technical innovation and financial viability of the mobile glass processing equipment produced.



The Supplier

Background

The supplier, Andela Products, was founded in 1981. It was a machining and fabrication shop serving the local community and area businesses in the industrial and agricultural sectors.

Andela Products developed to include the design and manufacturing of special purpose machines, tooling and gauge work. In 1990, the business expanded to include products designed, manufactured, and marketed directly to the recycling industry.

The Andela Glass Pulverizer was the first product designed for the glass recycling industry. This was followed by a wide range of equipment and systems for the glass and other recycling markets. Andela Products recently expanded to include a full glass processing facility which pulverizes, washes, dries, and screens post consumer waste glass. The resulting glass products are bagged and sold as sandblast abrasives (under the White Beauty name) and decorative landscape material (under the SUNSTONE name). Andela Products designed, engineered, and installed this turnkey facility to perfect the concept of turning glass waste into value added commodities which can then be sold either wholesale or retail.

In response to customer demand, Andela Products has assembled a team to provide turnkey systems which process a multitude of materials. Over the years Andela Product progressed from small glass processing systems to multi-million dollar facilities which handle everything from bottles to appliances.



The Equipment

Description	<p>Each basic system usually consists of a metering surge hopper, glass pulverizer, two conveyors and a trommel separator, if required, custom systems can be designed.</p> <p>Central to the system is the company's patented pulverizer. It uses a flexible impact system consisting of twin barrels of double pivoting hammers arranged spirally around central rotating shafts that pulverize glass into usable aggregate the consistency of fine sand and gravel. The spiral hammer arrangement does not require stationary ledgers or anvils inside the processing chambers. Processing is accomplished by infeed glass smashing repeatedly against itself as it is impelled through the chambers by the hammers.</p>
Process	<p>The flexible impact system eliminates the grinding process typical of other machines. Glass, primarily impacting on itself rather than the machine parts, reduces wear and maintenance and produces a distinctly different aggregate which is safe and easy to handle. The aggregate is different in shape at the microscopic level, cubic in nature as opposed to typical glass shards and is not sharp. Product samples are included with this report.</p> <p>The system produces an aggregate ranging from 10 to .1mm in size that is smooth enough to use in a child's sandbox. These turnkey pulverizer systems are available in units that can handle up to 20 tons/hour of glass. The glass does not need to be cleaned, sorted or colour separated and typical to dirty single stream municipal glass was processed during the demonstration. The system will also process ceramics, window glass and plate glass, (if oversized pieces are not introduced.) Windshield and other shatter resistant glass requires another system manufactured by the company.</p> <p>Separation of ceramics and window glass is not necessary prior to processing. This process capacity is interesting as it introduces the possibility of diverting additional tonnage not currently handled in the existing Ontario blue box system.</p> <p>The included trommel separator is designed to separate and size the glass-aggregate and to sort out any material or trash that is larger than 3/8" in size. If material other than glass (plastic, metal caps, or covers) goes through the pulverizer, these materials will keep their</p>

larger form and are easily and automatically separated from the processed glass/sand. In observations of the unit in operation, this residue separation system appeared to work very effectively with final residue containing approximately 5% glass. Plastics and metals emerged battered but intact so further magnetic separation of ferrous may be possible, if desired, prior to landfilling the residue.

One or two screen sizes can be used with the trommel to produce one aggregate mix (3/8" minus) or two different sized aggregates (1/8" minus and 1/8"-3/8").

All moving parts are readily accessible for ease of maintenance and replacement. A wear resistant liner protects the inside of the machine. The liner is segmented for easy replacement.

A dust reduction (misting) system is provided as standard equipment. Mobile systems come with a highway trailer and diesel generator included. Electrical systems are available in either USA or Canadian voltage.

The product created is suitable for a variety of end uses including: backfill, drainage and filtration material, decorative sand, sandblasting media, reflective surfaces, glassphalt, agricultural, arts and crafts, and terrazzo flooring. (See products section below)

Several supplier videos of the equipment in operation are provided with this report.



Mobile Equipment Configuration



Stationary Equipment Configuration



Equipment Operating Observations

- Background** The supplier, provided a full tour of their manufacturing, processing and demonstration facilities.
- In addition to manufacturing, the supplier processes municipal glass on site and therefore had a large supply of single stream as well as LCBO separated glass to demonstrate the operating characteristics of their equipment.
- The supplier was very cooperative and open concerning all aspects of the equipment operating and cost specifications and provided all additional information requested within a week of the site visit.
- Observations** The supplier operated a large 20tph version of the equipment on actual municipal glass for a duration sufficient to permit an accurate observation and evaluation of its performance characteristics.
- The unit was noticeably quieter while operating than most glass processing equipment, likely a result of its low horsepower requirements.
- The equipment generated expected levels of dust while processing. Due to the sub freezing temperatures during the test, the anti-dust mist system was not turned on for the demonstration. There is no reason to doubt that the application of a water mist would control dusting issues with this equipment. An environmentally friendly alcohol based antifreeze is available for low temperature operations of the unit. The supplier did point out that very low temperature operations can cause difficulty with the unit as glass piles tend to hold moisture which can result in frozen feed hoppers and ice plugged trommels. Movement of processed piles of glass is also more difficult in very low temperatures due to ice binding.
- For transportation of the unit, the MOT approved trailer is designed to be pulled with a standard highway tractor. However, the weight of the unit is modest and the supplier advises that some customers tow the unit with a fifth wheel attached to a 5 ton truck. Northern Ontario spring load restrictions could be overcome with the addition of a third axle to the trailer to further reduce wheel/axle weight if required/desired.
- Since, average throughput, longer daylight hours, maintenance, operator comfort and transportation would be much better in warmer weather, it is recommended that operation of this type of equipment be based on a model of stockpiling glass in the cold months and processing during the summer.



Preventative maintenance and storage of the mobile unit could logically be performed during the winter off season. The supplier claims that units will last indefinitely with routine maintenance as all wear parts are replaceable including steel liners for the hoppers. The supplier advises that some units continue to operate after more than twenty years in the field. For purposes of the costing calculations appearing later in this report, a fifteen year equipment life span will be assumed.

Once started, the equipment runs unattended except for feeding and discharge handling. The supplier advises that one trained person, (operation and maintenance training is provided in the purchase price) can operate the equipment provided that the unit is set up close to the supply pile and municipal staff and loader take away the processed material as it builds up. Observation of actual operation tends to support this claim.

A design weakness was observed with the discharge conveyors which appear to be too short for effective operation. This would result in small piles of processed material which must be removed frequently to keep the unit in continuous operation. The supplier is receptive to modifying the equipment to include two long swing out conveyors which may be inclined to permit much higher discharge piles that would require significantly less tending during operation and protect the short discharge conveyors from accidental loader impacts.

The supplier is also receptive to modifying the equipment for radio controlled remote shut down to permit emergency stops by a single operator who also feeds the unit with a skid steer.

The supplier reports that the mobile unit in the configuration pictured above can be set up and dismantled in about an hour which would yield a typical 7 hr. (30 tons) production day based on a 4 day 10 hr. shift rotation.

Conclusions

Overall observations of operation, product and residue suggest that this equipment will perform to the specifications claimed by the supplier.



Ontario Operating Alternatives

Limitations Extreme cold operating limitations along with local seasonal road weight limitations suggest that this equipment is best operated in a May to November duty cycle with March to April used for equipment preventative maintenance and operator training as required.

Operator vacations, training and time off could be scheduled in the winter season and if the operator were supplied by a municipality, the remainder of the winter season would fit well with a reassignment of the operator to snow plow duties.

Based on a 5tph unit, (supplier code, GPT-1 mobile), set up and dismantle cycles should be kept to a minimum to increase productivity, therefore, based on a 30 tpd production rate, municipal stockpiling should be organized into 30 ton multipliers. I.E. stockpile 30, 60, 90 etc., incremental tons of glass prior to scheduling an equipment session. These tonnage stockpiles would yield full days of equipment utilization with a minimum of setup and dismantle cycles.

Assuming 4 day work weeks and a 7 month duty cycle, this equipment will have a practical yield of 3360 tons per year or approximately 3,000 tonnes per year. Nothing prohibits operating this equipment after sunset provided additional lighting is installed or available at the worksite and suitable operators are available. There is no barrier to acquiring greater capacity equipment or additional mobile units, if the demand exceeds capacity.

Alternatives

1. A relatively larger municipality acquires the mobile equipment and sets up a fee for service arrangement with enough nearby municipalities to fully book out the equipment.
2. A multi-municipal group acquires stationary equipment and sets up a centrally located glass processing location within a short drive of all participants who deliver glass on rolloffs and remove product in the same bins. This hub and spoke arrangement would need replication until demand for the service is satisfied.
3. A multi-municipal group acquires mobile equipment, books it and pays costs proportionally based on tonnes processed.
4. A multi-municipal group tenders for the service similar to existing mobile compost turning or stump/brush grinding services. (A multi-municipal group may be required to insure enough tonnage is available to justify a private contractor acquiring/operating this equipment)
5. The CIF directly acquires, leases or subcontracts the equipment and sets up production runs to remote municipalities as required.
6. Larger tonnage municipalities acquire smaller capacity stationary units, with the assistance of the CIF, providing they permit neighbouring municipalities to use the equipment on a fee for service arrangement.

System Cost Evaluation

Capital Costs	Mobile 5tph units are supplied for approx. 269,000 US Stationary 5tph units are supplied for approx. 85,000 US
Operating Costs	<p>Electrical Energy Requirement: Total HP for GPT-1 System 17 HP Total kW/Hour for System 12.6 kW</p> <p>Wear Parts Cost Requirements: Estimated Wear Life: Hammers 24 @ \$75 ea. 250 - 400 hours Liners barrel \$2050 1000 hours Trommel Brushes 2 @ \$415 ea. 1000 hours</p> <p>Unit Fuel burn @ 0.80/l = 7.57l/hr /4.5tph = \$1.68/t Skidsteer Fuel burn @0.80/l = 8l/hr /4.45tph = \$2.52/t Estimated wear parts above = \$2.18/t Other wear parts = \$1.00/t Operator @ \$ 20/hr/4.45 = \$4.49/t Towing costs est. = \$3.00/t Capital 15 yr. amortization 3,000tpy x 15yrs = 45,000 equipment life in tonnes \$269,000*1.3 CDN\$ conversion = \$350,000 Amortization cost 350,000/45,000 = \$7.77/t</p> <p>Contingency @ 10% = \$2.64/t -----</p>
Gross Costs	<p>Total est. mobile operating and capital costs = \$25.28/t Total est. stationary operating and capital costs = \$16.77/t</p>
Cost Avoidance	<p>Current mixed glass processing costs = \$17.00/t Avg. shipping cost to processor = \$25.00/t Aggregate replacement cost = \$7.00/t Additional material diverted (landfill tip fees, collection fees etc) = \$???/t -----</p> <p>Total est. current municipal costs = \$49.00/t</p>
Net Cost	<p>Est. \$49.00 current municipal glass costs less est. \$25.28 local glass processing costs yields \$23.72 /tonne net benefit to the participating municipality. (excluding any tip fees avoided, WDO diversion funding increases, MRF sorting costs, reduced curbside sort costs, product revenue etc.)</p>



Conclusion and Recommendation

- Conclusion** On site operating observations suggest the proposed equipment will perform adequately to the manufacturers specifications.
- Cost analysis indicates that municipalities processing glass locally through this equipment should enjoy a net benefit of approximately \$23.00/tonne cost savings compared with existing glass shipping and processing methods.
- Therefore, analysis of this equipment appears to warrant further testing under actual Canadian field conditions.
- Recommendation** Based on the analysis above, it is the recommendation of The Emerald Group, that further field testing of this equipment should be conducted in Ontario.
- A scale test of at least 12 days of processing (300-400 tonnes) across at least 3 separate municipalities is recommended to permit evaluation of operation, costs, and transportation of equipment between municipalities.
- A test of this size is indicated to justify subcontracting the equipment from the United States as well as providing sufficient time and product to evaluate the equipment, cost and final product.
- The test, if undertaken, appears to be best scheduled for the summer of 2009 to permit recruiting interested municipalities, stockpiling sufficient glass feedstock and negotiating terms with the equipment supplier or a suitable subcontractor.

Barriers to Implementation

- Open Loop** The proposed type of glass recycling is not a closed bottle to bottle loop. Traditionally glass has been the primary example of closed loop recycling and therefore some resistance to introducing open loop recycling of this material may be encountered. It should be noted however that fibers are the only other material partially recycled as a closed loop in the program. This objection may be overcome with education and the fact that additional materials may be diverted with this open loop local recycling.



Costs Acquisition costs of this equipment are not trivial and therefore some municipalities may be reluctant to participate. A full scale field test funded by the CIF will prove the cost benefit to the satisfaction of any interested municipalities or ultimately determine that full implementation of this equipment Province wide is not justified.

Isolationism Municipalities often have reservations about planning activities and services with communities outside their own boundaries. Concerns frequently center on loss of autonomy and political jurisdictions. Staff and council may be concerned that they do not want to lose control of their program. Suggested solutions to overcome these issues are:

- Explore opportunities for shared decision-making and management.
- Clearly document roles and responsibilities, such that control is not lost.
- Clearly demonstrate that economies are gained.

Co-operation between two or more municipalities is becoming more common as municipalities face increasing budgetary constraints. Co-operative planning can lead to improved performance across virtually all recycling program components, enhancing effectiveness and efficiency in the following areas:

- Economies of scale
- Increased resident participation/satisfaction
- Optimized program funding
- Shared staff/time/costs/skills/equipment
- Improved supplier/contractor relations
- Reduced need for management supervision
- Reduced need for council time and attention

Status Quo Resistance to change is always a barrier to implementation of any new technology or process. It may be of assistance to point out that this technology will permit expansion of glass and ceramic materials recycled in participating communities. However, it is important to note that once this step is taken, it will be difficult to revert back to “container glass only” recycling. Cost savings are a large inducement to change the status quo in challenging economic times.



Best Practices

This project fits within the following fundamental best practices as identified by the Blue Box Program Enhancement and Best Practices Assessment Project (2007).

- Multi-municipal planning approach to collection and processing recyclables
- Optimization of operations in collections and processing
- Following generally accepted principles for effective procurement and contract management



Appendix 1 Potential Markets

Sandblast Media

several sizes of sandblast media made from recycled post-consumer glass.

- No heavy metals.
- Bottle Glass Abrasives are superior to other Glass Abrasives
- Bottle Glass is harder and lower dusting than the plate glass used in most other competitors glass abrasives.

Landscaping Media

- gravel size glass aggregate
- safe to handle, safe to walk on, no sharp edges
- attractive (may be distributed at local compost days)
- will not degrade
- environmentally friendly
- suitable for septic drainage
- suitable for agricultural drainage
- can replace biodegradable mulch

- The company reports that there is an emerging market for organic farm produce mulch because superior drainage reduces rot in fruit and deters crawling insects resulting in greater crop yields.

Play Sand

- manufactured sand
- free of all health hazards associated with natural sand
- permanent landscaping mulch that never fades or needs replacing
- unique alternatives to traditional bark or gravel mulches
- many Arts & Crafts uses including terrariums, aquariums, flower arrangements, frame borders.
- driveways, parking lots, walkways, garden paths, fish ponds
- pavers sand, sandbox sand (Silica Free)
- aggregate mix in concrete counter tops, terrazzo tile
- non skid & reflective paint applications
- decorative fountain stone, birdbaths
- natural deterrent to slugs and snails

Additional products and applications are described in the promotional material provided by the supplier and attached to this report.

