

# USE OF SOLID WASTE QUANTIFICATION AND CHARACTERIZATION PROGRAM TO IMPLEMENT AN INTEGRATED SYSTEM IN MERCER COUNTY, NEW JERSEY

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## ABSTRACT

The Mercer County Improvement Authority conducted a two-season waste quantification and characterization program to determine how to properly size their integrated solid waste management system.

Limited information was available because scales were not available at the landfill. The existing information was supplemented by two 2 week weighing programs six months apart and by two 5 day sorting programs six months apart.

The data from the weighing and sorting programs were used to develop 25 year waste quantity and composition projections to determine solid waste composition and fuel characteristics considering increased recycling due to state law.

## INTRODUCTION

The leaders of Mercer County New Jersey, through its implementing agency, the Mercer County Improvement Authority, have developed a long-term strategy to deal with residential, commercial, and industrial nonhazardous wastes generated within its boundaries relying on a collection system of municipal and private haulers presently serving the residents of the county.

The planned system includes a 975 TPD (tons per day) [890 tpd (metric tons per day)] Resource Re-

cover Facility, a 180 TPD (165 tpd) Recycling Facility, a 1200 TPD (1100 tpd) Transfer Station and a 25 year landfill to meet the waste disposal needs of the county.

To appropriately size the Mercer County Solid Waste System, a study was performed to determine the quantity and character of the waste within the county.

In order to prepare these estimates, three major tasks were performed:

(a) A two-season, (summer and winter) 2 week, 6 days per week weighing program to establish the weight and collection vehicle volume of material going to the commercial landfill was conducted.

(b) Two 5 day sorting programs to establish the composition of the waste for Mercer County were conducted.

(c) Existing solid waste collection data and records were reviewed.

Each task will be more fully described in the following paragraphs.

## TWO SEASON WEIGHING PROGRAMS

The following steps were required to plan and develop a county-wide weighing program.

A weighing program was necessary because there was no scale at the existing landfill. The tipping fee

charged was based on volume of a waste delivery vehicle, not its weight. An existing commercial platform scale in close proximity to the landfill was selected to weigh the vehicles. Portable axle scales were not considered since they are time-consuming and frustrating to the truck drivers as well as not being as accurate as platform scales.

The Trenton-Ewing Transfer Station, the only permitted transfer station in Mercer County, also was chosen to be monitored during the weighing program. This facility primarily receives residential solid waste collected by the City of Trenton Division of Garbage and Trash and the neighboring Ewing Township Department of Sanitation.

To insure that all vehicles were being counted, the entrance of the landfill was also monitored. An attendant interviewed drivers of vehicles hauling waste generated in Mercer County and maintained a vehicle count to double-check if any vehicles were not surveyed and weighed at either of the two scale locations.

Orientation meetings were held to familiarize municipal officials and haulers with the procedure of the upcoming weighing programs. As further notification, prior to the start of the first weighing program, the employees of landfill distributed a two-page flyer to all Mercer County haulers at the gate of the landfill. The first page was an announcement about the weighing program and the second page was a vicinity map locating the scale to be used.

When the program began, vehicle driver interviews and visual inspection of the vehicles were conducted to gather the following information:

Date	Vehicle weight (gross and empty)
Time interviewed	Fuel tank capacity and level
Hauler	Number of men weighed
Truck number	Area of collection
Vehicle type	Waste type
Vehicle volume	

The New Jersey Department of Environmental Protection has established categories of solid waste to standardize waste classification during planning studies and reporting of information to the agency. The solid waste types are:

Type 10—Residential	Type 25—Animal and Food
Type 10—Commercial	Processing
Type 13—Bulky	Type 27—Dry Industrial
Type 23—Vegetative	

The attendant at the scale or the Trenton-Ewing Transfer Station would register the vehicle on its first

arrival, assign a number and enter basic information for each vehicle. The driver would also be asked to be weighed empty at the start of the program to establish its true weight. Collection vehicles were surveyed at the Trenton-Ewing Transfer Station to more accurately determine the type and processibility of the solid waste received.

The attendant at the commercial landfill would interview the driver of each vehicle if not surveyed and weighed at either scale location, and enter the appropriate information in the landfill record. Drivers of the transfer trailers from the Trenton-Ewing Transfer Station were not interviewed at the landfill gate.

After the weighing program was completed, a mail survey of the two small permitted landfills in the county and all NJDEP registered haulers in Mercer County that were not seen during the two seasonal programs was conducted to establish a more complete and accurate estimate of the waste generated in the county.

## FIVE DAY SORTING PROGRAMS

Two sorting programs approximately 6 months apart were performed to establish the composition of the waste in Mercer County. The summer sorting program was conducted outdoors under a canvas canopy at the rear of the Trenton-Ewing Transfer Station. A larger enclosed area owned by a commercial hauler was selected as a suitable facility to conduct the winter sorting program.

Three residential areas and two commercial/industrial areas in the County were chosen for the sampling program. The origin of these loads were selected to provide representative samples of a particular waste source (residential or commercial/industrial). The number and size of the combined samples for the two waste sources were designated to be approximations of the 60% residential and 40% commercial/industrial distribution of processible solid waste presently generated in the county. This ratio was determined based upon the results of the weighing programs completed prior to the start of the respective sorting programs.

Interviews with municipal and private haulers were conducted to ensure delivery of the selected load on the proper day. Following the interviews, letters were sent to the participating haulers outlining procedures for the sorting program and confirming the arrangements. Rear loading compaction trucks delivered the residential waste loads and front loading compaction trucks delivered the commercial/industrial loads.

To recruit members for the sorting crew, advertisements were placed in the local newspaper and at the local employment service office of the New Jersey Department of Labor. In addition to the sorting crew supervisor and helper, the sorting crew consisted of seven members during the summer program and nine members during the winter program. On the day prior to initiating the sorting program, the equipment and supplies were delivered to the sorting facility. Orientation sessions with sorting crew members were conducted to outline procedures to be used, and each crew member was inoculated with a tetanus shot prior to initiating work.

### SORTING PROGRAM PROCEDURES

Each selected vehicle was weighed fully-loaded upon arrival and after unloading to determine the weight of the deposited material. The driver of the collection vehicle was interviewed to determine the following data:

Date collected	Vehicle gross weight
Delivery time	Vehicle empty weight
Weather	Municipality/Source
Hauler	Collection area and route
Vehicle driver	Collection frequency
Vehicle number	Additional comments
Vehicle type	

The following equipment was used to perform the solid waste sorting program:

- (a) Dial or digital readout portable platform scale with a maximum capacity of 0.5 lb (0.25 kg) minimum graduations.
- (b) Twenty heavy duty, 32 gal (150 L) plastic containers equipped with detachable platform casters for ease of mobility.
- (c) Two to three plastic buckets.
- (d) A shop apron for each crew member.
- (e) A dust respirator for each crew member.
- (f) Heavy gloves for each crew member.
- (g) Six snow shovels.
- (h) Three rakes.
- (i) Two hand cultivators.
- (j) Four push brooms.
- (k) 4 ft by 8 ft (1.3 m by 2.5 m) sorting table with 0.5 in. (12.5 mm) square mesh screen.
- (l) Two hand-held magnets.
- (m) Three-mil thick 32 gal (150 L) plastic bags for waste constituent samples.
- (n) Tape and identification tags for samples.
- (o) Heavy corrugated boxes for sample storage.

Each solid waste load would be sorted into the following 16 categories of solid waste constituents:

<u>Combustibles</u>	<u>Noncombustibles</u>
Newsprint	Glass
Corrugated Paper	Ferrous Metal
Other Paper	Aluminum
Film Plastic	Other Nonferrous Metals
Rigid Plastic	Brick, Ceramic & Rock
PET Plastic	
Textile, Rubber & Leather	
Food Waste	
Wood	
Yard Waste	
Sweepings	

The sorting crew would circle the load, accompanied by a container mounted on casters. Each container would be designated to receive one of the sixteen waste constituents. As the crew circled, they would pickup and deposit the assigned waste constituents in the appropriate container. The most abundant constituents would be generally addressed first. As containers would be filled, the crew members would wheel the containers to a platform scale for weighing and recording. As the crew members would circle and pick, the materials beneath would become exposed for the next member picking up different waste constituents.

The crew supervisor and his helper would weigh the filled sorting container and record its net weight and percent volume filled on log sheets. The scale attendant would also select representative pieces from the contents in the sorting container of a combustible waste constituent. The scale attendant would deposit these items into a plastic bag assigned for that particular constituent. Materials accumulated in the plastic bag during the day would be used as a sample for further laboratory analysis.

The sorting container, having been weighed and sampled, would be emptied into a large roll-off container or truck for disposal. The empty container would then be returned to the sorting area for reuse. Materials considered oversize and bulky would be separated, weighed, logged, and photographed.

As the pile of solid waste diminished, it was found that items consisting of a smaller size (1-4 in.) (25-100 mm) filtered to the bottom. Sorting of waste constituents with diminishing sizes significantly increases the time required to gather the data. A 4 ft by 8 ft

TABLE 1 MERCER COUNTY SOLID WASTE COMPOSITION BY WET WEIGHT

	Summer			Winter			Yearly Average*
	Res (%)	Comm/Ind (%)	Overall (%)	Res (%)	Comm/Ind (%)	Overall (%)	
Newsprint	4.9	15.6	8.9	15.1	6.8	11.8	9.4
Corrugated Paper	3.8	11.5	6.7	6.0	8.8	7.1	6.7
Other Paper	31.1	24.7	28.7	36.9	37.2	37.0	27.7
Film Plastic	2.7	5.1	3.6	3.1	3.7	3.4	3.5
Rigid Plastic	2.6	2.2	2.5	3.3	3.3	3.3	2.5
PET Plastic	0.3	0.2	0.3	0.6	0.5	0.5	0.3
Textile, Rubber & Leather	3.5	5.7	4.3	2.0	3.8	2.7	4.0
Food Waste	7.7	17.6	11.5	5.4	8.6	6.7	9.8
Wood	5.4	3.0	4.5	3.3	5.5	4.2	4.5
Yard Waste	13.7	1.0	8.9	1.1	1.2	1.2	10.3
Sweepings	7.6	2.5	5.6	11.8	9.1	10.7	7.1
	83.3	89.1	85.5	88.6	88.5	88.6	85.8
<u>Non-combustibles</u>							
Glass	7.6	3.2	5.9	6.4	7.9	7.0	5.9
Ferrous Metal	4.1	2.6	3.5	3.6	2.1	3.0	3.3
Aluminum	1.4	1.0	1.3	0.8	0.9	0.8	1.4
Other Ferrous Metals	0.2	0.1	0.2	0.2	-0-	0.1	0.2
Brick, Ceramic & Rock	3.4	4.0	3.6	0.4	0.6	0.5	3.4
	<u>16.7</u>	<u>10.9</u>	<u>14.5</u>	<u>11.4</u>	<u>11.5</u>	<u>11.5</u>	<u>14.2</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

\*Based upon annual projections of the weighing program and of the summer and winter sorting program.

(1.3 m by 2.5 m) sorting table with 0.5 in. (12.5 mm) square mesh screen was used to speed the separation of the remaining waste constituents.

After the entire load was sorted, all containers weighed, and any miscellaneous material remaining on the floor swept into containers for weighing, the unit weights were summed for comparison to the total weights of the material delivered. The total weight was somewhat less than the weight of the delivered material due to moisture loss from evaporation when the load was spread out for sorting. This moisture loss varied between 2% and 5% of the total material delivered during each sorting operation. The unit volumes were also summed in conjunction with the total weights and

used to calculate an average bulk density for each waste constituent by source.

The summer program was performed in August, 1986, and the winter program in February, 1987. The results of this program are presented below in Table 1.

The above percentages are calculated without considering the oversize and bulky waste items (large pieces of carpeting and linoleum, major appliances, furniture and mattresses) that were observed during the sorting program. These items, which would not normally be processed in a Resource Recovery Facility but bypassed directly to the landfill, constituted between 1% and 3% of the weight of the samples taken.

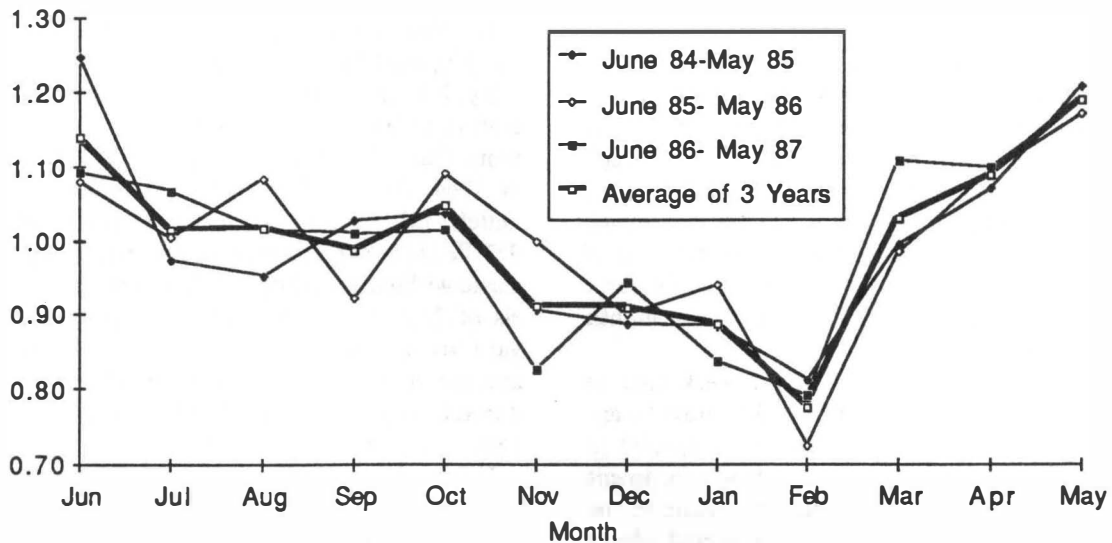


FIG. 2 MONTHLY VOLUME INDEXES

### EXISTING SOLID WASTE COLLECTION DATA

To size the resource recovery and recycling facilities, it was necessary to evaluate the 4 weeks of data from the seasonal weighing programs and the 3 years of collection vehicle volumetric data from coupons redeemed at the landfill for the residential waste. This information was used to project the total waste presently collected in the county. The coupon redemption data was analyzed for a 36 month period beginning June 1984 and ending May 1987. Further analysis was made, based on the three 12 month periods (June through May), to compare the seasonal nature of waste generation rates from one year to the next.

Due to discontinuous use of coupons by several municipalities in the 3 year period, coupon redemption data from only five municipalities could be compared on this 12 month basis. Fortunately, the five municipalities with continuous participation represented nearly 75% of the county's population.

A mean volume per month for each municipality was established for a 12 month period (June through May), and the actual monthly volume for each municipality was compared to its mean. Monthly volume indexes were calculated (the ratio of the month to the 12 month mean) and listed for each municipality. Similar analyses were prepared for the second and third 12 month periods. An index of 1.1 for a particular

month represents that the actual volume was 10% greater than the monthly mean for that 12 month period.

A county-wide monthly index was determined by multiplying the index for each of the five municipalities by its population, adding these values, and dividing by the total population of the five municipalities.

The county-wide averages for the 12 month intervals were developed in June through May periods, and the 3 year mean of these values were also analyzed. The resulting graphical analysis (Fig. 1 below) show good correlation among the three 12 month periods with regard to seasonal volumetric variation.

### WEIGHT

The actual volume indexes for July 1986 and January 1987 should correlate to the weight of waste determined during the two 2 week weighing programs during those months. However, to relate volume and weight information, the relationship between the density of the waste in the collection vehicles during the two weighing program periods and the percentage of waste volume collected during the two 2 week periods versus the entire month must be analyzed.

The average residential solid waste bulk density for the summer program was determined to be 735 lb cu

yd (435 kg/m<sup>3</sup>) compared to 658 lb cu yd (390 kg/m<sup>3</sup>) for the winter program, a 10.5% decrease.

Similarly, analysis of the coupon redemption information indicated a smaller percentage of the total monthly vehicle volume was realized during the 2 week period of the winter weighing program (38.5%) than in the summer weighing program (43.1%). A major influence on these differences was the occurrence of the New Year's holiday in the first week of January, creating larger volumes of waste earlier in the month than in the later weeks.

Therefore, to convert the January 2 week data to monthly data, a factor of 2.60 (1/0.385) must be applied, while a factor of 2.32 (1/0.431) is applied to similar data for the July program. The final adjustment is based on the percentage of residential waste in the total waste stream results for the summer and winter programs, which were very similar (54.44% versus 54.51%). Using these adjustments, the two weighing programs correlated within 3%.

Because nearly 90% of the residential waste was actually weighed during the summer program versus 67% for the winter program, the summer data was used to estimate the amount of total annual waste collected in 1986. One reason for the reduced participation during the winter weighing program was that several days of heavy snowfall reduced overall hauler participation. The actual combined monthly indexes of coupon redemptions for June 1986 through May 1987 for the five municipalities were used to adjust the July data to the other months in 1987. The estimated data for January 1987, was used for that month.

## CURRENT AVERAGE DAILY SOLID WASTE GENERATION

This study indicated that in 1987, 365,400 tons per year (332,200 MT per year), or an average of 1000 TPD (910 tpd), of waste was generated in the county. This quantity includes not only waste measured during the weighing program but also includes estimates of waste currently being recycled at drop-off points and by commercial haulers throughout the county and yard waste being composted at home and at municipal composting centers. The quantities in tons per day for each category of waste established by the New Jersey Department of Environmental Protection are set forth in the following Table 2:

In 1992, the anticipated first year of operation for the proposed Mercer County Resource Recovery Facility, it is expected that annual total solid waste generation before recycling in Mercer County would be more than 388,000 tons per year (352,700 t per year) or 1064 TPD (967 tpd). Of this quantity, approximately 357,000 tons per year (324,500 t per year) or 977 TPD (888 tpd) would be considered as processible waste without recycling. With minimum recycling levels of 25% under the State requirements (100% of yard waste plus 25% of the remaining material), the amount of processible waste available would be reduced to approximately 247,000 tons per year (224,500 t per year) or 676 TPD (615 tpd).

Using the processible waste quantity projections, a guaranteed waste throughput capacity for the resource recovery facility of 302,500 tons/year (275,000 t/year) and an expected 20 year operating life for the Mercer County Resource Recovery Facility, the minimum average daily and annual processing capacities were calculated for years 1992 through 2012 and presented below.

Year	Average Annual Tons Delivered(t)	Necessary Capacity in TPD(tpd)
1992	246,000 (224,200)	795(725)
1997	261,000 (237,300)	840(765)
2002	275,700 (250,600)	890(810)
2007	290,200 (263,800)	935(850)
2012	304,800 (277,000)	975(885)

Based on this analysis, a rated process processing capacity of 975 TPD day (88t tpd) was selected for the Mercer County Resource Recovery Facility. Even though the Facility capacity is slightly exceeded in the year 2012, the design capacity of the Facility is based upon 5600 Btu/lb waste (3115 cal/kg), which, when compared to the reference waste of 5350 Btu/lb (2975 cal/kg), provides an additional 39 TPD (36 tpd) or 14,100 tons/year (12,800 t/year) capacity and 4.6% throughput capacity increase. Initially, three 325 TPD (295 tpd) mass burn combustion-steam generation units will be installed, and provisions for addition of a fourth unit will be made if an unexpected increase in the county's population or the waste generation rate occurs in the future.

**Key Words:** Calorific Value; Characterization; Composition; Mercer County, New Jersey; Quantification

TABLE 2 SOLID WASTE GENERATION

Waste Category	TPD (MTPD)(1)	%	Per Capita pounds per day (Kg per day) (2)
Residential(Type 10)..	555(505)	55.5	3.36(1.52)
Commercial(Type 10)...	330(300)	33.0	2.00(0.91)
Industrial(Type 27)...	35(32)	3.5	0.21(0.19)
Bulky(Type 13).....	75(68)	7.5	0.45(0.40)
Vegetative(Type 23)...	5(5)	0.5	0.03(0.03)
Animal and Food Processing(Type 25)..<	0(0)	0.0	0.00(0.00)
<b>Total.....</b>	<b><u>1,000(910)</u></b>	<b><u>100.0</u></b>	<b><u>6.05(2.75)</u></b>

(1) Tons per day (metric tons per day) based on a seven day week.

(2) Based upon 1987 Mercer County population of 331,000.

The quantity of waste in future years was escalated based upon the population growth in the county. The per capita waste generation rate of 6.05 pounds per person(2.75 Kg per person) was maintained constant throughout the projection period and produced the following results:

Projection of Solid Waste Generated

Year	Population	TPY (MTPY)(1)	TPD (MTPD)(2)
1987	331,000	365,400(332,200)	1,000(910)
1988	335,100	369,900(336,300)	1,015(925)
1992	351,700	388,400(353,100)	1,065(970)
1997	372,400	411,300(373,900)	1,125(1025)
2002	393,200	434,100(394,600)	1,190(1080)
2007	413,900	457,000(415,500)	1,250(1140)
2012	434,600	480,000(436,400)	1,315(1195)

(1) Tons per year(MT per year).

(2) Tons per day(MT per day) based on a seven day week.