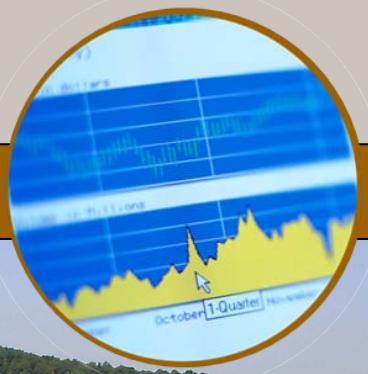
GEORGIA DEPARTMENT OF NATURAL RESOURCES, SUSTAINABILITY DIVISION

Statewide Construction and Demolition Debris Characterization Study



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Statewide Construction and Demolition Debris Characterization Study

Georgia Department of Natural Resources, Sustainability Division

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The Georgia Department of Natural Resources Sustainability Division (Sustainability Division) retained R. W. Beck, Inc., Cascadia Consulting Group, Inc., and Innovative Waste Consulting Services, LLC, collectively referred to as the R. W. Beck Project Team, to perform The Statewide Construction and Demolition Debris Characterization Study (Study). The objectives of the Study were to identify the amount and type of C&D disposed in the State of Georgia (the State), the factors influencing the C&D disposed, and the opportunities for diversion of these materials from disposal.

In Georgia, construction and demolition debris (defined by the State as "waste building materials and rubble resulting from construction, remodeling, repair, and demolition operations on pavements, houses, commercial buildings, and other structures"[1]) is disposed in both C&D and municipal solid waste (MSW) landfills. In addition, a subset of C&D debris can also be disposed in inert landfills. This Study characterizes the C&D disposed in C&D and MSW landfills across the State of Georgia.

C&D Characterization

A total of 786 loads of C&D material were characterized at ten landfills in March and September 2009. The findings were aggregated, weighted and extrapolated to the total tonnage of C&D disposed from October 1, 2008 through September 30, 2009, to estimate the amount of each material type disposed with C&D in the State in that year.

The total tonnage of C&D disposed in MSW and C&D landfills in Georgia was estimated to be 2,952,123 tons, 927,846 tons of C&D disposed in MSW landfills and 2,024,277 tons of C&D disposed in C&D landfills. This represents approximately 21.2% of all solid waste disposed in these landfills during these twelve months. However, historic data suggest that the amount of C&D disposed in Georgia in recent years has declined more quickly than other types of solid waste. Thus, in other years, C&D is likely to comprise a higher percentage of the solid waste disposed in the State.

Table ES-1 shows the resulting composition and estimated cubic yards and tons of each material type in C&D loads disposed at MSW and C&D landfills in the State from October 1, 2008 through September 30, 2009, with the lower and upper boundary on a 90% confidence interval shown.

[1] O.C.G.A. § 12-8-22(5.1)

Table ES-1
Statewide Aggregate Composition of C&D Disposed in Georgia
October 2008 – September 2009

Class	Material	% of C&D Debris Disposed	Estimated CY	Estimated Tons[1]	Lower Boundary[2]	Upper Boundary[2]
C&D Aggregate	Unpainted Concrete	14.0%	959,237	412,472	12.0%	16.0%
	Painted Concrete	1.2%	83,926	36,088	0.3%	2.1%
	Unpainted Asphalt Paving	2.5%	190,329	73,543	1.5%	3.4%
	Painted Asphalt Paving	0.0%	2,283	882	0.0%	0.1%
	Unpainted Brick and Other Aggregates	8.0%	546,951	235,189	6.5%	9.4%
	Painted Brick and Other Aggregates	0.2%	12,714	5,467	0.1%	0.3%
	Total C&D Aggregate	25.9%	1,795,439	763,641	20.4%	31.3%
C&D Wood	Clean Dimensional Lumber	5.3%	1,866,426	157,713	4.6%	6.0%
	Unpainted Large Structural Wood	0.5%	178,876	15,115	0.1%	0.9%
	Painted Large Structural Wood	0.0%	3,799	321	0.0%	0.0%
	Clean Engineered Wood	4.6%	1,005,366	134,719	4.0%	5.2%
	Standard Size Wood Pallets	1.5%	536,497	45,334	1.3%	1.8%
	Painted/Stained Wood	3.5%	1,229,882	103,925	3.0%	4.0%
	Other Treated Wood	0.1%	44,521	3,762	0.0%	0.2%
	Creosote-treated Wood	0.0%	5,692	481	0.0%	0.0%
	Other Wood Pallets and Crates	0.4%	136,521	11,536	0.2%	0.5%
	Total C&D Wood	16.0%	5,007,579	472,906	13.3%	18.7%
C&D Roofing	Composition Roofing	18.3%	1,474,520	538,937	16.6%	19.9%
	Other Asphalt Roofing	1.6%	125,256	45,781	0.7%	2.4%
	Total C&D Roofing	19.8%	1,599,776	584,718	17.3%	22.4%
C&D Other	Clean Gypsum Board	5.4%	684,861	159,915	4.2%	6.6%
	Painted/Demolition Gypsum	1.6%	199,370	46,553	1.1%	2.1%
	Acoustic Ceiling Tiles	0.2%	85,565	6,289	0.1%	0.3%
	Rock and Gravel	0.7%	40,799	20,379	0.3%	1.1%
	Dirt and Sand	10.5%	668,013	310,292	8.8%	12.2%
	Fiberglass Insulation	0.1%	371,529	3,158	0.1%	0.1%
	Expanded Polystyrene Insulation	0.2%	441,000	7,056	0.1%	0.4%
	Unpainted Remainder/ Composite C&D	6.3%	886,222	184,569	5.1%	7.4%
	Painted Remainder/Composite C&D	1.7%	239,166	49,810	1.3%	2.1%
	Total C&D Other	26.7%	3,616,525	788,021	21.0%	32.4%
Paper	Uncoated Corrugated Cardboard/ Kraft Paper	0.8%	881,132	23,350	0.7%	0.9%
	Other Recyclable Paper	0.3%	64,563	9,523	0.2%	0.4%
	Cellulose Insulation	0.0%	110,824	942	0.0%	0.1%
	Remainder/Composite Paper	0.3%	46,916	8,527	0.1%	0.5%
	Total Paper	1.4%	1,103,434	42,342	1.0%	1.9%
Glass	Glass Bottles and Containers	0.0%	2,690	807	0.0%	0.0%
	Flat Glass	0.4%	15,053	10,537	0.2%	0.5%
	Remainder/Composite Glass	0.2%	7,017	4,912	0.1%	0.3%
	Total Glass	0.6%	24,760	16,255	0.3%	0.8%

Class	Material	% of C&D Debris Disposed	Estimated CY	Estimated Tons[1]	Lower Boundary[2]	Upper Boundary[2]
Metal	Major Appliances	0.0%	13,200	957	0.0%	0.1%
	HVAC Ducting	0.0%	53,489	1,257	0.0%	0.1%
	Other Ferrous	2.8%	734,853	82,671	2.4%	3.2%
	Other Non-Ferrous	0.1%	29,636	3,334	0.1%	0.2%
	Remainder/Composite Metal	0.1%	56,529	4,037	0.0%	0.2%
	Total Metal	**3.1%**	**887,707**	**92,257**	**2.5%**	**3.7%**
Plastic	Recyclable Plastic Containers	0.0%	20,505	276	0.0%	0.0%
	HDPE Buckets	0.1%	161,250	1,935	0.1%	0.1%
	Expanded Polystyrene Packaging	0.0%	46,688	747	0.0%	0.0%
	Non-Bag Commercial and Industrial Packaging Film	0.1%	156,914	2,746	0.1%	0.1%
	Tyvek	0.0%	7,886	138	0.0%	0.0%
	Other Film	0.1%	252,836	3,900	0.1%	0.2%
	Plastic Siding/Decking	0.0%	54,240	1,356	0.0%	0.1%
	Plastic Pallets	0.0%	1,360	34	0.0%	0.0%
	Durable Plastic Items	0.2%	195,400	4,885	0.1%	0.2%
	Plastic Piping	0.7%	155,901	21,943	0.6%	0.9%
	Remainder/Composite Plastic	0.1%	78,480	1,962	0.0%	0.1%
	Total Plastic	**1.4%**	**1,131,460**	**39,922**	**1.0%**	**1.7%**
Organics	Yard Trimmings	1.4%	257,088	40,170	0.9%	1.8%
	Branches and Stumps	0.4%	188,803	11,989	0.2%	0.6%
	Total Organics	**1.8%**	**445,891**	**52,159**	**1.1%**	**2.5%**
E-waste/ HHW	E-Waste	0.0%	4,866	894	0.0%	0.1%
	Asbestos labeled bags	-	-	-	0.0%	0.0%
	Other HHW	0.2%	6,437	5,379	0.1%	0.3%
	Total E-waste/HHW	**0.2%**	**11,303**	**6,273**	**0.1%**	**0.3%**
Other Materials	Carpet	1.5%	587,279	43,165	0.6%	2.4%
	Carpet Padding	0.2%	211,258	6,549	0.1%	0.3%
	Wood Furniture	0.3%	93,692	7,917	0.2%	0.4%
	Plastic Furniture	0.0%	2,080	52	0.0%	0.0%
	Mattresses and Box Springs	0.1%	54,475	2,179	0.0%	0.1%
	Tires	0.0%	11,450	1,145	0.0%	0.1%
	Remainder/Composite Other Materials	0.4%	166,555	11,892	0.2%	0.6%
	Total Other Materials	**2.5%**	**1,126,789**	**72,899**	**1.1%**	**3.8%**
MSW	**Total MSW**	**0.7%**	**184,276**	**20,731**	**0.5%**	**0.9%**
Total C&D Disposed		**100.0%**	**16,934,939**	**2,952,123**		

[1] The R.W. Beck Project Team converted observed cubic yards to tons for each material based on conversion factors included in the following documents: "Measuring Recycling: A Guide for State and Local Governments," document no. EPA530-R-97-011 (September 1997); "Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste" (2006); "Converting C&D Debris from Volume to Weight: A Fact Sheet for C&D Debris Facility Operators" (2000); and resources from the Tellus Institute.

[2] The R.W. Beck Project Team calculated the upper and lower boundary at a 90% confidence interval.

Ten materials comprised approximately 78.6% of the C&D disposed in the State as shown in Figure ES-1.

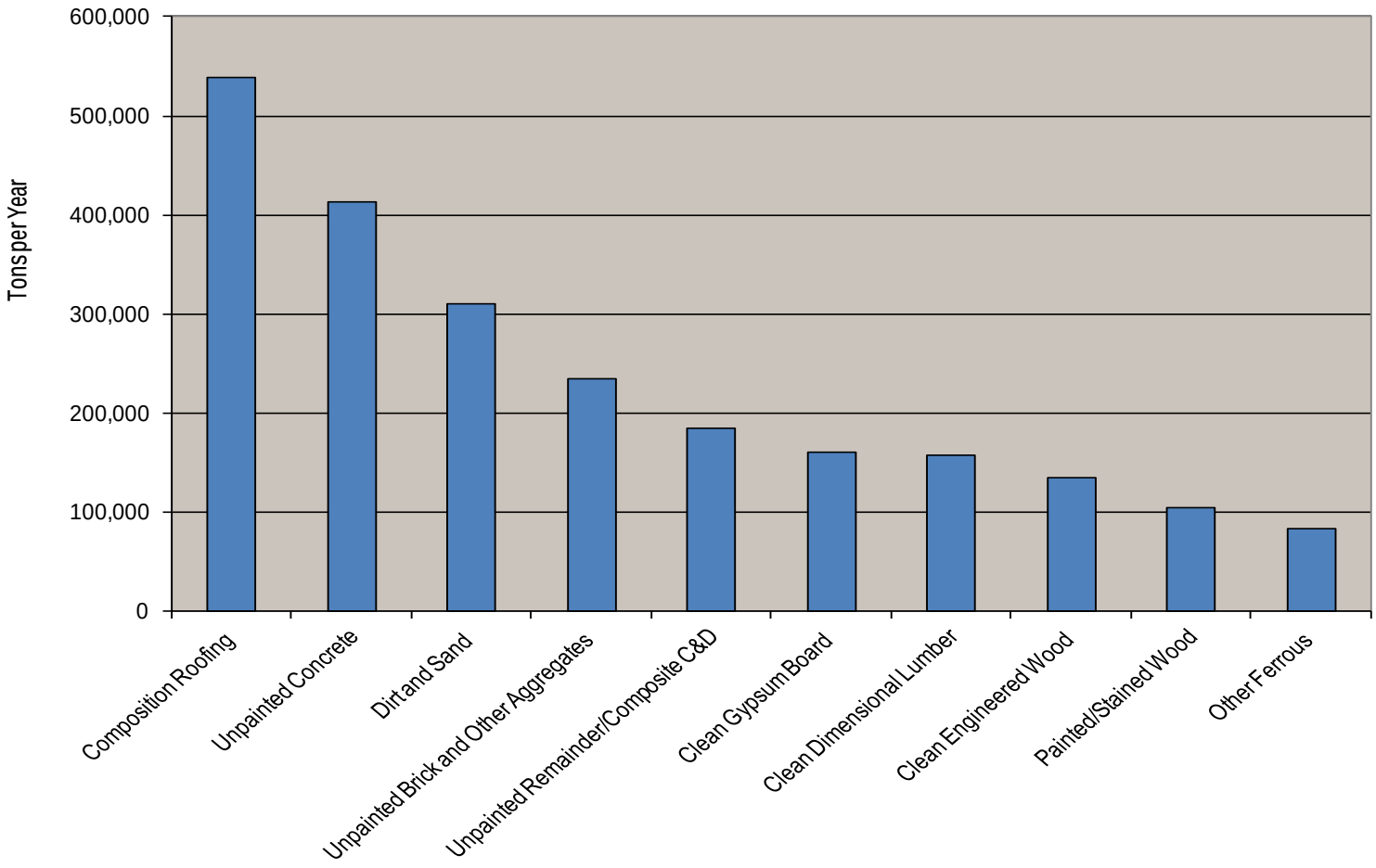


Figure ES-1. Top Ten Material Types in C&D Disposed in Georgia, October 2008 – September 2009

By Activity Type

The R. W. Beck Project Team characterized the C&D delivered from each activity type. Table ES-2 shows that more tons of C&D arrived at the landfills from non-residential new construction activities than from any other individual activity type, with roofing activities generating the second highest amount of C&D being disposed by an individual C&D activity type. The composition of material varied by activity type. For example, more clean dimensional lumber was found in residential than in non-residential loads, with loads from residential demolition sites likely to produce the highest tonnage. On the other hand, non-residential construction generated the greatest amount of unpainted aggregate (including the material types unpainted concrete, unpainted asphalt, and unpainted brick and other aggregates).

Table ES-2
Estimated Tons per Year Disposed by Activity Type
October 2008 – September 2009

Sector	Activity Type[1]	Estimated Tons
Residential	Residential new construction	249,329
	Residential renovation	400,055
	Residential demolition	454,997
	Residential - Subtotal	1,104,381
Non-Residential	Non-residential new construction	592,761
	Non-residential renovation	301,375
	Non-residential demolition	129,111
	Non-Residential - Subtotal	1,023,248
Roofing	Roofing	560,291
Other/Mixed	Other/Mixed	264,203
Total		2,952,123

[1] Based on activity type cited by driver.

By Region

Based on the data gathered in the field and the quarterly tonnage reported to EPD, just over half of the material from construction, renovation, demolition, and roofing sites disposed in the State is disposed in the ten counties of the metro Atlanta region. The C&D disposed in metro-Atlanta had more dirt and sand, rock and gravel, painted gypsum, and remainder/composite C&D than that disposed in other areas of the State. The C&D disposed outside metro-Atlanta had more wood, roofing, clean gypsum board, fiberglass insulation and expanded polystyrene insulation than that in the metro-Atlanta area.

Impact of Ban on Outdoor Burning

The potential impact of the ban on outdoor burning (effective in some areas of the State from May 1 to October 1 each year) on the composition of C&D disposed was

evaluated by looking at how the composition of C&D changed from March (when no burn ban is in effect) to September (when a burn ban is in effect in some counties) in areas subject to the ban as compared to the change between the seasons in areas that were not subject to the ban. The difference in the change in composition suggest that there may be a meaningful seasonal difference in the amount of C&D Wood and All Other Materials between counties with and without a burn ban during the September sampling period when the burn ban is in effect. However, there is not a clear causal relationship between the observed difference and the actual burn-ban policy.

Alternative Scenarios

C&D disposed in Georgia was characterized during the a time that the State and the country was in the midst of an economic downturn, one impact being the lowest housing starts seen in well over a decade. As a result, the tons of C&D disposed had declined an estimated 23.6% between FY2007 and FY2008. To consider how the amount and composition of C&D disposed may change under different conditions, the R. W. Beck Project Team developed a spreadsheet-based model that allows the assumptions about total tonnage of C&D debris disposed and the relative contribution by various activity types to be adjusted. For this Report, two alternative scenarios were analyzed using this model.

In the first scenario, the total tonnage of C&D disposed was assumed to be the same as the total tonnage reported during the Study period, however, the allocation by activity type was adjusted to reflect the allocation from a similar characterization study conducted in the State of California in 2006, before the economic downturn.[2] In this Study, more material came from residential construction and demolition, non-residential renovation, and other/mixed activity. Less material came from residential demolition, non-residential construction and roofing. When this contribution by activity types was assumed, more concrete, dirt and sand, remainder/composite C&D, clean dimensional lumber, clean engineered wood, painted/stained wood, and asphalt paving is projected. Less other (non-appliance) ferrous, brick and other aggregates, composition roofing and clean gypsum board are projected under this scenario.

In the second scenario, the total tons of C&D disposed is assumed to return to historical levels so that instead of 2,952,123 tons of C&D disposed per year, 4,900,000 tons is projected to be disposed. Although all materials increase in similar proportions, this scenario demonstrates how much more of each material would be available with a return to historic C&D disposal rates. Over 1.1 million tons of concrete, brick, and other aggregate, 894,541 tons of composition roofing, 250,000 tons of both clean gypsum board and clean dimensional lumber, and over 137,000 tons of other ferrous material are projected under this scenario.

[2] *Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste* commissioned by California Integrated Waste Management Board (June 2006).

Lead-based Paint in C&D Loads

As part of this Study, the R.W. Beck Project Team sampled C&D loads at five of the ten sites each season to determine the incidence of lead-based paint. Each load from demolition, renovation, roofing, and other C&D activity types that arrived when the lead-based paint detection unit was on-site was visually evaluated to identify whether it contained any painted surfaces. All painted surfaces observed were sampled using an x-ray fluorescence (XRF) device that provided a lead concentration readout. Measurements that indicated a lead concentration greater than or equal to 1 mg/cm^2 were identified as a "positive" result for lead-based on the State of Georgia definition that defines a surface as containing lead-based paint.

Table ES-3 shows that of the 364 loads received at the landfills when painted surfaces were being tested, 266 were from the activity types targeted (all but new construction) and 487 painted surfaces were tested in these loads. Seventy surfaces tested positive for lead-based paint; these surfaces were present in 37 loads.

Table ES-3
Summary of Lead-based Paint Sample Count, Detection Frequency, and Corresponding Tonnage

	Number	Tons
Loads Arriving While XRF On Site	364	1,731
Loads from Activity Types Targeted	266	1,292
Surfaces Tested	487	165
Surfaces with Lead Measurement ≥ 1 mg/cm^2	70	18

These seventy surfaces were on materials weighing a total of 18 tons, or about 1.1% of the total tons received during the lead-based paint-sampling period. About 60% of the material that had a painted surface that tested positive for lead was painted or stained wood, while painted concrete, painted R/C C&D, painted/demolition gypsum, and painted brick and other aggregates contributed 20%, 14%, 7% and less than 1%, respectively. About 12 tons (64%) was from residential demolition activities, 21% was from residential renovation activities, 12% was from non-residential renovation activities, 3% was from mixed/other activity types, and less than 1% was from non-residential demolition activities.

Asbestos-containing Material in C&D Loads

As part of this Study, the R.W. Beck Project Team also sampled these same loads to determine the incidence of asbestos-containing material (ACM) in C&D disposed. When a material type that could potentially contain asbestos was observed, a sample was taken, bagged, and sent to a certified laboratory for analysis.

Table ES-4 shows that of the 364 loads arriving at the site while samples were being taken for ACM, 182 loads had at least one material that fell into a material type potentially containing asbestos; 307 samples were collected from those 182 loads.

Fifteen of these samples were reported by the laboratory as containing a detectable amount of asbestos; four with an asbestos content greater than 1%.[3]

Table ES-4
Summary of ACM Sample Count and Detection Frequency

	Number	Tons
Loads that Arrived During Sampling	364	1,731
Samples Collected	307	-
Samples with Asbestos Detection	15	2.6
Samples with Detection > 1% Asbestos	4	0.4

Out of a total 1,731 tons that arrived at the facilities during the ACM sampling period, an estimated 2.6 tons of material sampled exhibited an asbestos concentration that was detected by the laboratory, 739 pounds of which exhibited an asbestos concentration greater than 1%. Wallboard and joint compound was the material subtype with the most frequent detection of asbestos while one sample of transite siding exhibited the highest single asbestos concentration (20%) of all materials sampled. By weight, the painted/demolition gypsum material type contributed most to the asbestos detections encountered, both in terms of frequency and weight.[4] Overall, residential demolition contributed the greatest fraction (by weight) of materials with asbestos detections, followed by residential renovation. The weight of material from roofing and non-residential demolition contributed relatively little compared to residential renovation and demolition.

Challenges and Opportunities to Recovery

The R.W. Beck Project Team interviewed generators, processors, and end users of some of the most prevalent C&D materials disposed in Georgia to assess the challenges and opportunities associated with recovery of these materials. Low tipping fees at landfills, limited space on construction sites, and the difficulty of source-separating material, especially from demolition and renovation sites, are commonly cited challenges faced by stakeholders interviewed, regardless of the material type. However, the growing interest in meeting green building standards that often include recycling C&D, the relatively source-separated nature of materials coming from phased new construction activities, and the potential to use some materials, such as

[3] The National Emission Standards for Hazardous Air Pollutants (NESHAP) threshold for defining a material as ACM.

[4] The material subtype "Wallboard and Joint Compound" includes both the wallboard and the corresponding joint compound. Since joint compound formulations commonly included asbestos, this was the portion of the material that was sampled and analyzed in the laboratory although the total weight of material was considered to contain asbestos. Thus, the actual weight of material in the painted/demolition gypsum material type that had asbestos is likely to be much less.

C&D aggregate and C&D wood on site, offer opportunities for increasing recovery of C&D.

Based on our research, there appears to be established markets for painted and unpainted concrete, dirt and sand, painted and unpainted brick and other aggregates, clean dimensional lumber, and other ferrous. However, even for these materials, the feasibility of accessing the markets depends on the source and quantity of material generated, the degree of on-site sorting, the specifications of the local market, the distance to markets, and the distance to disposal facilities. Primarily due to the increasing interest in biomass, processors and end users interviewed expressed a growing, but limited market, for other material types within C&D Wood, most notably clean-engineered wood and painted/stained wood. Limited markets were identified for the three remaining material types in the top ten, composition roofing, clean gypsum board, and remainder/composite C&D.

Reduction Strategies

The R. W. Beck Project Team considered the results of the characterization study, input from generators, processors, and end users of C&D materials, and case studies of successful C&D reduction strategies and programs across the country to recommend potential strategies to reduce the amount of C&D materials disposed in the State of Georgia.[5] These strategies are summarized below and covered in more detail in the full report.

Policy

- Consider setting diversion or recycling goals for those C&D materials for which markets are determined to exist.
- Evaluate and, if needed, strengthen the requirements to cover C&D as comprehensively as MSW in local Solid Waste Management Plan Updates and annual reports.
- Assist local governments and businesses to promote, through ordinances or other means, green building standards for construction activities in the Georgia that include specifying percentages for recycling debris.
- Continue to review regulatory requirements for C&D and inert landfills to ensure that they sufficiently protect public health and the environment and promote the waste reduction goals of the State.
- Consider requiring that C&D be processed prior to disposal to ensure that non-C&D material is not disposed in these facilities and to offer the opportunity for recovery.

[5] Case studies of C&D diversion approaches can be found in Appendix L and a list of stakeholders interviewed can be located in Appendix M of this report.

- Require all state owned, occupied, or funded buildings that are constructed, renovated, or demolished develop recycling plans, recycle a specified percentage of all C&D generated during the project, and use products with recycled content.
- To expand markets for materials made from recovered C&D, state procurement policies should promote products, services, and energy sources that promote the beneficial reuse of roofing materials, wood, aggregate and other C&D materials.
- Consider certifying facilities as C&D recycling facilities and set appropriate criteria such as requirements to demonstrate the tons of each material that is sent to market and that disposed.
- Evaluate whether manufacturers or retailers of any construction materials should be encouraged or required to recover the material they manufacture or sell.

Education and Technical Assistance

- Facilitate local policy-making by disseminating draft ordinances, contract language or other documents that are geared toward reducing the C&D disposed.
- Provide training to generators of C&D on the benefits of diversion.
- Coordinate roundtables with generators, processors, and end users for C&D materials.
- Upgrade the Georgia's Online Materials Exchange site to include a more extensive list of C&D materials, more detailed search functions such as material specifications, amounts, and region, and interactive features for suppliers and markets.
- Put all relevant C&D recycling information at a single well-linked online location.
- Explicitly incorporate the use of materials with recycled content as well as the recycling of C&D generated on-site during the construction, renovation, demolition, or re-roofing activity into the Georgia Peach Green Building Rating System.

Infrastructure Development

- Consider establishing regional hubs for aggregating C&D material like those the State has sponsored for recyclables disposed with municipal solid waste.
- Expand and promote C&D material reuse centers at locations where those with reusable materials and those needing them are likely to congregate.

Market Development

- Work with stakeholders to research the specific capabilities of all processors and end users for C&D materials identified in the characterization study and determine detailed collection, processing, and end use infrastructure and incentives required to divert C&D materials from disposal facilities.

- Evaluate the role of the State and others in aggregating, processing, and using C&D Wood in existing, proposed, or new biomass projects and clarify the role of biomass in the State's waste management hierarchy.
- Sponsor research into additional uses for composition roofing and clean gypsum board, perhaps by offering financial incentives, such as grants or tax incentives, to conduct research and develop infrastructure.
- Consider financial incentives, such as tax incentives or grants, for new C&D processing equipment.

Potential Partners

Many stakeholders were contacted for this Study to gather input on challenges, opportunities, and potential strategies to divert C&D from disposal. During the course of this research, it was evident that many resources to recover more C&D already exist in Georgia and across the country and in this time of limited resources, the State could benefit from this experience on a more long-term basis. Armed with the information provided by this characterization study, the State should collaborate with representatives from across the State that can provide insight, guidance, and resources to increase C&D recycling in the State, including:

- Local governments;
- Civic and environmental groups;
- Recyclers of C&D and other materials;
- Waste haulers;
- Landfill and transfer station operators;
- Chambers of Commerce;
- Builders;
- Roofers and other contractors;
- C&D generating businesses;
- Building inspectors;
- State agencies;
- Federal agencies;
- Architects/engineers;
- End users for wood, aggregate, roofing shingles; and
- Other generators, processors and end markets of C&D material.

Section 1
INTRODUCTION

Study Objectives

The Georgia Department of Natural Resources Sustainability Division (Sustainability Division) retained R. W. Beck, Inc., Cascadia Consulting Group, Inc., and Innovative Waste Consulting Services, LLC, collectively referred to as the R. W. Beck Project Team, to characterize the construction and demolition debris (C&D) disposed in Georgia landfills. The objectives of the Study were to identify the amount and type of C&D disposed in the State of Georgia (the State), the factors influencing the C&D non-residential disposed, and the opportunities for diversion of these materials from disposal.

The Study estimates the tons and the composition of C&D disposed at C&D and municipal solid waste (MSW) landfills in the State in the fourth quarter of 2008 and the first three quarters of 2009, the most recent four quarters for which statewide data were available at the time of the Study. The tonnage and composition of the C&D disposed is analyzed by region (the ten counties of metro Atlanta versus the rest of the State) and by source (residential or non-commercial; new construction, renovation, demolition, roofing, or other/mixed construction). Because the amount and composition of C&D at any point in time may not accurately reflect the tonnage and composition of C&D disposed historically or in the future, the R. W. Beck Project Team developed a model that allows the user to vary construction activity assumptions and project the impact on the tons of each material available.

Once the tonnage and composition of C&D disposed was estimated, the R. W. Beck Project Team evaluated the challenges, opportunities, and potential strategies to diverting some of the most prevalent materials in C&D loads from disposal. This analysis included a review of the markets available for the most abundant materials, a survey of stakeholders that would be involved in diverting these materials, and a review of programs and policies implemented by other comparable state and local governments to reduce the amount of C&D disposed.

In addition to characterizing C&D disposed, the R. W. Beck Project Team conducted additional data gathering on-site to determine the degree to which asbestos-containing material and lead-based paint is disposed with C&D in Georgia landfills. In addition, a separate analysis was performed of carpet gathered while on site during this Study to determine the composition of carpet disposed with C&D in Georgia, including the fiber type, the backing, and the weave. These data are included in a separate report to the Sustainability Division.

Report Organization

The Study Report is organized into the following sections:

- **Section 1 – Introduction:** This section introduces the objectives of the Study and describes the report structure.
- **Section 2 – Background:** This section presents a demographic and waste disposal overview and describes C&D management in the State of Georgia.
- **Section 3 – Methodology:** This section discusses the methodology used in the field research and data analysis.
- **Section 4 – Results of Characterization Study:** This section describes the findings regarding the amount and composition of C&D disposed across the State, by region, and by source of generating activity.
- **Section 5 – C&D Materials under Alternative Scenarios:** This section of the report evaluates how C&D disposed might change if assumptions about factors that influence C&D amounts and composition changed.
- **Section 6 – Lead-based Paint and Asbestos-containing Material:** This section reports the findings of the sampling of C&D disposed with regard to the presence of lead-based paint and asbestos-containing material.
- **Section 7 – Challenges and Opportunities:** This section describes the challenges and opportunities to recycle C&D currently disposed in Georgia based on interviews with stakeholders and other research.
- **Section 8 – Reduction Strategies:** This section presents waste reduction strategies developed based on the results of the characterization study combined with the market analysis, stakeholder interviews and case studies of C&D recycling programs currently in place in the United States.

Acknowledgements

The success of this Study could not been achieved without the assistance of numerous organizations and individuals. The staff at the Sustainability Division and the Environmental Protection Division (EPD) of the Georgia Department of Natural Resources provided valuable and responsive guidance on all aspects of the Study. Specifically, we like to acknowledge the following staff members:

- Roy Edwards, Sustainability Division
- Chuck Boelkins, Sustainability Division
- Marlin Gottschalk, Sustainability Division
- Stephanie Busch, EPD
- Mindy Crean, EPD
- William Spain, EPD

- Tamara Fischer, EPD

In addition, the Sustainability Division and the R. W. Beck Project Team would like to recognize the following disposal facilities for graciously allowing us on their sites and providing data and information about disposal practices as needed.

- APAC/GA - Donzi Ln., Ph 5A (L)
- Camden Co. - S.R. 110 C/D/I Waste Landfill
- Columbus, Pine Grove MSWL
- DeKalb Co. - Seminole Rd., Ph 2 (SL)
- Floyd Co. - Rome Walker Mtn. Rd. C/D Landfill
- Houston Co. - SR247 Klondike C/D Landfill
- Reliable Tire Services, Monroe Dr.
- Richmond Co. - Deans Bridge Rd., Ph III MSWL
- Walton Construction & Demolition Landfill
- Willow Oak C&D Landfill

We also appreciate the input provided by generators, processors, and end users of C&D materials as well as state and local governments that provided information that contributed to developing workable strategies for the State of Georgia.

Demographic Overview

Georgia is the largest state geographically east of the Mississippi River (24th overall), spanning a land area of 57,906 square miles. In 2008, the State of Georgia was home to 9.7 million people, nearly 44% of who lived in the ten counties of metro-Atlanta (Table 2-1). Table 2-2 shows that the population of the State has grown steadily in this decade, experiencing a 17.7% increase between 2000 and 2008.

Table 2-1
Regional Breakdown of Georgia Population, July 1, 2008

County	Population
Metro Atlanta	
Cherokee	210,529
Clayton	273,718
Cobb	698,158
DeKalb	739,956
Douglas	127,932
Fayette	106,465
Fulton	1,014,932
Gwinnett	789,499
Henry	191,502
Rockdale	83,222
Subtotal – Metro Atlanta	4,235,913
Non-Metro Atlanta	5,449,831
Total	9,685,744

Source: Population Division, U.S. Census Bureau, Release Date: March 19, 2009

Table 2-2
Georgia Population, 2000-2008

Year	Population
2000	8,230,053
2001	8,418,592
2002	8,583,674
2003	8,732,924
2004	8,910,741
2005	9,093,958
2006	9,318,715
2007	9,523,297
2008	9,685,744

Source: Population Division, U.S. Census Bureau, Release Date: March 19, 2009

The number of new residential construction permits authorized in Georgia has been declining since 2004 (Table 2-3), especially in the last couple of years. Between 2007 and 2008, the number of privately-owned housing units authorized in Georgia decreased by over 50% and the decrease between 2008 and 2009 was nearly that much again.

Table 2-3
New Privately Owned Housing Units Authorized in Georgia, 2000-2009

Year	Units
2000	93,328
2001	93,141
2002	97,385
2003	94,773
2004	105,889
2005	104,659
2006	98,843
2007	70,322
2008	32,232
2009	17,202

Source: U.S. Census Bureau, New Privately Owned Housing Units Authorized, Unadjusted Units for Regions, Divisions, and States, December 2009 Year-to-Date.

Waste Disposal Overview

In Georgia, construction and demolition debris (defined by the State as waste building materials and rubble resulting from construction, remodeling, repair, and demolition

operations on pavements, houses, commercial buildings, and other structures[6]) is disposed in both C&D and MSW landfills. In addition, a subset of C&D debris, including earth and earth-like products, concrete, cured asphalt, rocks, bricks, yard trimmings, stumps, limbs, and leaves can also be disposed in inert landfills.

There are 54 operating MSW landfills (including four unlined sanitary landfills) and 48 operating C&D landfills in the State of Georgia according to EPD's database. Each of these landfills report the tonnage received to EPD every quarter. In addition, there are two industrial landfills, including one that accepts baled carpet exclusively, that report annual tonnage to EPD. In addition, there are more than 2,000 inert landfills registered with EPD, some of which only serve a particular construction site. These facilities typically do not have scales and are not required to report their tonnage to the State. Thus, to quantify how much is disposed in inert landfills is problematic.

This Study characterizes the C&D disposed in C&D and MSW landfills across the State of Georgia. Quarterly reports submitted by disposal facilities to EPD indicate that a total of 12.9 million tons of solid waste were disposed in municipal solid waste (MSW) landfills, 3.3 million tons were disposed in C&D landfills, and 261,325 tons were disposed at other facilities (industrial landfills and incinerators) in FY2008. Figure 2-1 shows that total solid waste tonnage disposed in the State increased slightly from FY2005 to FY2007 and then declined slightly in FY2008. Most of this decline was attributable to a decrease in the amount of waste disposed in C&D landfills, where it is estimated that 23.6% less waste was disposed in FY2008 than in FY2007.

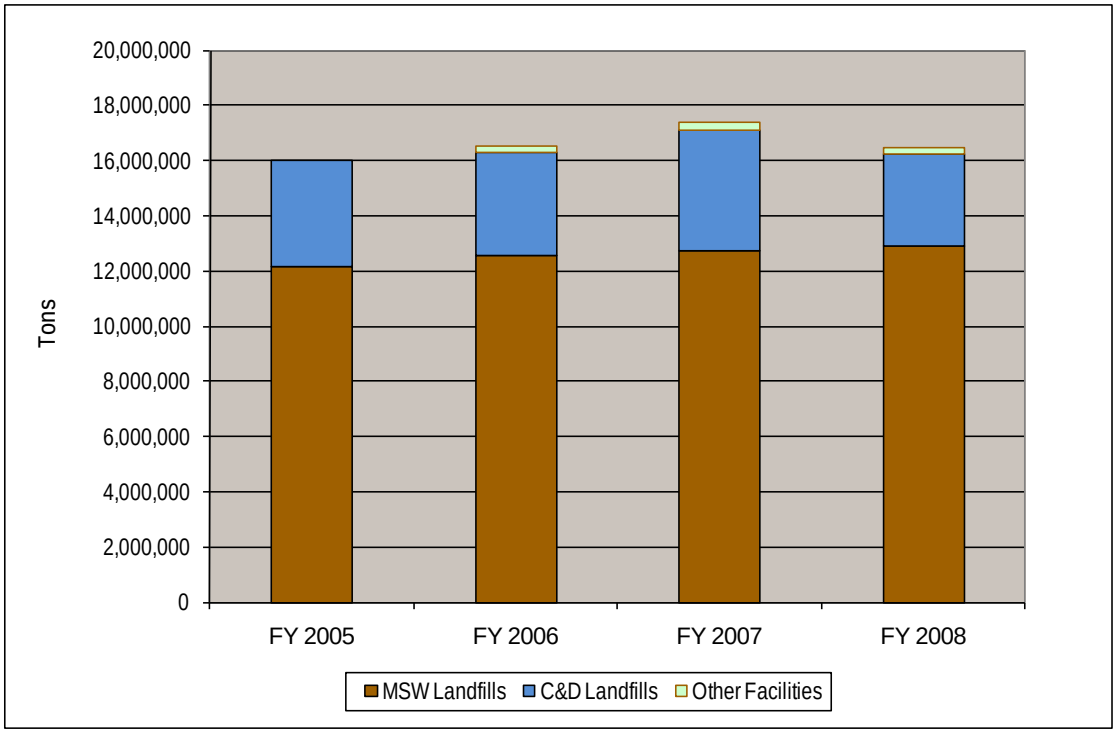


Figure 2-1. Tons of Solid Waste Disposed in Georgia, by Facility Type FY2005-FY2008

[6] O.C.G.A. § 12-8-22(5.1)

Section 3
METHODOLOGY

Introduction

The methodology for the Study was developed to estimate the amount and composition of C&D disposed at Georgia landfills. The methodology included the following key elements:

- Selecting landfills where C&D would be characterized;
- Finalizing the definition of C&D based on activity type, or source;
- Finalizing the material classes, types, and definitions to be considered;
- Developing a sampling plan;
- Characterizing C&D in the field; and
- Analyzing the data to provide statewide results.

This section of the report describes the approach taken to develop each of these elements.

Site Selection

The R. W. Beck Project Team considered the objectives of the Georgia Department of Natural Resources Sustainability Division (Sustainability Division) as part of the site selection process. One objective stated in the Sustainability Division's Request for Proposals (RfP) was to gather data at a minimum of ten sites and to include sites where C&D from the following areas was disposed:

- Metro-Atlanta (specifically three to four sites where C&D from Cherokee, Clayton, Cobb, Dekalb, Douglas, Fayette, Fulton, Gwinnett, Henry, or Rockdale County was disposed);
- Augusta;
- Macon;
- Savannah;
- Gainesville;
- Rome;
- Columbus; and
- Athens.

The R. W. Beck Project Team reviewed EPD's database of tonnage disposed in Georgia landfills. This database documents the total tonnage as reported by each landfill in the State and the location the material was generated (i.e. city name, county name, or out-of-State). The R. W. Beck Project Team searched the database to determine where C&D from each of the areas listed above was disposed in recent years. If no C&D landfill reported a substantial amount of tonnage from one of these areas, it was assumed that the C&D was disposed in MSW landfills. In these cases, the database was searched to determine which MSW landfills reported a substantial tonnage from these areas.

Another objective of the Study was to determine whether the C&D disposed at facilities located in areas that are covered by the State's seasonal ban on outdoor burning is different from the C&D disposed from those areas that are not. This ban on outdoor burning of land-clearing debris and vegetative material is in effect in 54 counties from May 1st to September 30th of each year. Thus, it was important to include sites that were inside and outside the shaded areas shown in Figure 3-1 to evaluate differences.

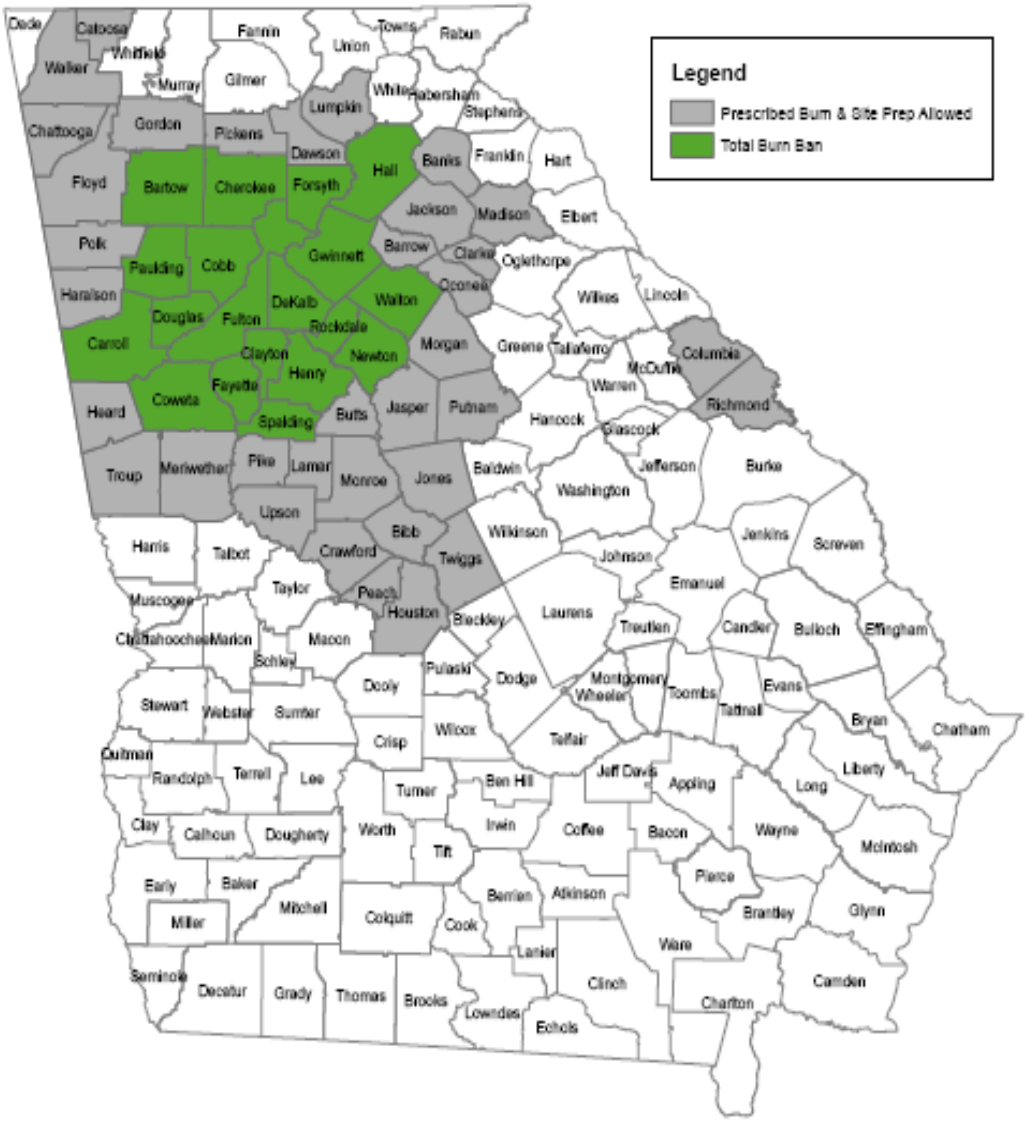


Figure 3-1. Georgia EPD Burn Ban Restriction Areas

Based on the information provided by Georgia EPD and the R. W. Beck Project Team's research, landfills were identified and then contacted to request their participation in the study. In most cases, the sites where most of the C&D from the designated areas was disposed agreed to participate with the primary exception being the landfill(s) where much of the C&D from the Savannah area is disposed.

Table 3-1 indicates the ten landfills that were ultimately included in the Study, the targeted area that disposes of C&D at that landfill, and whether the landfill is located in an area covered by the State ban on outdoor burning. The "targeted waste shed area" only describes which of the areas designated in the RfP issued by the Sustainability Division is covered. For the most part, these landfills also take C&D from other areas.

Table 3-1
Selected Landfills

Landfill	Targeted Waste Shed Area	Located in County Subject to Ban on Outdoor Burning?
APAC/GA - Donzi Ln., Ph 5A (L)	Metro Atlanta	Burn Ban
Camden Co. - S.R. 110 C/D/I Waste Landfill	[1]	Non-burn Ban
Columbus, Pine Grove MSWL	Columbus	Non-burn Ban
DeKalb Co. - Seminole Rd., Ph 2 (SL)	Metro Atlanta	Burn Ban
Floyd Co. - Rome Walker Mtn. Rd. C/D Landfill	Rome	Burn Ban
Houston Co. - SR247 Klondike C/D Landfill	Macon	Burn Ban
Reliable Tire Services, Monroe Dr.	Gainesville	Burn Ban
Richmond Co. - Deans Bridge Rd., Ph III MSWL	Augusta	Burn Ban
Walton Construction & Demolition Landfill	Athens	Burn Ban
Willow Oak C&D Landfill	Metro Atlanta	Burn Ban

[1] Camden Co. - S.R. 110 C/D/I Waste Landfill was included for purposes of representing the non-burn ban area. Camden Co. - S.R. 110 C/D/I Waste Landfill is not located in a targeted waste shed area.

Figure 3-2 presents a map of Georgia showing the location of the landfills selected for this Study.

Figure 3-2. Location of Landfills Included in Study

Defining C&D Based on Activity Type

The RfP issued by the Sustainability Division requested that the Study be conducted using a methodology that defines C&D by the activity where the C&D is generated rather than by the specific materials in the load or the type of landfill where the load is disposed. During the kick-off meeting, the R. W. Beck Project Team and the Sustainability Division refined the definition to include all loads that came from the following types of sites.

- **Residential New Construction:** Materials generated from the construction of new residential structures including single-family homes, townhouses, apartment complexes, and other multifamily residences. Excludes high-rise apartments, condominiums, and mixed-use buildings.
- **Non-residential New Construction:** Materials generated from the construction of new non-residential buildings, such as businesses, government offices, and schools. Also includes high-rise apartments, condominiums, and mixed-use buildings.
- **Residential Renovation:** Materials generated from the remodeling of residential structures including single-family homes, townhouses, apartment complexes, and other multifamily residences. May include material from the demolition and construction phases of a remodel. Excludes high-rise apartment, condominium, and mixed-use buildings.
- **Non-residential Renovation:** Materials generated from the remodeling of non-residential buildings, such as businesses, government offices, and schools. May include material from the demolition and construction phases of a remodel. Also includes high-rise apartments, condominiums, and mixed-use buildings.
- **Residential Demolition:** Materials generated from the breakdown and removal of an entire existing residential structure. If the activity includes renovating or remodeling any aspect of the existing structure it will be considered "residential renovation." Includes single-family homes, townhouses, apartment complexes, and other multifamily residences. Excludes high-rise apartments, condominiums, and mixed-use buildings.
- **Non-residential Demolition:** Materials generated from the breakdown and removal of an entire existing non-residential structure. If the activity included renovating or remodeling of any aspect of the existing structure, it was considered "non-residential renovation." Includes high-rise apartments, condominiums, and mixed-use buildings.
- **Roofing:** Materials generated from the new construction, remodeling, and/or demolition of residential or non-residential roofs.
- **Other/Mixed Construction:** Materials generated from a mix of activities (e.g., a load with both residential and non-residential demolition materials) or generated from activities not otherwise classified, such as the building, repair, and/or demolition of roads, bridges, and other public infrastructure.

Loads from other types of activities, including homeowner self-hauled C&D waste, manufacturing waste, bagged asbestos, and packing/crating materials were identified as non-C&D loads and the weights were documented, enabling us to quantify the proportion of incoming tonnage that did and did not fit the Study definition of C&D. No samples were characterized from the loads that did not fit the definition of activity types described above.

Material Definitions

The R. W. Beck Project Team and the Sustainability Division developed a comprehensive list of material classes and material types within the respective classes. The material classes initially defined were:

- Construction and Demolition (C&D);
- Paper;
- Glass;
- Metal;
- Plastic;
- Organics;
- E-waste/HHW; and
- Other Materials.

For each material class, the R. W. Beck Project Team defined material type(s) included within each material class.

During the analysis, the material class Construction and Demolition (C&D) was broken down further into four subclasses (C&D: Aggregate, C&D: Wood, C&D: Roofing, and C&D: Other). The final material list, representing 11 material classes/subclasses and 62 material types, is presented in Appendix A.

Sampling Plan

The R. W. Beck Project Team conducted an interview with staff at each of the selected landfills to gather:

- Site contact information;
- Vehicle and traffic information;
- Tonnage information;
- Weighing procedures;
- Material handling procedures; and
- C&D characterization procedures.

A copy of the interview questionnaire form is included in Appendix B.

Based on this information, a customized sampling plan was developed for each site. The sampling plan was used by the field teams to conduct the field characterization at each site.

C&D Field Characterization

Data was gathered at each site during two sampling periods in 2009. The first sampling period ran from March 16th through 30th when the ban on outdoor burning was not in effect and the second ran from September 14th through 25th when the ban on outdoor burning was in effect in the counties shaded in Figure 3-1. Two-field teams were mobilized during each event. Each field team included one person (the field team assistant) that documented incoming loads at the scale house, interviewed the driver, and selected the loads for characterization and a second person (the field team leader) that characterized the loads selected for sampling at or near the working face. An additional crewmember joined one team for the first event and the alternate team for the second event to collect data on the presence of lead-based paint and asbestos-containing materials in the C&D disposed (lead and asbestos expert).

Pre-Mobilization Training

Prior to the first field characterization event, all field staff participated in pre-mobilization training that included both off-site and on-site training. As part of the off-site pre-mobilization planning and training, the Project Manager reviewed the Health and Safety Plan (Appendix C) with the field team members and the lead and asbestos expert. In addition, the Project Manager distributed and reviewed the field data collection forms and procedures. Some of the forms that were distributed during the pre-mobilization planning and training were:

- Vehicle Survey Form (Appendix D)
- Vehicle Selection Form (Appendix E)
- Sample Placard (Appendix F)
- C&D Sample Form (Appendix G)
- Carpet Sample Form (Appendix H)
- Lead-based Paint Form (Appendix I)
- Asbestos-containing Materials Form (Appendix J)

Lastly, the field team members and the lead and asbestos expert received the equipment required to conduct the field data collection.

The team participated together in an on-site pre-mobilization training and calibration on the day prior to the first field collection event. As part of the on-site pre-mobilization training, the two field teams and the lead and asbestos expert performed field data collection together for a half-day. The field teams worked side by side during the training to ensure consistency in the application of the methodology.

Characterization of Loads

Sample Selection

Once in the field, the field team assistant interviewed every vehicle containing C&D material at each selected landfill. As part of the interview, the field team assistant completed the Vehicle Survey Form (Appendix D). The interview provided the information required to assign each load to an activity type and determine whether it was appropriate for characterization. Table 3-2 presents the total targeted samples by C&D activity type.

Table 3-2
Targeted Samples by C&D Waste Source

C&D Activity Type	Daily Targeted Samples	Total Targeted Samples
Residential new construction	5-8	110-150
Non-residential new construction	5-8	110-150
Residential renovation	7-9	140-180
Non-residential renovation	3-5	60-100
Residential demolition	4-6	80-120
Non-residential demolition	4-6	80-120
Roofing	1-4	30-70
Other/Mixed construction	1-4	30-70
Non-C&D Loads	0	0
Total Targeted Samples	40	800

Based on the information gained from the sampling plan developed for each landfill, the field team assistant used a systematic selection process to identify the vehicles selected for sampling. A sampling interval to determine vehicle-sampling frequency for each source was established at the commencement of each field day and adjusted according based on observed truck traffic. The initial sampling intervals were determined by dividing the total number of loads from each source arriving at the facility each day, as reported by the host facility by the number of samples targeted. The resulting number was the sampling frequency, which was used to determine whether, for example, every third vehicle, every sixth vehicle, or every 20th vehicle was to be selected for sampling, as shown on the Vehicle Selection Form (Appendix E). For example, the average targeted daily samples for residential renovation as shown above was eight (8) samples. Therefore, the field team assistant would select every third vehicle containing residential renovation if the host facility reported receiving twenty-four (24) residential renovation loads per day. If the number of vehicles arriving was less than the number anticipated, the field team assistant recalculated the sampling interval based on the actual number of vehicles observed at the host facility.

When a vehicle selected for sampling, the field team assistant placed a Sample Placard on the vehicle's windshield or dashboard to identify it as a vehicle intended for sampling and directed the driver to the sampling area. See Appendix F for an example of a Sample Placard. When the sampling crew intercepted the vehicle, they recorded the information from the sample placard onto the C&D Sample Form (Appendix G).

Characterization of Selected Samples

Once a load was selected for sampling, staff at the landfill directed the load to a designated area. At the designated area, the field crew used the following seven-step process to estimate the composition of all C&D loads identified for sampling by the field team assistant at the scale house.

- **Step 1 – Collect Sample Placard from Driver.** Record the sample number and date on the C&D Sample Form (Appendix G).
- **Step 2 – Measure Load Volume.** Measure and record the length, width, and height of the load while it was still in the vehicle (if possible) or after the load was tipped. Record measurements on the C&D Sample Form.
- **Step 3 – Photograph Sample.** Take photographs of the sample, with the sample placard clearly visible in the photograph.
- **Step 4 – Note which Material Classes are Present.** After the load is tipped, walk entirely around the load and indicate on the sampling form which material classes are present in the load.
- **Step 5 – Estimate Composition by Volume for Each Material Class.** Beginning with the largest material class presents by volume, estimate the percentage by volume of this material class and record it on the form. Repeat this process for the next most common material class, and so forth, until the volumetric percentage of every material class has been estimated. Ensure the total for this step is 100%.
- **Step 6 – Estimate Composition by Volume for Each Material Type.** Considering each material class separately, estimate the percentage by volume of the material class each material type comprises. An example of a material type within the material class of **Paper** is "other recyclable paper". For example, while considering only the **Paper** material class, estimate the volumetric percentages of Paper that other recyclable paper comprises and do so for each material type in the material class **Paper**. The total of percentages for all of the material types within each material class must equal 100%. Repeat this process for the other material classes, with all the material types in each material class totaling 100%.
- **Step 7 – Check and Reconcile Percentage Data.** Verify that the percentage estimates for the material classes add up to 100%. In addition, the percentage estimates for the material types within each material class total 100%.

In addition to the C&D characterization, the field team leader randomly selected loads containing carpet for an independent carpet analysis each day. If a load was selected to be included in the carpet analysis, the field team leader took a sample of all the carpet

types in the load and completed the Carpet Sample Form (Appendix H) which documented the estimated volume of each type of carpet in the load.

If the load was identified as coming from renovation, demolition, other/mixed construction, or roofing, the lead and asbestos expert completed the Lead-based Paint Form (Appendix I) and Asbestos-containing Materials Form (Appendix J) regardless of whether or not painted debris or a targeted potential asbestos-containing material was present. The lead and asbestos expert tested materials for lead at the field observation site using a handheld x-ray fluorescence (XRF) device. Additionally, the lead and asbestos expert collected samples from materials in each target load that potentially contained asbestos (a detailed listing of potential asbestos-containing materials was provided on the Asbestos-containing Materials Form). Collected samples were placed in tightly sealed containers and sent to an accredited asbestos laboratory upon conclusion of each field collection event.

Data Analysis

The data gathered in the field was combined with the annual tonnage data reported by landfills to EPD to estimate the quantity and composition by activity type of C&D disposed in Georgia landfills. A detailed description of the analytical procedure used, with examples, can be found in Appendix K.

Estimating Tons of C&D Disposed

The R. W. Beck Project Team estimated the tons of C&D disposed in Georgia landfills during the study period by estimating the percentage of the total tonnage disposed in MSW and C&D landfills (as reported by EPD) that is C&D as defined for this Study and applying that percentage to the reported tonnage disposed from October 2008 through September 2009. The percentage of material disposed in C&D landfills that fits the study definition of C&D was estimated based on data gathered in the field. While surveying loads delivered to C&D landfills, it was clear that some of the loads entering these facilities were not C&D as defined for this Study; in other words, they were not from construction, demolition, renovation, or roofing sites. These loads typically consisted exclusively of the following types of materials:

- Land clearing debris or yard trimmings;
- Materials from residential clean-outs (e.g., garages);
- Manufacturing waste (where landfill is permitted to accept);
- Pallets;
- Material recovery facility (MRF) residuals; and
- Bagged asbestos.

If the loads entering the C&D landfills contained exclusively the materials listed above and/or the hauler identified that the load came from a site other than a construction, demolition, renovation, or roofing site, these loads were noted and the

tonnage was documented but the loads were not considered C&D and thus not characterized for this Study. On the other hand, if the materials listed above came in loads that were from such sites, they were included in this Study and included in the composition analysis. By summing the tons of all loads that came into the C&D landfills that were from construction, renovation, demolition, roofing, or other types of construction activity and not exclusively the materials listed below, it was estimated that 90.1% of the total tonnage entering C&D landfills fit the definition of C&D for this Study.

To estimate the percentage of waste entering MSW landfills that was C&D was more complicated. A statewide characterization study of solid waste entering MSW landfills in the State concluded that 12.3% of the tonnage entering MSW landfills in 2004 was C&D.[7] However, because the tonnage disposed in C&D landfills in the State has declined by 36.7% while the tonnage of solid waste disposed in MSW landfills has only declined by 2.1% over the same time period, it is likely that the proportion of waste disposed in MSW landfills that is C&D has also declined proportionally. Thus, for this Study, we have assumed that the tons of C&D entering MSW landfills declined by the same 36.7% as all tons disposed in C&D landfills over this time period, resulting in an estimate 928,188 tons of C&D being disposed in MSW landfills during the study period. This is equal to 7.96% of the total solid waste disposed in MSW landfills. Thus, to estimate the total tonnage of C&D disposed during the study period, it is assumed that 7.96% of waste entering MSW landfills in Georgia was C&D during the study period.

Table 3-3
Calculation of C&D Disposed in MSW Landfills During Study Period

	2004	10/08 - 9/09	% Decline
Total Tons Disposed in C&D Landfills[1]	3,604,049	2,282,382	36.67%
Total Tons Disposed in MSW Landfills[1]	11,916,124	11,663,338	2.12%
Tons of C&D disposed in MSW Landfills	1,465,683[2]	928,188[3]	
Calculated Tonnage in MSW Landfills that is C&D		7.96%	

[1] EPD Tonnage Reports.
[2] Based on finding that 12.3% of solid waste disposed in MSW landfills in 2004 was C&D according to *Georgia Statewide Waste Characterization Study,* R. W. Beck, Inc. prepared for the Georgia Department of Community Affairs, June 2005.
[3] Assuming same 36.7% decline from 2004 as the total tonnage disposed in C&D landfills.

Estimating Tons of C&D by Activity and Region

The net weight of each load that was considered C&D was assigned to an activity type (e.g., residential demolition) based on the survey conducted with the driver. Loads that were not C&D, as described above, were excluded. The total tons received from each activity type during the sampling period were extrapolated to estimate the percentage of the C&D disposed at each landfill attributable to each activity type. These

[7] *Georgia Statewide Waste Characterization Study,* R. W. Beck, Inc. prepared for the Georgia Department of Community Affairs, June 2005.

percentages were applied to the total annual tonnage (adjusted to exclude the materials that were not defined as C&D for this Study) received at each landfill to estimate the tons of disposed C&D associated with each activity type at that particular landfill. In some cases, the activity type where the C&D load was generated was not known. Tonnages associated with unknown activity types were allocated proportionally to the other activity types based on the vehicle survey from that landfill. For example, if 10% of the tonnage of C&D received at a host landfill was from an unknown source and 30% was from residential new construction, 30% from non-residential new construction, and 30% from residential demolition, the unknown activity type tonnage would be split evenly among residential new construction, non-residential new construction, and residential demolition.

The allocated tonnage at the ten host landfills was then weighted and summed to estimate the tonnage by activity type separately for landfills 1) in the ten metro-Atlanta counties, 2) in the non-metro Atlanta counties that were subject to the seasonal ban on outdoor burning, and 3) in the non-metro Atlanta counties that were not subject to the seasonal ban on outdoor burning. These regional estimates by activity type were then summed to estimate the total tonnage of C&D disposed from each activity type across the State.

Estimating Composition of C&D

C&D composition was estimated by determining the volume of each material type in each load through visual observation, as described above and, based on industry standard density factors, converting volumes to weight for each material. Composition results by activity type and by region were aggregated, using a weighted averaging method, to estimate the composition across the region and across the state. The confidence interval for these estimates was derived in two steps by first determining the variance around the estimate and second, determining precision levels at the 90% confidence level for the mean of each material type. The composition calculations are described in detail in Appendix K.

Section 4
RESULTS OF CHARACTERIZATION STUDY

Loads Characterized for Study

A total of 786 loads of C&D material were characterized at the ten host sites identified in Section 3 over two seasons to determine the composition of C&D disposed in the State. Table 4-1 shows the number of loads sampled at each site in each of the two seasons while Table 4-2 shows the number of loads sampled within each activity type. As a result of inclement weather during the sampling period and the overall decrease in C&D material generated and disposed in the State, the daily targets indicated in Table 3-2 were not achieved at some of the sites with less traffic. However, by, adding extra days in the field and characterizing a higher proportion of the arriving C&D loads than planned at many sites, the R. W. Beck Team was able to collect sufficient data to characterize and draw conclusions about the composition of the C&D disposed statewide.

Table 4-1
Number of Samples Characterized by Site and Season

Facility Name	Spring 2009	Fall 2009	Total
APAC/GA - Donzi Ln Ph 5A (L)	45	64	109
Camden Co - S.R. 110 C/D/I Waste Landfill	43	65	108
Columbus, Pine Grove MSWL	25	23	48
DeKalb Co-Seminole Rd Ph 2 (SL)	6	10	16
Floyd Co - Rome Walker Mtn Rd C/D Landfill	36	44	80
Houston Co - SR247 Klondike C/D Landfill	49	33	82
Reliable Tire Services, Monroe Dr.	35	53	88
Richmond Co - Deans Bridge Rd Ph III MSWL	12	21	33
Walton Construction & Demolition Landfill	42	83	125
Willow Oak C&D Landfill	55	42	97
Total	348	438	786

Table 4-2
Number of Samples Characterized by Activity Type

Sector	Activity Type[1]	Spring 2009	Fall 2009	Total
Residential	New Construction	62	39	101
	Renovation	71	90	161
	Demolition	49	84	133
	Residential - Subtotal	182	213	395
Non-Residential	New Construction	66	69	135
	Renovation	39	41	80
	Demolition	12	18	30
	Non-Residential - Subtotal	117	128	245
Roofing	Roofing	29	75	104
	Roofing - Subtotal	29	75	104
Other/Mixed Construction	Other/Mixed Construction	20	22	42
	Other/Mixed Construction - Subtotal	20	22	42
	Total	348	438	786

[1] As identified by driver of vehicle delivering C&D load.

Generally, characterizing more samples is better because an increase in sample numbers reliably reduces the error ranges. With a material stream as variable from load to load as C&D (compared to single family residential garbage, which is relatively uniform from load to load, for example) this is especially true. Thus, with resource constraints in mind, the R.W. Beck Project Team, in consultation with EPD staff, set-sampling goals based on experience with similar studies in similar jurisdictions. For example, in 2004, a study for the State of California (with a population of nearly 37 million) characterized 622 samples of disposed C&D, with a goal of at least 40 samples per activity type (except for the other/mixed C&D activity). For this Study for the State of Georgia (population approximately 10 million), the R. W. Beck Project Team characterized at least 40 samples from each activity type (except non-residential demolition) for a total of 786 samples to create a robust data set.

Tons of C&D Disposed

As shown in Table 4-3, using the methodology described in Section 3, the resulting total tonnage of C&D disposed in MSW and C&D landfills in Georgia from October 1, 2008 through September 30, 2009 was estimated to be 2,952,123 tons, 927,846 tons in MSW landfills and 2,024,277 tons in C&D landfills. The Study design excluded tonnages of C&D material disposed in inert landfills due to the lack of tonnage data available. The Study also excluded tonnage disposed at the two industrial landfills due to the variation in materials authorized to be accepted at these facilities.

Table 4-3
Estimated C&D Disposed in Georgia
October 2008 – September 2009

Facility Type	Total Tons Disposed[1]	Adjusted Total Tons Disposed[2]	% of Solid Waste Disposed that is from Construction, Renovation, Demolition, and Roofing Sites	Estimated Tons
MSW Landfills	11,659,284	NA	8.0%[3]	927,846
C&D Landfills	2,286,436	2,245,729	90.1%[4]	2,024,277
Total	13,945,720	13,905,014	21.2%	2,952,123

[1] Tonnage received at the cell receiving C&D at the Columbus Pine Grove Landfill was treated as a C&D Landfill for purposes of the Study, although this tonnage was reported to EPD as an MSW landfill. For this reason, these totals do not exactly match the totals in the EPD reports.

[2] Select host facilities were permitted to accept industrial waste and/or 100% bagged asbestos. The adjusted total tons reflects the total tons reported to the State as disposed at C&D landfills less the industrial waste and 100% bagged asbestos accepted at the host facilities.

[3] Percentage from construction, demolition, renovation, and roofing activities was estimated to be 7.96% (rounded to 8.0%) for MSW landfills based on historical data.

[4] As measured for this Study.

Figure 4-1 illustrates that based on this analysis, an estimated 21.2% of the solid waste disposed in C&D and MSW landfills in Georgia was C&D as defined for this Study, that is C&D generated by construction, renovation, demolition, and roofing activities. Figure 4-2 shows that 68.6% of the C&D disposed in the State was disposed in C&D landfills while 31.4% was disposed in MSW landfills. Slightly more tons of C&D were disposed in metro than in non-metro Atlanta.

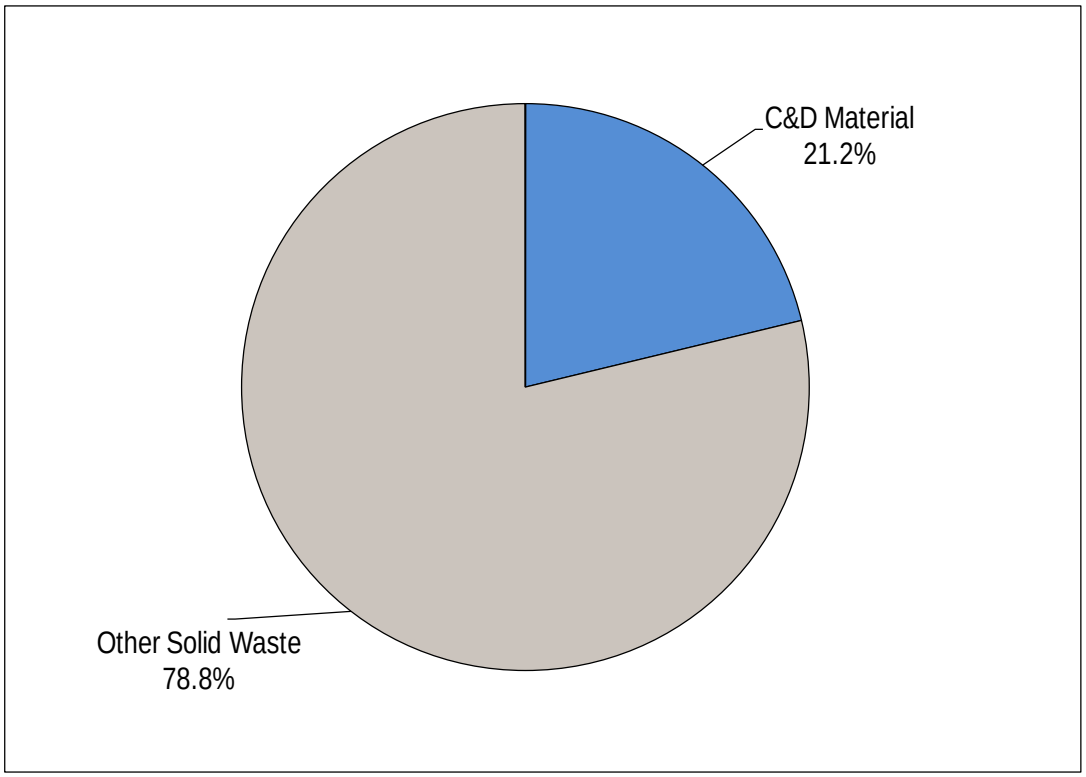


Figure 4-1. C&D and Other Solid Waste Disposed in C&D and MSW Landfills in Georgia, October 2008 – September 2009

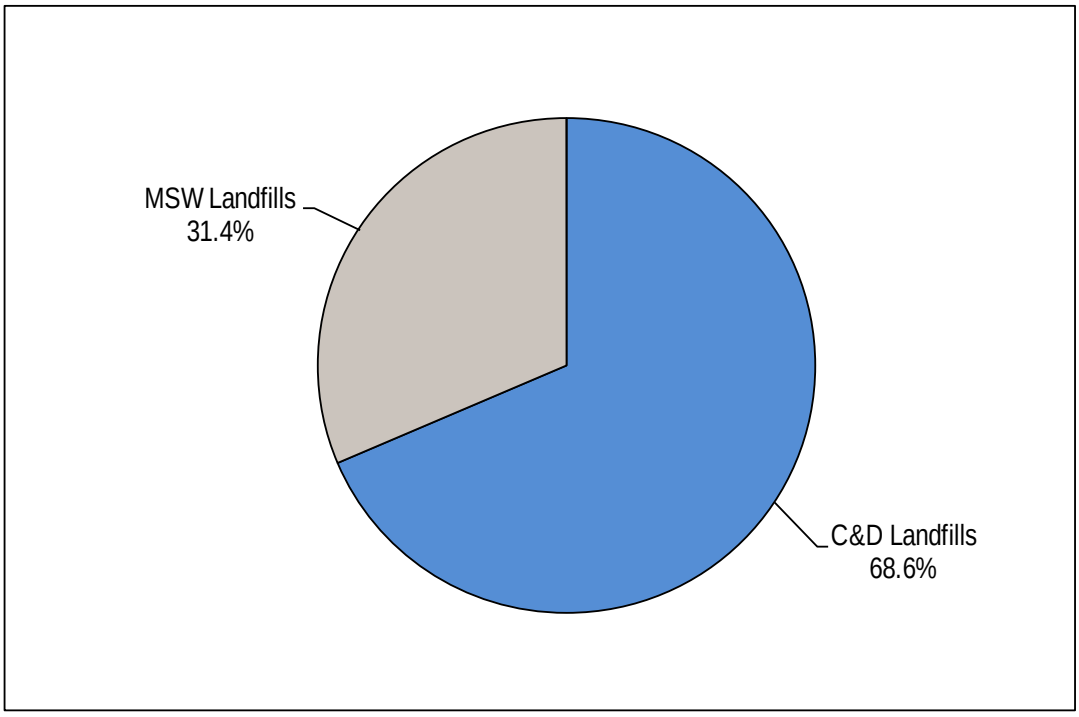


Figure 4-2. Type of Facility Where C&D is Disposed in Georgia, October 2008 – September 2009

Statewide Aggregate Composition

Figure 4-3 presents the statewide aggregate composition of C&D delivered for disposal by material class when the composition of the sampled loads was weighted and extrapolated to all C&D disposed statewide. More than 88% of the material in loads from C&D activities was defined by the Study as material types included in the C&D material class.

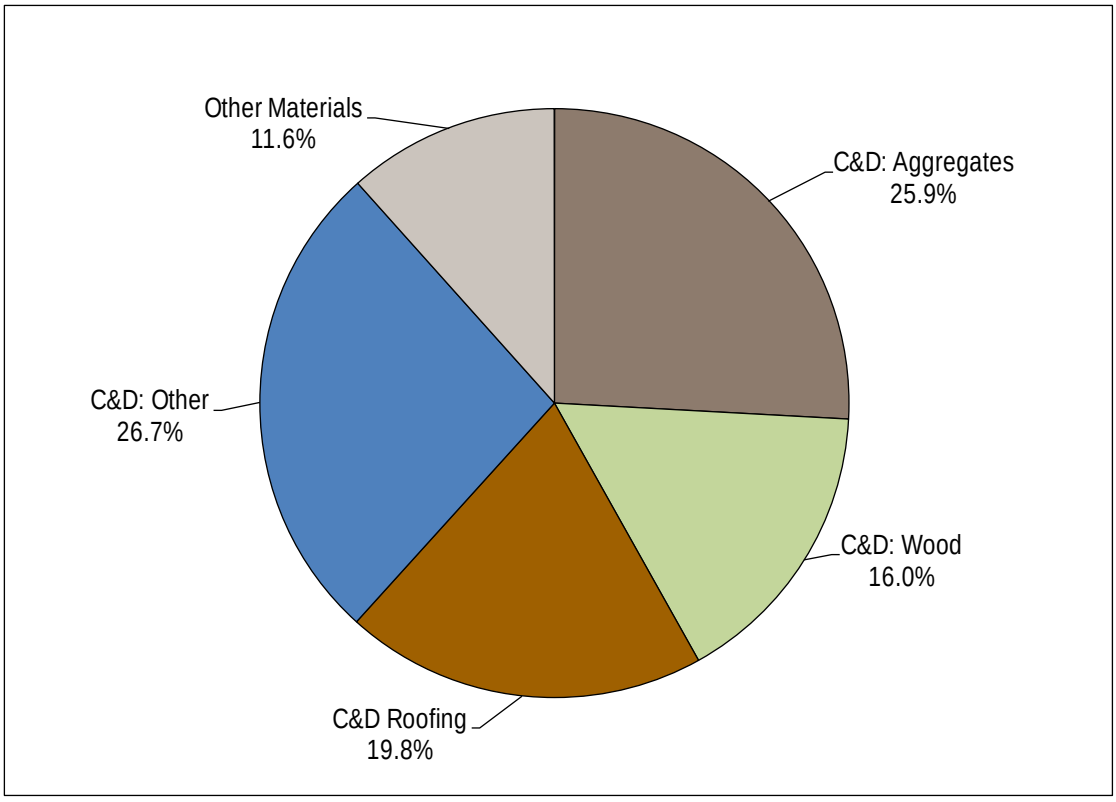


Figure 4-3. Composition of C&D Disposed in Georgia, by Material Class, October 2008 – September 2009

Table 4-4 shows the composition and estimated cubic yards and tons of each material type in C&D loads disposed at MSW and C&D landfills in the State.

Table 4-4
Statewide Aggregate Composition of C&D Disposed in Georgia
October 2008 – September 2009

Class	Material	% of C&D Debris Disposed	Estimated CY	Estimated Tons[1]	Lower Boundary[2]	Upper Boundary[2]
C&D Aggregate	Unpainted Concrete	14.0%	959,237	412,472	12.0%	16.0%
	Painted Concrete	1.2%	83,926	36,088	0.3%	2.1%
	Unpainted Asphalt Paving	2.5%	190,329	73,543	1.5%	3.4%
	Painted Asphalt Paving	0.0%	2,283	882	0.0%	0.1%
	Unpainted Brick and Other Aggregates	8.0%	546,951	235,189	6.5%	9.4%
	Painted Brick and Other Aggregates	0.2%	12,714	5,467	0.1%	0.3%
	Total C&D Aggregate	25.9%	1,795,439	763,641	20.4%	31.3%
C&D Wood	Clean Dimensional Lumber	5.3%	1,866,426	157,713	4.6%	6.0%
	Unpainted Large Structural Wood	0.5%	178,876	15,115	0.1%	0.9%
	Painted Large Structural Wood	0.0%	3,799	321	0.0%	0.0%
	Clean Engineered Wood	4.6%	1,005,366	134,719	4.0%	5.2%
	Standard Size Wood Pallets	1.5%	536,497	45,334	1.3%	1.8%
	Painted/Stained Wood	3.5%	1,229,882	103,925	3.0%	4.0%
	Other Treated Wood	0.1%	44,521	3,762	0.0%	0.2%
	Creosote-treated Wood	0.0%	5,692	481	0.0%	0.0%
	Other Wood Pallets and Crates	0.4%	136,521	11,536	0.2%	0.5%
	Total C&D Wood	16.0%	5,007,579	472,906	13.3%	18.7%
C&D Roofing	Composition Roofing	18.3%	1,474,520	538,937	16.6%	19.9%
	Other Asphalt Roofing	1.6%	125,256	45,781	0.7%	2.4%
	Total C&D Roofing	19.8%	1,599,776	584,718	17.3%	22.4%
C&D Other	Clean Gypsum Board	5.4%	684,861	159,915	4.2%	6.6%
	Painted/Demolition Gypsum	1.6%	199,370	46,553	1.1%	2.1%
	Acoustic Ceiling Tiles	0.2%	85,565	6,289	0.1%	0.3%
	Rock and Gravel	0.7%	40,799	20,379	0.3%	1.1%
	Dirt and Sand	10.5%	668,013	310,292	8.8%	12.2%
	Fiberglass Insulation	0.1%	371,529	3,158	0.1%	0.1%
	Expanded Polystyrene Insulation	0.2%	441,000	7,056	0.1%	0.4%
	Unpainted Remainder/ Composite C&D	6.3%	886,222	184,569	5.1%	7.4%
	Painted Remainder/Composite C&D	1.7%	239,166	49,810	1.3%	2.1%
	Total C&D Other	26.7%	3,616,525	788,021	21.0%	32.4%
Paper	Uncoated Corrugated Cardboard/ Kraft Paper	0.8%	881,132	23,350	0.7%	0.9%
	Other Recyclable Paper	0.3%	64,563	9,523	0.2%	0.4%
	Cellulose Insulation	0.0%	110,824	942	0.0%	0.1%
	Remainder/Composite Paper	0.3%	46,916	8,527	0.1%	0.5%
	Total Paper	1.4%	1,103,434	42,342	1.0%	1.9%
Glass	Glass Bottles and Containers	0.0%	2,690	807	0.0%	0.0%
	Flat Glass	0.4%	15,053	10,537	0.2%	0.5%
	Remainder/Composite Glass	0.2%	7,017	4,912	0.1%	0.3%
	Total Glass	0.6%	24,760	16,255	0.3%	0.8%

Class	Material	% of C&D Debris Disposed	Estimated CY	Estimated Tons[1]	Lower Boundary[2]	Upper Boundary[2]
Metal	Major Appliances	0.0%	13,200	957	0.0%	0.1%
	HVAC Ducting	0.0%	53,489	1,257	0.0%	0.1%
	Other Ferrous	2.8%	734,853	82,671	2.4%	3.2%
	Other Non-Ferrous	0.1%	29,636	3,334	0.1%	0.2%
	Remainder/Composite Metal	0.1%	56,529	4,037	0.0%	0.2%
	Total Metal	3.1%	887,707	92,257	2.5%	3.7%
Plastic	Recyclable Plastic Containers	0.0%	20,505	276	0.0%	0.0%
	HDPE Buckets	0.1%	161,250	1,935	0.1%	0.1%
	Expanded Polystyrene Packaging	0.0%	46,688	747	0.0%	0.0%
	Non-Bag Commercial and Industrial Packaging Film	0.1%	156,914	2,746	0.1%	0.1%
	Tyvek	0.0%	7,886	138	0.0%	0.0%
	Other Film	0.1%	252,836	3,900	0.1%	0.2%
	Plastic Siding/Decking	0.0%	54,240	1,356	0.0%	0.1%
	Plastic Pallets	0.0%	1,360	34	0.0%	0.0%
	Durable Plastic Items	0.2%	195,400	4,885	0.1%	0.2%
	Plastic Piping	0.7%	155,901	21,943	0.6%	0.9%
	Remainder/Composite Plastic	0.1%	78,480	1,962	0.0%	0.1%
	Total Plastic	1.4%	1,131,460	39,922	1.0%	1.7%
Organics	Yard Trimmings	1.4%	257,088	40,170	0.9%	1.8%
	Branches and Stumps	0.4%	188,803	11,989	0.2%	0.6%
	Total Organics	1.8%	445,891	52,159	1.1%	2.5%
E-waste/ HHW	E-Waste	0.0%	4,866	894	0.0%	0.1%
	Asbestos labeled bags	-	-	-	0.0%	0.0%
	Other HHW	0.2%	6,437	5,379	0.1%	0.3%
	Total E-waste/HHW	0.2%	11,303	6,273	0.1%	0.3%
Other Materials	Carpet	1.5%	587,279	43,165	0.6%	2.4%
	Carpet Padding	0.2%	211,258	6,549	0.1%	0.3%
	Wood Furniture	0.3%	93,692	7,917	0.2%	0.4%
	Plastic Furniture	0.0%	2,080	52	0.0%	0.0%
	Mattresses and Box Springs	0.1%	54,475	2,179	0.0%	0.1%
	Tires	0.0%	11,450	1,145	0.0%	0.1%
	Remainder/Composite Other Materials	0.4%	166,555	11,892	0.2%	0.6%
	Total Other Materials	2.5%	1,126,789	72,899	1.1%	3.8%
MSW	Total MSW	0.7%	184,276	20,731	0.5%	0.9%
Total C&D Disposed		100.0%	16,934,939	2,952,123		

[1] The R.W. Beck Project Team converted observed cubic yards to tons for each material based on conversion factors included in the following documents: "Measuring Recycling: A Guide for State and Local Governments," document no. EPA530-R-97-011 (September 1997); "Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste" (2006); "Converting C&D Debris from Volume to Weight: A Fact Sheet for C&D Debris Facility Operators" (2000); and resources from the Tellus Institute.

[2] The R.W. Beck Project Team calculated the upper and lower boundary at a 90% confidence interval.

Figure 4-4 shows the top ten most prevalent materials in C&D disposed in the State, by weight, when the results of 786 samples taken at the ten landfills were weighted and extrapolated to all C&D disposed statewide. More than 75,000 tons of each of these material types was estimated to be disposed in C&D and MSW landfills in Georgia from October 2008 through September 2009. Together, these materials comprised approximately 78.6% of the C&D disposed in the State. The most

commonly characterized material type disposed was composition roofing, with an estimated 538,937 total tons disposed in landfills in Georgia during the study year. Unpainted material types within the C&D Aggregates material class also comprised a large amount of C&D disposed with over 412,472 tons of unpainted concrete and over 235,189 tons of unpainted brick and aggregate estimated to be disposed at State C&D and MSW landfills during the study year. Also in the top ten material types is an estimated 310,292 tons of dirt and sand, 184,569 tons of unpainted remainder/composite C&D, 159,915 tons of clean gypsum board, 157,713 tons of clean dimensional lumber, 134,719 tons of clean engineered wood, 103,925 tons of painted/stained wood, and 82,671 tons of other ferrous. Diverting these high tonnage materials would have the most significant impact on total tons disposed, so the R. W. Beck Project Team primarily focused on these materials in researching challenges, opportunities, and reduction strategies. However, some of the materials comprising a smaller percentage of the total C&D disposed could also be diverted from disposal, either individually or in conjunction with one or more other material types. Figure 4-5 shows the remaining material types comprising more than one percent of the C&D disposed, or between 36,000 and 73,000 tons per year. Together, these material types comprise another estimated 12.9% of the C&D disposed and several of them likely could be diverted from disposal including standard sized pallets, carpet, and yard trimmings.

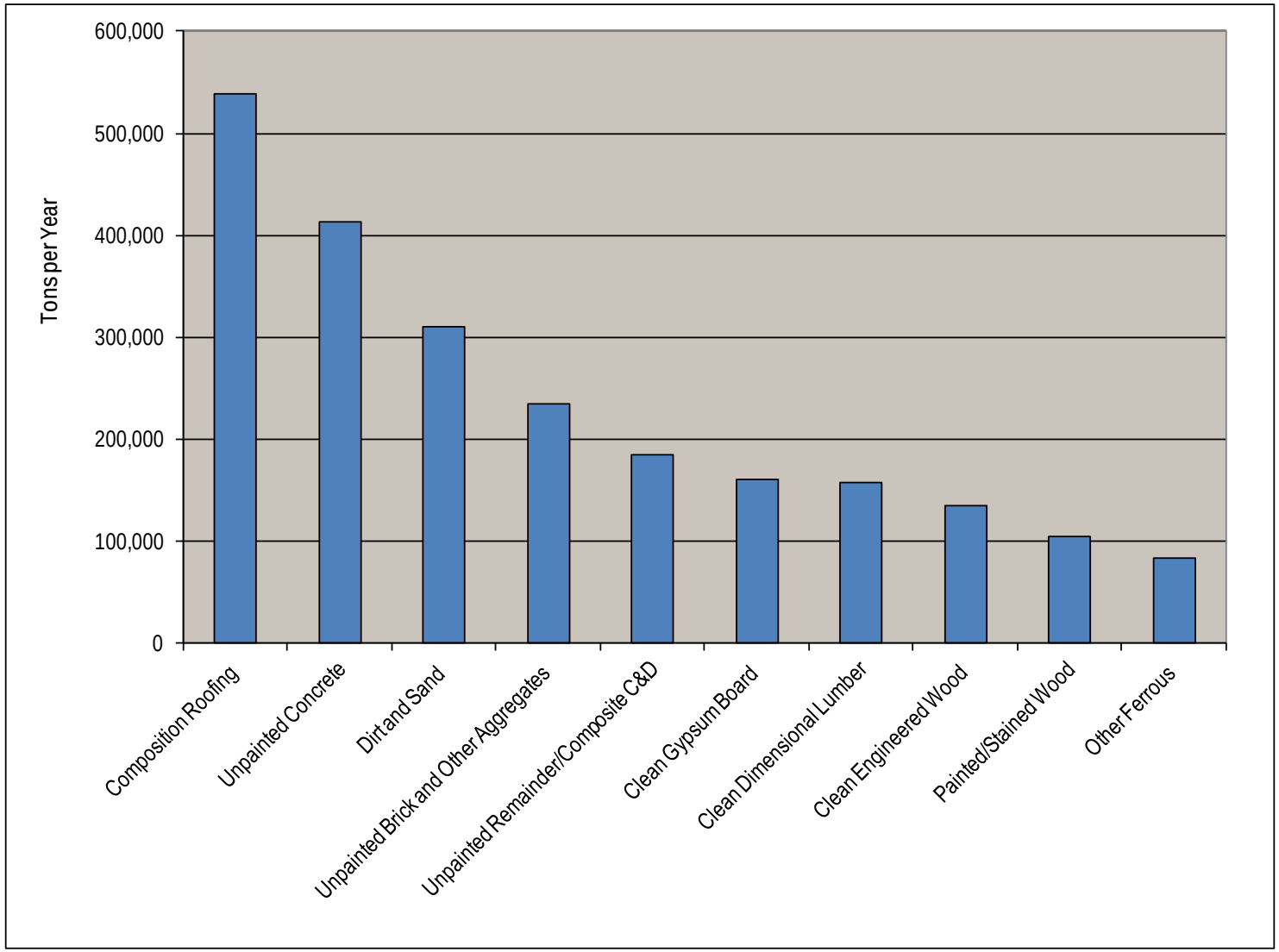


Figure 4-4. Top Ten Material Types in C&D Disposed in Georgia, October 2008 – September 2009

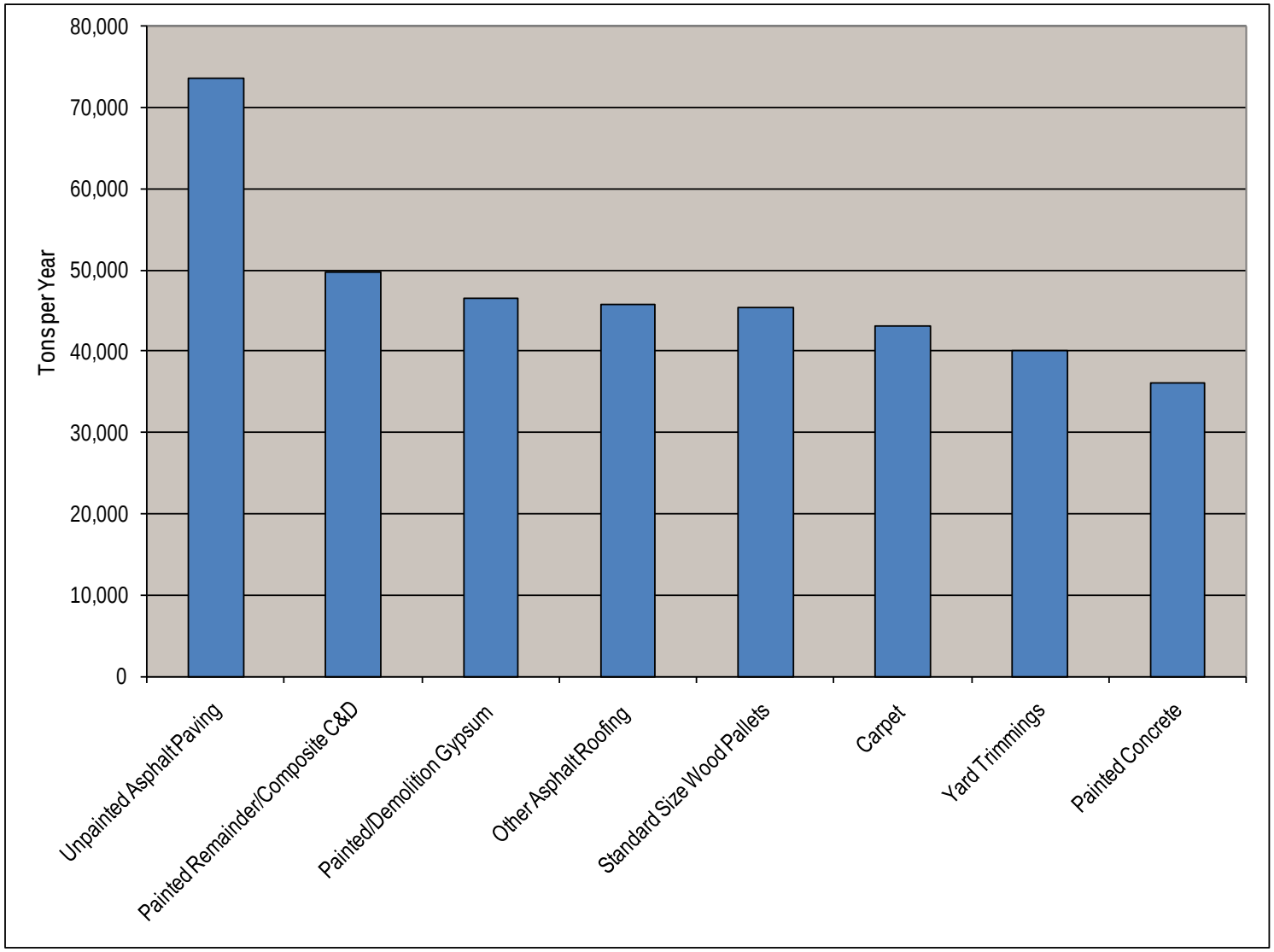


Figure 4-5. Other Material Types Comprising More than 1% of C&D Disposed in Georgia, October 2008 – September 2009

Quantity and Composition of C&D by Activity Type

The amount of C&D disposed from each activity type was estimated using the process described in Appendix K. Table 4-5 shows that more tons of C&D arrived at the landfills from non-residential new construction activities than from any other individual activity type, with roofing activities generating the second highest amount of C&D being disposed by an individual C&D activity type. Unique conditions during sampling could have resulted in more roofing material than average since at least at one site, property owners in the region were replacing roofs damaged by a recent hailstorm to meet an approaching deadline for insurance reimbursement. At this site, the majority of loads arriving in the second season of sampling were reportedly from roofing activities.

Table 4-5
Estimated Tons per Year Disposed by Activity Type
October 2008 – September 2009

Sector	Activity Type[1]	Estimated Tons
Residential	Residential new construction	249,329
	Residential renovation	400,055
	Residential demolition	454,997
	Residential - Subtotal	1,104,381
Non-Residential	Non-residential new construction	592,761
	Non-residential renovation	301,375
	Non-residential demolition	129,111
	Non-Residential - Subtotal	1,023,248
Roofing	Roofing	560,291
Other/Mixed	Other/Mixed	264,203
Total		2,952,123

[1] Based on activity type cited by driver.

Table 4-5 also shows that slightly more tons from construction, renovation, and demolition sites came from residential than non-residential sites. Within the residential sector, more C&D came from demolition and renovation than new construction whereas in the non-residential activity type, more C&D came from new construction. As a whole, however, more material came from new construction than any other activity type when residential and non-residential activities were considered.

Table 4-6 shows the estimated tons of C&D material types disposed in C&D and MSW landfills in Georgia from each of the eight activity types based on the samples taken in the field. These results can be used to evaluate the most likely sources of a particular material type. For example, Figure 4-6 shows that more clean dimensional lumber would likely be found in residential than in non-residential loads and loads from residential demolition sites would produce the highest tonnage of clean dimensional lumber. On the other hand, Figure 4-7 shows that non-residential construction is the activity type that generates the greatest amount of unpainted

aggregate currently disposed (including the material types unpainted concrete, unpainted asphalt, and unpainted brick and other aggregates). Figures 4-8 through 4-10 show similar information about the originating activity types for wood pallets other ferrous (non-appliances), and clean gypsum board.

Table 4-6
Estimated Tons of Material Types in C&D Disposed from Each Activity Type
October 2008 – September 2009

Class	Material	Residential			Non-Residential			Roofing	Other/ Mixed	Total
		NC	RN	DM	NC	RN	DM			
C&D Aggregate	Unpainted Concrete	26,832	30,840	73,563	127,278	84,392	27,217	1,090	41,261	412,472
	Painted Concrete	704	3,900	10,940	-	3,857	16,687	-	-	36,088
	Unpainted Asphalt Paving	834	48	-	8,022	6,531	1,414	9,539	47,154	73,543
	Painted Asphalt Paving	-	-	-	-	-	-	-	882	882
	Unpainted Brick and Other Aggregates	26,920	32,220	60,008	55,647	16,544	14,833	27,313	1,704	235,189
	Painted Brick and Other Aggregates	-	3,128	293	1,593	-	229	-	223	5,467
	Total C&D Aggregate	55,290	70,136	144,804	192,540	111,324	60,380	37,942	91,225	763,641
C&D Wood	Clean Dimensional Lumber	28,498	29,605	40,732	28,663	15,650	8,752	3,292	2,521	157,713
	Unpainted Large Demolition Wood	15	380	1,261	12,685	582	-	-	194	15,115
	Painted Large Demolition Wood	-	-	-	-	321	-	-	-	321
	Clean Engineered Wood	40,635	18,750	22,297	24,979	11,951	5,967	7,353	2,787	134,719
	Standard Size Wood Pallets	6,107	2,511	423	20,366	5,536	2,201	7,638	553	45,334
	Painted/Stained Wood	3,616	37,954	38,364	5,323	8,889	1,307	2,980	5,492	103,925
	Other Treated Wood	137	2,184	869	487	-	-	-	85	3,762
	Creosote-treated Wood	-	387	-	-	95	-	-	-	481
	Other Wood Pallets and Crates	2,038	577	-	5,833	960	2,011	75	41	11,536
	Total C&D Wood	81,045	92,348	103,945	98,335	43,983	20,239	21,338	11,673	472,906
C&D Roofing	Composition Roofing	10,639	41,880	22,017	3,435	3,072	3,341	447,735	6,820	538,937
	Other Asphalt Roofing	-	-	1,172	875	80	119	31,606	11,928	45,781
	Total C&D Roofing	10,639	41,880	23,188	4,310	3,152	3,460	479,341	18,748	584,718

Class	Material	Residential			Non-Residential			Roofing	Other/ Mixed	Total
		NC	RN	DM	NC	RN	DM			
C&D Other	Clean Gypsum Board	34,649	14,900	7,012	84,068	16,800	939	93	1,453	159,915
	Painted/Demolition Gypsum	601	13,667	9,760	2,043	16,021	3,326	613	523	46,553
	Acoustic Ceiling Tiles	-	489	-	1,895	3,905	-	-	-	6,289
	Rock and Gravel	1,388	910	133	13,016	3,197	-	-	1,735	20,379
	Dirt and Sand	16,520	28,202	18,920	89,503	23,623	10,009	1,703	121,812	310,292
	Fiberglass Insulation	197	737	220	1,419	448	118	2	16	3,158
	Expanded Polystyrene Insulation	281	448	68	5,229	503	170	357	-	7,056
	Unpainted Remainder/Composite C&D	11,810	36,786	83,266	17,354	10,719	20,677	2,532	1,425	184,569
	Painted Remainder/Composite C&D	88	23,124	19,300	2,189	3,183	114	-	1,812	49,810
	Total C&D Other	65,534	119,262	138,680	216,716	78,398	35,354	5,301	128,776	788,021
Paper	Uncoated Corrugated Cardboard/ Kraft Paper	3,717	2,926	426	9,937	4,346	185	1,545	269	23,350
	Other Recyclable Paper	622	1,656	1,313	1,942	2,243	518	1,156	72	9,523
	Cellulose Insulation	-	127	1	-	0	815	-	-	942
	Remainder/Composite Paper	9	2,734	4	2,474	2,443	-	19	842	8,527
	Total Paper	4,349	7,443	1,744	14,354	9,032	1,517	2,720	1,183	42,342
Glass	Glass Bottles and Containers	290	183	120	213	1	-	-	-	807
	Flat Glass	267	6,729	890	22	1,446	446	-	736	10,537
	Remainder/Composite Glass	1,058	2,349	122	324	633	220	206	-	4,912
	Total Glass	1,616	9,261	1,133	559	2,080	666	206	736	16,255
Metal	Major Appliances	-	523	327	-	108	-	-	-	957
	HVAC Ducting	81	295	129	122	310	42	257	22	1,257
	Other Ferrous	5,749	9,034	15,238	28,742	13,966	3,382	5,698	862	82,671
	Other Non-Ferrous	199	255	1,597	1,091	152	-	40	-	3,334
	Remainder/Composite Metal	1	880	944	112	1,942	78	5	75	4,037
	Total Metal	6,029	10,987	18,235	30,068	16,477	3,502	6,000	958	92,257

Class	Material	Residential			Non-Residential			Roofing	Other/ Mixed	Total
		NC	RN	DM	NC	RN	DM			
Plastic	Recyclable Plastic Containers	94	53	6	77	18	2	20	7	276
	HDPE Buckets	356	300	71	797	199	4	128	80	1,935
	Expanded Polystyrene Packaging	162	103	8	366	54	3	17	33	747
	Non-Bag Commercial and Industrial Packaging Film	479	149	81	1,302	199	19	319	199	2,746
	Tyvek	0	-	10	2	95	11	19	-	138
	Other Film	656	622	44	1,132	346	68	999	32	3,900
	Plastic Siding/Decking	236	467	228	177	1	117	-	131	1,356
	Plastic Pallets	-	-	-	34	-	-	-	-	34
	Durable Plastic Items	460	1,544	721	804	675	44	536	100	4,885
	Plastic Piping	2,945	760	4,880	10,019	2,927	318	20	74	21,943
	Remainder/Composite Plastic	117	580	127	336	333	99	5	365	1,962
	Total Plastic	5,506	4,577	6,175	15,046	4,847	685	2,064	1,022	39,922
Organics	Yard Trimmings	10,261	11,711	4,704	7,340	3,799	696	1,550	108	40,346
	Branches and Stumps	1,782	2,489	1,257	5,168	100	412	256	526	11,989
	Total Organics	12,043	14,200	5,962	12,508	3,899	1,109	1,806	634	52,159
E-Waste and Asbestos	E-Waste	34	355	246	123	128	-	-	7	894
	Asbestos-labeled bags	-	-	-	-	-	-	-	-	-
	Other HHW	229	1,913	503	245	2,461	-	28	-	5,379
	Materials That May Require Alt. Mgt	264	2,268	749	368	2,589	-	28	7	6,273
Other Materials	Carpet	2,625	9,374	2,623	2,622	17,756	1,020	843	6,301	43,165
	Carpet Padding	1,453	2,472	777	6	34	198	159	1,448	6,549
	Wood Furniture	86	4,292	684	52	2,297	205	252	49	7,917
	Plastic Furniture	-	-	-	-	14	38	-	-	52
	Mattresses and Box Springs	195	681	634	127	449	95	-	-	2,179
	Tires	391	352	173	200	28	-	-	-	1,145
	Remainder/Composite Other Materials	771	4,632	2,574	695	1,400	507	1,313	-	11,892
	Total Other Materials	5,521	21,804	7,467	3,701	21,978	2,062	2,568	7,798	72,899
MSW	Total MSW	1,493	5,890	2,916	4,256	3,616	138	976	1,444	20,731
TOTAL C&D DISPOSED		249,329	400,055	454,997	592,761	301,375	129,111	560,291	264,203	2,952,123

NC = New Construction, RN = Renovation, DM = Demolition

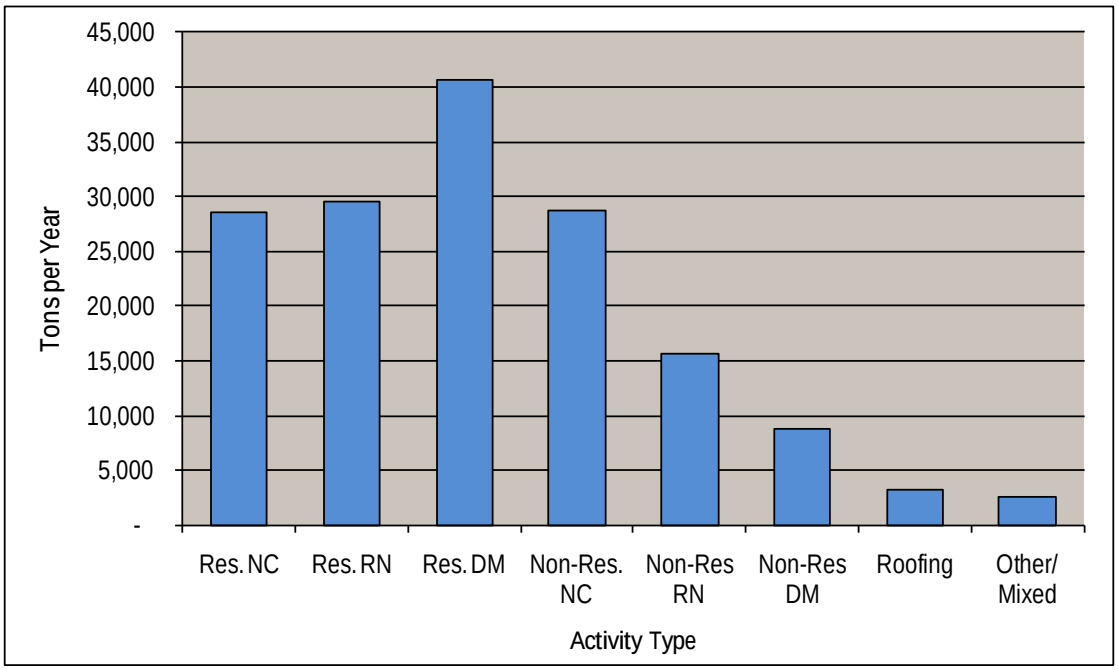


Figure 4-6. Estimated Tons of Clean Dimensional Lumber from Each Activity Type, October 2008 – September 2009

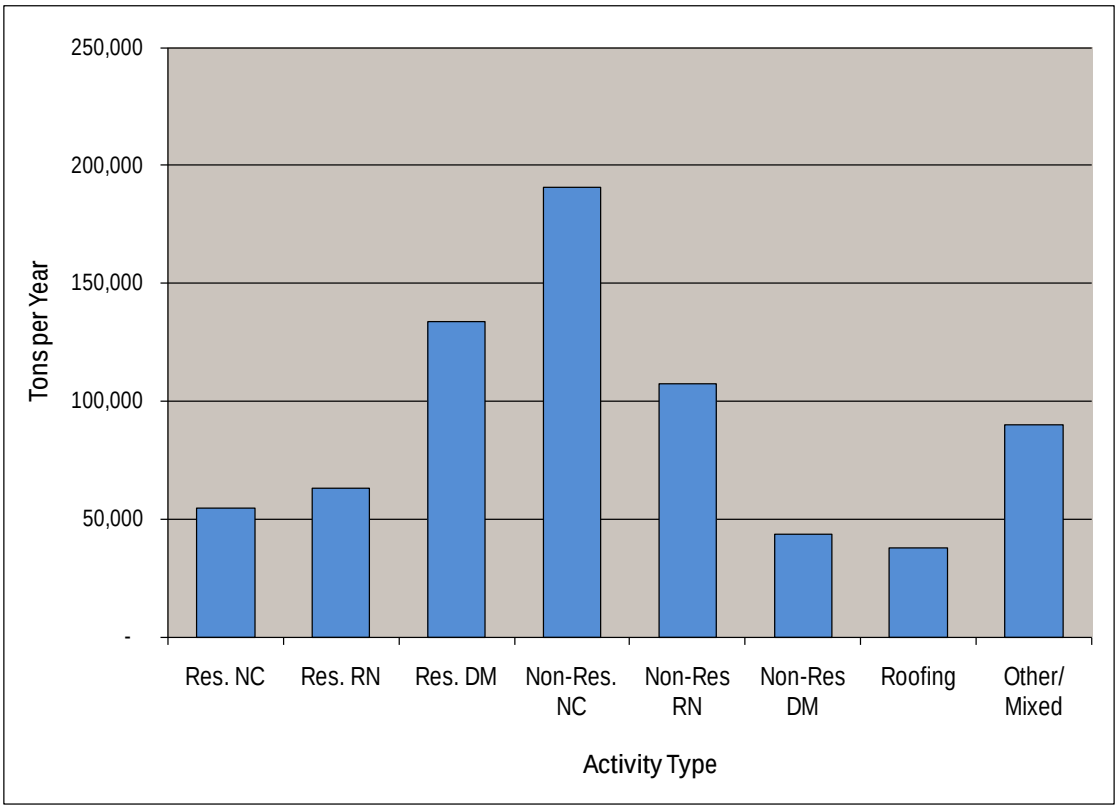


Figure 4-7. Estimated Tons of Unpainted Aggregate from Each Activity Type, October 2008 – September 2009

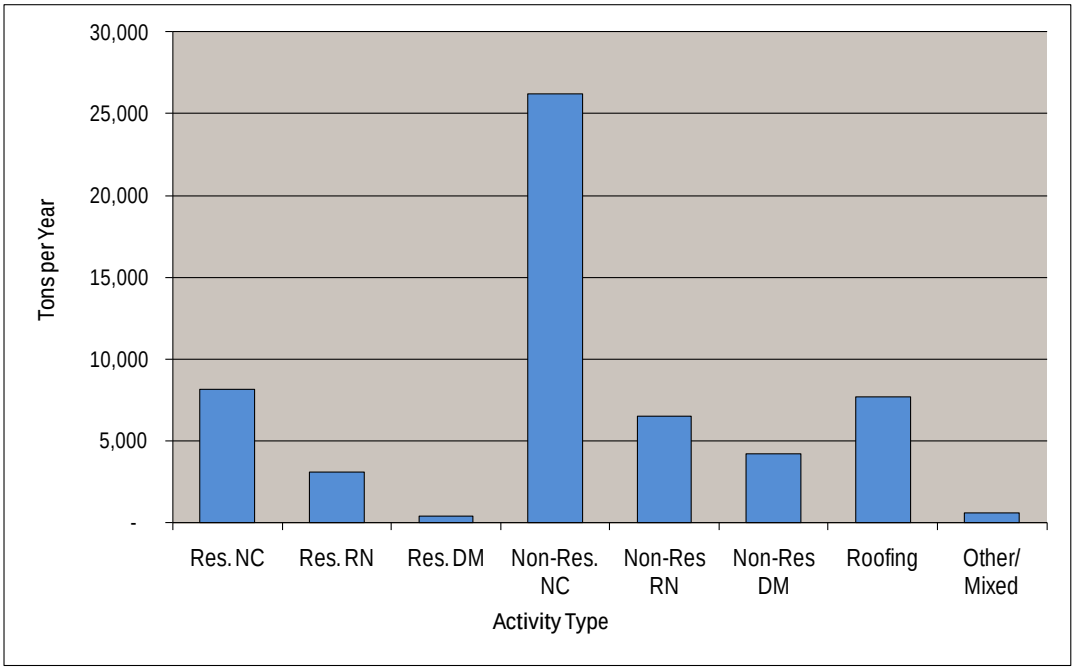


Figure 4-8. Estimated Tons of Wood Pallets from Each Activity Type, October 2008 – September 2009

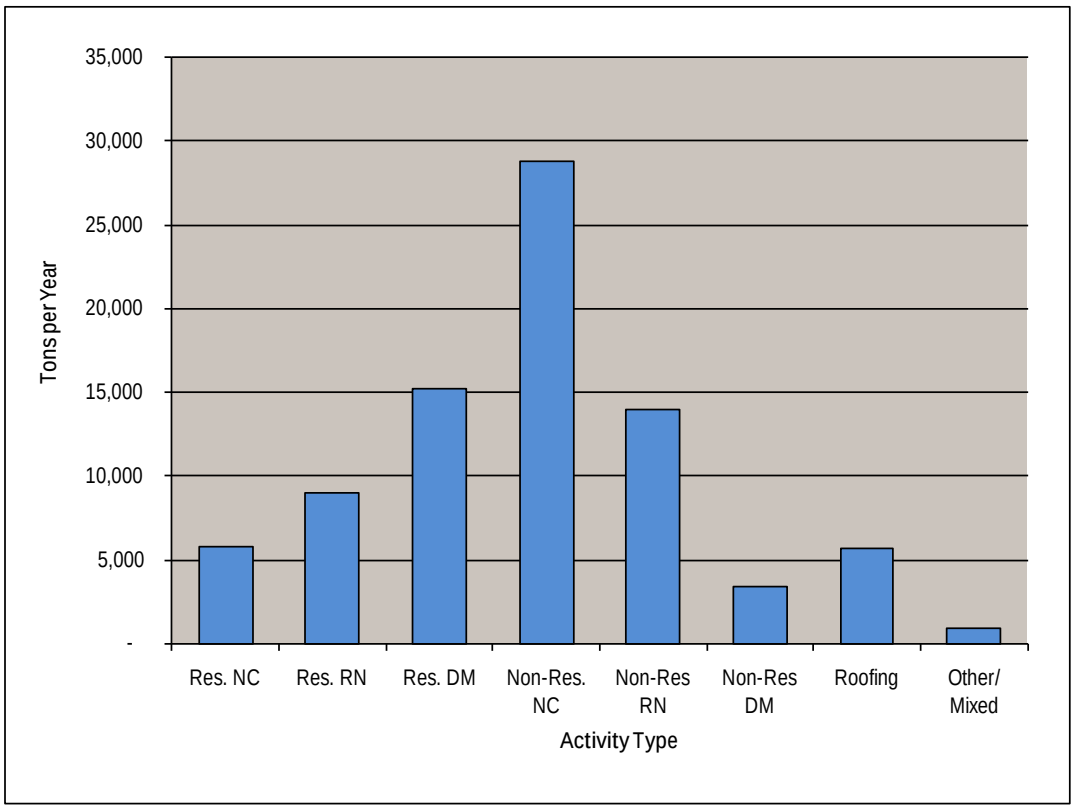


Figure 4-9. Estimated Tons of Other Ferrous from Each Activity Type, October 2008 – September 2009

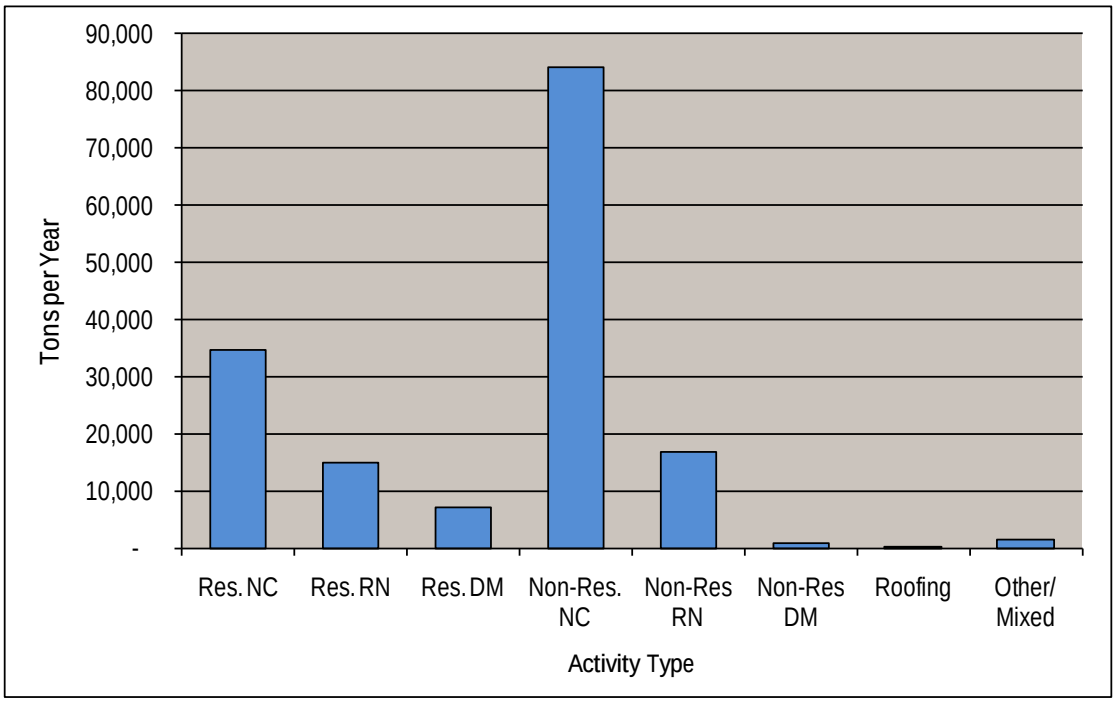


Figure 4-10. Estimated Tons of Clean Gypsum Board from Each Activity Type, October 2008 – September 2009

Quantity and Composition by Region

To further analyze where individual types of C&D materials are disposed, the R. W. Beck Project Team analyzed the respective tonnages and composition of C&D disposed in the ten counties of the metro-Atlanta region and all other areas of the State. Based on the data gathered in the field and the quarterly tonnage reported to EPD, just over half of the material from construction, renovation, demolition, and roofing sites disposed in the State is disposed in the ten counties of the metro Atlanta region as shown in Figure 4-11.[8]

[8] For purposes of this study, the metro-Atlanta region includes the ten counties of the Atlanta Regional Commission, specifically Cherokee, Clayton, Cobb, Dekalb, Douglas, Fayette, Fulton, Gwinnett, Henry, and Rockdale.

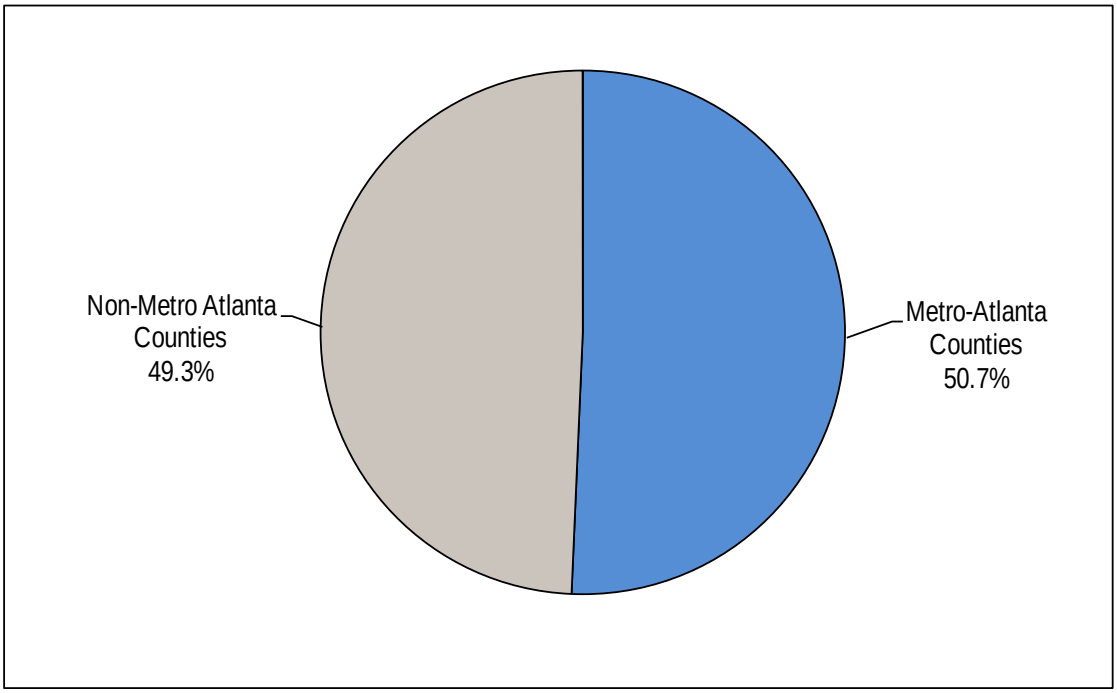


Figure 4-11. Estimated Proportion of C&D Disposed by Region
October 2008 – September 2009

The composition between the C&D disposed in the metro-Atlanta region and that disposed elsewhere in the State is shown in Figure 4-12. More wood and roofing materials are found in C&D disposed outside of metro-Atlanta while more C&D: Other is found in C&D disposed in metro-Atlanta counties. Table 4-7 shows that the main reason that there is nearly twice as much of the C&D: Other material class found in C&D disposed in metro-Atlanta is because there was more dirt and sand in C&D disposed in metro-Atlanta than in other areas of the State. When the sample results were weighted and extrapolated statewide, more than six times more dirt and sand was disposed in C&D loads in metro-Atlanta than elsewhere. In fact, dirt and sand comprised 18% of the total C&D disposed in metro-Atlanta. More rock and gravel, painted gypsum, and remainder/composite C&D was also found in metro-Atlanta C&D disposed while more clean gypsum board, fiberglass insulation and expanded polystyrene insulation was found in other parts of the State.

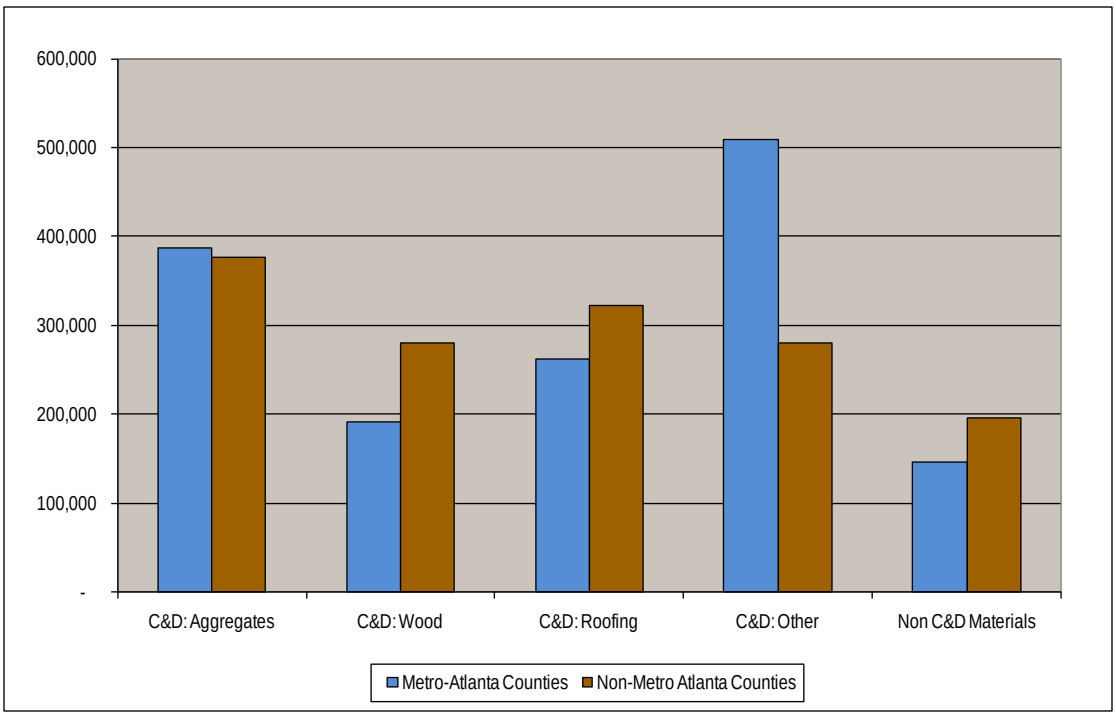


Figure 4-12. Estimated Tons of C&D Material Classes Disposed by Region, October 2008 – September 2009

Table 4-7
Estimated Tons of "C&D: Other" Disposed by Region
October 2008 – September 2009

Material	Metro-Atlanta	Outside Metro-Atlanta
Clean Gypsum Board	60,778	99,137
Painted/Demolition Gypsum	28,426	18,127
Acoustic Ceiling Tiles	2,937	3,351
Rock and Gravel	11,870	8,508
Dirt and Sand	269,033	41,259
Fiberglass Insulation	1,197	1,961
Expanded Polystyrene Insulation	1,083	5,973
Unpainted Remainder/Composite C&D	103,941	80,628
Painted Remainder/Composite C&D	28,983	20,827
Total	508,249	279,772

Impact of Ban on Outdoor Burning

One task in this Study was to determine whether the ban on outdoor burning in many counties across the State has an effect on the amount and/or composition of C&D waste disposed in MSW and C&D landfills. Certain counties are covered by a ban on outdoor burning of vegetative material and land-clearing debris from May 1 to September 30 each year. Those counties are shown with green or gray shading in

Figure 4-13. Eight of the ten landfills that hosted data collection activities for the Study are located in areas covered by the burn ban.

It should be noted that, although the burning of vegetative material and land-clearing waste is governed by the burn ban, those materials represent a relatively small portion of C&D waste. Therefore, the burn ban might not be expected to have a discernable effect on C&D waste composition, regardless of whether the policy is effective in regulating the burning of vegetative material and land-clearing waste. It also should be noted that, according to EPD rules, the more common components of C&D waste, which are combustible, such as lumber, are prohibited from outdoor burning in any county at any time of the year.

For both types of counties—those affected by the burn ban and those that are not covered—the R. W. Beck Project Team examined the difference in amounts of key combustible materials in C&D waste between burn season and non-burn season. The estimated magnitude of the seasonal change in burn-ban counties was compared to the estimated magnitude for non-burn-ban counties.

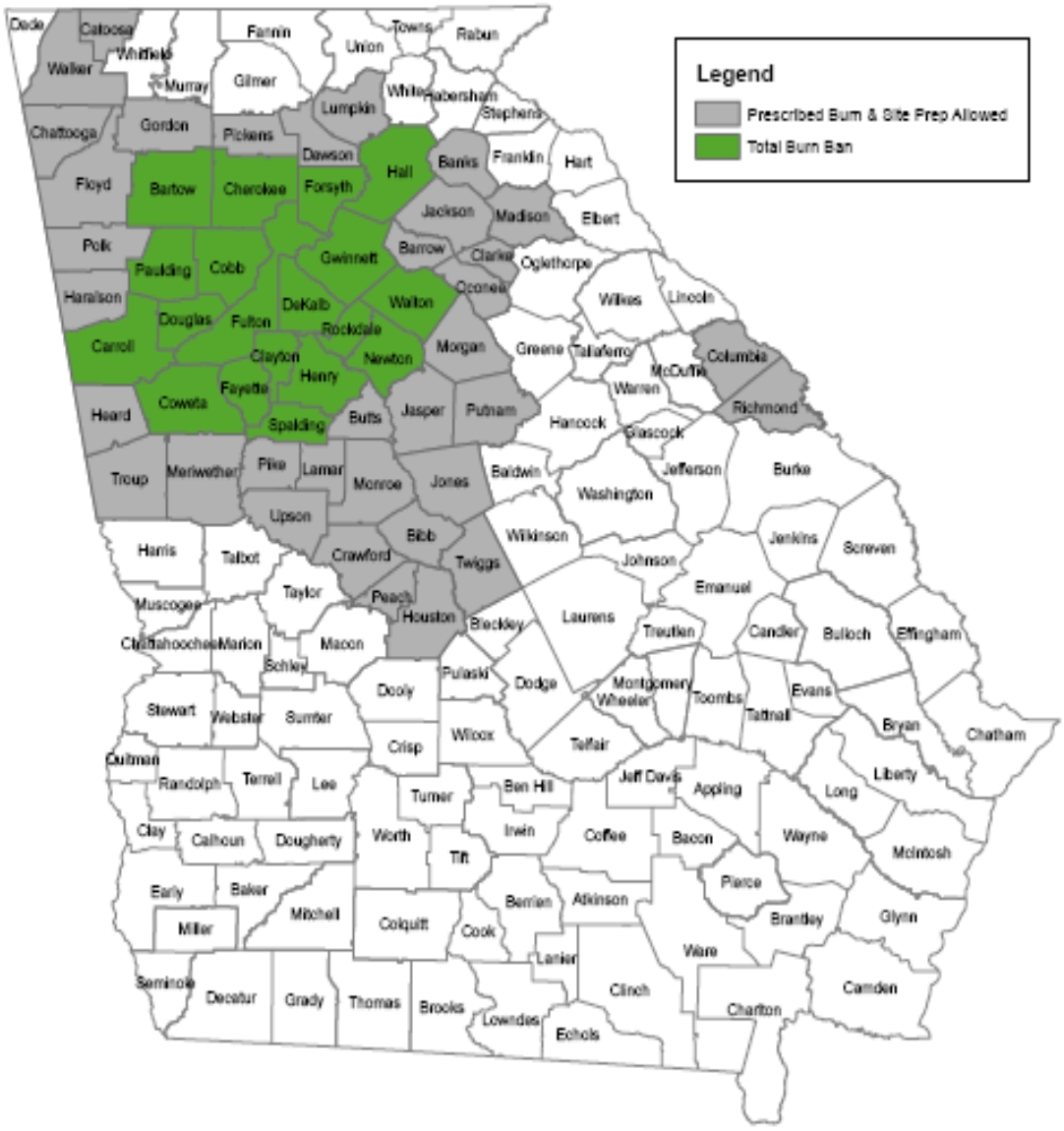


Figure 4-13. Area Covered by the Ban on Outdoor Burning of Vegetative Material and Land Clearing Debris

Four groups of materials were identified for the purpose of comparison – Organics, C&D: Wood, Paper, and All Other Materials. As a first step, the estimates of each of those material groups were compared across seasons to identify possibly important seasonal differences. The estimated percent of the C&D waste stream corresponding to each material is shown in Table 4-8 for each season, in burn-ban counties and non-burn-ban counties. Table 4-8 also shows the calculated differences between the seasonal estimates.

Table 4-8
Comparison of Change in Composition of C&D Debris Between Seasons
In Areas Affected and Unaffected by Ban on Outdoor Burning

	Facilities in Counties Covered by Burn Ban			Facilities in Counties Not Covered by Burn Ban		
Material Class[1]	March[2]	September[2]	Difference[3]	March	September	Difference[3]
Organics	1.7%	1.8%	0.1%	2.7%	0.8%	-1.9%
C&D: Wood	16.1%	13.4%	-2.7%	19.6%	24.6%	5.1%
Paper	1.6%	1.2%	-0.4%	1.3%	1.8%	0.5%
All Other Materials	80.6%	83.5%	3.1%	76.4%	72.7%	-3.7%
Total	100.0%	100.0%		100.0%	100.0%	

[1] The material types listed are those the R. W. beck Project Team identified as potentially being impacted by the burn ban.
[2] March represents burn ban not in effect and September represents burn ban in effect.
[3] Difference represents the composition in when the burn ban is in effect (September) less the composition when the burn ban is not in effect (March).

For example, the material C&D: Wood represented approximately 16.1% of the C&D waste stream in burn-ban counties in March, and it represented approximately 13.4% of the C&D waste stream in the same counties in September. The seasonal change is estimated to be -2.7% from March to September. With this example, as with every material and estimate examined here, it is important to remember that the figure 16.1% merely represents the best estimate of the amount of that material present in the seasonal waste stream. The true amount may be greater than or less than the figure shown, and the "boundaries" within which the true amount probably lies are represented by a confidence interval surrounding the best estimate. (Although confidence intervals are not shown in Table 4-8, they are shown in many of the waste composition tables elsewhere in this report.)

Similarly, the best estimate of the difference between seasons for C&D: Wood in burn-ban counties is -2.7%, but the estimated difference is the result of subtracting one uncertain estimate from another uncertain estimate. The actual seasonal difference may be greater or less than -2.7%, but the single best estimate is -2.7%. A confidence interval also surrounds the estimated difference.

The actual figures being compared are the estimated differences for burn-ban counties and non-burn-ban counties. Therefore, continuing with the example above, we would wish to compare the estimated -2.7% seasonal change in C&D: Wood found with

burn-ban counties against the estimated 5.1% seasonal change found with non-burn-ban counties. At this point in the comparison, we are examining the difference of differences.

Again, it is important to remember that every estimate that was a factor in this comparison carries with it some degree of uncertainty, as implied by the confidence intervals. Uncertainty exists around each waste composition estimate, and it is magnified when one estimate is subtracted from another estimate. Uncertainty is further magnified when one estimated difference is subtracted from another estimated difference. Therefore, the consultant's task was to determine whether a calculated "difference of differences" between burn-ban counties and non-burn-ban counties is statistically meaningful or not.

In our experience, there is not an established statistical test to prove or disprove the statistical significance of this kind of comparison. The most compelling approach was to examine the confidence intervals surrounding each estimate of difference. If the confidence intervals for two estimated differences overlap, it suggests that there may not be a meaningful difference between the two differences. If the confidence intervals do not overlap, it suggests there is probably a meaningful difference between the differences. In other words, when the confidence intervals for a material overlap for burn-ban vs. non-burn-ban counties, we would conclude that the burn ban does not have a meaningful correlation between the policy and disposal of the material in question. If the confidence intervals do not overlap, we conclude there probably is a correlation.

The confidence intervals described above were estimated using a "bootstrapping" method, which involved compiling numerous alternate sets of data from the samples that were acquired in the Study and calculating the difference of differences. As would be expected, the many iterations of the bootstrapping calculation produced estimates that ranged above and below the mean estimates. The ranges were translated into confidence intervals based on the assumption of normality.

Table 4-9 presents the lower and upper bounds of bootstrapped confidence intervals surrounding the estimated "difference of differences" for each material group. The confidence intervals were calculated at the 90% confidence level. As explained above, overlap between these ranges suggests there is no meaningful difference between the burn-ban counties and the non-burn ban counties. A lack of overlap suggests there is a meaningful difference. A more ambiguous answer results when the confidence intervals themselves are wide and there is just a small amount of overlap between them. This was the case with two materials – C&D: Wood and All Other Materials.

Table 4-9
Confidence Intervals Surrounding the Estimated Seasonal "Difference of Differences" in Composition of C&D Between Counties Covered and not Covered by the Burn Ban

	Facilities in Counties Covered by Burn Ban		Facilities in Counties Not Covered by Burn Ban	
Material	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Organics	0.0%	4.0%	-1.0%	1.9%
C&D: Wood	-13.0%	4.4%	2.7%	9.9%
Paper	-1.6%	0.5%	-0.4%	0.9%
Other Materials	-6.1%	11.8%	-11.0%	-3.0%

These results do not show a statistically meaningful seasonal difference between the percentage of Organics or Paper in C&D between the two types of counties. On the other hand, the results suggest that there may be a meaningful seasonal difference in the amount of C&D: Wood and All Other Materials between counties with and without a burn ban during the September sampling period.

However, even though a meaningful difference is suggested for some materials, there is not a clear causal relationship between the observed difference and the actual burn-ban policy. Burning of construction and demolition debris, defined by the State as "waste building materials including, but not limited to wood 2x4s, (plywood, pallets, lumber of any type), paper, cardboard, siding, sheetrock, insulation, shingles, buckets, carpet, wiring, etc.," is never allowed anywhere in the State according to EPD rules. On the other hand, vegetative material and land clearing debris, including stumps, leaves, limbs, and brush (which were excluded from this Study unless they arrived in loads from construction, renovation, or demolition sites) are allowed to be burned at certain times of year in certain counties in accordance with Chapter 391-3-1 (5)(a) of the Georgia Rules for Air Quality Control. Thus, the R.W. Beck Project Team concludes that the difference between the composition of C&D materials disposed at landfills when the burn ban is or is not in effect and for counties covered or not covered by the burn ban is probably caused by factors other than the burn ban restriction such as the seasonal fluctuations in the construction activity.

Section 5
C&D PROJECTED UNDER ALTERNATIVE SCENARIOS

Introduction

The composition and projected tonnage of individual materials were developed based on samples taken from ten host landfills over four and a half weeks in March and September 2009. Although approximately 800 C&D loads were characterized, the results still represent the composition profile at one point in time. When the Study was conducted, the State and the country were in the midst of an economic downturn, one impact being the lowest housing starts seen in well over a decade (as described in Section 2). As a result, the tons of C&D disposed were down an estimated 23.6% between FY2007 and FY2008. In addition to these macroeconomic factors influencing the tonnage, and possibly the type of C&D disposed, there were torrential downpours and widespread flooding at the host landfills during both sampling periods. According to the National Weather Service, rainfall in the State exceeded the thirty year average by 63% in March 2009 and was nearly two and half times the thirty year average in September 2009. This, too, may have influenced the C&D delivered to the sites during the study period.

Economic and weather conditions certainly affect the amount and composition of C&D debris disposed and leads to results that are not "normal". However, experience suggests than there may be no such thing as normal when it comes to the composition of C&D. To address the variation in C&D disposed, the R. W. Beck Project Team has developed a spreadsheet-based model for the Sustainability Division that allows the assumptions about total tonnage of C&D debris disposed and the relative contribution by various activity types to be adjusted. For example, if the Sustainability Division was projecting the composition of C&D disposed in 2012 and economic data suggest that new housing starts increased by 100% between 2009 and 2012, the user can change the assumptions to reflect a higher proportion of C&D originating from residential new construction than that found in 2009. The model calculates the projected tonnage of each material under such scenarios. For the purposes of this report, two alternative scenarios are presented in this section describing how different assumptions about tonnage and contribution by each activity type would change the composition of C&D disposed and specifically, the tonnage of each material available.

Scenario 1: Alternative Contributions by Activity Type

In the first scenario, the total tonnage of C&D disposed was assumed to be the same as during the study period but the allocation by activity type was adjusted to reflect the allocation from a similar characterization study conducted in the State of California in

2006.[9] The California study was selected because the defined activity types, with the exception of demolition, aligned with those of the characterization study conducted by the R. W. Beck Project Team for the State of Georgia. Furthermore, the R. W. Beck Project Team and the Sustainability Division selected the California study as a basis for the Scenario 1 because the California study was conducted three years prior to this Study thus presenting a reallocation of contribution by the activity types based on a different period of time. The allocations assumed in this scenario are shown in Table 5-1 as compared to the actual allocations identified during the study period.

Table 5-1
Assumptions for Projection Scenario 1

Sector	Activity Type	2009 Actual	Scenario 1
Residential	New Construction	8.4%	9.1%
	Renovation	13.6%	17.7%
	Demolition[1]	15.4%	14.4%
	Total - Residential	37.4%	41.2%
Non-Residential	New Construction	20.1%	7.4%
	Renovation	10.2%	18.5%
	Demolition[1]	4.4%	4.1%
	Total – Non-Residential	34.7%	30.0%
Roofing		19.0%	13.2%
Other/Mixed		8.9%	15.6%
Total		100%	100%
Total Tonnage of C&D Disposed		2,952,123	2,952,123

[1] The California study combined Residential and Non-Residential Demolition. Therefore, the ratio between residential and non-residential for purposes of Scenario 1 was based on the field observations for this Study.

Figure 5-1 shows how shifting the contribution of activity types to the total C&D disposed changes the composition of C&D disposed by material class. With a higher proportion of the C&D coming from residential renovation, non-residential renovation, and other/mixed activities and less from non-residential new construction and roofing, there is projected to be more C&D aggregates, "other" C&D, and non C&D materials, and less roofing material.

[9] *Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste* commissioned by California Integrated Waste Management Board (June 2006).

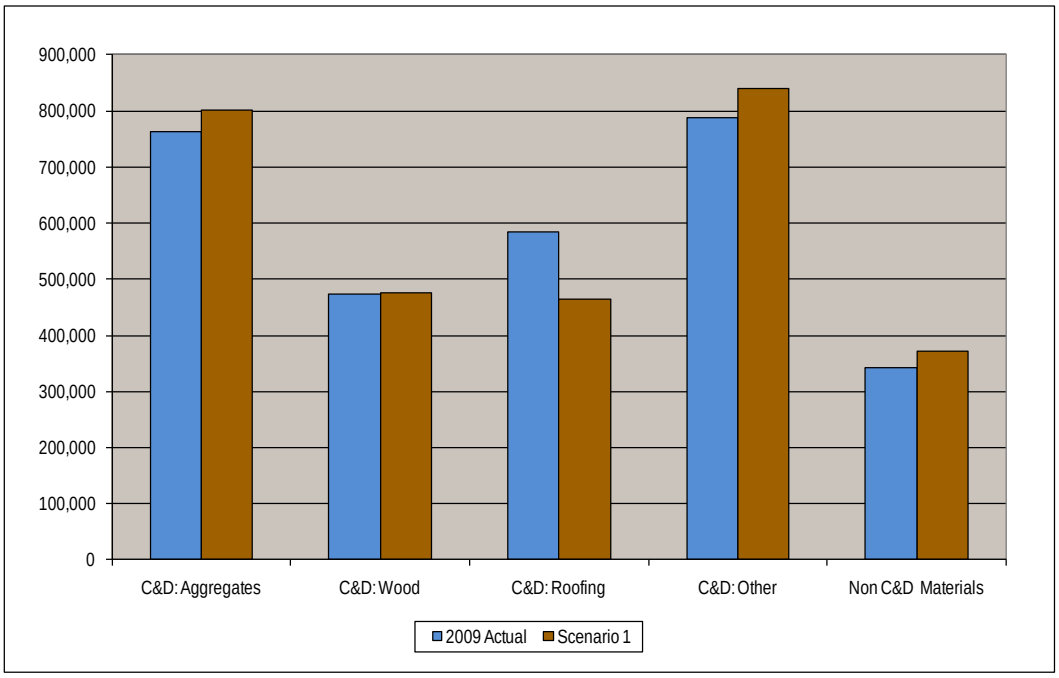


Figure 5-1. C&D Disposed by Material Class, 2009 Actual Compared to Scenario 1 (Estimated Tons per Year)

Table 5-2 shows the projected tonnages of the top ten most abundant materials under Scenario 1 as compared to the 2009 actual estimates. In both cases, the top ten materials comprise about 80% of the C&D currently disposed. In Scenario 1, the amount of concrete, dirt and sand, remainder/composite C&D. clean dimensional lumber, clean-engineered wood, painted/stained wood, and asphalt paving would increase with this shift in activity type. Other ferrous, brick and other aggregates, composition roofing and clean gypsum board would go down.

Table 5-2
Estimated Tonnage of Most Prevalent Material Types Under Scenario 1

Material Type	Estimated Tons in 2009	Projected Tons in Scenario 1
Concrete	448,560	474,541
Composition Roofing	538,937	420,364
Dirt & Sand	310,292	371,072
Remainder/Composite C&D	234,379	246,001
Brick and Other Aggregates	240,656	219,044
Clean Dimensional Lumber	157,713	161,198
Clean Engineered Wood	134,719	135,544
Clean Gypsum Board	159,915	128,335
Painted/Stained Wood	103,925	120,162
Asphalt Paving	74,425	107,481
Total Tonnage of C&D Disposed	2,403,521	2,383,743

Scenario 2: Return to Historic Tonnages

This scenario projects the amount of each material class that is projected if the total tons of C&D disposed returned to historic tonnages. The R. W. Beck Project Team and the Sustainability Division analyzed this scenario to project the amount of each material type that would be generated if construction related activities rebounded. This information may be useful for those considering investing in infrastructure to divert one or more materials since it shows the high end of the range of tonnage of each material that may be available.

For this scenario, we assumed 4.9 million tons per year of C&D is disposed in Georgia, which approximates the average from EPD records from fiscal year 2004 through fiscal year 2008. We assume that 12.3% of tonnage disposed in MSW landfills is from C&D activities, as was the case in the statewide MSW characterization study in 2004, and 90.1% of tonnage disposed in C&D landfills is from C&D activities. The allocation of material by activity type is assumed to remain the same as that estimated in 2009, as shown in Table 5-3.

Table 5-3
Assumptions for Projection Scenario 2

Sector	Activity Type	2009 Actual	Scenario 2
Residential	New Construction	8.4%	8.4%
	Renovation	13.6%	13.6%
	Demolition	15.4%	15.4%
	Total - Residential	37.4%	37.4%
Non-Residential	New Construction	20.1%	20.1%
	Renovation	10.2%	10.2%
	Demolition	4.4%	4.4%
	Total – Non-Residential	34.7%	34.7%
Roofing		19.0%	19.0%
Other/Mixed		8.9%	8.9%
Total		100%	100%
Total Tonnage of C&D Debris Disposed		2,952,123	4,900,000

Figure 5-2 shows the projected tonnage for each material class as compared to the 2009-estimated tonnage. Table 5-4 shows the projected tonnage of the top ten materials if the total C&D tonnage increased by approximately 2,000,000 tons per year. In this scenario, there is projected to be over 1.1 million tons of concrete, brick, and other aggregate, and 894,541 tons of composition roofing. There is also projected to be more than a quarter of a million tons of both clean gypsum board and clean dimensional lumber plus and over 137,000 tons of other ferrous material.

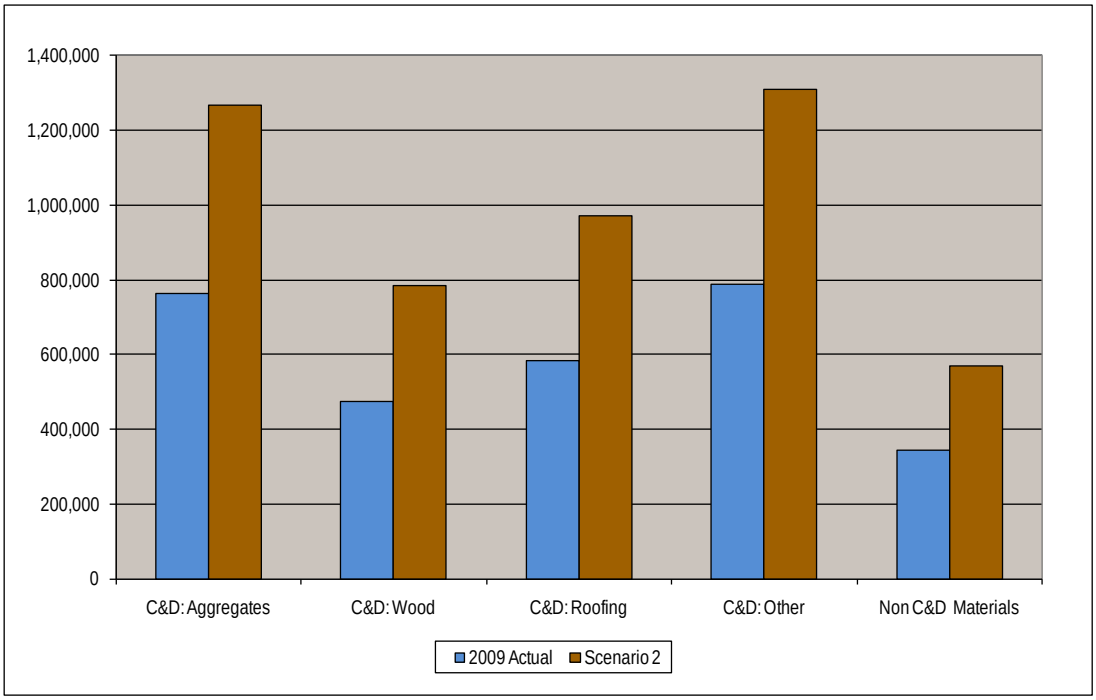


Figure 5-2. Tons of C&D by Material Class, 2009 Actual Compared to Scenario 2 (Estimated Tons per Year)

Table 5-4
Estimated Tonnage of Specific Materials Under Scenario 2

Material Type	2009 Actual	Scenario 2
Composition Roofing	538,937	894,541
Concrete	448,560	744,531
Dirt & Sand	310,292	515,030
Brick and Other Aggregates	240,656	399,446
Remainder/Composite C&D	234,379	389,028
Clean Gypsum Board	159,915	265,430
Clean Dimensional Lumber	157,713	261,776
Clean Engineered Wood	134,719	223,609
Painted/Stained Wood	103,925	172,497
Other Ferrous	82,671	137,219
Total Tonnage of C&D Disposed	2,411,767	4,003,105

Section 6
LEAD-BASED PAINT AND ASBESTOS CONTAINING MATERIAL

Lead-based Paint in C&D Loads

As part of this Study, the R.W. Beck Project Team sampled targeted incoming loads to determine the incidence of lead-based paint in C&D disposed. The methodology used and the results are described in this section.

Methodology

To determine the degree to which lead-based paint is present in the C&D loads characterized for this Study, the R. W. Beck Project Team gathered data at half the sites during the first sampling event and at the other half during the second sampling event. Thus, data regarding the presence of lead-based paint was gathered for a single season at each site.

The targeted loads for the lead-based paint characterization included those from demolition, renovation, roofing, and other C&D sources; loads from new construction sites were not considered since the use of lead-based paint had been banned since 1978. Each load from the eligible activity types was visually evaluated to identify whether they contained any painted surfaces. All painted surfaces observed were sampled using a portable x-ray fluorescence (XRF) device that provided a lead concentration readout in mg/cm^2. Measurements that indicated a lead concentration equal to or greater than 1 mg/cm^2 were identified as a "positive" result for lead, consistent with the State of Georgia's definition of lead-based paint (Chapter 391-3-24.03(47)).

At least one XRF measurement was taken on each color and type of painted debris identified in the load (e.g., if a load's only debris included several pieces of painted drywall that appear to be from the same job and several pieces of painted wood that appear to be from the same structure but were painted three different colors, then at least one XRF sample was collected from the drywall and at least three samples were collected from the wood). Sampling locations were selected so that the tested area was representative of the paint present in other areas of that piece or type of debris. In cases where multiple layers of paint appeared to be present, the top surface was scraped so that the underlying surface(s) could also be tested with the XRF.

Results

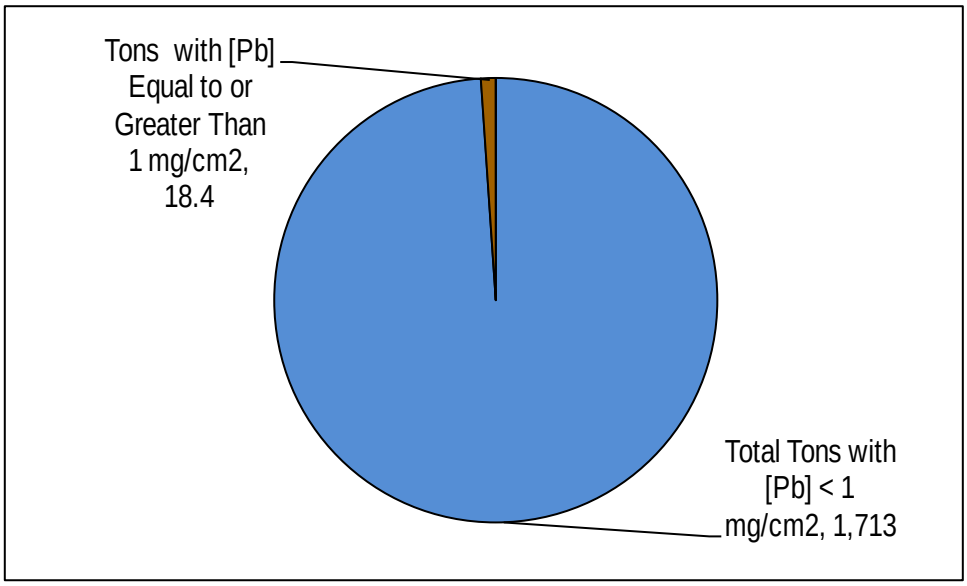
Table 6-1 presents a summary of the samples collected during the lead-based paint evaluation. A total of 364 loads were received at the landfills when painted surfaces

were being tested for lead-based paint. Of these 364 loads, 266 were from the activity types targeted (all but new construction) and a total of 487 painted surfaces were tested in these loads. Seventy surfaces tested positive (≥ 1 mg/cm^2) for lead-based paint; these surfaces were present in 37 loads.

Table 6-1
Summary of Lead-based Paint Sample Count, Detection Frequency, and Corresponding Tonnage

	Number	Tons
Loads Arriving While XRF On Site	364	1,731
Loads from Activity Types Targeted	266	1,292
Surfaces Tested	487	165
Surfaces with Lead Measurement ≥ 1 mg/cm^2	70	18

A total of 18 tons of material had a painted surface that exhibited a lead concentration ≥ 1 mg/cm^2. Approximately 1,731 tons were received while the testing was being conducted; 1,292 tons of the loads were from the activity types tested (all but new construction). Figure 6-1 shows that about 1.1% of the total tons received during the lead-based paint-sampling period corresponded to a material type with a painted surface with a lead concentration ≥ 1 mg/cm^2.



Note: PB: lead

Figure 6-1. Tons of Material from Demolition, Renovation, and Roofing that were ≥1 mg/cm^2 and <1 mg/cm^2 For Lead

Figure 6-2 shows that of the painted surfaces that tested positive for lead, approximately 59% was painted or stained wood, while painted concrete, painted R/C C&D, painted/demolition gypsum, and painted brick and other aggregates contributed 20%, 14%, 7% and less than 1%, respectively. In part, painted or stained wood contributed a large fraction of the positive readings simply because this material type was more frequently encountered during the Study.

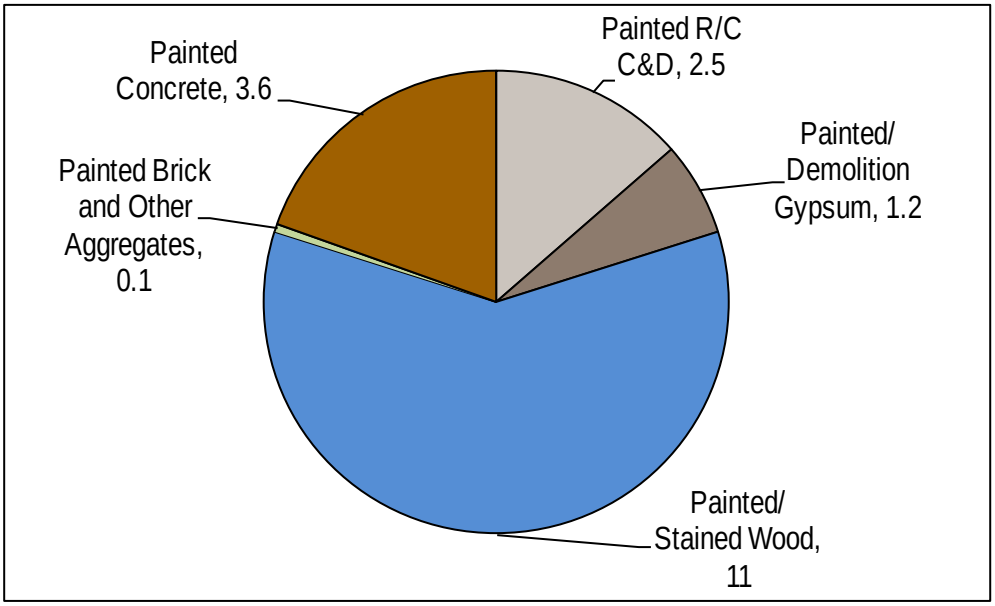


Figure 6-2. Tons of Each Material Type with Positive Readings for Lead-based Paint (≥1 mg/cm^2)

Figure 6-3 shows that of the 18 tons of material that had a painted surface that equaled or exceeded 1 mg/cm^2 of lead, 12 tons were from residential demolition activities, nearly 4 tons were from residential renovation, about 2 tons were from non-residential renovation, about 0.1 tons were from non-residential demolition, and 0.5 tons were from mixed/other activity types. Seven tons of material that exhibited a painted surface concentration equal to or greater than 1 mg/cm^2 of lead were received at metro Atlanta facilities, while 11 tons were received at facilities in other areas of the State.

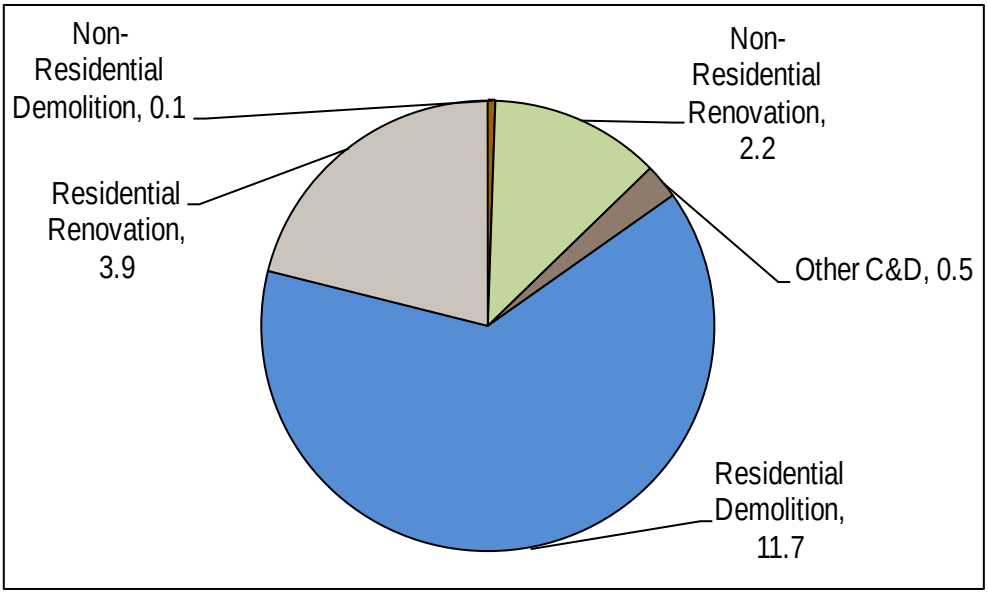


Figure 6-3. Tons of Material from Each Activity Type with Positive Readings for Lead-based Paint (≥1 mg/cm2)

It is important to note that a lead concentration of ≥1 mg/cm^2 does not mean that the waste is considered hazardous and therefore managed separately from other solid waste. The presence of lead can cause a material to be a "toxicity characteristic (TC) hazardous waste". However, the relevant Resource Conservation and Recovery Act (RCRA) rules for defining a waste as a TC hazardous waste pertains to the solid waste as a whole, not the individual components of the solid waste (i.e., no distinction is made between a piece of wood and the paint that is present on the wood's surface).

Asbestos-containing Material in C&D Loads

As part of this Study, the R.W. Beck Project Team sampled targeted incoming loads to determine the incidence of asbestos-containing material in C&D disposed. The targeted incoming loads excluded packaged materials labeled as asbestos containing materials. The methodology used and the results are described in this section.

Methodology

As with lead-based paint, only loads from demolition (residential and non-residential), renovation (residential and non-residential), roofing, and other C&D activity types were targeted to test for asbestos-containing material (ACM). Similarly, each site was sampled during one season: five sites were sampled during the spring sampling event and five sites were sampled during the fall sampling event.

When a load from one of these activity types was identified, the R. W. Beck Project Team would look for any material suspected of containing asbestos based on the material class and type lists assembled during the project sampling plan

development.[10] When such a material was identified, a sample was taken, bagged, and sent to a National Voluntary Laboratory Accreditation Program (NVLAP) certified asbestos laboratory (Bureau Veritas, Kennesaw, GA) for analysis using polarized light microscopy.

Results

Table 6-2 summarizes the samples collected as part of the ACM characterization at the ten sites sampled. Of the 364 loads arriving at the site while samples were being taken for ACM, 182 loads had at least one material that fell into the one of the material types originally targeted in the sampling plan. Of those 182 loads, 307 samples were collected. Fifteen of the 307 total samples collected (approximately 4.9%) were reported by the laboratory as containing a detectable amount of asbestos. Only four of the collected samples (or 1.3% of those collected) exhibited an asbestos content greater than 1%, which are the National Emission Standards for Hazardous Air Pollutants (NESHAP) threshold for defining a material as ACM.

Table 6-2
Summary of ACM Sample Count and Detection Frequency

	Number	Tons
Loads that Arrived During Sampling	364	1,731
Samples Collected	307	-
Samples with Asbestos Detection	15	2.6
Samples with Detection > 1% Asbestos	4	0.4

On a weight basis, 2.6 tons of material sampled exhibited an asbestos concentration that was detected by the laboratory out of a total 1,731 tons that arrived at the facilities during the ACM sampling period (this figure may be an overestimate as described below). Figure 6-4 shows the relative weight of materials with and without asbestos detections. Of the 2.6 tons of material with some level of asbestos detected, 739 pounds exhibited an asbestos concentration greater than 1%.

[10] Loads that arrived which contained bagged asbestos were not sampled and were not included as part of the overall ACM characterization effort, however, they were weighted and documented. Five loads of bagged asbestos arrived while field teams were on site, weighing a total of 30.6 tons. Three of these loads (totaling 85.1% of the total tonnage) were from non-residential demolition, one was from residential demolition (representing 14.4% of the total tonnage), and one was from non-residential renovation (representing .5% of the total tonnage).

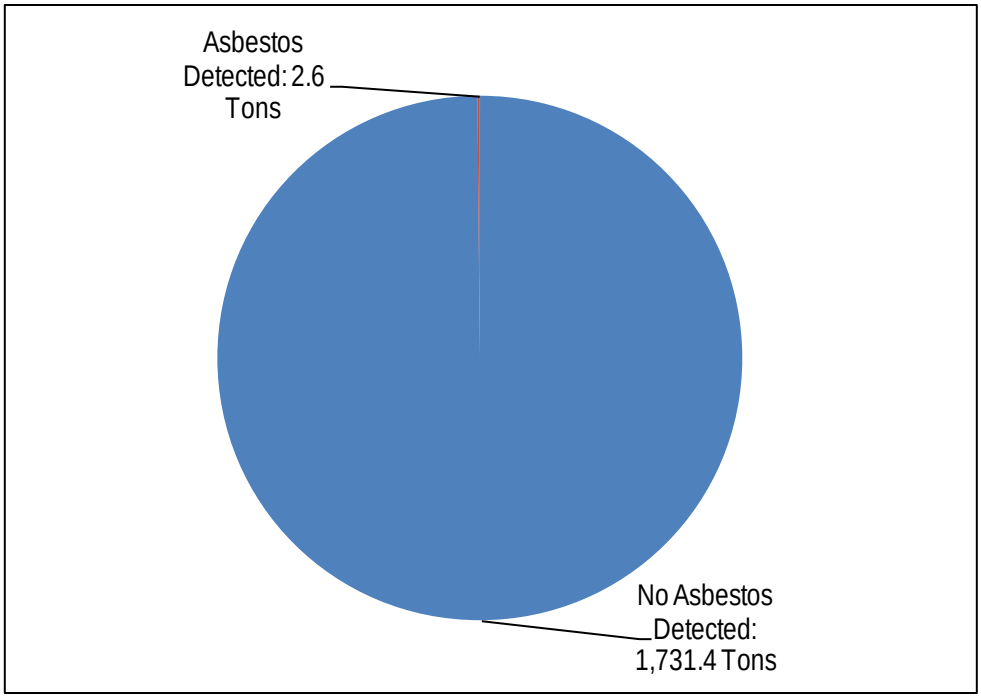


Figure 6-4. Tons of Material in with and without Asbestos Detected

Table 6-3 indicates that wallboard and joint compound was the material subtype with the most frequent detection of asbestos while one sample of transite siding exhibited the highest single asbestos concentration (20%) of all materials sampled with a detectable concentration of asbestos. Figure 6-5 summarizes the tonnage of each material type that exhibited an asbestos detection. By weight, the painted/demolition gypsum material type contributed most to the asbestos detections encountered, in terms of both frequency (from Table 6-4) and weight (Figure 6-5). This is largely because the material subtype "Wallboard and Joint Compound" includes both the wallboard itself as well as corresponding joint compound. Since joint compound formulations commonly included asbestos, this was the portion of the material that was sampled and analyzed in the laboratory although the total weight of material was considered to contain asbestos. The actual weight of material in the painted/demolition gypsum material type that had asbestos is likely to be much less than 2.09 tons as shown in Figure 6-5. The weight of material corresponding to the other material types (R/C C&D, other asphalt roofing, composition roofing, and R/C plastic) is expected to approximate the actual weight of material with asbestos present.

Table 6-3
Material Types and Corresponding Asbestos Detections

Material Type	Material Subtype	Result	Number of Samples
Painted/Demolition Gypsum	Wallboard and Joint Compound	<1%	9
R/C C&D	Insulation	<1%	1
Other Asphalt Roofing	Roof Silver Coating	<1%	1
Composition Roofing	Roof Mastic and Coatings	3%	1
R/C Plastic	Resilient Floor Covering	15%	1
R/C Plastic	Resilient Floor Covering	19%	1
R/C C&D	Asbestos Cement (Transite) Siding	20%	1
Total Asbestos Detections			15

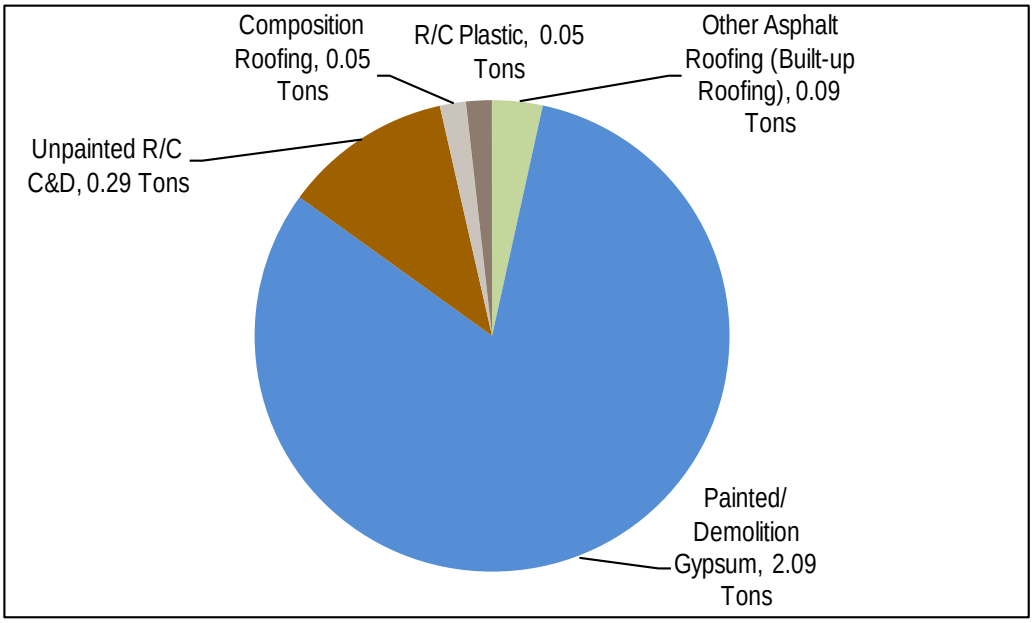


Figure 6-5. Tons of Each Material Type with a Detection of Asbestos

Figure 6-6 shows the activity type where material that exhibited an asbestos detection originated. Overall, residential demolition contributed the greatest fraction (by weight) of materials with asbestos detections, followed by residential renovation. The weight of material from roofing and non-residential demolition contributed relatively little compared to residential renovation and demolition.

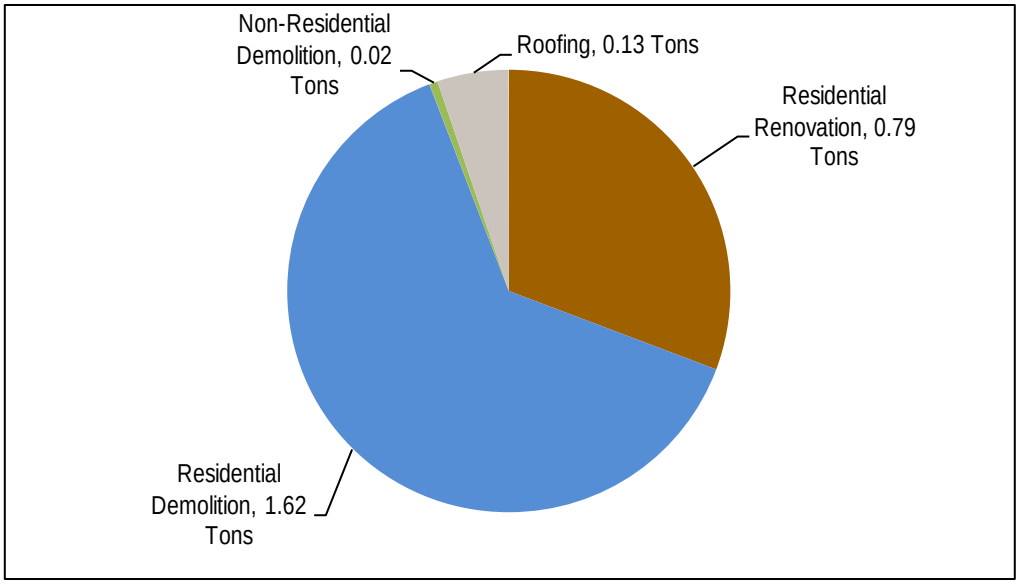


Figure 6-6. Tons of Material with Asbestos Detection, by Activity Type

Summary of Lead-based Paint and Asbestos-containing Material Evaluation

The overall incidence of lead detections was low during the sampling period – lead was detected at a concentration ≥ 1 mg/cm^2 in approximately 13% of all painted surfaces that were tested with the XRF. The debris that exhibited a lead concentration ≥ 1 mg/cm^2 corresponded to waste that comprised about 1% (by weight) of all material evaluated by the R.W. Beck Project Team at the sites where the XRF operator was present. Residential projects contributed the greatest proportion (by weight) of materials that positive for lead. Disposal requirements for painted debris from residential structures are less stringent than those for non-residential structures[11].

The weight of debris with lead concentrations ≥ 1 mg/cm^2 was greater at facilities located in non-metro Atlanta compared to facilities located in metro Atlanta; however, the low frequency of detection precluded a meaningful statistical comparison. The 1 mg/cm^2 threshold was used as a screening tool, which is consistent with the definition of lead-based paint in the State of Georgia rules. Exceeding this threshold does not define a waste as hazardous; rather, the leachable concentration of lead would have to exceed the TC concentration listed in the RCRA regulations. Although no numerical correlation can necessarily be drawn between a measured surface lead concentration (mg/cm^2) and the total or leachable concentration of lead in that debris (mg/kg or mg/L, respectively), it is anticipated that much of the debris that had a detectable concentration of lead would not meet the TC hazardous waste definition, since RCRA rules require that the entire weight of the waste component be considered when making the hazardous waste determination, not just the mass and concentration of the lead-containing material (in this case, paint).

[11] EPD Guidance Letter dated October 31, 2001.

Similar to lead, the frequency of detection of asbestos was low during the Study. Of more than 300 samples collected (noting that the samples collected were based on an extensive list of materials that may contain asbestos, per the project's approved asbestos sampling plan), 15 total detections of asbestos were reported by the laboratory, and of these 15 samples only four exhibited an asbestos content greater than 1%. The material type that exhibited the most frequent asbestos detection was wallboard joint compound. This result is consistent with historical information, including published US EPA reports, that indicates joint compounds may include asbestos as an ingredient. While frequently detected, no sample of wallboard joint compound resulted in an asbestos content greater than 1%.

The weight of materials that had detectable levels of asbestos was small (approximately 2.6 tons) compared to materials that did not contain asbestos (1,731.4 tons), and residential projects contributed the greatest proportion (by weight) of materials that exhibited a detection of asbestos. The weight of materials with an asbestos detection is skewed high somewhat since the most frequently detected material type, wallboard and joint compound, contributed a relatively large amount of mass (because of the presence of wallboard) but only a small amount of material with actual asbestos (the joint compound).

Section 7
CHALLENGES AND OPPORTUNITIES TO RECOVERY

Introduction

As part of the Study, the R.W. Beck Project Team researched existing C&D recycling programs and interviewed generators, processors, and end users of some of the most prevalent C&D materials disposed in Georgia to assess the challenges and opportunities associated with recovery of these materials. The initial list of selected C&D recycling programs and stakeholders was developed with the input from the Sustainability Division and the Georgia Environmental Protection Division. As the initial list of stakeholders were contacted, additional programs and stakeholders were identified. A set of case studies resulting from this research can be found in Appendix L and the final list of stakeholders interviewed is included in Appendix M. Stakeholders interviewed were asked questions regarding current disposal and recycling practices, markets for materials, barriers to reduction, potential incentive/disincentive programs, and other related topics. This section reports on the challenges and opportunities provided by these stakeholders specifically and thus do not necessarily represent the trends, opinions, and status of C&D diversion opportunities across the country. However, they do represent some of the major issues that generators, processors, end users, and others are currently facing with regard to diversion of C&D materials in Georgia today.

The R. W. Beck Project Team focused the material specific research on the ten C&D material types representing the largest quantity of disposed material by weight as reported in Section 4 of this report. Between October 1, 2008 and September 30, 2009, it is estimated that these ten material categories accounted for nearly 82% of the total tons of waste disposed from C&D activities in the State. Table 7-1 presents these materials, including the material class, estimated tons, and percent of total tonnage of C&D disposed in Georgia.

Table 7-1
Statewide Aggregate Composition of C&D Disposed in Georgia
Top Ten Material Types by Tons
October 2008 – September 2009

Rank	Material Class	Material Type	Estimated Tons Disposed	% of Total C&D Disposed
1	C&D Roofing	Composition Roofing	538,937	18.3%
2	C&D Aggregate	Painted and Unpainted Concrete[1]	448,560	15.2%
3	C&D Other	Dirt & Sand	310,292	10.5%
4	C&D Aggregate	Painted and Unpainted Brick and Other Aggregates[1]	240,656	8.2%
5	C&D Other	Remainder/Composite C&D	234,379	7.9%
6	C&D Other	Clean Gypsum Board	159,915	5.4%
7	C&D Wood	Clean Dimensional Lumber	157,713	5.3%
8	C&D Wood	Clean Engineered Wood	134,719	4.6%
9	C&D Wood	Painted/Stained Wood	103,925	3.5%
10	Metal	Other Ferrous	82,671	2.8%
Total of Top 10 C&D Material Types Disposed			2,411,767	81.7%
Total C&D Disposed			2,952,123	100.0%

[1] Note that based on available markets the unpainted and painted material categories were combined for Concrete and Brick, and Other Aggregates so the tonnages are higher than in broken down categories in Section 4.

In many cases, the costs and savings associated with diverting C&D are tied to volume of the material rather than tonnage. For example, generators typically pay a hauler each time a container is pulled (hauled away) and assess charges based on the container size. Thus, it is important to consider the volume of C&D disposed as well as the tonnage. In 2009, the top ten material types alone accounted for approximately 10.4 million cubic yards of disposed C&D material, as indicated in Table 7-2.

Table 7-2
Statewide Aggregate Composition of C&D Disposed in Georgia
Top Ten Material Types by Tons and Cubic Yards
October 2008 – September 2009

Rank	Material Class	Material Type	Estimated Tons Disposed in 2009	Estimated CY Disposed in 2009[1]
1	C&D Roofing	Composition Roofing	538,937	1,474,520
2	C&D Aggregate	Concrete	448,560	1,043,163
3	C&D Other	Dirt & Sand	310,292	668,013
4	C&D Aggregate	Brick and Other Aggregates	240,656	559,665
5	C&D Other	Remainder/Composite C&D	234,379	1,125,388
6	C&D Other	Clean Gypsum Board	159,915	684,861
7	C&D Wood	Clean Dimensional Lumber	157,713	1,866,426
8	C&D Wood	Clean Engineered Wood	134,719	1,005,366
9	C&D Wood	Painted/Stained Wood	103,925	1,229,882
10	Metal	Other Ferrous	82,671	734,853
Total of Top 10 C&D Material Types Disposed			2,411,767	10,392,137

[1] The estimated CY disposed was calculated using the industry weight conversion factors for each material type from Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste, performed by Cascadia Consulting Group for California Integrated Waste Management Board, 2006.

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Challenges and Opportunities Related to All Materials

Some challenges to diverting C&D from disposal in Georgia are common to many materials. Low tipping fees at C&D and municipal solid waste landfills in the State discourage separation and transport of any C&D material to recycling markets, especially when the landfill is nearby and a market is distant. The Solid Waste Annual Report issued by the Georgia Department of Community Affairs (as revised on July 31, 2009) reports an average tipping fee for at C&D landfills of $23.72 per ton, with a low range of $14 to $20 per ton in some regions, including metro Atlanta, and a high range of $35 to $40 per ton in south Georgia. Some C&D facilities in the State, including one of the landfills where samples were taken for this Study, charge by the cubic yard rather than the tons of material delivered. This reduces the cost to dispose of heavier materials, for example, concrete, and provides another disincentive to recycle them. For those generators considering only the financial aspects of recycling C&D, the net cost of recycling (the cost to sort if necessary, transport and process the material to market offset by the revenue received for the recycled materials) would need to be lower than the tipping fee at the disposal facility plus hauling costs to the disposal facility. However, the relative cost of recycling compared to disposal may not be the only factor a generator considers when deciding whether to recycle C&D.

Another challenge for some generators is keeping the material sorted, or sorting it later, in a way that maximizes the marketability of the material. This is especially true

on renovation and demolition sites where multiple materials are often generated simultaneously. Space is often limited on sites and storing materials separately requires space as well as training of personnel. Stakeholders report that some markets accept C&D materials commingled, but that this is likely to reduce the revenue received for the materials or increase processing costs charged. For example, one stakeholder reported an additional cost of $30 to $50 dollars and another stakeholder reported an additional cost of $100 to $150 for collection and processing a 30 cubic yard roll-off container of commingled C&D as opposed to C&D material separated at the job site into multiple containers.

Some of the opportunities for recycling are common to multiple C&D materials as well. Activity at new construction sites is typically phased, which may lead to relatively homogenous loads of clean material. For example, clean wood may come first from framing, then gypsum board from sheetrock, then cardboard and metal from finishing work. These loads may be sent directly to market or diverted from disposal when they arriving at a landfill.

Another factor driving C&D recycling efforts is the growing interest by building owners, tenants, and developers to meet green building standards. Federal, state, and local governments, universities, and specific companies around the State of Georgia are requiring that their buildings meet specific green building standards, such as those established by the U. S. Green Building Council's Leadership in Energy and Environmental Design (LEED). The U. S. Green Building Council reports that Georgia is one of the strongest states in the U.S. with regard to green building and sustainable development with over 135 LEED Certified buildings and 890 LEED Registered buildings. Many of the certification programs give points for both recycling C&D generated on-site as well as using products made with recycled content. This has stimulated the development of collection, processing, and end use infrastructure in the region.

Another opportunity for many materials is the ability to process and use certain C&D materials on-site. Because many materials like dirt and sand and aggregate are heavy, the costs associated with transportation and disposal are high. If they can be processed and reused on-site, the savings in transportation costs alone may make using the material on site as fill, or in the case of wood, as mulch, worthwhile, even if some processing such as crushing clean aggregate or chipping wood, is required.

The remainder of this section addresses the challenges and opportunities identified with recycling the most prevalent materials classes and types currently disposed in C&D in Georgia landfills on a material-by-material basis.

C&D Roofing

The "C&D Roofing" material class comprised nearly 20% by weight of the C&D disposed in the State as shown in Figure 7-1. As defined for the Study, this material class included two material types: composition roofing and other asphalt roofing. Composition roofing was the single largest material type identified in C&D disposed in Georgia, comprising an estimated 539,000 tons during the project year. Eighty-two

percent of the C&D Roofing material class came from roofing activity (rather than new construction, renovation, or demolition) activities, as shown in Figure 7-2, suggesting these loads would be the largest target for recovery efforts. Loads from roofing sites are relatively homogenous; more than 85% of the tons of material in loads from roofing sites were characterized as C&D: Roofing, as shown in Table 7-3.

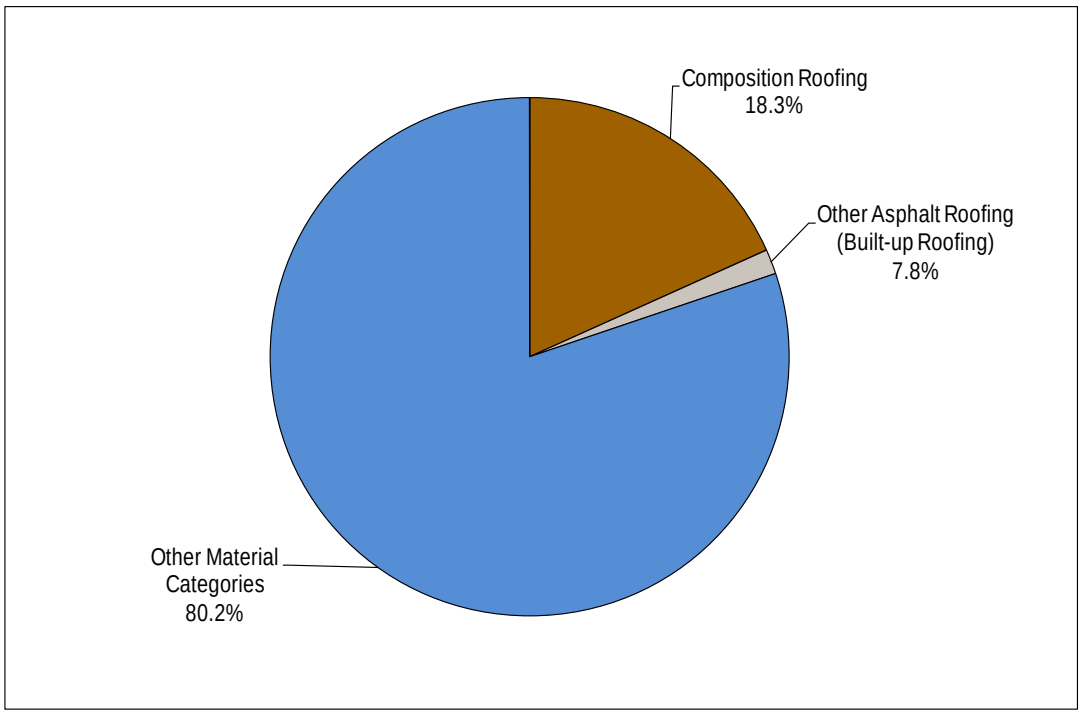

Figure 7-1. C&D Roofing Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

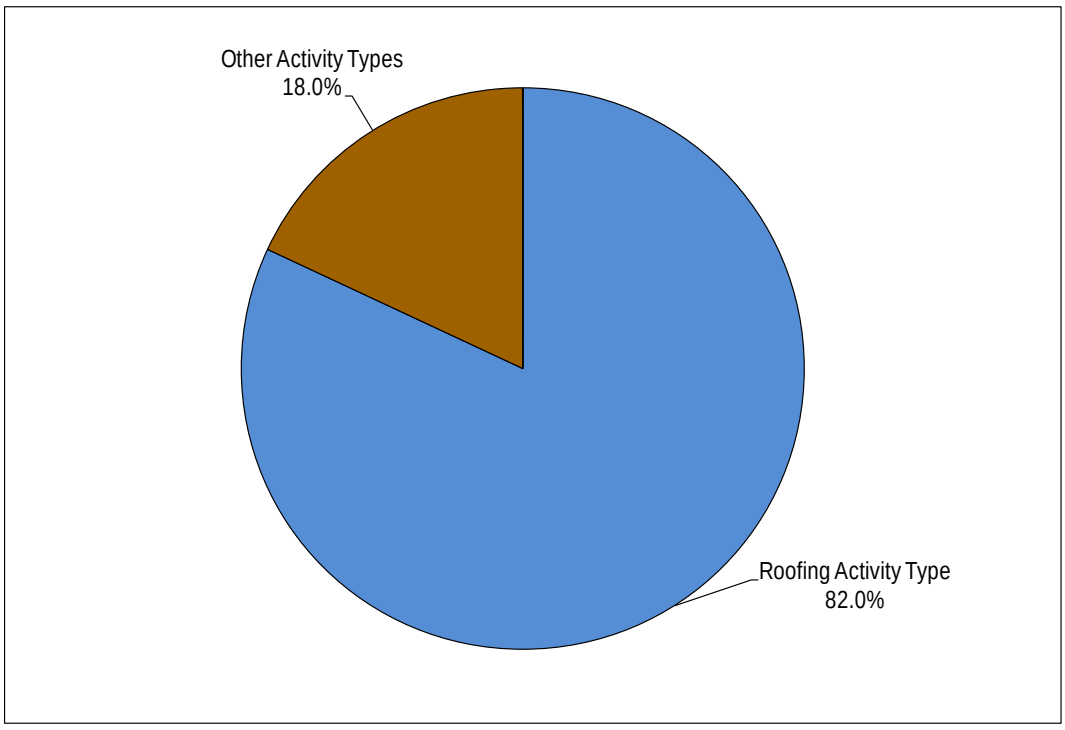

Figure 7-2. C&D Roofing Disposed by Activity Type (% of Annual Tonnage), October 2008 – September 2009

Table 7-3
Composition of Activity Type C&D Roofing by Material Class
(Estimated Tons per Year)
October 2008 – September 2009

Material Class	Estimated Tons Disposed in 2009 by Roofing Activity Type	% of Total C&D Disposed in 2009 by Roofing Activity Type
C&D Aggregate	37,942	6.8%
C&D Wood	21,338	3.8%
C&D Roofing	479,341	85.6%
C&D Other	5,301	0.9%
Paper	2,720	0.5%
Glass	206	0.0%
Metal	6,000	1.1%
Plastic	2,064	0.4%
Organics	1,806	0.3%
E-Waste and Asbestos	28	0.0%
Other Materials	2,568	0.5%
MSW	976	0.2%
Total	560,291	100.0%

Nationwide, composition-roofing scrap has been used for such end-markets as the following:

- Asphalt pavement;
- Aggregate base and sub base;
- Cold patch for potholes, sidewalks, utility cuts, driveways, ramps, bridges, and parking lots;
- Pothole patch;
- Road and ground cover;
- New roofing; and
- Fuel oil.[12]

C&D roofing materials, along with gypsum board discussed later in this section, were identified as having limited end markets within the State of Georgia by stakeholders. Currently, according to stakeholders interviewed, the primary end market for C&D Roofing in Georgia is asphalt paving by the paving industry. Based on the interviews with stakeholders in the roofing industry, the following challenges and opportunities associated with recovering C&D Roofing materials were identified:

- **State Requirements:** The Georgia Department of Transportation (Georgia DOT) authorizes the use of recycled composition shingles in Georgia DOT projects. According to a shingle recycling stakeholder, Georgia DOT is one of approximately 15 states that permit the use of recycled post industrial shingles and one of only nine states that permit the use of recycled post consumer shingles in state paving projects. Currently, Georgia DOT authorizes the use of up to 5% of recycled asphalt shingles by weight of the total weight of the hot-mix asphalt mixture. For GA DOT contractors who use post consumer composite shingles, such as materials from a residential tear-off roofing job, the paving contractor is required to provide test results of Bulk Sample Analysis to ensure the material does not contain asbestos. To increase the demand for recovered asphalt shingles, the Georgia DOT is evaluating alternatives for increasing the use of recyclable materials in the load base for state road construction projects. One State that currently has a higher allowance for asphalt shingles than Georgia is Missouri. The Missouri Department of Transportation has developed a hot-mix asphalt spec that permits up to 7% of recycled asphalt shingles.[13]
- **Specifications for Materials:** Stakeholders identified two main factors that influence the demand for recovered composite shingles, contamination and consistency. Processors of C&D roofing materials require the material to be clean from contaminants such as rock and gravel. Ensuring that these contaminants are

[12] Asphalt Roofing Shingles Recycling: Introduction, CalRecycle, ttp://www.calrecycle.ca.gov/condemo/Shingles/.
[13] Missouri Department of Transportation Section 403 Asphaltic Concrete Pavement located at http://www.modot.mo.gov/business/standards_and_specs/Sec0403.pdf

not in roofing loads requires cost and time on the part of the roofers and/or the processor. Furthermore, processors may limit the asphalt shingles accepted at the processing facility to more consistent loads of shingles requiring less processing, such as post industrial (also referred to as manufacturer's scrap) roofing material. Stakeholders who currently do not recycle roofing material consistently expressed a lack of information as to requirements and opportunities for recycling roofing materials.

- **Hauling:** Currently, processors are requiring loads from smaller generators, such as roof tear-offs, to be delivered to the processing facility at the expense of the generator. For larger generators, such as manufacturing plants, the processor may be willing to pick up containers of roofing materials and the cost to do so will typically be negotiated between the processor and the hauler or builder on a project-by-project basis.
- **Processing:** The cost to process asphalt shingles varies based on the contamination of the C&D Roofing materials. For example, roofing shingles from a tear-off will require additional processing due to nails, wood, and other contamination and thus processing costs will be higher. One Georgia roofing processor estimated the processing fee for a 10 cubic yard load, estimated to weigh approximately 17 to 18 tons, at a flat rate of $50. At an average tipping fee of $23.72 per ton, the cost for processing a load may be a fraction of the cost to dispose of the same load. On the other hand, with limited processing capacity in the State, a processor may be much further away than a disposal facility[14], making shipping to a market cost-prohibitive, even if the market was willing to accept the material.
- **Other Materials that May be Accepted by the Same Processor:** The processors for C&D Roofing may be willing to accept other C&D material. Specifically, processors that are incorporating the material into a hot mix asphalt or producing a product made with C&D aggregates also may be willing to accept the following materials:
  - Painted Concrete;
  - Unpainted Concrete;
  - Painted Asphalt Paving;
  - Unpainted Asphalt Paving;
  - Painted Brick and Other Aggregates; and
  - Unpainted Brick and Other Aggregates.

  However, the more these materials are mixed, the more likely it may be that the processors or end users would require testing of materials delivered. For example, if painted concrete, asphalt, or brick and other aggregates are included, processors or end users may require testing to ensure that no lead-based paint is in the load.

[14] According to ShingleRecycling.org, there are two shingle recyclers in the State of Georgia.

C&D Aggregates

Two of the top ten material types, concrete and brick and other aggregates, comprised an estimated 690,000 tons of material disposed in landfills in the State. The C&D Aggregates material class also included asphalt paving. Figure 7-3 presents the breakdown between material categories defined as C&D Aggregates and other C&D materials.

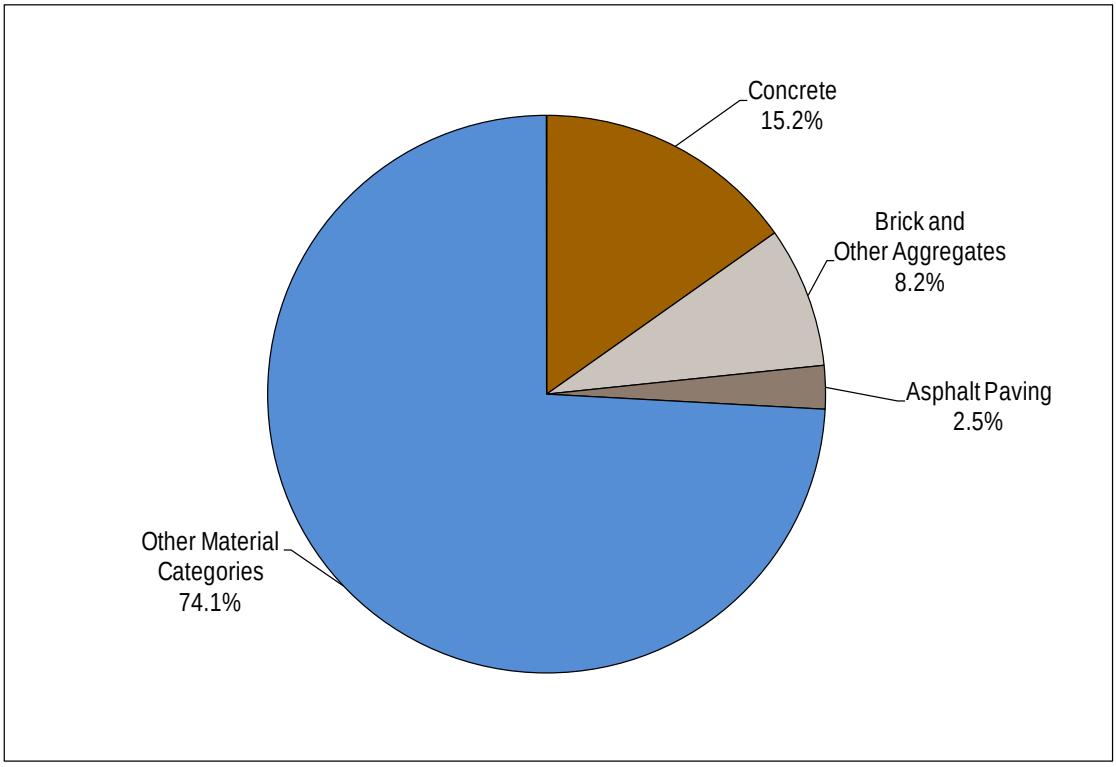

Figure 7-3. C&D Aggregate Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

Figure 7-4 shows the breakdown by material categories in the C&D aggregate material class. Nearly 85% was comprised of unpainted concrete and unpainted brick/ other aggregate, resulting in an estimated 648,000 tons disposed per year. This was of interest to some processors and end markets interviewed because some end-use specifications require unpainted material to meet end-product aesthetics or to address concerns about lead-based paint. Another 41,555 tons was comprised of painted concrete and painted brick/ other aggregate and some markets were willing to accept this material as well.

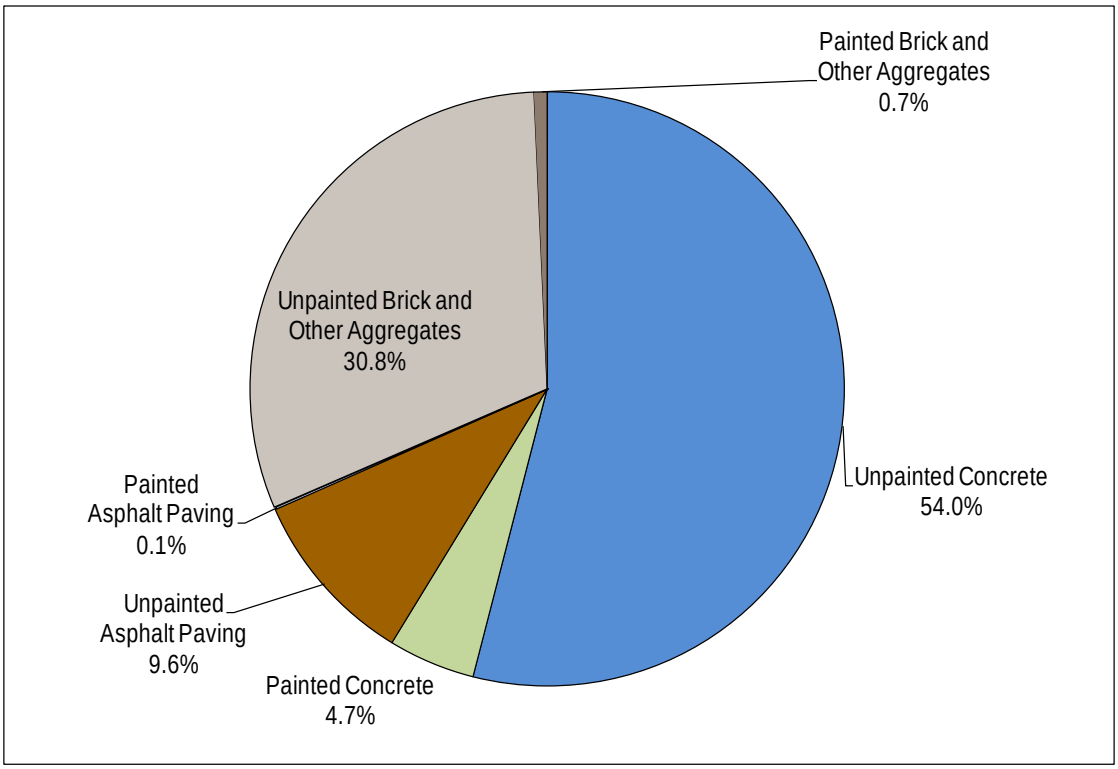

Figure 7-4. C&D Aggregates Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

Currently, the end markets identified for C&D Aggregates include:

- Reuse at the site where the materials is generated as a base or fill material;
- Paving contractors;
- Cement product manufacturers; and
- At landfills for road construction or maintenance, daily cover, and other onsite uses.

Stakeholders that currently recycle aggregates consistently reported that recycling C&D Aggregates at an off-site processing facility or an on-site at construction site was relatively straightforward. Generators, processors and end markets for C&D Aggregates identified the following issues associated with diverting C&D Aggregates from disposal:

- **Specifications for Materials:** Specifications are highly dependent on the end use for aggregate from C&D. End markets for lower end uses such as base material allow for less consistent mixed aggregates. However, certain end markets, such as a concrete product requiring a homogenous color, will require greater consistency of materials. The presence of rebar or other metal or lead-based paint in aggregate may increase processing costs or decrease marketability.
- **Hauling:** Even though the end markets for C&D Aggregates are reportedly well established, hauling to a processor or end user that is located a greater distance

from the disposal facility may be cost-prohibitive due to the weight of the materials. A metro-Atlanta stakeholder whom owns and operates a C&D landfill and processing facility stated that the general rule of thumb is that the costs of recycling C&D Aggregates is less than the cost for disposal if an end market is located within 20 miles of the generator.

- **Processing:** In recent years, equipment to crush C&D Aggregate has gotten more portable, making it more cost effective to bring in equipment to process material on-site for smaller amounts of material. (Stakeholders that send aggregate off-site for processing and reuse are likely to pay a fee. Based on stakeholder interviews, the processing costs associated with offsite recycling of a 15 cubic yard container of C&D Aggregate is approximately $40, but the ultimate cost depends on the quality and quantity of material.
- **End Use:** C&D Aggregate is often crushed and used on a construction site or at a site nearby as base material. For example, the developer of Atlantic Station in Atlanta reports that 132,000 cubic yards of concrete from the former steel mills on the site and 164,000 cubic yards of excavated granite was crushed and used as backfill, road base and in retaining walls on the site. Several stakeholders reported recycling up to 100% of concrete generated from the construction activity at the site where generated. The cost of virgin material was a factor identified by multiple stakeholders for increasing the use of recycled C&D Aggregates at their job sites. For example, a stakeholder reported that the costs of virgin material was approximately $15 per ton and the cost for recycled material was $6 per ton thus resulting in a cost savings of $9 per ton of material purchased. Some stakeholders also reported that relatively clean C&D Aggregate loads delivered to a landfill were set aside until sufficient volume was accumulated and then a mobile crusher was used to crush the material so it could be used at the landfill site.
- **Other Materials that May be Accepted by the Same End Market:** The end markets for C&D Aggregates may accept the following materials depending on the intended use of the aggregate::
  - Painted Asphalt Paving;
  - Unpainted Asphalt Paving; and
  - Dirt and Sand.

C&D Wood

Three of the top ten C&D material categories disposed in Georgia were of the material class wood. Specifically, clean dimensional lumber, clean engineered wood, and painted/stained wood were identified in the top ten materials and accounted for 396,000 tons of the approximately 2,952,000 tons of C&D disposed in the State. Figure 7-5 illustrates the composition of C&D Wood disposed in Georgia landfills as estimated by the characterization study.

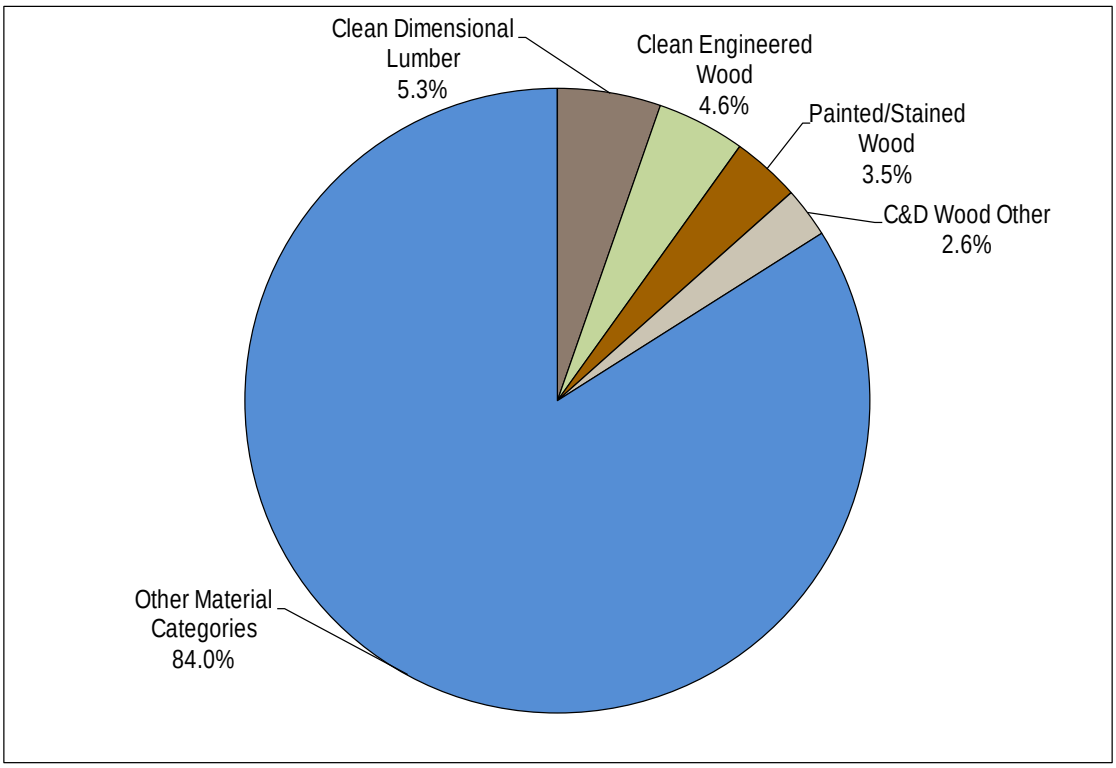

Figure 7-5. C&D Wood Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

Of the C&D Wood disposed in the State in 2009, an estimated 61.8% was either clean dimensional lumber or clean-engineered wood. Figure 7-6 below presents a breakdown of the C&D Wood by material categories.

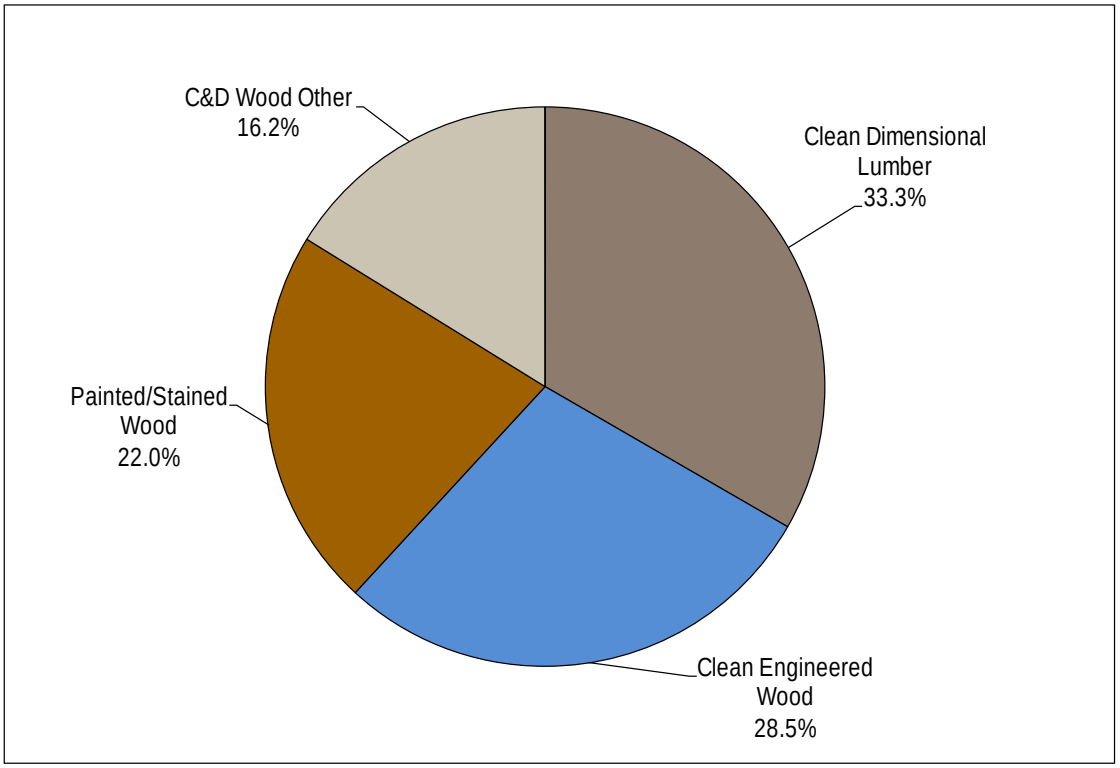

Figure 7-6. C&D Wood Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

Stakeholders contacted about recovery of C&D Wood primarily expressed an interest in materials generated from new construction activities. As presented in Table 7-4, approximately 39.0% of the C&D Wood material coming from new construction activities is clean dimensional lumber and unpainted large structural lumber, resulting in nearly 70,000 tons per year. Another 66,000 tons per year is estimated to be clean-engineered wood.

Table 7-4
Composition of C&D Wood from New Construction Activities (Estimated Tons per Year)
October 2008 – September 2009

C&D Wood Material Type	Residential New Construction Tons	Non-residential New Construction Tons	Total Tons C&D Wood	% of Total C&D Wood
Clean Dimensional Lumber	28,498	28,663	57,161	31.9%
Unpainted Large Structural Wood	15	12,685	12,699	7.1%
Clean Engineered Wood	40,635	24,979	65,614	36.6%
Standard-sized Wood Pallets	6,107	20,366	26,473	14.8%
Other Wood Pallets and Crates	2,038	5,833	7,871	4.4%
C&D Wood: Other	3,753	5,809	9,562	5.3%
Total	81,045	98,335	179,380	100.0%

The C&D Wood end markets identified include:

- Mulching;
- Composting;
- Pallet Recycling;
- Wood Pellet Producers;
- Energy Generation; and
- Pulp Mills.

Some of the key challenges and opportunities regarding the diversion of C&D Wood from disposal included the following.

- **Specifications for Materials:** Stakeholders consistently expressed that markets were available for clean dimensional lumber and unpainted large structural wood, especially materials generated at construction sites (as opposed to renovation or demolition sites). One company that mulches wood reportedly would only accept clean dimensional lumber while an energy generation facility may accept a wider range of C&D Wood, even engineered wood. Depending on the end use, the distance to market, and the quantity of material available, the supplier may be required to remove nails or chip material prior to sending C&D Wood to the processor/end market. Stakeholders reported that typically, the farther the generator is from the processor or end market, the more chipping for volume reduction, must be done before shipment to decrease the overall cost of transportation.

  In addition, an interest was identified for clean-engineered wood and pallets from select end markets. However, the interest for clean-engineered wood and pallets depended on the supplier being able to meet the specifications, especially with regard to adhesives and other potential contaminants.

- **Impact of Biomass to Energy Projects on Markets:** Some stakeholders expressed that with the growing interest in generating energy from biomass, the demand for C&D Wood is likely to increase. Although many biomass projects are looking to virgin material from forestry operations (), one biomass end market stated a preference for C&D Wood versus virgin material from forestry operations due to the lower moisture content of the material (debris with a higher moisture content requires more energy to combust relative to the same debris with a lower moisture content). One benefit of increased demand for C&D Wood by the biomass industry may be reduced processing requirements prior to sending C&D Wood to an end market. In order to get the wood, end users may need to develop the capability, through developing their own infrastructure or contracting with wood processors, to perform the necessary processing themselves. One stakeholder stated that the improved access to biomass markets and increased price for wood could encourage a generator of wood or a landfill that accepted C&D wood to invest in wood processing equipment by the stakeholders.

- **Hauling:** Hauling costs for wood waste vary based on composition of the materials and the distance to be hauled. Stakeholders expressed the potential opportunity to reduce hauling costs by collaborating with local transfer station or disposal facilities for storage and transferring of wood waste to an end market.
- **Processing:** Processors stated that the cost to process wood depends on the moisture content and contamination found in the wood. Therefore, materials from a new construction project would be expected to have lower processing costs than material from a renovation or demolition project. Processing costs would also be lower for clean dimensional lumber and unpainted large structural wood if separated from other C&D Wood and other C&D material.
- **Other Materials that May be Accepted by the Same Processors:** The processors for C&D Wood may also accept yard trimmings, branches and stumps, especially if the material is being used for energy generation. The quantity of yard trimmings available at landfills is greater than the amount reported by the Study since these materials are found in significantly quantities in non-C&D loads (land-clearing loads, MSW, etc.) as well as the C&D characterized for this Study.

C&D Other

The "C&D Other" material class includes C&D materials that did not fall within the C&D Wood, aggregates or roofing classes. Specifically, C&D Other includes the following material categories:

- Clean Gypsum Board;
- Painted/Demolition Gypsum;
- Composite Acoustic Ceiling Tiles;
- Rock and Gravel;
- Dirt and Sand;
- Fiberglass Insulation;
- Expanded Polystyrene Insulation; and
- Remainder/Composite C&D.

Of the materials included in the C&D Other material class, clean gypsum board, dirt and sand, and remainder/composite C&D material categories were included in the top ten C&D material categories disposed in the State. Due to the variety of materials in the remainder/composite C&D material type, it is unlikely that as generated, it would be highly marketable. Thus, the R. W. Beck Project Team focused the market analysis for C&D Other on clean gypsum board and dirt and sand, which together comprise 15.9% of the C&D Other material class as shown in Figure 7-7.

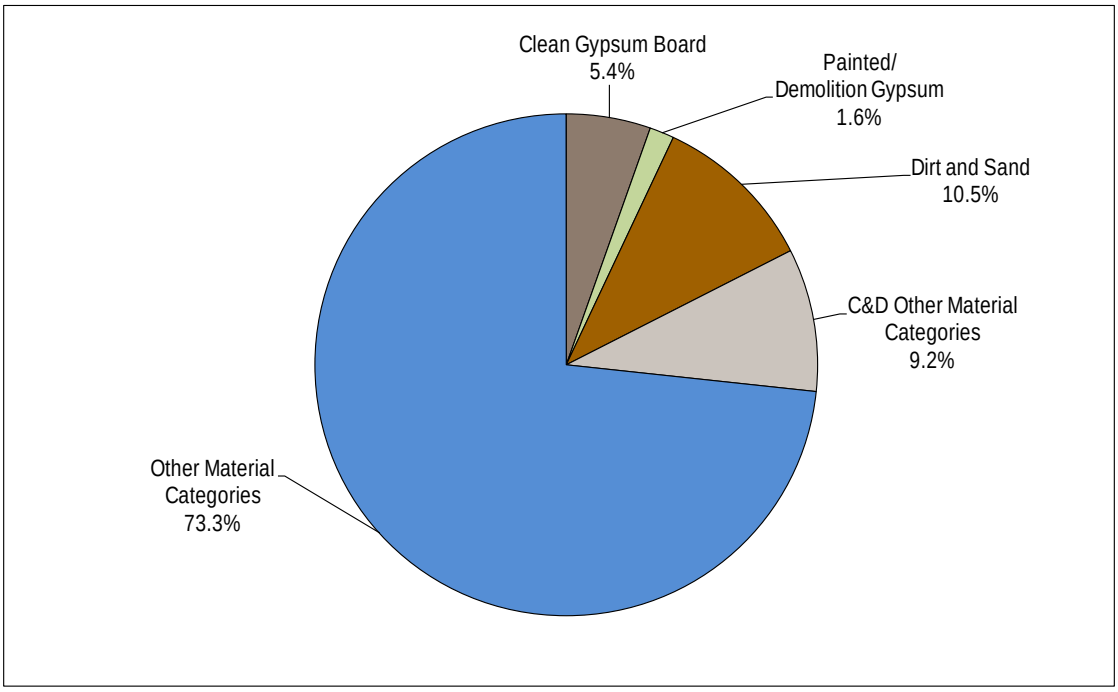

Figure 7-7. C&D Other Disposed by Material Type (% of Annual Tonnage)
October 2008 – September 2009

Clean Gypsum Board

- **Uses in Georgia:** According to stakeholders interviewed, primary end markets for clean gypsum board in Georgia include onsite soil amendment, soil conditioner for agricultural applications, and as a component for manufacturing Portland cement or new drywall.
- **Availability of Gypsum from Other Sources:** Some stakeholders report that markets in Georgia for recovered gypsum board are more saturated than elsewhere because of the abundance of gypsum produced in power plant scrubbers when limestone forced oxidation processes of gas-phase sulfur oxides are employed, resulting in the formation of gypsum. For example, Georgia Pacific uses the gypsum from scrubbers in fossil-fuel burning plants to produce synthetic gypsum wallboard. In addition, the cost of virgin rock gypsum and synthetic gypsum is relatively low which makes it difficult for recycled gypsum to compete. One stakeholder reported that when he inquired into gypsum board end markets for a construction project in Georgia, the closest end market was located in Florida, approximately 300 miles from the construction site.

Dirt and Sand

- **Uses in Georgia:** Dirt and sand may be used on-site at construction sites or at a local landfill to reduce the need for off-site "borrow" material. Alternatively, another construction site in the area may be a potential market. The key

determinant in the ability to divert dirt and sand from disposal is the proximity of an end user to the generator. In some cases, dirt and sand may be marketed by a broker to end-users.

- **Specifications for Materials:** End markets for dirt and sand typically require the material to be free of stumps and other contaminants. Some end users may require a particular particle size so some generators or processors may screen dirt to meet such requirements. For other markets, the source and resulting composition of the dirt is a consideration. For example, some end users prefer not to have recovered screened material from a demolition or construction site because they do not want small gypsum wallboard particles included in the materials.
- **Hauling:** Unlike other C&D materials, dirt is often free if picked up from the generator.
- **Processing:** If a generator is unable to utilize the dirt on site or find a local end market to pick up the dirt, a local dirt processor may accept truckloads of dirt delivered to processing facility and screen and market the material, especially if a large end user is nearby. One dirt supplier reportedly charges $16.00 per cubic yard for fill dirt while another stakeholder indicated a $25 to $30 processing cost for a 15 cubic yard load of dirt. Based on these costs, the costs to process dirt and sand for an end user may be lower than disposal of the material at a C&D landfill if the facilities are equidistant so the determining factor may be haul distance.

Metal

Based on the characterization study, approximately 3.1% of the total tonnage of C&D disposed in the State of Georgia, or 92,000 tons per year, is metal. Table 7-8 illustrates the amount of metal in comparison to other C&D materials currently disposed in landfills across the State.

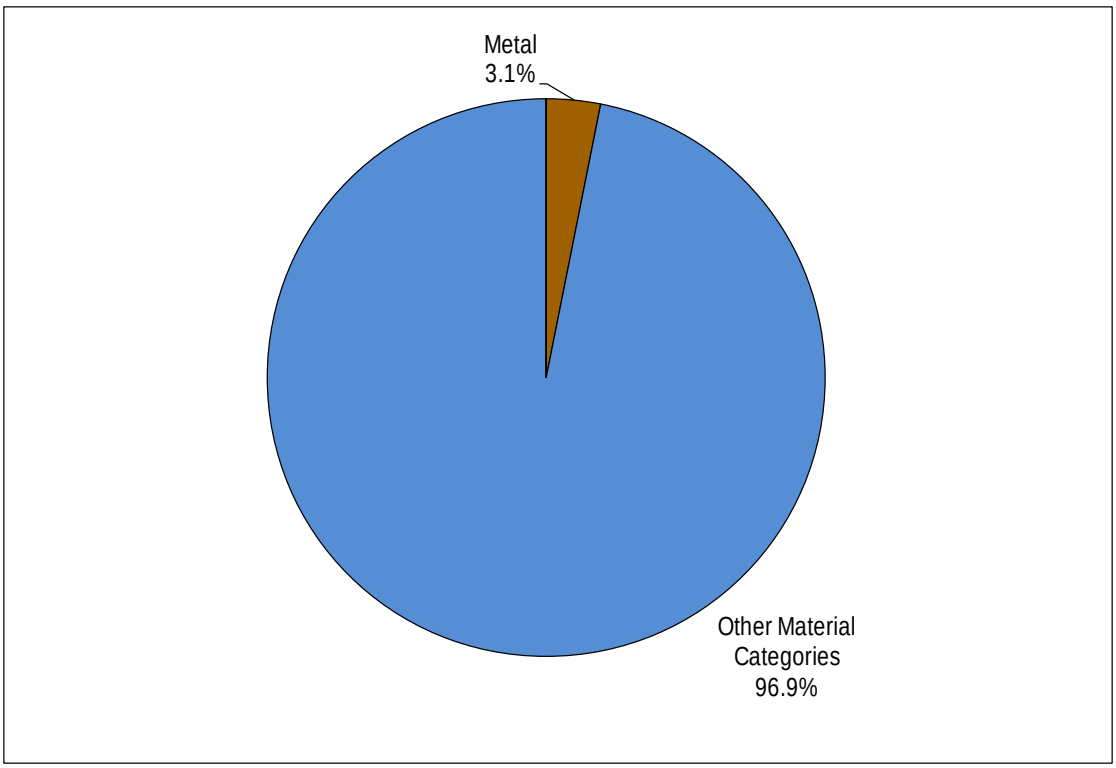

Figure 7-8. Metal Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

Approximately 83,000 tons, or 90% of the metal in C&D loads disposed of in Georgia landfills is other (non-appliance) ferrous as shown in Figure 7-9. For purposes of the Study, other ferrous included items such as tin/steel cans, structural steel beams, boilers, metal pipes, and other ferrous C&D materials. One metal processor interviewed stated that the current price for these materials delivered to their facility ranges from $120 to $130 per ton, therefore, in 2009, an estimated $10 million worth of metal may have been disposed in Georgia landfills.

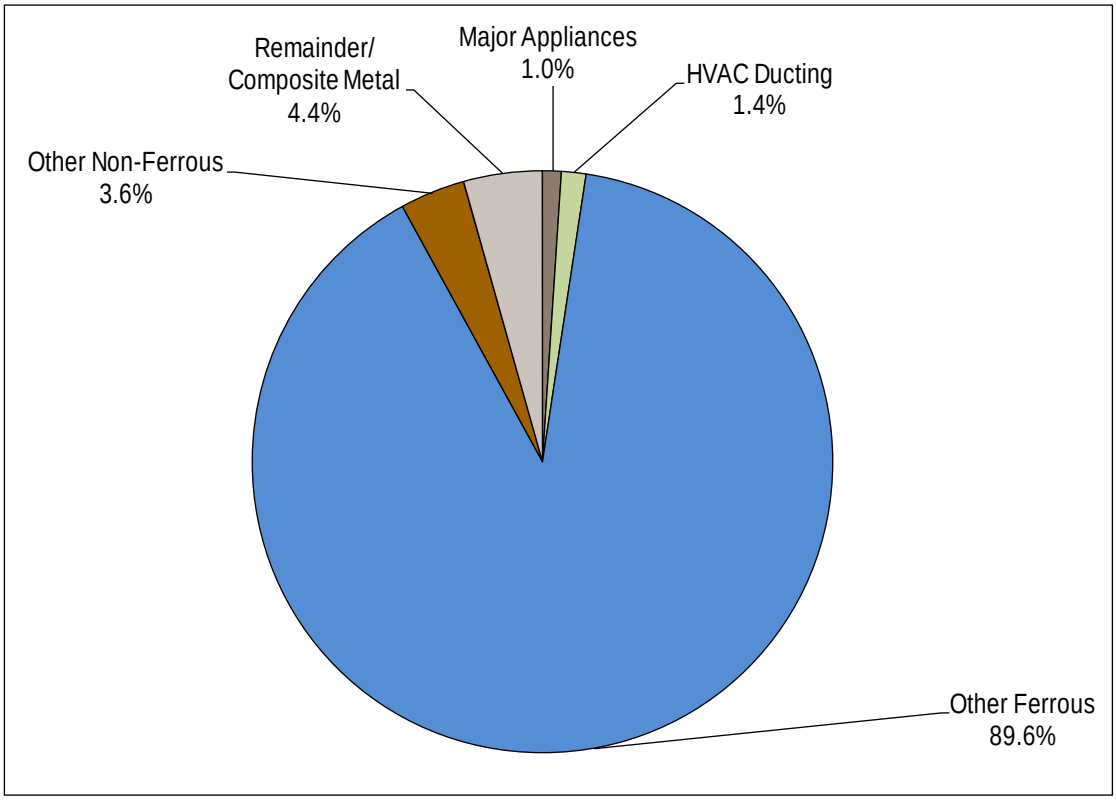

Figure 7-9. C&D Metal Disposed by Material Type (% of Annual Tonnage), October 2008 – September 2009

- **Markets for Material:** Even with the downturn in the recyclables markets, the current markets for metals are typically strong enough to provide a financial incentive for generators to recycle versus dispose of metal, especially in the more populated areas of the State where the distance to markets is not cost-prohibitive. The Georgia Department of Community Affairs Recycling Markets Directory identifies 70 markets, for ferrous metals generated within the State located in 39 of the 159 Georgia counties. Typically, the larger processors are taking old cars and appliances and shredding them for market.
- **Specifications for Materials:** Recyclers are willing to accept metal source separated or commingled with other metal. Some may even accept C&D Metal mixed with C&D Aggregate, for example, metal rebar with concrete attached, if they have the capability to sort and use the aggregate. However, they may charge a processing fee or pay less for the recovered materials if more processing is required and/or other C&D materials are included. The composition of the metal will dictate the price a processor is willing to pay for the material.
- **Hauling:** Because metal tends to be a higher value of the material, many markets will provide containers and collect the material at no cost at a construction site or landfill. However, the revenue received for the material is likely to be lower than if the generator hauls the material to market so, generators with the capability to do so will often haul sorted C&D Metal directly to market.

- **Processing:** It often involves pulling out the higher value metals, such as copper or aluminum, and shredding the ferrous for market. If a load is mostly metal, then the processor is likely to pay the generator for the material, even if the processor collects the material at the construction site. One processor stated that generators delivering materials to a metal recycler would receive $6.00 per 100 lb of metal ($120 per ton). However, if the metal had concrete affixed then the processing payment for the material would be reduced to approximately $4.00 per 100 lb ($80 per ton).

Summary

Low tipping fees at landfills, limited space on construction sites, and the difficulty of source-separating material, especially from demolition and renovation sites, are commonly cited challenges faced by stakeholders interviewed, regardless of the material type. However, research conducted into the ten C&D material types representing the largest tonnage of disposed material identified established markets for five of the top ten material types. The material types identified by the R. W. Beck Project Team as having established markets were within C&D Aggregates, C&D Wood and Metal material classes.

Specifically, the R. W. Beck Project Team identified developed relatively accessible markets for Painted and Unpainted Concrete, Dirt & Sand, Painted and Unpainted Brick and Other Aggregates, Clean Dimensional Lumber, and Other Ferrous. However, even for these materials, the feasibility of accessing the markets depends on the source and quantity of material generated, the degree of on-site sorting, the specifications of the local market, the distance to markets, and the distance to disposal facilities.

Primarily due to the increasing interest in biomass, processors and end users interviewed expressed a growing, but limited market, for other material types within C&D Wood, most notably Clean Engineered Wood and Painted/Stained Wood. To the contrary, the remaining three material types in the top ten, Composition Roofing, Clean Gypsum Board, and Remainder/Composite C&D, were identified as having limited or no markets currently available.

Section 8
REDUCTION STRATEGIES

Introduction

The R. W. Beck Project Team considered the results of the characterization study, input from generators, processors, and end users of C&D materials, and case studies of successful C&D reduction strategies and programs across the country to develop potential strategies to reduce the amount of C&D materials disposed in the State of Georgia.[15] Some of the strategies can be undertaken by State agencies while others are geared toward providing others, such as local governments or disposal facilities, with tools to implement their own strategies.

Policy

- **Set Goals.** The State may consider setting recycling goals for those C&D materials for which markets are determined to exist. State reduction and recycling goals for other materials have been effective in garnering more attention from stakeholders right here in Georgia, leading local governments to identify ways to reduce these materials in their solid waste planning efforts and encouraging the private sector to invest in infrastructure to handle the materials that become available. The State of Florida has recently passed legislation that sets a statewide recycling goal of 75%. As one initiative to achieve this goal, the legislation specifically directs the Florida Department of Environmental Protection to assist local governments in planning and implementing construction and demolition diversion programs. The State of Georgia should base recycling goals for construction and demolition debris on a rigorous market analysis and development strategy with input from generators, processors and end users of the materials considered.
- **Conduct Policy Review.** State policies, such as those that establish permitting requirements for solid waste handling facilities in the State, may inadvertently discourage C&D recycling. Therefore, the State should review existing state policies and those proposed in the future, to ensure such policies do not discourage C&D material recovery.
- **Ensure Local Solid Waste Management Plans and Annual Reports Consider C&D Management.** Currently, all local governments in Georgia are required to develop solid waste management plan updates and submit annual reports to the State. Although the State's Minimum Planning Standards and Procedures require

[15] Case studies of C&D diversion approaches can be found in Appendix L and a list of stakeholders interviewed can be located in Appendix M of this report.

that C&D materials be included in a waste stream analysis and disposal element, the planning and reduction requirements are not as comprehensive as those for municipal solid waste. The State should consider evaluating the requirements to reduce and plan for C&D to ensure that they promote reduction and recycling of these materials. The annual reports submitted by each local government should also incorporate data regarding C&D tonnages and management practices.

- **Promote Existing Green Building Standards that Incorporate C&D Recycling and Use of Construction Materials with Recycled Content.** In Georgia and around the country, one of the biggest boons to increasing C&D recycling has been the focus by the federal, state, and local governments, private companies, universities and others on green building initiatives and rating systems, the most familiar being the U. S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System. The City of Atlanta, Chatham County, and the City of Tybee Island are three local governments in Georgia that have adopted ordinances promoting LEED certification for buildings they build, own, and sometimes fund or occupy.[16] The State should assist local governments and businesses to promote, through ordinances or other means, green building standards, including required percentages for recycling debris, for construction activities in the Georgia.

- **Review Requirements for Disposal Facilities where C&D is Disposed.** Currently, C&D landfills in the State are not required to meet the same design and operating requirements as MSW landfills. For example, they are not required to have liners or leachate collection systems. As a result, the average tipping fee at C&D landfills in the State was $23.72 in 2008, more than $10 less than the average statewide tipping fee at MSW landfills.[17] Inert landfills, which can only take a subset of what can be accepted at a C&D landfill, are even less strictly regulated. The State should continue to review regulatory requirements at these landfills to determine whether they sufficiently protect public health and the environment and promote the waste reduction goals of the State.

- **Evaluate Requirements for Processing C&D Material Prior to Disposal.** The State of Georgia may want to consider that C&D material be processed prior to disposal at specified landfill locations to ensure that non-C&D material is not disposed in these facilities and to offer the opportunity for recovery of some materials. Currently, the Florida Department of Environmental Protection has proposed the legislature consider requiring current and future C&D landfills to incorporate an onsite or off site materials recovery facility to increase diversion of C&D materials. Florida contends that the requirement to process C&D materials prior to disposal will assist in meeting the State's recently promulgated recycling goal of 75%.

[16] See U. S. Green Building Council LEED Public Policies (Updated 12/1/2009)
[17] 2008 Solid Waste Management Update, Georgia Department of Community Affairs, Revised July 31, 2009.

- **Establish and Implement Aggressive Recycling Plans for Construction, Renovation, or Demolition of Buildings Owned, Occupied, or Funded by the State.** To set an example, all state owned, occupied, or funded buildings that are constructed, renovated, or demolished should be required to develop recycling plans, for example to recycle at least 50 to 75% of all C&D generated during the project, and use products with recycled content in the case of a construction or renovation project. The State of Vermont requires a waste management plan as part of the building permit process.[18] According to the US Green Building Council, some local governments in Georgia who have adopted C&D recycling ordinances for municipal buildings include Athens-Clarke County, City of Chamblee, City of Conyers, and City of Doraville.[19] Some of the recycling requirements are part of larger policies such as requiring that all construction meet green building certification requirements.

- **Incorporate the Use of Products Made of Recycled Content in State Procurement Policies.** To expand markets for materials made from recovered C&D, state procurement policies should promote products, services, and energy sources that promote the beneficial reuse of roofing materials, wood, aggregate and other C&D materials. Such policies could include requiring vendors of supplies and services, including construction contractors or energy providers, to document the use of recovered C&D materials or to use minimum recycled content. Some states offer a price preference for products with recycled content while others include such products on state contracts that can be accessed by local governments, school districts, and others. At a minimum, the State can maintain a database of suppliers who use materials made from recycled C&D materials as well as other recyclables.

- **Strengthen Documentation and/or Certification Requirements for those Recovering C&D.** C&D recyclers suggested that some certification of C&D recycling facilities would help generators ensure that their materials are actually being recycled. Stakeholders stated that an owner of a building being constructed, renovated, or demolished sometimes requires the contractor to provide documentation as to the end markets for recovered C&D from the job site. The builders stated that the requirement from the owner was consequently incorporated into agreements with subcontractors. This contractor then is compelled to get this information from the facilities where the C&D is delivered. Lee County, Florida requires by ordinance that commingled C&D material generated by covered projects within the County be processed at a County certified commingled C&D processor prior to the disposal. The State should consider certifying facilities as C&D recycling facilities and set appropriate criteria such as requirements to demonstrate the tons of each material that is sent to market and that disposed.

- **Consider whether any Materials could be Included in Take-Back Programs.** Some countries, states, and even local governments require that manufacturers, wholesalers, or retailers take back certain materials that they produce or sell. For

[18] See case studies of C&D diversion approaches located in Appendix L
[19] See U. S. Green Building Council LEED Public Policies (Updated 12/1/2009)

example, here in Georgia, tire retailers must take back old tires from their customers. In addition, some manufacturers take back material voluntarily; for example, many carpet manufacturers have started take-back programs for post-consumer, as well as post-industrial carpet. State or local governments may require that items like pallets be accepted back by those that distribute them. Builders could require that their suppliers take back any of their materials remaining on site when a project is complete. Such an approach would most likely require statewide legislation to be effective.

Education and Technical Assistance

- **Provide Technical Assistance to Local Governments to Develop Policies.** Many policies that would further C&D diversion are most effective at the local level. Local governments can establish recycling requirements as part of a permit process and even ban recyclable C&D materials from disposal. The State could facilitate local policy-making by disseminating draft ordinances, contract language or other documents that are geared toward reducing the C&D disposed. For example, CalRecycle drafted a model C&D recycling ordinance for local governments that requires that builders prepare a waste management plan that includes provisions to recycle 50% of the C&D generated on a site in order to receive a building permit. The draft ordinance requires the builder to provide a security deposit, which is only refunded when documentation is provided that sufficiently, demonstrates recycling goals have been achieved. Many local governments in the State have passed C&D recycling ordinance using the State's model ordinance as a guide.
- **Provide Training to Generators of C&D on the Benefits of Diversion.** A training program designed for generators of C&D material, whether builder or contractors, can cover topics such as the financial and environmental benefits of recycling construction waste, how to effectively handle materials at the jobsite, using recovered materials on-site, processing equipment, and processors and end users for materials. This could be conducted in cooperation with a regular conference or meeting of developers, builders, and contractors or with an organization such as Southface, which holds related workshops.
- **Facilitate Roundtables on Markets for C&D Materials.** During stakeholder interviews, lack of awareness of available markets was cited as a barrier to recovery of C&D material. An annual or semi-annual roundtable that involves generators, disposal facilities, processors and end users of C&D materials is another way to match up those that generate materials with those that can use them. Appendix L, which includes a list of stakeholders contacted for this Study, could serve as a starting point for an invitation list. For example, such a roundtable could be conducted as part of a meeting of the Georgia Homebuilders Association, the Georgia Chapter of the Solid Waste Association of North America, or the Georgia Recycling Coalition. Due to the site-specific nature of material markets, it is recommended that the roundtables be held on a regional basis.

- **Upgrade and Promote the Use of Georgia's Online Materials Exchange.** The Georgia Sustainability Division has established an online materials exchange, the Georgia Industrial Materials Exchange. This site allows Georgia companies, institutions, commercial entities, or businesses to post their unwanted materials. Those that are looking for materials may also post. Although there are some C&D materials listed on the site, it appears that the site is not extensively used. The site should be upgraded to include a more extensive list of C&D materials and more detailed search functions such as material specifications, amounts, and region. The site could be more interactive, perhaps by incorporating an on-line "chat" function for buyers and sellers. The site should be promoted to builders, contractors, recyclers and others, in part by making it part of a broader C&D recycling resource site.
- **Put All Relevant C&D Recycling Information at a Single Well-Linked Online Location.** All information about C&D recycling, some of it already created and much of it recommended in this section of the report, should be easily accessible to all types of stakeholders online. A single webpage should include the results of this Study and all future updates, weight to volume conversion factors, case studies, model ordinances, material specifications, a recycler's database with linked location maps, a materials exchange listing, and other information. The Sustainability Division should ensure that the site is promoted by the organizations representing potential partners listed at the end of this section. An example of a content rich site established by a state agency to increase C&D recycling can be viewed at http://www.calrecycle.ca.gov/condemo/.
- **Incorporate Reduction, Reuse, and Recycling of C&D into Green Building Recognition Programs.** The Georgia Peach Green Building Rating System establishes energy efficiency and sustainable construction standards for state buildings that include requirements for commissioning of the project, water use reduction, and the use of Georgia based materials. These requirements could be expanded to include requirements for the use of materials with recycled content as well as the recycling of C&D generated on-site during the construction, renovation, demolition, or re-roofing activity. Well-tested guidelines can be found in the U. S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System. For example, in this system, a project gets points for storing and collecting recyclables (a prerequisite), reusing an existing building shell, diverting construction waste, reusing resources, and using products with recycled content.

Infrastructure Development

- **Support Development of Regional C&D Recycling Hubs.** Similar to the recycling hubs the State has sponsored for residential recyclables, the State may want to consider establishing similar regional hubs for aggregating C&D material, especially in the more rural areas of the State. The goal would be to offer generators a more convenient and/or less costly location to deliver C&D for recycling rather than disposing of the same materials. As need dictates, these hubs

could be equipped with the necessary equipment to process the material for efficient transportation to market, such as wood chippers or aggregate crushers depending on the specifications of the market to be accessed and the distance to market. The hubs may be most effective if sited at existing transfer stations or disposal facilities where C&D materials may otherwise be delivered for disposal and if they are located near major transportation routes or on a rail line for shipment of material to market. Such facilities could be publicly or privately owned or operated as are the regional hubs developed for recyclables in municipal solid waste.

- **Support Development, Expansion, and Promotion of C&D Reuse Centers.** A few local governments, non-profit organizations like Habitat for Humanity and for profit entities operate reuse centers at locations across the State. The State should make a concerted effort to expand and promote these locations, perhaps encouraging the establishment and/or promotion of C&D material reuse centers at locations where those with reusable materials and those needing them are likely to congregate such as wholesale locations and disposal facilities. In addition, the State should ensure that C&D recycling/reuse facilities are able to apply for any state-offered grants or low-interest loans aimed at small businesses and green jobs.

Market Development

- **Work with Stakeholders to Develop Comprehensive Market Development Plan for Each of the Key Material Categories Identified in this Study.** This Study includes an overview of market issues associated with C&D materials in Georgia based on a discussion with several dozen stakeholders. However, the scope of work did not include a comprehensive market analysis or the development of a marketing plan. The State should work with stakeholders to research the specific capabilities of all processors and end users for C&D materials identified in the Study and determine detailed collection, processing, and end use infrastructure and incentives required to divert C&D materials from disposal facilities. Similar research has been done for many years for traditional recyclables such as paper, plastic, metal containers, and glass. A comprehensive understanding of existing markets and required infrastructure would allow the State to set achievable waste reduction or recycling goals, determine the need for regional hubs, evaluate the feasibility of a statewide disposal ban on particular C&D materials, or establish other statewide requirements. As an example, the State of Massachusetts banned specific C&D materials after a three-year planning process that assessed the potential impact of the disposal ban and potential markets for these materials. At the time, the disposal ban went into effect there were a number of construction and demolition (C&D) processing facilities operating in Massachusetts and in New Hampshire with the capability to separate out the banned materials from mixed C&D. However, the use of screened fines as landfill cover in that State has some drawbacks and lessons that could also be included as part of a market development plan.

- **Assess what is Needed to Divert C&D Wood that is Currently Disposed to Emerging Biomass Markets.** C&D Wood represents three of the top ten C&D materials disposed by quantity in the State of Georgia. With federal energy policies emphasizing a shift toward renewable energy sources, developers, utilities, and government agencies are focused on identifying readily available sources of biomass, including C&D Wood, to use as a feedstock. The State should consider an analysis of the potential to aggregate, process, and use the C&D wood identified in this Study in existing, proposed, or new biomass projects. This analysis could determine the infrastructure and funding required, potential sources of funding, and the role of the State to divert C&D Wood from disposal to biomass facilities.
- **Sponsor Research into the Expansion of Composition Roofing and Clean Gypsum Markets.** More composition roofing is disposed in Georgia landfills than any other single C&D material. In addition, gypsum board is within the top ten materials categories of disposed material. However, the research conducted for this Study suggests that for these materials especially, there are not sufficient markets in Georgia to handle the tonnage disposed. The State should sponsor research into additional uses for these materials by offering financial incentives, such as grants or tax incentives to conduct research and develop infrastructure. One particular area of study should be to work with Georgia Department of Transportation to determine whether the percentage of composition roofing in road applications can be increase. For example, the State of Missouri conducted research that allowed them to develop a hot mix asphalt specification that allows for 7% recycled asphalt shingles.
- **Provide Tax Incentives for C&D Recycling Equipment.** The capital costs associated with the acquisition of C&D recycling equipment is an impediment to processors entering the C&D recycling industry. To promote new C&D processing facilities, the State should provide financial incentives, such as tax incentives or grants, for new C&D processing equipment.

Potential Partners

Many stakeholders were contacted for this Study to gather input on challenges, opportunities, and potential strategies to divert C&D from disposal. During the course of this research, it was evident that many resources to recover more C&D already exist in Georgia and across the country and in this time of limited resources, the State could benefit from this experience on a more long-term basis. Armed with the information provided by this Study, the State should collaborate with representatives from across the State that can provide insight, guidance, and resources to increase C&D recycling in the State. These may include organizations and entities such as the following:

- Local governments;
- Civic and environmental groups;
- Recyclers of C&D and other materials;
- Waste haulers;

- Landfill and transfer station operators;
- Chambers of Commerce;
- Builders;
- Roofers and other contractors;
- C&D generating businesses;
- Building inspectors;
- State agencies;
- Federal agencies;
- Architects/engineers;
- End users for wood, aggregate, roofing shingles; and
- Other generators, processors and end markets of C&D material.

It is often most effective to reach potential partners through their trade associations and membership organizations. Some to consider may include: Association County Commissioners of Georgia, Georgia Municipal Association, Georgia Recycling Coalition, Georgia Chapter of the Solid Waste Association of North America, Georgia Chamber of Commerce, Home Builders Association of Georgia, Roofing and Sheet Metal Contractors Association of Georgia, Building Officials Association of Georgia, Construction Materials Recycling Association (CMRA), Southface Energy Institute and state universities.

A list of stakeholders contacted for this Study is included in Appendix L.

Appendix A
ACTIVITY TYPE, MATERIAL CLASS, AND MATERIAL TYPE DEFINITIONS

Appendix A
ACTIVITY TYPE, MATERIAL CLASS, AND MATERIAL TYPE DEFINITIONS

Construction Activity Types

- **Residential new construction:** Materials generated from the construction of new residential structures including single-family, townhouses, apartment complexes, and other multifamily residences. Excludes high-rise apartment, condo, and mixed-use buildings.
- **Non-residential new construction:** Materials generated from the construction of new non-residential buildings, such as businesses, government offices, and schools. Includes high-rise apartment, condo, and mixed-use buildings.
- **Residential renovation:** Materials generated from the remodeling of residential structures including single-family, townhouses, apartment complexes, and other multifamily residences. May include material from the demolition and construction phases of a remodel. Excludes high-rise apartment, condo, and mixed-use buildings.
- **Non-residential renovation:** Materials generated from the remodeling of non-residential buildings, such as businesses, government offices, and schools. May include material from the demolition and construction phases of a remodel. Includes high-rise apartment, condo, and mixed-use buildings.
- **Residential demolition:** Materials generated from the break-down and removal of an entire existing residential structure. If the activity includes renovating or remodeling any aspect of the existing structure it will be considered "residential renovation." Includes single-family, townhouses, apartment complexes, and other multifamily residences. Excludes high-rise apartment, condo, and mixed-use buildings.
- **Non-residential demolition:** Materials generated from the break-down and removal of an entire existing non-residential structure. If the activity includes renovating or remodeling any aspect of the existing structure it will be considered "non-residential renovation." Includes high-rise apartment, condo, and mixed-use buildings.
- **Roofing:** Materials generated from the new construction, remodeling, and/or demolition of residential or non-residential roofs.
- **Other/Mixed construction:** Materials generated from a mix of activities (e.g., a load with both residential and non-residential demolition materials) or generated from activities not otherwise classified, such as the building, repair, and/or demolition of roads, bridges, and other public infrastructure.

- **Non-C&D Loads:** Materials generated from non-construction and demolition activities. Includes homeowner self-hauled C&D waste, manufacturing waste, and packing/crating materials. (This category will only be used for the purposes of classifying incoming vehicles. No samples will be characterized from these loads.)

Material List and Definitions

PAPER		
1.	Uncoated Corrugated Cardboard/ Kraft Paper	Corrugated boxes or paper bags made from Kraft paper. It does not have any wax coating on the inside or outside. Examples include entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. Kraft includes bags and sheets made from Kraft paper. Examples include paper grocery bags, fast food bags, department store bags, and heavyweight sheets of Kraft packing paper. This category does not include chipboard.
2.	Other Recyclable Paper	Recyclable items made mostly of paper that do not fit into the above category. Paper may be combined with minor amounts of other materials such as wax or glues. This category includes items made of bond paper, newsprint, glossy coated paper, chipboard, groundwood paper, and deep-toned or fluorescent dyed paper. Examples include ledger, newspaper, manila folders, cereal and cracker boxes, unused paper plates and cups, goldenrod colored paper, school construction paper/butcher paper, milk cartons, ice cream cartons and other frozen food boxes, junk mail, colored envelopes for greeting cards, pulp paper egg cartons, unused pulp paper plant pots, magazines and catalogues, phone books and directories, and softcover books.
3.	Cellulose Insulation	Pulped paper, usually newsprint, installed as insulation in walls using a dense-packing or spraying technique. Typically treated with fire retardants.
4.	Remainder/ Composite Paper	Items that are not listed in another paper category. This category also includes Items that are comprised mostly of paper but combined with large amounts of other materials such as wax, plastic, glues, foil, food, and moisture. Examples include waxed corrugated cardboard, aseptic packages, waxed paper, tissue, paper towels, blueprints, sepia, onion skin, fast food wrappers, carbon paper, self-adhesive notes, hardcover books, and photographs.
GLASS		
5.	Glass Bottles and Containers	Glass beverage and food containers. Examples include whole or broken soda and beer bottles, fruit juice bottles, peanut butter jars, whole or broken wine bottles, and mayonnaise jars.
6.	Flat Glass	Clear or tinted glass that is flat. Examples include glass window panes, doors, and table tops, flat automotive window glass (side windows), safety glass, and architectural glass. This category does not include windshields, laminated glass, or any curved glass.
7.	Remainder/ Composite Glass	Glass that cannot be put in any other category. This category also includes items made mostly of glass but combined with other materials. Examples include Pyrex, Corningware, crystal and other glass tableware, mirrors, non-fluorescent light bulbs, and auto windshields.

METAL		
8.	Major Appliances	Major appliances of any color. These items are often enamel-coated. Examples include washing machines, clothes dryers, hot water heaters, stoves, refrigerators, furnaces and heating and cooling equipment. This category does not include electronics, such as televisions and stereos.
9.	HVAC Ducting	Sheet metal tubing, typically galvanized, used for conveying ventilation air.
10.	Other Ferrous	Any iron or steel that is magnetic and not defined elsewhere. Examples include tin/steel cans, structural steel beams, boilers, metal clothes hangers, metal pipes, stainless steel cookware, security bars, and scrap ferrous items and galvanized items such as nails and flashing.
11.	Other Non-ferrous	Any metal item, including aluminum cans, that is not magnetic. These items may be made of aluminum, copper, brass, bronze, lead, zinc, or other metals. Examples include aluminum window frames, aluminum siding, uninsulated copper wire, shell casings, brass pipe, and aluminum foil.
12.	Remainder/ Composite Metal	Metal that cannot be put in any other category. This category also includes items made mostly of metal but combined with other materials and items made of both ferrous metals and non-ferrous metal combined. Examples include small non-electronic appliances such as toasters and hair dryers, motors, insulated wire, and finished products that contain a mixture of metals, or metals and other materials, whose weight is derived significantly from the metal portion of its construction.
PLASTIC		
13.	Recyclable plastic containers	PET and HDPE containers other than five gallon buckets generally accepted in recycling programs. Examples include bottled water containers, shampoo bottles, soda bottles, milk, and detergent bottles.
14.	HDPE Buckets	HDPE buckets in standard 5 gallon commercial sizes with metal wire or other type handles. Usually have a round or square shape and are frequently used as containers for paint or other construction materials.
15.	Expanded Polystyrene Packaging	Items marked with a PS or a #6. Examples include packaging blocks/forms, packaging peanuts, food packaging trays, and EPS clamshell containers. Does not include EPS insulation.
16.	Non-bag Commercial and Industrial Packaging Film	Film plastic used for large-scale packaging or transport packaging. Examples include shrink-wrap, mattress bags, furniture wrap, and film bubble wrap.
17.	Tyvek	Includes Tyvek brand building wrap and other similar products.
18.	Other Film	Other plastic film that does not fit in another category. Examples include plastic bags (grocery bags, sandwich bags, zipper-recloseable bags, newspaper bags, produce bags, frozen vegetable bags, bread bags), food wrappers such as candy-bar wrappers, mailing pouches, bank bags, X-ray film, metallized film (wine containers and balloons), plastic food wrap, agricultural film (films used in various farming and growing applications, such as silage greenhouse films, mulch films, and wrap for hay bales), plastic sheeting used as drop cloths, and trash bags.
19.	Plastic Siding/ Decking	Rigid plastic planks or sheets used for exterior finishing or deck surfaces.
20.	Plastic Pallets	Shipping flats made of plastic.

21.	Durable Plastic Items	Plastic objects other than containers and film plastic usually made to last for more than one use. Examples include plastic toys and sporting goods, CD's, and plastic housewares, such as mop buckets, dishes, cups, and cutlery. This category also includes building materials such as window sashes and frames; housings for electronics such as computers, and televisions and stereos.
22.	Plastic Piping	Pipes and fittings made of PVC (polyvinyl chloride), ABS (acrylonitrile butadiene styrene), or other rigid plastics.
23.	Remainder/ Composite Plastic	Plastic that cannot be put in any other categories including other rigid plastic packaging not listed above. This category also includes items made mostly of plastic but combined with other materials. Examples include auto parts made of plastic attached to metal, plastic drinking straws, foam packing blocks (not including expanded polystyrene blocks), plastic strapping, new plastic laminate (e.g., Formica), vinyl, linoleum, plastic lumber, imitation ceramics, handles and knobs, plastic lids, some kitchen ware, toys, plastic string (as used for hay bales), and plastic rigid bubble/foil packaging (as for medications).
COMPOSTABLES		
24.	Yard trimmings	Plants and woody material less than four inches in diameter from any public or private landscape. Examples include leaves, grass clippings, sea weed, plants, prunings, shrubs, and small branches This category does not include stumps or tree trunks.
25.	Branches and Stumps	Tree trunks and stumps, including associated dirt, that exceed four inches in diameter from any public or private landscape.
CONSTRUCTION AND DEMOLITION		
26.	Concrete [1] [2]	A hard material made from sand, gravel, aggregate, cement mix, and water. This category includes concrete containing steel mesh and/or reinforcement bars, or "rebar". Examples include pieces of building foundations, concrete paving, and cinder blocks.
27.	Asphalt Paving [1] [2]	A black or brown, tar-like material mixed with aggregate used as a paving material. This category includes asphalt paving containing steel mesh and/or reinforcement bars, or "rebar".
28.	Composition Roofing [4]	Composite shingles composed of fiberglass or organic felts saturated with asphalt and covered with inert aggregates as well as attached roofing tar and tar paper. Commonly known as three tab roofing. Examples include asphalt shingles and attached roofing tar and tar paper. Does not include built-up roofing.
29.	Other Asphalt Roofing (Built-up Roofing) [4]	Other roofing material made with layers of felt, asphalt, aggregates, and attached roofing tar and tar paper normally used on flat/low pitched roofs usually on commercial buildings. Sometimes referred to as torch-down roofs.
30.	Brick and Other Aggregates [1] [2]	Bricks and aggregates other than concrete and asphalt paving such as masonry tile, ceramics, porcelain toilets, and clay roofing tiles.
31.	Clean Dimensional Lumber [3]	Unpainted/untreated new or demolition dimensional lumber. Includes materials such as 2 x 4s, 2 x 6s, 2 x 12s, and other residual materials from framing and related construction activities. May contain nails or other trace contaminants.
32.	Large Structural Wood [1] [3]	Posts and beams from renovation or demolition projects that are larger than 6 x 6 (or equivalent) and longer than 4 feet. This material is often salvaged and used for architectural or structural purposes. Can be clean or stained/treated/painted.

33.	Clean Engineered Wood [3]	Unpainted/untreated new or demolition scrap from sheeted goods such as plywood, particleboard, wafer board, oriented strand board, and other residual materials used for sheathing and related construction uses. May contain nails or other trace contaminants.
34.	Standard-sized Wood Pallets [5]	Unpainted wood pallets that are approximately 48 x 40 inches.
35.	Other Wood Pallets and Crates [3]	Unpainted, non-standard-sized pallets, crates, and packaging made of lumber/engineered wood.
36.	Painted/ Stained Wood [3]	Wood that has had an external coating, such as paint, stain, or varnish, applied. Examples include handrails and trim.
37.	Other Treated Wood[3]	Wood that has been treated with a chemical preservative not included in any other category, such as chromated copper arsenate (CCA), also called "pressure-treated wood." This type of wood may have a greenish tint or be perforated. Examples include some cedar shakes and shingles and most wood from playgrounds, decks, and other outdoor structures.
38.	Creosote-treated Wood [3]	Wood that has been treated with creosote. Examples include railroad ties, marine timbers and pilings, landscape timbers, and telephone poles.
39.	Clean Gypsum Board [5]	Unpainted gypsum wallboard or interior wall covering made of a sheet of gypsum sandwiched between paper layers. Examples: This category includes used or unused, broken or whole sheets. Gypsum board may also be called sheetrock, drywall, plasterboard, gypboard, gyproc, or wallboard.
40.	Painted/ Demolition Gypsum Board [5]	Gypsum wallboard or interior wall covering made of a sheet of gypsum sandwiched between paper layers that has been painted, wallpapered, or broken during demolition activities. Gypsum board may also be called sheetrock, drywall, plasterboard, gypboard, gyproc, or wallboard.
41.	Composite Acoustic Ceiling Tiles[5]	Ceiling panels made from spun mineral wool fiber mixed with starch, typically supported by a metal grid system.
42.	Rock & Gravel [5]	Pieces of mineral matter or rock. Examples include landscaping rock, paving stones, pathway gravel and other natural or mechanically crushed materials.
43.	Dirt & Sand [5]	Nutrient rich decayed organic matter and fine pieces of mineral matter, often left over from land clearing activities. This category also includes non-hazardous contaminated soil.
44.	Fiberglass Insulation [5]	Any of the various types of synthetic fiber insulation including both faced and unfaced batts. Used in ceilings, walls and around ducting for both thermal insulation and sound attenuation.
45.	EPS insulation [5]	Insulation panels marked with a PS or a #6.
46.	Remainder/ Composite C&D [1]	Construction and demolition material that cannot be put in any other category. This category may include items from different categories combined, which would be very hard to separate. This category may also include demolition debris that is a mixture of materials such as non-porcelain sinks, synthetic counter tops, plate glass, wood, tiles, gypsum board, flexible HVAC ducting, and aluminum scrap.
POTENTIALLY HAZARDOUS WASTE		
47.	E-Waste	Brown goods, such as microwaves and VCRs; computer-related electronics; small consumer electronics, such as cell phones, computer games, and digital cameras; and televisions and other items containing a CRT.
48.	Asbestos-labeled bags	Asbestos waste contained in airtight and puncture resistant, asbestos-labeled bags. May be labeled, "Danger/Contains Asbestos Fibers/Avoid Creating Dust/Cancer and Lung Disease Hazard." Do not open these bags.

49.	Other HHW	HHW includes paint, vehicle and equipment fluids, used oil, batteries, and any other household hazardous waste such as fluorescent lights, pesticides, and caustic cleaners.
OTHER MATERIALS		
50.	Carpet	Flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material. Does not include carpet padding.
51.	Carpet Padding	Plastic, foam, felt, and other materials used under carpet to provide insulation and padding.
52.	Wood Furniture	Finished and unfinished furniture made primarily of wood. Examples include bed frames, wooden chairs, book cases, media cabinets.
53.	Plastic Furniture	Furniture made primarily of plastic. Examples include office chairs, and plastic outdoor furniture.
54.	Mattresses and Box Springs	Mattresses and box springs.
55.	Tires	Vehicle tires. Examples include tires from trucks, automobiles, motorcycles, heavy equipments, and bicycles.
56.	Remainder/ Composite Other Waste	Includes ash, sewage solids, industrial sludge, and treated medical waste, auto fluff, auto-bodies, trucks, trailers, truck cabs, untreated medical waste/pills/hypodermic needles, base components, and artificial fireplace logs.
MSW		
57.	MSW	Mixed household garbage, including trash bags containing non-C&D waste, food, leather items, cork, hemp rope, garden hoses, rubber items, hair, cigarette butts, diapers, feminine hygiene products, and wood products (Popsicle sticks and toothpicks).

[1] The identified material types were defined into painted and non-painted subtypes for purposes of the Study.
[2] The identified material types were defined as C&D Aggregate for purposes of the Study.
[3] The identified material types were defined as C&D Wood for purposes of the Study.
[4] The identified material types were defined as C&D Roofing for purposes of the Study.
[5] The identified material types were defined as C&D Other for purposes of the Study.
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Appendix B
HOST FACILITY INTERVIEW FORM

Appendix B
HOST FACILITY INTERVIEW FORM

General Information

Name of site: _____

Name of site contact completing questionnaire: _____

Date survey completed: _____

Notes on communications: _____

_____

_____

_____

Introduction

Hello, my name is _____ and I am a member of the team conducting the Georgia Pollution Prevention Assistance Division's (P2AD's) Statewide Construction and Demolition Waste Characterization Study. First, I would like to thank you for participating in this important study. I'm calling you now to gather information for a site specific sampling plan that will allow us to gather the field data in a way that interferes as little as possible with your operations. As mentioned in prior conversations, all facility results will be maintained by us, the private consultants, and will be provided only in aggregate form to the State. This call should take about 15 minutes. Is this a good time? (If not, arrange a time to call back.)

Schedule

Sampling is scheduled for March and September 2009. Each sampling event shall be for a period of 2 to 3 consecutive days.

1. Do you anticipate any conflicts with having us on site for during the month of March?

□ Yes

□ No

□ Other:_____

2. Do you anticipate any conflicts with having us on site for during the month of September?

□ Yes
□ No
□ Other:_____

Contact Information

For future communications please provide contact information for the following individuals:

General Facility Information

Address: _____
_____

On-site Manager or Supervisor

Name: _____
Phone: _____
Email: _____
Will he/she be available when we are on site? _____

Person with data on the site:

Name: _____
Phone: _____
Email: _____

Contact person for crew when they arrive the morning of sampling:

Name: _____
Phone: _____
Email: _____

Back-up contact person for crew when they arrive the morning of sampling:

Name: _____
Phone: _____
Email: _____

Scale house contact:

Name: _____
Phone: _____
Email: _____

Person to whom correspondence should be sent to:

Name: _____

Phone: _____

Email: _____

Address: _____

_____

Site Information

Based on our experience, there are vehicle, traffic, tonnage and other site specific information that is beneficial in developing our sampling plan. Therefore, we would like to get an understanding of these topics as to your site. Please provide the following information based on the current operations of your site.

Vehicle Information

Currently, how many vehicles hauling construction and demolition waste dispose waste at your landfill on a typical weekday? Saturday? Sunday? Please include only disposed loads in your estimates.

	Estimated number or range of vehicles		
	Weekday	**Saturday**	**Sunday**
Small vehicles (including passenger cars, pick-up, SUV, or van)			
Flat beds, box, and dump trucks			
Loose (open-top) roll-offs			
Other large and end-dumps (for disposal only)			
Other vehicles?			
Total C&D Vehicle Count			

Traffic Information

In addition to understanding the type of vehicles we find it beneficial have an understanding of peak times for C&D loads at each facility. Please provide us the hours of operation and the peak hours for C&D loads for each day of the week?

	Facility's Hours of Operation	Peak Hours for C&D Loads
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
Saturday		
Sunday		

Do you accept vehicles before opening the gate to the public? _____

If so, what hours and what kinds of vehicles? _____

C&D Tonnage Information

1. In the last month, approximately how many tons of construction, demolition and renovation debris was disposed at your facility?
2. How does that compare to a year ago? _____
    a. Two years ago? _____
3. Approximately what percentage of your overall C&D waste stream is:

    Note: Use the definitions as approved for the study for the below categories.

    a. Construction debris? _____
    b. Demolition debris? _____
    c. Renovation debris? _____
    d. Roofing debris? _____
    e. Other C&D debris (i.e. road)? _____

Other Site Information

These set of questions cover are miscellaneous questions pertaining to your facility.

1. Are there site conditions we need to be aware of such as high winds, snakes or other animals, other special circumstances? _____

    _____
2. How many gatehouses does your facility have? _____
3. How many scales? _____
4. Do different types of vehicles go to different gatehouses/scales – i.e., all self-haul going to one scale? If yes, please explain. _____

    _____

5. Does your facility accept asbestos-containing material (ACM)? _____
    a. If yes, does your site have a special disposal area for ACM? _____
6. Regardless of whether your facility accepts ACM for disposal or not, does your facility routinely receive shipments of ACM? _____
    a. If yes, how does it typically arrive (bagged/unbagged)?
7. Does your facility frequently encounter painted wood or painted demolition debris? _____
8. Has your facility initiated testing for incoming debris suspected of containing lead-based paint materials in the past? _____
    a. If yes, how frequently?

Net Weight Procedures

As to the scale house procedures:

1. Do all vehicles get weighed? _____
    a. If no, which vehicles don't get weighed? _____
    _____
2. Drivers of loads will be surveyed at the entrance throughout the day. The survey is very brief, involving just a few questions. We also will need to learn the net weight of each vehicle that we survey. When tare weights are unavailable, we will give the driver of each vehicle a numbered card to hand to your gatehouse staff when the driver leaves the facility. Can your gatehouse staff write the net weight of each vehicle on each card? _____

Material Handling

1. Some sites process or recover materials on site. Does any processing or material recovery occur on site? _____
2. If processing or material recovery occurs on site:
    a. If yes, what materials are recovered at this site?

Material	How and when diverted

    b. If yes, how and where are vehicles identified for potential recovery or processing? _____

_____

c. The purpose of the study is to take samples of disposed wastes only. How can we sample from loads after they have had material recovered?

_____

_____

Sampling and Sorting Procedures

1. We may need to have 4 to 5 loads on the ground at one time while we are visually characterizing them. Sampling usually takes 15-20 minutes per load.
    a. Can the site accommodate this? _____
    b. Where do you think that will be? _____
2. Crews have hardhats, orange vests, and boots. Are there any other safety equipment or special procedures you want us to use? _____

    _____
3. We will need to have the loads cleared periodically throughout each day, probably by a bulldozer or cat. Is this okay? _____

    _____

Final Logistics

1. Can you please send me a plan or map of area where we could sample (taken from permit) _____
2. Lastly, I will contact you in upcoming weeks as to the exact dates we will be at your site. Please remember to notify your personnel of our study.
3. Is there anything else you need from us? If you have any questions please contact me.

Appendix C
HEALTH AND SAFETY PLAN

R·W·BECK
An SAIC Company

Appendix C
HEALTH AND SAFETY PLAN

Introduction

This Health and Safety Plan (HASP) has been developed by R. W. Beck for the Construction and Demolition (C&D) Waste Characterization Study being performed for the State of Georgia Department of Natural Resources Pollution Prevention Assistance Division.

The HASP principally addresses general health and safety concerns relate to conducting field characterization of C&D. Specific sections of this Plan address the additional health and safety protection efforts that will be employed by personnel conducting the optional Lead-Based Paint and Asbestos Containing Materials task. These sections were developed by Innovative Waste Consulting Services (IWCS) specifically for the lead- and asbestos-related activities.

Corporate Safety Policy

R. W. Beck, Inc. believes that the health and safety of its employees is of paramount importance. The issue of health and safety is particularly important in conducting solid waste composition field sorting. The term "visual characterization" and the like may be used interchangeably, and all relate to any project that requires the visual characterization by material type of C&D debris.

This HASP has been developed to provide guidelines to Project Managers, Field Leaders, and Field Assistants involved in R.W. Beck's waste characterization studies. This Plan has also been prepared for distribution to third parties, such as R. W. Beck's clients who are commissioning the visual characterization study, solid waste management facility managers who may be hosting a visual characterization study, and subconsultants retained by the firm to assist with the performance of any of the on-site activities of a visual characterization study.

Objectives of the Plan

R. W. Beck's HASP for visual characterization has the following objectives:

- To describe the visual characterization process, the hazards that may be encountered at a facility that manages C&D, and hazard mitigation strategies.
- To align R. W. Beck's health and safety efforts with policies and procedures that are already in place at the solid waste management facilities that host visual characterization studies.

- To describe the roles and responsibilities of professional staff regarding health and safety.
- To describe the personal protective equipment (PPE) and site safety equipment that is provided at all visual characterization sites.
- To provide field personnel with a description of the safety procedures to be followed in visual characterization.
- To describe the training and monitoring that R. W. Beck field personnel, subconsultants, and temporary workers must undergo before engaging in visual characterization activities.

Visual Characterization and the Hazards that May Be Encountered at a C&D Management Facility

Visual characterization involves viewing loads of C&D to estimate the component makeup of the material being delivered. There is minimal physical interaction between the field staff and the material being visually sampled, so the exposure to potentially hazardous materials is minimized.

Hazard Assessment

C&D represents a mixture of materials that are by definition not hazardous waste. C&D may contain materials that were improperly or inadvertently discarded into the waste stream. As with municipal solid waste, the main hazards that may be encountered in C&D include:

1. Physical

   The most likely hazards to be encountered at a C&D facility are those of a physical nature. The C&D waste stream may contain sharp objects, broken glass, and other items capable of causing cuts or other injuries. Blowing debris or loose items during load dumping can cause eye injuries. Personnel should be aware of trip-and-fall hazards associated with C&D and with physical hazards associated with moving equipment. Protection from physical hazards can be provided by the use of hardhats, sturdy work boots, puncture-resistant gloves, and protective eyewear.

2. Biological

   Biological waste and bloodborne pathogens (e.g., “red bags,” blood-soaked dressings, used hypodermic needles, or other material containing bodily fluids) are not likely to be discarded in the C&D waste stream, but personnel must remain vigilant to their presence at disposal facilities. Protection from these materials can take the form of personal hygiene techniques and the use of barrier PPE.

3. Chemical

   C&D waste may contain improperly discarded chemicals that may be flammable, corrosive, reactive, or toxic. These items can be recognized through their labels (e.g., hazard warning labels), container shapes (e.g., drums or pails), the presence

of smoke from a reaction, strange liquids or powders, or odd smells (e.g., the smell of solvent or ammonia). Good ventilation, proper personal hygiene, and PPE (e.g., gloves and safety glasses) can limit exposure to these chemicals. Observing waste deliveries from an up-wind position (so that dust does not blow onto the observer) can limit exposures to airborne hazards.

4. Radiological

   Radiological hazards include alpha-, beta-, or gamma-emitting radionuclide. Because these sources are closely regulated by the Nuclear Regulator Commission, their presence in the C&D waste stream is unlikely. Alpha and beta radiation sources principally present a hazard due to ingestion or inhalation and can be avoided by minimizing sources of ingestion and inhalation. Gamma radiation has the ability to penetrate the body and cause cell or organ damage. Many waste management facilities have radiation detectors that will limit the deliveries of radiation containing material to the facility. Waste handlers should be alert to containers with radioactive labeling (i.e., the radiation trefoil labels) or material with unusual shapes (e.g., small metallic pellets of cesium, etc.).

Hazard Mitigation Strategies

Hazards to employees can be minimized through the use of prudent practices and the use of PPE.

Prudent practices include:

- Initial observations should be attempted to be made with the wind at the field staff's back (i.e., from an up-wind position) to minimize exposure to dust or other airborne contaminants.
- Personnel should practice good hygiene practices such as removing gloves and cleaning hands by washing or using moist towlettess before eating, drinking, or smoking.
- Personnel should be aware of their surrounding to be aware of trip-and-fall hazards and hazards associated with moving equipment.
- Personnel should remain in designated work and break areas and not wander into the facility's operating areas.
- Personnel should maintain communication with facility operations, particularly heavy equipment operators, so that their presence is known.

PPE – Visual characterization activities do not typically require the handling of waste materials. The use of the following PPE is described later in this plan.

- Protective eyewear protects eyes from windblown or projectile objects.
- Puncture resistant gloves protect hands from physical and chemical hazards.
- Appropriate attire, such as pants, to protect workers from dust and chemical splash.
- Sturdy boots protect feet from puncture or scrapes.

- Hardhats protect heads from overhead physical hazards.
- Reflective vests can make personnel more visible to equipment operators providing protection from equipment physical hazards.
- The voluntary use of dust masks can offer workers relief from nuisance dusts.

Host Facility Health and Safety Coordination

Facilities at which R.W. Beck will visually characterize waste may be owned and operated by third parties that have their own health and safety plans and procedures. It is important that, as guests at the facility, R.W. Beck's workers understand and adhere to the facility's HASP. Adherence to the facility plan may include:

- Confining visual sorting activities to the areas designated by the facility's owner/operator
- Wearing safety equipment required by the facility's owner/operator
- Understanding emergency plans and procedures

It is important that the Field Leader or Project Manager work closely with the facility's owner/operator to integrate operations, including training staff regarding health and safety planning. Specific hold harmless or indemnification requirements by the Host Facility should be reviewed in accordance with the firm's Authorization Policy.

Staff Roles and Responsibilities

Every visual characterization study is unique in some way. Differences in the scope of work, size of the project, and host sites, for example, will require different configurations of staffing. However, for the purposes of this Health and Safety Plan, the responsibilities of four types of professionals are described here: (1) Safety Manager, (2) Project Manager, (3) Field Leader, and (4) Field Assistant. Some of these roles may overlap in practice. The roles and responsibilities, in the area of safety and health, of these professionals are described below.

Safety Manager

The Safety Manager is an R. W. Beck employee who is responsible for overseeing the health and safety policies and practices for all visual characterization projects across the firm. This responsibility includes seeing that the HASP is up-to-date, that an appropriate level of safety training for professional staff and temporary workers is maintained, that the most appropriate safety equipment is available to Field Leaders and Field Assistants, and that issues relating to the health and safety on visual characterization projects have been addressed. The Safety Manager is also responsible for communicating significant HASP changes or updates, newly acquired visual characterization-related projects, and any health or safety-related events that occur while performing a visual characterization study to R. W. Beck's Risk Management

Department so that the firm can comprehensively and accurately monitor the success of the Plan.

Project Manager

The Project Manager of a visual characterization study has overall responsibility for the safety and health of all members of his Project Team. Although he/she will delegate some of these responsibilities to the Field Leader, the Project Manager remains the primary responsible party. The Project Manager must be an R. W. Beck employee.

The Project Manager is responsible for developing a project budget, schedule, and scope of work that provides the time and funds for conducting a safe visual characterization. Proper safety equipment (Exhibit A – Personal Protection Equipment and Exhibit B – Site Safety Equipment) must be obtained and issued to workers, and the training of the professional staff and temporary workers must take place before any actual visual characterization begins. This training is discussed in more detail below. The Project Manager must instill in his/her Project Team an attitude of prudence and care in carrying out the visual characterization.

The Project Manager is also responsible for coordinating with host facility management regarding risk management issues such as waivers, indemnification, and/or adding the host facility as an additional insured to Beck's insurance policy(s), if required. Additionally, the Project Manager must assure that the host facility's safety requirements are followed by R. W. Beck staff.

The Project Manager is not required to participate in any phases of the on-site visual characterization. However, when less experienced Field Leaders may be involved, the Project Manager should use professional judgment in deciding whether to observe and/or participate on the initial day of visual characterization to ensure that health and safety practices are being followed, and to communicate to the client, host facility manager, or other parties in the event of any problems. The Project Manager is also responsible for performing periodic observations, as appropriate, to assure that HASP standards are met.

Field Leader

The Field Leader is generally the most experienced and knowledgeable member of the field sorting team. The Field Leader will be the primary contact with the host site owner/operator, coordinating visual characterization activities with other site activities, and supporting any incidents that may occur. The Field Leader does not have to be an R. W. Beck employee.

The Field Leader has overall responsibility for the visual characterization site, including the designation of the area where the visual characterization activities will take place. In addition to securing the visual characterization site (i.e. identifying and marking the boundaries of the visual characterization site), the Field Leader should be sure that the Field Assistants are in no danger from other equipment or activities on

the site. Typically, the Field Leader will oversee the selection, delivery, and queuing of samples.

In addition, the Field Leader is the individual most directly responsible for the health and safety of the individuals conducting the visual characterization. He/She should take a leading role in pre-sort training, be sure that Field Assistants are properly outfitted in safety gear, and that safe visual characterization procedures are followed throughout the project. As the supervisor working most closely with assistants, the Field Leader must be alert to unsafe practices and warn workers about these practices when they occur. The Field Leader may be the first person to see an accident and must take appropriate action immediately.

The Field Leader has the authority to reject any samples and/or immediately terminate any staff that are not following appropriate health and safety practices. If the crew size is small, this role may be filled by the Field Leader.

Field Assistants

Field Assistants for visual characterization studies may be acquired from multiple organizations, including subconsultants, college or high school internship programs, professional solid waste trade association membership, and volunteers from numerous other sources (including the client organization and from within R. W. Beck during visual characterization training). Regardless of the labor source, Field Assistants are responsible for observing the training provided at the outset of a visual characterization, adhering to the proper health and safety practices throughout the visual characterization, wearing the appropriate PPE while engaged in visual characterization, and following the directions provided by the Field Leader at all times. Any Field Assistant not following directions may be terminated immediately without cause.

Safety Equipment

PPE

PPE is broken down into two classes: (1) PPE that must be worn at all times during any visual characterization of C&D, (2) PPE that may be used in addition to the required PPE, depending on local host facility requirements and/or work conditions.

All workers are required to wear a sturdy work boots. A more detailed description of the personal safety equipment is presented in Exhibit A. At a minimum, the following equipment must be worn at all times by all members while performing visual characterization.

- Hard hat
- Reflective vest
- Sturdy work boots

The following safety equipment may be provided (or made available to) for each Field Assistant depending on the host facility requirements and comfort.

- Protective coveralls
- Protective eyewear
- Puncture-resistant gloves
- Ear plugs
- Hard hat
- Reflective vest
- Puncture-resistant gloves
- Dust masks (voluntary option)

Other PPE may be required depending on the policy of the facility operator or the judgment of the Field Leader.

Site Safety Equipment

In addition to the personal safety equipment provided to each worker, each site will have the following equipment:

- A Industrial First Aid Kit;
- An Eye-Wash kit or five eye wash bottles per crew person;
- Moist towelettes;
- Traffic cones;
- Yellow caution tape;
- A fire extinguisher;
- A cell phone or facility-maintained two-way radio;
- Insect Repellent;
- Ice chest with drinks;
- Tent, if appropriate, and
- Heaters, if necessary.

A more detailed description of the site safety equipment is provided in Exhibit B.

Field Visual Characterization Safety Procedures

Site Layout

Visual characterization may take place at a variety of venues – landfills, transfer stations, or other facilities. Before any characterization takes place, an R.W. Beck supervisor must inspect the site to ensure the following:

1. Visual characterization activities will be conducted well away from other activities that might endanger or impede visual characterization work.

2. There is adequate room to carry out the characterization activities, including the receiving and queuing samples and the disposal and recycling of waste. This includes safety precautions related to vehicle and heavy equipment traffic.

3. Arrangements for toilet facilities and "break" areas.

4. Access to the site by a vehicle is available to move the visual characterization equipment and crew on and off of the site.

Once a suitable site has been located, the Project Manager or the Field Leader will schedule the visual characterization at a time agreed to by the Client and the site owner/operator. When the schedule has been determined, arrangements will be made to deliver visual characterization and safety equipment to the site.

If the site is close to operational activities at the facility, it should be marked with traffic cones or high visibility warning tape so that it is clear to all Field Leaders, Field Assistants, and facility workers exactly what area is designated for the visual characterization activities. It must be made clear that all areas which are not designated for visual characterization activities are strictly off-limits.

Facility Safety Procedures

If the site is located at a facility that disposes, transfers, or otherwise processes MSW or C&D, R.W. Beck's Project Manager or Field Leader should meet with the Site Owner/Operator to coordinate the safety procedures at the site with R.W. Beck's safety procedures. For example, the site may require the wearing of reflective vests and this must become a requirement for the sorting crew on this project. This meeting must take place before any sorting commences.

The Site Manager should outline the facility's HASP and explain the facility's emergency procedures. The location of the nearest hospital, emergency services, and poison control offices should be obtained from the Site Owner/Operator.

R. W. Beck's Field Leader should provide the Site Owner/Operator with a copy of this Health and Safety Plan, explain our safety procedures, and provide documentation of safety training for the Field Assistants on the visual characterization. During this exchange of information, any potential conflicts in approach or procedures should be resolved and both parties should be clear regarding safety and health issues.

The Project Manager should be prepared to sign an indemnification form, and possibly, to add the host landfill as an additional insured on R. W. Beck's general liability policy in consultation with the Risk Management Department.

In the event of any emergency, the Site Owner/Operator will be notified and the Site emergency plan shall be followed as appropriate.

Communications

It is important that supervisory staff be able to communicate with each other at all times and to be able to make emergency notification if required. If one of the professional staff must leave the site for some reason, he/she should make it clear where they are going, when they will return, and what steps should be taken in case of an emergency to the highest level staff member on site. The Field Leader should have a working cell phone or a facility-managed two-way radio (a standard Site Safety Equipment item) in case of an emergency.

In the event of an emergency, site personnel should be notified by voice communication. Off-site personnel and emergency resources should be contacted by cell phone or radio.

Site Control

The integrity of the visual characterization site must be maintained at all times. Where appropriate, the area boundaries should be marked. Workers should understand that they must remain within the visual characterization area or other authorized areas of the site and that other areas on the site are prohibited. The Field Leader is responsible for ensuring that visual characterization activities and workers stay within the visual characterization area.

There should be no smoking, eating, or drinking during visual characterization activities. Food and non-alcoholic liquids must be consumed away from the visual characterization area. Drinks should be taken in single-use disposable cups or from the original single serve containers.

Environmental Conditions

Extreme Heat

The risk of heat stress can be significant in summer visual characterization where the temperature and humidity are high. In these conditions, Field Leaders should monitor workers for signs of fatigue and listlessness. Breaks in the work schedule, plenty of fluids, and clothing which allows sweat to evaporate can all help to alleviate the dangers of heat stress.

The following are First Aid procedures for conditions caused by hot temperature extremes that may be aggravated by required PPE:

Heat Stress

Caused by: Prolonged hot spell, excessive exposure, physical exertion.

Symptoms: Profuse sweating, weakness, dizziness, and sometimes heat cramps; skin is cold and pale, clammy with sweat; pulse is thready and blood pressure is low. Body temperature is normal or subnormal. Vomiting may occur. Unconsciousness is rare.

First Aid: Move to a cooler environment immediately. Provide rest and a cool drink of water. Seek medical attention if symptoms are severe.

Heat Stroke - Warning: Can be fatal

Caused by: Failure of the body to regulate its temperature because of excessively warm weather and physical exertion has depleted it of fluids needed to perspire.

Symptoms:

1. Weakness, dizziness, nausea, headache, heat cramps, heat exhaustion, excessive sweating, skin flushed and pink.
2. Sweating stops (usually) and body temperature rises sharply. Delirium or coma is common; skin changes from pink to ashen or purplish.

First Aid: Call for emergency medical services. Immediate medical care is needed; heat stroke is very serious. The body must be cooled soon. Provide victim with cool water to drink if conscious. Move the victim to a cooler place, remove protective clothing, and bathe in cold water. Use extreme care and frequently check ABCs (airway, breathing, and circulation) if the person is unconscious.

Extreme Cold

Winter visual characterization may take place at sites with very low temperatures and high winds. Protection from the cold should include proper clothing, walls on the tent to lessen the effects of wind, and electric or gas heaters (properly ventilated). Field Leaders should be alert for indications of cold effects, such as shivering and fatigue.

Fatigue

Most projects have tight schedules and the uncertainties associated with the delivery of solid waste to a landfill or transfer station can interrupt this schedule. As a result, there is usually pressure to work as long and as quickly as possible. This, in turn, can lead to carelessness and worker fatigue. Regular breaks in visual characterization should be built into the schedule to provide for rest and recuperation. Typically these breaks include 15 minute breaks in the morning and afternoon and a 30 to 60 minute lunch break. If visual characterization activities go beyond eight hours, additional breaks should be scheduled. The judgment of the Field Leader is critical. Workers showing signs of fatigue should be given an opportunity to rest, especially if they are becoming careless or tired.

Injury Prevention

The most common source of potential injury in visual characterization activities is walking into areas where heavy equipment is operating. Controls against injury associated with this risk are:

1. Employees shall wear proper safety equipment at all times.
2. Employees must remain aware of their surroundings and any heavy equipment activity in the area.

Identified Hazardous Waste, Suspect Materials, or Medical Waste

Visual characterizations are conducted on samples of waste that do not typically contain hazardous or medical waste. Unidentifiable liquids or powders should be treated as hazardous. If there is any question about any material or object, the Field Assistant should immediately stop the visual characterization and notify the Field Leader. If, at any time, the Field Leader believes that the sample being characterized includes institutional medical waste or hazardous materials, the crew should stop sorting. The Crew chief and Field Leader should confer and determine if that sample should be discarded without further sorting. The characterization of institutional medical waste and commercial hazardous waste is not performed by R. W. Beck, and the responsibility for handling this material shall be solely with the host facility in the event such material is encountered. It is the responsibility of the Field Leader to alert the host facility management. Personnel should follow the facility's plan for managing unacceptable waste.

If an employee has been exposed to a suspected hazardous waste, the material should immediately be flushed from the skin or clothing. The area should be flushed with clean water for 15 minutes and medical attention sought if necessary.

Blood Borne Pathogens

Injuries involving cuts and puncture wounds can potentially offer an entry-point for bloodborne pathogens, such as those carrying Hepatitis and HIV. Every cut and puncture wound should be treated and the following steps should be taken by the Crew chief or Field Leader:

- First aid should be rendered if appropriate.
- If, in the judgment of the Field Leader, the wound caused by a hypodermic needle or a metal object, poses a health or safety risk to the worker, or if the worker believes medical treatment is necessary, emergency medical services will be contacted or the worker will be taken to the nearest hospital or clinic for treatment;
- Notify the Site owner/operator, the Employment Agency (if the patient is a temporary worker), and the Project Manager, who in turn should alert the Safety Manager; and the R.W. Beck Risk Manager.
- Document the incident on an accident report form and submit the completed form to the Safety Manager.

Similar steps should be taken if the worker has been exposed to potentially hazardous material and exhibits abnormal signs or experiences unusual symptoms.

Accident Reporting & Investigation

As a part of the Site Training of the crew, the Field Leader should educate workers so they are familiar with the Emergency Contact Information Sheet (see Exhibit D) and that a copy is clearly posted in the visual characterization area.

All accidents must be reported in writing by the Field Leader, using the Accident Report Form shown in Exhibit E. A copy of the completed form should be provided to the Site Owner/Operator and the Employment Agency (if the patient is a temporary worker), the Project Manager, who in turn notifies the Safety Manager.

It is the responsibility of the Safety Manager to maintain a file of completed accident report forms and to see that the "lessons learned" for accidents are incorporated into the HASP.

Health and Safety Training

All members of a crew responsible for visually characterizing waste must undergo, at a minimum, the training outlined below.

Professional Staff Training

R. W. Beck's professional staff should, at a minimum, have 8 hours of pre-characterization training and serve a 2-day apprenticeship before taking on the role of Field Leader. The pre-characterization training must include review and understanding of the HASP and viewing R.W. Beck's safety videos. Training related to other aspects of the visual characterization such as material identification can also be done during this 8-hour period. Professional staff should have first aid training and a current tetanus booster.

A Field Leader should work for at least one full week before being considered for the position of Field Leader.

Field Assistant Training

Before any visual characterization activities takes place, the Project Manager and/or Field Leader must review relevant sections of the R.W. Beck HASP with temporary workers, be sure that all safety procedures are clear, and that all questions from the Field Assistants have been answered. A Field Assistant Training Acknowledgment Form is presented in Exhibit E.

Next, a "test visual characterization" should be run at a very slow pace to be certain that all safety equipment is being worn properly and that Field Assistants understand the safe and proper way to visual characterization samples of waste.

At the beginning of each day of the visual characterization, the Field Leader should take a few minutes to check that all safety equipment is being worn and is in good shape. The Field Leader should also remind the Field Assistants about safe visual characterization activities and go over the lessons learned from any accidents, or near accidents that have occurred.

Additional Health and Safety Elements Specific to Lead and Asbestos Training (supplied by IWCS)

Asbestos-Related Additional Health and Safety Requirements

Overview

A portion of the overall C&D waste visual characterization effort includes an assessment of asbestos-containing material (ACM) for targeted incoming waste loads at each facility. Personnel conducting the assessment of ACM shall hold current certification for the *Asbestos in Building: Inspection and Assessments* training course from a Georgia EPD-approved training provider at all times during the characterization effort. Furthermore, personnel will also undergo additional training (e.g., basic site safety, right-to-know) as appropriate before initiation of the ACM characterization effort.

Additional Personal Protection Equipment Requirements

In addition to the PPE requirements for waste characterization personnel described earlier in the HASP, personnel involved in ACM characterization shall also utilize an N, R, or P100 air-purifying respirator at all times during ACM characterization activities. The respirator used shall be fit tested in accordance with 40 29 CFR 1910.134, Exhibit A before initiation of the ACM characterization to ensure appropriate protection is provided by the respirator.

ACM Sampling

Incoming targeted waste loads will be initially characterized to assess the potential for ACM to be present in the load. If materials present in the load are suspected to contain ACM, such materials will be sampled in accordance with the sampling protocol established as part of the project plan. Collected samples will be sent under chain-of-custody protocol to a National Voluntary Laboratory Accreditation Program (NVLAP) certified laboratory. Sampled materials will be staged appropriately pending analytical results. Based on the analytical results, the material shall be managed as either ACM or non-ACM in accordance with the disposal facility's operations plan. All management of material sampled for ACM following the receipt of analytical results will be handled by landfill operations personnel.

Lead-Based Paint-Related Additional Health and Safety Requirements

Overview

Part of the C&D debris visual characterization effort includes an assessment of the presence of lead paint (LBP) in targeted incoming loads. Personnel conducting the evaluation of LBP in the field shall hold current certification for the *Lead Abatement*

Worker Training by a Georgia EPD-approved training provider. Personnel shall also undergo additional training (e.g., basic site safety, right-to-know) as appropriate before initiation of the LBP evaluation effort. Note that the personnel conducting the ACM assessment will concurrently conduct the LBP evaluation.

Additional Personal Protection Equipment Requirements

Personnel conducting the LBP evaluation will not require additional personal protection equipment beyond the requirements for all waste characterization personnel and the respirator requirement described in the ACM section.

LBP Sampling

Incoming waste loads will be initially characterized to assess the potential for LBP to be present in the load. Painted surfaces in the load will be sampled using a portable X-ray fluorescence (XRF) device. The LBP estimator will use the XRF device in accordance with the manufacturer's standard operating procedures. Additional sampling of paint materials, if applicable, will be conducted in accordance with the protocol established as part of the project plan. Following painted surface sampling, the landfill operations personnel shall be responsible for managing the debris in accordance with the site's operations plan.

Exhibit A
Personal Protection Equipment[1]

Personal Protection Equipment (PPE) protects workers visually characterizing waste from the various hazards that might be encountered in carrying out their work. Some of the PPE is mandatory and must be worn at all times by all workers. Other PPE may be worn depending on the weather, site conditions, policy of the site, and judgment of the Crew chief and Field Leader.

The mandatory PPE includes:

- Hard hat
- Reflective vest
- Sturdy work boots

PPE, which may be required, at the discretion of the Field Leader, includes:

- Protective coveralls
- Protective eyewear
- Puncture-resistant gloves
- Ear plugs
- Puncture-resistant gloves
- Dust masks (voluntary option)
- Our preferred gloves are MAPA Stanzoil Heavy-Duty Neoprene Gloves
- Also, recommended are Wells Lamont Puncture- and cut-resistant gloves and Wells Lamont Drivers gloves.

PPE that may be worn voluntarily by the field staff

- Dust Masks – to filter nuisance dusts.
- Our preferred dust mask is the 3M 3-panel disposable Respirator
- Also recommended are the AOSafety "Pleats Plus" and the Wilson Saf-T-FIT N95 Respirators.
- Ear plugs

All pieces of equipment listed above will be available to all crewmembers at any time.

[1] Workers are not required to work in areas where exposure to noise or dust exceeds OSHA PPE thresholds. Workers conducting lead and asbestos sampling will use a higher level of PPE as described

Exhibit B
Site Safety Equipment

Site Safety Equipment (SSE) will be available at all times on the site to protect workers from hazards and provide emergency first aid. The standard SSE includes:

- A Industrial First Aid Kit – an OSHA-rated 25-person first aid kit or better
- An Eyewash kit or five eyewash bottles per crew.
- Moist towelettes
- Traffic cones – four cones to help demarcate the visual characterization area
- Yellow caution tape – to mark the visual characterization area.
- A fire extinguisher – a multi-purpose extinguisher that can be used on ordinary combustibles, flammable liquids, and electrically energized fires.
- A cell phone or facility-managed two-way radio
- Insect Repellent
- Ice chest with drinks

If site conditions and weather warrant, a tent will be provided to protect against sun, rain, and wind. Side flaps may also be installed if the weather is cold and/or windy. For very cold conditions, a gas or electric heater may be used. If a gas heater is used, adequate ventilation must be arranged.

Exhibit C
Accident Report Forms

Sort Dates:	
Sort Site Information	
Location:	
Office Telephone:	
General Manager:	
Site Manager:	
Field Leader:	
Crew chief(s):	
Description of Accident:	
Date	
Name of Person Injured	
Actions Taken:	

Prepared by: _____

Date: _____

Exhibit D
Emergency Contact Form

Sort Dates:	
Sort Site Information	
Location:	
Office Telephone:	
General Manager:	
Site Manager:	
Field Leader:	
Crew chief(s):	
Local Hospital	
Name:	
Address:	
Telephone:	
Directions from Sort Site:	
Emergency Medical Services	
Name:	
Address:	
Telephone:	
Directions from Sort Site:	

Police	
Name:	
Address:	
Telephone:	
Directions from Sort Site	
Fire	
Name:	
Address:	
Telephone:	
Directions from Sort Site:	
Poison Control Center	
Telephone:	

R.W. Beck Office
R. W. Beck, Inc
1000 Legion Pl., Suite 1100
Orlando, FL 32801
(407) 422-4911
Contact: David Gregory, Safety

Exhibit E
Field Assistant Training Acknowledgment Form

A critical element of training personnel to visually characterize waste is health and safety training. Before any work can begin, all visual characterization personnel are trained in safe procedures for handling and visually characterizing waste. This training includes the following topics.

- Purpose of the waste sort
- Site layout – Landfill hazards
- Introduction to professional staff roles and responsibilities
- Field Assistants responsibilities
- Punctuality
- Rest
- No drugs or alcohol
- No smoking
- Prescribed medications
- Sort Safety Procedures
- Waste handling
- Use of Personal Protective Equipment
- Site Safety Equipment
- Designated work and break areas
- Ergonomics
- Safe lifting to avoid back stress
- Environmental Conditions
- Heat Stress
- Cold
- Fatigue
- Injury Prevention
- Hazardous Wastes
- Bloodborne Pathogens
- Emergency Procedures
- Accident Reporting
- Training Sort

Acknowledgement

I acknowledge that the professional staff from R.W. Beck, Inc. has discussed and explained the topics listed above, addressed any question I have about these topics, and conducted a training visual characterization to demonstrate the safe handling and visually charactering of waste.

Signed _____ Date _____

Appendix D
VEHICLE SURVEY FORM

2009 Georgia C&D Waste Characterization Study

Verify that the load contains at least 80% C&D waste AND is to be disposed (not recycled).

SAMPLE ID	ORIGIN	VEHICLE	HAULER	ACTIVITY	BUILDING TYPE		NET WT	NOTES
	City or County	RO=roll-off DB=dump bed SE=semi truck LG=other large vehicle PU=pick-up/passenger	COM=commercial haulers BSH=business self-haul HSH=homeowner self-haul* **Do not sample HSH loads.*	NC=new construction R=renovation DEMO=demolition RF=roofing OC=other c&d/mixed DK=don't know* NA=not from a construction site **Do not sample DK or NA loads.*	R=residential buildings NR=non-residential buildings M=Mixed load OS=Other structures* **Record job type in NOTES*	*If demo, reno, or roof:* Is this load the only load for this job site? If not, how many loads will this job site generate?	Net weights only *Record gross weights in NOTES*	Record the following, if applicable: 1) Comments 2) Weigh Back Ticket #'s 3) Min. Vehicle Weight 4) Weigh back card ID
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			
		RO DB SE LG PU	COM BSH HSH	NC R DEMO RF OC DK NA	R NR M OS			

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Complete this section for every page

Page _____ of _____

Date: _____ Site: _____

Gatekeeper: _____

Complete this section for first page only

Inclement Weather? _____

Start Time: _____ Stop Time: _____

Other notes about today's sampling:

If found, please call R. W. Beck, Inc. at (404) 870-9091.

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Appendix E
VEHICLE SELECTION FORM

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An SAIC Company

2009 Georgia C&D Waste Characterization Study
Vehicle Selection Form

Site: _____ **Goal: 20 Samples/day**

Date: _____ **40 Samples Total**

When you reach the number circled, ask this vehicle to go to the sorting area.

Residential new construction — NEED 3 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Non-residential new construction — NEED 4 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Residential renovation — NEED 4 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Non-residential renovation — NEED 2 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Residential demolition — NEED 2 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Non-residential demolition — NEED 3 TOTAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Roofing — NEED 1 TOTAL

(1)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Other/Mixed — NEED 1 TOTAL

(1)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Notes on Vehicle Selection:

Residential/homeowner C&D self-haul is excluded from the Study.

Try to meet activity type sampling goals, first by day, then by site, then by burn vs. non-burn group.

Residential does not include high-rise apartment buildings.

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Appendix F
SAMPLE PLACARD

NC-1

Date___/___

WEST TEAM

Appendix G
C&D SAMPLE FORM

2009 Georgia C&D Waste Characterization Study

Step 1:

Site: _____

Date: _____

Sample ID: _____

Step 2: Measure and record the load volume.

(Include trailer dimensions if applicable.)

Dimensions:

_____ft x _____ft x _____ft

_____ft x _____ft x _____ft

Step 3: Identify and record all broad material categories (in bold) that appear in the load.

Step 4: Estimate composition of load by volume for each broad material category (in bold).

Step 5: For each broad material category, estimate composition by volume of each specific material component.

Step 6: Make sure broad material category estimates AND material component estimates EACH total 100%.

Step 7: Identify whether this sample was part of the carpet, lead (LBP), or asbestos special studies. Fill in shaded boxes for LBP samples.

☐ **Paper: _____%**

	Uncoated OCC/Kraft Paper
	Other Recyclable Paper
	Cellulose Insulation
	R/C Paper
%	***Subtotal (must equal 100%)***

☐ **Glass: _____%**

	Glass Bottles/Containers
	Flat Glass
	R/C Glass
%	***Subtotal (must equal 100%)***

☐ **Metals: _____%**

	Major Appliances
	HVAC Ducting
	Other Ferrous
	Non-ferrous
	R/C Metal
%	***Subtotal (must equal 100%)***

☐ **Plastic: _____%**

	Recyclable Plastic Containers
	HDPE Buckets
	EPS Packaging
	Non-bag Com. and Ind. Pack. Film
	Tyvek
	Other Film
	Plastic Siding/Decking
	Plastic Pallets
	Durable Plastic Items
	Plastic Piping
	R/C Plastic
%	***Subtotal (must equal 100%)***

☐ **Construction & Demolition: _____%**

	Concrete, Unpainted	
	Concrete, Painted	% LBP
		%Non-lead
	Asphalt Paving, Unpainted	
	Asphalt Paving, Painted	% LBP
		%Non-lead
	Composition Roofing	
	Other Asphalt Roofing	
	Brick and Other Aggregates, Unpainted	
	Brick and Other Aggregates, Painted	% LBP
		%Non-lead
	Clean Dimensional Lumber	
	Large Demolition Wood, Unpainted	
	Large Demolition Wood, Painted	% LBP
		%Non-lead
	Clean Engineered Wood	
	Standard-sized Wood Pallets	
	Other Wood Pallets and Crates	
	Painted/Stained Wood	% LBP
		%Non-lead
	Other treated Wood	
	Creosote-treated Wood	
	Clean Gypsum	
	Painted/ Demolition Gypsum	% LBP
		%Non-lead
	Acoustic Ceiling Tiles	
	Rock & Gravel	
	Dirt & Sand	
	Fiberglass Insulation	
	EPS insulation	
	R/C C&D, Unpainted	
	R/C C&D, Painted	% LBP
		%Non-lead
%	***Subtotal (must equal 100%)***	

☐ **Compostables: _____%**

	Yard trimmings
	Branches and Stumps
%	***Subtotal (must equal 100%)***

☐ **Other Materials: _____%**

	Carpet
	Carpet Padding
	All Wood Furniture
	Plastic Furniture
	Mattresses and Box Springs
	Tires
	R/C Other Waste
%	***Subtotal (must equal 100%)***

☐ **Potentially Hazardous Waste: ____%**

	E-Waste
	Asbestos-labeled bags
	Other Potentially Haz Waste
%	***Subtotal (must equal 100%)***

☐ **MSW: _____%**

	MSW
%	***Subtotal (must equal 100%)***

NOTES: _____

Grand Total:_____%
(Must equal 100%)

☐ **Lead**

☐ **Asbestos**

☐ **Carpet**

Please identify whether this load was part of any of the following special studies:

**Remember to select a carpet sample every 2-3 hours. For those samples, fill in the carpet form on the back of this form.

Appendix H
CARPET SAMPLE FORM

2009 Georgia C&D Waste Characterization Study

Use this form for samples selected for the CARPET special study.

1) Take a sample of each type of carpet present in the load.
2) Bag samples and clearly mark with the sample number (e.g., NC-1), today's date, your initials, and the corresponding Carpet ID# from the below table.
3) For each carpet sample, record the volume percentage of the TOTAL CARPET present in the load.

Carpet ID#	Description (e.g., Orange shag)	% of Carpet by Volume
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Grand Total % (must equal 100)		

NOTES: _____

_____

_____

_____

_____

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Appendix I
LEAD-BASED PAINT FORM

2009 Georgia C&D Waste Characterization Study

Lead-Based Paint and Asbestos-Containing Materials Volume Estimating and Sampling Form (Side 1)

Step 1: Record Sample Details

Date: _____

Site: _____

Sample #: _____

Initials: _____

Step 2: Have C&D visual estimator provide volume estimates of painted debris you identify in the load and record volume fraction.

Step 3: Collect XRF reading for all painted debris. Record result as "LBP" (if result is > 1 mg/cm^2**), else "<".**

Step 4: LBP may be sampled via scraping if XRF results are greater than 1 mg/cm^2**; record unique sample ID on the form.**

Step 5: Take picture of the sample collected.

Step 6: Turn this form over and conduct ACM evaluation for the load.

***Note: If a load contains more types of waste within a given category that are measured for LBP or potentially ACM, please use an additional form.

LBP-Related Material	Painted Fraction of Category (%)	XRF Sampling Results	Laboratory Sample ID	Comment	LBP-Related Material	Painted Fraction of Category (%)	XRF Sampling Results	Laboratory Sample ID	Comment
Asphalt Paving					**Large Demolition Wood**				
Brick and Other Aggregates					**Painted/Stained Wood**				
Concrete					**Painted/Demolition Gypsum**				
Notes:					**R/C C&D**				

Appendix J
ASBESTOS-CONTAINING MATERIALS FORM

2009 Georgia C&D Waste Characterization Study

Lead-Based Paint and Asbestos-Containing Materials Volume Estimating and Sampling Form (Side 2)

Step 7: Identify all potential ACM in the load based on those listed in the form.
Step 8: Have the C&D visual estimator provide a volume estimate of those materials identified as being potential ACM in Step 1.
Step 9: Identify the potential ACM category (Category I, Category 2, RACM, bagged ACM) and record on the form where applicable.
Step 10: Identify the volume fraction of a given material type that is Non-ACM.
Step 11: Add up the volume fractions for each Material Category and make sure the fractions add to 100%.
Step 12: Collect samples of potential ACM in the load and record unique sample ID on the form. Note that no more than 30 samples shall be collected at a given facility.

ACM-Related Material	Fraction of Category that is Potential ACM (%)	Potential ACM Category	Laboratory Sample ID	Comment
Composite Acoustic Ceiling Tiles				
Ceiling Tile		RACM		
Non-ACM				
Composition Roofing				
Asbestos Asphalt Shingles		1		
Asbestos (Transite) Roofing		RACM		
Asbestos Flashing		1		
Roof Mastics and Coatings		1		
Roofing Silver Coating		1 or RACM		
Non-ACM				
Other Asphalt Roofing				
Asbestos Flashing		1		
Built-Up Roofing		1		
Roof Mastics and Coatings		1		
Roofing Silver Coating		1 or RACM		
Non-ACM				
Concrete				
Light Weight Concrete		2 or RACM		
Non-ACM				
Painted/Demolition Gypsum				
Wall Board and Joint Compound		RACM		
Non-ACM				
Clean Gypsum				
Wall Board and Joint Compound		RACM		
Non-ACM				
R/C Plastic				
Resilient Floor Coverings (linoleum		1 or RACM		
Non-ACM				

ACM-Related Material	Fraction of Category that is Potential ACM (%)	Potential ACM Category	Laboratory Sample ID	Comment
R/C C&D				
Asbestos Cement (Transite) Panel		2 or RACM		
Asbestos Cement (Transite) Shingle		RACM		
Asbestos Gasket		1 and RACM		
Boiler Insulation		RACM		
Cover (baseboard) molding mastic		1		
Ceiling Plaster		RACM		
Duct Seam Mastic		1		
Duct Vibration Dampeners		1		
Exterior Duct Insulation		RACM		
Felt Duct Tape		RACM		
Floor Mastic		1		
Fireproofing		RACM		
Fireproofing and overspray		RACM		
Floor Tile		1		
Floor Tile and Mastic		1 or RACM		
Interior Duct Insulation		RACM		
Joint Compound Only		RACM		
Floor Leveling Compounds, Caulking		1 or RACM		
Pipe Insulation Straight Runs		RACM		
Pipe Insulation Elbow and Fittings		RACM		
Textured Ceiling		RACM		
Textured Ceiling Plaster		RACM		
Tank Insulation		RACM		
Window Glazing		1 or RACM		
Wall Plaster		RACM		
Non-ACM				

Appendix K
METHODOLOGY FOR ANALYSIS

Appendix K
METHODOLOGY FOR ANALYSIS

Description of Calculations and Statistical Procedures Used

The general calculation strategy involved two common themes: (1) the use of ratio estimators to determine the composition percentages of the waste stream; and (2) aggregation of sample data from the facility level to the regional level to the statewide level. A ratio estimator involves the ratio of two quantities, both of which are random variables. For most of the steps in the analysis, the basic ratio estimator was derived as the ratio of the weight of material in a given sample over the total weight of the sample. The general procedure involved creating a new ratio estimator by weighting across ratios from a lower level. For example, statewide ratio estimators were created by weighting of the region-level ratio estimators.

Quantifying Disposed Waste

Disposed waste from each sector was quantified through the use of vehicle surveys and tonnage reports at the field observation site. The calculation method is described below. Quantity estimates were calculated for each season independently then for the study period as a whole. The quantity was also calculated for materials disposed at C&D landfills and at MSW landfills and unlined sanitary landfills separately. The two-landfill types have similar but slightly different methods. The two methods are described separately below.

As part of the calculations, each field observation site's reported disposal tonnage was obtained for Q4 2008 through Q3 2009. The reported tonnage at each field observation site was adjusted to remove tonnage associated with certain disposal activities the Project Team and GA DNR Sustainability Division chose to exclude from the reported C&D tonnages. The reported tonnage minus the tons from excluded disposal activities is referred to as the adjusted tonnage throughout the following sections. All calculations are based on this adjusted tonnage. Table K-1 lists the field observation sites, the types of disposal activities excluded and any other adjustments made to the reported tons.

Table K-1
Excluded Disposal Activities by Site

Field Observation Site Name	Excluded Disposal Activities	Other adjustments
APAC-Donzi Lane		
Camden Co. SR110	Industrial Waste, permitted bagged asbestos	
Columbus, Pine Grove		Tonnage disposed in C&D cell subtracted from MSW reported tonnage and added to C&D reported tonnage.
Dekalb Co.-Seminole Rd		
Floyd Co-Rome Walker Mtn.		
Houston Co. SR247 Klondike	Permitted bagged asbestos	
Reliable Tire Services		
Richmond Co-Deans Bridge Rd.		
Walton	Permitted bagged asbestos	
Willow Oak	Permitted bagged asbestos	

Quantifying Waste Disposed at C&D Landfills

Step 1: Aggregating Survey Records to Produce Findings at the Field Observation Site Level.

For a given field observation site on a given day, each vehicle that was included in the gatehouse survey had its net weight assigned to one of the C&D waste sources (e.g., residential demolition), according to the response of the driver. Loads from excluded disposal activities were removed from the survey data. The tonnages identified through the survey were used to calculate the relative proportions of the C&D stream associated with each source.

The relative proportions described above were applied to the adjusted reported tonnage to produce estimates of the tons of disposed C&D associated with each source at the field observation site in question.

Example of Estimating Sector Proportions at the Field Observation Site Level

For example, imagine that Field Observation Site A was visited on two days and that there are five sources of C&D waste. The following scenario describes how the percentages of C&D for each source were calculated for this field observation site.

First, survey data from the field observation site for the two survey days were examined to determine the tons associated with each source. A hypothetical accounting of tonnages is shown below. Example numbers are rounded and decimals are not carried through calculations.

Calculation A

Field Observation Site A	Res, New Construction	Non-res, New Construction	Roofing	Unknown Source	Not from Construction	Total
Tonnage from survey day 1	20	20	20	15	15	90
Tonnage from survey day 2	30	15	25	20	10	100
Tonnage for two survey days	50	35	45	35	25	190

Next, the tonnages were converted into percentages, as shown below.

Calculation B

Field Observation Site A	Res. New Construction	Non-res. New Construction	Roofing	Unknown Source	Not from Construction	Total
Tonnage for two survey days	50	35	45	35	25	190
Percentages	27%	18%	24%	18%	13%	100%

These percentages were then applied to the adjusted annual tonnages for the field observation site. In this example, the field observation site reported 120,000 adjusted annual tons.

Calculation C

Field Observation Site A	Res. New Construction	Non-res. New Construction	Roofing	Unknown Source	Not from Construction
Adjusted Annual Tonnage			120,000		
	32,400	21,600	28,800	21,600	15,600

Tons from unknown sources were assumed to have been generated at construction sites. The percentage of material generated at construction sites with known sources was calculated for each field observation site.

Calculation D

Field Observation Site A	Res. New Construction	Non-res. New Construction	Roofing	Total
Tonnage for two survey days	50	35	45	130
Percentages	38%	27%	35%	100%

These percentages were applied to the tons with an unknown source.

Calculation E

Field Observation Site A	Res. New Construction	Non-res. New Construction	Roofing
Adjusted Annual Tonnage		21,600	
	8,208	5,832	7,560

These tons were then added to the previously calculated adjusted annual tonnage and the tonnage associated with unknown sources was zeroed.

Calculation F

Field Observation Site A	Res. New Construction	Non-res. New Construction	Roofing	Unknown Source	Not from Construction
Adjusted Annual Tonnage	40,608	27,432	36,360	0	15,600

Step 2: Aggregating Tonnage from Field Observation Sites to Produce Findings at the Regional Level. The tonnage estimates for each source at all field observation sites within a region were aggregated, and relative proportions were calculated for each source at the regional level. The aggregated proportions for each source were then applied to the total Q4 2008 through Q3 2009 adjusted annual tonnage for the region. Counties were categorized according to three regions:

- **No burn ban, outside Atlanta.** This region included all counties that did not restrict burning at any time of the year and were not one of the ten Metro Atlanta counties.
- **Has burn ban, outside Atlanta.** This region included all counties that restricted burning for at least part of the year were not one of the ten Metro Atlanta counties.
- **Has burn ban, inside Atlanta.** This region included the ten Metro Atlanta counties, all of which restricted burning for at least part of the year.

Example of Aggregating Site Tonnage to the Regional Level

For example, hypothetical adjusted annual tonnages by source for two field observation sites visited in a region are shown in the table below.

Calculation G

	Res. New Construction	Non-res. New Construction	Roofing	Not from Construction	Total
Field Observation Site A	40,608	27,432	36,360	15,600	120,000
Field Observation Site B	150,000	80,000	10,000	5,000	245,000
Total (tons)	190,608	107,432	46,360	20,600	365,000
% of Total	52%	29%	13%	6%	100%

For this example the adjusted annual tonnage for this region was 1,000,000 tons, quantities were assigned to sources according to the percentages from calculation G.

Calculation H

Region 1	Res. New Construction	Non-res. New Construction	Roofing	Not from Construction	Total
Percents	52%	29%	13%	6%	100%
Adjusted Annual Tonnage			1,000,000		
Tons	520,000	290,000	130,000	60,000	1,000,000

Next the not-from-construction-site tons were zeroed and the proportions of disposed C&D from each source was calculated for loads generated at construction sites within the region. These proportions were used when calculating the C&D tonnage disposed at MSW sites.

Calculation I

	Res. New Construction	Non-res. New Construction	Roofing	Not from Construction	Total
Region 1	520,000	290,000	130,000	0	940,000
% of Total	55%	31%	14%	0%	100%

Step 3: Aggregating Regional Findings to Produce Sector Tonnage Estimates Statewide. The adjusted annual disposed C&D tonnage from each sector in each region was aggregated to estimate the adjusted annual statewide disposed tonnage at C&D landfills. This step resulted in a final set of adjusted annual statewide disposed tonnage and relative proportions for each source of C&D waste.

Example of Aggregating Regional Tonnage to the State Level

For example, hypothetical adjusted annual tonnages by source for two regions in the state are shown in the table below.

Calculation J

	Res. New Construction	Non-res. New Construction	Roofing	Not from Construction	Total
Region 1	520,000	290,000	130,000	60,000	1,000,000
Region 2	500,000	450,000	95,000	16,000	1,061,000
Total (tons)	1,020,000	740,000	225,000	76,000	2,061,000
% of Total	49%	36%	11%	4%	100%

Next the not-from-construction-site tons were zeroed and the proportions of disposed C&D from each source was calculated for loads generated at construction sites.

Calculation K

	Res. New Construction	Non-res. New Construction	Roofing	Not from Construction	Total
Region 1	520,000	290,000	130,000	0	940,000
Region 2	500,000	450,000	95,000	0	1,045,000
Total (tons)	1,020,000	740,000	225,000	0	1,985,000
% of Total	52%	37%	11%	0%	100%

The Q4 2008 through Q3 2009 figures for tonnage disposed at C&D landfills in each region are shown in Table K-2.

Table K-2
Adjusted Annual Tons from Construction Sites Disposed by Region at C&D Landfills

Study Regions	Reported Annual Tons	Excluded Tons	Adjusted Annual Tons	Adjusted Annual Tons from Construction Sites
No Burn Ban, Outside Atlanta	275,691	39,174	236,517	235,206
Burn Ban, Outside Atlanta	591,445	103	591,342	494,563
Burn Ban, In Atlanta	1,419,300	1,430	1,417,870	1,294,508
Statewide Total	2,286,436	40,707	2,245,729	2,024,277

Quantifying Waste Generated at Construction Sites Disposed at MSW Landfills

Step 1: Estimate the Proportion of Disposed MSW that is C&D. A survey conducted for the State by R. W. Beck in 2004 indicated that at that time, an estimated 12.3 percent of the waste disposed in MSW landfills was C&D. However, landfill reports indicate that while the amount of waste disposed in MSW landfills has stayed relatively steady in recent years, the tonnage disposed in C&D landfills has declined. When the relative decline in C&D disposed versus MSW disposed is applied to the

assumed percentage of total waste disposed in MSW landfills attributable to C&D loads, the percentage decreases from 12.3 to 8 percent.

Step 2: Estimate the Quantity of C&D Disposed at MSW Landfills in each Region. The adjusted annual tons disposed at all MSW and unlined sanitary landfills in a region were multiplied by the eight percent calculated in Step 1 to estimate the quantity of C&D material disposed in MSW landfills.

Example of Calculating the C&D Tonnage at MSW Landfills

Calculation M

	Adjusted Annual Tons	C&D Proportion of Disposed MSW	C&D Disposed at MSW Landfills
Region 1	4,000,000	8.0%	320,000

Step 3: Distribute the Quantity of C&D Disposed at MSW Landfills Across Sources within Regions. The entire quantity of C&D disposed at MSW landfills was assumed to have been generated at construction sites so the proportions shown in calculation I were multiplied by the estimated C&D quantities disposed at MSW landfills to calculate the tonnage disposed from each source.

Example of Calculating the Disposed Tons from Each Source

In this example it was assumed that 320,000 tons of C&D were disposed at MSW landfills in Region 1.

Calculation N

Region 1	Res. New Construction	Non-res. New Construction	Roofing	Total
Total C&D Tons Disposed at MSW Landfills		320,000		
Source Proportions (from Calculation I)	55%	31%	14%	100%
C&D Tons Disposed at MSW Landfills	176,000	99,200	44,800	320,000

Step 4: Aggregating Regional Findings to Produce Sector Tonnage Estimates Statewide. The adjusted annual disposed C&D tonnage from each sector in each region was aggregated to estimate the adjusted annual statewide disposed C&D tonnage at MSW landfills. This step resulted in a final set of adjusted annual statewide disposed tonnage and relative proportions for each source.

Example of Aggregating Regional Tonnage to the State Level

Hypothetical adjusted annual tonnages by source for two regions in the state are shown in the table below.

Calculation J

	Res. New Construction	Non-res. New Construction	Roofing	Total
Region 1	176,000	99,200	44,800	320,000
Region 2	43,000	27,000	20,000	90,000
Total (tons)	219,000	126,200	64,800	410,000
% of Total	53%	31%	16%	100%

The Q4 2008 through Q3 2009 figures for tonnage disposed at MSW and unlined sanitary landfills in each region are shown in Table K-3.

Table K-3
Adjusted Annual MSW Tons from Construction Sites by Region

Study Regions	Reported Annual Tons	Excluded Tons	Adjusted Annual Tons	C&D Tons
No Burn Ban, Outside Atlanta	3,891,703	0	3,891,703	309,702
Burn Ban, Outside Atlanta	5,236,093	0	5,236,093	416,688
Burn Ban, In Atlanta	2,531,488	0	2,531,488	201,456
Statewide Total	11,659,284	0	11,659,284	927,846

Quantifying Total Waste Generated at Construction Sites Disposed in Georgia Landfills

The total quantity of waste generated at construction sites and disposed at landfills in Georgia was the sum of the quantity disposed at C&D landfills and the quantity disposed at MSW landfills. Table X summarizes this total disposal by each source.

Table K-4
Tons Generated at Construction Sites Disposed Annually by Region and Source

	Non-res. Demo.	Res. Demo.	Non-res. New Const.	Res. New Const.	Non-res. Ren.	Res. Ren.	Roofing	Other/ Mixed Const.	Total
No Burn Ban, Outside Atlanta	20,404	64,444	175,349	124,973	41,314	56,477	44,093	17,855	544,908
Burn Ban, Outside Atlanta	33,330	173,794	176,851	72,228	64,525	97,324	245,590	47,611	911,251
Burn Ban, In Atlanta	75,377	216,760	240,562	52,128	195,537	246,254	270,608	198,736	1,495,964
Statewide Total	129,111	454,997	592,761	249,329	301,375	400,055	560,291	264,203	2,952,123

Estimating Waste Composition

Waste composition estimates were calculated using a method that gave equal weighting or "importance" to each sample within a given stratum. Confidence intervals (error ranges) were calculated based on assumptions of normality in the composition estimates.

In the descriptions of calculation methods, the following variables are used frequently:

- *i* denotes an individual sample;
- *j* denotes the material type;
- c_j is the weight of the material type *j* in a sample;
- *w* is the weight of an entire sample;
- r_j is the composition estimate for material *j* (*r* stands for *ratio*);
- *a* denotes a region of the state (*a* stands for *area*);
- *s* denotes a particular stratum; and
- *n* denotes the number of samples in the particular group that is being analyzed at that step.

Estimating the Composition

The following method was used to estimate the composition of waste belonging to each stratum.

For a given stratum (that is, for the samples belonging to the same source within the same region), the composition estimate denoted by r_j represents the ratio of the material type's weight to the total weight of all the samples in the stratum. This estimate was derived by summing each material type's weight across all of the selected samples belonging to a given stratum and dividing by the sum of the total weight of waste for all of the samples in that stratum, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i} \qquad (1)$$

where:

- *c* = weight of particular material type;
- *w* = sum of all material type weights;
- for *i* = 1 to *n*, where *n* = number of selected samples; and
- for *j* = 1 to *m*, where *m* = number of material types.

For example, the following simplified scenario involves three samples. For the purposes of this example, only the weights of the material type carpet are shown.

	Sample 1	Sample 2	Sample 3
Weight (*c*) of carpet	5	3	4
Total Sample Weight (*w*)	80	70	90

$$r_{Carpet} = \sum \frac{5+3+4}{80+70+90} = 0.05$$

To find the composition estimate for the material type carpet, the weights for that material are added for all selected samples and divided by the total sample weights of those samples. The resulting composition is 0.05, or 5%. In other words, five percent of the sampled material, by weight, is carpet. This finding is then projected onto the stratum being examined in this step of the analysis.

The confidence interval for this estimate was derived in two steps. First, the variance around the estimate was calculated, accounting for the fact that the ratio included two random variables (the material type and total sample weights). The variance of the ratio estimator equation follows:

$$\mathrm{Var}(r_j) \approx \left(\frac{1}{n}\right)\left(\frac{1}{\overline{w}^2}\right)\left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right) \qquad (2)$$

where:

$$\overline{w} = \frac{\sum_i w_i}{n} \qquad (3)$$

(For more information regarding Equation 2, refer to *Sampling Techniques, 3rd Edition* by William G. Cochran [John Wiley & Sons, Inc., 1977].)

Second, precision levels at the 90 percent confidence level were calculated for a material type's mean as follows:

$$r_j \pm \left(z\sqrt{\mathrm{Var}(r_j)}\right) \qquad (4)$$

where z = the value of the z-statistic (1.645) corresponding to a 90 percent confidence level.

Estimating Composition of Entire Statewide Disposed C&D Stream

Composition results for strata were then combined, using a weighted averaging method, to estimate the composition of larger portions of the waste stream. This

method works to combine any number or combination of strata. The relative tonnages associated with each stratum served as the weighting factors. The calculation was performed as follows:

$$O_j = \left(p_1 * r_{j1} \right) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + \ldots \qquad (5)$$

where:

- p = the proportion of tonnage contributed by the noted waste stratum (the weighting factor);
- r = ratio of material type weight to total waste weight in the noted waste stratum (the composition percent for the given material type); and
- for j = 1 to m, where m = number of material types.

For example, the equation 5 is illustrated here using three waste strata.

	Stratum 1	**Stratum 2**	**Stratum 3**
Ratio (r) of carpet	5%	10%	10%
Tonnage	25,000	100,000	50,000
Proportion of tonnage (p)	14.3%	57.1%	28.6%

To estimate the composition of larger portions of the waste stream, the composition results for the three strata are combined as follows.

$$O_{Carpet} = (0.143 * 0.05) + (0.571 * 0.10) + (0.286 * 0.10) = 0.093 = 9.3\%$$

Therefore, 9.3 percent of this examined portion of the waste stream is *carpet*.

The variance of the weighted average was calculated as follows:

$$\mathrm{Var}(O_j) = \left(p_1^2 \ \mathrm{Var}(r_{j1}) \right) + \left(p_2^2 \ \mathrm{Var}(r_{j2}) \right) + \left(p_3^2 \ \mathrm{Var}(r_{j3}) \right) + \ldots \qquad (6)$$

Appendix L
CASE STUDIES

Appendix L
CASE STUDIES

Introduction

R. W. Beck has prepared the case studies in this Section to describe some key strategies that other state and local governments have implemented to divert C&D from disposal. , R. W. Beck worked with the Sustainability Division to select strategies and then conducted research and telephone interviews with state or local governments that had implemented them to obtain insights about the strategies selected such as factors that contributed to the success of the strategy, what could have made the strategy more successful, etc. R. W. Beck aimed to focus on state-level examples, but in some examples of strategies were best demonstrated at the local level.

Disposal Ban

State of Massachusetts

Description of the Program

In 1990, the Massachusetts Department of Environmental Protection (MassDEP) introduced its first bans on landfilling and combustion of easy-to-recycle and toxic materials. Additional "waste bans" were phased in over the next several years. MassDEP amended its regulations at 310 CMR 19.017 in July 2006 to add asphalt pavement, brick and concrete (ABC waste), metal, and wood to its list of materials banned from disposal. Existing bans covered cardboard and leaf and yard trimmings, which are also frequently generated in C&D projects. The ban on C&D materials was implemented after a three-year planning process, which assessed the potential impact of the ban and potential markets for these materials. At the time, the ban went into effect there were a number of C&D processing facilities operating in Massachusetts and in adjacent New Hampshire with the capability to separate out the banned materials from mixed C&D.

The disposal bans require disposal facilities in the Commonwealth to submit a waste ban plan describing the following:

- Ongoing waste stream monitoring of all incoming loads, including:
  - monitoring procedures;
  - unacceptable quantities and *de minimus* acceptable quantities; and
  - record keeping.

- Comprehensive load inspections, including:
  - loads not subject to comprehensive load inspections;
  - load selection;
  - inspection procedures;
  - unacceptable quantities and *de minimus* acceptable quantities; and
  - record keeping.
- Facility response to failed loads, including:
  - communication; and
  - failed load disposition.
- Other compliance plan elements, including:
  - training;
  - signage; and
  - annual waste ban report.

All disposal facilities in the Commonwealth must comply with disposal bans. The ban provides some exceptions, for example:

- Loads that come to a transfer station that only receives small loads (e.g., less than 5 cubic yards, which includes most of municipal transfer stations) are not subject to the ban (e.g., restricted materials do not need to be removed).
- A *de minimis* quantity means loads that contain less than 20 percent of all banned materials, by visual inspection.
- If the material is contaminated such that it is not marketed, it can be disposed.

Materials currently included in the disposal ban are:

- Asphalt pavement, brick & concrete
- Cathode ray tubes
- Ferrous & non-ferrous metals
- Glass & metal containers
- Lead acid batteries
- Leaves & yard trimmings
- Recyclable paper, cardboard & paperboard
- Single resin narrow-necked plastics
- Treated & untreated wood & wood waste
- White goods (large appliances)
- Whole tires (banned from landfills only; shredded tires acceptable)

Further, exceptions to the disposal bans can be obtained if it is determined that markets are not available for a particular material generated in a certain region, for example.

Implementation Process

MassDEP worked with a "Construction and Demolition Debris Subcommittee" to develop the disposal prohibition of certain construction and demolition debris material. The C&D Subcommittee was comprised of architects/engineers, building owners, contractors, haulers, C&D processors, landfill owners, transfer station owners, municipalities, environmental groups, trade associations, law firms and consultants. The C&D Subcommittee identified that there are recycling and reuse markets for asphalt pavement, brick, concrete, metal and wood and this material is routinely diverted from disposal. The regulations were promulgated in October of 2005, and were implementation on July 1, 2006.

Law

The waste disposal ban is codified in 310 CMR 19.107, Waste Disposal Ban Regulation, which can be found at the following web site:

http://www.mass.gov/dep/recycle/laws/bansreg.htm

The Disposal regulation holds operators of disposal facilities responsible for ensuring that regulated loads do not contain more than 20 percent, by visual inspection, of the banned materials.

Why This Strategy was Selected

Mass DEP selected to utilize a disposal ban strategy because the state already had banned some materials from disposal. The C&D bans, however, were the first Non-MSW disposal bans (the Department also hopes to ban the disposal of other non-MSW wastes, such as some sludges). Interestingly, the Commonwealth initially planned to ban the disposal of "unprocessed" C&D waste, however the industry prompted the Commonwealth to reconsider that aspect, as banning "unprocessed C&D" they feared, would simply result in the grinding and disposal of C&D wastes, rather than avoidance of disposal. Further, the strategy was a reflection of their 2000 solid waste master plan.

When deciding which materials to ban from disposal, the Department may consider the following factors, as described in 210 CMR 19.107:

- the nature and degree of potential adverse impacts;
- the quantities of restricted materials generated;
- the availability of non-disposal management options for the restricted materials;
- the economic impact on the facility, class of facilities or generators subject to the restriction; and
- such other factors as the Department deems relevant to such a determination.

Cost of Implementing Strategy

In Massachusetts the disposal ban is enforced at the disposal facility level. Therefore, each disposal facility has inspectors that inspect loads, and the Commonwealth also has state inspectors that inspect disposal facilities periodically to ensure that they are following the protocol of the disposal ban.

The costs to implement a C&D disposal ban in the Commonwealth were relatively minor, considering that a disposal ban was already in place for other materials, so most disposal facilities, rather than increasing staff, simply had their staff look for the additional materials. The incremental cost to add C&D materials was negligible.

Evidence of Success

The Commonwealth indicates that the disposal ban has been effective. They note that before the ban was implemented there were only nine C&D processing facilities in the Commonwealth, and now there are 14. Also, the end markets for wood have improved. When the ban was first implemented much of the recovered wood, for example, was being ground and used for alternative daily cover (ADC) at landfills, or combusted for fuel. Now much of the wood is going to a "higher and better use" – to a manufacturer of particleboard and thermofusesd melamine panels named Tafisa who has a plant located just outside of Quebec.

Additional Strategies Implemented to Encourage C&D Waste Minimization

MassDEP worked with the Massachusetts Division of Capital Asset Management to develop a regulation ensuring that a waste management plan is submitted for all state construction and demolition projects. This was implemented around the same time as the disposal bans. Originally state projects had to achieve a 50 percent recycling rate, which was not too challenging. Now that rate has been increased to 75 percent, which becomes a little more challenging. In addition, there is a requirement that all clean gypsum wallboard must be recycled.

In addition MassDEP provides information on their web site such as:

- Information about specific materials (e.g., asbestos, carpet, pressure-treated wood, asphalt shingles, wood with lead paint, etc.);
- Information about reuse, recycling and disposal options;
- Project planning tools (C&D bid specifications, green building specifications and guidelines, etc.); and
- Reports and case studies.

Factors Leading to Success of Strategy

A contact at MassDEP indicates that factors leading to the success of the strategy include:

- Working with stakeholders from the initial phase – six years, total. The industry provided input regarding which materials to ban first, and involving them helped grow the C&D recycling industry;

- Ensuring that adequate markets existed for the materials before implementing a ban;
- Including reasonable exceptions, as described above (e.g., small amounts allowed, exceptions when needed, etc.);
- Having experience and an infrastructure and legal framework already in place to handle waste disposal bans.
- Continue to work with industry to identify future materials that could potentially be banned from disposal.
- Worked with bordering states to help ensure that there is a regional infrastructure in place.

Orange County, North Carolina

Description of the Program

Orange County, North Carolina has mandated that certain materials generated within Orange County be separated from waste that is to be disposed. The regulated materials include:

- Corrugated cardboard;
- Clean wood waste;
- Scrap metal; and
- Vegetative yard trimmings.

In addition, there is a statewide disposal ban on pallets at MSW landfills.

Loads of waste delivered to a landfill that contain more than 1/3 cubic yard of a concentrated amount of one of these materials must either be sorted or charged double the tip fee at an Orange County Landfill. Loads containing 50 percent or more of these materials may be fined a surcharge of up to $400.

The Orange County Landfill accepts MSW for $50 per ton, C&D waste for $44.00 per ton, and separate clean wood for $18.00 per ton. Vegetative yard trimmings is also $18.00 per ton. The wood is ground on site for use as mulch.

Separated cardboard and scrap metal are accepted at no charge.

If a driver delivers a load containing more than *de minimis* quantities of regulated materials, the driver is given the option to separate out the regulated materials. In general, however, landfills are not equipped for this, and the load is therefore assessed a per-ton fee of double the standard tip fee.

In addition there is a building permit process (countywide, with cooperation and/or adoption from in-county municipalities) which requires those seeking a building permit to obtain a regulated materials permit as part of the building permit process. The County asks where material will be delivered. The containers are “tagged” and facilities that receive the material (and tag) send the tag back to the County, along with an accounting of what materials were received, and in what quantities, as well as their

disposition (e.g., whether they were recycled or disposed). Each permitting agency (the County and certain municipalities) have some discretion regarding whether a project will be required to have a regulated materials permit. Very small projects can be waived, for example, or projects that would generate only non-recyclable materials (e.g., a deck project that would generate only treated lumber).

The ordinance also requires that haulers be permitted, which gives the county more enforcement power, should waste not be separated properly.

Implementation Process

In the late 1990's it was recognized that the C&D landfill on Eubanks Road was going to be filled sometime in 2003. The Orange County Board of County Commissioners agreed to build a new C&D landfill but only if certain bulky materials (those materials that take up the most room in the landfill) were required to be recycled. The County formed a task force to develop a means of diverting C&D waste. The task force included waste haulers, builders, elected officials, the solid waste advisory board, the Home Builder's Association, thee Chamber of Commerce, haulers, etc.. At first there was resistance – people didn't think they could adequately train staff to sort material into different dumpsters – they thought they might need to make several trips, etc. They found, however, that when they planned adequately, it wasn't a big deal – in many cases certain materials are generated at specific points in the project, so it can be pretty simple to keep them separate. Sometimes with very large jobs it's more complicated to sort. Those projects often result in commingled waste in roll-off containers sent to a C&D processing facility. They look for a 30 percent recycling rate for that material. Most of the C&D recycling facilities are about 22 miles from the County's landfill.

Law

The County Commissioners passed an ordinance in 2002 which applies to the unincorporated areas of the County. The ordinance was also adopted in Carrboro, Chapel Hill. Hillsboro adopted the ordinance via a Memorandum of Understanding. The regulated materials ordinance is tied to the building permit process. Chapel Hill and Carrboro issue building permits within their municipalities, and conduct their own site inspections. Orange County conducts site inspections for Hillsboro.

The County's Article III Sections 34-71 through 34-78 describes the regulations. The ordinance can be found on Municode, and is described at the following web site:

http://www.co.orange.nc.us/recycling/ordinance.asp

Why this Strategy was Selected

This strategy was selected to extend the life of the landfill. The County commission realized, however, that there are times when materials are too contaminated to marketable, or are generated in such small quantities that they may not be worthwhile etc., so they wanted the program to be realistic. Also, having the landfill accept the sorted materials at a lower cost or no cost provides an economic incentive for compliance. Also, this strategy allows for monitoring materials that go to out-of-

county facilities (the county has not been able to site a C&D recycling facility within its boundaries) through the container tag component.

Cost of Implementing Strategy

The program is funded largely through the building permit fee. Eight percent of the cost of the building permit is allocated to the recycling and waste reduction program. The County has had to hire one new staff person to manage the program, and they also hired an additional mechanic and two landfill operators because they added a mulching operation when the ordinance went into place.

Evidence of Success

The County conducts a waste sort every five years. The 2005 sort showed that there was an 11 percent decline in the disposal of recyclable materials since 2000. Also, the County has noted a decrease in the amount of waste going to the landfill, however, it is difficult to know how much of this is due to less waste being generated due to the economic decline versus the increased recycling. A significant amount of targeted materials, however, are being recovered.

Additional Strategies Implemented to Encourage C&D Waste Minimization

As described above, the banning of specific Orange County-generated C&D materials from the disposal stream works hand-in-hand with the issuance of a Regulated Materials Permit (referred to as an RM Permit), which helps inform developers and homeowners of expectations and options for regulated materials. The RM process includes a "tag" program whereby containers on the job site are "tagged," then when they are delivered to a disposal or recycling facility, the facility sends the tag to the County or municipality indicating the quantity and disposition of the items. In addition, the County has a hauler licensing program, which is also described in the ordinance, which stipulates that haulers who handle recyclable regulated materials must be licensed by the County. This provides the County with the ability to revoke a hauler's license if they do not comply with the ordinance. The ordinance also prohibits open burning of regulated waste materials. Also as part of this strategy commingled recycling facilities (those which accept both regulated recyclable materials and non-regulated materials) must be certified by the County. This provides the County with an opportunity to revoke their license if they do not comply with the provisions of the ordinance.

The County provides information on their web site regarding how specific material types can be managed, and provide suggestions during the permit process, including ReStores and Craigslist. County staff also visit home stores to ensure that the regulated recyclable materials generated at their locations are also recycled according to the ordinance.

Factors Leading to Success of Strategy

Factors that led to success of the program include:

- Including stakeholders in the development of the program;

- Linking C&D recycling and materials management to the building permit process;
- Funding the C&D waste minimization program, at least in part, through the permit fees (the program is 95 percent self-fudned);
- Having a financial incentive (lower tip fee) to encourage generators of C&D debris to separate recyclable materials;
- Having a hauler permit requirement, to allow for further enforcement options;
- Promoting the use of reuse centers, Craigslist, and "swaps;" and
- Conducting education and outreach with large retailers such as Home Depot.

Landfill Surcharge

Wake County, North Carolina

Description of the Program

Wake County, North Carolina currently has just one MSW landfill in operation (the South Wake Sanitary Landfill in Apex) and one MSW transfer station (The East Wake Transfer Station in Raleigh). These facilities do not accept C&D loads from commercial haulers, although C&D materials that are delivered to the County's convenience sites are delivered to the County's MSW landfill for disposal.

Until 2004, however, the County also had C&D landfill capacity. The County had conducted research that indicated that 22 percent of the solid waste going into the MSW landfills in Wake County was C&D debris. The County Commissioners wanted to ensure that the MSW landfill (which is more costly to construct and operate due to the requirements of Subtitle D) was being used for MSW, not bulky C&D waste. Therefore, the County Commissioners enacted an ordinance to place a surcharge on C&D waste that was delivered to the MSW landfill for disposal.

According to the language of the ordinance, if a public or private hauler servicing commercial, industrial, institutional and governmental establishments disposed of a solid waste load at a County facility, and the load consisted at least 10 percent of C&D debris by volume or weight, then the County would charge double the tip fee at the transfer facility, and double the tip fee at the MSW landfill. (For a short time the C&D landfill was not yet constructed, and therefore a higher tip fee of $37 per ton, as opposed to the $29.50 per ton of MSW, was charged at the MSW landfill).

Implementation Process

The County has a solid waste advisory committee, and they formed a sub committee to examine the issue of C&D. The County Commission was involved too – they were concerned with extending the life of the MSW landfill. Part of the process involved identifying outlets for C&D – ensuring there were adequate facilities to reuse and recycle C&D, and informing the public /developers of these options. The Commission made a conscious decision not to compete with the private facilities that had developed. Stakeholders were involved in the process for two years before the

surcharge became effective. When the surcharge was first implemented they gave haulers a warning first, then the next time they charged them the surcharge.

Law

The Ordinance enacted by the County, though no longer valid because the County does not have C&D landfill capacity, is available at the following web site:

http://www.wakegov.com/NR/rdonlyres/F90DE026-CDAD-4773-9535-8C2169ADFC3F/0/ConstandDemolitionOrdinance.pdf

Those in violation of the ordinance could receive up to a $500 fine and imprisonment of not more than 30 days. The ordinance could be enforced by the Waste Management Department and/or the County Sheriff.

Why this Strategy was Selected

This strategy was selected to extend the life of the MSW landfill. The hope was that doubling the MSW tip fee for C&D debris would provide an adequate financial incentive for generators of waste to deliver C&D loads to the C&D landfill.

Cost of Implementing Strategy

The cost of the strategy was two "spotters" that identified loads from on top of a hill. They also photographed the loads (using a Polaroid camera) to avoid disputes. They then used two-way radios to communicate with the scalehouse staff regarding which haulers were to be charged the surcharge. The cost included the two spotters and the camera and radio equipment. In addition the County used resources to educate haulers and advertise the new ordinance.

Evidence of Success

The strategy is still in use for cardboard. It is successful in keeping cardboard out of the disposed loads. The County was unable to track the impact of the ordinance on the MSW landfill.

Additional Strategies Implemented to Encourage C&D Waste Minimization

The County provides information on their web site regarding where generators of C&D waste can deliver their materials. They also use the county television channel to promote C&D reuse and recycling opportunities, and promote waste reduction through inserts placed in tax bills.

The trash takers site, found at the following link http://www.wakegov.com/recycling/trashtakers/default.htm, allows users to enter a material type, and they are provided with information regarding how to manage that type of material in Wake County. The information provided includes the City where the facility is located, the phone number, a hotlink to the company's web site (if available), and whether the material is reused, disposed, or recycled through that service provider.

Also, when someone applies for a building permit, there are two questions on the permit application related to waste generated on the construction site. These questions provide an opportunity for permitting staff to educate the applicant about opportunities to reduce waste, but do not require that a waste management plan be submitted, or that a certain portion of the waste generated be recycled.

Factors Leading to Success of Strategy

Factors leading to success of the strategy include:

- The County had met with a task force which included haulers, for one to two years in advance of implementing the ordinance – and then they began informing haulers about the change six months in advance.
- The program was most successful when the County was able to focus on enforcement. There were times when staff were pulled in too many different directions, but having the political will and staff to focus on enforcement is key to success.
- The state has since implemented a ban on wooden pallets at MSW landfills. The County believes that having a state law in place helps the municipalities and counties enforce the law at their facilities.
- The fact that haulers had the option to dispose of the waste at the facility (albeit at a surcharge) reduced the level of frustration for the hauler (e.g., as opposed to refusing to accept the load).

Waste Management Plan Required as Part of Building Permit

State of Vermont

Description of the Program

The State of Vermont requires development/rehabilitation projects of over 10,000 square feet, as well as all projects on state-owned land (of any size) to obtain an "venues permit" in the construction process. As part of the application for the venues permit, applicants must submit a C&D waste management plan. The program is authorized through Act 250, and this portion of the Act was implemented in 2002. The Waste Management Plan requests the developer to provide the following information:

- Steps that have been taken to prevent waste from being generated during the project. (Examples – using designs that favor standard sizes or specifying building techniques that incorporate few materials. On job sites it could include providing a central location for all wood cutting to facilitate use of cut-off pieces. It could also include asking suppliers to take back excess materials, removing salvageable materials before construction/renovation/demolition or including specifications requiring subcontractors to prevent waste).

- How the Waste Management Program will be communicated to construction crews and subcontractors, and how contractors will ensure that subcontractors abide by the plan. (For example, there's usually a pre-construction meeting with everyone involved, and then generally the project manager will have a weekly update. The plan should include how the project manager intends to convey information to subcontractors.)
- What contract specifications have been included to reuse or recycle certain materials, and a description of how these specifications have been enforced.

The state does not require the recycling of certain materials or a certain percentage of materials. Instead, each project is examined on a case-by-case basis.

Implementation Process

The State educated developers in advance about the upcoming regulations. They also educated all state inspectors. DEC met with permitting staff initially. The program has evolved over time with feedback from developers, haulers, architects and other stakeholders involved.

Law

The Vermont rules that describe the law are in Act 250, which is provided at the following web site:

http://www.nrb.state.vt.us/lup/publications/rules/2009rules.pdf

Questions and Answers about Act 250 requirements are provided at the following web site:

http://www.nrb.state.vt.us/lup/faqs.htm

There are about 50 state employees that issue permits throughout Vermont. Before this section of the Act was adopted, the permits ensured that projects considered things like storm water runoff, proper management of wastewater, etc.

Why the Strategy was Selected

This was one way to build on an existing program – the state inspectors. The program does not target every single project, but instead targets the larger projects, and the state projects – the state, they think, should serve as an example. Also, the requirements are pretty minor compared with everything else the applicant has to do, so it just seems like part of the process. The state considered landfill bans on certain materials, but realized they do not have the resources to enforce/monitor a landfill ban. They also felt that they would need to be sure markets are available for materials before they could implement a landfill ban. This strategy allows them to look at each project on a case-by-case basis, which provides for flexibility in considering the quantity, types, and condition of waste generated. Also, the regional markets can be examined at the time of the project. This strategy, being tied to the Venues Permit, provides an incentive for the developer to cooperate and comply.

Cost of Implementing Strategy

The Department (Vermont's Department of Environmental Control) dedicates about ¼ of a full-time equivalent staff person to the program (it used to be ½, but the Department reduced staffing due to budget issues). At its peak there were about 200 permit applications per year. Now, however, there are about 50 annually.

Evidence of Success

Vermont does not have data to show that the program has been a success, but anecdotally DEC staff believe it has been successful. The program has spurred awareness about C&D waste reduction. The state does not have any C&D recycling facilities, which limits their success to some degree, however the awareness is beginning to get people talking about developing a C&D recycling facility. One is being discussed for the Burlington, Vermont area.

Additional Strategies Implemented to Encourage C&D Waste Minimization

The DEC's web site provides resources, best management practices, tracking forms, and contacts for recycling materials in and around Vermont. The information is provided at the following web site:

http://www.anr.state.vt.us/dec/wastediv/recycling/planning.htm#tracking

The DEC used to have a grant program, which was discontinued in 2009 due to lack of funding. This program would provide funds to try progressive means of reusing or recycling C&D materials. The most recent project, for example, was to try land application of drywall on site. money. Last one was for drywall land application on the site.

Factors Leading to Success of Strategy

Factors leading to the success of Vermont's program include:

- The program is a natural extension of an existing permit program;
- Vermont's citizens tend to be environmentally conscious, so this helps. Many developers are interested in LEED certification, for example;
- The program allows for flexibility with specific materials generated as well as with market conditions; and
- Vermont has high tipping fees (about $100 per ton) so there is a built-in financial incentive to reduce waste.

Requirements on Disposal Facilities

State of Florida

Description of the Program

Since the mid 1990s, the State of Florida has required each C&D facility to submit an annual report accounting for the tonnage of C&D recovered and disposed including C&D used for fill or cover. To assist C&D facilities with the annual reporting requirements, the State has developed the following materials available on the Florida Department of Environmental Protection (Florida DEP) website:

- Instructions for annual reporting;
- C&D conversion calculations from volume to weight; and
- Reporting form.

C&D facilities are required to report C&D material recovered or disposed by county of origin. In addition, the C&D facility must provide the quantity recovered, the end market, and quantity disposed for each of the following C&D materials:

- Asphalt;
- Concrete;
- Fines/Recovered Screen Materials;
- Wood;
- Land Clearing Debris;
- Drywall;
- Shingles/Roofing;
- Paper;
- Plastic;
- Metals; and
- Textiles.

Approximately two years ago, the State of passed The Energy, Climate Change and Economic Security Act of 2008 increasing the statewide recycling goal to 75 percent to be achieved by 2020. The Act required Florida Department of Environmental Protection (DEP) to submit a comprehensive program to the State legislature detailing methods to achieve the statewide recycling goal. In January 2010, DEP, as part of the comprehensive program, recommended that all loads of mixed C&D, regardless of whether disposed in a C&D landfill or another facility, be processed at a materials recovery facility prior to disposal in a lined or unlined landfill in Florida. Furthermore, the Florida DEP proposed that all new and existing C&D facilities be required to incorporate a materials recovery facility to the front end of their process.

Implementation Process

For two decades, the State of Florida has required that each C&D landfill report annual tonnages to the State as part of the permitting process. The current reporting process captures C&D disposed at C&D landfills. If the State of Florida elects to require processing of all C&D materials prior to disposal, the requirement would be applicable to any and all Florida facilities accepting C&D material.

Law

The Division of Solid Waste Management for the State of Florida Rule § 62-701.730 grants the State the authority to mandate reporting by C&D facilities. The rule may be found on the Florida DEP's website at http://www.dep.state.fl.us/waste/quick_topics/rules/default.htm.

The rule forms, located in State of Florida Rule § 62-701.900(7), clearly defines the information required to be reported by each permitted C&D facility. The forms are located on Florida DEP's website at http://www.dep.state.fl.us/waste/quick_topics/forms/pages/62-701.htm.

Why This Strategy was Selected

A representative from Florida DEP stated that a significant amount of recoverable C&D material was being disposed at C&D landfills and non-C&D landfills within the State. To promote the recovery of C&D, Florida DEP proposed mandatory processing of C&D as a mechanism to achieve the statewide recycling goal.

Cost of Implementing Strategy

If the State of Florida mandates processing of C&D materials, the implementation costs shall vary based on the stakeholder. For example, initial capital costs may be incurred by a public or private disposal facility to develop a new processing facility; however, these costs may be offset by the savings in landfill space over time and revenue from the sale of material. This financial analysis would have to be performed separately at each facility and will depend on variables such as the facility location, tonnage received, and materials handled. However, requiring that all facilities develop the processing capacity should level the playing field. To minimize the costs to existing facilities, Florida DEP recommended existing disposal facilities be permitted to partner with existing or new off-site processing facilities. As to generators, Florida DEP's report projected that generators may realize little to no costs or savings if the Florida DEP's recommendations are put into effect.

Evidence of Success

Over two decades ago, the State of Florida set a recycling goal of 30 percent. Today, the State reports a recycling rate of 28 percent which may be due, in part, to the requirement that C&D facilities report tonnage recovered and landfilled. At a minimum, this information has helped to quantify progress toward the recycling goal.

The proposed requirement that all disposal facilities arrange for processing of C&D for disposal, as one measure to help achieve an increased recycling goal of 75 percent, has not yet been implemented. Thus, success can not be measured yet.

Additional Strategies Implemented to Encourage C&D Waste Minimization

In addition to mandatory reporting and proposed mandatory processing requirements, the State of Florida recently funded the following research into C&D recovery:

- The State of Construction and Demolition Debris Recycling in Florida (2001): This report is a snapshot of the C&D recycling practices in Florida. The Study was conducted per the direction of the 2000 State Legislature.
- Innovative Recycling and Waste Reduction Grants: The Innovative Recycling and Waste Reduction Grants commenced in 1997. The grants are available to support innovative programs related to recycling. Some of these grants have been awarded to support C&D recycling.

Information about these programs and other C&D recycling information is available on Florida DEP's website.

Factors Leading to Success of Strategy

By incorporation of the mandatory reporting requirement into the State permitting process, the State of Florida was able to identify recovery of C&D as an opportunity to achieve the statewide recycling goal. Furthermore, the discussions of the mandatory C&D processing on the State level has resulted in at least one local government, Lee County, requiring documentation of C&D materials processing as a component of the permitting process fro construction projects within its jurisdiction.

Mandatory Recycling

Lee County, Florida

Description of the Program

As of January 1, 2008, Lee County, Florida mandated the following projects requiring a building, demolition, or similar permit to divert 50 percent of their debris:

- Residential and commercial construction projects valued at greater than $90,000;
- Residential and commercial alterations, including renovation and demolition projects, greater than $10,000 in value; and
- Roofing projects requiring old roofing removal.

To assist with enforcement of the law, Lee County has developed a materials handling worksheet and a certification form. The C&D materials handling worksheet assists the covered project permittee in estimating the total, salvaged, recycled, and disposed quantities of the following materials:

- Asphalt and concrete;

- Brick/Masonry/Tile;
- Building Materials;
- Cardboard;
- Carpet/Padding/Foam;
- Ceiling Tiles;
- Drywall;
- Wood;
- Metals;
- Landscape Debris;
- Dirt; and
- Appliances.

For garbage/trash and mixed C&D debris, the permittee must report the total quantity generated. Salvaged and recycled quantities from the mixed C&D debris will only be counted if the material was delivered to a County approved facility. Currently, the County has two private and one County operated facility authorized to receive and process commingled C&D. In addition, the County has approved 19 source separated C&D recycling facilities.

Upon completion of the C&D project and prior to receiving a Certificate of Occupancy from the County Permitting Department, the covered project permittee must complete a separate C&D recycling certification form. By completing the C&D recycling certification form, the permittee certifies compliance with the mandatory C&D processing ordinance and is subject to penalty of perjury if the information provided is inaccurate or incomplete. If a permittee elects to certify that the project was non-compliant with the County ordinance, the permittee is required to pay the financial penalties set forth in the mandatory C&D processing ordinance prior to issuance of a Certificate of Occupancy.

Implementation Process

In March of 2007, the County commenced research into mandatory C&D recycling programs across the country. As part of the research, the County met with the Board of Commissioners, Sierra Club, building associations, and other stakeholders. The County adopted the law in September of 2007. Prior to implementation, the County gathered historical tonnage information from the one approved facility for C&D recycling. In addition, the County integrated the permitting software to assist with the administration of the ordinance. Lastly, the County added two staff members to the Solid Waste Division to administer the program.

Law

Lee County Ordinance 07-25 contains the requirement for recycling of C&D materials by covered projects. The ordinance may be located at http://www3.leegov.com/solidwaste/uploads/Final_Scanned_Ordinance.pdf

Why the Strategy was Selected

According to the representative of Lee County, Florida, the strategy was developed as a proactive measure due to discussions at the State level to increase the recycling goal. Lee County worked with the local C&D stakeholders in the development of the mandatory C&D recycling ordinance.

Cost of Implementing Strategy

The Lee County representative stated that the costs for implementing the program were minimal. To implement the program, the County modified the permitting database to automatically notify the permitting office whether the project was a project subject to the mandatory C&D recycling ordinance. Therefore, the permitting office would have access to information that demonstrates whether the permittee had complied with the C&D recycling ordinance or was subject to penalties for non-compliance prior to issuing the Certificate of Occupancy. In addition to adapting the permitting database, the County added two staff positions in the Solid Waste Division.

Evidence of Success

The success of the program can be quantified by the number of permits that comply with the C&D recycling requirements and the amount of penalties assessed. The percent of covered projects in compliance has increased from 67 percent to 76 percent in the past three months. In addition, the amount of penalties has dropped from $120,000 in the first year to $60,000 in the 2nd year.

Additional Strategies Implemented to Encourage C&D Waste Minimization

Lee County has developed a website to address questions as to the ordinance and to provide contact information for approved facilities that accept commingled and source separated C&D. The website is http://www3.leegov.com/solidwaste/Autopage_T1_R123.htmm. In addition to the ordinance, Lee County, conducts multiple workshops per year and participates in special events to promote recycling.

Factors Leading to Success of Strategy

Lee County stated that one main factor that promoted the success of the program was the impetus provided by the State of Florida's recycling goal of 75 percent and the fact that Florida DEP identified C&D recovery as a recommendation to achieving the goal. Therefore, Lee County elected to take the initiative and enact an ordinance mandating C&D recycling.

Appendix M
LIST OF STAKEHOLDERS

Stakeholder Affiliation	Stakeholder Representative
Federal/State/Local Government	
CalRecycle	Gregory Dick
City of Portland, Oregon	Debbie Cleek
Florida Department of Environmental Protection	Suzanne Boroff
GEFA	David Dunagan
Georgia Department of Community Affairs	Randy Hartmann
Georgia Department of Transportation	J.T. Rabun
Georgia Department of Transportation	Peter Wu
Lee County, Florida	Lindsey Sampson
Massachussetts Department of Environmental Protection	James McQuade
Metro	Bryce Jacobson
Orange County, North Carolina	Grant Gale
Sustainable Atlanta	Danielle Doss
U.S. EPA	Jay Bassett
U.S. EPA Office of Resource Conservation and Recovery	Kimberly Cochran, PhD
Vermont Agency of Natural Resources, Department of Environmental Control, Waste Management Division	Buzz Surwillo
Wake County, North Carolina	Lowell Shaw
Other Stakeholders	
AMR Waste Systems	Tony Green
Bo Pallets, Inc.	Greg Bowen
Crutchall Resource Recycling, LLC	Ellie Kane
CMRA	William Turley
Debra S. Haugen, LLC	Debra Haugen
Dykes Paving and Construction Company, Inc.	Lee Young
EarthCycle, Inc.	Gerry Simmons
Georgia Recycling Coalition	Gloria Hardegee
Hedgewood/GAHBA	Pam Sessions
Independent	Adam Deck
Independent	Luke Thompson
MBA Waste Services, LLC	Ken Mitchell
Packer Industries, Inc. and Patterson Services, Inc.	Cynthia Poselensky
Parrish Construction Group, Inc.	Travis Miller
Pinnacle Custom Builders, Inc.	Robert Soens
Rollcast Energy, Inc.	John Campbell
Scott Wood Products, LLC	Jerry Scott
Self Recycling	Ben Self
Southface	Candice Groves
Shaw Industries, Inc.	Randy Ramey
Stephens MDS, LP	Wade Brannan
The Pennsylvania State University	Professor Kalsbeek
Trident Sustainability Group	Tommy Linstroth
Turner Construction Company	Brian Burleigh
United States Gypsum	Pace Pickel
University of Georgia	Professor Adolphson
University of Georgia	Professor Geller

[1] Metro is an elected regional government serving Clackamas, Multnomah and Washington counties and 25 cities in the Portland region of Oregon.