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I.

Waste-Not Recycling

Disruptive Innovative Technology: Waste to Product in Colorado

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II. WORK PLAN

Deliverables & Key Activities	Completion Date	Comments <i>(if deliverable was not completed, please explain why and what progress has been made)</i>
The Contractor shall submit to the CDPHE Program Administrator a final design and process schematic of the equipment line. This will include any pertinent reports from the hired engineering firm.	March 2, 2015	
The Contractor shall submit to the CDPHE Program Administrator a summary report on plastic sources to be used in the manufacturing process.	June 5, 2015	
The Contractor shall submit to the CDPHE Program Administrator a market entry sales plan.	June 15, 2015	
The Contractor shall purchase and install all equipment necessary to implement the project no later than June 15, 2015.	June 30, 2015	All equipment has been purchased and is installed on site. Due to the complex nature of the project, getting all the various pieces of equipment operational has been challenging and will be ongoing until all functions are working and staff are fully trained.

III. PROJECT SUMMARY

1. Executive Summary

Colorado recyclers are struggling to find stable markets for 3 through 7 and mixed rigid plastics. Waste-Not's goal was to purchase and install the necessary equipment to turn that material into a product with a variety of applications. While the PIM (Powdered Injection Molding) process is a proven method and the project is worthy of much effort, it has come with a multitude of challenges. Some of the noteworthy challenges have included being able to work within a short timeframe and with limited space. Thanks to qualified engineers and responsive manufacturers, we have been able to overcome both of those obstacles while moving forward to our goal. Finalizing the orchestration of accepting post-consumer scrap plastic through the steps necessary to make a recycled-plastic panel has proven to be more challenging and time consuming.

Determining the best type of equipment to convey the granulated and ultimately powdered plastic through each piece of equipment has been an important reason for pause, research and testing. In order to ensure that the material will flow efficiently, material at different stages was tested. We also had the materials tested in a lab in the UK for characteristics and ability to be manufactured into a quality product (see Material Sourcing Report). Our new understanding of the characteristics of plastics and how they react to each other, to being heated as well as providing rigidity will allow us to blend a variety of types of plastic into the process. A known remaining challenge is the removal of metal and organics from the plastic stream as those materials will cause excessive wear on the equipment, especially to the pulverizer and may be detrimental to the manufacturing of the finished products.

Creating opportunities for recycled plastic to be manufactured into a product in Colorado will have a positive social, financial and environmental impact. We have met with local recyclers and tested materials from recycling companies including EcoCycle and Goodwill. We also tested many of our own materials. There are other recyclers who are looking forward to our ability to provide a home for materials that are otherwise destined for long-term storage or the landfill. Our process represents significant progress for the state of Colorado in terms of capacity to create local jobs from recycling, reduce the amount of materials being sent overseas for partial recycling and to landfills, while generating sales revenue from a new, environmentally friendly product being introduced into the United States.

2. Project Description & Overview of Work Completed

The project goal of providing an end-use market for recycling post-consumer plastics in Colorado is important for many reasons. Foremost, Coloradans generate the scrap plastics being used in production, and the ability to use this mixed plastic stream was not available anywhere in the region. While traveling in Europe to learn more about various recycling technologies, we discovered the patented PIM process and saw products made from this technology. Our desire to bring this technology to the U.S. was realized when the RREO funding was awarded. We have negotiated the license to the PIM technology through

Environmental Recycling Technologies. With ERT's support and the expertise of Kansas Green Technologies we purchased the equipment that will be used to pulverize, convey, blend, mold, trim and ultimately manufacture 4' x 8' panels made from 100% recycled plastic.

The project required a significant amount of design work to collaborate manufacturing of the process equipment with process requirements defined through the patented methods. Waste-not aligned with Kansas Green Technology to manufacture and supply the equipment to these specifications. KGT installed a complete turnkey system that includes multiple components for panel manufacturing as follows;

- Ribbon blending equipment - this equipment allows for multiple polymer blends to be adequately mixed with additives for panel mold application.
- Conveying equipment - multiple conveying points are installed to transfer plastic powders to mold application equipment, application to mold stacks, removal of the finished goods, and transfer to trim stations for final cutting.
- Robotic applicators - These machines are installed to provide accurate applications of mixed plastic powder to mold stacks. The application is critical to the formation of flat and consistent panel surface formation.
- Molds - the mold stacks are installed on carriage mechanisms that allow for continuous filling and panel extraction. The quality of the molds is critical in providing even melting of plastics to create high quality panels, and as such, represent a large investment in the process.
- Cartridge heating and cooling oven - The installed oven provides a closely controlled heating and cooling cycle critical to panel formation and polymer adhesion.
- Trim line - the final stage of panel production is edge trimming and flashing removal through the trim saw.
- Pulverizer - mixed plastics must be micronized before mixed polymer adhesion will effectively occur. The pulverizer represents the final step in particle reduction and material preparation for the panel line. This unit is stand-alone to produce multiple plastic mixes for the line.

We maintain that the objective to utilize post-consumer 3-7 plastics is still achievable but acknowledge a number of significant challenges we have encountered along the way. The most challenging issue identified to date is the significant amount of metal contamination that we have found in processed 3-7 plastics from local suppliers. Although many believe they have removed metal content from their bales our testing is showing that all sources still contain high levels of metal contaminants. It is important to note here that the contamination is not simple ferrous or aluminum pieces. Our testing is showing a number of hardened alloys that do not separate with magnetic or eddy current technologies.

We have divided our attack on this issue into several fronts to overcome the metal as follows;

- Ongoing discussions with suppliers about their true capabilities to remove metal and what can be done to provide metal free mixed plastics.
- Accelerated testing of 3-7 sources at the UK lab to ensure that clean sources could ultimately be used for panel production.
- Discussions with equipment engineers about potential metal separation technologies.

The accelerated board production testing has been exciting. Once the plastics are cleaned to an acceptable level of contaminants it appears that not only is panel production possible but 3-7 material will work well as a feedstock.

Another issue identified is a varying degree of organic contamination. The significance and resolution of this challenge is still being explored.

3. Summary of Results

Licensors continually approached by U.S. for 3-7 solutions. Our targeted research is moving both equipment manufacturers and material suppliers toward a solution that will bring steady supply and outlets for 3-7. The successful testing referred to above has produced quality test panels in expanded lab tests. The picture below is of an actual 3-7 test panel from production testing.

We have opened discussions with a number of potential end-users of the panels. One specialized use is the application of panels as an internal wall structure that utilizes physical characteristics of the panels such as noise reduction and plastic surface molding variations to enhance its value. We are actively pursuing testing and applications for using the panels either as is or upgraded with additional applications such as Kevlar, fiberglass or bamboo. One of our partners is currently working with Federal agencies, schools and at risk businesses to use the panels as a quick and simple retrofit enclosure with antiballistic capabilities.

There will be long term economic benefits to multiple stakeholders. Recyclers and waste generators who process plastic will have a local option for getting the material recycled. This will either reduce costs and or increase revenue streams for those entities. Consumers of panel products will have a new waterproof product that can be reused many times. Due to the nature of the plastic panels, they can be used in many new and existing applications. The sale of this new product will generate local and state sales and income taxes. It will also create new product opportunities such as making table or counter tops from recycled plastic that can then be sold to individual consumers. Additional jobs are created from both product manufacturing and sales.

Environmental benefits include keeping a resource out of the landfill and into the recycling or reuse cycle thus reducing the need for mining for new raw resources. By eliminating the need to make a product from raw resources, we save the energy needed to mine and transport the material, leave habitats intact for wildlife, farms or recreation and also reduce the energy needed to transform oil into plastic. Since we use the minimal amount of energy needed to

reform the plastic into a new product, we generate a panel that is made of 100% recycled material, that can be recycled again once it's useful life is ended, and reduces the overall need for energy consumption.

We have generated interest in the recycled panels from a variety of applications such as covering the walls in a horse arena, restroom dividers in large corporate facilities, to concrete forms and other applications in the construction industry as well as specialty carpenters who want to make tables or other products from the sheet material. With very limited exposure to media, we have surprisingly received calls of interest. Once we are fully operational we expect to kick off a campaign to let the region know about the product through advertisements, an open house and displaying the product as shows. A sample board is currently being tested by one of our potential buyers of the panels. She is testing it for ballistic and other strength characteristics. Once we are producing panels on a regular basis, we will also send the panel is for structural tests.

4. Summary of Unanticipated Outcomes or Roadblocks

Installing all the equipment in an already full recycling facility has been a huge challenge. Balancing the existing operational needs with the needs of the new manufacturing line has meant many discussions among all the impacted departments and employees had to be carefully considered. However being able to find a metal free stream of post-consumer plastic has surprisingly proven to be the most difficult. Even plastics that have been put through automated sorting lines with a follow-up hand sorting process contain unacceptable amounts of metal (an average of 16 lbs. /ton!) Metal cannot be sent through the pulverizing equipment without considerable risk of damage. This has caused numerous delays as we work to find ways to clean up the stream including float tank separation, conversations with consultants from the mining industry, and re-calibration of our own magnets, eddy current, etc. This obstacle has been one of the primary reasons for delay. Because we know that we must feed nearly 100% metal free material through the pulverizer we have had to run extensive testing into the levels of contamination and the physical options to extract this metal prior to equipment damage. We have identified a number of proven metal removal technologies that are available in the market. These solutions are very expensive which has prevented many sorting facilities from implementing them to remove metal contamination from baled 3-7. This was unanticipated and we do not feel that local sorting facilities will be interested or capable of implementing this technology.

We have identified a proven technology used in rotomolding manufacturing facilities that can detect small amounts of metal in a high speed flow. Once the metal is detected a gate opens and ejects a portion of the plastic stream to protect downstream equipment. This provides a last point of protection for our pulverizing equipment. Because our pulverizer is fed through a pneumatic vacuum system we will be able to utilize this technology and Waste-Not has ordered two of these metal detectors for installation in our conveying system. This will provide pulverizer protection but ultimately does not provide a complete solution for the metal contamination issue. If the detectors identify large quantities of metal contamination they simply stay open and all of the processed plastic is lost due to rejection. Additional testing of other technologies to separate metals are ongoing but the addition of the Sesotech

metal detectors will allow panel production with selected low-contamination plastic streams. Mixed 3-7 will require further processing upstream or at our facility for inclusion in these streams.

5. Communication of Project Findings

The Public Service Announcement generated by ERT surprisingly brought interest in the PIM process from a business owner in Estes Park. She had already been researching the PIM process and felt it will benefit her construction company. We have also received phone calls from numerous Colorado recyclers and communities who wish to market their materials to us once we are able to purchase in volume. We believe that once we are able to buy materials we will be inundated with interest. We are cautious about prematurely communicating our capabilities and know the importance of timing our marketing efforts to correlate with function. We have met with organizations such as Boulder County PACE (Partners for a Clean Environment), Vail Resorts and spoken to committees in Larimer and Weld counties all of which are awaiting the announcement that the project can now serve their communities or that products are available for purchase.

The licensor of the technology ERT is aligned with the international marketing group KREAB. KREAB and ERT have planned extensive marketing campaigns and announcements once we have a comfort level in our production capabilities.

Waste-Not also intends to reach out to a number of local publications to generate interviews and local excitement for the process once production levels are more predictable. We have had conversations with the Mayor of Loveland, City of Fort Collins staff and Larimer county officials who will be invited to an open house and tour of the operation once we are manufacturing panels.

6. Future Impact of the Project

Once we build a demand for the end product, we will have a very positive impact on recycling programs across the state as our ability to process plastics increases. We believe that this project represents the best hope for many plastics that will otherwise end up in landfills. Because we can utilize lower value plastics, we will be able to partner with other recyclers that can remove the more valuable materials to support their programs and businesses. We intend to work with other grant recipients to best serve each of our goals. The technology used in our process has already stimulated discussion on how to expand the capability and we are looking to develop additional applications. Downstream effects may include introducing the “take-back” concept to the construction industry as we will be able to regrind the panels to make new panels.

Waste-Not is determined to overcome the issues identified with mixed 3-7 plastics. The initial phase of the panel production line will consume over 2.5 million pounds of mixed plastics at full production. Additional jobs are being created through the manufacturing, sale, distribution, and management of the panel process. The panel line made possible through the RREO grant will also provide a manufacturing model that will be duplicated in other markets around the country as finished product demand grows.

7. Financial Summary

The following is a summary of funds spent to date. There will be significant additional matching funds spent once the entire manufacturing line is operational, all employees are hired, marketing efforts are underway and plastic is being purchased.

Description	Grant Funds Spent	Matching/In Kind Amount	Total Amount
Personnel Salaries	\$0.00	\$143,000.00	\$143,000.00
Fringe Benefits	\$0.00	\$29,500.00	\$29,500.00
Tuition/Fees	\$0.00	\$0.00	\$0.00
Travel Costs	\$0.00	\$16,000.00	\$16,000.00
Materials/Supplies/Equipment(under \$5000)	\$0.00	\$4,260.00	\$4,260.00
Equipment Purchases (over \$5000)	\$933,209.00	\$330,020.00	\$1,263,229.00
Contractors/Subcontractors	\$0.00	\$98,626.00	\$98,626.00
Consultants	\$0.00	\$150,000.00	\$150,000.00
Training/Education	\$0.00	\$0.00	\$0.00
Marketing/Advertising	\$0.00	\$0.00	\$0.00
Other Direct Costs	\$0.00	\$54,200.00	\$54,200.00
Indirect Costs	\$0.00	\$12,000.00	\$12,000.00
Total Project Cost:	\$933,209.00	\$837,606.00	\$1,770,815.00

8. Conclusion

We become increasingly more excited as we talk with clients, equipment suppliers, and potential users as well as with ERT, our UK licensor. Once fully operational we will be able to recycle mixed plastics into a very durable and needed product. The business expansion and economic potential is relatively limitless.

Our enthusiasm for the process is only hampered by the fact that metal contaminants in mixed plastics remains a challenge.

9. Appendix

- a. Grant Metrics Table
- b. Community Leader Contact Information
- c. EcoSheet Flyer
- d. EcoSheet Specifications (Will need updated with our specifics once in production.)

Appendix A: Grant Metrics Table

Date project fully operational:

January-16

Based on deliverables. Provide the month during which the grant project increased diversion/created jobs/increased number of customers.

Diversion Rates:

Choose one material per blue box from the drop-down menu provided. If your material is not listed, enter a description in the "Other" box. Only list materials diverted as a direct result of the grant project. Must be listed in tons. See tab labeled "Conversion Tables" if needed.

Material Diverted #1	Plastics (#1-7)
"Other" Material:	7-Mar
Tons Diverted	
July-15	6000
August-15	
September-15	
October-15	
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	6000

Material Diverted #2	Plastics (#1-7)
"Other" Material:	HDPE
Tons Diverted	
July-15	
August-15	
September-15	1000
October-15	1000
November-15	1500
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	3500

Material Diverted #3	Plastics (#1-7)
"Other" Material:	Polystyrene
Tons Diverted	
July-15	1500
August-15	2500
September-15	2500
October-15	4000
November-15	4000
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	14500

Material Diverted #4	Plastics (#1-7)
"Other" Material:	LDPE
Tons Diverted	
July-15	500
August-15	500
September-15	1000
October-15	1000
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	3000

Material Diverted #5	
"Other" Material:	
Tons Diverted	
July-15	
August-15	
September-15	
October-15	
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	0

Material Diverted #6	
"Other" Material:	
Tons Diverted	
July-15	
August-15	
September-15	
October-15	
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	0

Material Diverted #7	
"Other" Material:	
Tons Diverted	
July-15	
August-15	
September-15	
October-15	
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	0

Material Diverted #8	
"Other" Material:	
Tons Diverted	
July-15	
August-15	
September-15	
October-15	
November-15	
December-15	
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Total	0

End use of diverted materials:
Describe where materials are going (e.g. MRF, new products, reuse)

Plastic will be manufactured into a flat sheet product.

Number of Permanent Jobs Created:
Include full-time & part time paid positions.
1 FTE = 40 Hours Per Week

3

Type of Permanent Job(s) Created:
Provide titles of jobs created

While we have not yet worked through all the aspects of getting the entire line functioning, we have hired a machine operator to work with the engineers to learn how to operate the manufacturing line. Additionally we have hired two recycling techs to begin learning how to sort and run the grinding line, operate a forklift and to ship and receive materials.

Average Salaries of Jobs Created:
Average of all jobs created

\$30,001 - \$40,000

Average Monthly Customers:
Estimate or refer to customer list

Avg. Monthly Amount	
July-15	
August-15	
September-15	
October-15	
November-15	
December-15	1
January-16	
February-16	
March-16	
April-16	
May-16	
June-16	
Avg / FY 15	1

Appendix B Community Leaders Contact Information

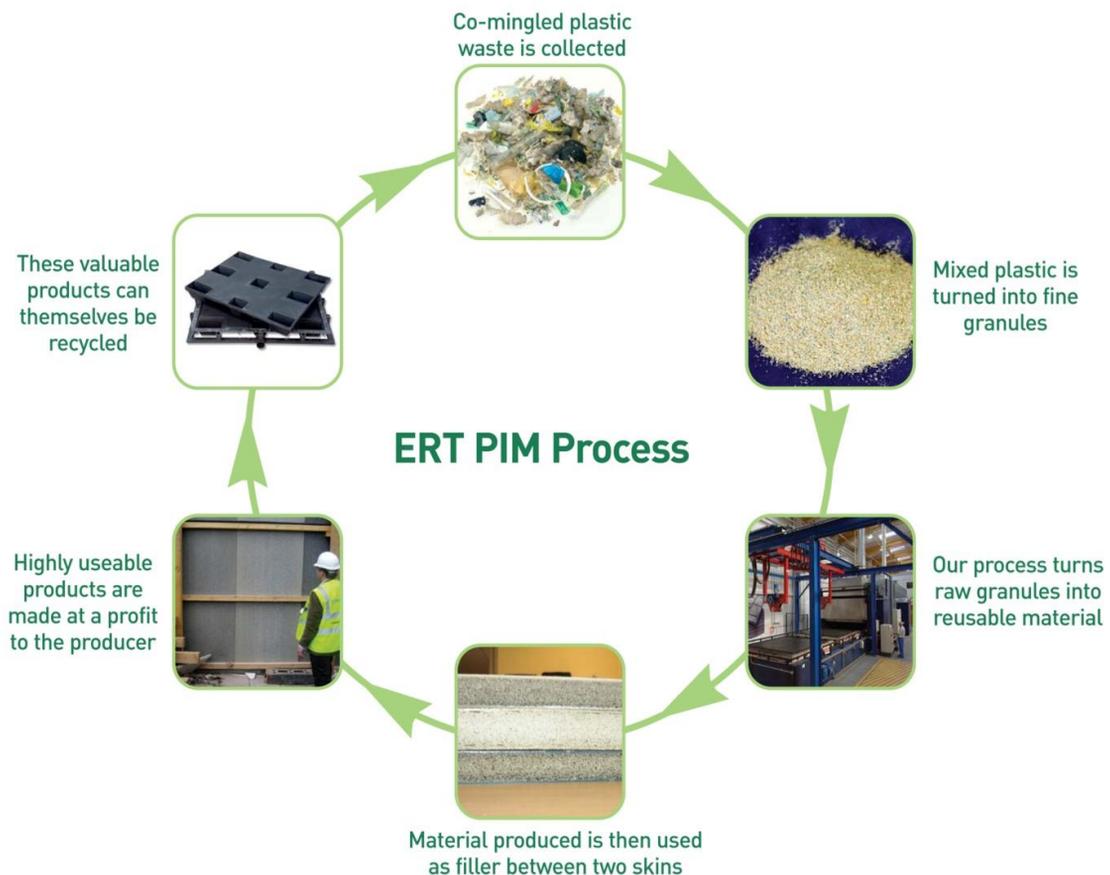
- i. Cecil Gutierrez, Mayor, City of Loveland, (970) 619-0025, mayor@cityofloveland.org.
- ii. Susan Gordon, Senior Environmental Planner, City of Fort Collins (970) 221-6265. sgordan@FCgov.com
- iii. Nick Ampe, Environmental Health Specialist , New Belgium Brewing (970) 443-7110, Nampe@newbelgium.com
- iv. Phil Brewer, Environmental Specialist III, Weld County Department of Public Health and Environment, (970) 356-4000 x 2227, pbrewer@co.weld.co.us

Additional contacts include Avago Technologies who is interested in using the panels as dividers in restroom facilities and Medtronics (formerly Covidien in Boulder) expressed interest in purchasing panels that contain their recycled plastic.

THE SOLUTION TO MIXED PLASTICS WASTE



- Waste-Not is partnering with ERT who owns the worldwide intellectual property rights to a novel plastics processing technology called **Powder Impression Moulding**, or “**PIM**” process
- PIM’s uniqueness is the ability to convert **un-sorted, mixed plastic waste** and other material into a saleable product
- This means PIM can use material no one else can economically use but which otherwise would still go to landfill or incineration



Revolutionising the use of recycled plastics

WHY WASTE-NOT ?

Waste-Not Recycling through partnership with ERT UK has the U.S. licensing right to use PIM, a unique breakthrough plastics recycling technology capable of utilizing mixed plastics waste which cannot be used in conventional plastic recycling processes. PIM is –

- **Lucrative:** PIM eliminates expensive and impractical plastics sorting from the plastics recycling process, creating opportunities to manufacture highly profitable alternatives to a huge range of plastics applications from very inexpensive raw materials (mixed plastics waste)
- **Proven:** PIM is already demonstrably generating value for manufacturing companies that are using it to create viable, profitable products
- **Scalable:** Waste-Not will have a fully automated manufacturing process that can produce thousands of panels each month, satisfying the needs of even the largest projects.

BENEFITS OF THE ECOSHEET

- EcoSheet is an alternative to plywood which can be used in many different building and agricultural applications.
- The Waste-Not facility will utilize over 2 million pounds annually of mixed plastics to manufacture the sheets.
- The EcoSheet is waterproof, durable, won't splinter, provide sound and insulation qualities.



Courtesy of 2K Manufacturing Limited

For further information please contact us at -

Waste-Not Recycling
1065 Poplar Street
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P. (970) 669-9912
F. (970) 669-9926
E-mail: sales@waste-not.com
www.waste-not.com



Revolutionising the use of recycled plastics



Ecosheet Specification Sheet

Dimensions:	2,440mm x 1,220mm x 18mm, length +0/- 10mm, width +0/- 5mm, thickness +2.5/- 0.5mm
Weight	Approximately 33kg +/- 2kg
Density	605 kg/m ³
Flexural modulus	Approximately 700 MPa
Flexural stress	Approximately 8 MPa
Nail-pull force	Range: 300 - 400 N
Breaking failure	Approximately 800-950 N
Compression	Resistance 3MPa @ 10% deflection
Water resistance	Weatherproof and will not rot, but is not suitable for tanking
U Value	6.67 W/(m ² *K)
R Value	0.15 (m ² *K)/W
Compliance	Ecosheet complies with annex XIV: 38 SvHC compounds of REACH regulation 1907/2006/EC The product complies with smoke and toxicity according to BS 6853:1999: Annex B.2
Creep Resistance	Ecosheet shows good resistance to creep over time in internal trials at room temperature

Using Ecosheet

Wind resistance	In-house testing for site-hoarding applications indicate that Ecosheet can withstand Beaufort Scale 10 when supported on an appropriate 3 rail timber post and rail structure.
Water permeability	The closed cell structure makes Ecosheet completely waterproof. This means that there can be no water-induced swelling or structural deformation.



The recycled alternative to plywood

Release properties: In-house testing for pre-cast applications indicate that Ecosheet requires little or no release agents.

Load bearing Please discuss your application, fixings etc with us when using for horizontal load bearing.

Expansion gaps We recommend 3-4mm per metre to allow for thermal expansion when exposed to the sun.

Practical User Guides

Painting

Ecosheet has a paint ready face (the roughened dull side). This can be coated for external applications using either solvent-based or water-based paints. A good solvent wood primer/undercoat is applied first before top coating in Exterior Gloss, or a water-based primer, before a masonry paint.

Cutting

You can cut Ecosheet with a hand saw. For the best cutting, a laminate cutting saw is recommended. When using a circular saw we recommend TCT blades, as they cut well with minimal friction. We can recommend the DeWalt 1206 TCT and the Evolution Fury TCT blades. There is little or no breakout when using these saw blades. Ecosheet produces a plastic swarf when cut and needs no special breathing protection.

Drilling

Ecosheet drills well with HSS or wood drill-bits. Holes are best cut by wood spade cutters. Pilot holes are not needed. Ecosheet can be countersunk, although this is not usually needed with posi-screws which will sit neatly just below the surface.

Fillers

Wood fillers generally do not work with Ecosheet. Instead, we suggest Isopon P38 or Ultima Plastic Padding, which are basic epoxy fillers.

Routing

Ecosheet can be CNC routed, using a tungsten carbide head.

Profiling

Ecosheet can be profiled, although the structure of the panel means that the strength is in the skin and the core is foamed, and it will not give a smooth edge.

Laminating and Edging

High Pressure Laminates (HPL) can be bonded to the face using Bostik Aquaseal 29952. Ecosheet can be edge-banded with a plastic or wood edging.

Gluing

Wood glues don't work: we have tried and can confirm that Loctite 3038, Sikaflex 552, Stixall and CT1 grab adhesive will bond Ecosheet when used on the face. Evode Contact adhesive is also recommended.

Screwing

Self tapping posi-screws take and hold well without pilot holes. Screws fix well in Ecosheet as its elasticity means it stretches and then grips around the screw's thread.

Nailing



The recycled alternative to plywood

Round wires and ring shanks work well. Nail guns can be used when fixing Ecosheet board into timber, provided the gun is set to a suitably low pressure or 'flush' setting.

Laminating with films

Ecosheet can be PVC wrapped or laminated with 3M Controltac.

Food areas

The small pits in its surface make Ecosheet unsuitable for canteen table tops, food preparation surfaces and chopping boards.

Welding

Ecosheet is made from mixed polymers and cannot be welded, joints should be sealed with a waterproof PU adhesive.

Cleaning

A light wash with a hose should be sufficient to keep boards clean, if you do use a jet wash, turn the pressure down and keep nozzle at least 300mm from the board.

Oct 2012