
Construction Waste Assessment:

**A Case study of the South Central Iowa
Solid Waste Agency
Environmental Education Center**



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Construction Waste Assessment

A case study of the South Central Iowa Solid Waste Agency Environmental Education Center

Introduction

Construction and demolition debris is increasingly becoming a larger portion of waste disposed in U.S. landfills. According to *Waste News*, a 1998 Environmental Protection Agency (EPA) study reports that each year Construction and Demolition (C&D) debris from buildings amounts to 136 million tons or 2.8 lbs per person per day. The most recent EPA figures show 232 million tons of municipal solid waste (MSW) discarded each year or 4.5 lbs per person per day.

According to the EPA, C&D debris consists of 48 percent demolition waste, 44 percent renovation waste and 8 percent new construction waste.

As C&D amounts increase, efforts are underway to find ways to divert some of this waste stream from our landfills. Green building projects in particular are looking for ways to not only divert waste from landfills but also to reduce waste at the job site.

Project description

The South Central Iowa Solid Waste Agency is a four-county governmental agency serving Lucas, Marion, Monroe and Poweshiek counties. The landfill is located in southeast Marion County. Poweshiek County operates a transfer station where waste is collected daily and brought to the landfill by transfer trailer. The counties are mainly rural and serve a total population of approximately 70,000. Almost 60,000 tons of waste are buried each year at the landfill.

In 2002, the Agency received a Solid Waste Alternatives Program (SWAP) grant/loan from the Iowa Department of Natural Resources for construction of an Environmental Education Center. The Agency planned to use sustainable or “green” construction materials and practices, including recycled-content materials, less toxic finishes, adhesives and materials, salvaged materials and materials made from natural or renewable resources.

C&D debris from buildings amounts to 136 million tons or 2.8 lbs per person per day.

The education center was built as an addition to the existing scale house and office building. The finished main floor is approximately 2,000 square feet with a 2,000 square foot unfinished basement. A door on each level connects the new building with the existing scale house/office. The project included renovating the existing scale house/office by replacing the roofing and siding with materials that matched those used on the exterior of the new addition. The floor plan is included in the addendum.

As part of the grant, the Agency conducted a construction waste study to determine the composition of waste generated and to assess the quantity potentially diverted from the landfill. The study was conducted throughout the entirety of construction from April 2003 to November 2003.

Methodology

The first step of the project was to determine what materials could be recycled or reused at the markets within a reasonable proximity to our area. The Agency landfill is located approximately 30 miles from Chamness Technology, Inc., a composting facility that takes unfinished wood and OSB material. Several recycling centers that accept corrugated cardboard (OCC) are located in or near Marion county. Scrap metal is recycled at the landfill. No facilities for recycling asphalt shingles or drywall exist in the area.

For our project, roll-offs for wood scraps, cardboard and general waste were set up near the construction area were set up near the construction area. The Agency provided a trailer for scrap metal.

Request for proposals (RFP) were sent to area waste haulers for rental and pulls of three 10-yard containers. Because many area haulers did not have that size roll-off readily available, we stipulated the hauler could provide any size box over 10 yards, but they would only be pulled as filled. A copy of the RFP is contained in the addendum.

The project bid document included a description of the project with duties required of the general contractor. The general contractor was responsible for informing subcontractors about the project and making sure they separated and discarded the waste according to the plan. When the contractor was not onsite, Agency staff monitored the disposal practices and retrieved any materials not separated correctly from the roll-offs.

The hauler placed two 30-yard roll-offs for wood and cardboard, and a 20- yard roll-off for general waste. All roll-offs were emptied only once in the late fall. The metals trailer was emptied as needed by landfill staff. All materials were weighed at the scale house and the weight

recorded. The asphalt shingles from the old building and new shingle scrap waste were collected in the subcontractor's truck and weighed. The drywall contractors also collected and weighed scrap drywall separately.

Staff conducted a waste sort at the end of construction. The roll-off containing general refuse was emptied on the landfill shop floor where Agency staff separated and weighed the various waste stream components using a small platform scale. In some cases when subcontractors generated a large volume of a single type waste at the site, it was weighed in a pickup at the scale house or on site using a portable scale.

Results

Renovation /new construction

Tables 1 and 2 include waste from construction of the new building plus the old roofing, siding and gutters from the existing scale house renovation. The total weight of all waste generated was 16,622 lbs.

<i>Recycled materials:</i>			
Roll-off contents	wt in lbs.	% of component	% of total weight
Wood- recycled	2,960.0	76.0	17.8
Cardboard	445.8	76.5	2.7
Metal	1,300.0	94.0	7.8
Total Recycled*	4,705.8		28.3

Table 1
Renovation/new construction

Recycled materials

*Does not include concrete waste from door cut through basement wall into the existing scale house from the new building. It was inadvertently not measured, but was reused as riprap in landfill erosion control projects.

<i>Total project waste- general refuse plus recycled materials:</i>		
Waste type	weight in lbs	% of total
Roofing	4,540.0	27.3
Wood	3,895.9	23.4
Drywall	3,635.8	21.9
Metal	3,383.5	8.3
Siding-fiber cement	639.3	3.9
Cardboard	582.7	3.5
Other	1944.8	11.7
Total waste	16,622.0	100.0

Table 2
Renovation/new construction

All waste

See addendum for complete break down of waste numbers.

New construction only

For comparison purposes, we will look at the weight of new construction debris only. Since the only weight from the renovation was the roofing and metal siding and gutters, it is relatively easy to isolate that weight from the total. Tables 3 and 4 look at recycled materials and the breakdown by components of all waste from new construction only. Total waste from new construction only was 11,342 lbs.

Table 3

New construction
Recycled materials

Recycled materials:

<u>Roll-off contents</u>	<u>wt in lbs.</u>	<u>% of component</u>	<u>% of total weight</u>
Wood- recycled	2,960.0	76.0	26.1
Cardboard	445.8	76.5	3.9
Total Recycled	3,405.8		30.0

Table 4

New construction
All waste

Total project waste- general refuse plus recycled materials:

<u>Waste type</u>	<u>weight in lbs</u>	<u>% of total</u>
Wood	3,895.9	34.3
Drywall	3,635.8	32.1
Siding-fiber cement	639.3	5.6
Cardboard	582.7	5.1
Roofing	560.0	4.9
Other	2028.3	17.9
Total waste	11,342.0	100.0

Discussion***Waste Diversion***

For the SCISWA Environmental Education Center project, actual waste diverted from the landfill was 28 percent for renovation/new construction and 30 percent for new building construction only. Markets are available for wood, cardboard and metal in the Agency area. We were able to recycle 76 percent of the wood waste, which did not include finished and laminated wood. Nearly all the metal was recycled. The metal discarded in the general refuse roll-off (0.5 percent of all metal) was not recycled. Over 76 percent of the total cardboard was recycled. Non-corrugated (paper board), contaminated OCC and small scraps of OCC discarded in the general refuse roll-off were not recycled.

The single biggest reason that more waste is not diverted is the lack of recycling processors of asphalt shingles and drywall in the area. Those two streams make up 49 percent of the renovation/new construction and 37 percent of new construction only wastes.

While waste is measured by weight in this study, we should note that certain waste types are larger by volume. For example, corrugated cardboard, while representing a small portion of the total weight (446 lbs.), nearly filled a 30 yard roll-off.

Of note also is the fact that little hazardous waste was found in the debris. Part of the reason for that was vigilance by the contractor and Agency staff, but in a “green” building, there are fewer toxic or hazardous chemicals to begin with. There was little or no recyclable paper or plastic found.

Our numbers vs. typical

Comparisons with other projects are somewhat difficult because of the differences in types of projects and the fact that there is not a lot of data available. In 1998 the EPA did a study on building waste using data from several sources including the National Home Builders Association (NHBA) Research Center. The following data is for construction waste from a new 2,000 square foot residential home. The home in this scenario most closely matches the SCISWA Education Center in size, appearance and materials used.

	<u>EPA Data</u>	<u>SCISWA Data</u> for new construction
Wood	42%	34%
Drywall	26%	32%
Masonry*	11%	6%
Cardboard	4%	5%
Metals	2%	1%
Other	22%	22%

*Data assumes one side of the house made of brick. SCISWA Education Center used fiber cement siding on all sides.

Table 5
New construction waste composition. EPA data vs. SCISWA

The study also includes compostion data for residential renovation debris. Table 6 shows the composition of typical renovation waste. Though our total project included new construction along with renovation of the existing building, this data indicates the roofing components were similar – 28 percent EPA study to 27 percent in Agency study.

Table 6
Typical residential
renovation waste
composition

Wood	45%
Roofing	28%
Drywall	21%
Misc.	6%

The EPA study also found that when measuring by volume, cardboard made up 30 percent of the total waste. While we did not measure our waste carefully by volume, this number would seem to be close to what we found by visual observation.

Problems encountered

Separating and measuring waste for the most part went well on the project. The biggest problem was making sure the subcontractors properly sorted the wastes. This was a problem especially when the general contractor was not on-site. Agency staff was required to pay more attention to the construction process, which was not always possible. Agency staff, therefore, had to manually separate unsorted waste or waste that was disposed of in the wrong receptacles.

Another problem that was specific to our situation at the landfill was customers using the construction roll-offs instead of the designated location for MSW disposal. Although the roll-offs were placed away from the area where landfill customers normally unloaded, some found the roll-offs anyway. Staff then fenced off the area and placed additional signs in the area.

While construction worker debris (food, beverage) was minimal, it would have been wise to place receptacles for pop cans and bottles and other recyclable containers on-site.

Costs

The average cost for disposal of new construction waste on a typical new home is about \$511, according to the National Association of Home Builders Research Center. Green Building Source reports the costs for construction waste disposal are 0.5 percent of the total cost of construction. This could amount to 5 percent of the profit on a home. Therefore, proper management of waste has an economical advantage.

Additional costs would come from having more than one roll-off or other receptacles on site for separation of wastes. That could be offset somewhat by the reduced need for pulls.

Other costs, particularly in rural areas where there are fewer processors, would come from additional transportation or tipping fees in excess of normal landfill tipping fees. These could very well be deciding factors in the decision to separate and recycle wastes.

In some cases, a contractor may have an advantage if he/she offers recycling to some customers. As the "green" construction trend grows, customers would see waste diversion as a definite environmental benefit.

Our total cost for waste collection and separation was \$300. That does not cover landfill tipping fees and any additional transportation costs because our project was located at the landfill. Of the total waste generated by our renovation/construction project, 12,316 lbs. (6.2 tons) were landfilled. Normal disposal costs for that would be \$174. Therefore, the Agency's total of \$474 would be close to the typical disposal costs even with recycling and diversion efforts in place. We were fortunate to be located close to cardboard and wood recycling facilities.

Waste reduction and other construction practices

Construction practices that reduce waste offer the most economical and easiest ways to cut waste. More efficient framing practices can lessen wood waste, for example. The contractor on SCISWA's project made waste reduction a priority in construction.

Better planning for purchasing the correct amount of materials is important as well as re-using any leftover materials.

Feasibility

Barriers and opportunities

The major barriers to recycling construction and demolition debris remain costs and availability of markets for the recyclable materials. In our area no markets exist for two of the major waste streams- drywall and roofing.

Cardboard is the easiest material to recycle and while its weight does not amount to much, its volume can add to costs of disposal because it fills up roll-offs faster requiring additional charges for multiple pulls. Wood is also more likely to have available markets for recycling either at composting facilities like Chamness or at many landfills which offer that service.

Contractor and subcontractor compliance is another barrier to recycling waste, but is definitely one that can be overcome with some vigilance. In our project, once informed of the requirement to separate waste, most subcontractors willingly complied.

The major barriers to recycling c&d debris remain costs and availability of markets for the recyclable materials.

A common problem at many construction sites is illegal dumping. This may become a problem if too much contamination of the recyclables occurs. Proper fencing and receptacle location can help reduce this problem.

Conclusion

- ◆ Through waste separation during construction of the new Education Center and renovation of the existing scale house, the Agency was able to divert 4300 lbs of waste from the landfill or 28 percent of the total. That represents avoided disposal fees of \$60.20 to offset project collection costs of \$300.
- ◆ The top six components of the waste were roofing, wood, drywall, metal, siding and cardboard, which made up 88 percent of the waste.
- ◆ Readily available markets for wood, cardboard and metal made recycling feasible.
- ◆ We were able to reclaim 76 percent of all cardboard and 76 percent of all wood for recycling.
- ◆ While it is possible to recycle roofing and drywall, which made up nearly half of the waste on the SCISWA project, these materials were not recycled because of lack of available markets.
- ◆ Distance from processors and transportation costs are determining factors regarding the feasibility of construction waste recycling. Often the cost of landfilling the waste is cheaper than the cost of separating and transporting recyclables to processors.
- ◆ The makeup of waste at the SCISWA project was similar to those of other studies.
- ◆ Vigilance is needed to ensure proper separation of waste by subcontractors at the construction site.
- ◆ Source reduction is the most efficient and cost effective way to reduce construction waste, for example efficient use of lumber in the framing process. Better planning for materials purchasing and re-using leftover materials is also important.

Sources and Resources

- Waste News*, Market Focus: Construction, March 31, 2003
- Characterization of Building-Related Construction and Demolition Debris in the United States, EPA530-R-98-010. June 1998
- Green Building Source- www.oikos.com
- Tool Base Services – www.toolbase.org
- Sustainable Building Sourcebook- www.greenbuilder.com
- Peaks to Prairies- Pollution Prevention Information Center, Montana State University Extension
- Vermont Agency of Natural Resources: Planning for Waste Reduction

Addendum

1. Waste analysis - Renovation/new construction
2. Waste analysis - New construction only
3. Request for proposal - waste hauling contract
4. Project photos

Waste analysis -Renovation/new construction

				%of total	%of total
Wood	Recycled unfinished	2,960.0		17.8%	
	finished	524.3		3.2%	
	sawdust	395.4		2.4%	
		16.2	3,895.9	0.1%	23.4%
Cardboard	Recycled OCC noncorrugated	445.8		2.7%	
	contaminated	83.0		0.5%	
	not recycled OCC	43.4		0.3%	
		10.5	582.7	0.1%	3.5%
Paper	Nonrecyclable contaminated (drywall)	19.2		0.1%	
	recyclable	148.0		0.9%	
		0.6	167.8	0.0%	1.0%
Metal	Recycled (siding) recyclable in trash	1,300.0		7.8%	
		83.5	1,383.5	0.5%	8.3%
Plastic	Film/bags/wrap nonrecyclable	241.8		1.5%	
	pipes- pvc/drain/geother	25.3		0.2%	
	styrofoam	41.3		0.2%	
	other-tape/electrician deb	60.4		0.4%	
		15.0	383.8	0.1%	2.3%
Drywall	left-over sorted from trash	2,860.0		17.2%	
	underlayment-floors	188.5		1.1%	
		587.3	3,635.8	3.5%	21.9%
Siding	Cemplank	639.3	639.3	3.8%	3.8%
Ceiling tile	scrap	137.3	137.3	0.8%	0.8%
Insulation	batting	60.8		0.4%	
	duct and foil	10.0	70.8	0.1%	0.4%
Cans/conta paint/stain	paint/chem cans	25.3		0.2%	
	tubes-caulk/adhesive	21.4		0.1%	
	pails and grout	50.8		0.3%	
	paint/stain rollers, rags	14.8	112.3	0.1%	0.7%
Floor scraps	Ceramic tiles	32.2		0.2%	
	Marmoleum	52.4	84.6	0.5%	0.5%
Haz Waste	adhesive/sealer styro	1.9	1.9	0.0%	0.0%
Worker debris	pop cans/bottles	8.8		0.1%	
	eating debris	4.1	12.9	0.0%	0.1%

Decking	scraps	100.0	100.0	0.6%	0.6%
Misc.	rubber hose	2.9		0.0%	
	tarpaper	7.7		0.0%	
	countertop	16.1		0.1%	
	Misc. trash - wood, etc	440.0	466.7	2.6%	2.8%
Misc. Fines	Floor fines	109.5		0.7%	
	wet sawdust or ??	37.9		0.2%	
	sort fines/dbris	259.3	406.7	1.6%	2.4%
Roofing	demo	3,980.0		23.9%	27.3%
	new scrap	560.0	4,540.0	3.4%	
			16,622.0		
				100.0%	

Waste analysis - New construction only

				%of total	%of total
Wood	Recycled	2,960.0		26.1%	
	unfinished	524.3		4.6%	
	finished	395.4		3.5%	
	sawdust	16.2	3,895.9	0.1%	34.3%
Cardboard	Recycled OCC	445.8		3.9%	
	noncorrugated	83.0		0.7%	
	contaminated	43.4		0.4%	
	not recycled OCC	10.5	582.7	0.1%	5.1%
Paper	Nonrecyclable	19.2		0.2%	
	contaminated (drywall)	148.0		1.3%	
	recyclable	0.6	167.8	0.0%	1.5%
Metal	Recycled (siding)			0.0%	
	recyclable in trash	83.5	83.5	0.7%	0.7%
Plastic	Film/bags/wrap	241.8		2.1%	
	nonrecyclable	25.3		0.2%	
	pipes- pvc/drain/geother	41.3		0.4%	
	styrofoam	60.4		0.5%	
	other-tape/electrician deb	15.0	383.8	0.1%	3.4%
Drywall	left-over	2,860.0		25.2%	
	sorted from trash	188.5		1.7%	
	underlayment-floors	587.3	3,635.8	5.2%	32.1%
Siding	Cemplank	639.3	639.3	5.6%	5.6%
Ceiling tile	scrap	137.3	137.3	1.2%	1.2%
Insulation	batting	60.8		0.5%	
	duct and foil	10.0	70.8	0.1%	0.6%
Cans/conta paint/stain	paint/chem cans	25.3		0.2%	
	tubes-caulk/adhesive	21.4		0.2%	
	pails and grout	50.8		0.4%	
	paint/stain rollers, rags	14.8	112.3	0.1%	1.0%
Floor scraps	Ceramic tiles	32.2		0.3%	
	Marmoleum	52.4	84.6	0.5%	0.7%
Haz Waste	adhesive/sealer styro	1.9	1.9	0.0%	0.0%
Worker debris	pop cans/bottles	8.8		0.1%	
	eating debris	4.1	12.9	0.0%	0.1%

Decking	scraps	100.0	100.0	0.9%	0.9%
Misc.	rubber hose	2.9		0.0%	
	tarpaper	7.7		0.0%	
	countertop	16.1		0.1%	
	Misc. trash - wood, etc	440.0	466.7	3.9%	4.1%
Misc. Fines	Floor fines	109.5		1.0%	
	wet sawdust or ??	37.9		0.3%	
	sort fines/dbris	259.3	406.7	2.3%	3.6%
Roofing	scrap	560.0	560.0	4.9%	4.9%
			11,342.0		

SCISWA Construction Waste Study



Left: Construction waste disposal area near construction site. Roll-offs are marked and fenced off from landfill customer area.

Below: General refuse is dumped on shop floor ready to be weighed and sorted.



Above: Waste mid-way through sort.

Right: Scale and containers used for sorting components of the waste.

