**M.L. 2015 Project Abstract**
For the Period Ending June 30, 2018

**PROJECT TITLE:** Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste
**PROJECT MANAGER:** Victor Krause
**AFFILIATION:** University of Minnesota Duluth, Natural Resources Research Institute
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**FUNDING SOURCE:** Environment and Natural Resources Trust Fund
**LEGAL CITATION:** M.L. 2015, Chp. 76, Sec. 2, Subd. 07c; M.L. 2017, Chapter 96, Section 2, Subdivision 18

**APPROPRIATION AMOUNT: $155,000**
**AMOUNT SPENT: $155,000**
**AMOUNT REMAINING: $0**

**Overall Project Outcome and Results**

NRRI partnered with Better Futures MN and Northwest Indian Community Development Center to promote building deconstruction as an alternative to demolition. Deconstruction is the systematic disassembly of a building, with the purpose of recovering materials for reuse or manufacturing into new products. This partnership hopes to bring awareness to Minnesotans that building deconstruction is a reliable way to manage our natural resources used for construction, and reduce the environmental impact and costs associated with disposal of demolition wastes.

NRRI activities during the project period:

1) Assisted with the development of safe, cost-effective methods for the removal of materials to retain maximum value of items harvested. As an aid to the partners, a final report was generated by NRRI that covers a list of potential end uses for materials and suggests some methods for determining value for the various materials that were harvested during the project period.
2) Provided training to participants from Better Futures and NWICDC to select quality materials, practice safety in the wood shop, build indoor/outdoor benches, and suggested methods to determine value of the items built. Participants learned additional skills to make themselves more marketable to future employers.
3) Assisted with the promotion of building deconstruction across the state of Minnesota by participating in the assembly and presentation of several case studies with examples of the benefits of deconstruction; shared the case studies during meetings with county officials, at regional Green Building meetings, and at two conventions in Minneapolis and Duluth.
4) Provided input to Ecotone Partners, who developed a tool for calculating yield and environmental impact of materials harvested from deconstruction. Reports produced using the tool provide information on greenhouse gas reduction, energy savings, reduced landfill use, and materials reused.

**Project Results Use and Dissemination**

Over the course of the project, NRRI was consistently promoting deconstruction and material reuse by engaging the public during public tours at our facility in Duluth. A display was constructed from

harvested materials that highlighted the value and the environmental impact of diverting materials from the landfill and reusing or converting them into usable commodities. NRRI engaged others through the use of social media to promote activities that the partners were involved with. Media events connected to specific projects in St. Louis County helped to showcase the positive impact offered through deconstruction by highlighting local job creation, landfill diversion, and the lack of material recycling and reuse in greater Minnesota.

# Environment and Natural Resources Trust Fund (ENRTF)
# M.L. 2015 Work Plan

**Date of Report: 9/07/18**

**Date of Next Status Update Report: NA**

**Date of Work Plan Approval: 6/11/2015**

**Project Completion Date: 6/30/2018**

**Does this submission include an amendment request? NO**

**PROJECT TITLE: Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste**


**Project Manager:** Victor Krause

**Organization:** University of Minnesota Duluth, Natural Resources Research Institute

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**Location: Twin Cities Metropolitan Area, North Central Minnesota, Duluth**

| **Total ENRTF Project Budget:** | | |
|---|---|---|
| | **ENRTF Appropriation:** | **$155,000** |
| | **Amount Spent:** | **$155,000** |
| | **Balance:** | **$0** |

**Legal Citation:** M.L. 2015, Chp. 76, Sec. 2, Subd. 07c
M.L. 2017, Chapter 96, Section 2, Subdivision 18

**Appropriation Language:**
(c) Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste
$845,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with Better Futures Minnesota in cooperation with the Northwest Indian Opportunities Industrialization Center and $155,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota Duluth for the Natural Resources Research Institute to develop and test a model for implementing building deconstruction and material reuse as a competitive alternative to demolition for the purpose of reducing greenhouse gas emissions, reducing landfill waste, and providing job training.

Carryforward (a) The availability of the appropriations for the following projects are extended to June 30, 2018: (7) Laws 2015, chapter 76, section 2, subdivision 7, paragraph (c), Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste.

**I. PROJECT TITLE:** Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste

**II. PROJECT STATEMENT:** This project will establish deconstruction as an alternative to demolition and develop viable techniques for reducing greenhouse gas emissions and the amount of reusable building materials buried in landfills. The U.S. EPA estimates that construction and demolition debris is the second-largest component of our waste stream, just behind municipal solid waste. Only 20-30 percent of this waste is recycled. One goal for this project is to deconstruct at least 30 buildings over a two-year period. We estimate that the environmental impact of this effort is projected to: reduce carbon dioxide (CO2) emissions by 900 metric tons, reduce the emission of methane gas ($CH_4$) by 45 tons, conserve the equivalent of 6,400 MMBTUs of energy, and divert 2,600 tons of building material from landfills.

As summarized by The Institute for Local Self-Reliance, deconstruction is the systematic disassembly of a building, with the purpose of recovering valuable materials for reuse or manufacturing into new products. By reducing waste, deconstruction also reduces greenhouse gas emissions and abates the need for new landfills and incinerators. It helps to steer the construction and demolition industry towards sustainability and reuse. It reduces the industry's consumption of virgin materials, helps preserve natural resources, and protects the environment from pollution related to extraction, processing, and disposal of raw materials.

The goals for this project are to: (1) test and fully develop effective techniques and incentives for deconstructing buildings; (2) develop and build value-added products and sustainable markets for the range of reusable materials recovered; and (3) document the environmental, social, and economic benefits of deconstruction, including reduced greenhouse gas emissions, reduced landfill use, and the reuse of natural resources. These goals will be achieved by: (1) developing efficient techniques for deconstructing buildings safely; (2) promoting deconstruction as alternative to demolition and establishing a marketplace for reclaimed materials; (3) creating and manufacturing products made from reclaimed materials; and (4) calculating the environmental impact of this project and deconstruction work.

This endeavor is a partnership between Better Futures Minnesota (Minneapolis), the Northwest Indian Community Development Center (NWICDC) (Bemidji), and the Natural Resources Research Institute (NRRI) at the University of Minnesota Duluth. To advance this project and achieve the outcomes outlined in the work plan, the partners intend to meet monthly via conference call and hold face-to-face meetings each quarter.

Better Futures will: serve as the project manager; take the lead on testing and refining efficient techniques for taking apart buildings; take the lead on educating Tribal, local, county and state government agencies about the practice and benefits of deconstruction and work with these entities to implement incentives, policies, and practices that promote deconstruction as an environmentally beneficial alternative to demolition; deconstruct up to 20 uninhabitable properties in various states of condition; and work with the NRRI to develop and test products that can be manufactured from reclaimed materials. $503,397 of the ENRTF appropriation is allocated to cover Better Futures' projected expenses.

The NWICDC will: help test and inform the development of efficient techniques for taking apart buildings in north central Minnesota; hire, train, and supervise NWICDC crew chief and workers; work with Tribal, State, county, and local agencies to implement incentives, policies, and practices that promote deconstruction as an environmentally beneficial alternative to demolition; and deconstruct up to 10 uninhabitable properties in various states of condition. $341,603 of the ENRTF appropriation is allocated to cover Northwest Indian OIC's projected expenses.

The NRRI will: inform the development of techniques that maximize the quality and quantity of materials harvested from buildings that are in various states of condition and assess the value, quality, and quantity of materials harvested; identify or develop a tool for calculating the yield and environmental impact of materials

harvested from buildings, including reduced greenhouse gas emissions, energy savings, reduced landfill use, and the reuse of natural resources; and build prototypes and test products that can be manufactured from reclaimed materials. $155,000 of the ENRTF appropriation is being appropriated directly to NRRI to cover its projected expenses.

**III. OVERALL PROJECT STATUS UPDATES:**

**Project Status as of 12/31/2015:** NRRI staff that have been involved thus far have primarily been researching the environmental impact portions of this project including literature search and conversations with environmental leaders about how to calculate the environmental impacts of deconstruction to include air and water impacts. Visits to deconstruction sites have led to discussions with Better Futures and NWICDC team leaders about issues faced on the job sites that make it difficult to harvest specific materials during deconstruction. Assessing materials harvested during deconstruction has begun, as the first few locations have been started and finished over the past few months. NRRI has also been discussing deconstruction with Mr. Tim Roman from Ecotone Partners GBC, Inc. (Ecotone) to develop a better understanding of the practices of deconstruction, what methods are currently in use, what other organizations in other parts of the country are doing in the area of deconstruction, and where we can assist Better Futures and NWICDC to improve on current activities. A search was started to evaluate popular products that are made from reclaimed materials. A variety of possibilities for manufacturing products have been discussed with Better Futures and NWICDC team leaders. Examples of a few products were recently shared with Better Futures and NWICDC.

**Project Status as of 06/30/2016:** NRRI staff continue efforts to find alternative uses for materials harvested from deconstruction, and Ecotone continues to assist Better Futures and NWICDC to collect and develop inventories of their materials. An idea to create a garden bench patterned after a design, credited to conservationist Aldo Leopold, has been developed as an educational tool. The benches serve multiple purposes: an educational tool to inform the purchasers about the efforts of Better Futures and NWICDC to divert deconstruction materials from the landfill, to draw awareness to deconstruction as an alternative to demolition, and to create a new, higher-value use for harvested materials. Alternative uses for drywall, stucco, and insulation are being investigated. Opportunities to co-present information about deconstruction as an alternative are continually sought out, focusing on associations that can assist in moving public policy and informing the general public about the benefits of deconstruction. Together, Ecotone and NRRI staff have also continued to assess how to incorporate air and water quality impacts from diverted materials and to better understand the environmental effects of all materials being diverted.

**Project Status as of 12/31/2016:** NRRI staff members have been assisting both partners to better understand the value of the materials they are harvesting. Harvested materials are those that are taken out of a structure during deconstruction that are reusable/resalable. Value-added products that can be made from deconstruction waste streams and harvested materials were investigated, and a few of the ideas generated are being developed for Better Futures and NWICDC to share the ideas with potential markets. NRRI staff also participated with the partners to train participants to construct different types of furniture from the harvested materials. NRRI staff members have also worked with Ecotone to identify deconstruction materials, assemble environmental impact reports for the partners, and review other important metrics to complete the environmental impacts reporting.

**Project Status as of 06/30/2017:** NRRI staff identified the species types from samples of harvested materials. Our team is developing an affordable method to process drywall materials into a variety of sizes that might make them useable by various industries and a potential product for our project partners. We continue to investigate other deconstruction businesses around the US to develop a better understanding of how harvested materials are valued and what materials are being repurposed. Presentations about the project are scheduled for July and October to connect with professionals in transportation and building industries.

**Project Status as of 12/31/2017:** NRRI staff hosted a training session for NWICDC to demonstrate assembly of two benches made from dimensional lumber harvested from deconstruction jobs. To demonstrate the value of

deconstruction versus demolition to the region, the partnership met with planners from St Louis County, MN to develop a plan to deconstruct uninhabitable buildings in that county. Better Futures and NRRI teamed up for a presentation at the annual meeting for the Transportation Research Board held in Duluth, MN in July. Additional work was done to develop a marketable product made from clean drywall harvested during deconstruction. Plans to trial the developed products are being set for spring of 2018. A tool was developed to be used during the deconstruction process that will allow team leaders to track labor, materials, and environmental impact.

**Amendment Requested by NRRI: 8/16/2018**

NRRI is requesting an amendment to the budget retroactive to February 1, 2018. NRRI would like to shift dollars originally allocated for equipment/tools/supplies, travel, and other expenses to cover salaries and fringe and a deconstruction training session with a national organization. The reasons for the requested budget amendment are as follows:

- NRRI experienced staffing changes in August 2017 and April 2018, and all remaining tasks were absorbed by staff members who were already involved with the project. Additionally, promotions and salary increases for staff involved in the project caused some of the initial individual estimated needs to be low.
- Initial travel estimates were high, as NRRI was often used as a mid-state meeting location for project managers to gather and discuss results and plan for other activities.
- Overestimating for equipment, tools, and supplies as well as expenses needed for shipping samples, testing services, and commercial grinding of wood materials left a surplus in those areas for Activities 1, 2, and 3.

1) NRRI requests to shift $2,858 to Activity 1 to cover changes in personnel and cover fees for a deconstruction training conference attended by two NRRI staff members April 30 – May 3, 2018. The funds would be shifted from travel and other in Activity 1 and also partially from equipment, travel, and other in Activity 3. The new total budget for Activity 1 would be $21,684.
2) NRRI would like to shift $2,290 to Activity 2 to balance travel associated with this activity and to cover changes in personnel. The funds would be shifted from travel and other in Activity 2 and also partially from equipment, travel, and other in Activities 3 and 4. The new total budget for Activity 2 would be $28,949.
3) NRRI requests to shift funds from Activity 3 to cover changes in personnel in Activities 1 and 2. The new total budget for activity 3 would be $65,962.
4) NRRI requests to shift funds from Activity 4 to cover changes in personnel in Activities 1 and 2. The new total budget for Activity 4 would be $38,405.

Amendment Approved: [**08/31/2018**]

**Overall Project Outcomes and Results 8/16/2018:**

NRRI prepared a final report discussing wood and other materials harvested from deconstruction jobs. The report covers a list of potential end uses for materials and suggests some methods for determining value for the various materials that were harvested during the project period. NRRI participated with Better Futures and NWICDC to present information at various meetings, seminars, poster sessions, and media events. An overview of deconstruction and the environmental impact we were trying to accomplish through the partnership was discussed and displayed. NRRI visited and trained participants from Better Futures and NWICDC to select quality materials, practice safety in the wood shop, build indoor/outdoor benches, and provide some suggestion how to determine value of the items the built. NRRI provided input to Ecotone, who developed a tool for calculating yield and environmental impact of materials harvested from deconstruction. Reports produced using the tool provide information on greenhouse gas reduction, energy savings, reduced landfill use, and materials reused. Case studies with examples of the benefits of deconstruction were developed and shared during meetings with officials in Hennepin and St. Louis County, at the Transportation Resources Board convention in Duluth, and at an architect's convention in Minneapolis. NRRI organized a media event in St. Louis County with Better Futures

and NWICDC to introduce deconstruction as an alternative to demolition, demonstrate successful training of local labor, and encourage reuse of materials harvested during the demonstration.

**IV. PROJECT ACTIVITIES AND OUTCOMES:**

**ACTIVITY 1: Develop efficient techniques for deconstructing tribal, publically owned, or uninhabitable buildings safely.**

**Description:**
One key strategy for making deconstruction a cost-effective alternative to demolition is demonstrating viable, safe techniques for dismantling a building. In addition, as proponents of deconstruction, the partners must document the yield, value, and quality of the materials diverted. Accordingly, the tasks and outcomes in this area of activity are aimed at testing and refining techniques for maximizing the yield, quality, and value of material diverted from landfills either through recycling or reuse. The objective of maximizing yield and value of material diverted must be balanced with the cost of time and labor required to meet this objective.

As outlined in their work plan, Better Futures and the NWICDCwill take apart in a methodical manner at least 30 Tribal, publically-owned, or uninhabitable buildings that are in various stages of condition (i.e., fully intact to partially damaged). These projects will be used to continuously refine deconstruction and material processing techniques during the course of this project. Better Futures and NWICDC will also use the practical experience from these projects to develop and refine protocols that help workers maximize the yield, quality, and value of material harvested from each building. A related task is that partners will test a range of techniques for processing the material harvested to achieve the greatest value from recycling or reuse.

**UMD NRRI Work Plan Activities**
NRRI will be helping Better Futures and NWICDC with assessing the value, quality, and quantity of materials harvested. Specifically, this includes identifying the materials that are collected during deconstruction and assessing their quality. For wood materials, this would include identifying information about the wood species, the visual grade, and the quantity of materials collected. Further, other important material information would be generated, including quantities of other building and construction materials collected. An assessment will be conducted to validate value options for these materials based on published information, data collected from other national deconstruction companies, and other third-party sources. Ecotone will participate in this activity under a contract for professional service. He has significant experience in deconstruction.

**Summary Budget Information for Activity 1:**

**ENRTF Budget: $21,684**
**Amount Spent: $21,684**
**Balance: $ 0**

| Outcome | Completion Date |
|---|---|
| 1. NRRI will develop a final report that will provide information on the quality, grade, and value of the wood materials and other deconstruction materials based on information collected during the activity. This will include a range of values based on grades, potential end uses, and other factors such as wood species and customer feedback. | June 30, 2018 |

**Project Status as of 12/31/2015:**
Much of the current wood material that has been harvested from deconstruction projects thus far is lumber manufactured in the past 50-75 years. The materials are primarily spruce, pine, and fir species. Some of the larger pieces of lumber that are clear and have no through holes hold better value than small-dimension lumber. Better Futures has attempted to harvest dimension lumber in as close to full installed length as possible to retain as much value as possible. These materials are suitable for reuse as small building projects where grade

stamping is not required or in craft and trade projects to build items such as table tops, furniture, or other projects where framing is required.

NRRI staff visited work sites with Better Futures and NWICDC. Numerous issues encountered while deconstructing were discussed. From one discussion, NRRI plans to research options for a tool or method to speed up the removal of solid wood subflooring which will allow Better Futures and NWICDC to have more time to harvest longer, larger, and more-valuable pieces of lumber used for flooring joists.

During the site visits NRRI staff also discussed with Better Futures and NWICDC project coordinators issues to be addressed such as improving techniques for harvesting specific types of materials, values of certain types of materials, issues faced on the job sites that might prevent more valuable materials from been harvested in a timely manner, and non-harvested items that have potential value.

**Project Status as of 06/30/2016:** Better Futures and NWICDC are continuing to harvest primarily lumber manufactured in the past 50-75 years. Higher-value materials such as oak flooring and architectural trim are desired in the marketplace but offer challenges for removal. NRRI continues to search for more efficient methods of removing higher-valued materials with as little damage as possible. Flooring and its support structures offer specific challenges to the teams that improved techniques and proper tooling will surely improve. NRRI staff suggested a new tool for de-nailing harvested materials to Better Futures and NWICCDC. NWICDC invested in the suggested equipment and found it shortens handling time and improves the end appearance and can be used during downtime right on the job site.

Ecotone has worked with Better Futures and NWICDC to collect and inventory the following materials: reclaimed materials by type and weight, recycled concrete by weight, on-site source-separated materials for recycling by type and weight, off-site separated materials for recycling by type and weight, Alternative Daily Cover by weight, and direct landfill by weight.

An assessment is being conducted to look at uses of harvested materials by other national deconstruction companies around the US. Examples of alternative uses for traditionally difficult-to-reuse materials like stucco and fiber insulation are being targeted.

**Project Status as of 12/31/2016:** NRRI assisted both partners, Better Futures and NWICDC, to identify the most valuable materials in their deconstruction projects and improve the way these materials are removed during deconstruction. Identification of older materials that yield higher returns was explained to both partners. NRRI also stressed the importance of care while removing these materials from job sites, as the older materials tend to be easy to damage, which reduces their value. Ecotone assisted with gathering data and assembling it into a spreadsheet to help Better Futures and NWICDC to better quantify labor hours, materials, and fair market value of reclaimed materials. NRRI staff assisted in species identification for reclaimed wood materials so that they could be properly marketed. A nationwide (state-by-state) review of deconstruction policies is in the early stages.

**Project Status as of 06/30/2017:** NRRI scientists received samples from deconstruction materials to identify the wood species and suggest potential specialty uses if the wood species were particularly suited for them. The hardwood species identified were: red oak trim, basswood lumber, ash lumber, maple trim and flooring, and teak trim. The hardwood materials are primarily suited for interior use in furniture and craft applications. The softwood species identified were: red pine lumber and boards, white pine boards, hemlock boards and trim, Douglas fir lumber, and as acceptable for use in interior and some exterior applications provided either the design of the object or finishing was appropriate for outdoor use. NRRI staff is assembling a board for Better Futures and NWICDC to use in their warehouse space to assist them with wood identification and valuation.

**Project Status as of 12/31/2017:** NRRI staff members have been working with the partners to find recycling centers outside of the metro area that will recycle materials harvested during deconstruction rather than just

place them into a landfill. This has proven difficult due to the lack of demand for such materials in greater Minnesota. The Labor Effort tool was developed with the partners' input to allow the job managers to estimate materials, labor, and environmental impact for each deconstruction job. The tool covers everything from tracking materials harvested, tracking labor effort used to harvest materials, transportation, support staff, sales, and connects everything involved to its environmental impact using the EPA WARM model.

**Final Report Summary: 8/16/2018**
Over the course of the project, NRRI staff assisted Better Futures and NWICDC to become more efficient at deconstructing structures by suggesting proven methods from nationally known deconstruction organizations. NRRI team members researched and introduced new tools that helped to improve material yield, preserve quality, and speed up processes like de-nailing wood. NRRI team members also tried to develop alternative uses for materials that are typically difficult to reuse. A few ideas for drywall were generated; line marking chalk for ball fields, soil amendments, and animal litter were investigated but found to require significant additional research to provide a marketable product.

NRRI prepared a final report for each partner that discussed the various materials harvested during deconstruction activities. The report summarized quality of materials and discussed the value based on local markets and compared to other deconstruction/salvage practices across the US. The report was added as an attachment to the final report summary. NRRI staff finished a display board for each cooperator to use in their resale centers that identifies a variety of softwood and hardwood samples commonly found in deconstruction projects. The boards will assist the cooperators to identify wood types and help them to sort and place value based on wood species. NRRI staff participated in deconstruction manager training with Better Futures and NWICDC to broaden the understanding of job site safety, techniques used to harvest materials, and maintaining value in the materials they harvest.

**ACTIVITY 2: Promote deconstruction as a sustainable alternative to demolition and a establish a marketplace for reusing materials harvested from projects**

**Description:**
Another key strategy for making deconstruction a viable alternative to demolition is to introduce the value and benefits of deconstruction to a range of people in the community: homeowners, contractors, demolition companies, architects, Tribal, local, county and state government officials, and consumers. This effort to educate the community and public officials will consist of two objectives: promote the practice of deconstruction as a viable, cost-effective alternative to demolition and increase awareness about the value and uses for materials harvested from buildings. A combination of information, promotion, and practical demonstrations are expected to generate a trend toward making deconstruction a common practice. In addition, these efforts are expected to increase the amount and types of materials being recycled and reused by consumers, contractors, architects, and government agencies.

As outlined in the Better Futures work plan, the key activities in this area will consist of studying strategies and incentives used by public agencies across the country to promote the practice of deconstruction. In addition, we will study the practices of deconstruction and reuse organizations nationwide to determine their methods for promoting deconstruction and fostering a demand for reclaimed building materials. This scan of practices nationwide will help inform the partners' efforts in Minnesota. Specifically, Better Futures and the NWICDC will develop briefing materials outlining the "why, what, and how" of deconstruction, including a primer on the environmental benefits of this practice compared to demolition. A strategy for promoting deconstruction within key sectors (homeowners, contractors, architects, demolition companies, and public agency officials) will be developed and implemented. Briefing materials will be tailored for each of these audiences. Outreach tactics will include presentations at home improvement shows and conventions sponsored by architects and builders. We will also host seminars and offer presentations for local, county, Tribal, and state government officials, focusing on those officials with responsibility for issuing demolition permits and increasing waste recycling rates. The goal of this education and promotion effort is to increase the practice of building deconstruction statewide. In

addition, we will work with local, county, and state officials to adopt incentives for deconstruction such as reduced permit fees and/or diversion goals for projects.

**UMD NRRI Work Plan Activities**

NRRI will provide support to the Better Futures and NWOIC in this activity. Specifically, NRRI will identify information on products, quality, and performance of materials that come from deconstruction. We will participate in the study of other deconstruction and reuse organization and support the modification of practices to support this effort in Minnesota. NRRI will develop and present information on these aspects in support of the education and promotion efforts outlined in the Better Futures work plan. This will include information about the environmental benefits and range of potential uses for reclaimed materials will be prepared. This information will be promoted and accessible via each partner's website.

**Summary Budget Information for Activity 2:**

**ENRTF Budget: $28,949**
**Amount Spent: $28,949**
**Balance: $0**

| Outcome | Completion Date |
|---|---|
| 1. NRRI will participate in meetings with Tribal, local, county, and state officials to support the practice of deconstruction and information regarding its environmental benefits. NRRI will provide information for and participate in information and education information booths and seminars at home improvement shows and trade conventions for architects, contractors, and demolition companies. NRRI will also participate in continuing education sessions regarding the practice and benefits of deconstruction and the reuse of materials are hosted by the partners. Architects and contractors are the prime audience for these sessions. | June 30, 2018 |

**Project Status as of 12/31/2015:**

NRRI staff has had little action in this activity thus far but have begun to identify what products are being harvested by the Better Futures and NWICDC teams with the intent of comparing them to materials that other deconstruction organizations are harvesting during for the purpose of manufacturing items or selling the materials for reuse.

**Project Status as of 06/30/2016:** NRRI developed a plan for Better Futures and NWICDC to construct garden bench kits and offer them for sale to groups such as state parks, environmental learning centers, or greenhouses that would then hold classes on bench building. During the class, information about the two organizations would be shared as well as the benefits of deconstruction and the diversion of the harvested materials from landfills. A number of locations were approached and showed interest in holding classes.

NRRI contacted True North Certified on behalf of Better Futures and NWICDC to determine the potential for their harvested lumber to be FSC certified "reclaimed" under the True North certificate. The application process and fee structure were discussed during a manager meeting in May, and Better Futures planned to follow up with True North Certified. NRRI continues to seek and inform Better Futures and NWICDC of association gatherings, public events, and conventions where the attending audience would benefit from hearing about the practice of deconstruction as an alternative to demolition.

**Project Status as of 12/31/2016:** NRRI staff members have made presentations to various groups including local chapters of the US Green Building Council and Northern Minnesota Young Entrepreneurs during their visits to our institute. NRRI staff explained the benefits of deconstruction, showcased potential reuses for materials harvested, and explained the importance of deconstruction to the environment. Future presentations are being developed to share with continuing education groups. Literature that explains the environmental benefits of deconstruction was drafted to accompany any products manufactured by Better Futures and NWICDC. NRRI

staff also attended several events and brought deconstruction into the conversation with architects, engineers, city planners, and environmentalists. Events included the North East Lunch and Learn: Designing for a Post Carbon Economy sponsored by LHB Architects in Duluth, Building Green Conference in Duluth, MN, and the Go Green Event for the US Green Building Council regional chapter. During breakout sessions, NRRI staff had time to discuss possibilities for designing future organizational structures for deconstruction at lifecycle end and incorporating reusable harvested materials in new construction. Connections were made with city planners and other officials to discuss potential for support for deconstruction and reuse as a desired practice over demolition and landfill. NRRI also showcased our involvement with each partner on our Twitter and Facebook feeds.

**Project Status as of 06/30/2017:** NRRI staff presented "Environmental Stewardship of Used Building Materials: The Benefits of Deconstruction and Reuse" to the University for Seniors in February. Participants provided feedback on how deconstruction in Minnesota might be expanded from its current localized groups in Minneapolis and Bemidji. NRRI attended a meeting with St. Louis County, MN officials, Better Futures and NWICDC to discuss a pilot deconstruction project with the partners involving county-owned properties.

**Project Status as of 12/31/2017:** NRRI assisted the partners to present "Environmental Stewardship of Used Building Materials: The Benefits of Deconstruction and Reuse" to the Transportation Research Board. The connection between the transportation industry and deconstruction practice was highlighted as a potential introduction to utilize materials harvested from deconstruction in transportation-related projects. Better Futures, NWICDC, and NRRI staff met with St. Louis County officials to discuss a potential partnership for deconstructing county-owned structures that were deemed uninhabitable. The county offered a list of structures that fit the rules for the current LCCMR grant, and Better Futures and NWICDC toured potential sites for a pilot project. As these projects get underway, NRRI has connected with local media to promote deconstruction as an alternative to demolition. NRRI has also contacted local facilities that are capable of recycling or reusing materials harvested from deconstruction that cannot be sold as is for reuse.

**Final Report Summary 8/16/2018:**
NRRI staff assisted Better Futures and NWICDC to promote building deconstruction as a more environmentally friendly alternative to demolition by participating in person or through Ecotone to present and display case studies, environmental and economic benefits, and discuss alternative uses for harvested materials with numerous groups.

NRRI promoted a pilot deconstruction project in St. Louis County in northern Minnesota along with Better Futures and NWICDC to bring awareness about the practice of deconstruction and diversion of the harvested materials from landfill to northern Minnesota. Materials harvested during the pilot were marketed to local crafters, homeowners, and other wood product users via word of mouth, social media, local news outlets including radio and television, and University of Minnesota organizational newsletters. A media day event was held at one of the deconstruction sites in St. Louis County to give media a first-hand look at the work being performed, the materials that were being made available for reuse, and to discuss the partnerships needed to succeed.

**ACTIVITY: 3 Create and test higher value uses for reclaimed materials; develop markets for products made from reclaimed building materials**

**Description:**
**UMD NRRI Work Plan Activities**
NRRI will identify and test potential products that can be manufactured from reclaimed materials. Specifically, efforts will focus on the deconstruction materials and their grade/yield identified during Activity 1 of this project. This may include: hardwood and softwood construction lumber, plywood, and other wood construction panels, concrete, porcelain, glass, interior furnishings like hardwood lumber, and cabinetry. This may include support for reselling the raw materials as deconstructed or using them as a feedstock for new products such as

furniture, cabinetry, flooring, landscaping products, or others. An effort will be made to determine suitable product options that can be processed from wood materials not suitable as solid wood, such as wood mulch.

Prototype samples will be produced, and in cooperation with Better Futures and NWICDC they will be presented to potential customers or specifiers in order to gauge realistic market expectations. Performance testing of these products will be conducted.

NRRI will work with Better Futures and Northwest OIC staff to assess the economic market options for these products and work to develop manufacturing processes, standards, specifications, and equipment needed to build products. NRRI will also offer advice to Better Futures and Northwest OIC staff as they prepare for and begin manufacturing products.

**Summary Budget Information for Activity 3:**

**ENRTF Budget: $65,962**
**Amount Spent: $65,962**
**Balance: $0**

| Outcome | Completion Date |
|---|---|
| 1. NRRI will utilize reclaimed deconstruction wood materials to create at least three new products such as end tables, conference tables, and counter tops. Further ideas and prototypes will be generated based on other materials generated during deconstruction. | June 30, 2018 |
| 2. Provide support to Better Futures and NWOIC to assess manufacturing and fabrication equipment and production costs for the products developed. | June 30, 2018 |
| 3. Provide information to Better Futures and NWOIC on the specification of production equipment, techniques, and standards required for the products. | June 30, 2018 |

**Project Status as of 12/31/2015:**
The main focus of this activity is to find higher-value uses for wood materials. Potential products that have been explored include tabletops/countertops for commercial and residential use, small tables, shed buildings, furniture, and decorative accent items. A set of prototype tables made by NRRI is currently being used by Better Futures to assess interest and value. NWICDC has expressed interest in NRRI processing some of their materials so that simple decorative items can be assembled with minimal tools and effort. The possibility of harvesting wood materials in panel form so that they can be reused in kits for residential storage sheds and containers has been discussed and will continue to be developed.

NRRI has also discussed with Better Futures some uses for non-wood materials that are also available from deconstruction such as drywall, insulation, and porcelain. Better Futures and NWICDC currently have no use for any of these materials. Potential uses for each type of material have been demonstrated, are being researched, or can be improved upon to allow Better Futures and NWICDC to achieve their goals of diverting materials from landfills.

**Project Status as of 06/30/2016:** Over the past six months, NRRI has developed a number of prototypes for BF and NWICDC to use as test pieces to judge market response. NRRI staff assisted BF and NWICDC with participant training and construction of prototype pieces as well as education on business practice for marketing higher-value goods made from harvested materials. On site at Better Futures, NRRI staff trained six participants in careful selection of quality materials and construction techniques to produce garden benches. Participants were then able to produce additional benches as well as modify the designs to create additional products of similar design. Ecotone and NRRI are planning to include the estimated impact per unit for the new design of the Leopold benches in the form of a chart that shows per-bench impact and the implications for 100 units and 1,000 units.

Additional ideas are being evaluated for materials other than wood. NRRI is researching uses for products made from drywall, and a few are currently being evaluated in small groups for feedback.

**Project Status as of 12/31/2016:** Additional products discovered by NRRI during 2016 are being constructed by Better Futures and NWICDC for resale. Both partners have asked NRRI to find reuse ideas for 2-by-4-inch dimension lumber. A few ideas were discovered and demonstrated to Better Futures and NWICDC that utilize this material exclusively. Three bench designs were prototyped and presented to the partners: one garden bench, one park style bench, and one utility bench or stool. Each partner has begun construction of quantities for sale of at least one of the bench designs. They have also begun showing them to potential end users, including storefront shop owners for use in front of their retail space, and also to community organizers for possible use in public areas, and listing and selling them via their onsite resale and online stores.

Attention was also paid to materials other than dimension lumber that could potentially be reused by Better Futures and NWICDC to construct higher-valued items for sale. This list included items like plumbing and other hardware removed from structures. NRRI suggested that these materials can be combined with harvested wood to produce simple tables and shelving.

The effort to develop alternative uses for commonly landfilled materials like drywall and stucco are continuing. NRRI has partnered with a local installer to obtain quantities of these materials for evaluation of processing into a few predetermined products. Mini case studies have been drawn up to evaluate the products as sufficient quantities are produced. NRRI will then assist the partners to market these products to potential wholesalers or end users.

**Project Status as of 06/30/2017:** NRRI acquired drywall from a deconstruction project and is determining a simple, cost-effective way for Better Futures and NWICDC to process this material into a manageable size for use as a soil amendment, line marking material, animal bedding, or litter product.

A heavyweight bench design was found, and prototypes are being developed. The new style has potential for use as an interior or exterior bench for public and private use. NRRI staff also provided advice and training materials to both groups to assist with producing and assembling the benches from materials they harvested during deconstruction jobs.

**Project Status as of 12/31/2017:** NRRI staff traveled to NWICDC in Bemidji, MN to host a two-day training session with participants. NRRI staff provided a short course on wood shop safety and an assessment of the available equipment at NWICDC, suggesting layout changes. NRRI staff also assisted in building two bench-building jigs to improve quality and efficiency of manufacturing the two types of benches made from lumber harvested from deconstruction projects. One of each type of bench was built by NRRI staff and participants for the demonstration. NRRI staff assessed other materials that are difficult for NWICDC to move, sell, or reuse as they are harvested, including hardwood flooring, siding materials, sheet goods, and doors. NRRI is pursuing local outlets for harvested materials to promote reuse during the St. Louis County pilot.

**Final Report Summary: 8/16/2018**
NRRI researched ideas to utilize materials harvested during deconstruction. Three bench designs were chosen as candidates to teach Better Futures and NWICDC participants to construct products made with the materials they had harvested. Better Futures and NWICDC teams met with NRRI staff to discuss value, material selection, safety, and product development. The team built a number of benches patterned after a design credited to Aldo Leopold, the Leopold Bench. An instruction manual for constructing the benches is included with the final report summary. Two additional bench types were presented, and training was provided to the NWICDC team. Prototype benches were built at the NWICDC shop. NRRI staff also researched alternative uses for difficult-to-recycle materials such as insulation and drywall. While some initial ideas were generated, all of the ideas require research and additional funding to further develop into a market-ready product that could be sold.

NRRI staff provided instruction to Better Futures and NWICDC participants on safe wood shop practices, setting up a space for building products made from reclaimed materials and valuing the products that were produced. At each location, equipment and space was assessed for adequacy. Suggestions were made to the leadership of each organization to improve safety and quality of the equipment being used. Participants in the two-day training events were taught safe, proper use of tools, how to select quality materials for production from those harvested during deconstruction, and a method for determining value of end products. NRRI staff developed additional prototypes for each organization to have as display pieces at their facilities.

**ACTIVITY 4: Calculate the environmental impact of this project and deconstruction work.**

**Description:**
**UMD NRRI Work Plan Activities**
It is critical to document and report greenhouse gas (GHG) emission reductions from different materials management practices associated with building deconstruction. Further, the team will work to develop information documenting that the reductions of the total material removed from the project site was recycled, salvaged, or otherwise diverted from a landfill or incinerator.

The NRRI team will assess the current models being used by Better Futures, including several calculators from the US Environmental Protection Agency (EPA). A detailed review of other models, calculators, and formulas will be investigated during the project from private organizations and state and federal agencies. This will include the determination of proper reporting metrics and appropriate environmental benefits. Adaptation and modification of these models will be pursued in order to develop models that accurately reflect the reality of the deconstruction strategy and techniques utilized by Better Futures and NWOIC.

This model will then be used to track and assess the deconstruction projects completed by Better Futures and NWOIC during this project. Individual and cumulative tallies will be completed and reported annually. Several case study examples will be identified and reported. Finally, the NRRI will develop a presentation outlining the results during at least one environmental/green building conference during the project period. Mr. Tim Roman from Ecotone will participate in this activity under a contract for professional service. He has significant experience in deconstruction and assessment of environmental benefits associated with deconstruction.

**Summary Budget Information for Activity 4:**

**ENRTF Budget: $38,405**
**Amount Spent: $38,405**
**Balance: $ 0**

| Outcome | Completion Date |
|---|---|
| 1. Identify/modify or develop a tool for calculating the yield and environmental impact of materials harvested from buildings, including reduced greenhouse gas emissions, energy savings, reduced landfill use, and the reuse of natural resources. | June 30, 2018 |
| 2. Develop several case study examples of environmental impact of building deconstruction and make a presentation at an environmental/green building event in Minnesota. | June 30, 2018 |

**Project Status as of 12/31/2015:**
In cooperation with Ecotone, NRRI staff began researching considerations needed to add air and water impacts to the Environmental Assessment tool that are being used by Better Futures and NWICDC during their deconstruction projects. NRRI focused on naming and calculating air quality and health impacts for each ton of material diverted from landfills. We also focused on naming and calculating air and water impacts that occur at the job site during the deconstruction process. An effort is also being made to evaluate social impacts that deconstruction has on the people in the neighborhood, community, state, and region.

A network of researchers is continually being developed to assist us as we research adding air and water impacts. These include engineers, water resource professionals, researchers, and landfill specialists. A literature review of current relevant air and water research/data was initiated and will continue over the course of this project to maintain up-to-date information.

An assessment of currently available models employed to calculate the impacts of diverting materials from landfills is continuing as additional models are found during literature searches or are brought forth by cooperators of this project.

**Project Status as of 06/30/2016:** NRRI continues to focus efforts to provide clarity–specifically, how air and water quality are impacted by the materials being diverted. A partial literature review was presented to the group at a face-to-face managers' meeting in May. Preliminary research shows three distinct categories of impacts for deconstruction: environmental (reduction of GHG emissions, reduced demand on natural resources and waste); economic (salvage and labor rates are some limiting factors, reclaimed old growth source of superior lumber); social (job creation, workforce development). Top barriers to deconstruction in the literature are: not understanding the process (education), available markets, and the cost of labor. Big six environmental impact categories: acidification potential (originate from sulphur dioxide emissions; eutrophic potential (originates from nitrogen and phosphorus); global warming potential (index); ozone depletion potential (ozone breakdown); ozone creation (ground level ozone or smog); and primary energy use (energy embodied in natural resources). The literature review highlighted a lack of air quality assessments in deconstruction.

**Project Status as of 12/31/2016:** NRRI, with its partner Ecotone, continues work on the environmental impact reports, quantifying the material reclaimed and its EPA WARM Model proxy category. The reuse and/or recycling impact of reclaimed materials based on weight were completed for the project partners. Ecotone has completed eight of the reports thus far. A discussion was started to develop a presentation for the results of the environmental impacts comparing and contrasting deconstruction (from actual data) with demolition. Various organizational events and conferences are being targeted as potential places to present the material. The annual Architects Association conventions, as well as regional architectural/building conferences, are on the list.

**Project Status as of 06/30/2017:**

NRRI, with Ecotone, produced one environmental impact statement for this project during the reporting period. Additional work was done preparing and submitting a proposal to present for the fall Green Building Conference in Duluth, MN this October.

**Project Status as of 12/31/2017:** NRRI and Ecotone prepared three environmental impact statements for this project period. The three projects diverted a total of 94 tons of material from the landfill. Materials that were harvested and sold for reuse included lumber from the structures and trim and goods from the structures' interior. Concrete, metal, and asphalt were recycled when the facilities were available to do so. Literature searches continued to find helpful data on environmental impact of building materials found in the common residential home. This information will help to fine tune the environmental assessment process we are currently using.

**Final Report Summary: 8/16/2018**
The database that Ecotone Analytics built to quantify the impact of the LCCMR pilot was based on previous work done with Better Futures Minnesota and the Minnesota Pollution Control Agency, with guidance from Hank Fisher at MPCA.

***EPA WARM Model - Calculating the value of reuse and recycling***
The database uses the EPA Waste Reduction Model (WARM), which is a library/dataset-based lifecycle assessment (LCA) of the energy use and GHG emissions of over 50 different material types, from "aluminum cans" to "mixed metals" to "wood flooring," for example. These lifecycle assessments are the amount of GHGs and energy each item saves by recycling or reusing the materials vs. putting them in a landfill. The deconstruction calculations use two important fields from the EPA data set: recycling emissions calculations and "source reduction" emissions calculations. "Source reduction" is the theoretical elimination of "one additional manufactured item" that is accounted for by the reuse of a reclaimed home good item, beyond what would be its normal lifecycle. The items reclaimed for reuse by NWICDC and BFM would have otherwise gone to landfill. By reclaiming and reselling the items, the customer has eliminated the purchase of a new item made from virgin materials. These two fields, therefore, contain the GHG emissions savings from recycling and reuse.

***Proxies - Mapping all the reclaimed material to categories***
Because there are a large or infinite number of materials that can be found in homes versus the 50 typical types of materials in the lifecycle assessments, EPA has provided guidelines for using "proxies" for the actual materials found in homes. For example, the GHG emissions and energy embodied in the production of "wood flooring" (basically, dimensional lumber with additional manufacturing and transportation energy added to route, cut, and package it as flooring) can be used as a proxy for other types of wood materials that have been "worked" into balusters, stair treads, trim, etc. For this reason, "worked" wood items have a higher GHG and embodied energy savings as a replacement for virgin materials vs. dimensional lumber (-2.02 Metric Tons of Co2 emissions per ton vs. -4.05 MTCO2e for wood flooring). The EPA provides a guide for choosing these proxies along with the WARM data set. We used the proxies to guide the categorization of all of the reclaimed and recycled materials in this project, and that is reflected in the dataset and calculator.

***Weights and Median Weights***
For the first year of the project, Better Futures Minnesota and NWICDC were actually weighing almost every item that came into the warehouse with an industrial scale. With staff turnover and a physical move to a new warehouse, material weights began to be estimated based on past experience, and in some cases material weight data was missing from the harvested material reports. For this reason, we aggregated all of the historical data to date (c. Sept 2017) and began to classify reclaimed goods by "family" (all toilets, for example, or all cabinets), and we found the median weight for materials in these categories. The median toilet, for example, weighs 93 pounds. This saves labor effort and inventory friction as materials are received into the warehouse.

***EPA Greenhouse Gas (GHG) Equivalencies***

In order to make the GHG savings more understandable by lay audiences, the EPA also provides an "emissions equivalences" calculator/dataset. Landfill gas is composed of approximately 50% methane and the rest CO2 and other volatile organic compounds. Each of these different gasses has a "global warming potential." Methane, for example, is much worse for global warming than CO2, but the calculations are performed and all emissions are normalized as a quantity of CO2 emissions. One metric ton of CO2 emission are equivalent to approximately 30 cubic meters of volume at sea level…of invisible gas! This can be hard to communicate and conceptualize for just about everyone, so EPA provides a dataset and calculator that "translates" these emissions into common equivalencies that can be more easily understood: homes' energy use in one year, for example, or the emissions from a certain number of cars in one year, or the number of tree seedlings grown for ten years in urban areas that would be needed to "sequester" this amount of carbon. If that is still hard to comprehend, imagine this scenario: a tree seedling begins to convert CO2 to energy and it grows. It holds that carbon in its material (the tree is made of carbon, right?); if you were to burn that tree at some point, you would be left with a pile of carbon–this is equal to the amount of carbon the tree is able to "sequester" and keep out of the atmosphere. That is the science behind the embodiment of the carbon in the plant material and how the calculator is able to give an estimate of the amount of carbon that is kept out of the atmosphere, expressed in "trees saved," for example.

Several case studies that offered examples of environmental impact of building deconstruction were reviewed and used to assemble presentations at city and county board meetings, a conference for architects in Minneapolis, a local MN Building Green Conference held in Duluth, and a national transportation event in Duluth.

**V. DISSEMINATION:**

**Description:**
**UMD NRRI Work Plan Activities**
As noted in the work plan, the NRRI will provide support to Better Futures and NWOIC in the preparation of marketing materials that promote the practice and multiple benefits of building deconstruction. These materials will focus on informing homeowners, architects, contractors, Tribal governments, and government agencies (with a focus on north central Minnesota and the Twin Cities). The partners also intend to identify key gatherings such as trade shows, industry conventions, and the State Fair to promote the practice of deconstruction and the reuse of used materials. NRRI will participate in these events to help demonstrate the positive reuse of building deconstruction materials and the environmental and economic impacts of the project activities. NRRI will also feature regular updates about the purpose and status of this project through its website (www.nrri.umn.edu), newsletters (NRRI Now), and social media presence.

**Project Status as of 12/31/2015:**
NRRI has suggested a few opportunities that might ae of interest for this project: 1) attendance of some or all participants (Better Futures, NWICDC and NRRI) at the AIA Minnesota Annual Architects Convention and Exposition; and 2) attendance, and possibly presentation, at a state Green Building Council event or a local GBC meeting to tell the story of deconstruction and material reuse. Plans for 2016 will be discussed during the January project meeting.

**Project Status as of 06/30/2016:** Networking events presented by the US Green Building Council have been suggested as a potential location for meeting others interested in moving practice and policy of deconstruction in a forward direction. Earth Day events were thought to be a likely target, though few had formal gatherings where tabletop ideas could be presented.

Future events to target include: MN AIA Convention, home improvement expos, building products expos, the MN Recycling Association Conference, local Green Building Council events, and Tribal events.

**Project Status as of 12/31/2016:** NRRI staff attended regional US Green Building Council events and local architectural conferences. At each event, deconstruction as an alternative to demolition was discussed with attendees including architects, designers, engineers, city officials, and business owners. NRRI's partner ECOTONE was proxy for NRRI at a CISRR Association of Recycling in Minnesota (ARM) meeting with Better Futures in Hennepin County. A presentation discussed deconstruction and the environmental benefits.

**Project Status as of 06/30/2017:** NRRI staff presented "Environmental Stewardship of Used Building Materials: The Benefits of Deconstruction and Reuse" to the University for Seniors in February 2017. The partnership of Better Futures, NWICDC, and NRRI met with and discussed the possibility of a pilot event in northern Minnesota with St. Louis County. The meeting proposed working with the county to deconstruct a number of county-owned properties that could qualify for deconstruction under this project. The pilot continues to move forward with a potential start date in fall of 2017.

**Project Status as of 12/31/2017:** NRRI staff partnered with Better Futures to present an overview of deconstruction at the annual Transportation Research Board conference. Connections were made within the transportation industry and public agency representatives that attended who expressed interest in the material and environmental benefits of deconstruction. NRRI has contacted local media outlets in greater Minnesota to promote the practice of deconstruction during the pilot partnership being developed with St. Louis County. NRRI continues to promote the partners' efforts to bring awareness to the benefits of deconstruction such as material reuse and diversion from landfills through participation at association and social engagements and by using social networking and other news media outlets.

**Final Report Summary: 8/16/2018** NRRI staff and Ecotone assisted Better Futures and NWICDC to present deconstruction and material reuse as a more environmentally friendly alternative to demolition and landfilling at a number of events across Minnesota including Building Green Conferences, architects conferences, educational events, public displays at the Minnesota State Fair, and at the NRRI facility. NRRI promoted events and activities through its social media outlets as well as local media in northern Minnesota. NRRI arranged a media event to introduce deconstruction to St. Louis County, MN and greater Minnesota by showcasing a pilot partnership with St. Louis County. The event was attended by local television and print media, and additional interviews were given on local radio and other print during the following weeks as the message was picked up by other media outlets.

**VI. PROJECT BUDGET SUMMARY:**

**A. ENRTF Budget Overview:**

| Budget Category | $ Amount | Overview Explanation |
|---|---|---|
| Personnel: | $ 129,509 | PI, Scientist 1 (V. Krause): $43,697 (79.2% salary, 20.8% benefits), 30% FTE for 2 years<br><br>Scientist 2 (S. Johnson): $13,318 (79.2% salary, 20.8% benefits), 10% FTE for 2 years<br><br>Coordinator (T. Hagen): ): $11,409 (74.7% salary, 25.3% benefits), 5% FTE for 2 years<br><br>Junior Scientist (R. Hueffmeier): $17,894 (79.2% salary, 20.8% benefits), 20% FTE for 2 years<br><br>Technician (R. Vatalaro): $27,813 (79.2% salary, 20.8% benefits), 18% FTE for 2 years<br><br>Undergraduate student (1 student): $10,739 (100% salary 0.0% fringe), 19% FTE for 2 years |
| Professional/Technical/Service Contracts: | $22,300 | Consultant, Ecotone Partners GBC, Inc. will assist with the development of a tool for calculating the yield and environmental impact of materials harvested from buildings, including reduced greenhouse gas emissions, energy savings, reduced landfill use, and the reuse of natural resources. |
| Equipment/Tools/Supplies: | $847 | General woodworking supplies, saw blades, adhesives, wood finishes, cutting bits, stains, hardware. |
| Travel Expenses in MN: | $2,100 | Travel to Minneapolis and Bemidji area for project activities associated with deconstruction of buildings. Mileage: $2,565 (10 trips to MSP, 5 to Bemidji); Lodging: $1,240 (20 nights); and Meals: $960 (20 days) |
| Other: | $244 | Shipping of samples and prototypes, Laboratory testing of energy content of wood samples, Grinding of wood materials that are not usable in sold form by a commercial wood grinding company. |
| **TOTAL ENRTF BUDGET:** | **$155,000** | |
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| | | |
| | | |

**Explanation of Use of Classified Staff:**

**Explanation of Capital Expenditures Greater Than $5,000:**

**Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:** 2.0

**Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:** 0.30

**B. Other Funds: NA**

| Source of Funds | $ Amount Proposed | $ Amount Spent | Use of Other Funds |
|---|---|---|---|
| **Non-state** | $ NA | $ NA | |
| | | | |
| **State** | $ NA | $ NA | |
| | | | |
| **TOTAL OTHER FUNDS:** | **$ NA** | **$ NA** | |

**VII. PROJECT STRATEGY:**

**A. Project Partners:**

This endeavor is a partnership between Better Futures Minnesota (Minneapolis) and the Northwest Indian CDC (Bemidji). Better Futures will serve as the project manager. Both agencies are committed to supporting at-risk adults who are committed to changing their lives and lifestyles. Job creation and employment are core activities for both. For the past four years, Better Futures has been working with counties, contractors, and the MPCA to promote the practice of building deconstruction and develop markets and alternative uses for construction waste diverted from landfills. Their experience informs the proposal outlined in this work plan. Better Futures is partnering with the Northwest CDC to help build their capacity to provide this service in north central Minnesota. The NRRI recently began working with Better Futures to identify, prototype, and assess uses for reclaimed materials. This grant will enable NRRI to increase their level of research and assistance for both Better Futures and the Northwest Indian OIC.

The following is a summary of each partner's role and responsibilities during this project. To advance this plan and achieve the outcomes outlined in the plan, the partners intend to meet monthly via conference call and hold face-to-face meetings each quarter.

**<u>Better Futures Minnesota:</u>**

1. Serve as Project Manager with overall responsibility for:
   A. Preparing LCCMR work plan and budget and submitting status and final reports to the LCCMR.
   B. Organizing and shepherding the partnership, including managing contracts with each partner, establishing and monitoring work plans with each partner, and hosting monthly video meetings and quarterly face-to-face meetings with partners.
2. Take the lead on testing and refining efficient techniques for taking apart buildings.
3. Develop, disseminate. and update as needed operating manuals and protocols to maximize the amount of material recovered from deconstruction properties and diverted from landfills.
4. Develop, disseminate, and update as needed a training regimen related to safety, product identification, and harvesting techniques to maximize the yield, value. and quality of materials from deconstruction properties.
5. Hire, train, and supervise Better Futures crew chiefs and workers.
6. Assist NRRI with assessing the quality, quantity, and value of materials harvested during the deconstruction process.

7. Assist NRRI with developing strategies that maximize quality and quantity of materials harvested from buildings in various states of condition.
8. With advice and assistance from NRRI and the Northwest Indian OIC, develop marketing handouts and implement a statewide promotion strategy targeting homeowners, architects, contractors, and government agencies.
9. With advice and assistance from NRRI and the Northwest Indian OIC, develop expertise for valuing and selling materials using on-line stores and auctions.
10. Take the lead on recommending strategies for sustaining the practice of deconstruction statewide.
11. With the NRRI and the Northwest Indian OIC, promote deconstruction services and materials and the environmental benefits of this approach through relations with trade groups, trade shows, social media, and web pages.
12. Assist NRRI with studying model deconstruction/diversion policies from across the country; take the lead on drafting model policy and practice options for Tribal, local, county and state government agencies to consider.
13. Work with Tribal, state, county, and local agencies to implement public policies and practices that promote deconstruction as an environmentally beneficial alternative to demolition.
14. Deconstruct up to 20 properties in various states of condition.
15. Work with the NRRI to develop and test products that can be manufactured from reclaimed materials
16. Prepare an operating and financial plan to launch the manufacture of at least three products from deconstruction reclaimed materials. This plan may result in products being made by Better Futures, or NWICDC independently, or in cooperation with each other.

**Natural Resources Research Institute at the University of Minnesota Duluth:**

1. Assess the quality, quantity, type, and value of materials harvested during the deconstruction process.
2. Develop strategies that maximize the quality and quantity of materials harvested from buildings that are in various states of condition and assess the value, quality, and quantity of materials harvested.
3. Study similar endeavors across the nation (i.e.. their techniques, products, and the policies that support these techniques and products) with an emphasis on integrating the values and traditions of the Native American and African American cultures.
4. Build prototypes and test products that can be manufactured from reclaimed materials.
5. Review and test prototypes with potential customers; identify viable products.
6. Develop manufacturing plan, identify equipment, and provide technical support, product specifications and quality assurance for each viable product in cooperation with Better Futures and NW Indian OIC.
7. Identify or develop a tool for calculating the yield and environmental impact of materials harvested from buildings including reduced greenhouse gas emissions, energy savings, reduced landfill use, and the reuse of natural resources.

**Northwest Indian OIC**

1. Help test and inform the development of efficient techniques for taking apart buildings.
2. Contribute to the drafting and updates of operating manuals and protocols related to material recovery and waste diversion.
3. Assist with drafting and training regimens related to safety, product identification, and harvesting techniques.
4. Hire, train, and supervise NWICDC crew chief and workers.
5. Assist NRRI with assessing the quality, quantity, and value of materials harvested during the deconstruction process.
6. Assist NRRI with developing techniques that maximize quality and quantity of materials harvested from buildings in various states of condition.
7. Assist with drafting a business and financial plan for sustaining this enterprise when start-up funding, including the LCCMR funding, ends.

8. Assist NRRI with studying model deconstruction/diversion policies from across the country; take the lead on drafting model policy and practice options for Tribal, local, county and state government agencies to consider.
9. Work with Tribal, state, county, and local agencies to implement public policies and practices that promote deconstruction as an environmentally beneficial alternative to demolition.
10. Deconstruct up to 10 properties in various states of condition.
11. Work with the NRRI to develop and test products that can be manufactured from reclaimed materials.
12. Prepare an operating and financial plan to launch the manufacture of at least three products from deconstruction reclaimed materials. This plan may result in products being made by Better Futures, or NWICDC independently, or in cooperation with each other.

**B. Project Impact and Long-term Strategy:**

By adopting deconstruction on a broad scale, Minnesota can achieve significant reductions in GHG emissions, reduce the amount of waste buried in landfills, and increase the amount of materials reused. There are, however, a set of challenges that hinder the development of deconstruction into a standard practice statewide. These include:

1. At present, there is no economic model to support this line of work. The cost of dumping in Minnesota is much cheaper than recycling and reuse, and there are no established marketplaces for selling reclaimed materials. A new economic model must be developed, and changes in public policy and practice are the main drivers for helping to foster this new model.
2. Local and state government is presently focused on the lowest bid to remove buildings, and there are no current policy or incentives to take into account the additional jobs and environmental benefits that would be achieved from deconstruction.
3. Launching a new line of business and reaching a level of stability takes time (at least five years) and sufficient start-up capital.
4. Minnesota is an under-developed market for deconstruction, meaning that no one is offering this service, there is no prominent marketplace for selling used or reclaimed materials, and current public policy undermines attempts to develop the market more fully. This is both a challenge and an opportunity.
5. At present, there is only one appraiser who is willing to provide private owners with an appraisal for the goods donated to Better Futures, and this appraiser has very limited experience with the method for appraising harvested materials and complying with IRS policies.

This project is focused on addressing these challenges. The four activities being funded over the two-year grant period–(1) developing efficient techniques for deconstructing buildings safely; (2) marketing deconstruction and establishing a marketplace for selling reclaimed materials; (3) creating, manufacturing, and marketing products made from reclaimed materials; and (4) calculating the environmental impact of this project and deconstruction work–are formulated to demonstrate the social, and economic value of deconstruction. In addition, the partners' experience gained and data generated will help inform the development of policies and practices to support deconstruction as an alternative to demolition. These new policies and practices will also help foster a marketplace for the reuse and reclamation of used building materials, and the experience and data will help inform strategies to support deconstruction as a financially viable practice statewide. Long term, deconstruction can become a financially sustainable line of business once the level of work generates adequate revenue from dismantling buildings, selling used materials, and selling products manufactured from reclaimed materials.

**C. Funding History:**

| Funding Source and Use of Funds | Funding Timeframe | $ Amount |
|---|---|---|
| | | |
| | | $ |
| | | $ |

**IX. VISUAL COMPONENT or MAP(S):**

**X. RESEARCH ADDENDUM:**

**XI. REPORTING REQUIREMENTS:**
**Periodic work plan status update reports will be submitted no later than: December 31, 2015; June 30, 2016; December 31, 2016; June 30, 2017; and December 30, 2017. A final report and associated products will be submitted no later than August 31, 2018.**

**Environment and Natural Resources Trust Fund**
**M.L. 2015 Project Budget**

**Project Title:** Building Deconstruction to Reduce Greenhouse Gas Emissions and Solid Waste
**Legal Citation:** M.L. 2015, Chp. 76, Sec. 2, Subd. 07c
**Project Manager:** Victor Krause
**Organization:** Regents of the University of Minnesota, University of Minnesota Duluth Natural Resources Research Institute
**M.L. 2015 ENRTF Appropriation:** $155,000
**Project Length and Completion Date:** 3 Years, June 30, 2018
**Date of Report:** Sept 07, 2018

| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | Activity 1 Budget | Amount Spent | Activity 1 Balance | Activity 2 Budget | Amount Spent | Activity 2 Balance | Activity 3 Budget | Amount Spent | Activity 3 Balance | Activity 4 Budget | Amount Spent | Activity 4 Balance | Total Budget | TOTAL BALANCE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BUDGET ITEM** | **Develop efficient techniques for deconstructing tribal and publically-owned buildings** | | | **Promote deconstruction as a sustainable alternative to demolition and establish a marketplease for reusing materials harvested from projects** | | | **Create and test higher value uses for reclaimed materials; develop markets for products made from reclaimed building materials.** | | | **Calculate the environmental impact of this project and deconstruction work.** | | | | |
| **Personnel (Wages and Benefits)** | $15,734 | $15,734 | $0 | $27,615 | $27,615 | $0 | $62,125 | $62,125 | $0 | $24,035 | $24,035 | $0 | $129,509 | $0 |
| PI, Scientist 1 (V. Krause): $43,697 (79.2% salary, 20.8% benefits), 30% FTE for 2 years | | $9,260 | | | $18,260 | | | $17,954 | | | $11,385 | | | |
| Scientist 2 (S. Johnson): $13,318 (79.2% salary, 20.8% benefits), 10% FTE for 2 years | | $2,779 | | | $3,973 | | | $12,758 | | | | | | |
| Coordinator (T. Hagen): ): $11,409 (74.7% salary, 25.3% benefits), 5% FTE for 2 years | | | | | | | | $6,867 | | | | | | |
| Junior Scientist (R. Hueffmeier): $17,894 (79.2% salary, 20.8% benefits), 20% FTE for 2 years | | $494 | | | $5,382 | | | $501 | | | $12,650 | | | |
| Technician (R. Vatalaro): $27,813 (79.2% salary, 20.8% benefits), 18% FTE for 2 years | | $2,858 | | | | | | $19,493 | | | | | | |
| Undergraduate student (1 student): $10,739 (100% salary 0.0% fringe), 19% FTE for 2 years | | $343 | | | | | | $4,552 | | | | | | |
| **Professional/Technical/Service Contracts** | | | | | | | | | | | | | | |
| Consultant, Ecotone Partners GBC, Inc. will assist with the development of a tool for calculating the yield and environmental impact of materials harvested from buildings, including reduced greenhouse gas emissions, energy savings, reduced landfill use, and the reuse of natural resources. | $5,500 | $5,500 | $0 | | | | | $2,500 | $0 | $14,300 | $14,300 | $0 | $22,300 | $0 |
| **Equipment/Tools/Supplies** | | $0 | $0 | $300 | $300 | $0 | $547 | $547 | $0 | $0 | $0 | $0 | $847 | $0 |
| General woodworking supplies, saw blades, adhesives, wood finishes, cutting bits, stains, hardware, | | | | | | | | | | | | | | |
| **Travel expenses in Minnesota** | | | | | | | | | | | | | | |
| Travel to Minneapolis and Bemidji area for project activities associated with deconstruction of buildings. Mileage: $2,565 (10 trips to MSP, 5 to Bemidji); Lodging: $1,240 (20 nights) ; and Meals: $960 (20 days) | $450 | $450 | $0 | $790 | $790 | $0 | $790 | $790 | $0 | $70 | $70 | $0 | $2,100 | $0 |
| **Other** | | | | | | | | | | | | | | |
| Shipping of samples and prototypes | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Laboratory testing of energy content of wood samples | $0 | $0 | $0 | $244 | $244 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $244 | $0 |
| Grinding of wood materials that are not usable in sold form by a commercial wood grinding company | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **COLUMN TOTAL** | **$21,684** | **$21,684** | **$0** | **$28,949** | **$28,949** | **$0** | **$65,962** | **$65,962** | **$0** | **$38,405** | **$38,405** | **$0** | **$155,000** | **$0** |

| | | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| | | Technique | Show | Make | Enviro | |
| | % | | 60 | 40 | | |
| 559.55 | | | 223.82 | 335.73 | | 559.55 |