CHELSEA CENTER FOR RECYCLING AND ECONOMIC DEVELOPMENT

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Determining the Best Formulation for a Unique Asphalt Cold Patch Product made with #3-7 Rigid Plastic Aggregate

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The Chelsea Center for Recycling and Economic Development, a part of the University of Massachusetts' Center for Environmentally Appropriate Materials, was created by the Commonwealth of Massachusetts in 1995 to create jobs, support recycling efforts, and help the economy and the environment by increasing the use of recyclables by manufacturers. The mission of the Chelsea Center is to develop an infrastructure for a sustainable materials economy in Massachusetts, where businesses will thrive that rely on locally discarded goods as their feedstock and that minimize pressure on the environment by reducing waste, pollution, dependence on virgin materials, and dependence on disposal facilities. Further information can be obtained by writing the Chelsea Center for Recycling and Economic Development, 180 Second Street, Chelsea, MA 02150.

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1.0 BACKGROUND

Conigliaro Industries provides Total Recycling Services to businesses, institutions and industries across New England. Conigliaro transports, shreds, grinds, densifies and bales all types of plastic, paper, metal, glass, textiles and wood.

Since its inception in 1990, Conigliaro Industries has grown from one to thirty-five employees and now operates a fleet of 9 trucks and 50 tractor-trailers. The firm owns and operates a fully permitted 88,000 square feet Material Recovery Facility in Framingham, MA. In its ninth year of operation, Conigliaro Industries serves 550 industrial, institutional and municipal customers.

Early in 1992, in an effort to diversify and vertically integrate, Conigliaro Industries began manufacturing products made from many of the materials collected from customer locations. The first product, "PolyCorn," is a packing "peanut" manufactured from 100% recycled, 92% post-consumer Polystyrene Foam, a #6 plastic. Since its debut, Conigliaro Industries has developed and now markets "Pink PolyCorn", a packing peanut manufactured from 100% recycled Polyethylene Foam, a #4 plastic or Polypropylene Foam, a #5 plastic. PolyCorn has been a recipient of the Governor's Packaging Challenge in the "Outstanding" Category on three occasions.

Design and development of the machines needed for these operations was accomplished by Conigliaro Industries' Vice President of Engineering, Anthony Conigliaro, holder of many U.S. Product and Process Patents.

As more and more "unique" #3 - 7 plastic material combinations were sent to Conigliaro Industries' lab for analysis, the decision was made internally to develop a viable market for these difficult materials. A processing line was developed and a company that manufactures asphalt products and recycles oily soils was contacted. At Conigliaro Industries' urging, they applied for and were granted several BUD's[1] for the inclusion of mixed plastics, #3 - 7, into their product line of asphalt matrix products, such as road bedding material and other cold mix products. Over the last several years, Conigliaro Industries has built the volume of processed #3 - 7 plastics sent to their facility to almost 100,000 pounds per month.

With the advent of the most recent technological revolution, the life span of most computers and electronics has shortened dramatically. Currently, for example, Conigliaro Industries has begun to receive and scrap 486 computers – computers that were state of the art just two years ago. In addition, the advent of High Definition Television (HDTV) and its imminent approval by the Federal Communications Commisssion, translates into enormous volumes of projected computer and electronic (C&E) scrap. This volume is expected to increase further with the Massachusetts Department of Environmental Protection's proposed CRT Landfill Ban. The expected influx of waste C&E materials will be further increased by the proposed shut down of analog TV signals in

1 Beneficial Use Determination, or BUD, is the assessment of the use of a previously used or "waste" material as an effective substitute for a commercial product or commodity.

favor of digital signals by the year 2005; this analog shut down essentially makes all older TV's and their associated housings completely obsolete.

As C&E scrap has increased over the last several years, dismantlers of C&E equipment have cropped up all over Massachusetts. These firms specialize in the dismantling and resale of computer and electronic components. As C&E scrap volume has increased, so has the number of associated plastic housings. Conigliaro Industries has provided these dismantlers with a plastic-housings endmarket, however, the infrastructure for handling the huge future volume of plastic is not in place at this time.

Perceiving an opportunity, Conigliaro Industries identified this huge volume of #3 - 7 plastic and petitioned the American Plastics Council (APC) for help in developing a viable, high volume processing line for this material. The APC agreed to grant to Conigliaro Industries $100,000 in processing equipment, including a 100 HP Herbold Granulator, an in-feed Conveyor, a Metal Detection System and an Aspiration/Dust Control System as well as the associated electrical controls. This equipment arrived at Conigliaro Industries in early September 1998. Conigliaro Industries provided in-house design services as well as paid for the shipping, rigging and installation of equipment and all electrical upgrades and hookups. As of fall 1999, the equipment was in place and running, producing in excess of 100 tons of high-grade mixed plastics aggregate per month.

Early in 1998, in an ongoing effort to vertically integrate, Conigliaro Industries began to seek additional end uses for the #3 - 7 plastic scrap. Initial emphasis was placed on the concept of using the plastic regrind as an integral part of a new product. The goal was to use plastic regrind in such a way that it enhanced the consistency and the performance of the new final product rather than just acting as an aggregate filler. The company wanted to develop a product where the plastic would not be "just along for the ride."

Cold Patch was identified as a viable product to achieve those basic goals. Cold Patch is an asphalt-like material used specifically to mend and/or patch large cracks and potholes in a paved area, not for minor surface repairs. Cold Patch is typically sold in bags or buckets, normally 20 - 90 pounds per unit. It is designed to be ready to use and simple to apply (i.e. pour, tamp and set). Most currently available cold patch products use standard aggregates such as rock, sand and asphalt emulsion.

With the APC grant in place for the initial processing equipment, Conigliaro petitioned for and received a Recycling Industries Reimbursement Credit (RIRC) Grant from the Department of Environmental Protection for $45,000. This money was used to develop the cold patch mixing system and to further upgrade the mixed plastics processing system.

At the same time Conigliaro petitioned the Chelsea Center For Recycling and Economic Development, of the University of Massachusetts, for a Product Development Grant to determine the best formulation for a unique asphalt cold patch product made with #3-7 rigid plastic aggregate.

Using this grant money, a concerted effort was put forth over a six-month period to develop a recipe for cold patch that would involve the use of plastics as an enhancement to the product. Several emulsion formulations were tried as well as various mixes of standard aggregates and plastic regrinds.

Many sample plugs were created and tested in a real world application as well as under extremely hot and cold conditions. This report outlines the results of those lab and real world tests and identifies the best Cold Patch Formulation.

2. THE BEST COLD PATCH FORMULATION

Thanks to this Product Development Grant Conigliaro has developed what it perceives to be an excellent Cold Patch Product with all of the correct specifications. The result - a Cold Patch with the following characteristics:

- May be used in any weather and stands up in severe weather conditions (hot, cold, wet)
- May be applied at a wide range of temperatures
- Patches large cracks and deep potholes, ruts and expansion joints
- Nothing to add
- No mixing required
- Lightweight
- Does not require sealing after it sets
- Quick curing
- After tamping and setup, results in a permanent repair
- Plastic regrind amounts to over 75% of product volume
- Addition of plastics #3 - 7 adds durability and flexibility for varied climates
- Immediate traffic over patch is allowable and in fact preferred to enhance initial compaction

3. PHASE ONE - LAB TESTING

This Product Development project involved the optimization of a recipe which usually consists of asphalt emulsion, sand (as a filler) and stone (as an aggregate). The main objective was to replace the stone aggregate with plastic aggregate made from ground #3-7 plastics. One of the main plastic feedstock materials, plastic computer and electronics housings (C&E plastics), are known as #7 (other).

There were three ingredients to work with; asphalt emulsion, sand, and plastics. However, before proceeding, the evaluation of two asphalt emulsion formulations was necessary. Both formulations were typical water-based paving emulsions, provided by Tri Ram Corporation, and coded “A” and “B”. Visual observation showed “A” to be more viscous than “B”. The emulsion was kept constant and varying amounts of sand “S” and plastic “P” were used. Numbers presented in the matrix below are parts by volume.

Note: To reduce the field of testing while trying to pick the emulsion of choice, only the **bolded** entries were tested.

1A 1S 1P	1A 2S 1P	1A 3S 1P	**1A 4S 1P**	1A 5S 1P
1A 6S 1P	**1A 7S 1P**	1A 8S 1P	1A 9S 1P	**1A 10S 1P**
1A 1S 1P	1A 1S 2P	1A 1S 3P	**1A 1S 4P**	1A 1S 5P
1A 1S 6P	**1A 1S 7P**	1A 1S 8P	1A 1S 9P	**1A 1S 10P**
1B 1S 1P	1B 2S 1P	1B 3S 1P	**1B 4S 1P**	1B 5S 1P
1B 6S 1P	**1B 7S 1P**	1B 8S 1P	1B 9S 1P	**1B 10S 1P**
1B 1S 1P	1B 1S 2P	1B 1S 3P	**1B 1S 4P**	1B 1S 5P
1B 1S 6P	**1B 1S 7P**	1B 1S 8P	1B 1S 9P	**1B 1S 10P**

Comparisons were made as to texture, coring time, hardness, ease of compacting and processing (i.e. "pumpability", "mixability", abrasion resistance and adhesion). All tests were internally developed. As a cold patch product, meant for the consumer market, the testing was not intended to meet highway standards. All tests were based on observation as well as comparison to two other competitive brands.

Phase One Results

The intent of Phase One was to pick the best emulsion formulation. All factors considered, it was felt that "B" emulsion had more favorable characteristics than "A," (i.e. ease of processing because of its lower viscosity, more rapid cure time, better texture and compacting). Although "B" cured to a harder consistency than "A," it was flexible enough for cold patch purposes.

Henceforth, the "B" emulsion was held constant at one part per volume, and the sand "S" and the plastic "P" were varied as follows:

1B 1S 1P	1B 1S 2P	1B 1S 3P	**1B 1S 4P**	1B 1S 5P
1B 1S 6P	**1B 1S 7P**	1B 1S 8P	1B 1S 9P	**1B 1S 10P**
1B 2S 1P	1B 2S 2P	1B 2S 3P	**1B 2S 4P**	1B 2S 5P
1B 2S 6P	**1B 2S 7P**	1B 2S 8P	1B 2S 9P	**1B 2S 10P**

Selected samples were made as indicated and compared using the same criteria as the "A" vs. "B" emulsion test. Again only the **bold** samples were tested. Because of the absorbing nature of the sand as well as the desire to use as much plastic aggregate as possible, sand volume was limited to two parts.

The first choice was 1B - 1S - 7P. Based on this, the following formulations were tested further.

1B 1S 5P 1B 1S 6P 1B 1S 7P 1B 1S 8P

The best three out of four were selected for field-testing. The plan was to have twenty test sites with three different test samples at each site. The final choices for field-testing were:

1B 1S 5P **1B 1S 6P** **1B 1S 7P**

4. PHASE TWO - FIELD TESTING

The three candidates listed above for final testing in the field were:

1B 1S 5P 1B 1S 6P 1B 1S 7P

Samples of each were placed at 20 different sites. Sites varied from low traffic (i.e. parking lots), to medium traffic (i.e. driveways) to heavy traffic (i.e. roadways). Patches were also made in wood, asphalt and cement sites.

At each site three potholes were selected. Each pothole was prepared - it was swept out, edges were trimmed and each hole was at least two inches deep. Cold patch candidate formulations were then poured into each pothole, and tamped using a standard handheld plate tamper for approximately one minute. Tamped potholes were then considered ready for traffic.

Phase Two Results

All twenty test sites have been through a winter, spring and summer. At this writing, it appears that all three final candidates were acceptable with no appreciable difference in performance. In all cases, color, appearance, compaction and ability to take sealer were essentially constant. (Photos in Appendix.)

One test site in Winter Park, Florida did not show favorable results due to the extreme summer heat. Further research showed this to be normal. Other cold patch companies actually develop different formulations for parts of the country with extreme temperatures. Conigliaro Industries intends to market cold patch in the Northeastern United States during the first several years. This is further supported by the fact that the new product can only be shipped cost effectively from Framingham to the Northeast. In the future, as the business expands to other parts of the country, additional manufacturing facilities and cold patch formulations will be necessary.

Based on the above test results and marketing considerations, Conigliaro determined that the best mix for practical purposes would be:

1B 1S 6P

By choosing this formulation, the final product will be manufactured within the range of 5P to 7P, allowing for slight manufacturing variations.

5. PLASTIC AGGREGATE

More should be said about the plastic aggregate portion of the cold patch mixture. The plastic aggregate used in this mixture is made from all types of rigid plastics #3 - 7. This mix includes PVC #3, LDPE #4, PP #5, PS #6 and Other #7 plastics. It was found that darker colors are preferable, although lighter colors actually help the patch look more like its surroundings, mimicking the look of normal “worn” asphalt which has stone aggregate showing through.

Examples of plastics used to make this portion of the mix included dirty flower pots, unmarked plastics, computer and electronic housings (housings normally contain ABS, PC, PVC and

combinations thereof).

6. MARKET DEVELOPMENT ACTIVITIES

At the same time as the field testing, market testing was also accomplished. Samples of cold patch in buckets were placed on sale at Monnick Supply, a local ServiStar® outlet in Framingham, Massachusetts. Customers found the lightweight of the cold patch mixture to be beneficial. Many customers later told the store's owner that the cold patch was easy to use, lightweight and worked very well. By this time the product's name had also been developed - "Boston's Best Patch."

On April 6, 1999 an American Plastics Council/DEP sponsored press event was held at the Framingham plant to show how three grants had helped Conigliaro Industries successfully launch this new process and product. The APC had provided $110,000 in processing equipment, the DEP RIRC grant provided $45,000 to develop further mixing equipment and further upgrade our processing system, and the Chelsea Center provided this $8,000 grant to develop the final product mix.

The press event resulted in nationwide, in fact worldwide, press showing the "computers to road" patch process. The concept of paving the highway with the information highway was played up heavily in many of these press reports. Press reports were seen in over one hundred print, TV and radio media outlets including CNN, Fox News, ABC, NBC, CBS, BBC, National Geographic, High Tech News, Boston Globe, Boston Herald and the Boston Business Journal to name just a few.

In addition, a pallet of cold patch (forty-eight 3.5 gallon buckets) was sent to four municipalities under the Massachusetts Operational Services Division's Pilot Purchasing Program for Recycled Content Products. Waltham, Holyoke, Groton and Great Barrington all received material in May 1999. Follow up calls to these four municipalities revealed, as of this writing, that the material was found to be very workable and effective.

Another customer, Guild Drilling of Rhode Island, was also identified. This company had seen the product on TV due to the April 6, 1999 press event. Guild Drilling performs core drilling along highways and in other asphalt paved areas. After first ordering a sample bucket, Guild Drilling has since ordered two more pallets of Boston's Best Patch and has found the product to work extremely well for patching drill holes. (Letter in Appendix)

Conigliaro Industries also worked to develop a method to deliver Boston's Best Patch to municipal customers in bulk. Bulk mixers were designed and built and at this writing two municipalities have received Boston's Best Patch by the cubic yard - the City of Cambridge and the Town of Natick. Test results were not available as of the writing of this report. Initial comments have centered upon how the DPW workers like this product better than others due to its light weight and workability.

In order to introduce the product to the market place in a more formal fashion, Conigliaro

Industries hired Big East Green during the summer of 1999. This firm, run by Richard Aleo, specializes in marketing green products. Under Mr. Aleo's direction, Conigliaro Industries has developed marketing materials, including product labels, a UPC symbol and information booklets to show potential retail customers. Big East Green is currently in the process of marketing Boston's Best Patch to regional hardware and building supply retailers. This marketing process will take place throughout the fall and winter of 1999 resulting in orders for product during the next "cold patch season," the spring of 2000.

Finally, Conigliaro Industries has worked closely with Plastican, a manufacturer of plastic buckets to develop the final artwork, bucket, handle and lid. These buckets are due to arrive at the Framingham facility by November 1999, at which time Conigliaro will begin manufacturing Boston's Best Patch in volume. The buckets are black, contain post-industrial recycled content, and will have a green lid.

7. CONCLUSION

Working in partnership, Conigliaro Industries, the American Plastics Council, the Department of Environmental Protection and the Chelsea Center for Recycling and Economic Development have completed the start to finish development of a new product, Boston's Best Patch. Specifically, the Chelsea Center's Product Development Grant allowed Conigliaro Industries to develop the final product formulation as outlined in this report.

This product is made from the optimal mix of asphalt emulsion, sand and recycled plastic aggregate - 1B - 1S - 6P. Per the original goal, the following mixture is being manufactured:

	By Volume	**By Weight**
Asphalt Emulsion	12.5%	9.9 % or 2.85 lbs/bucket
Sand/Standard Aggregate	12.5%	17.3% or 5 lbs/bucket
Plastic Aggregate	75%	72.8% or 21 lbs/bucket

The formulations were developed as pothole fillers, and as such, the depth of the hole must be at least two inches. The size of the hole can vary within reason, up to about 5' x 5', if the depth is there. One bucket, which comes complete with use instructions, should fill a hole of approximately ½ cubic foot or 3" x 2' x 1'.

This formulation has been tested at twenty sites across New England and Florida, by many retail customers, a drilling company, and two large municipalities. Findings indicate that these initial customers have enjoyed favorable results using Boston's Best Patch.

Thanks to equipment expansions made possible by the APC and DEP grants, Conigliaro Industries is now producing over 100 tons of mixed plastic aggregate per month. This aggregate is then diverted to Conigliaro Industries' cold patch manufacturing line, allowing production in excess of 10,000 buckets of cold patch per month. Initial analyses have shown that Conigliaro Industries can cost-effectively produce Boston's Best Patch while remaining cost-competitive with other cold patch products currently on the market. This, combined with the lighter weight

and recycled-content, puts Boston's Best Patch in a position to grab market share in the Northeastern United States.

All told, players involved in this project have expended in excess of $375,000 to develop this process from start to finish. The product formulation has been determined. The lab and field tests have been completed. The name has been picked. Initial customer tests have proven successful using Boston's Best Patch. Full-scale marketing efforts are now in full swing as the final packaging is developed. Boston's Best Patch will hit retail shelves and municipalities in bulk during March 2000 - just in time for the next big cold patch buying season.