

## ABSORPTION TEST IN FEILD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-01*

DEPTH OF HOLE: *6.25 m*

CASING BELOW GROUND LEVEL: *5.25 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *3.90 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *16.00 l*

### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.46 m	1.600 l
10 min	0.43 m	1.440 l
15 min	0.39 m	1.380 l
20 min	0.37 m	1.300 l
25 min	0.47 m	1.500 l
30 min	0.45 m	1.420 l
35 min	0.41 m	1.320 l
40 min	0.44 m	1.400 l
45 min	0.41 m	1.400 l
50 min	0.42 m	1.440 l
55 min	0.42 m	1.440 l
60 min	0.42 m	1.440 l
65 min	0.42 m	1.440 l
70 min		
75 min		

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### ABSORPTION TEST IN FEILD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-02*

DEPTH OF HOLE: *3.00 m*

CASING BELOW GROUND LEVEL: *2.00 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.15 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *4.90 l*

#### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
03 min	0.25 m	0.800 l
08 min	0.25 m	1.100 l
13 min	0.25 m	1.125 l
18 min	0.25 m	1.080 l
23 min	0.22 m	1.100 l
28 min	0.22 m	1.100 l
33 min	0.22 m	1.100 l
38 min		
43 min		
48 min		
53 min		
58 min		
63 min		
68 min		
73 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement  
of Solid Waste Management at Badulla.*

LOCATION: *BH-02*

DEPTH OF HOLE: *9.55 m*

CASING BELOW GROUND LEVEL: *8.55 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.50 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *12.30 l*

**READING**

**\*WATER LEVEL FROM TOP OF CASING**

**\*\*WATER TAKEN TO FILL UP TO TOP OF CASING**

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.02 m	0.080 l
10 min	NIL	0.001 l
20 min	NIL	0.001 l
30 min	NIL	0.001 l
40 min	NIL	0.001 l
50 min	NIL	0.001 l
60 min	NIL	0.001 l
70 min	NIL	0.001 l

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## ABSORPTION TEST IN FEILD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-03*

DEPTH OF HOLE: *3.50 m*

CASING BELOW GROUND LEVEL: *2.50 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *Nil*

WATER TAKEN TO FILL UP TO TOP OF CASING: *15.90 l*

### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.78 m	2.540 l
10 min	0.71 m	2.300 l
15 min	0.66 m	2.120 l
20 min	0.63 m	1.900 l
25 min	0.61 m	1.900 l
30 min	0.59 m	1.880 l
35 min	0.59 m	1.820 l
40 min	0.56 m	1.760 l
45 min	0.56 m	1.760 l
50 min	0.56 m	1.760 l
55 min		
60 min		
65 min		
70 min		
75 min		

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## ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-03*

DEPTH OF HOLE: *7.00 m*

CASING BELOW GROUND LEVEL: *6.00 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *2.20 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *9.32 l*

### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	1.35 m	4.000 l
10 min	0.90 m	2.740 l
15 min	0.80 m	2.400 l
20 min	0.80 m	2.500 l
25 min	0.83 m	2.540 l
30 min	0.87 m	2.560 l
35 min	0.85 m	2.410 l
40 min	0.82 m	2.500 l
45 min	0.78 m	2.840 l
50 min	0.78 m	2.840 l
55 min	0.78 m	2.840 l
60 min	0.78 m	2.550 l
65 min	0.78 m	2.550 l
70 min	0.78 m	2.550 l
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-04*

DEPTH OF HOLE: *3.50 m*

CASING BELOW GROUND LEVEL: *2.50 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.55 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *15.00 l*

#### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.120 m	0.38 l
10 min	0.030 m	0.10 l
15 min	0.025 m	0.08 l
20 min	0.025 m	0.08 l
25 min	0.020 m	0.06 l
30 min	0.020 m	0.08 l
35 min	0.015 m	0.04 l
40 min	0.015 m	0.04 l
45 min	0.015 m	0.04 l
50 min	0.015 m	0.04 l
55 min		
60 min		
65 min		
70 min		
75 min		

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**ABSORPTION TEST IN FIELD.**

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-07*

DEPTH OF HOLE: *2.30 m*

CASING BELOW GROUND LEVEL: *1.30 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *Nil*

WATER TAKEN TO FILL UP TO TOP OF CASING: *4.0 l*

**READING**

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.14 m	0.500 l
10 min	0.12 m	0.460 l
15 min	0.14 m	0.480 l
20 min	0.13 m	0.480 l
25 min	0.13 m	0.460 l
30 min	0.11 m	0.400 l
35 min	0.14 m	0.500 l
40 min	0.14 m	0.500 l
45 min	0.14 m	0.500 l
50 min	0.14 m	0.500 l
55 min	0.14 m	0.500 l
60 min		
65 min		
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BII-08*

DEPTH OF HOLE: *1.30 m*

CASING BELOW GROUND LEVEL: *0.30 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.15 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *9.35 l*

**READING**

**\*WATER LEVEL FROM TOP OF CASING**

**\*\*WATER TAKEN TO FILL UP TO TOP OF CASING**

TIME	*DEPTH (m)	**VOLUME ( l )
05 min	1.32 m	9.90 l
10 min	1.29 m	10.00 l
15 min	1.29 m	10.15 l
20 min	1.29 m	10.35 l
25 min	1.29 m	10.35 l
30 min	1.29 m	10.35 l
35 min	1.29 m	10.35 l
40 min		
45 min		
50 min		
55 min		
60 min		
65 min		
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-09*

DEPTH OF HOLE: *2.50 m*

CASING BELOW GROUND LEVEL: *1.50 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *Nil*

WATER TAKEN TO FILL UP TO TOP OF CASING: *14.0 l*

**READING**

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME:	*DEPTH (m)	**VOLUME (l)
05 min	1.17 m	3.800 l
10 min	1.14 m	3.600 l
15 min	1.08 m	3.460 l
20 min	1.07 m	3.280 l
25 min	1.06 m	3.240 l
30 min	1.06 m	3.240 l
35 min	1.00 m	3.160 l
40 min	1.00 m	3.080 l
45 min	0.99 m	3.100 l
50 min	1.03 m	3.100 l
55 min	1.02 m	3.100 l
60 min	0.99 m	3.100 l
65 min		
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BII-10*

DEPTH OF HOLE: *3.00 m*

CASING BELOW GROUND LEVEL: *2.00 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *Nil*

WATER TAKEN TO FILL UP TO TOP OF CASING: *16.66 l*

#### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	1.55 m	5.320 l
10 min	1.50 m	5.040 l
15 min	1.48 m	4.875 l
20 min	1.37 m	4.600 l
25 min	1.30 m	4.525 l
30 min	1.18 m	4.275 l
35 min	1.20 m	4.275 l
40 min	1.18 m	4.200 l
45 min	1.18 m	4.175 l
50 min	1.13 m	4.125 l
55 min	1.13 m	4.200 l
60 min	1.15 m	4.200 l
65 min	1.18 m	4.200 l
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BII-11*

DEPTH OF HOLE: *4.78 m*

CASING BELOW GROUND LEVEL: *3.78 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.90 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *10.90 l*

#### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.94 m	5.000 l
10 min	1.06 m	5.580 l
15 min	1.05 m	5.700 l
20 min	1.00 m	5.340 l
25 min	1.05 m	5.760 l
30 min	1.04 m	5.540 l
35 min	1.03 m	5.400 l
40 min	1.05 m	5.530 l
45 min	0.98 m	5.120 l
50 min	1.05 m	5.580 l
55 min	1.03 m	5.700 l
60 min	1.02 m	5.420 l
65 min	0.95 m	5.275 l
70 min	0.99 m	5.400 l
75 min	1.00 m	5.420 l
80 min	1.02 m	5.420 l
85 min	1.00 m	5.420 l

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BII-13*

DEPTH OF HOLE: *1.20 m*

CASING BELOW GROUND LEVEL: *0.20 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *1.25 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *12.60 l*

#### READING

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME ( l )
05 min	0.45 m	11.00 l
10 min	0.46 m	9.50 l
15 min	0.40 m	9.10 l
20 min	0.57 m	9.50 l
25 min	0.40 m	7.75 l
30 min	0.35 m	6.60 l
35 min	0.50 m	9.40 l
40 min	0.40 m	7.30 l
45 min	0.33 m	7.00 l
50 min	0.42 m	8.60 l
55 min	0.52 m	9.35 l
60 min	0.50 m	9.35 l
65 min	0.50 m	9.35 l
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-14*

DEPTH OF HOLE: *3.00 m*

CASING BELOW GROUND LEVEL: *2.00 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *Nil*

WATER TAKEN TO FILL UP TO TOP OF CASING: *14.80 l*

**READING**

\*WATER LEVEL FROM TOP OF CASING

\*\*WATER TAKEN TO FILL UP TO TOP OF CASING

TIME	*DEPTH (m)	**VOLUME ( l )
05 min	0.97 m	4.20 l
10 min	1.10 m	3.95 l
15 min	1.05 m	3.35 l
20 min	1.05 m	3.40 l
25 min	1.00 m	3.20 l
30 min	0.80 m	3.55 l
35 min	0.99 m	3.00 l
40 min	0.86 m	2.55 l
45 min	0.86 m	2.60 l
50 min	0.86 m	2.60 l
55 min	0.86 m	2.60 l
60 min	0.86 m	2.60 l
65 min		
70 min		
75 min		

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### ABSORPTION TEST IN FIELD.

PROJECT: *Geological Survey for the Study on Improvement of Solid Waste Management at Badulla.*

LOCATION: *BH-14*

DEPTH OF HOLE: *10.00 m*

CASING BELOW GROUND LEVEL: *9.00 m*

CASING ABOVE GROUND LEVEL: *1.00 m*

WATER LEVEL AT BEGINNING OF TEST: *0.59 m*

WATER TAKEN TO FILL UP TO TOP OF CASING: *1.70 l*

**READING**

**\*WATER LEVEL FROM TOP OF CASING**

**\*\*WATER TAKEN TO FILL UP TO TOP OF CASING**

TIME	*DEPTH (m)	**VOLUME (l)
05 min	0.08 m	0.12 l
10 min	0.08 m	0.12 l
15 min	0.08 m	0.13 l
20 min	0.08 m	0.13 l
25 min	0.08 m	0.13 l
30 min	0.08 m	0.13 l
35 min	0.08 m	0.13 l
40 min		
45 min		
50 min		
55 min		
60 min		
65 min		
70 min		
75 min		

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*APPENDIX 3: Summary of Analysis of Permeability Test Results*

**Appendix 3 – Summary of Analysis of Permeability Test Results**

<b>Borehole No. BH-01</b>	
Depth = 2.0 m	
Depth to GWL = 1.55 m	k = 6.801E-07 cm/s
	k = 6.801E-09 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 2.0 cm <sup>3</sup> /min	8.4 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 255 cm	

<b>Borehole No. BH-01</b>	
Depth = 5.25 m	
Depth to GWL = 3.9 m	k = 5.097E-05 cm/s
	k = 5.097E-07 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 288.0 cm <sup>3</sup> /min	1203.1 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 490 cm	

<b>Borehole No. BH-02</b>	
Depth = 2.0 m	
Depth to GWL = 1.15 m	k = 8.873E-05 cm/s
	k = 8.873E-07 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 220.0 cm <sup>3</sup> /min	919.0 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 215 cm	



**Borehole No. BH-02**  
 Depth = 8.55 m  
 Depth to GWL = 1.5 m  
 $k = 3.815E-08 \text{ cm/s}$   
 $k = 3.815E-10 \text{ m/s}$   
 Rate of water absorption = 0.5 ml/min.per sq.m  
 $k = q / (FH_c)$   
 $q = (Q/t) = 0.11 \text{ cm}^3/\text{min}$   
 $F = 192.2058 \text{ cm}$   
 $H_c = 250 \text{ cm}$

**Borehole No. BH-03**  
 Depth = 2.5 m  
 Depth to GWL = Not encountered  
 $k = 1.387E-04 \text{ cm/s}$   
 $k = 1.387E-06 \text{ m/s}$   
 Rate of water absorption = 1470.4 ml/min.per sq.m  
 $k = q / (FH_c)$   
 $q = (Q/t) = 352.0 \text{ cm}^3/\text{min}$   
 $F = 192.2058 \text{ cm}$   
 $H_c = \text{Not determined}$

**Borehole No. BH-03**  
 Depth = 6.0 m  
 Depth to GWL = 2.2 m  
 $k = 1.382E-04 \text{ cm/s}$   
 $k = 1.382E-06 \text{ m/s}$   
 Rate of water absorption = 2130.4 ml/min.per sq.m  
 $k = q / (FH_c)$   
 $q = (Q/t) = 510.0 \text{ cm}^3/\text{min}$   
 $F = 192.2058 \text{ cm}$   
 $H_c = 320 \text{ cm}$

<b>Borehole No. BH-04</b>	
Depth = 2.5 m	
Depth to GWL = 1.55 m	k = 2.720E-06 cm/s
	k = 2.720E-08 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 8.0 cm <sup>3</sup> /min	33.4 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 255 cm	

<b>Borehole No. BH-05</b>	
Depth = 1.1 m	
Depth to GWL = Not encountered	k = 6.590E-05 cm/s
	k = 6.590E-07 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 760.0 cm <sup>3</sup> /min	3174.7 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = Not determined	

<b>Borehole No. BH-07</b>	
Depth = 1.3 m	
Depth to GWL = Not encountered	k = 8.671E-06 cm/s
	k = 8.671E-08 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 100.0 cm <sup>3</sup> /min	417.7 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = Not determined	

<b>Borehole No. BH-08</b>		
Depth = 0.3 m		
Depth to GWL = 1.15 m	k =	8.349E-04 cm/s
	k =	8.349E-06 m/s
$k = q / (FH_c)$	Rate of water absorption =	
$q = (Q/t) =$ 2070.0 cm <sup>3</sup> /min		8647.0 ml/min.per sq.m
F = 192.2058 cm		
H <sub>c</sub> = 2.15 m		

<b>Borehole No. BH-09</b>		
Depth = 1.5 m		
Depth to GWL = Not encountered	k =	5.376E-05 cm/s
	k =	5.376E-07 m/s
$k = q / (FH_c)$	Rate of water absorption =	
$q = (Q/t) = 620.0$ cm <sup>3</sup> /min		2589.9 ml/min.per sq.m
F = 192.2058 cm		
H <sub>c</sub> = Not determined		

<b>Borehole No. BH-10</b>		
Depth = 2.0 m		
Depth to GWL = Not encountered	k =	7.284E-05 cm/s
	k =	7.284E-07 m/s
$k = q / (FH_c)$	Rate of water absorption =	
$q = (Q/t) = 840.0$ cm <sup>3</sup> /min		3508.9 ml/min.per sq.m
F = 192.2058 cm		
H <sub>c</sub> = Not determined		

<b>Borehole No. BH-11</b>	
Depth = 3.78 m	
Depth to GWL = 1.9 m	k = 3.241E-04 cm/s
	k = 3.241E-06 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 1084.0 cm <sup>3</sup> /min	4528.2 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 2.90 m	

<b>Borehole No. BH-13</b>	
Depth = 0.2 m	
Depth to GWL = 1.25 m	k = 7.207E-04 cm/s
	k = 7.207E-06 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 1870.0 cm <sup>3</sup> /min	7811.5 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = 2.25 m	

<b>Borehole No. BH-14</b>	
Depth = 2.0 m	
Depth to GWL = Not encountered	k = 4.509E-05 cm/s
	k = 4.509E-07 m/s
k = q / (FH <sub>c</sub> )	Rate of water absorption =
q = (Q/t) = 520.0 cm <sup>3</sup> /min	2172.2 ml/min.per sq.m
F = 192.2058 cm	
H <sub>c</sub> = Not determined	

<b>Borehole No. BH-14</b>		
Depth = 9.0 m		
Depth to GWL = 2.45 m	k =	6.585E-06 cm/s
	k =	6.585E-08 m/s
$k = q / (FH_c)$		Rate of water absorption =
$q = (Q/t) = 26.2 \text{ cm}^3/\text{min}$		109.4 ml/min.per sq.m
$F = 192.2058 \text{ cm}$		
$H_c = 3.45 \text{ m}$		

*APPENDIX 4: Laboratory Test Results*

PROCTOR COMPACTION TEST - LABORATORY WORK SHEET						
Client: Geotech Limited		Job ref. ML/S/459		Client ref.		
Project: Waste Disposal Site: Badulla		Test Pit No.		Sample No. 1		
		Depth. m		Date 05.09.2003		
Location: Badulla						
Soil description: Soil						
Test Method ASTM D 698						
Compaction mould			Compacted by hand / machine			
Diameter	cm	15.20	Weight of rammer	kg	2.5	
Height	cm	11.70	Dropping Height	cm	30.5	
Volume	cm <sup>3</sup>	2133.1	Number of Layers		3	
Weight	g	3020	Blows per Layer		56	
Trial No.		1	2	3	4	5
Wt. of wet soil + container	g	252.90	232.26	268.92	289.59	242.41
Wt. of dry soil + container	g	218.90	199.20	224.66	237.76	197.00
Wt. of container	g	54.35	54.48	59.67	57.72	55.33
Wt. of water	g	34.00	33.06	44.26	51.84	45.41
Wt. of dry soil	g	164.55	144.72	164.99	180.03	141.67
Moisture content	%	20.66	22.84	26.83	28.80	32.05
Wt. of mould + wet soil	g	6630	6760	6995	7070	7055
Wt. of mould	g	3020	3020	3020	3020	3020
Wt. of wet soil	g	3610	3740	3975	4050	4035
Bulk density	g/cm <sup>3</sup>	1.700	1.762	1.872	1.908	1.901
Dry density	g/cm <sup>3</sup>	1.409	1.434	1.476	1.481	1.439

**Dry Density-Moisture Relation**

Maximum Dry Density	1.481 g/cm <sup>3</sup>	Optimum Moisture content %	28.2
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**ENGINEERING & LABORATORY SERVICES (PVT) LTD**

62/3, Neelamahara Road, Katuwawala, Boralagsamuwa, Sri Lanka.

Telephone : 0094 01 517037 / 517365 / 517777, Fax : 0094 01 509806, E-Mail : els@lanka.com.



<b>PROCTOR COMPACTION TEST - LABORATORY WORK SHEET</b>						
Client: Geotech Limited	Job ref.	MLS/459				
Project: Waste Disposal Site Badulla	Client ref.					
	Test Pit No.					
	Sample No.	2				
	Depth m					
	Date	05.09.2003				
Location: Badulla						
Soil description: Soil						
Test Method ASTM-D 698						
Compaction mould			Compacted by hand / machine			
Diameter cm	10.13	Weight of Rammer	kg	2.5		
Height cm	11.70	Dropping height	cm	30.5		
Volume cm <sup>3</sup>	943.0	Number of Layers	3			
Weight g	4225	Blows per Layer	25			
Trial No.		1	2	3	4	5
Wt. of wet soil + container	g	282.72	247.17	290.67	310.26	342.07
Wt. of dry soil + container	g	243.23	223.85	259.09	270.31	293.76
Wt. of container	g	53.78	55.60	64.47	52.10	55.07
Wt. of water	g	19.49	23.32	31.58	39.95	48.31
Wt. of dry soil	g	189.45	168.25	194.62	218.21	238.69
Moisture content	%	10.29	13.06	16.23	18.31	20.24
Wt. of mould + wet soil	g	5965	6185	6215	6190	6150
Wt. of mould	g	4225	4225	4225	4225	4225
Wt. of wet soil	g	1740	1940	1990	1965	1925
Bulk density	g/cm <sup>3</sup>	1.845	2.057	2.110	2.084	2.041
Dry density	g/cm <sup>3</sup>	1.673	1.607	1.816	1.781	1.698

**Dry Density-Moisture Relation**

Maximum Dry Density	1.825 g/cm <sup>3</sup>	Optimum Moisture content %	15.2
---------------------	-------------------------	----------------------------	------

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**ENGINEERING & LABORATORY SERVICES (PVT) LTD**

62/R, Neelamahara Road, Katiwawala, Boralesgamuwa, Sri Lanka.

Telephone: 0094 01 517037 / 51365 / 519727, Fax: 0094 01 509806, E-Mail: els@lanka.com.





### PROCTOR COMPACTION TEST - LABORATORY WORK SHEET

Client: Geotech Limited	Job ref: ML/S/459		
Project: Waste Disposal site Badulla	Client ref:		
	Test Ref No:		
	Sample No:	3	
	Depth (m):		
	Date:	05.09.2003	
Location: Badulla			
Soil description: Soil			
Test Method: ASTM D 698			
Compaction mould		Compacted by hand / machine	
Diameter (cm)	15.20	Weight of Rammer (kg)	2.5
Height (cm)	11.70	Dropping Height (cm)	30.5
Volume (cm <sup>3</sup> )	2123.1	Number of Layers	3
Weight (g)	3020	Blows per Layer	56

Trial No.	1	2	3	4	5
Wt. of wet soil + container (g)	289.62	259.62	325.62	413.45	345.63
Wt. of dry soil + container (g)	273.90	240.24	295.13	365.58	302.00
Wt. of container (g)	55.30	55.59	62.95	56.35	50.20
Wt. of water (g)	15.60	19.38	30.49	47.87	43.63
Wt. of dry soil (g)	218.60	183.65	232.18	309.23	261.80
Moisture content (%)	7.14	10.55	13.13	15.48	17.33
Wt. of mould + wet soil (g)	7285	7520	7665	7720	7745
Wt. of mould (g)	3020	3020	3020	3020	3020
Wt. of wet soil (g)	4265	4500	4635	4700	4725
Bulk density (g/cm <sup>3</sup> )	2.009	2.120	2.183	2.214	2.226
Dry density (g/cm <sup>3</sup> )	1.875	1.917	1.930	1.917	1.897

**Dry Density-Moisture Relation**

Maximum Dry Density	1.930 g/cm <sup>3</sup>	Optimum Moisture content %	13.0
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*[Signature]*

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**ENGINEERING & LABORATORY SERVICES ( PVT ) LTD**

G2/3, Neelammahara Road, Kaluwawala, Boralesgamuwa, Sri Lanka.

Telephone : 0094 01 517037 / 517365 / 519227, Fax : 0094 01 509806, E-Mail : ets@lanka.com.



<b>SPECIFIC GRAVITY OF SOIL</b>				
ASTM D 354				
Client : Geotech Limited	Job ref :	ML/S /459		
Project :Waste Disposal Site Badulla	Client ref :	-		
Consultant :	Borehole No	-		
Location : Badulla	Date	06.09.2003		
Sample No	1	2	3	
Specific Gravity Bottle No.	5	6	5	
Weight of Empty Bottle                   g	28.085	28.196	28.699	
Weight of Bottle + Oven Dry Soil       g	40.444	35.51	41.493	
Weight of Oven Dry Soil                   g	12.359	9.314	12.794	
Weight of Bottle + Soil + Water       g	86.288	84.542	86.579	
Temperature of Water                   °C	28	28	28	
Weight of Bottle Full of Water       g	78.658	78.732	78.658	
Volume of Soil                           cm <sup>3</sup>	4.729	3.504	4.873	
Specific Gravity of Soil	2.613	2.658	2.625	

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**GEOTECH TESTING SERVICES (PVT) LTD.**

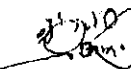
SIEVE ANALYSIS TEST RESULTS		PROJECT : Geotechnical Survey for Improvement of Solid Waste Management at Badulla.			
Analysis Date : 28/08/2003		Location: Area - 01		Sample No: 01	
Particle Size Analysis Total Mass Taken (g) = 200 g			Sieve Analysis		
Sieve Number	Sieve size (mm)	Mass of Soil (g)	Cumulative mass (g)	Percent retained (%)	Percent Finer (%)
1	19.000	0	0	0.00	100.00
2	9.500	0	0	0.00	100.00
3	4.750	12.23	12.23	6.11	93.89
4	0.850	102.98	115.21	57.60	42.40
5	0.710	0.95	116.16	58.08	41.92
6	0.425	49.71	165.87	82.93	17.07
7	0.250	12.01	178.78	89.39	10.61
8	0.150	12.13	190.91	95.45	4.55
9	0.075	3.98	194.89	97.44	2.56
10	0.063	2.06	196.95	98.47	1.53
11	Pan	2.70	199.65	99.82	0.18

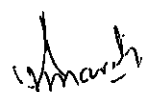
  

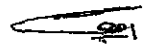
Particle size Distribution

Percentage Finer (%)

Particle Size (mm)

  
 Tested by

  
 Checked by

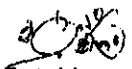
  
 Approved by


**GEOTECH TESTING SERVICES (PVT) LTD.**

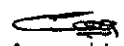
<b>SIEVE ANALYSIS TEST RESULTS</b>		PROJECT : <i>Geotechnical Survey for improvement of Solid Waste Management at Badulla.</i>			
Analysis Date : 28/08/2003		Location: Area 02		Sample No: 01	
Particle Size Analysis Total Mass Taken (g) = 200 g			Sieve Analysis		
Sieve Number	Sieve size (mm)	Mass of Soil (g)	Cumulative mass (g)	Percent retained (%)	Percent Finer (%)
1	19.000	0	0	0.00	100.00
2	9.500	2.42	2.42	1.21	98.79
3	4.750	5.46	7.88	3.94	96.06
4	0.850	56.82	64.70	32.35	67.65
5	0.710	1.63	66.33	33.16	66.84
6	0.425	70.03	136.36	68.18	31.82
7	0.250	21.77	158.13	79.06	20.94
8	0.150	22.60	180.73	90.36	9.64
9	0.075	7.14	187.87	93.93	6.07
10	0.063	4.21	192.08	96.04	3.96
11	Pass	5.63	197.91	98.95	1.05

Particle size Distribution

  
 Tested by

  
 Checked by

  
 Approved by


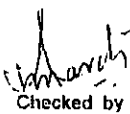

**GEOTECH TESTING SERVICES (PVT) LTD.**


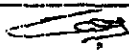
<b>SIEVE ANALYSIS TEST RESULTS</b>		PROJECT : Geotechnical Survey for Improvement of Solid Waste Management at Badulla.			
Analysis Date : 28/08/2003		Location: Area 03		Sample No: 01	
Particle Size Analysis Total Mass Taken (g) = 400 g			Sieve Analysis		
Sieve Number	Sieve size (mm)	Mass of Soil (g)	Cumulative mass (g)	Percent retained (%)	Percent Finer (%)
1	19.000	0	0	0.00	100.00
2	9.500	23.16	23.16	11.58	88.42
3	4.750	33.54	56.70	28.34	71.65
4	0.850	77.25	133.95	66.97	33.03
5	0.710	1.05	135.00	67.50	32.50
6	0.425	22.73	157.73	78.86	21.13
7	0.250	10.25	167.98	83.99	16.01
8	0.150	14.64	182.62	91.31	8.69
9	0.075	3.07	185.69	92.84	7.16
10	0.063	7.15	192.84	96.42	3.58
11	Pass	6.23	199.07	99.53	0.47

Particle size Distribution

 Tested by	 Checked by	 Approved by
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<b>GEOTECH TESTING SERVICES (PVT) LTD.</b>						
<b>Moisture Content</b>						
Project: Geotechnical Survey for Improvement of Solid Waste Management				Location: Badulla		
Samples No's:				Relevant test:		
Tested by: Geotech Limited				Date started: 28/08/2003		
<b>Sample No. &amp; Ref:</b>	<b>Area - 01</b>	<b>Area - 02</b>	<b>Area - 03</b>			
Container No.	1	2	3			
Wet Soil & Container: (g)	300.03	300.03	300.01			
Dry Soil & Container: (g)	255.24	284.55	289.06			
Container (g)	44.88	33.37	35.38			
Dry Soil (g)	210.36	251.18	253.70			
Moisture Loss (g)	44.79	15.48	10.95			
Moisture Content %	21.29	6.18	4.31			
Average Moisture %						
Sample No. & Ref:						
Container No.						
Wet Soil & Container: (g)						
Dry Soil & Container: (g)						
Container (g)						
Dry Soil (g)						
Moisture Loss (g)						
Moisture Content %						
Average Moisture %						
Sample No. & Ref:						
Container No.						
Wet Soil & Container: (g)						
Dry Soil & Container: (g)						
Container (g)						
Dry Soil (g)						
Moisture Loss (g)						
Moisture Content %						
Average Moisture %						
Remarks:	Operator signature: 					
	Calculation:					
	Passed: 					

<b>GEOTECH TESTING SERVICES (PVT) LTD.</b>						
15/1, Pepiliyana Mawatha						
Koluwala						
Nugegoda						
Liquid Limit and Plastic Limit Test	Project: Geotechnical Survey for Improvement of Solid Waste Management at Badulla.					
Date: 28/08/2003	Hole No.	Sample No.	Area 1	Sample Depth: Surface		
Description of soil: Brownish fine to medium clayey sand						
Test No.						
Type of Test						
No. of blows						
Moisture Content Determination						
Can No.						
Weight of wet Soil + Can (g)						
Weight of dry Soil + Can (g)						
Weight of can (g)						
Weight of dry Soil (g)						
Weight of water (g)						
Moisture content %						
Liquid Limit =	%	Plastic Limit =	%	PI =	%	
Re marks: Can not be done						
Liquid Limit and Plastic Limit Test	Project: Geotechnical Survey for Improvement of Solid Waste Management at Badulla.					
Date: 28/08/2003	Hole No.	Sample No.	Area 2	Sample Depth: Surface		
Description of soil: Light Brown fine to medium sand with some clay and quartz pebbles						
Test No.						
Type of Test						
No. of blows						
Moisture Content Determination						
Can No.						
Weight of wet Soil + Can (g)						
Weight of dry Soil + Can (g)						
Weight of can (g)						
Weight of dry Soil (g)						
Weight of water (g)						
Moisture content %						
Liquid Limit =	%	Plastic Limit =	%	PI =	%	
Re marks: Can not be done						

<b>GEOTECH TESTING SERVICES (PVT) LTD.</b>						
13/1, Pepiliyana Mawatha Kohuwala Nugegoda						
<b>Liquid Limit and Plastic Limit Test</b>		<b>Project: Geotechnical Survey for Improvement of Solid Waste Management at Badulla.</b>				
<b>Date:</b> 28/08/2003	<b>Hole No.</b>	<b>Sample No.</b> Arac3	<b>Sample Depth:</b> Surface			
<b>Description of soil:</b>		Brownish fine clayey sand with big quartz crystal				
<b>Test No.</b>						
<b>Type of Test</b>						
<b>No. of blows</b>						
<b>Moisture Content Determination</b>						
<b>Can No.</b>						
<b>Weight of wet Soil + Can (g)</b>						
<b>Weight of dry Soil + Can (g)</b>						
<b>Weight of can (g)</b>						
<b>Weight of dry Soil (g)</b>						
<b>Weight of water (g)</b>						
<b>Moisture content %</b>						
<b>Liquid Limit =</b>	<b>%</b>	<b>Plastic Limit =</b>	<b>%</b>	<b>PI =</b>	<b>%</b>	
<b>Re marks:</b> Can not be done						
<b>Liquid Limit and Plastic Limit Test</b>		<b>Project:</b>				
<b>Date:</b>	<b>Hole No.</b>	<b>Sample No.</b>	<b>Sample Depth:</b>			
<b>Description of soil:</b>						
<b>Test No.</b>						
<b>Type of Test</b>						
<b>No. of blows</b>						
<b>Moisture Content Determination</b>						
<b>Can No.</b>						
<b>Weight of wet Soil + Can (g)</b>						
<b>Weight of dry Soil + Can (g)</b>						
<b>Weight of can (g)</b>						
<b>Weight of dry Soil (g)</b>						
<b>Weight of water (g)</b>						
<b>Moisture content %</b>						
<b>Liquid Limit =</b>	<b>%</b>	<b>Plastic Limit =</b>	<b>%</b>	<b>PI =</b>	<b>%</b>	
<b>Re marks:</b>						



# Chapter 5

## Badulla Waste Stream Analysis

**A. Household garbage collection service, garden waste and recycling/composting survey data**

2.1&2.2 Garbage coll'n	No	%
Have and use	62	51.7
Have but don't use	35	29.2
Don't have	23	19.2
Total	120	100.0

3.8 Garden waste	No	%
Yes	99	82.5
No	21	17.5
Total	120	100.0

**Q4-5 to 4-8 Recycling**

Qns	Yes	No	Fd/Ki	Paper	Textile	Plastic	Gr/Wd	Le/Ru	Metal	Glass	Ce/St	Tyres	Total
4.5/4.6 Individual collector	101	18	0	18	10	1	0	0	6	48	0	1	55
4.7/4.8 Take to shop	33	87	0	2	0	0	0	0	0	31	0	0	33
4.9 Comp ki &/or ga waste	13	107	11				13						

1 don't know; 101 are visited but only 55 actually give/sell

**Notes:**

- Household questionnaire listed paper and cardboard separately and "metal can" and "other metal" separately, whereas these items were a single category in WACS. Hence, as more responses were obtained for paper compared with cardboard, it was assumed total paper = paper (not paper + cardboard)
- Hence, as more responses obtained for metal can compared with other metal, it was assumed total metal = metal can (not metal can + other)
- Assume same people are both giving/selling things to collectors and taking things to shops so that total doing some recycling is max no from these 2 questions, not sum
- In Q4.9, 13 households stated they compost both kitchen & garden waste - this answer assumed more accurate than Q3.9, where 10 households stated they compost their garden waste.

**B. Other household survey data and calculation of discharge/behaviour method %s for surveyed area**

**WACS Collection Vehicle Waste Composition over 8 days - wt %**

	Fd/Ki	Paper	Textile	Plastic	Gr/Wd	Le/Ru	Metal	Glass	Ce/St	other	Total
Kandy	58.21	11.95	1.40	7.94	12.31	0.68	0.84	1.13	5.13	0.40	99.99
Matale	61.29	6.40	1.07	4.35	18.14	1.11	0.42	0.36	6.60	0.26	100.00
Badulla	64.29	10.84	1.81	3.38	14.10	0.44	0.80	1.82	2.79	0.23	100.50

**Average Household waste composition over 8 days - wt %**

	Fd/Ki	Paper	Textile	Plastic	Gr/Wd	Le/Ru	Metal	Glass	Ce/St	other	Total
Kandy	69.90	6.93	1.11	5.08	11.70	0.41	0.96	1.07	2.65	0.18	100.00
Matale	66.50	6.98	1.34	3.59	15.68	0.40	0.37	1.33	3.36	0.46	100.00
Badulla	73.48	6.95	1.85	2.48	12.80	0.21	0.81	4.23	1.43	0.25	104.49

H'hold wt avg WACS values  
H'hold wt avg WACS values  
See note 1

Household survey (120 respondents)	Q3.1 garb disp		5.9 others behaviour	Weighted no of responses to different methods of waste disposal for different waste types											Wt avg	Rev'd	Rev'd %	
	Main	Other		Fd/Ki	Paper	Textile	Plastic	Gr/Wd	Le/Ru	Metal	Glass	Ce/St	other					
LA colln	54	6	77	44.4	44.4	44.4	44.4	13	44.4	44.4	44.4	44.4	44.4	44.4	412.6	36.9	45.5	43.8
Self-disp (OSD)	49	26	34	44.4	44.4	44.4	44.4	75	44.4	44.4	44.4	44.4	44.4	44.4	474.6	44.3	34.1	32.8
Compost	6	3	0	11	0	0	0	13	0	0	0	0	0	24	8.6	7.2	8.9	
Recycle	0	0	0	0	18	10	1	0	0	6	48	0	1	84	2.6	2.3	2.2	
Open dump	11	3	31	9.4	9.4	9.4	9.4	1	9.4	9.4	9.4	9.4	9.4	85.6	7.6	14.7	14.2	
Total	120	38	142	109.2	116.2	108.2	99.2	102	98.2	104.2	146.2	98.2	99.2	1080.8	100	103.9	100.0	
Weight	0.8	0.2						Q3.9										

**Notes:**

- Badulla household weighted average composition data calculated for each waste type (except paper) as Badulla VWC x 0.5 x (Kandy HHWC/Kandy VWC + Matale HHWC/Matale VWC) assuming:
  - variations in VWC between towns reflects variations in local conditions; and
  - the ratio of town HHWC/town VWC is approximately constant
 where VWC = vehicle waste composition and HHWC = household waste composition. The calculated %s are then be adjusted on a pro rata basis to give a total of 100%. For paper, average of Matale and Kandy data used, as VWC considered to be high for paper, probably due to high proportions of paper contributed by the commercial and institutional sectors.
- Q5.9 generally supports Q3.1 except for suggesting open dumping is more common. Q3.1 used in prelim analysis, applying weights to main/other answers as shown (results then adjusted in 4-6).
- For compost and recycle options, use answers from other questions as indicated, rather than 3.1.
  - For those recycling different materials, assumed 90 % of materials generated are recycled - gives revised total shown in last column
  - For those composting food/kitchen and garden waste, calculated 83 % of materials generated are composted (from Q4-9 survey results) - gives revised total in final column
- LA colln % considered too low based on observation, disp site tonnages & Q5.9. Q5.9 LA colln % = 54.2 % - LA % revised to be avg of value in 3rd to last column & this value
- Self-disposal % considered too high based on observation, disp site tonnages & Q5.9. Q5.9 OSD % = 23.9 % - OSD % revised to be avg of value in 3rd to last column & this value
- Illegal-disposal % considered too low based on observation, disp site tonnages & Q5.9. Q5.9 ID % = 21.8 % - ID % revised to be avg of value in 3rd to last column & this value

**C. Extension of survey results to entire BMC area**

Household waste stream results in final column of above table have been adopted as representative of surveyed areas. This survey was undertaken in areas where 80.9% of households receive a garbage collection service (see Q2.1 & 2.2). Discussions with NEMC Supervisors indicated that the NEMA service coverage is approx. 80 % in Badulla (range = 75 - 85%) Hence, the survey results were adjusted to account for the different overall service coverage as set out below:

Area (fraction)	Formulae			Survey area			Overall		
	Serviced A	Unserviced B	Total 1	Serviced 0.81	Unserviced 0.19	Total 1	Serv. 0.80	Unserv. 0.20	Total 100
LA collection	X1	Y2	Z1	54.2	0.0	43.8	54.2	0.0	43.4
Self-disposal	X2	Y2	Z2	26.8	58.5	32.8	26.8	58.5	33.1
Compost	X3	Y3	Z3	5.7	12.3	6.9	5.7	12.3	7.0
Recycle	X4	Y4	Z4	1.8	4.0	2.2	1.8	4.0	2.3
Open dump	X5	Y5	Z5	11.5	25.2	14.2	11.5	25.2	14.3
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

**Notes:**

1. In general:
  - a.  $X1 = Z1/A$
  - b.  $X2 \cdot A + Y2 \cdot B = Z2$ ;  $X3 \cdot A + Y3 \cdot B = Z3$ ; etc.
  - c. Assume for areas not provided with collection service, waste is disposed of by other methods in proportion to %s in serviced areas. i.e.  $X2/(X2+X3+X4+X5) = Y2/(Y2+Y3+Y4+Y5)$  which simplifying becomes  $X2/(100-X1) = Y2/100$  as  $Y2+Y3+Y4+Y5 = 100$ ; etc. for X3, X4, X5
  - d. Combining these equations gives  $Y2 \cdot (A \cdot (100-X1)/100+B) = Z2$ ; etc.
- Solving these equations gives the relative %s for different disposal methods in serviced and unserved areas within the survey area.
2. These %s are then assumed applicable to all BMA:
  - a. Overall %s calculated as  $((\% \text{ serviced area}) \times (\text{disposal method \% in that area}) + (\% \text{ unserved area}) \times (\text{disposal method \% in that area}))/100\%$
  - b. Results in last column used in waste stream.

**D. Waste Generation Rate (WGR) data**

Town/city	Pop'n	WGR (kg/cap d)	F/K waste Comp (%)
Kandy	110,049	0.545	69.90
Matale	36,331	0.451	66.50
Badulla	40,920		70.32

These are estimated WGRs based on measured waste discharge rates in Kandy and Matale.

Adopted Badulla WGR = 0.477 kg/cap. d. = Matale value x ratio of F/K waste in Badulla to Matale as town size, characteristics and vehicle waste composition of Badulla and Matale are very similar, but can expect Badulla waste to be slightly heavier per capita due to the higher (heavier) F/K waste content.

**Collection worker recycling (data from collection worker survey)**

Item	Total
No of workers collecting items for recycling	9
Total no of workers interviewed	30
Average income(Rs/mth)	99
% of those interviewed collecting recyclables	30
Total no of SWM workers	67
% interviewed/total workers	45
Estimated total no of workers collecting recyclables	20

**Notes:**

- Total SWM workers = 77 labrs + 3 drivers - (5 cemetry + 1 disposal site + 3 slaughterhouse + 1 ayurvedic + 3 conservancy) labrs = 67
- Collection workers indicate recyclables are sold to Nadar Kade (8) or Viharagoda (1)

**Collection worker - recycling quantities**

Item	No collecting	Qty	Units	Price	Units	Est total kg/mth	Est total kg/d	%
Bottles	8	82	kg/mth	0.5-1.5	Rs ea	182.8	6.0	54.1
Cardboard	2	20	kg/mth	2.0-2.5	Rs/kg	44.7	1.5	13.2
Iron	2	4	kg/mth	2.5-6.0	Rs/kg	8.9	0.3	
Metal can	4	30	kg/mth	1.5-4.0	Rs/kg	67.0	2.2	32.7
Aluminium	2	15.4	kg/mth	40-60	Rs/kg	34.4	1.1	
<b>Total quantity</b>	<b>9</b>	<b>151.24</b>	<b>kg/mth</b>			<b>337.8</b>	<b>11.1</b>	<b>100.0</b>
Est. tot. qty collected by all labourers		338	kg/mth					
		38	kg/labr.mth					

**Notes:**

- Average weight of bottles (mainly beer and arrack) = 0.66 kg ea (average weight, based on measurements of 5 arrack and 5 beer bottles)
- No of bottles collected per month = 124 bottles/mth, converted to kg/mth using above average weight
- Overall quantity recycled = 11 kg/d, which is relatively small. However, household survey indicates lot of recyclables collected at discharge + MM survey indicates very few middlemen receive recyclables from collection workers. Assume correct.
- From time and motion study, 4WT labourers said they collect about 5kg/d tins and 10 bottles/d per tractor = 2.9 kg/labr.d or 88.2 kg/labr.mth which is approx. 2.4 times the surveyed amount.
- A separate disposal site survey gave the following information:

- 2WT labrs collect
  - 2kg/d of metal/metal cans, which they sell at 3Rs/kg to a shop in Mosque Rd
  - 25-30kg/wk cardboard which they sell at 2Rs/kg to a shop in Viharagoda Rd
  - 10-15 bottles/wk which they sell at 1-1.5Rs ea to a shop in Mosque Rd

- Total daily collection = 7.1 kg/d or 2.4 kg/worker.d (2 labrs + driver)
- 4WT labrs collect (one tractor)
    - 6-7kg/d of metal/metal cans, which they sell at 4Rs/kg to a shop in Mosque Rd
    - 7-8 bottles/wk which they sell at 1-1.5Rs ea to a shop in Mosque Rd

- Total daily collection = 7.2 kg/d or 1.8 kg/worker.d (3 labrs + driver)
- 4WT labrs collect (another tractor)
    - 5kg/d of metal/metal cans, which they sell at 4Rs/kg to a shop in Mosque Rd
    - 4-5 bottles/d which they sell at 1-1.5Rs ea to a shop in Mosque Rd
    - 50kg/wk cardboard which they sell at 2.5Rs/kg to a shop in Viharagoda Rd.

Total daily collection = 15.1 kg/d or 3.8 kg/worker.d (3 labrs + driver)

d. Overall recycling for these three collection vehicles = 29.4 kg/d or 2.7 kg/worker.d = 81.4 kg/labr.mth

which is just over two times the collection survey amount

e. Corresponding income = 86.9 Rs/d or 7.9 Rs/labr.d = 240.3 Rs/labr.mth, which is about 2.4 times the collection survey amount.

6. It can be expected that vehicle labourers will collect more recyclables than other MC labourers but the difference between the collection and disposal site surveys is quite large - hence adopt average of collection and disposal site survey figures:

- Collection labr recycling rate = 59 kg/labr.mth x 20 labrs collecting recyclables = 30.3 kg/d
- Corresponding income is approx. 169.7 Rs/labr.mth Adopted amounts of different materials = avg %s from collection and disposal site surveys, shown in column above

Breakdown	kg/d	%	Adopted	Actual
			%	qty (kg/d)
Bottles	4.9	16.5	35.3	13.9
Cardboard	11.1	37.6	25.4	10.0
Metal/metal cans	13.5	45.9	39.3	15.4
	29.4	100.0	100.0	39.3

**Final disposal site - recycling**

- The 1 BMC labourer working at the final disposal site does not collect recyclable materials.
- Scavengers collect approx 2x the amount of recyclables from incoming vehicles as collected by BMC labourers (JICA disposal site survey).
  - 2WT + 2 x 4WTs + 1 extra vehicle (compactor) at avg 4WT recycling rate gives total recycling = 40.6 kg/d
  - Doubling this gives 81.2 kg/d, which is recycled at the disposal site.

1. WASTE STREAM HOUSEHOLD, COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL DATA

a. Residential	Permanent		Floating		Notes
	H'holds	People	H'holds	People	
July 2001 census		40920			1
BMC PHI data		40920		10000	2,3
Adopted	0	40920	n/a	10000	

Other data:  
Area = 10.36 km<sup>2</sup>

Notes:

- Provisional July 2001 census results
- Data from BMC PHI
- H'holds = housing units + collective living quarters
- Badulla population growth rate based on the following data:
  - Census data for Badulla MC gives an average compound growth rate of 1.07 % over the period 1981-2001 (refer table).
  - UDA Draft Development Plan (1994) uses an average popn growth rate of 2.5 % for its pop'n projection based on a number of factors. However, discussions with the UDA Uva Province Acting Director indicated that these figures have now been revised:
    - The Urban Development Task Force is using a projected growth rate of 1.3 % pa.
    - National Physical Planning Policy is using a growth rate of 1.7 % pa.
  - Census data for Badulla district shows the popn has grown from 640952 in 1981 to 774555 in 2001, giving a compound population growth rate of 0.95 % - expect Badulla urban area growth rate to be higher than this
  - Adopted population growth rate = 1.07 % = actual 1981-2001 average annual growth rate, this being intermediate between the Badulla district growth rate and the other UDA related growth rates.
  - Hence, BMC population 2002 = ~~41358~~

BMA Popn data		Cmpd gr rate (%)	
Year	Pop'n	bet census	relative to 1946
1881	4746		
1891	5023	0.57	
1901	5924	1.66	
1911	6488	0.91	
1921	8126	2.28	
1931	9849	1.94	
1946	13387	2.07	
1953	17043	3.51	3.51
1963	27115	4.75	4.24
1971	35470	3.41	3.97
1981	33068	-0.70	2.62
2001	40920	1.07	2.05

5-4

General Notes on Shading

- Yellow indicates waste generators surveyed/interviewed during this study.
- Blue relates to specific notes described under relevant items.
- Purple shows data used in waste stream calculations
- Brown indicates cells affected by changes in collection tonnages

Abbreviations

- Waste type codes: F = food/kitchen, G = garden, Gl = glass, Hz = hazardous, in = inert, M = metal, M/F = meat/fish, O = other, P = paper/cardboard, Pl = plastic, R = rubber/leather, Sw = sawdust, T = textile, WC = woodchips
- Disposal method codes: A-D = LA collection; E-F = on-site disposal, G = recycling, H = composting, I = illegal dumping, J = other
- Waste stream codes: OSD = on-site disposal, comp = composting, LA colln = BMC collection, Recy = recycling, ID = illegal dumping, DH = direct haulage
- Other: WDR = waste discharge rate; WGR = waste generation rate; SW = solid waste

Recycled material weights:

- Average arrack/beer bottle = 0.66 kg Measured
- Other bottle = 0.2 kg Measured
- Large plastic container = 0.75 kg Measured
- Small plastic cans/containers = 100-125 kg Measured
- Polysacks/gunny bag = 0.1 kg Measured

2. COMMERCIAL & INDUSTRIAL SECTOR - DETAILED INFORMATION

a. General

Cat.	Name	Address	Relevant Data		SW gen (kg/d)	Main 3 wastes	Disposal		OSD	Comp	LA colln	Recy	DH	Total	Notes
			No staff	Type			Main	other							
SW1	Krishnas	91, Pahala Veediya, Badulla	2	Retail	15	F>P>PI	A		0.0	0.0	15.0	0.8	0.0	15.8	
SW2	Techno	64A, Super Market, Badulla	3	Radio repairs	0.25	PI>P>F	C		0.0	0.0	0.3	0.0	0.0	0.3	
SW3	Sri Gold House	233, Pahala Veediya, Badulla	10	Jewellery Shop	6	P>F>In	A	G	0.0	0.0	5.4	0.6	0.0	6.0	
SW4	Lucky Tailors	81, Pahala Veediya, Badulla	4	Tailoring	1	T>PI>In	A		0.0	0.0	1.0	0.0	0.0	1.0	
SW5	Jayalath Grocery	31/32, South Lane, Badulla	1	Grocery	1	P>PI	B		0.0	0.0	1.0	0.0	0.0	1.0	
SW6	Seylan Bank	57, Bazar St., Badulla	22	Finance	3	F>P>PI	A		0.0	0.0	3.0	0.0	0.0	3.0	
SW7	Samarasinghe Stores	3, South Lane, Badulla	5	Retail Shop	10	F>P>PI	A	G	0.0	0.0	9.7	0.3	0.0	10.0	
SW8	Coop City	South Lane, Badulla	5	Supermarket	2	F>P>PI	B		0.0	0.0	2.0	0.0	0.0	2.0	
SW9	Domiyano Shop	26, Bazar St., Badulla	4	Electronic items	2	P>F>GI	A		0.0	0.0	2.0	0.0	0.0	2.0	
SW10	National Development Bank	242, Pahala Veediya, Badulla	12	Finance	2	P>F>PI	A	G	0.0	0.0	1.8	0.2	0.0	2.0	
SW11	Communication Centre	4, Station Rd., Badulla	1	Communication	1	P>In>F	C	B	0.0	0.0	1.0	0.0	0.0	1.0	
SW12	Ashoka Traders	68, Pahala Veediya, Badulla	2	Retail Shop	2	P>In>PI	C		0.0	0.0	2.0	0.0	0.0	2.0	
SW13	Dimulana Traders	15B, Super Market, Badulla	1	Retail Shop	2	P>In>PI	A	G	0.0	0.0	1.5	0.5	0.0	2.0	
SW14	Kalei Magal Hardware Stores	209, Pahala Veediya, Badulla	2	Hardware	5	P>M>F	B		0.0	0.0	5.0	0.0	0.0	5.0	
SW15	Badulla Apothecaries	229, Pahala Veediya, Badulla	3	Pharmacy	3	P>F>PI	B		0.0	0.0	3.0	0.0	0.0	3.0	
Large			77	Small	WGR =	3.68	kg/ent.d								
LW5	New Rajan Printers	30, Bank Rd., Badulla	6	Printing work	20	P>PI>M	F	C, G	9.3	0.0	4.0	6.7	0.0	20.0	
LW29	Central Motors Ltd.	14, Ward St., Badulla	12	Vehicle repair/service	30	M>P>F	C	G	0.0	0.0	25.8	4.2	0.0	30.0	
LW30	Badulla Motor Works	15, RH Gunawardana Rd., Badulla	20	Vehicle repair	50	M>F>P	C	G	0.0	0.0	37.8	12.2	0.0	50.0	
LW39	Ceylon Transport Board	Badulla	680	Bus company	60	M>G>F	J	F, G	16.9	0.0	0	3.6	39.5	60.0	
LW21	Suganthi Vila's Hotel	181, Pahala Veediya, Badulla	12	Restaurant	11	F>P>PI	B		0.0	0.0	11.0	0.0	0.0	11.0	
LW22	Sambusa Hotel	16, Mosque Rd., Badulla	5	Restaurant	15	F>P>PI	D	G	0.0	0.0	14.9	0.1	0.0	15.0	
LW23	Misriya Hotel	20, Raja Veediya, Badulla	7	Restaurant	10	PI>P>F	C	G	0.0	0.0	9.8	0.2	0.0	10.0	Avg
LW24	Ja -Ela Hotel	59, Cocowaththa Rd., Badulla	15	Restaurant	175	F>P>In	A		0.0	0.0	175.0	0.0	0.0	175.0	guests/d
LW11	Green Wood Holiday Inn	301, Bandarawela Rd., Badulla	11	Hotel/guesthouse	50	F>PI>P	D	E, F, G	14.6	0.0	34.1	1.3	0.0	50.0	40
LW12	Green Mount Hotel	89, Mahiyangana Rd., Badulla	5		14	G>F>P	C		0.0	0.0	14.0	0.0	0.0	14.0	3
LW13	Lanka Inn	30, Race Course Rd., Badulla	3		10	G>F>P	D		0.0	0.0	10.0	0.0	0.0	10.0	5
LW14	Badulla New Tourist Inn	122, Mahiyangana Rd., Badulla	16		25	G>F>P=PI	B	F	8.8	0.0	16.3	0.0	0.0	25.0	15
LW15	River Side Holiday Inn	27, Pahala Raja Veediya, Badulla	13		125	F>G>P	D	G	0.0	0.0	122.3	2.7	0.0	125.0	10
LW16	Dunhinda Falls Inn	Bandaranayake St., Badulla	10		30	F>P>G	C	G, F	5.5	0.0	12.9	11.6	0.0	30.0	6
LW17	Peace Haven Inn	18, Pilipanagama Rd., Badulla	6		35	F>G>In	C	F, G	12.2	0.0	22.7	0.1	0.0	35.0	6
LW18	Namunu Rest	138, Station Rd., Badulla	3		2	G>P>F	C		0.0	0.0	2.0	0.0	0.0	2.0	2
LW19	Araiya Hotel	1, Green Land Drive, Thailagoda, Badulla	7		50	F>G>PI	C	G	0.0	0.0	49.4	0.6	0.0	50.0	10
LW20	Badulla Tourist Inn	15/10, First Lane, Bandaranayake Rd.	6		12	F>G>GI	F		12.0	0.0	0.0	0.0	0.0	12.0	3
Total									79.4	0.0	615.6	45.6	39.5	780.0	
Notes:				Large	WGR =	40.2	kg/ent.d	Disp %	10.2	0.0	78.9	5.8	5.1	100.0	

1. Additional waste stream generation data:

- a. Chief Charlie, Bazaar - mainly polythene - waste gen = 15.0 kg/d
- b. Dance Textile, Muthiyangana Rd 12.0 kg/d
- c. Salgadu hotel 22.5 kg/d (20-25kg/d)
- d. Muslim hotel 8.0 kg/d
- e. Hargiyar hotel 8.0 kg/d
- f. Central hotel 8 kg/d

2. Waste stream breakdown data:

- a. SW1 recycles 10kg paper, 10 c'board boxes & 25 polysacks per mth = 0.75 kg/d, assuming 1 cardboard box = 1kg & 1 polysack = 0.1kg
- b. SW3 recycles an unspecified quantity of dust per mth - assume 10 % of waste generation
- c. SW7 recycles 10kg/mth cardboard = 0.33 kg/d
- d. SW10 recycles 7kg/mth of paper = 0.23 kg/d
- e. SW13 recycles 10kg/mth cardboard & 55 polysacks/mth = 0.52 kg/d
- f. LW5 recycles 100kg/mth paper & 100kg/mth metals = 6.7 kg/d; assume OSD for 70 % of other waste & LA colln for residual

- g. LW29 recycles 100 plastic cans & 50kg animal feed /mth = 4.2 kg/d
  - h. LW30 recycles 20 plastic cans & 350kg metals /mth = 12.2 kg/d
  - i. LW39 recycles 25kg/mth paper, 83kg/mth metals & 160-165 tyres/mth = 3.6 kg/d, neglecting tyres as believed not to be included in waste gen & is a special case, which if included above will distort %
  - Assume direct haulage (J) = 70 % of other waste; residual = OSD
  - j. LW22 recycles 25-30 polysack bags/mth = 0.1 kg/d
  - k. LW23 recycles 6kg/mth cardboard = 0.2 kg/d
  - l. LW11 - no data on recycling provided - assume 2.5 % of generation & LA colln for 70 % of other waste; residual = OSD
  - m. LW14 - assume LA colln = 65 %; residual = OSD
  - n. LW15 recycles 100 bott/mth & 20 plast cans = 2.7 kg/d
  - o. LW16 recycles 500 bottles/mth & 25 plastic cans = 11.6 kg/d; assume LA colln for 70 % of other waste; residual = OSD
  - p. LW17 recycles 2x20L & 10x2L plastic containers/mth = 0.1 kg/d; assume LA colln for 65 % of other waste; residual = OSD
  - q. LW19 recycles 15 bottles/mth & 10 pi cans/mth = 0.58 kg/d
3. Hotel/guesthouse waste generation has been combined with other large waste generators as waste generation per hotel/guesthouse is similar to that of other large waste generators.
- Note, hotel/guesthouse total staff+ guests = 180 staff+guests with waste gen = 353 kg/d or 1.96 kg/(guests+staff).d
4. Total commercial waste generation estimated from trade licence data and approximate proportions of small and large waste generators, as follows:
- a. Trade licence data gives a total of 1235 comm enterprises (excluding markets) with 7.5 % large waste generators and 92.5 % small waste generators
  - b. Total comm waste generation =
 

93 large waste generators x	40.2 kg/enterprise.d =	3726 kg/d
1142 small waste generators x	3.68 kg/enterprise.d =	4208 kg/d
		7933 kg/d or 7.93 T/d

5. Estimating commercial waste generation from BMC collection data:

- a. According to Supervisors, about 6 compactor loads/d are collected from the predominantly commercial Central and Darmadutha wards
- Inspection of JICA disposal site records shows 4 compactor trips were recorded on the one day when the compactor was in service (3 in morning, 1 in afternoon), the morning performance being consistent with T&M study observations.
- Assuming 3 trips/d is normal (averaged over week) actual compactor tonnage = 3 trips/d x 2.08 T/trip = 6.18 T/d
- b. According to Supervisors, about 2-3 tractor loads/d are collected from the Muthiyangana, Mailagastenna, Kannupelalla, Hingurugamuwa and Hindagoda wards, with the Muthiyangana and Mailagastenna wards being about 60% commercial.
- From BMC ward population data, total population in these two wards = 5581 x WGR of 0.477 kg/cap.d = 2662 kg/d x 43.4 % waste discharge rate = 1155 kg/d, which accounts for 40% of collected waste in area -> total comm waste coll'n = 1732 kg/d or 1.73 T/d. Total commercial waste collection = 7.91 T/d
- c. Subtracting market and pola waste collection of 2.78 T/d gives comm, non-market waste collection = 5.13 T/d
- d. This represents 78.9 % of total commercial waste generation. Hence, comm waste generation = 6.50 T/d
- e. These values agree reasonably well - adopt average value = 7.22 T/d
- f. Summary: No of comm enterprises = 1235; comm waste generation = 7.22 T/d, equivalent to 5.84 kg/ent.d

**b. Markets and Slaughterhouse**

ID	Name	No of stalls				Total	WD (kg/d)	WDR kg/stall.d	Main wastes	OSD	Comp	LA colln	Recy	ID	Notes
		Meat/Fish	Veg/Fruit	Goods	Other										
	Permanent														
CM	Central market	13	12	15	97	137	2090	15.26	M/F>Ot>	0	0	2088.7	1.3	0	
WM	Temporary Welekade market	4	15	10	13	42	689.7	16.42	F/K	0	0	689.7	0	0	
	Pola														
	Wednesday			75	1045	11	149	13.93		0	0	149	0	0	
	Sunday			600	6270	86	896	10.45		0	0	896	0	0	
	Slaughterhouse					20	211	10.55		1	10	0	140	60	
						286	4035.7	13.7		1	10	3823	141	60	
									Waste strm %s	0.0	0.2	94.7	3.5	1.6	

Notes: In this case, F/K = vegetable/fruit waste/leaves, coconut shells, etc.

1. The Welekade market is being rebuilt - hence, a temporary location has been given to market traders along Clinic Rd until the new market is completed. Six stalls at this temporary market are currently closed.
2. BMC runs one slaughterhouse within city limits. This composts 10kg/d of animal dung, recycles 140kg/d of bones,skins/fat, burns 1kg/d of garden waste and dumps ~60kg/d of animal dung into the Badulla Oya. Assumed equivalent to 20 stalls.
3. Waste generation based on:
 

a. Central market produces	1 TL/d, equiv to	2.09 T using	2.09 T/load (4WT with small trailer), of which it recycles	40.0 kg/mth paper/cardboard
b. Welekade market produces	0.33 TL/d, equiv to	0.69 T using	2.09 T/load (4WT with small trailer)	
c. Wed Pola =	0.5 TL/d, equiv to	1.05 T using	2.09 T/load (4WT with small trailer)	
d. Sunday Pola =	3 TL/d, equiv to	6.27 T using	2.09 T/load (4WT with small trailer)	
- (Welekade market stated waste generation reduced from 1 T/d to what is considered a more realistic figure)
- e. BMC CDO said there is another area of about 100 stalls near the Post Office comprising mainly vege/fruit and some retail stalls, producing around 2 Tr loads/d of waste - these are assumed to be included in commercial waste.

5-6

c. Industries

1. Timber Depots and Sawmills

	Surveyed Industries	Address	Type	No of Staff	SW Gen (kg/d)	Main 3 wastes	Waste disposal		Waste stream breakdown							
							Main	Other	OSD	Comp	LA colln	Recy	ID	DH	Total	
S1	Tata Timber Depot	Passara Rd, Badulla	Timber depot	3	25	Sw	G		0.0	0.0	0.0	25.0	0.0	0.0	25.0	
S2	Kandy Timber Dealers	33 Station Rd, Badulla	Timber depot	2	258	Sw,WC	G		0.0	0.0	0.0	258.3	0.0	0.0	258.3	
S3	Managalasiri Mills	20 Bank Rd, Badulla	Sawmill	3	833	Sw,WC	G		0.0	0.0	0.0	833.3	0.0	0.0	833.3	
LW1	Central Timber Stores	38, Bank Rd, Badulla	Timber depot	13	550	Sw,WC	I	G	0.0	0.0	0.0	200.0	350.0	0.0	550.0	
				21	1667		Total		0.0	0.0	0.0	1316.7	350.0	0.0	1666.7	
Notes:				WGR	79 kg/worker.d	21	1667	Disp method (%)		0.0	0.0	0.0	79.0	21.0	0.0	100.0

1. Waste generation and waste stream breakdown based on the following:
- a. S1 produces 0.75T/mth of sawdust, which it gives away for free (recycling) = 25 kg/d
  - b. S2 produces 6.8T/mth of sawdust and 0.95T/mth of woodchips which it gives away for free or sells = recycling = 258 kg/d
  - c. S3 produces 18.75T/mth of sawdust, 4.75T/mth of woodchips and 1.5T/mth of bark which it gives away of sells = recycling = 833 kg/d; no of workers varies as they work on contract basis - typically 3
  - d. LW1 produces 550kg/d of sawdust and woodchips of which it recycles 200 kg/d sawdust and illegally disposes of remainder.
2. Total timber depot and sawmill waste generation based on 1 sawmill (surveyed) and 6 timber depots (3 surveyed) = 7 sawmills/timber depots
- a. Average timber depot WGR = 278 kg/timber depot.d
- b. Total timber depot waste gen = 1667 kg/d + sawmill waste of 833 kg/d = 2500 kg/d or 357 kg/industry.d

2. Rice and grinding mills

	Surveyed Industries	Address	Type	No of Staff	SW Gen (kg/d)	Main 3 wastes	Waste disposal		Waste stream breakdown							
							Main	Other	OSD	Comp	LA colln	Recy	ID	DH	Total	
LW41	Luxmi Mills	7, Darmadutha Rd Badulla	Rice mill	6	150	G>In>P	J	G	0.0	0.0	0.0	30.7	0.0	119.3	150.0	
LW42	Rohana Rice mills	18, Station Rd, Badulla	Rice mill	3	291	PH, RB	G		0.0	0.0	0.0	291.2	0.0	0.0	291.2	
				9	441		Total		0.0	0.0	0.0	321.8	0.0	119.3	441.2	
Notes:				WGR	49.0 kg/worker.d	9	441	Disp method (%)		0.0	0.0	0.0	72.9	0.0	27.1	100.0

1. Waste generation based on:
- a. LW42 produces ~15 TL/mth of mainly paddy husks and some rice bran - assume 2.2 m3 trailer with density = 290 kg/m3 (same as sawdust) and 85 % full + another 600 kg/mth of rice bran
2. Waste stream breakdown based on:
- a. LW41 recycles 600kg rice bran and 320kg paddy husks /mth = 30.7 kg/d
  - b. LW42 recycles 600kg rice bran and 15 TL paddy husks /mth = all generated waste
3. Total rice/grinding mill waste generation based on: 12 rice mills and 4 grinding mills = 16 mills with average WGR = 221 kg/mill.d = 3529 kg/d
4. Waste stream breakdown %s assumed reasonable as BMC said at least 3 rice mills direct haul their waste to the final disposal site.

3. Other Industries

	Surveyed Industries	Address	Type	No of Staff	SW Gen (kg/d)	Main 3 wastes	Waste disposal		Waste stream breakdown						
							Main	Other	OSD	Comp	LA colln	Recy	ID	DH	Total
LW2	Colombo Commercial Engineering Co	Kanupalalla Rd, Badulla	Tea industry machine rep	32	45	M>G	F	G	37.9	0.0	0.0	7.1	0.0	0.0	45.0
LW3	Asia Great Unicom Garment Pvt. Ltd	6, Passara Rd, Badulla	Garment factory	172	132	T>G>F	G	F	120.1	0.0	0.0	11.9	0.0	0.0	132.0
LW4	Distilleries Company of Sri Lanka Ltd	90, Kanupalalla Rd, Badulla	Liquor production	54	60	G>F>GI	D	G	0.0	0.0	37.5	22.5	0.0	0.0	60.0
LW31	Unicom Industries	28, Pahala Raja Veediya, Badulla	Lathe machine/reboring	3	2.5	M>G>P	G	F	1.5	0.0	0.0	1.0	0.0	0.0	2.5
LW32	M.G.M. Lathe Machine Works	6, Bank Rd, Badulla	Lathe machine work	2	3	M>P>T	G		1.3	0.0	0.0	1.7	0.0	0.0	3.0
				263	243		Total		160.9	0.0	37.5	44.1	0.0	0.0	242.5
Notes:				WGR	0.922 kg/worker.d		Disp method (%)		66.4	0.0	15.5	18.2	0.0	0.0	100.0

1. Waste generation based on:
- a. LW3 = 0.5 TL/d; assume normal Works trailer = 2.2 m3, with density = 120 kg/m3 (mainly textile followed by garden waste)
2. Waste stream breakdown based on:
- a. LW2 recycles 12kg/mth paper and 200kg/mth metals = 7.1 kg/mth
  - b. LW3 recycles 3kg/mth cardboard, 3kg/mth metals & 350kg/mth textiles = 11.9 kg/mth
  - c. LW4 recycles 7kg/mth paper, 10kg/mth c'board, 667kg bott & 10 polysack bags = 22.5 kg/mth
  - d. LW31 recycles 30kg/mth metals = 1.0 kg/d, assume remainder = OSD
  - e. LW32 recycles 50kg/mth metals = 1.7 kg/d
2. Total other industry waste generation based on there being 1 CCEC factory, 1 garment factory, 1 distillery and 3 lathe workshops in Badulla from trade licence data. As lathe workshop waste generation is so small (2.5-3kg/d), total waste generation has not been increased to allow for the extra lathe workshop.



3. INSTITUTIONS - DETAILED INFORMATION

a. Schools

Schools	Location	Students	Teachers	Total	Hostel	Type	Notes
1 Badulla Central	Badulla	2275	137	2412		1AB	
2 Badulla Udayaraja MV	Puwakgodamulla	525	23	548		1C	
3 Vishaka Balika MV	Badulla	2200	108	2308		1AB	
4 Badulla Pinarawa Primary School	Pinarawa	168	23	191		2	
5 Uva MV	Badulla	1530	82	1612		1C	
6 Viharamaha Devi Balika MV	Badulla	2002	84	2086		1C	
7 Dharmadutha MV	Badulla	1750	108	1858		1AB	
8 Sujatha Primary Girls	Badulla	321	20	341		2	
9 Rahula MV	Maitagastenna	585	43	628		1C	
10 Dhammadanda MV	Hidagoda	597	36	633		1C	
11 Saraswathi MMV	Muthiyangana Rd	818	31	849		1AB	
12 Saraswathi Primary	Dewala Veediya	309	16	325		3	
13 Tamil Girls School	Badulla	1121	47	1168		1C	
14 Al-Adhan Muslim MV	Badulla	923	46	969		1C	
15 Sri Rathnapola Vidyalaya	Badulla	178	17	195			
<b>Total</b>		<b>15302</b>	<b>821</b>	<b>16123</b>			

Survey Results		Students	Staff	St + St	SW (kg/d)	Waste Types	Waste disposal		Waste Stream Data					
							Main	Other	OSD	Comp	LA colln	Recy	ID	Total
LW6	Viharamaha Devi Balika Maha Vidyalaya	2002	84	2086	30	F>P>G	C	F	10.5	0.0	19.5	0.0	0.0	30.0
LW7	Vishaka Balika Maha Vidyalaya	2200	108	2308	40	F>G>P	C		0.0	0.0	40.0	0.0	0.0	40.0
LW8	Dharmadutha Maha Vidyalaya	1750	108	1858	25	G>P>F	A	F	8.8	0.0	16.3	0.0	0.0	25.0
LW9	Uva Maha Viduhaia	1530	82	1612	10	G>In>F	A		0.0	0.0	10.0	0.0	0.0	10.0
LW10	Badulla Central Collage	2275	137	2412	25	F>G>P	A	E,F	8.8	0.0	16.3	0.0	0.0	25.0
	<b>Total</b>	<b>9757</b>	<b>519</b>	<b>10276</b>	<b>130</b>				<b>28.0</b>	<b>0.0</b>	<b>102.0</b>	<b>0.0</b>	<b>0.0</b>	<b>130.0</b>

Notes:

WGR = 0.013 kg/(students+staff).d

Waste stream % = 21.5, 0.0, 73.5, 0.0, 0.0, 100.0

- LW6 stated waste generation of 3kg/d considered too low - increased to 30 kg/d
- For LW6,8,10, assume LA colln = 65 %; resid = OSD
- Surveyed schools staff+students represent 63.7 % of total school population

b. Other Educational Institutes

No	Name	Location	Students	Teachers	Total	Boarders	SW (kg/d)	Waste Types	Waste disposal		Waste Stream Data				Total	Notes
								Main	Other	OSD	Comp	LA colln	Recy	ID		
LW27	Nurses Training School	Badulla	540	48	588	148	120	F>G>P	C	E,F,G	36.0	0.0	83.9	0.1	0.0	120.0
LW28	Technical College	Badulla	1000	56	1056		25	In>F>P	F		25.0	0.0	0.0	0.0	0.0	25.0
	London Technical College		180	4	184											
	International School	Copywatta Rd	100	13	113											
	Vision (private tuition)		200	9	209											
	Higher Studies (private tuition)		1805	8	1813											
LW25	Sri Siddartha (private school+tuition)	Badulla	700	20	720		15	G>P>F	F	I	9.8	0.0	0.0	0.0	5.3	15.0
LW29	Vidyothansa (tuition centre)	Viharagoda, Badulla	250	9	259	20	10	G>F>P	F		10.0	0.0	0.0	0.0	0.0	10.0
	<b>Total</b>		<b>4775</b>	<b>167</b>	<b>4942</b>		<b>170</b>			<b>80.7</b>	<b>0.0</b>	<b>83.9</b>	<b>0.1</b>	<b>5.3</b>	<b>170.0</b>	

Notes:

Survey total = 2623

WGR = 0.065 kg/(S+S).d

Waste stream % = 47.5, 0.0, 49.4, 0.1, 3.1, 100.0

- Waste stream breakdown based on JICA survey data for four institutions:
  - LW27 recycles 3kg/mth paper = 0.1 kg/d; assume LA colln for 70 % of other waste; residual = OSD
  - LW25: assume OSD = 65 %; residual = illegal dumping
- Overall waste generation estimated allowing another 40 % of staff and students for the 22 MC and 15 private pre-schools (montisorris) Hence, estimated total students and staff = 6919 students & staff, giving total waste generation = 448 kg/d
- Vidyothansa is a buddhist seminary with an attached tuition centre - above data relates to tuition centre activities only.

c. Hospitals

Name	Location	Type	No of beds	Bed Occup. (%)	Avg no per day		Staff	Patients + Staff	SW (kg/d) survey	WDR (kg/(P+S))	Main waste types	Notes
					Out-patients	Clinical patients						
BH1	Badulla General (Teaching)	Govt	1004	115%	916	757	1061	3889	1365	0.351	F>P>PI	
BH2	Central hospital	priv.	29	40%	5	25	34	76	12	0.159	GI>P>PI	
BH3	Lanka Nursing Home	priv.	20	100%	20	10	40	90	30	0.333	F>P>M	
<b>Total</b>			<b>1053</b>	<b>113%</b>	<b>941</b>	<b>792</b>	<b>1135</b>	<b>4054</b>	<b>1407</b>	<b>0.347</b>		

Notes:

1. WDR = 0.347 kg/(patients+staff)/d - c.f. Kandy = 0.374 & Galle = 0.28 - OK

Waste stream data summary

Hospital	Waste generation									OSD	LA colln	Recy	ID	DH	Tot	
	Norm	Clin	BP	Plac	Shp	HI	Other									
BH1	1365	22.5	0.2		30.0	2.1	Small	Small		24.6	1365.0	10.1	0.0	0.0	30.2	1429.8
BH2	12	0.1	Small		0.2	0.0	0.0	Small		0.2	12.1	0.7	0.0	0.0	0.0	12.9
BH3	30	Small			0.3	0.1	0.0	Small		0.4	30.0	0.0	0.0	0.0	0.0	30.4
<b>Total</b>	<b>1407</b>	<b>22.6</b>	<b>0.2</b>		<b>30.5</b>	<b>2.1</b>	<b>0.0</b>			<b>25.1</b>	<b>1407.1</b>	<b>10.8</b>	<b>0.0</b>	<b>0.0</b>	<b>30.2</b>	<b>1473.1</b>
<b>Notes:</b>										<b>Waste stream %s</b>	<b>1.7</b>	<b>95.5</b>	<b>0.7</b>	<b>0.0</b>	<b>2.0</b>	<b>100.0</b>

1. Other = G,C,R; paint tins, etc.

2. Waste stream breakdown based on the following:

a. BH1 - norm = LA colln; clin = OSD; B parts/placentas = to cemetery every 10d (classified as DH); Sharps/Hi = incinerate on-site

Some liquid HI wastes (e.g. lab wastes) are disinfected and then discharged to the hospital drainage system

b. BH1 recycled 5,630 plastic items, 1,500 bottles, 230 metal tins/cans in the last 6 mths and an estimated 10kg/d of coconuts are used as incinerator fuel = 10.1 kg/d

c. BH2 - norm + clin = LA colln (some recycling); body parts = some sent to Colombo for experiments; some discharged to drainage system;

other body parts+placentas+sharps = burn/bury on-site

d. BH2 recycles 5kg/mth cardboard and 15kg/mth plastic = 0.67 kg/d

e. BH3 - norm = LA colln; clin+placentas+sharps = OSD

3. Overall WGR = 0.347 kg/(staff+patients).d

d. Religious Places

Name	No	No of workers	Notes:
Buddhist	13	48	1. Waste stream data based on:
Hindu	3	9	a. buddhist institutes - average of 4 monks @ 11 temples and two large institutes with 40 workers
Mosques	7	21	(one = Vidyothansa buddhist seminary; 2nd = Muthiyangana temple (LW33))
Churches	4	12	b. Hindu kovil - average of 3 clergy at each place
<b>Total</b>	<b>27</b>	<b>90</b>	c. Mosque - average of 3 clergy at each place
			d. Churches - average of 3 clergy at each place
			2. Assume avg WGR = 1.01 kg/clergy.d and use waste strm %s from Kandy/Matale data: LA colln = 20 %, OSD: 80 %
			together with survey data for Muthiyangana Temple (by far the largest waste generator)

Name	Address	No of residents	Avg no of guests	SW Gen (kg/d)	WGR kg/clergy.d	Main wastes	Disp method		OSD	Comp	LA colln	Recy	ID	Total	Notes				
							Main	Other											
LW33	Muthiyangana Raja Maha Viharaya	20	500	220	11.00	G>In>F	D	F,G,H	59.2	50.0	109.9	1.0	0.0	220.0					
	Other places	70		70.7				LA colln	56.6	0.0	14.1	0.0	0.0	70.7					
<b>Total</b>		<b>90</b>		<b>290.7</b>				<b>Total</b>	<b>115.7</b>	<b>50.0</b>	<b>124.0</b>	<b>1.0</b>	<b>0.0</b>	<b>290.7</b>					
<b>Notes:</b>									<b>Overall WGR =</b>	<b>3.23</b>	<b>kg/worker.d</b>	<b>(high due to Muthiyangana Temple)</b>	<b>Waste stream %s</b>	<b>38.8</b>	<b>17.2</b>	<b>42.7</b>	<b>0.3</b>	<b>0.0</b>	<b>100.0</b>

1. LW33 waste generation estimated based on 0.5TL/d, assuming a small trailer of 2.2 m<sup>3</sup> & waste density = 200 kg/m<sup>3</sup> (mainly garden waste + inerts and F/K waste)

2. LW33 waste stream breakdown based on:

a. LW33 recycles 30kg/mth paper = 1 kg/d

b. LW33 compost 1500kg/mth of flowers for own/neighbor's use = 50 kg/d

c. Assume LA collects 65 % of other waste; residual = OSD

65 % of other waste; residual = OSD

e. Government Offices

	Name	Address	Avg workers	Notes
LW36	Badulla Municipal Council	Badulla	348	
LW37	Provincial Council Complex	Badulla	700	
LW38	Uva Prov. Health Director's Office	69, Bandaranayake St, Badulla	44	
LW40	Divisional Secretariat Office	Badulla	150	
	Chief Secretariat Office Education, Health Service Ministry House Construction, Village Dev & Transport Ministry Agriculture, Land and Irrigation Ministry Handloom and Social Service Ministry Probation, Childcare, Womens Affairs Ministry Planning Section, Uva Provincial Council Provincial Council Secretary Office Internal Audit Directors Office Uva Governors Office Uva Province Govt Service Commission Cooperative Workers Commission Cooperative Development Dept Regional Engineers Office			NA 80 These offices are all part of 22 the Provincial Council Complex 45 which was surveyed = 453 75 workers which is less than 700 PCC 38 workers stated. However, there are 33 a lot of field officers associated 24 with the PCC - hence 700 workers 23 is assumed to cover these workers 31 and associated field workers 22 -> these workers are not counted 7 again 35 20
	Uva Province Agriculture Director		18	
	Uva Province Land Commissioners Office		12	
	Uva Province Revenue Dept		16	
	Provincial Health Service Assistant Directors Office		153	
	District Secretariat		46	
	District Survey Office		25	
	Land Use Planning Division		6	
	Statistics Division		7	
	Land and District Registrar Office		21	
	Secretary District Strategy Making		6	
	Badulla District Integrated Rural Development Project		43	
	Veterinary Office		5	
	High Court		37	
	District Court		25	
	Magistrate Court		32	
	Labour Court		11	
	Chest Clinic		28	
	Audit Sub-Office		28	
	MOH		40	
	Regional Malaria Office		19	
	District Labour Office		41	
	Institute of High Technology		30	
	Regional Inland Revenue Office		30	
	Assessment Dept		27	
	Export Agriculture assistant director		17	
	Agrarian Service Assistant Commissioner Office		35	
	Superintendent of Police		28	
	District Forest Office		13	
	Regional Industrial Service Centre		19	
	Industrial Development Board, Uva Province		10	
	UDA		20	
	Water Supply and Drainage Board		88	
	SL Bureau of Foreign Employment		9	2 perm, 7 casual
	Excise Dept	Kanupawella Rd	21	
	Kachcheri		234	

Name	Address	Avg workers	Notes	OSD	Comp	LA colln	Recy	ID	Total	Notes	
Total, excluding Prison and Police			2442								
<b>Survey Data</b>											
LW36	Badulla Municipal Council	Badulla	292 G>F>P	50 D			50	0	0	50	
LW37	Provincial Council Complex	Badulla	700 F>G>P	110 D	F		38.5	0	71.5	110	
LW38	Uva Prov. Health Director's Office	69, Bandaranayake St, Badulla	44 P>G>F	40 A	F		14	0	26	40	
LW40	Divisional Secretariat Office	Badulla	150 F>P>G	5 F			5	0	0	5	
Total		1186		205			57.5	0.0	147.5	205.0	
WGR =		0.173 kg/worker.d					28.0	0.0	72.0	100.0	
All govt offices excluding Police and Prison			2442	422.1			118.4	0.0	303.7	422.1	Calculated using WGR & %s
LW34	Prison	Badulla	150 F>G>P	70.0 D	F, G		10.5	0.0	19.5	70.0	Prison has 350 inmates
LW35	Sri Lanka Police Station	Badulla	125 F>P>P	150.0 C			0.0	0.0	150.0	150.0	Police has 60 residents
Total		2717		642.1			128.9	0.0	473.2	642.1	
Waste stream %s							20.1	0.0	73.7	6.2	100.0

Notes: 1. Worker numbers obtained from individual places, either by telephone or survey

2. Waste stream breakdown based on:

a. For LW37, 38, assume LA colln =

65 %; residual = OSD

b. LW34 recycles 1,200kg/mth coconut waste =

40 kg/d; assume LA colln for

65 % of residual; other = OSD

c. Assumed LW36-38&40 results are representative of all govt offices excluding police and prison - hence, calculated WGR and waste stream %s applied to total govt workers (less police+prison workers) to get total govt office waste generation excluding prison and police workers. Prison and police waste generation then added to get overall govt office waste generation. This equates to an overall WGR of 0.236 kg/worker.d but note that this does not account for the 350 inmates at the prison. If these are included as "workers", WGR = 0.209 kg/worker.d

#### 4. OTHER WASTE

##### a. Parks

	Workers	Main wastes	SW(kg/d)	Main disp	Other disp	OSD	Comp	LA colln	Recy	ID	DH	Total	Notes
1 Childrens Park	8	G>P	76.5	LA colln		0.0	0.0	76.5	0.0	0.0	0.0	76.5	Cleaned by MC
2 Botanical Gardens	11		340.2	compost	LA colln	0.0	323.2	17.0	0.0	0.0	0.0	340.2	
3 Dewala Pittaniya (park)	1		25.5	compost		0.0	25.5	0.0	0.0	0.0	0.0	25.5	
4 Vincent Dias playground			37.8	compost		0.0	37.8	0.0	0.0	0.0	0.0	37.8	
5 Racecourse			75.6			0.0	60.5	15.1	0.0	0.0	0.0	75.6	
6 Cemetery/other small playgrounds	>6		37.8			0.0	18.9	18.9	0.0	0.0	0.0	37.8	
Total		20	593.4			0.0	465.9	127.5	0.0	0.0	0.0	593.4	
WGR =		29.67 kg/worker/d				0.0	78.5	21.5	0.0	0.0	0.0	100.0	
Waste stream %s													

Notes:

1. Other small playgrounds includes Badulupitiya ground, Deiyannewela, Mallagastenna, Kakupelella, Hingulupitiya

2. Waste stream data obtained from BMC:

a. Childrens Park (1.5 acres): 8 MC labrs (6 works, 2 health), 1 wheelbarrow, normally 4-5 polysacks/d (mainly ga waste, some inorganic (e.g. lunch packet waste)); Apr-Jun - 10 polysacks/d; put into bins; collected by MC tractor -> disposal site.

One polysack is approximate to 200.0 L @ 100 kg/m3 for garden waste = 17 kg/sack, assuming polysacks are 85 % full; normal waste gen calc'd from this

b. Botanical Garden (3.5 acres): 11 MC labrs (8 works, 3 health); 1 HC, 1 WB; normally 8-10HC/d, increasing to 12 HC/d during leaf falling season (Apr-Jun); almost entirely garden waste - made into piles, sprayed with urea -> compost; inorganics (v. small) separated out and burnt. Weight of one HC = 37.8 kg/HC for HCs of 0.42 m3/HC x 100.0 kg/m3 x 90.0 % full; normal waste gen calculated from this & assumed 95 % composted; residual = LA colln

c. Dewala Park (30 perches): 1 MC works labr; 1-2 polysacks/d, mainly garden waste; composted in pit.

d. Vincent Dias playground - normal waste generation = 1 HC/d - assumed mainly ga waste & composted in pit.

e. Cemetery: 6 MC labrs (4 health, 2 works) - sweeping and weeding only; negligible garbage.

f. Racecourse - assume 2 HC/d as in Nuwara Eliya 75.6 kg/d; assume 80 % composted; residual collected by LA

g. For other places, assume a nominal waste generation figure of 1 HC/d, of which 50 % is composted, while residual collected by BMC.

##### b. Road and drain cleaning

1. BMC has a total of 55.2 km of roads administered by them (there is another 14.1 km of A and B class roads managed by RDA).

2. BMC constructs and maintains 19,000ft of cement and earth drains = 5.79 km of drains

3. Average road sweeping waste estimate = 49.1 kg/km.d from three other JICA studies in Poland, Honduras and Dar-es-salaam

4. Assuming that 5 % of all roads are swept daily, total waste gen'n = 135 kg/d or 1.1 HC/d based on 120 kg/HC

5. Assuming drain cleanings are of similar magnitude to road sweepings = 135 kg/d

6. Total road/drain cleaning waste = 271 kg/d or 2.3 HC/d; average length of road cleaned per HC = 0.49 km based on 5 HCs

This is considered reasonable.

7. It is assumed that 50 % of this waste is left at the side of the roads/drains/canals and 50 % collected by BMC.

5. WASTE STREAM ESTIMATION

Waste Source	Waste Generation Rate (WGR)		No	Gen'n (T/d)	Sub-total		OSD	Comp	LA colin	Recycle	ID	DH	Total (check)	Notes
	WGR	Units			(T/d)	(%)								
<b>Households</b>	0.477	kg/cap.d	41358	19.73	19.73	47.9	6.53	1.38	8.56	0.45	2.82	0.00	19.73	1
<b>Commercial</b>	5.84	kg/business.d	1235	7.22	7.22	17.5	0.73	0.00	5.70	0.42	0.00	0.37	7.22	2
<b>Markets</b>	13.66	kg/stall.d	295	4.04	4.04	9.8	0.00	0.01	3.82	0.14	0.06	0.00	4.04	3
<b>Institutions</b>														
a. Schools	0.013	kg/(students+staff).d	16123	0.20			0.04	0.00	0.16	0.00	0.00	0.00	0.20	4
b. Other Educ Inst.	0.065	kg/(students+staff).d	6919	0.45			0.21	0.00	0.22	0.00	0.01	0.00	0.45	5
c. Hospitals	0.363	kg(patients+staff).d	4054	1.47			0.03	0.00	1.41	0.01	0.00	0.03	1.47	6
d. Govt offices	0.236	kg/worker.d	2717	0.64			0.13	0.00	0.47	0.04	0.00	0.00	0.64	7
e. Religious places	3.23	kg/clergy.d	90	0.29	3.06	7.4	0.12	0.05	0.12	0.00	0.00	0.00	0.29	8
<b>Industries</b>														
a. Sawmills (1) & Timber Depots (6)	357	kg/d	7	2.50			0.00	0.00	0.00	1.98	0.53	0.00	2.50	9
b. Rice and grinding mills	221	kg/mill.d	16	3.53			0.00	0.00	0.00	2.57	0.00	0.95	3.53	9
c. Other	0.92	kg/worker.d	263	0.24	6.27	15.2	0.16	0.00	0.04	0.04	0.00	0.00	0.24	9
<b>Other</b>														
a. Parks	593	kg/d		0.59			0.00	0.47	0.13	0.00	0.00	0.00	0.59	10
c. Rd and drain cleaning	0.27	T/d		0.27	0.86	2.1	0.14	0.00	0.14	0.00	0.00	0.00	0.27	11
<b>Total</b>	1.00	kg/cap.d	41358	41.17	41.17	100.0	8.09	1.90	20.76	5.66	3.41	1.35	41.17	
Recycling from discharge									0.00	0.00				12a
Recycling from collection									-0.04	0.04				12b
Adjusted totals					Adjust =	1.11	8.09	1.90	20.72	5.69	3.41	1.35	41.17	
Adjustment to final disposal amount									-1.11		1.11			13
<b>Disposal to landfill from within and outside BMA (JICA survey data)</b>									19.61			1.35		14
Recycling from final disposal									-0.08	0.08				12c
Recycling from illegal dumps									0.02	-0.02				12d
<b>Revised total</b>				41.17	41.17		8.09	1.90	19.53	5.79	4.51	1.35	41.17	

Notes:

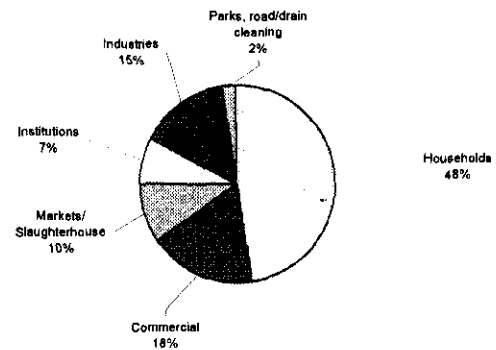
- Household WGR was determined from Kandy, Matale & Badulla WACS data while waste stream %s were calculated using household survey data and taking into account service coverage, which gave the following %s:
- Commercial waste generation calculated from interview survey results and other data collected.
- Market waste generation calculated from interview survey results and other data collected - see details above.
- School's waste stream data calculated from interview survey results
- Other educational institutes waste stream data calculated from interview survey results - see calculations under institute data
- Hospital waste stream data calculated from interview survey results.
- Govt offices waste stream data based on no of workers, estimated WGR (obtained from survey data) and waste stream breakdown (survey data)
- All religious places treated together - however, Muthiyangana temple is responsible for ~76% of all religious places waste generation due to high no of daily visitors
- Industry waste generation based on surveys of sawmills/timber depots, rice/grinding mills and other industries - refer details above
- Parks covers Childrens playground, Botannical gardens, Racecourse and a no of other parks - refer details above.
- Road and drain cleaning waste based on total length of roads and drains cleaned by BMC & data from other studies & BMC comments.
- Recycling at discharge: 0.00 T/d, assumed negligible due to high at source recycling (collectors/direct to shops) + very few scavengers seen collecting recyclables after discharge
- Recycling during collection: 0.039 T/d, from collection worker's survey data
- Recycling at landfill: 0.061 T/d, from disposal site survey, CPHI comments and estimated recycling rates.
- Recycling from illegal dumps 0.018 T/d, pro rata from illegal dumping amt/total waste disposal to landfill
- Illegal dumping amount adjusted to account for difference between estimated collection+direct haul amount and measured landfill disposal amounts
- JICA disposal site survey gave a total of 19.61 T/d, excluding direct haulage

Method	OSD	Comp	Disch	Recy	ID	DH	Total
%	33.1	7.0	43.4	2.3	14.3	0.0	100.0

% details on separate sheet

Data for Waste Generation by source graph

Waste Source	Generation (T/d)
Households	19.7
Commercial	7.2
Markets/ Slaughterhouse	4.0
Institutions	3.1
Industries	6.3
Parks, road/drain cleaning	0.9
Total	41.2



Trade licence data -supporting data

Category	No	Notes
1 Jewellery/gems	56	
2 Retail	228	
3 Hotels/tea shops	30	
4 Veges/fruit	28	
5 Textiles/tailors	111	
6 Garment factory	1	Industry
7 Beauty parlours	5	
8 Bicycle sales/repairs/welding works/spare parts	29	
9 Cement/bricks/clay pans/items	13	
10 Banks/finance/insurance	31	
11 Stalls	40	
12 Grocery	60	
13 Confectionery	46	
14 Laundry	5	
15 Funeral parlours	3	
16 Weights/measures	3	
17 Filling station	2	
18 Dentist	5	
19 Restaurant/guesthouse	73	Large
20 Goods	48	
21 Shoes	31	
22 Furniture	19	
23 Vehicle/motorcycle/3 wheeler spare parts	70	
24 Tyre sales/stores, battery charging, name boards, rubber seals	20	
25 Western/eastern pharmacy & private hospital	40	
26 Hardware	27	
27 Carpentry shops, sawmills, grinding mills, lathe machines	31	Industry
28 Salon	30	
29 Radio/TV repairs/video centre	48	
30 Photocopy, local, IDD communications	39	
31 Electrical items sale/repair	18	
32 Local/foreign liquor shops	16	
33 Printers	7	
34 Stationery	19	
35 Opticals	9	
36 Watch repairs	7	
37 Betting centres	5	
38 Fitness & foreign employment centres	5	
39 Legal office/union office	20	
40 Middlemen shops	8	Recycling
41 Bakeries/ Coconut oil/coconuts	21	Large
42 Picture framing	17	
43 Cool drinks	10	
44 Educational institutes	17	Schools/other educ inst.
45 Cane furniture/bags, tea leaves	20	
46 Fertiliser (chemical)	11	
47 Fish/meat/dried fish	28	
47 Other	53	To get total = 1461, as per BMC records
Total	1461	

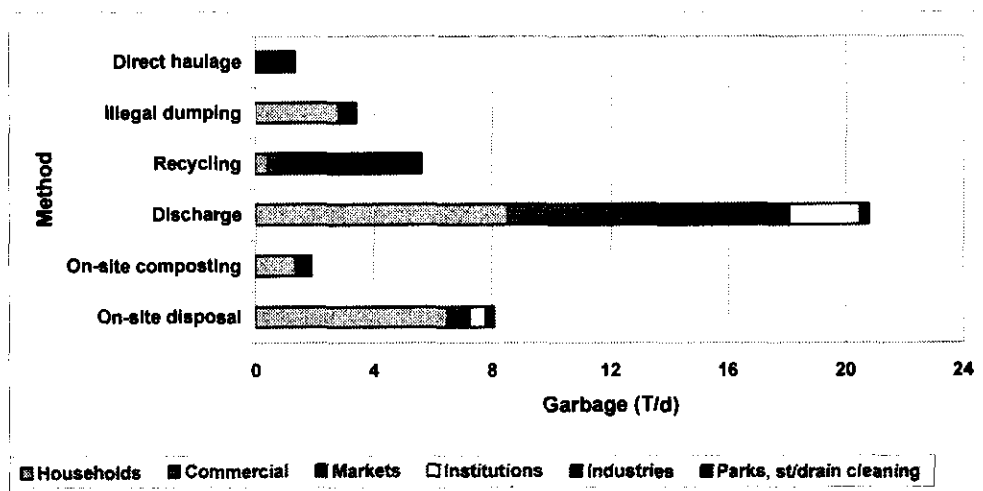
Notes:

- Commercial enterprises calculated as total trade licences (on an enterprise basis) = 1461  
less enterprises covered by other categories:
  - a. Garment factory 1
  - b. Carpentry shops, sawmills, grinding mills, lathe machines 27 (only counting those enterprises specified as industries above)
  - c. Educational institutes 17
  - d. Private hospitals 2

47  
1414  
179  
1235
- less Central and Walekade market stalls (also counted in trade licences)
2. No of large waste generators estimated from above list to be 94 or 6.6 %  
BMC Revenue Inspector estimates large waste generators = 5-10% of all enterprises - calculated value is in approx mid-point of this range - adopt 7.5 % = mid-point  
Hence, no or large waste generators is 93 or 7.5 %  
Hence, no of small waste generators is 1142 or 92.5 %

Data for waste stream breakdown graph

	On-site disposal	On-site composting	Discharge	Recycling	Illegal dumping	Direct haulage
Households	6.53	1.38	8.56	0.45	2.82	0.00
Commercial	0.73	0.00	5.70	0.42	0.00	0.37
Markets	0.00	0.01	3.82	0.14	0.06	0.00
Institutions	0.53	0.05	2.39	0.05	0.01	0.03
Industries	0.16	0.00	0.04	4.59	0.53	0.95
Parks, st/drain cleaning	0.14	0.47	0.26	0.00	0.00	0.00
<b>Total</b>	<b>8.09</b>	<b>1.90</b>	<b>20.76</b>	<b>5.66</b>	<b>3.41</b>	<b>1.35</b>



# Chapter 6

## Badulla Waste Collection Analysis

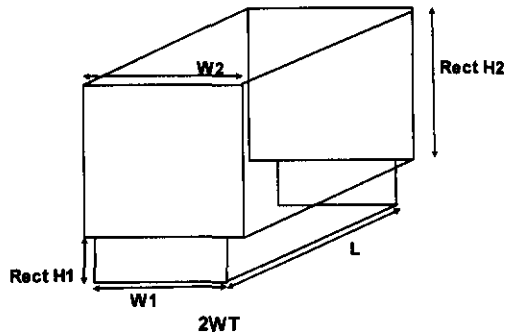




Type	Veh Reg	Rect H1	Rect H2	L	W1	W2	Rect V1	Rect V2	Tot Vol	Avg FF	Act wt(T)	Full wt(T)
2WT	74-1732	0.4	0.9	1.69	1.07	1.46	0.72	2.22	2.94	0.73	0.84	1.15
4WT	37-6053	1.22	-	3.45	2.09	0	8.80	0.00	8.80	1.02	3.50	3.43
	49-0682	0.89	-	2.99	1.71	0	4.55	0.00	4.55	1.09	1.94	1.77
	Avg								6.67	1.06	2.72	2.60
Compactor	68-7907	1.1	-	1.97	1.48	-	-	-	3.70	0.92	2.06	2.25

**Notes:**

1. Compactor top length = 1.84m, bottom length = 2.10m; average quoted above.  
 These dimensions give a compactor vol of 3.2 m<sup>3</sup>, which is less than stated capacity of 4m<sup>3</sup> but there is some uncertainty over the accuracy of the stated measurements. In Kandy and Matale, 4m<sup>3</sup> compactors were measured (accurately) to have actual capacities of 3.7-3.8m<sup>3</sup>. Hence, vol adopted here = 3.7 m<sup>3</sup>, as per Kandy/Matale data
2. 2WT/4WT density = 390 kg/m<sup>3</sup>; compactor density = 608 kg/m<sup>3</sup>



No of Trips/d

Date	Vehicle				Total	Avg trips/d	
	2 WT 74-1732	4 WT 37-6053	4 WT 49-0682	Compactor 68-7907			
24-Sep	Tue	2	4	4	3	13	3.25
25-Sep	Wed	2	4	4	0	10	2.50
26-Sep	Thu	2	3	5	0	10	2.50
27-Sep	Fri	0	3	4	0	7	1.75
28-Sep	Sat	2	0	4	2	8	2.00
29-Sep	Sun	0	0	3	0	3	0.75
30-Sep	Mon	2	2	4	4	12	3.00
Avg		1.43	2.29	4.00	1.29	9.00	2.25
Tot		10	16	28	9	63	15.75

No of Equiv Loads/d

Date	Vehicle				Total	Avg eq loads/ Veh.d	
	2 WT 74-1732	4 WT 37-6053	4 WT 49-0682	Compactor 68-7907			
24-Sep	Tue	1.72	4.84	4.94	2.25	13.5	3.39
25-Sep	Wed	1.30	3.45	6.22	0.00	10.0	2.49
26-Sep	Thu	1.25	2.69	2.83	0.00	6.8	1.69
27-Sep	Fri	0.00	3.19	4.89	0.00	8.1	2.02
28-Sep	Sat	1.47	0.00	4.12	2.00	7.6	1.90
29-Sep	Sun	0.00	0.00	3.92	0.00	3.9	0.98
30-Sep	Mon	1.59	2.33	4.70	4.00	12.6	3.15
Tot		7.32	16.32	30.62	8.25	62.5	15.63
Avg		1.05	2.33	4.37	1.18	8.93	2.23
Avg FF		0.73	1.02	1.09	0.92	0.99	0.99

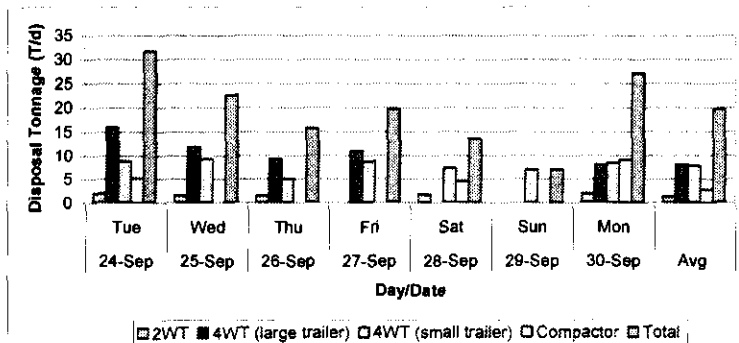
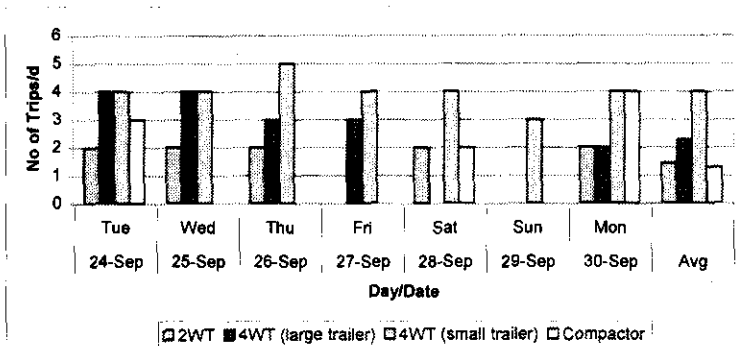
Daily Tonnage

Date	Vehicle				Total	Avg T/veh.d	
	2 WT 74-1732	4 WT 37-6053	4 WT 49-0682	Compactor 68-7907			
24-Sep	Tue	1.97	15.93	8.76	5.06	31.73	7.93
25-Sep	Wed	1.49	11.85	9.27	0.00	22.61	5.65
26-Sep	Thu	1.43	9.25	5.01	0.00	15.69	3.92
27-Sep	Fri	0.00	10.95	8.67	0.00	19.62	4.91
28-Sep	Sat	1.69	0.00	7.31	4.50	13.50	3.38
29-Sep	Sun	0.00	0.00	6.96	0.00	6.96	1.74
30-Sep	Mon	1.82	8.00	8.34	9.00	27.16	6.79
Avg		1.20	8.00	7.76	2.65	19.61	4.90
Tot		8.40	55.98	54.34	18.56	137.27	34.32

Notes:

1. Average 2WT/4WT waste density = 390 kg/m<sup>3</sup>
2. Average compactor waste density = 608 kg/m<sup>3</sup>

Graphical Data



**A. General Notes**

**Badulla MC**

**1. SWM Staff Salary + allowance costs**

Item	Salary	Allowance	Total	Adopted
Driver	3985	2200	6185	6,185
Labourer	3400	2200	5600	5,600

**Notes:**

- BMC data - average driver salary = 3,985Rs/mth + 2,200Rs/mth allowance = 6,185Rs/mth + 110Rs/yr annual increment
- BMC data - average labourer salary = ,3400Rs/mth + 2,200Rs/mth allowance = 5,600Rs/mth + 80Rs/yr annual increment
- Collection worker survey gave average salary of 5,534 Rs/mth, including allowances, or 3,134 Rs/mth basic salary
- Adopt labourer salary = 3400 Rs/mth and driver salary = 3985 Rs/mth + 2200 allowance

**2. Equipment Costs**

Item	Cost (Rs)	Lifetime	Notes
Ekel broom	45	1 mth	Cost from Chilaw data
Cane basket	40	2 mths	
Rakes	75	6 mths	
Fork	280	6 mths	
Mamoti	300	1yr	Only issued to drain cleaners
Raincoats	575	1yr	550-600Rs
Gumboots	1000	3yr	Not generally issued (possibly for disposal site worker)
Gloves	60	3 mths	Not issued

No/yr	
600	brooms
300	baskets
10	rakes
12	forks
100	brushes
1000	soap
35	boots
60	gloves

**Notes:**

- BMC data indicates no of different items of equipment purchased/yr (see final column) but note that gloves are not generally issued. These qty's were used to revise some of the equipment lifetimes, based on 600 ekel brooms/yr lasting 1mth ea. = 50 items issued at a time.

**B. SWM Vehicles - Current Costs**

Handcart - 3 labourers	Rate	Unit	No	Amt (Rs)	Notes
Labourers	5600	Rs/mth	36	201600	Labrs = 3
Protective gear/equipment	2010	Rs/yr	1	2010	
Oil	0	Rs/mth	12	0	
Maintenance	2500	Rs/yr	1	2500	Incl. wheel repair/replacement
Insurance	0	Rs/yr	1	0	
Rev Licence	0	Rs/yr	1	0	
Depreciation	3417	Rs/yr	1	3417	
<b>Total</b>				<b>209527</b>	
			Case A	Case B	
Avg no of trips per day		trips/d	3.0	5.0	
Avg amt collected per mth		T/mth	9.4	15.6	
Average amount collected per yr		T/yr	112	187	
Unit cost		Rs/T	<b>1865</b> Rs/T	<b>1119</b> Rs/T	

**Notes:**

- Staff protective equipment based on BMC equipment data and current prices:
 

a. Ekel broom	3 broom/HC x	12 sets/yr @	45 Rs ea =	1620 Rs/yr
b. Basket	1 Basket/HC x	6 set/yr @	40 Rs ea =	240 Rs/yr
c. Rake	1 rake/HC x	2 sets/yr @	75 Rs ea =	150 Rs/yr
Total labourer protective equipment costs =				<u>2010 Rs/yr</u>
- Consider two cases for average no of HC trips/d, based on Supervisors comments @ 0.12 T/load
 

Case A - No of trips/d =	3.0	Average tonnage per HC per d =	0.36 T/HC.d or	9.36 T/HC.mth, based on	26 working days/mth
Case B - No of trips/d =	5.0	Average tonnage per HC per d =	0.60 T/HC.d or	15.60 T/HC.mth, based on	26 working days/mth
- Capital cost = 10,250 Rs with estimated lifetime of 3 yrs (capital cost of HCs in use now, from BMC Revenue section)  
Depreciation = 3416.7 Rs/yr (straight line method)
- Maintenance value assumed in absence of any data from BMC (based on data from other towns/cities).

Two Wheel Tractor	No	Rate	Unit	Total	Notes
Driver	12	6,185	Rs/mth	74220	
Labourers	24	5,600	Rs/mth	134400	No of labourers = 2
Protective gear/equipment	LS	930	Rs/yr	930	
Diesel + Oil	1	17661	Rs/yr	17661	
Tractor Maintenance	1	74359	Rs/yr	74359	Assumed includes tyres/tubes (cost is high)
Insurance	LS	154	Rs/yr	154	
Licence	LS	150	Rs/yr	150	
Depreciation	LS	6044	Rs/yr	6044	
<b>Total</b>				<b>307919</b>	
Avg no of trips/d (24-30 Sep 02)		trips/d		1.43	
Avg amt collected 24-30 Sep 02		T/d		1.2	T/d
Average amount collected per yr		T/yr		375	
Unit cost		Rs/T		<b>822</b>	Rs/T

**Notes:**

- Staff protective equipment based on BMC equipment data and current prices:
 

a. Ekel broom	1 broom/2WT x	12 sets/yr @	45 Rs ea =	540 Rs/yr
b. Basket	1 Basket/2WT x	6 set/yr @	40 Rs ea =	240 Rs/yr
c. Rake	1 rake/2WT x	2 sets/yr @	75 Rs ea =	150 Rs/yr
Total labourer protective equipment costs =				<u>930 Rs/yr</u>
- Capital cost data: tractor = 105775 with estimated lifetime of 17.5 yrs (15-20yrs range)  
Straight line deprec'n = 6044 Rs/yr (capital cost data = average cost of GMC 2WT)
- Annual tonnage based on avg T/d x 26 working days/mth x 12 mth/yr

Four Wheel Tractor	No	Rate	Unit	Total	Notes
Driver	12	6,185	Rs/mth	74220	
Labourers	36	5,600	Rs/mth	201600	No of labourers = 3
Protective gear/equipment	LS	1170	Rs/yr	1170	
Diesel + Oil	1	54347	Rs/yr	54347	
Tractor Maintenance	1	35572	Rs/yr	35572	Assumed includes tyres and tubes
Trailer Maintenance	1	9017	Rs/yr	9017	Average cost for 3 trailers
Insurance	LS	584	Rs/yr	584	
Licence	LS	150	Rs/yr	150	
Depreciation	LS	41127	Rs/yr	41127	
<b>Total</b>				<b>417787</b>	
				37-6053	49-0682
Avg no of trips/d (24-30 Sep 02)		trips/d		1.43	2.71 See note 5 below
Avg amt collected 24-30 Sep 02		T/d		5.00	5.27
Average amount collected per yr		T/yr		1559	1643
Unit cost		Rs/T		<b>268</b>	<b>254</b> Avg = 261

**Notes:**

- Staff protective equipment based on BMC equipment data and current prices:
 

a. Ekel broom	1 broom/4WT x	12 sets/yr @	45 Rs ea =	540 Rs/yr
b. Basket	2 Basket/4WT x	6 set/yr @	40 Rs ea =	480 Rs/yr
c. Rake	1 rake/4WT x	2 sets/yr @	75 Rs ea =	150 Rs/yr
Total labourer protective equipment costs =				<u>1170 Rs/yr</u>
- Capital cost data: tractor = 535000 with estimated lifetime of 17.5 yrs (15-20yrs range)  
Straight line deprec'n = 30571 Rs/yr
- Capital cost data: trailer = 95,000 with estimated lifetime of 9 yrs (8-10yrs)  
Straight line deprec'n = 10556 Rs/yr (capital cost data based on avg cost from other towns/cities)  
(For tractor, capital cost based on average cost of all units currently in use)
- Annual tonnage based on avg T/d x 26 working days/mth x 12 mth/yr
- Average no of trips/d was calculated as follows:
 

a. 37-6053 normally does one shift per day, but was covering for the compactor whilst it was out of service for 3.5d during this period. It made a total of 6 trips after 3pm (2nd shift) - hence, these trips were subtracted to get normal single shift performance =	10
trips/wk or	1.43 trips/d; converted to a tonnage using the average filled capacity of this tractor
b. Similarly, 49-0682 did 19 trips during the morning shift and 9 during the afternoon shift - single shift performance =	19
trips/wk or	2.71 trips/d; converted to a tonnage using the average filled capacity of this tractor

Compactor	No	Rate	Unit	Total	Notes
Driver	12	6,185	Rs/mth	74220	
Labourers	36	5,600	Rs/mth	201600	No of labourers = 3
Protective gear/equipment	LS	1170	Rs/yr	1170	
Diesel + Oil	1	83368	Rs/yr	83368	
Compactor maintenance	1	38513	Rs/yr	38513	Assumed includes tyres and tubes
Insurance	LS	14120	Rs/yr	14120	
Licence	LS	3050	Rs/yr	3050	
Depreciation	LS	150000	Rs/yr	150000	
<b>Total</b>				<b>566041</b>	
Avg no of trips/d		trips/d		2.25	See note 3
Avg amt collected		T/d		4.7	T/d
Average amount collected per yr		T/yr		1453	T/yr
Unit cost		Rs/T		<b>390</b>	Rs/T

**Notes:**

1. Staff protective equipment based on BMC equipment data and current prices:

a. Ekef broom	1 broom/compr x	12 sets/yr @	45 Rs ea =	540 Rs/yr
b. Basket	2 Basket/compr x	6 set/yr @	40 Rs ea =	480 Rs/yr
c. Rake	1 rake/compr x	2 sets/yr @	75 Rs ea =	150 Rs/yr
Total labourer protective equipment costs =				<u>1170 Rs/yr</u>

2. Capital cost data: compactor = 900000 with estimated lifetime of 6 yrs (3-9yrs)

Straight line deprec'n = 150000 Rs/yr (assumed capital cost using data from other towns)

3. Daily trips based on 9 trips over 4 days during this period (as out of service for 3.5days) = 2.25 trips/d

3. Daily tonnage based on compactor capacity of 3.7 m<sup>3</sup> (from BMC), estimated compaction density of 608 kg/m<sup>3</sup> and fill factor of 92 %

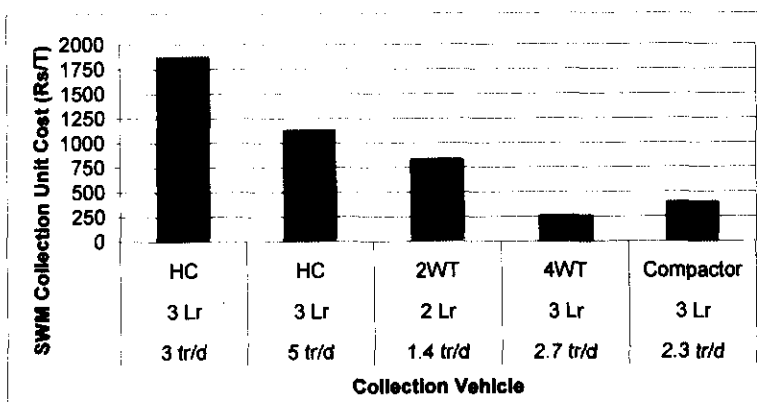
4. Annual tonnage based on avg T/d x 26 working days/mth x 12 mth/yr

**C. Summary**

	Item	SW Amt (T/yr)	Cost (Rs/yr)	Unit cost (Rs/T)
<b>Current</b>				
4WT	4WT (3Lr, 2.7 trips/d)	1643	417787	254
Compactor	Compactor (3Lr, 2.3 trips/d)	1453	566041	390

**Current Situation**

Trips/d	No of Labrs	Vehicle	Unit costs (Rs/T)
3 tr/d	3 Lr	HC	1865
5 tr/d	3 Lr	HC	1119
1.4 tr/d	2 Lr	2WT	822
2.7 tr/d	3 Lr	4WT	254
2.3 tr/d	3 Lr	Compactor	390



## BMC Supervisor Interview Survey Results

Area	Basic SWM Data	Problems	Ideas for Improvement
Head Overseer Area	<ul style="list-style-type: none"> <li>Wards: Pitawelagama, Central, Dharmadutha (+ Muthiyangana Rd)</li> <li>Vehicles: Central: Compactor, 4 HC, 2 WB; Dharmadutha: Compactor (shared with Central ward); Pitawelagama: 4WT shared with other area.</li> <li>Labrs: 3 compactor, 3 4WT, 12 HC, 2 DC</li> <li>CPs: 18 perm, 17 temp</li> <li>LWG: Chief Charlie (15kg/d); Salgadu (20-25kg/d). Muslim (8kg/d), Hargiyar (8kg/d) &amp; Central (8kg/d) hotels: Dance Textile (12kg/d), Riverside Inn</li> <li>L/d: 6 Comp'r L/d (3am, 3 pm); 0.25 4WT; 30 HC/d</li> </ul>	<ul style="list-style-type: none"> <li>Poor public cooperation – people throw their waste anywhere.</li> <li>Labourer absenteeism, creating a labourer shortage, while labourers may also go home early (e.g. 10am rather than 11am).</li> <li>Vehicles often breakdown.</li> <li>Poor labourer health – no vaccinations or medical checkups.</li> <li>Many labourers are illiterate and can not prepare their own overtime sheets.</li> <li>No spare equipment. It may take 2-3 months to get a new handcart. One 4WT has been out of service for three months.</li> <li>Equipment does not come on schedule.</li> <li>No proper place for discharging gully sucker waste</li> </ul>	<ul style="list-style-type: none"> <li>Education/awareness programme specially for traders.</li> <li>Schedule garbage collection time, coupled with a fine system for traders not complying (but this requires vehicles being in good condition).</li> <li>Stationary trailers in public places.</li> <li>Proper treatment plant for gully sucker waste.</li> <li>Make large waste generators pay.</li> </ul>
Minor Supervisor 1	<ul style="list-style-type: none"> <li>Wards: Muthiyangana, Mailagastenna, Kanupelalla, Hingurugamuwa, Hindagoda</li> <li>Vehicles: 4WT, 3WB (3HCs under repair)</li> <li>Labrs: 3 Tr, 3WB (1 Pr, 2 SW)</li> <li>CPs: 22 perm, 27 temp</li> <li>LWG: Wed (2 Tr/d) and Sun (3Tr/d) Pola</li> <li>L/d: 2-3 Tr/d</li> </ul>	<ul style="list-style-type: none"> <li>Insufficient vehicles.</li> <li>Insufficient labourers.</li> <li>Insufficient equipment.</li> <li>4WT can not turn around down Dalada Ela Rd.</li> </ul>	<p>Modify community garbage collection bins so that polysacks can be fitted inside them, with garbage being placed directly into the polysack. Labourers can then remove a full polysack and replace it with an empty one.</p>
Minor Supervisor 2	<ul style="list-style-type: none"> <li>Wards: Kailagoda, Puwakgodamulla, Helagama, Katupellagama, Pinarawa, Welekade, Malwatta</li> <li>Vehicles: 4WT (Kailagoda, Puwakgodamulla, Malwatta), 4WT (Pinarawa, Welekade, Helagama), no service to Katupellagama unless requested</li> <li>Labrs: 2 x 3 for each tractor</li> <li>CPs: 40 perm, 22 temp</li> <li>LWG: Welekade market (0.33-1.0Tr/d), New Tourist Inn, Dunhinda Falls Inn, Greenwood Hotel, General hospital bin (0.75TR/d).</li> <li>L/d: 3Tr/d from each of two areas serviced by 4WT (i.e. 6Tr/d).</li> </ul>	<ul style="list-style-type: none"> <li>Poor public cooperation – many people have enough space to do on-site disposal but don't, choosing to give their garbage to BMC instead.</li> <li>Insufficient vehicles.</li> <li>Labourer absenteeism.</li> <li>High garden waste generation.</li> <li>Political interference.</li> <li>Beggars' dead bodies found in the streets are taken by SWM tractor to the hospital.</li> </ul>	<ul style="list-style-type: none"> <li>Provide vehicles for supervisors.</li> <li>Enforce SWM by-laws.</li> <li>Ambulance for BMC Health section for transport of beggars' dead bodies.</li> </ul>
Minor Supervisor 3	<ul style="list-style-type: none"> <li>Parks/public spaces</li> <li>Vehicles: HC, 2 WB</li> <li>Labrs: 17 works, 10 health</li> <li>CPs: Not applicable</li> <li>LWG: Children's Park, Botannical Gardens</li> <li>L/d: 4-5 polysacks/d from Children's Park; almost all Botannical Gardens waste composted on-site.</li> </ul>	<ul style="list-style-type: none"> <li>No major problems (Supervisor has recently started this job).</li> </ul>	<ul style="list-style-type: none"> <li>None</li> </ul>

**Notes:**

1. CP = collection point, DC = drain cleaner, HC = handcart, LWG = large waste generators, L/d = loads/day, SW = sweeper, Tr = tractor, WB = wheel barrow, 2WT = two wheel tractor, 4WT = four wheel tractor; M = Monday, Tu = Tuesday, W = Wednesday, Th = Thursday, F = Friday, Sa = Saturday, Su = Sunday.
2. The 2WT is not referred to in the above list. It serves the Badulupitiya Housing Scheme (one driver and two labourers). Hence, total number of garbage collection labourers, sweepers and drain cleaners = 44.
3. Total number of vehicle trips amounts to 6 compactor loads/d and 8.25-9.25 4WT/d. This is about 100% greater than the actual number of daily loads measured during the JICA seven day disposal site survey.



