NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

March 30, 2009

Mr. Donald M. Long, Director
City of Durham
Department of Solid Waste Management
1833 Camden Avenue
Durham, North Carolina 27704

Dear Mr. Long:

Enclosed is your permit to construct a Large Type I Solid Waste Compost Facility in Durham County, North Carolina. Your permit number is SWC-32-04.

Please carefully review all permit conditions. Please note that a permit to operate the facility is required before the facility can begin to operate or receive waste. Permit condition five states that the Division shall receive written certification that the facility was constructed in accordance with the approved plans and as built drawings shall be submitted prior to obtaining a permit to operate.

Chris Marriott, Waste Management Specialist, will be responsible for facility inspections. Mr. Marriott can be contacted at 336-771-5090. If you have any questions please feel free to contact our staff engineer Mr. Zi-Qiang Chen, Ph.D. at 919-508-8523, or myself at 919-508-8508.

Sincerely,

Michael E. Scott, Supervisor
Composting & Land Application Branch

cc: Chris Marriott, Environmental Senior Specialist, Winston-Salem Regional Office
Zi-Qiang Chen, Ph.D., Composting & Land Application Branch
Central File, Solid Waste Section, Division of Waste Management

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-508-8400 \ FAX: 919-733-4810 \ Internet: www.wastenotnc.org

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT
1646 MAIL SERVICE CENTER, RALEIGH N.C. 27699-1646

City of Durham, NC

is hereby issued a permit for the construction of a

Large, TYPE I SOLID WASTE COMPOST FACILITY

at

2115 Eastern Club Boulevard
Durham County, NC
Permit Number SWC-32-04

in accordance with Article 9, Chapter 130A, of the General Statutes of North Carolina and all rules promulgated thereunder and subject to the conditions set forth in this permit.

Paul S. Crissman, Chief
Solid Waste Section

3-30-09
Date

Conditions of Permit:

1. This facility shall be constructed in accordance with the Solid Waste Compost Rules (15A NCAC 13B, Section .1400), the approved plans and the conditions of this permit. Any proposed modifications to the approved plan will require prior approval by the Solid Waste Section.

2. All sedimentation and erosion control activities shall be conducted in accordance with the plan approved by the Division of Land Resources and the Sedimentation Control Act (15 NCAC 4).

3. All the wastewater managing practices shall be conducted within the scope of the approved Wastewater Management Plan.

4. Michael E. Scott, Composting and Land Application Branch Supervisor, shall be contacted prior to the start of facility construction. The construction site shall be accessible to Solid Waste Section staff during regular working hours.

5. The Division shall receive written certification that the facility was constructed in accordance with the approved plans and as built drawings shall be submitted prior to obtaining a permit to operate.

6. Prior to receiving any waste at this facility a permit to operate a Solid Waste Compost Facility shall be obtained.

7. A pre-operation inspection and meeting shall be conducted prior to receiving any waste at the facility. Operation plans will be reviewed with Field Operations staff at that time.

8. Operation and management of the facility shall be confined within the boundary of the approved Permit and Operation Manual. All the Incoming feedstocks and bulking agents shall be pre-approved. The annual receiving tonnage at the facility shall not exceed the approved amount.

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Beverly Eaves Perdue
Governor
Dexter R. Matthews
Director
Dee Freeman
Secretary

February 23, 2009

Mr. Donald Long, Director
Solid Waste Management Department
101 City Hall Plaza
Durham, NC 27701

Subject: City of Durham
Solid Waste Composting Facility Permit Application
And Wastewater Management Plan
Facility Permit No.: SWC-TBA

Dear Mr. Long:

The Division of Waste Management Solid Waste Section has completed its technical review of the subject Permit Application and Wastewater Management Plan. A copy of the comments resulting from this review is attached for your reference. These comments are also being sent to your consulting engineer, Frederic D. Rash, P.E., by copy of this letter. A revised Permit Application and Wastewater Management Plan that incorporate responses to these comments should be submitted for our review and approval as soon as possible. Providing thorough and complete responses to these comments in a timely manner is necessary to avoid delays of the Division's decision on the Permit Application.

If you or your engineer have any question or need assistance in resolving the technical review issues, please contact Mr. Zi-Qiang Chen, Ph.D., at (919)-508-8523. Also, you may contact me at (919)-508-8508.

Sincerely,

Michael E. Scott, Supervisor
Composting & Land Application Branch

ZQC:dr

Attachment (all cc's)

cc: Frederic D. Rash, P.E., KCI Associates of NC
Joesephine Valencia, City of Durham Solid Waste Disposal Manager
Paul Crissman, Section Chief, Solid Waste Section
Zi-Qiang Chen, Ph.D., Environmental Engineer II
DWM/SWS/CLA/PERMIT

CITY OF DURHAM

Technical Review Comments
For Solid Waste Composting Facility Permit Application
And
For the Facility's Wastewater Management Plan
Facility Permit No.: SWC-TBA

February 23, 2009

NOTE: Please provide a response to all of the comments on a "comment for comment" basis. Where appropriate, add or revise narrative in the text of both the Permit Application and the Facility's Wastewater Management Plan that addresses the issues discussed in the comments. In addition, the comments and responses may be included as a part of the revised Permit Application and Wastewater Management Plan (e.g. in an appendix).

I. General

1. Both the Permit Application and the facility's Wastewater Management Plan are considered engineering documents; therefore, the front page or cover of the documents should be signed, dated and sealed by an engineer licensed to practice in North Carolina. The signee is responsible for the enclosure of other related engineering work in the documents, such as the facility's Operation & Maintenance Manual, and facility sizing report if these segmented engineering reports are not originally signed, dated and sealed.

II. Permit To Operate Application

1. Page 1, §1.1: Correct the typographical error – fill the missing word "permit" - in the last sentence.

2. Page 1, § 1.3: The threshold between a small and large type I facility is 6,000 cubic yards of material per quarter (.1402(f)(7)).

3. Page 1, §1.3.1: There is no such area plan with a scale of 1" = 175' in the submittal package.

4. Page 1, §1.3.1: Add scale, legend, and true north in Figure 1. The scale shall be less than or equal to 1 inch: 400 feet. On the scaled drawing (plan), show the location of all homes, wells, industrial buildings, public or private utilities, roads, watercourses, dry runs, and other applicable information regarding the general topography within 500 feet of the proposed facility.

* Ask about temporary storage prior to shipping out.

5. Page 1, §1.3.2, and Figure 2: Provide the total acreages for the areas within the so-called "Waste Management Unit (WMU) Boundary" and the "*Site-Development Boundary*".

6. Page 2, §1.3.4, Area Plan: Denote the well(s) on the plan.

7. Page 4, §1.3.9, Figure 3 (Page 15), §3.4.4, Wastewater Management Plan (Page 1): Explain the discrepancy: Will all the compost products be used for the city internally or for retail distribution? Or only the screening rejects ("overs") will be used for the city internally?

8. Page 15, §3.4, Figure 3: Confirm that the requested annual composting capacity at the proposed facility is 7,200 cubic yards, or approximately 1,607 tons per year.

9. Page 21, §3.8.1: In order to determine the adequate compost-mulch inventory reduction level, provide an estimate of the annual compost-mulch consumption demand that the city of Durham's Public Works has internally.

10. Page 23, §4.1.5: The dimensions in this section for storage piles should include the maximum pile sizes as previously listed (12' X 25'X200'). An additional method of fire prevention needs to be the monitoring of piles for excessive temperatures and the monitoring of incoming feedstocks for "hot loads."

11. Page 28, §4.2.7: The on-site storm water from the wastewater retention pond can be used for watering a windrow if the windrow has not achieved or entered into its PFRP stage.

12. Page 29, §4.3.2: Describe how a 3-6-inch blanket of finished compost is placed over the odorous or potentially odorous windrow? Which equipment(s) will be used? How to achieve the even-thickness of the blanket over a windrow?

13. Page 29, §4.3.2: Provide a detailed discussion in this section addressing how to minimize offensive odor at the property boundary and what kinds of corrective actions would be taken if an offensive odor crosses the property boundary.

III. Section Wastewater Management (WM)

1. WM-Page 1, §§1.0, WM-Appendix D: Explain how the surface runoff from *Area A*, namely the 4.4 acres of off-site surface runoff will not enter the wastewater pond. In addition, clarify how the runoff from the area immediately adjacent to the northeast section of area B will be adequately drained.

2. WM-Page 1, §§1.0, WM-Appendix D: Confirm that adequate storm-water handling capacity is in place along the southern boundary of *Area D* to cut-off the

Dave will adjust the A, B, C, D acreage

inundating surface runoff from off-site higher elevation drainage areas from the south.

3. WM-Page 1, §§1.0, WM-Appendix D: Provide a chart to show the acreage for each of the 4 drainage Areas A, B, C, and D.

Dave will address

4. WM-Page 4, §§2.0, WM-Appendix D: Clarify if the stated 10.87 acres (41%) of the total (26.2 acres) site area are referred to the combined three drainage areas of B, C, and D, *excluding* the retention pond. Provide a chart to show the areas of drainage areas A, B, C and D, as well as the area of the retention pond at the top elevation of the embankment.

Dave, will clarify the increment.

5. WM-Page 5, §§3.0, WM-Appendix D: Confirm that a 0.05-hour time increment was used to run all the *Intelisolve* hydraulic flow models for this report.

6. WM-Page 5, §§4.0, Wastewater Pond Design: The maximum permeability in cm/sec needs to be listed for the synthetic liner. Please note that the Division shall receive a written certification prepared by a NC Professional Engineer that the construction of the wastewater pond was completed in accordance with approved plans prior to any waste being introduced into the system.

<u>The following comments are for the **25-year/24-hour** hydrographic summary:</u>

7. WM-Appendix D_Page 1: Explain why the time interval is 10 minutes instead of 0.05 hour (or 3 minutes, see Comment II.6 above) as stated in the text? Please add the results from 3-minute interval runs if possible.

8. WM-Appendix D_Page 1: Provide definitions for both "Existing" and "Proposed" SCS Runoffs in the chart.

9. WM-Appendix D_Page 1: Specify the difference, in terms of initial model-running conditions, between Hyd. No. 1 and Hyd. No. 2.

10. WM-Appendix D_Page 1: Confirm that the drainage area for running both Hyd. No. 1 and Hyd. No. 2 are the same, namely, the drainage area = B + C + D = 11.77 acres.

11. WM-Appendix D_Page 1: Since there is only one pond (Pond 1) to be constructed and dealt with in the proposed project, what is *Pond 2* referred to? Provide clear description for these ponds.

12. WM-Appendix D_Page 1: What is the lowest water-level (elevation) to be maintained in the proposed retention pond, at which no water-withdrawal (the pumping-and-hauling operation) is needed?

13. WM-Appendix D_Pages 2, 3, and 5: Explain why a 0.0% slope was used to run all the computations when an up to 6% slope (WM_Page 4) is pronounced in Drainage Areas B, C, and D.

14. WM-Appendix D_Page 4, Hyd. No. 4: Re-plot the hydrograph with adjustment to show the X-axis (time penal) with the same scale (24 or 27 hours) as the previous graphs.

15. WM-Appendix D_Page 4, Hyd. No. 4: Confirm that the maximum drainage water input to the retention pond from the 11.77-acrea drainage areas B, C, and D during a 25-year and 24-hour storm event is approximately 119,146 cubic feet.

16. WM-Appendix D_Page 5: Confirm that the top elevation of the embankment is 304' and that the maximum storage of the retention pond is thus 261,769 cf. Also see **Comment III-14** above.

17. WM-Appendix D_Page 5: Since the top of the berm (embankment) is at 304' (see Plan Sheet C-4.0), does the Stage-5 (at elevation 305') indicate a 1 foot available freeboard capacity? The freeboard should be depicted on the drawing.

<u>The following comments are for the report's **100-year** hydrographic summary:</u>

18. WM-Appendix D_Page 6: Clarify the difference between Hyd. No. 1 and Hyd. No. 2, in terms of geometry and model-running conditions.
Amount of impervious surface after construction

19. WM-Appendix D_Page 6: As to above Comment II-10, what does "*Pond 2*" refer to if only one pond (*Pond 1*) is constructed?

Dave will prepare

20. WM-Appendix D_Page 6: What is the lowest allowed water-surface elevation at the retention pond, at or below which no pump-haul is required?

21. WM-Appendix D_Page 6: For comparison, provide the modeling result running at a 3-minute (0.05-hour) time interval as mentioned in the text.

22. WM-Appendix D_Pages 7 & 8: Confirm that the modeling area is for Drainages B, C, and D, including that of the retention pond.

Dave will explain

23. WM-Appendix D_Pages 7, 8 and 10: Explain why a 0.0% slope was used to run all the computations when an up to 6% slope (WM_Page 4) is pronounced in Drainage Areas B, C, and D. It is 6% and part of the equation

24. WM-Appendix D_Page 9: Confirm that the maximum drainage water input to the retention pond from the 11.77-acrea Drainage Areas B, C, and D during a 100-year and 24-hour storm event is approximately 171,571 cubic feet, which stands for what percentage of total precipitation in the drainage areas during the 100-year and 24-hour storm event?

60% of rainfall in the pond

25. WM-Appendix D_Page 9: What were the surface runoff (R) to the retention pond, evaporation (E), transpiration (T), and change in storage (ΔS) used in the computations? - Information not used.

26. WM-Appendix D_Page 9: Provide a preliminary engineering calculation and add a narrative to show how the City of Durham will manage to keep the water surface level in the retention pond at or below the elevation of 300'. The narrative should explain how the facility staff will regularly monitor the pond wastewater level and procedures for implementing a pump and haul.

27. WM-Appendix D_Page 10: Provide details for the a10-inch diameter emergency spillway that is built at the elevation of 302.75'. 40' wide weir

---------- End of Comments ----------

Compost Windrows (UTM 17 North)

A	693554.59	3990298.37
B	693577.37	3990262.37
C	693544.11	3990233.66
D	693479.85	3990216.35
E	693437.93	3990209.05
F	693428.36	3990229.56
G	693411.05	3990244.14
H	693398.29	3990285.61
I	693480.31	3990287.89

Pile 1a

E	693437.93	3990209.05
F	693428.36	3990229.56
G	693411.05	3990244.14
L	693432.92	3990202.68
M	693402.39	3990237.76

Pile 1b

D	693479.85	3990216.35
E	693437.93	3990209.05
J	693509.02	3990216.35
K	693509.47	3990198.12
L	693432.92	3990202.68

Pile 6

N	693385.53	3990275.13
O	693360.47	3990274.22
P	693361.83	3990260.55
Q	693363.66	3990249.61
R	693349.53	3990275.13
S	693348.62	3990261.00
T	693348.62	3990246.42
U	693335.86	3990273.76
V	693335.40	3990261.91
W	693334.95	3990248.70
X	693320.37	3990264.65

Pile 5a

CC	693462.99	3990358.52
DD	693514.03	3990355.33
EE	693514.49	3990358.97
FF	693461.63	3990363.99

Pile 5b

Y	693458.44	3990346.67
Z	693523.14	3990343.94
AA	693519.50	3990352.14
BB	693455.25	3990355.78

Pile 3a

RR	693457.53	3990378.57
SS	693454.79	3990417.76
TT	693450.24	3990421.40
UU	693447.50	3990401.81
VV	693452.97	3990376.74

Pile 3b

GG	693475.75	3990376.29
HH	693470.74	3990418.67
II	693468.92	3990435.98
JJ	693477.58	3990460.59
OO	693472.11	3990461.96
PP	693458.44	3990431.43
QQ	693466.18	3990378.11

Pile 3c

CCC	693437.93	3990423.22
DDD	693441.58	3990433.25
EEE	693456.61	3990453.30
FFF	693452.06	3990456.03
GGG	693432.92	3990438.72
HHH	693430.64	3990423.68

Pile 3d

JJ	693478.03	3990460.13
KK	693488.06	3990476.99
LL	693486.23	3990487.02
MM	693487.15	3990495.22
NN	693482.13	3990497.95
OO	693472.11	3990461.96

Pile 2

WW	693449.32	3990360.80
XX	693442.94	3990420.03
YY	693425.63	3990421.86
ZZ	693422.89	3990401.81
AAA	693418.34	3990392.24
BBB	693432.92	3990365.81

Pile 4a

SSS	693413.33	3990451.93
TTT	693432.01	3990477.45
UUU	693444.77	3990491.12
VVV	693441.58	3990493.85
WWW	693428.36	3990486.11
XXX	693409.68	3990464.23

Pile 4b

III	693429.27	3990446.01
JJJ	693435.65	3990461.50
KKK	693430.64	3990464.23
LLL	693423.35	3990446.46

Pile 4c

MMM	693453.88	3990471.53
NNN	693467.55	3990486.11
OOO	693474.39	3990496.59
PPP	693469.37	3990497.95
QQQ	693458.44	3990489.75
RRR	693444.77	3990469.25

South Debris 1 & 2 = P.1e 1 (2a)

N Garbage area = P.1e 2 (2b)

N Debris 1 & 2 = P.1e 3 (2c)

NV 1 & NV 2 = [illegible] (4)

FP 1, 2, 3 = P.1e 4 (#5)

NV 3 & 4 = P.1e 5 (#6)

Off site area = P.1e 6 (#7)

Active impact area = (#3)

ATTACHMENT 1

1. The City of Durham shall secure a permit from the Division of Waste Management prior to operating the solid waste management facility (hereinafter called the "Facility") located at 2115 East Club Boulevard, Durham, North Carolina as a yard waste composting facility.

2. The City of Durham acknowledges that piles of waste material remain at the Facility, as identified as Piles 1 through 6 in the Map attached hereto. As conditions precedent to securing a yard waste composting permit for the Facility, but no later than January 31, 2007, the City of Durham shall remove for proper solid waste disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B, the materials in:

a) Pile 1, consisting of old, mixed waste material and stumps located behind the south side of the Facility;

b) Pile 2, consisting of garbage-contaminated waste material along and in the ditch along the west side of the north half of the Facility; and

c) Pile 3, consisting of two windrows of old mixed waste material located to the west of the burn area; except that the northern portion of the eastern windrow is usable material and its removal from the Facility is not a condition precedent to the issuance of a yard waste composting permit.

These conditions precedent apply notwithstanding that the City of Durham's permit application for a yard waste composting facility may otherwise meet all applicable permitting criteria.

3. The City of Durham acknowledges at the time of the signing of this Agreement that approximately fifteen (15) windrows of yard waste material are located at the south end of the Facility. The City of Durham shall manage these existing windrows in accordance with the operating plan contained in the Facility's expired Permit #32-04 SWC. The Division of Waste Management agrees that the City of Durham shall have up to and including September 1, 2007, in which to remove these materials from the Facility through sale or proper solid waste disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B.

4. The northern portion of the eastern windrow of Pile 3 (see Map), consisting of usable material, shall be removed from the Facility through sale or proper solid waste disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B, on or before July 31, 2007.

5. Pile 4 (see Map) consists of old, usable material and is located in a flood plain. The City of Durham shall move Pile 4 out of the flood plain by April 28, 2007, unless the Division of Water Quality requires that the Pile be removed prior to this date. After the material in Pile 4 is removed from the flood plain, the City of Durham shall remove the waste from the Facility through sale or for proper solid waste disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B, on or before July 31, 2007.

6. Pile 5 consists of two windrows of usable material and is located south of the burn area. The City of Durham shall remove this material by sale or proper solid waste disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B, on or before July 31, 2007.

7. Pile 6 consists of a large pile of buried yard waste (approximately ten feet deep and spanning a surface area approximating a football field) that is covered with burned material and clay and is located in the southwest corner of the Facility. The disposal of this waste is without a permit required by the solid waste management regulations, 15A NCAC Chapter 13B. The City of Durham shall remove the material for proper disposal in accordance with the solid waste management regulations, 15A NCAC Chapter 13B, according to the following schedule:

a) remove one-fourth of the material on or before July 31, 2007;

b) remove the second fourth of the material on or before December 31, 2007;

c) remove the third fourth of the material on or before May 30, 2008; and

d) remove the last fourth of the material on or before November 28, 2008.

8. With respect to all material sold or disposed of in accordance with the requirements in Paragraphs 2-7 of this Attachment, the City of Durham shall maintain records of the sale and disposal transactions including, but not limited to, the amount of material sold or disposed, the buyer of the material or the solid waste facility to which the material was transported for disposal, the sale price or the cost of disposal. All records shall be made available upon request by the Division of Waste Management.

9. With respect to all deadlines for the removal of materials from the Facility as set forth in Paragraphs 2 through 7(a)-(d), the City of Durham acknowledges that its failure to complete the removal of the identified materials in accordance with any one or more of the deadlines in said paragraphs shall constitute a violation of 15A NCAC 13B .0103(a), .0201(a), .0501, .0502, and shall subject the City of Durham to penalties, injunctive relief, or other legal action subject to the discretion of the Division of Waste Management.

10. It is recognized that the City of Durham has an ongoing duty to collect the yard waste generated by its citizens in order to protect the public health by preventing the nuisance accumulation of this waste. The City of Durham may manage its citizens' yard waste at its Facility in accordance with the following restrictions:

a) The City may receive yard waste generated by its citizens at the Facility provided that the waste is delivered by City trucks or by large commercial vehicles that collect and transport yard waste on behalf of the City of Durham's citizens. Citizen vehicles and small commercial vehicles are prohibited from entering the Facility. Citizen vehicles and small commercial vehicles may transport yard waste to the citizen drop-off location at the City of Durham Transfer Station (Permit #32-12T). The City may then transport this yard

waste from the transfer station to its Facility to be managed in accordance with the restrictions set forth below in Paragraph 10(b).

b) The City of Durham shall grind the yard waste that it receives at the Facility a minimum of two times per week and shall remove the ground waste from the Facility within twenty-four (24) hours of grinding. The City of Durham shall remove the ground waste to a facility authorized to accept the waste. The City of Durham shall grind and remove the waste in order to prevent the accumulation of yard waste, or ground yard waste, at the Facility.

c) The City of Durham shall record on a daily basis the amount of yard waste received at the Facility, the amount of yard waste ground at the facility, and the amount of yard waste removed from the Facility, including the facility to which the waste is transported for proper disposition. The City of Durham shall make these records available to the Division of Waste Management upon request.

d) It is the intent of these restrictions to prohibit the operation of the Facility as a composting facility. Accordingly, the City of Durham is expressly prohibited from windrowing and composting the yard waste that it receives until it has secured a permit from the Division of Waste Management for these activities.

e) "Yard waste" is defined in 15A NCAC 13B .0101(46) and means "yard trash," defined in N.C.G.S. § 130A-290(a)(45) as "solid waste consisting solely of vegetative matter resulting from landscaping maintenance," as well as "land-clearing debris," defined in N.C.G.S. § 130A-290(a)(15) as "solid waste which is generated solely from land-clearing activities," and includes stumps, limbs, leaves, grass, and untreated wood.

f) Nothing in Paragraph 10 of this Attachment and its subparagraphs, or in this Agreement, prohibits the City of Durham from managing its citizens' yard waste by directly transporting, or arranging for the transportation of the yard waste, to a facility permitted by the Division of Waste Management for the receipt, disposal, treatment, processing, or composting of said waste originating from the City of Durham.

11. The City of Durham acknowledges that by entering into this Agreement, which includes the terms set forth in this Attachment, the Division of Waste Management makes no guarantee that a permit for a yard waste composting facility shall be issued. The City of Durham must fulfill the conditions precedent set forth in Paragraph 2(a)-(c) of this Attachment, and must meet all applicable permitting requirements in order to secure a permit for its Facility to operate as a yard waste composting facility.

12. It is contemplated by the parties that the permitting process for a yard waste composting facility should be capable of resolution between the City of Durham and the Division of Waste Management by January 31, 2007. The terms of Paragraph 10 of this Attachment and its subparagraphs (a)-(d) shall remain in effect pending the issuance of a permit to the City of Durham for the operation of the Facility as yard waste composting facility, or until January 31,

2007, whichever occurs first. In the event that the City of Durham is unable to secure a permit for a yard waste composting facility by January 31, 2007, it shall cease all acceptance of yard waste at the Facility. The City of Durham shall investigate its options for managing its citizens' yard waste in consultation with the Division of Waste Management.

PERMIT TO OPERATE APPLICATION

Solid Waste Compost Facility
City of Durham, North Carolina

Prepared for:

City of Durham
Department of Solid Waste Management
1833 Camden Avenue
Durham, NC 27704

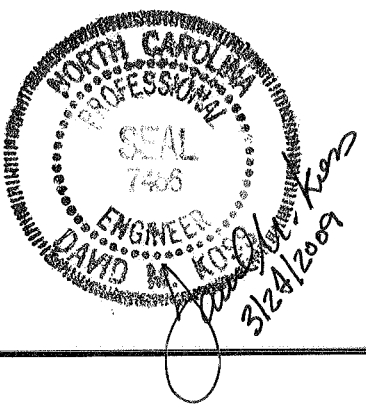
March 2009

Prepared by:

KCI Associates of North Carolina, P.A.
Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609

In association with:

Coker Composting & Consulting
1213 Spradlin Rd.
Vinton, VA 24179



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Appendices

Section 1
Executive Summary

1.1 General

The City of Durham (city or Durham) operated a Large Type I Solid Waste Compost Facility (yard waste compost facility, compost facility, or YWCF) at 2115 E. Club Boulevard in Durham from 1992 until 2006. This permit application is for the issuance of a new for a smaller facility.

1.2 Durham Composting Facility Background

The City of Durham obtained a permit for a yard waste compost facility to begin operation in January 1992. The facility is located on a portion of the borrow area of the closed sanitary landfill which has an entrance at 2115 East Club Boulevard. The yard waste received at the facility is from both City Yard Waste vehicles and from the general public.

The North Carolina Department of Environment and Natural Resources, Division of Waste Management, issued Permit No. SWC-32-04 to the City for the operation of the yard waste compost facility on July 7, 1999. That permit expired in 2004. Operations at that facility ceased in September 2006. This application is for a new permit for a smaller yard waste composting facility on a portion of the old site.

1.3 Application Requirements Summary

This section summarizes the application requirements for a Large Type 1 facility as outlined in 15A NCAC 13B.1405. The facility will handle approximately 1,800 cubic yards (CY) per quarter, which exceeds the 1,000 CY/quarter threshold between Small and Large Type I facilities.

1.3.1 Area Plan

An area plan (scale 1" = 175'), showing all features required by 15A NCAC 13B.1405(a)(1), was prepared by the Durham City/County Geographic Information Systems (GIS) Department based on 2005 aerial photogrammetry (see Figure 1).

1.3.2 Site Plan

A site plan (scale 1" = 60'), showing all features required by 15A NCAC 13B.1405(a)(5), was prepared by a NC licensed land surveyor based on an October, 2006 site survey (see Figure 2).

1.3.3 Land Ownership and Zoning

The site of the yard waste compost facility is owned by the City of Durham, North Carolina. The compost facility is allowed within the existing zoning.

1.3.4 Siting/Design Requirements

Floodplains

No active composting, curing or product storage areas are located in a floodplain (see Figure 1).

Property Line Buffer

The compost area (Waste Management Unit, or WMU) is not within the 50-foot property line buffer requirement.

Residence Buffer

The compost area (WMU) meets the 500-foot buffer distance to residences or dwellings not owned and occupied by the permittee.

Well Buffer

The nearest well is more than 100 feet from the compost area (WMU).

Perennial Streams/Rivers Buffer

The compost area (WMU) is located greater than 50 feet from any perennial streams or rivers.

Surface Water Quality Standards

Ellerbe Creek is classified as a Nutrient Sensitive Class C waterway. All site runoff from storms up to and including the 100-yr, 24-hr storm will be captured on-site and a portion hauled off to the North Durham Wastewater Treatment Plant.

Closed Disposal Area

The facility is not located over a closed-out disposal area.

Adequate Access

The minimum required access buffer of 25 feet will be maintained for fire-fighting access to the compost areas within the WMU.

Surface Water Requirements

The City proposes to use an extended detention storm water management pond to capture and control the site runoff from the 100-year, 24-hour storm, and to haul a portion of that runoff to the North Durham Wastewater Treatment Plant.

Ground Water Requirements

The site is protective of groundwater standards (15A NCAC 2L) as a site investigation in 1991 (see Appendix B) indicated no presence of ground water within four (4) feet of the surface, and as no putrescible organic solid waste is accepted at the facility, leachate formation is minimal.

Public Access

The compost facility will not be open to the public during normal operating hours of the transfer station. Citizens delivering yard waste to the City's solid waste complex will deposit incoming yard wastes into designated containers (as is the current practice).

Sedimentation Pollution Control Law

In the event of land-disturbing activities at the Durham facility, silt fencing rock check dams and a temporary sediment trap will be used for sediment and erosion control. A permit has already been obtained from DENR's Division of Land Quality.

Air Pollution Control Requirements

The City of Durham yard waste composting facility is operated to be in compliance with the requirements of 15A NCAC 2D.1800 (Control of Odors).

1.3.5 Facility Engineering Plan

Section 3 of this Permit Application spells out the facility's design and engineering features, which are the same as the features used in the ongoing operation of the facility. The only construction activities contemplated at the Durham Compost Facility are: minor grading in portions of the site and construction of a storm water management pond.

1.3.6 Operations & Maintenance Manual

Section 4 of this Permit Application defines the operating procedures to be used at Durham Yard Waste Composting Facility.

1.3.7 Contingency Plans

Section 3.6 (page 16) spells out the contingency plans to be implemented in the event of equipment breakdown, air pollution/odor incidents, non-conforming waste, spillage and/or undesirable conditions.

1.3.8 Quality Assurance Plan

Section 3.7 (page 17) defines the Quality Assurance Plan for feedstock and process monitoring, sampling and analysis, and recordkeeping.

1.3.9 Product Marketing & Distribution

All compost produced by the facility will be used internally by the City. No compost will be made available for sale to the general public.

Section 2
Siting/Design Requirements
(15A NCAC 13B.1404)

2.1 Land Ownership & Zoning (15A NCAC 13B.1405(a)(2))

The City of Durham yard waste compost facility is a portion of approximately 260 acres owned by the City that is used for a wastewater treatment plant and a now-closed MSW landfill. The Durham City/County Planning Department has indicated that the site zoning of IL(D)/I(D) is suitable for a yard waste composting facility (see Appendix A).

2.2 Floodplains (15A NCAC 13B.1404(a)(1))

A portion of the permitted facility is located in the 100-year floodplain of Ellerbe Creek, a tributary to the Neuse River in the Falls Lake watershed. No active compost areas, curing areas, product storage areas, or other operational areas of the site are located within the 100-year floodplain boundaries or associated buffer.

2.3 Property Line Buffer (15A NCAC 13B.1404(a)(2))

The compost facility meets the 50' minimum property line buffer requirements. The facility boundary is 50' from the boundary of the compost area (Waste Management Unit). The property line is approximately 175 feet away from the facility boundary at its closest point.

2.4 Residence Buffer (15A NCAC 13B.1404(a)(3))

The nearest non-applicant owned and occupied residences are approximately 825 feet to the northeast of the compost facility.

2.5 Well Buffer (15A NCAC 13B.1404(a)(4))

The nearest well is greater than 200 feet from the compost facility.

2.6 Perennial Stream/River Buffer (15A NCAC 13B.1404(a)(5))

The compost facility is located approximately 1,250 feet away from Ellerbe Creek. The land between is heavily wooded and will remain undisturbed.

2.7 Surface Water Quality Standards (15A NCAC 13B.1404(a)(6))

The site is located in the Falls of the Neuse Reservoir watershed, near Ellerbe Creek. Ellerbe Creek runs along the Interstate 85 corridor, and drains 8.9 square miles of north Durham at this location. The entire stream from its source to Falls Lake is on the state's 303(d) list of impaired streams. The portion of Ellerbe Creek adjacent to the

site carries a Water Quality Classification of "C" (freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife) and is considered to be a Nutrient Sensitive Waterway (NSW). The Durham facility is more than 1,000 feet away from Ellerbe Creek.

2.8 Closed Disposal Area (15A NCAC 13B.1404(a)(7))

The facility is not located over a closed disposal area. The City's closed MSW landfill is on an adjacent property.

2.9 Adequate Access (15A NCAC 13B.1404(a)(8))

As the facility is part of a larger municipal public works complex, there are two roads (one gravel, one dirt) through the site to allow access by fire-fighting equipment. The minimum buffer requirement of 25 feet between compost areas and swales/berms will be maintained.

2.10 Surface Water Requirements (15A NCAC 13B.1404(a)(9))

The City proposes to use an extended detention storm water management pond to capture and control the site runoff from the 100-year, 24-hour storm, and to haul that runoff to the North Durham Wastewater Treatment Plant.

2.11 Ground Water Requirements (15A NCAC 13B.1404(a)(10))

All areas used for composting activities are native soil pads. As the facility will not accept putrescible wastes, only ground yard waste will be composted and pallets and clean woody waste will be ground into mulch. These wastes produce very little leachate during the composting process or as a result of grinding into mulch. In addition, a test pit dug at the site in 1991 (see Appendix B) did not find any evidence of a seasonal high water table within four (4) feet of the ground surface. Thus, no migration of potential pollutants to the groundwater table is expected.

2.12 Public Access (15A NCAC 13B.1404(c)(1))

The public will not be allowed to deliver yard waste or pick up composted materials at this facility. The entire municipal public works complex is secured by fencing and locked gating when it is not open.

2.13 Sedimentation Control Law (15A NCAC 13B.1404(c)(2))

Erosion and sedimentation control plans have been prepared for the grading and other minor construction work associated with this site and a permit has been obtained from NCDENR.

2.14 Air Pollution Control Requirements (15A NCAC 13B.1404(c)(3) and (c)(4))

The City composting facility is operated to be in compliance with the requirements of 15A NCAC 2D.1800 (Control of Odors). Please see Sec. 4.3.2 in the Operations Manual (page 22) for a discussion of odor control practices at the facility.

Section 3
Facility Engineering Plan
(15A NCAC 13B.1405(a))

3.1 Area Plan

The area plan, showing all information required by 15A NCAC 13B.1405(a)(1), is presented in Figure 1.

3.2 Site Plan

The site plan, showing all information required by 15A NCAC 13B.1405(a)(5), is presented in Figure 2.

3.3 Facility Report

3.3.1 Waste Types and Quantities

Yard waste, consisting of brush, branches, leaves and grass clippings, delivered to the Durham compost facility over the past five years is summarized in Table 1:

Table 1
Incoming Yard Waste Tonnages

Month	2001	2002	2003	2004	2005	2006	2007	2008	
January	1,196.0	621.9	1,278.7	915.6	801.7	1,173.4	750.2	1,000.2	
February	1,127.0	794.4	724.7	611.5	568.4	761.0	563.7	797.9	
March	1,320.5	903.1	2,053.8	1,555.5	917.2	1,157.8	1,134.9	1,128.6	
April	1,440.4	1,614.0	2,139.3	1,668.6	1,563.5	1,431.3	1,550.8	1,294.6	
May	1,198.2	1,182.7	2,369.9	1,324.5	1,265.9	1,451.8	1,262.6	1,510.8	
June	1,104.2	763.1	1,648.0	1,185.4	1,152.2	1,243.9	935.0	933.1	
July	892.2	760.5	1,260.0	949.9	1,040.8	983.7	793.8	1,502.6	
August	1,072.3	715.6	1,402.2	1,065.8	1,083.4	872.3	1,450.4	822.6	
September	979.6	885.6	1,970.5	1,136.7	1,085.3	1,223.6	674.9		
October	1,123.5	886.4	1,642.8	1,046.4	941.0	962.9	745.5		
November	1,215.1	1,296.5	1,702.1	1,398.4	1,178.4	1,365.0	972.3		
December	1,045.4	1,343.0	1,269.4	1,050.7	1,231.7	1,237.3	1,152.0		
									Totals
Total	13,714.3	11,766.6	19,461.4	13,909.0	12,829.4	13,863.8	11,986.0	8,990.4	106,520.9
Average Monthly	1,142.9	980.6	1,621.8	1,159.1	1,069.1	1,155.3	998.8	1,123.8	1,156.4
Peak	1,440.4	1,614.0	2,369.9	1,668.6	1,563.5	1,451.8	1,550.8	1,510.8	2,369.9

The average monthly tonnage (1,156.4 tons/month) has been used for sizing the facility. Based on a field-measured bulk density of 500 lbs/cubic yard (when ground up) the average monthly volume of yard waste is 4,626 cubic yards. The highest three-month period of incoming yard waste tonnage was during March, April & May of 2003, when an average monthly tonnage (during that three month period) of 2,187.7

tons was received. Peak monthly volume was realized in May, 2003, when 9,480 CY of yard waste and storm debris was received.

3.3.2 Feedstock Storage and Pre-Processing

Incoming yard waste will be stockpiled in the Waste Receipt Area on a daily basis. On a daily basis, facility operators will push the waste, using front end loaders, into windrows, each a maximum of approximately 12' high by 24' wide by 200' long, spaced approximately 25' apart to allow room for fire-fighting equipment. Approximately four (4) storage piles will fit in the designated area after allowing for fire lanes.

At least once per week an outside contractor will come in to grind up the accumulated waste in the designated Grinding Area. Ground up material will then be formed into piles for temporary storage. Under average conditions, the contractor will have to grind about 213 cubic yards per day (most of this ground material will not be handled by the compost facility). The contractor will have to form two (2) temporary storage piles, each 25' wide x 10' high x 160' long. As these piles will only hold about 1.5 weeks of yard waste grinding quantities, that material which is not diverted to the Windrow Area #1 for composting will be moved off-site for use as boiler fuel or transferred to an off-site landfill.

3.3.3 Compost Recipe Development

As the Durham facility accepts only yard waste, the only issues with regard to composting recipe development are adjusting the Carbon: Nitrogen ratios in the spring season when grass clippings are a major portion of the yard waste stream and in the fall season, when the majority of the waste stream is collected leaves. In the summer, fall and winter, the City may explore the use of urea nitrogen fertilizer to adjust C:N ratios. The City will keep a stockpile of ground brush on-site for mixing with the spring season grass clippings wastes and will encourage citizens to practice Grasscycling in their yards to cut down on the quantities of grass clippings coming to the facility.

Table 1 contains seasonal compost recipes based on the use of urea. The seasonal distributions of yard waste constituents are based on literature values. The quantities in Table 1 are based on a capacities analysis of the designated Windrow Area #1, which indicated that designated area could only handle about 13% of the total yard waste stream (or about 150 tons/month).

Table 2
Compost Recipe

Notes:

Available capacity in Windrow Area #1	1,774.6	tons/year		
	Spring	Summer	Fall	Winter
Seasonal Quantity Distr.	40%	20%	30%	10%
Quantity per season (tons):	709.8	354.9	532.4	177.5
Quantity per month (tons):	236.6	118.3	177.5	59.2
Quantity per week (tons):	59.2	29.6	44.4	14.8
Seasonal Distributions:	Spring	Summer	Fall	Winter
Grass Clippings	35%	25%	10%	0%
Brushy Yard Waste	65%	75%	40%	80%
Leaves	0%	0%	50%	20%

MIX RATIO CALCULATIONS - Spring

Example Weekly Recipe

INGREDIENTS	Urea	Brushy Yard Wastes	Grass Clippings	Leaves (Freshly fallen)	TOTAL MIX	TARGET
C (% AS IS)	0	53.0	41.0	37.3		
N (% AS IS)	46	1.0	3.0	1.5		
MOISTURE%	1	42.5	80.0	54.1		
UNITS IN MIX BY WGT (T)	0.0	38	21	0	59.2	
UNITS IN MIX BY WGT (LB)	0	76,899	41,407	0	118,307	
UNITS IN MIX BY VOL (CY)	0	154	83	0	237	
DENSITY (LBS/CY)	1600	500	500	200		
RELATIVE DENSITY	1.00	0.31	0.31	0.13		
	0.00	76899.33	41407.33	0.00		
POUNDS OF CARBON	0	40,757	16,977	0	57,734	
POUNDS OF NITROGEN	0	769	1,242	0	2,011	
C:N RATIO	0.00	53.00	13.67	24.87	**28.71**	20 TO 30
POUNDS OF MOISTURE	0	32,682	33,126	0	65,808	
NUMBER OF UNITS	0	76,899	41,407	0	118,307	
PERCENT MOISTURE					**55.63**	50 TO 65%

MIX RATIO CALCULATIONS - Summer

Example Weekly Recipe

INGREDIENTS	Urea	Brushy Yard Wastes	Grass Clippings	Leaves (Freshly fallen)	TOTAL MIX	TARGET
C (% AS IS)	0	53.0	41.0	37.3		
N (% AS IS)	46	1.0	3.0	1.5		
MOISTURE%	1	42.5	80.0	54.1		
UNITS IN MIX BY WGT (T)	0.2	22	7	0	29.8	
UNITS IN MIX BY WGT (LB)	400	44,365	14,788	0	59,553	
UNITS IN MIX BY VOL (CY)	0	89	30	0	119	
DENSITY (LBS/CY)	1600	500	500	200		
RELATIVE DENSITY	1.00	0.31	0.31	0.13		
	400.00	44365.00	14788.33	0.00		
POUNDS OF CARBON	0	23,513	6,063	0	29,577	
POUNDS OF NITROGEN	184	444	444	0	1,071	
C:N RATIO	0.00	53.00	13.67	24.87	**27.61**	20 TO 30
POUNDS OF MOISTURE	4	18,855	11,831	0	30,690	
NUMBER OF UNITS	400	44,365	14,788	0	59,553	
PERCENT MOISTURE					**51.53**	50 TO 65%

MIX RATIO CALCULATIONS - Fall

Example Weekly Recipe

INGREDIENTS	Urea	Brushy Yard Wastes	Grass Clippings	Leaves (Freshly fallen)	TOTAL MIX	TARGET
C (% AS IS)	0	53.0	41.0	37.3		
N (% AS IS)	46	1.0	3.0	1.5		
MOISTURE%	1	42.5	80.0	54.1		
UNITS IN MIX BY WGT (T)	0.3	18	4	22	44.7	
UNITS IN MIX BY WGT (LB)	600	35,492	8,873	44,365	89,330	
UNITS IN MIX BY VOL (CY)	0	71	18	222	311	
DENSITY (LBS/CY)	1600	500	500	200		
RELATIVE DENSITY	1.00	0.31	0.31	0.13		
	600.00	35492.00	8873.00	44365.00		
POUNDS OF CARBON	0	18,811	3,638	16,548	38,997	
POUNDS OF NITROGEN	276	355	266	665	1,563	
C:N RATIO	0.00	53.00	13.67	24.87	**24.96**	20 TO 30
POUNDS OF MOISTURE	6	15,084	7,098	24,001	46,190	
NUMBER OF UNITS	600	35,492	8,873	44,365	89,330	
PERCENT MOISTURE					**51.71**	50 TO 65%

MIX RATIO CALCULATIONS - Winter

Example Weekly Recipe

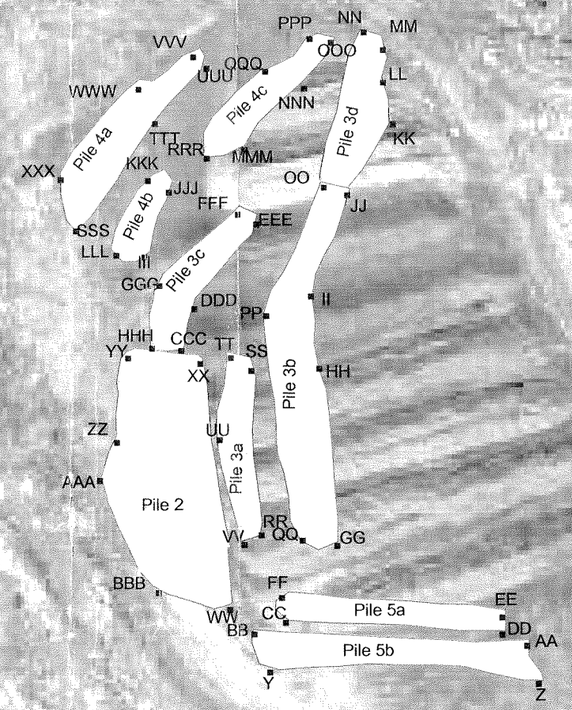
INGREDIENTS	Urea	Brushy Yard Wastes	Grass Clippings	Leaves (Freshly fallen)	TOTAL MIX	TARGET
C (% AS IS)	0	53.0	41.0	37.3		
N (% AS IS)	46	1.0	3.0	1.5		
MOISTURE%	1	42.5	80.0	54.1		
UNITS IN MIX BY WGT (T)	0.2	12	0	3	15.0	
UNITS IN MIX BY WGT (LB)	400	23,661	0	5,915	29,977	
UNITS IN MIX BY VOL (CY)	0	47	0	30	77	
DENSITY (LBS/CY)	1600	500	500	200		
RELATIVE DENSITY	1.00	0.31	0.31	0.13		
	400.00	23661.33	0.00	5915.33		
POUNDS OF CARBON	0	12,541	0	2,206	14,747	
POUNDS OF NITROGEN	184	237	0	89	509	
C:N RATIO	0.00	53.00	13.67	24.87	**28.95**	20 TO 30
POUNDS OF MOISTURE	4	10,056	0	3,200	13,260	
NUMBER OF UNITS	400	23,661	0	5,915	29,977	
PERCENT MOISTURE					**44.24**	50 TO 65%

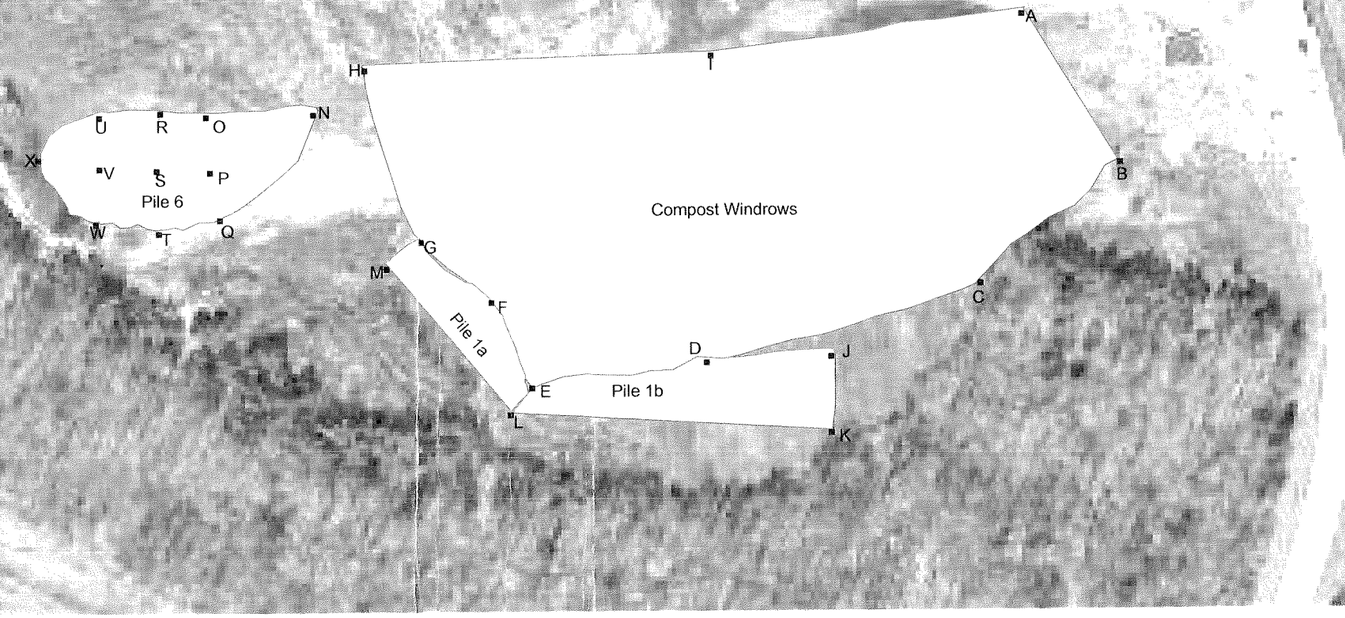
Figure 1
Area Plan

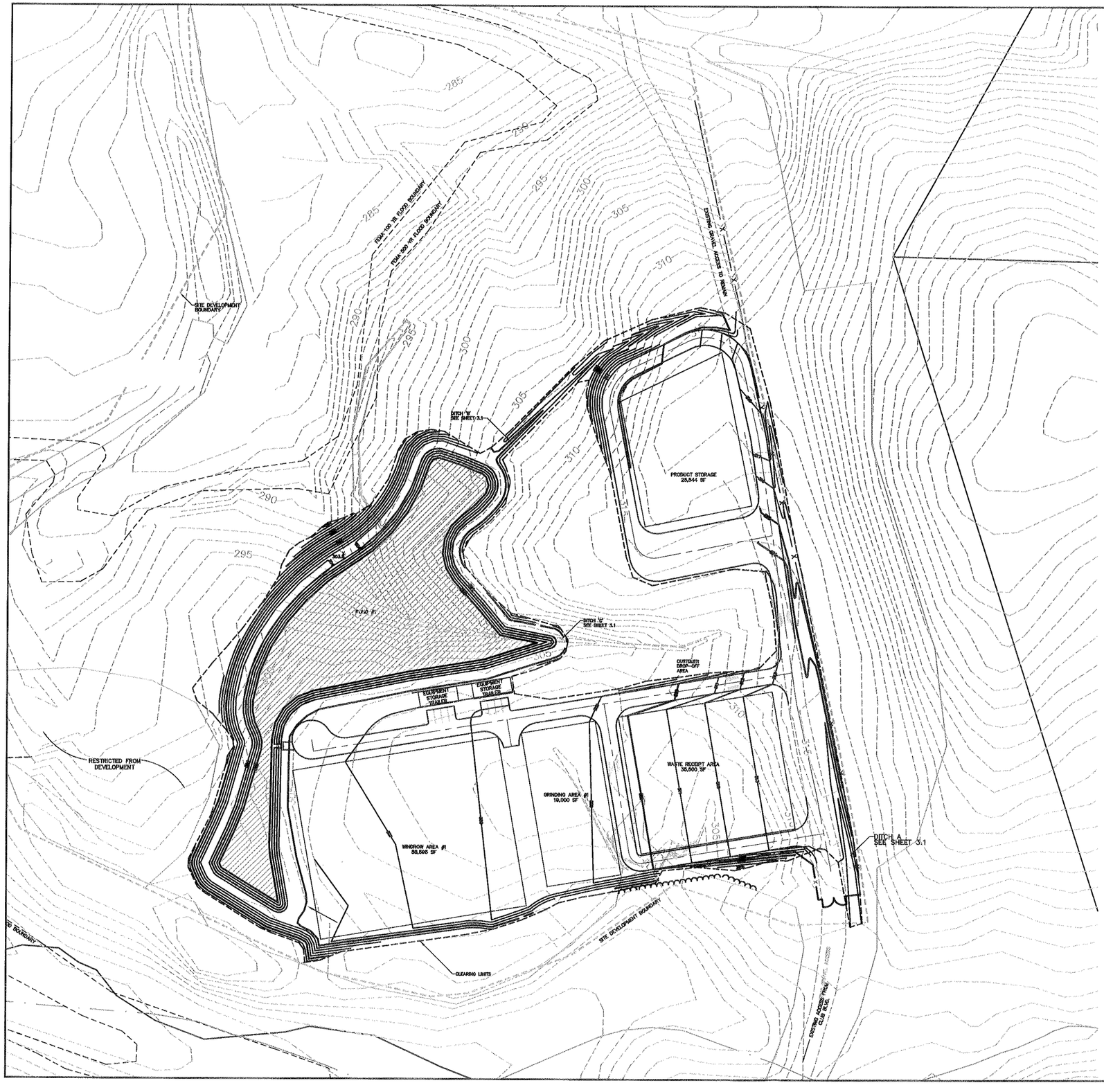

Ellerbe Creek
SITE

Figure 2
Site Plan

Durham Compost Facility







Site Volume Table: Adjusted

Site	Stratum Surf1	Surf2	Cut cy	Fill cy	Net cy	Method
durham_waste_site_LDD	durhamwaste	existing proposed	5394.27	17651.49	12257.21 (F)	Grid

GENERAL NOTES--GRADING

CUT AND FILL SLOPES SHALL HAVE SIDE SLOPES NO STEEPER THAN 4:1 EXCEPT AS PROVIDED BELOW:

SLOPES BETWEEN 3:1 AND 4:1 MAY BE ALLOWED IF STABILIZED WITH VEGETATION THAT REQUIRES MINIMAL MAINTENANCE SUCH AS WEEPING LOVE GRASS, RED FESCUE OR OTHER VARIETY WITH SIMILAR CHARACTERISTICS. SUCH SLOPES SHALL NOT BE STABILIZED WITH TURF GRASS.

SLOPES THAT ARE STEEPER THAN 3:1 MAY BE ALLOWED IF STABILIZED WITH PERMANENT SLOPE RETENTION DEVICES OR A SUITABLE COMBINATION OF PLANTINGS AND RETENTION DEVICES. SLOPES BETWEEN 2:1 AND 2.5:1 SHALL REQUIRE STRUCTURAL REINFORCING SUCH AS GEOGRID AND ONE AND ONE--HALF (1.5) YEAR LIFE BIODEGRADABLE EROSION CONTROL MATTING. SLOPES BETWEEN 2.5:1 AND 3:1 SHALL REQUIRE ONE AND ONE HALF (1.5) YEAR BIODEGRADABLE EROSION CONTROL MATTING.

GRAPHIC SCALE

60' 0 60' 120'

(IN FEET)
1 inch = 60 ft.

CITY OF DURHAM
PUBLIC WORKS DEPARTMENT
APPROVED

ENGINEERING _____ DATE _____
STORM WATER _____ DATE _____
TRANSPORTATION _____ DATE _____
_____ DATE _____
_____ DATE _____

FINAL DESIGN-NOT FOR CONSTRUCTION

REVISIONS

NO.	DATE	DESCRIPTION	APPROVED
1.			
2.			
3.			

KCI Associates of North Carolina, PA
Engineers • Planners • Scientists • Construction Managers
4601 Six Forks Road, Landmark Center II, Suite 220
Raleigh, NC 27609-5210
Phone (919) 783-9214
Fax (919) 783-9266
http://www.kci.com

DURHAM YARD WASTE CONSTRUCTION PLANS

CITY OF DURHAM
DURHAM COUNTY

GRADING AND DRAINAGE PLAN

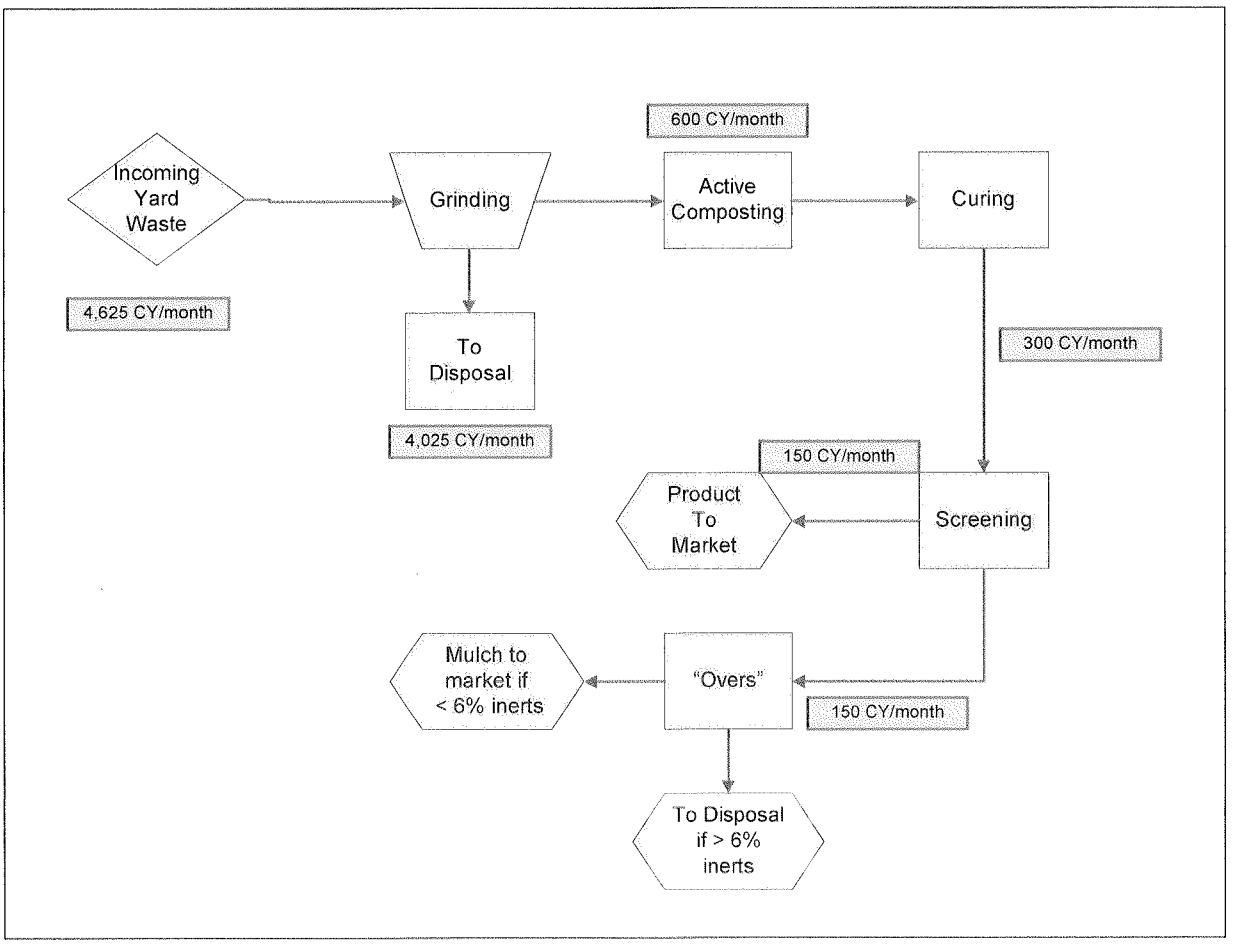
NORTH CAROLINA PROFESSIONAL SEAL 7466 ENGINEER DAVID M. KOSS

HORZ SCALE:	
VERT SCALE:	
DRAWN BY:	ACL
CHECKED BY:	FR
DATE:	08-25-08
PROJECT NO.	12065870A
SHEET NO.	C-3
SHEET	OF

3.4 Compost System Process Design

A Process Flow Diagram of the Durham Composting Facility is presented in Figure 3.

Figure 3
Process Flow Diagram



3.4.1 Grinding/Preparation

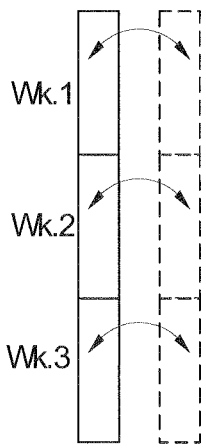
Incoming yard waste will be ground by a contractor using either a tub or horizontal grinder who will grind up accumulated yard waste materials every week. Under average conditions, the contractor will have to grind about 213 cubic yards per day. The contractor will have to form two (2) temporary storage piles, each 25' wide x 10' high x 160' long.

The contractor will grind all the incoming materials together. In the spring, with the higher percentage of grass clippings in the yard waste, the natural ratio of high-carbon

brushy material to high-nitrogen grass clippings should be about 2:1. If the site operators observe higher amounts of grass clippings in a load, they will "pre-mix" those clippings with previously-ground brushy material to help maintain the acceptable C:N ratios. In other seasons, with lesser grass clippings, this step will not likely be needed. The compost recipes in Table 2 call for the use of small amounts of urea fertilizer to adjust C:N ratios. This is the same procedure used by the Mecklenburg County Compost Central yard waste composting facility in Charlotte, NC (although they only add urea during the fall high-leaf waste season).

3.4.2 Active Composting

Composting will be done with the turned windrow method, where the windrows will be built with front end loaders and where windrows will be turned with a front end loader (FEL). Windrows will be turned a minimum of one (1) time in a 3-day consecutive period once windrow temperatures have reached 131° F (in accordance with the requirements of 15A NCAC 13B.1406(10). Windrows will be turned weekly after that. Aeration in the windrows will be provided by turning and the passive "chimney" effect of air movement in a windrow with adequate porosity (35-50% free air space). Total windrow residence time is planned to be about six (6) months for both composting and curing.



Wks 1-3 (typ.)

Due to the size of the designated Windrow Area #1, the facility will only be able to process about 30 CY/day of freshly ground yard waste (the remainder will be shipped off-site for out-of-state landfilling or sold as boiler fuel or feedstock to another composting facility). Windrow Area #1 will be set up for thirteen (13) windrows, each 7' high by 14' wide x 215' long. It will take about 3 weeks to completely build out a windrow so windrow turning will be done using the "open-space" turning method. In this method, a FEL is used to pick up the windrow and physically relocate it to an adjacent "windrow space", mixing the material as the new windrow is reformed.

The City may elect to purchase a straddle-type windrow turner in the future to optimize the production space on the compost pad.

3.4.3 Curing

Curing will be done "in-place", that is, the material will be left in the windrow after the active composting phase is complete. Windrows that have finished composting will be combined for curing to utilize the volumetric shrinkage that occurs during composting to free up additional pad area for active composting.

3.4.4 Screening

Screening will be done by the Contractor with a vibratory screen. Screening rejects ("overs") will be stored in maximum 10' high piles in the Product Storage Area and will be used internally by the City of Durham.

3.4.5 Product Storage

Following final curing and screening, finished compost product is stored in the Product Storage Area (see Figure 2). This area is sized to hold six (6) months accumulation of product inventory. "Overs" will be stored in an adjacent storage area. Both the Product Storage Area and the Screened Overs Storage Area will be about 20' wide by 120' long and consist of a maximum ten (10)-foot tall pile of material covering the storage area. There is no need to windrow this finished material. If the "overs" contain less than 6% inert matter, they will be sold/donated as an "enhanced" mulch. If they contain more than 6% inerts, the "overs" will be disposed of at the Transfer Station. The percentage of inerts in the "overs" will be determined by the methodology specified in 15A NCAC 13B.1408(a)(5).

3.5 Environmental Controls

3.5.1 Storm water

Storm water management at the site will be provided by the construction of an extended detention pond sized to capture and control the runoff from the site arising from a 100-year, 24-hour storm (approximately 160,000 cubic feet). Runoff from areas upgradient of the compost facility will be re-routed around the facility by the use of swales and berms. Runoff water will be periodically pumped out and hauled to a wastewater treatment plant.

3.5.2 Erosion Control

In the event of any land-disturbing activities at the Durham compost facility, the City will contact DENR-DLQ regarding any needed permits.

3.5.3 Air Pollution

The only potential air pollutants generated at the Durham compost facility are odors and dust. Odors arising from the composting operation (as distinct from those arising from the nearby wastewater treatment plant) are minimized by following good composting management practices (i.e. promptly mixing grass clippings, keeping moisture levels below 65%, and ensuring adequate porosity in the compost piles). The compost facility is in the middle of the 260-acre City property and there are

significant buffer areas between the facility and the nearest residences (the closest is over 800 feet away, in the prevailing wind direction).

Dust can be generated during screening operations. The lack of any nearby neighbors and the presence of thickly wooded buffer areas around the composting operation minimize any risk of dust nuisance problems.

3.5.4 Noise

There are no sources of noise other than those associated with normal equipment operations (i.e. back-up beepers). Distances to off-site potential sensitive receptors are great enough to mitigate any noise before it reaches the property line.

3.6 Contingency Plans

3.6.1 Equipment Breakdown

The Durham Department of Solid Waste Management has existing contingency plans in the event of equipment failure, including: an on-site Master Mechanic, on-site support from the City's Fleet Management Department, availability of substitute equipment from other City departments, and the ability to lease equipment and/or services as necessary.

3.6.2 Air Pollution

Careful attention to operating practices is the key at Durham compost facility to minimizing any odorous air pollutants from the composting operation, including:

- Prompt grinding of accumulated yard waste and prompt inclusion of incoming grass clippings into windrows
- Proper mixing and windrow construction
- Avoiding windrow turning during temperature inversions with low wind speeds
- Covering any odorous material with either finished compost or wood waste

Dust is minimized by not screening during periods of high winds in the direction of the residence approximately 800 feet northeast of the screening area.

3.6.3 Non-conforming Waste

Any non-conforming waste arriving at the Durham Compost Facility must pass through two inspections: one by camera at the scale house, where vehicles are re-routed to the citizen and commercial drop-off areas of the solid waste transfer station to remove non-conforming waste before proceeding to the yard waste area; and visual inspections by facility staff during the unloading process. Any non-conforming waste

found during the unloading process is directed to an on-site 8-CY dumpster, which is periodically emptied at the Transfer Station.

3.6.4 Spillage

The Durham compost facility will not allow any wastes to be delivered other than yard wastes (branches, brush, leaves, clippings, etc.). No liquids or semi-solid solid wastes will be accepted, thus minimizing the potential for waste spillage. Non-conforming wastes arriving commingled with yard waste will be redirected to the Solid Waste Transfer Station further minimizing the potential for spillage on-site.

3.6.5 Undesirable Conditions

Undesirable conditions include fires, vectors, and odors (15A NCAC 13B.1405(a)(10)(B)). Odors have been addressed above.

In the event of fire, the personnel at the Durham Composting Facility have been trained to contact 911 and seek assistance from the local fire department.

Vectors (i.e. flies, mosquitoes, rodents, etc.) are a potential problem with mismanaged yard waste composting operations. Proper windrow management by regular turning will prevent rodents from nesting in windrows and by turning windrows, fly larvae and eggs are exposed to the higher interior temperatures of the windrows. Windrows should be turned weekly to break fly reproductive cycles. Mosquitoes and similar insects who breed in pools of standing water can be controlled by proper pad slope and drainage (at least 2%).

3.7 Quality Assurance Plan

3.7.1 Feedstock Monitoring

Incoming loads of yard waste are visually inspected for contaminants (plastic, metal and glass), which are removed manually.

3.7.2 Process Monitoring

3.7.2.1 Moisture

Moisture content of the yard waste compost will be monitored periodically with a "squeeze test". A handful of the fresh mix is squeezed into a ball in the hand; if water drips out it is too wet. If it crumbles apart after being squeezed, it is too dry. In the event of the material being too wet, the City will increase windrow turning frequency to enhance moisture evaporation. If the mix is too dry, the City will add moisture by either a water truck or by using potable water. Storm water from the on-site pond will not be used for moisture control.

3.7.2.2 Temperature

Temperatures are monitored in the composting windrows using a Reotemp™ 36" compost thermometer. Temperatures are monitored Mondays through Fridays (except for holidays) for at least the first seven to ten days to ensure that temperatures meet regulatory requirements. Temperature data is recorded on the Temperature Monitoring Form (see Section 4, Operations Plan). Any windrow not meeting the 15A NCAC 13B.1406 (10) requirement of 55° C. (131 F) or greater for three consecutive days will be torn down and the contents remixed with freshly ground yard waste, thus restarting the composting process.

3.7.3 Sampling & Analysis

The city will test the compost every six months for the parameters indicated in 15A NCAC 13B.1407 and 15A NCAC 13B.1408. Samples may be analyzed by the NC Dept. of Agriculture and by a local laboratory for pathogens and mercury content (these tests are not available from NCDA&CS).

After 90 days in a windrow, compost should be tested with a Solvita® test to see if it meets a compost stability standard score of "6" or more, indicating that the curing phase has begun. Solvita® test kits are available from www.solvita.com. Compost stability and maturity are important considerations for knowing when compost is ready to be used as a soil amendment. Stability refers to the degradation of the organic wastes used to make compost. Stable compost means the wastes have decomposed and no longer resemble the original material used in the mix. Solvita® is based on a gel-colorimetry technology in which respiration gases from composts are captured and accurately indicated in a color-coded system calibrated to a wide range of known conditions. The test measures carbon dioxide (CO_2) respiration and ammonia (NH_3) volatilization.

Testing of finished compost may also include other parameters for market support reasons.

3.7.4 Recordkeeping

In addition to temperature, moisture and stability data, plant operators will also track quantities of incoming yard wastes, dates of initial windrow formation, estimated composition of the windrow, turning dates, and approximate dates when the curing process began. Copies of all operational data, process monitoring logs and any compost lab analysis results will be kept on file in the operational log for the Durham compost facility. An Annual Report will be filed with NC DENR DWM by August 1st of each year, covering the period preceding between July 1 and June 30.

3.8 Product Marketing & Distribution

3.8.1 Markets

Under average monthly waste receipt conditions, the compost facility will produce approximately 150 CY each of compost product and screened overs ("enhanced mulch"). Any compost product not meeting the city's quality standards or the quality requirements in 15A NCAC 13B.1407 will either be recomposted with fresh feedstocks (depending on available pad space) or be used within the Public Works complex for applications such as vegetative enhancement of the final cover on the closed-out landfill, sediment and erosion control within the complex, etc., subject to specific usage approval by DENR-DWM.

The City will use the compost and mulch products for internal municipal uses.

In the event market conditions force an increase in product inventories at the compost facility in excess of one (1) year, and if on-site uses do not allow adequate inventory reduction, the City will negotiate an agreement for discounted wholesale distribution to one of the other major composting operations in North Carolina or provide material at no charge.

3.8.2 Distribution

The City will not distribute its products.

Section 4
Operations Plan
(15A NCAC 13B.1406)

4.1 General Facility Operations

4.1.1 Composting Overview

Composting is the controlled aerobic decomposition of organic materials by microorganisms into a stable, mature soil-like end product (compost). The City of Durham compost facility uses the turned windrow method of composting, wherein organic materials are mixed and formed into triangular-shaped windrows and turned periodically to reaerate the windrow, release heat and moisture, and to maintain porosity.

4.1.2 Contact and Facility Information

Any questions or correspondence regarding the Durham facility should be directed to:

Mr. Donald Long
Director, Department of Solid Waste Management
City of Durham
101 City Hall Plaza
Durham, NC 27701
Tel: (919) 560-4186
Fax: (919) 560-1228
Email: Donald.Long@durhamnc.gov

The compost facility is open Mondays through Fridays from 7:30 AM until 4:30 PM. On Saturdays, the facility is open from 7:30 AM to 12 Noon.

4.1.3 Access Control

Access to the Durham compost facility is limited to normal operating hours (see above). Outside of normal operating hours, the entire municipal public works complex is closed, with locked gates and video camera security at several points. The entire complex is fenced off to prevent unauthorized access.

4.1.4 Signage

Several signs containing the information required by NC DENR-DWM have been placed near the public entrance to the City's public works complex, indicating hours of operation, permit number and acceptable and non-acceptable wastes.

4.1.5 Fire Management

Fires can start in composting facilities through three primary mechanisms: spontaneous combustion in compost piles that have excessively low moisture content, carelessly discarded cigarettes/cigars, and fires caused by internal combustion engine malfunctions. Fire potential will be reduced at the Durham compost facility by careful attention to moisture content in the windrows, sizes of storage piles (less than 12 feet high by 20 feet wide and 200 feet long), enforcing a "no-smoking" rule at the facility, and preventive maintenance procedures on equipment . Fire extinguishers at the compost facility will be used in the event of equipment-related fires. In the event of fire, the local fire department will be called.

4.1.6 Health & Safety

The facility will be operated to ensure the health and safety of City staff, contractor staff and the general public at all times. Open burning is prohibited at the site and any fire observed will be handled using the facility's fire management procedures. Fire extinguishers will be carried on all mobile equipment for use in the event of a fire involving a piece of equipment. All personnel at the compost facility will be trained in the safety procedures of the facility and of the City. The City of Durham has several health and safety policies currently in effect. These include:

S201 - Safety and Health Policy
S202 - Monthly Safety Inspections of City Facilities
S203 - Response to OSHA Complaints and Routine Inspections
S204 - First Aid Kits
S206 - On-the-job Accident Report
S301 - General Safety Rules
S401 - Housekeeping Policy
S501 - Personal Protective Equipment
S502 - Hearing Conservation
S503 - Respiratory Protection Policy
S504 - Safety Shoe Policy
S601 - Airborne Contaminants, Pathogens and Carcinogens
S602 - Bloodborne Pathogens
S602A - Bloodborne Pathogens
S603 - Chemical Hygiene in Laboratories
S605 - Injury and Illness Record Keeping
S606 - Airborne Contaminants, Pathogens and Carcinogens
S607 - Access to Medical and Exposure Records
S607A - Access to Medical and Exposure Records
S701 - Fire Protection
S702 - Emergency Action Plan Policy
S801 - Hand and Portable Power Tools
S802 - Ladders and Scaffolds
S803 - Lockout/Tagout
S804 - Fall Protection
S805 - Electrical Safety-Related Work Practices
S901 - Public Safety Personnel Policy
S902 - Welding and Cutting Operations
S904 - Trenching and Excavating
S906 - Handling of Materials
S908 - Hazard Communications
S1001 - Vehicle/Equipment Maintenance Safety
S1002 - Trailer Tongue Jack Policy
S1101 - Employee Driver's License Policy
S1102 - Operation of City Vehicles and Motorized Equipment
S1103 - Alcohol and Drug Testing Requirements for CDL Holders

All operations at the Durham compost facility will be conducted in accordance with these policies.

4.1.7 Recordkeeping Program

The Durham compost facility will maintain the following records in its operational records:

- Daily records of incoming yard waste
- Quantities of unacceptable wastes received (in tons) and the ultimate disposition of those wastes
- Estimated composition of the windrow
- Dates of initial windrow formation
- Turning dates
- Approximate dates when the curing process began.
- Temperature monitoring records for regulatory compliance
- Compost quality analytical laboratory test results, and
- Disposition of product that did not meet regulatory standards

An example of an operational log form is included in Table 3.

An annual report for the period from July 1 to June 30 shall be submitted by the City to the DENR Division of Waste Management by August 1 of each year. The report shall include:

1. The facility name, address and permit number;
2. The total quantity (in tons) and type of waste received at the facility during the year covered by the reports, including tons of waste received from local governments of origin;
3. The total quantity (in tons) and type of waste processed into compost during the year covered by the report;
4. The total quantity (in tons) and type of compost produced at the facility, by product classification, during the year covered by the report;
5. The total quantity (in tons) and type of compost removed for use or disposal from the facility, by product classification, along with a general description of the market during the year covered by the report; and
6. Temperature monitoring records to verify compliance with 15A NCAC 13B.1406(10).

Monthly reports, which contain daily logbook entries, as well as a copy of the annual report, will be kept in the official operating record in the City's Solid Waste Management offices.

City of Durham YWCF Date _____
Operational Log Operator _____

Waste Management

Amount of new yard waste in (CY) _____
Amount of unacceptable waste (%) _____
What happened to unacceptable waste?

New Composting Windrows

Windrow No.: _____

Which part? _____ First third _____ 2nd third _____ Last third

Date Windrow Built _____

What was windrow made of?

_____ % grass _____ % brush _____ % leaves

Amount of urea added (lbs) _____

Existing Windrows

Windrow #:	1	2	3	4	5	6	7
Turned? (Y/N)							
Temperatures:							
Location 1							
Location 2							
Location 3							
Water Added? (Y/N)							
Solvita Test Result							

Windrow #:	8	9	10	11	12	13
Turned? (Y/N)						
Temperatures:						
Location 1						
Location 2						
Location 3						
Water Added? (Y/N)						
Solvita Test Result						

Product Management

Quantity Screened (CY) _____
Amount of compost (CY) _____
Amount of overs (CY) _____

Table 3
Example Operational Log

4.2 Compost Operations

4.2.1 Waste Receipt

Incoming waste shall consist only of yard waste, which is leaves, grass clippings, stems, pruning materials, small brush and biodegradable paper yard waste bags generated in residential and commercial lawn and garden care in the City of Durham, and clean wood waste including pallets. The waste is to be received and weighed at the scale house, and checked for unacceptable wastes. Any unacceptable wastes shall be removed by the customer and disposed of in the designated disposal container at the Recycling Center. Uncontaminated yard waste shall then be unloaded by the compost facility customer at the Waste Receipt Area.

At the compost facility, the site operator will conduct a second inspection of the incoming yard waste. Vehicles containing unacceptable waste will be rejected. Any extraneous unaccepted waste found while unloading or after the customer has left the site shall be placed into a dumpster at the composting facility.

Incoming yard waste will be stockpiled in the Waste Receipt Area on a daily basis. On a daily basis, facility operators will push the waste, using front end loaders, into windrows, each a maximum of approximately 12' high by 24' wide by 200' long, spaced approximately 25' apart to allow room for fire-fighting equipment. Approximately four (4) storage piles will fit in the designated area after allowing for fire lanes.

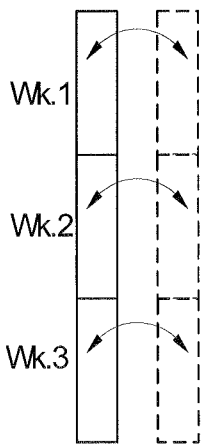
4.2.2 Feedstock Preparation

At least every week an outside contractor will come in to grind up the accumulated waste in the designated Grinding Area. Ground up material will then be formed into piles for temporary storage. Under average conditions, the contractor will have to grind about 213 cubic yards per day. The contractor will have to form two (2) temporary storage piles, each 25' wide x 10' high x 160' long. As these piles will only hold about 1.5 weeks of yard waste grinding quantities, that material which is not diverted to the Windrow Area #1 for composting will be moved off-site for use as boiler fuel or transferred to out-of-state landfills.

The contractor will grind all the incoming materials together. In the spring, with the higher percentage of grass clippings in the yard waste, the natural ratio of high-carbon brushy material to high-nitrogen grass clippings should be about 2:1. If the site operators observe higher amounts of grass clippings in a load, they will "pre-mix" those clippings with previously-ground brushy material to help maintain the acceptable C:N ratios. In other seasons, with lesser grass clippings, this step will not likely be needed. The compost recipes used by the City call for the use of small amounts of urea fertilizer to adjust C:N ratios.

4.2.3 Active Composting

Composting will be done with the turned windrow method, where the windrows will be built with front end loaders and where windrows will be turned with a front end loader (FEL). Windrows will be turned a minimum of one (1) time in a 3-day consecutive period once windrow temperatures have reached 131° F (in accordance with the requirements of 15A NCAC 13B.1406(10). Windrows will be turned weekly after that. Aeration in the windrows will be provided by turning and the passive "chimney" effect of air movement in a windrow with adequate porosity (35-50% free air space). Total windrow residence time is planned to be about six (6) months for both composting and curing.



Wks 1-3 (typ.)

Due to the size of the designated Windrow Area #1, the facility will only be able to process about 30 CY/day of freshly ground yard waste (the remainder will be shipped off-site for out-of-state landfilling or sold as boiler fuel or feedstock to another composting facility). Windrow Area #1 will be set up for thirteen (13) windrows, each 7' high by 14' wide x 215' long. It will take about 3 weeks to completely build out a windrow so windrow turning will be done using the "open-space" turning method. In this method, a FEL is used to pick up the windrow and physically relocate it to an adjacent "windrow space", mixing the material as the new windrow is reformed.

At some point in the future, the City may elect to purchase a windrow straddle-type turner to turn windrows and to optimize processing capacity on the compost pad.

4.2.4 Curing

Curing will be done "in-place", that is, the material will be left in the windrow after the active composting phase is complete. Windrows that have finished composting will be combined for curing to utilize the volumetric shrinkage that occurs during composting to free up additional pad area for active composting.

4.2.5 Screening

Screening will be done by the Contractor with a vibratory screen. Screening rejects ("overs") will be stored in maximum 10' high piles in the Product Storage Area and will be used for internal purposes by the City of Durham.

4.2.6 Product Storage

Following final curing and screening, finished compost product is stored in the Product Storage Area (see Figure 2). This area is sized to hold six (6) months accumulation of product inventory. "Overs" will be stored in an adjacent storage area. Both the

Product Storage Area and the Screened Overs Storage Area will be about 20' wide by 120' long and consist of a maximum ten (10)-foot tall pile of material covering the storage area. There is no need to windrow this finished material. If the "overs" contain more than 6% inerts, the "overs" will be disposed of at the Transfer Station. The percentage of inerts in the "overs" will be determined by the methodology specified in 15A NCAC 13B.1408(a)(5).

4.2.7 Process Monitoring

Moisture

Moisture content of the yard waste compost will be monitored periodically [at least how often?] with a "squeeze test". A handful of the fresh mix is squeezed into a ball in the hand; if water drips out it is too wet. If it crumbles apart after being squeezed, it is too dry. In the event of the material being too wet, the City will increase windrow turning frequency to enhance moisture evaporation. If the mix is too dry, the City will add moisture by either a water truck or by using potable water. The on-site storm water pond is not to be used for watering windrows.

Temperature

Temperatures are monitored in the composting windrows using a Reotemp™ 36" compost thermometer. Temperatures are monitored Mondays through Fridays (except for holidays) for at least the first seven to ten days after windrowing to ensure that temperatures meet regulatory requirements. Temperature data is recorded on the Operational Log (see Table 3). Any windrow not meeting the 15A NCAC 13B.1406 (10) requirement of 55° C. (131 F) or greater for three consecutive days will be torn down and the contents remixed with freshly ground yard waste, thus restarting the composting process.

4.2.8 Staffing

The City will provide a part-time attendant to oversee the facility and seek to retain a private contractor to handle most of the work in processing yard wastes and composting material.

4.3 Environmental Management

4.3.1 Surface Water Control

Surface water control is needed to ensure that rainfall-induced runoff that may be contaminated with waste materials at a composting facility does not cause water quality problems in nearby streams. Surface water control will be achieved with an extended detention or bioretention pond. This pond will be inspected by Facility staff daily. Inspection requirements will address the following at a minimum:

- Inspect plantings
- Settling, woody growth, animal burrowing, and signs of piping in the embankment
- Signs of seepage on the downstream face of the embankment
- Condition of wet detention basin floor, perimeter of the wet detention basin, and grass cover on the embankment
- Excessive erosion or sedimentation in or around the basin
- Riprap displacement or failure
- Principal and emergency spillway meet design plans for operation
- Outlet controls, inlet controls, debris racks, and mechanical and electrical equipment
- Inlet and outlet channel conditions
- Stability of slopes
- Safety features of the facility
- Access for maintenance equipment
- Signs of trespass or unauthorized traffic
- Sediment build–up

4.3.2 Odors

Odors (and air quality) will be managed in accordance with 15A NCAC 2D, Air Pollution Control Requirements, to minimize fugitive emissions and odors. Odors and dust are the two main air quality issues associated with composting. Odors will be minimized by careful attention to incorporating grass clippings into windrows within 24 hours of receipt, ensuring good porosity in compost windrows, and keeping moisture levels at appropriate levels. In the case of unusual odor conditions, a 6" blanket of finished compost will be placed over the windrows for absorption of odors.

4.3.3 Vectors

Vectors (i.e. flies, mosquitoes, rodents, etc.) are a potential problem with mismanaged yard waste composting operations. Proper windrow management by regular turning will prevent rodents from nesting in windrows and by turning windrows, fly larvae and eggs are exposed to the higher interior temperatures of the windrows. Windrows should be turned weekly to break fly reproductive cycles. Mosquitoes and similar insects who breed in pools of standing water can be controlled by proper pad slope and drainage (at least 2%).

4.3.4 Dust

Dust will be controlled by avoiding screening activities in dry, windy conditions. A water truck is available for dust suppression in severely dry weather.

4.3.5 Severe Weather Conditions

Operations at the compost facility will be covered by the City of Durham Adverse Weather Plan, which calls for cessation of waste collection activities during severe weather events. The solid waste transfer station, however, tries to remain in operation during most weather events. The compost facility is open whenever the transfer station is open. The Durham Solid Waste Adverse Weather Plan is provided in Appendix D.

4.4 Equipment Maintenance

All City equipment used in Solid Waste Operations is routinely maintained for proper performance with a very thorough Preventive Maintenance Program.

4.5 Site Maintenance

Maintaining the Durham YWCF site in a good operational condition is an important part of successful composting operations. Areas where site maintenance is important are: repairing eroded and rutted areas, maintaining site access roads, and in making sure the storm water pond operates properly.

Facility staff will conduct a "walk-around" inspection of the whole facility every morning. Problems will be noted in the operational log and repair work will be scheduled as soon as practicable. Eroded or rutted areas in the compost pad will be repaired with compacted fill dirt. Rutted area in the gravel access roads will be repaired with fresh gravel. For observed problems with the storm water pond, a qualified contractor will be called in.

Appendix A

Zoning Approval Letter from City of Durham

DURHAM
1869
CITY OF MEDICINE

CITY OF DURHAM | DURHAM COUNTY
City-County Planning Department
101 CITY HALL PLAZA | DURHAM, NC 27701
919.560.4137 | F 919.560.4641

www.durhamnc.gov

October 2, 2006

Ted Lyon, Branch Head
Solid Waste Composting and Land Applications Branch
Solid Waste Section
Division of Waste Management
NC Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Subject: **Zoning and Subdivision Consistency Determination For:**
Yard Waste Compost Facility
Glenn Road, Durham, NC
PIN: 0843-03-34-9342, 0843-03-32-9488

Dear Mr. Fuller:

This letter is to confirm zoning consistency for the City of Durham's Type 1 Solid Waste Compost Facility (15 NCAC 13B.1400 etc.) permit application for the above referenced project. This office has reviewed the application and makes the following findings:

1. The property in question is zoned IL(D)/I(D).
2. The use of the facility as a yard waste compost facility is an allowable use pursuant to Section 5 of the Unified Development Ordinance.
3. The proposed use will be in compliance with all local zoning and subdivision regulations.

Should you have any questions regarding this matter, please contact the undersigned at (919)560-4137, ext. 223.

Sincerely,

Steven L. Medlin, AICP
Assistant Planning Director

Cc: Julia Mullen, Solid Waste
Teri Danner, Supervisor, Design Review

Appendix B

Site Soil Test Report

AGRICULTURAL
EXTENSION
SERVICE

North Carolina State University
College of Agriculture and Life Sciences

Address reply to:
County Extension Office

721 Foster Street
Durham, North Carolina 27701
November 4, 1991

Nancy Clayton
City of Durham Sanitation Dept.
101 City Hall Plaze
Durham, N.C. 27701

Dear Ms. Clayton:

I visited the Durham City Landfill at 2115 E. Club Blvd. on October 30, 1991 for the purpose fo evaluating the soil at the proposed composting site.

A pit was dug approximately 4 feet deep. I collected soil samples from the bottom and sides of the pit for textural classification and for evidence of water table levels. I determined that the sample was a loam soil. This was confirmed by Mr. Eddie Culberson of the Soil and Water Conservation Service.

There was no evidence that the water table was present or had ever been present at the bottom of the pit.

I am looking forward to working with you on this project.

Sincerely,

Carl A. Matyac, Ph.D.
Assoc. Agricultural Ext. Agent

Appendix C

Facility Sizing Report

Coker
Composting & Consulting

3331 Glade Creek Blvd., Ste. 7,
Roanoke, VA 24012
(540) 904-2698
Fax: (540) 904-6732
craigcoker@cox.net
www.cokercompost.com

September 26, 2008

MEMORANDUM

To: Dave Koss, KCI
Fred Rash, KCI
From: Craig Coker
Re: Durham Yard Waste Composting Facility
Facility Sizing Report (Revised)

This memorandum outlines the facility sizing issues for the City's yard waste composting facility. It is a revision to my October 23, 2006 memo. It is based, in part, on new tonnage data received from the City on September 25 and on the site plan prepared by KCI dated February 28, 2008.

Incoming Waste Volumes

Tonnage data from the City was provided for the period of 2001 – present and is summarized below:

Month	2001	2002	2003	2004	2005	2006	2007	2008	
January	1,196.0	621.9	1,278.7	915.6	801.7	1,173.4	750.2	1,000.2	
February	1,127.0	794.4	724.7	611.5	568.4	761.0	563.7	797.9	
March	1,320.5	903.1	2,053.8	1,555.5	917.2	1,157.8	1,134.9	1,128.6	
April	1,440.4	1,614.0	2,139.3	1,668.6	1,563.5	1,431.3	1,550.8	1,294.6	
May	1,198.2	1,182.7	2,369.9	1,324.5	1,265.9	1,451.8	1,262.6	1,510.8	
June	1,104.2	763.1	1,648.0	1,185.4	1,152.2	1,243.9	935.0	933.1	
July	892.2	760.5	1,260.0	949.9	1,040.8	983.7	793.8	1,502.6	
August	1,072.3	715.6	1,402.2	1,065.8	1,083.4	872.3	1,450.4	822.6	
September	979.6	885.6	1,970.5	1,136.7	1,085.3	1,223.6	674.9		
October	1,123.5	886.4	1,642.8	1,046.4	941.0	962.9	745.5		
November	1,215.1	1,296.5	1,702.1	1,398.4	1,178.4	1,365.0	972.3		
December	1,045.4	1,343.0	1,269.4	1,050.7	1,231.7	1,237.3	1,152.0		
									Totals
Total	13,714.3	11,766.6	19,461.4	13,909.0	12,829.4	13,863.8	11,986.0	8,990.4	106,520.9
Average Monthly	1,142.9	980.6	1,621.8	1,159.1	1,069.1	1,155.3	998.8	1,123.8	1,156.4
Peak	1,440.4	1,614.0	2,369.9	1,668.6	1,563.5	1,451.8	1,550.8	1,510.8	2,369.9

The average monthly tonnage coming to the facility during the period of record is 1,156.4 tons. Peak monthly tonnage (May, 2003) was 2,369.9 tons but that tonnage is considerably higher than other peak month tonnages during the period.

These tonnages were converted to volumes using a field-measured (in October 2006) bulk density of 500 lbs/cubic yard:

Month	2001	2002	2003	2004	2005	2006	2007	2008		
January	4,783.8	2,487.6	5,114.6	3,662.6	3,206.6	4,693.7	3,000.8	4,000.9		
February	4,508.1	3,177.5	2,898.6	2,446.1	2,273.4	3,044.0	2,254.8	3,191.7		
March	5,281.9	3,612.2	8,215.2	6,221.8	3,668.6	4,631.0	4,539.6	4,514.5		
April	5,761.5	6,455.8	8,557.4	6,674.5	6,254.2	5,725.1	6,203.2	5,178.2		
May	4,792.8	4,730.7	9,479.5	5,297.9	5,063.7	5,807.0	5,050.4	6,043.3		
June	4,416.7	3,052.3	6,592.2	4,741.6	4,608.8	4,975.4	3,740.0	3,732.5		
July	3,568.7	3,042.0	5,039.9	3,799.6	4,163.4	3,934.6	3,175.2	6,010.3		
August	4,289.2	2,862.3	5,608.8	4,263.3	4,333.4	3,489.2	5,801.6	3,290.4		
September	3,918.3	3,542.3	7,882.0	4,546.7	4,341.3	4,894.6	2,699.4			
October	4,494.2	3,545.5	6,571.3	4,185.6	3,763.9	3,851.6	2,981.8			
November	4,860.5	5,186.1	6,808.5	5,593.4	4,713.5	5,460.0	3,889.3			
December	4,181.4	5,372.1	5,077.5	4,202.8	4,926.9	4,949.2	4,607.8			
									Totals	
Total	54,857.2	47,066.5	77,845.5	55,635.8	51,317.8	55,455.4	47,943.9	35,961.7	426,083.7	
Average Monthly	4,571.4	3,922.2	6,487.1	4,636.3	4,276.5	4,621.3	3,995.3	4,495.2	4,625.7	avg. monthly over period
Peak Month	5,761.5	6,455.8	9,479.5	6,674.5	6,254.2	5,807.0	6,203.2	6,043.3	9,479.5	highest volume in period
2nd Peak Month	5,281.9	5,372.1	8,557.4	6,221.8	5,063.7	5,725.1	5,801.6	6,010.3	8,557.4	2nd highest volume in period
3rd Peak Month	4,860.5	5,186.1	8,215.2	5,593.4	4,926.9	5,460.0	5,050.4	5,178.2	8,215.2	3rd highest volume in period

For the purposes of facility sizing, an average incoming monthly volume of 4,626 cubic yards has been used.

Incoming Waste Receipt

Yard waste arriving at the Durham YWCF will be off-loaded into the Waste Receipt Area and stockpiled for later grinding. A dedicated area of 35,600 SF is shown on the site plan for this function. Raw waste piles should be roughly formed into piles, no more than 12' high x 24' wide. The Waste Receipt Area capacity is as follows:

Waste Receipt Area

A. Available area = 35,600 SF
Deduct for portion of customer dropoff gravel lane
Deduct strip 10' W x 200' L = 2000 SF

Net available area =

35,600 - 2,000 =	33600	SF

B. Waste Storage Piles

Assume maximum of 12' high
Use 2:1 width:height ratio
Maximum width = 24'
Area : use high parabolic formula (NRAES-114, p.11)

A = (2/3)(base)(height)		
A = (0.667)(24')(12') =	192.096	SF

Volume = Area x Length

V = (192.096)(200) =	38419.2	Cubic feet
=	1422.9	Cubic yards

C. Capacity of Waste Receipt Area for average volumes

Allow a 25-foot fire-fighting access aisle between piles
Each pile = 24 feet wide

Available width = 178' - 10' =	168	ft
Assume 4 piles, 3 aisles:		
(4 x 24' w) + (3 x 25' w) =	171	ft.
Available volume:		
4 piles @ 1,423 CY/pile =	5691.7	CY
Average monthly volume =	4625.7	CY
Capacity:		
5,691.7 CY / 4,625.7 CY =	1.230	months

D. Capacity of Waste Receipt Area for peak volumes:

Peak monthly volume of record =	9479.5	CY
Capacity:		
5,691.7 CY / 9,479.5 CY =	60%	

The Waste Receipt Area will handle about 5 weeks worth of average incoming yard waste quantities, so weekly grinding by the City's contractor should be able to keep up with incoming volumes (allowing for inevitable downtime). Peak volumes of yard waste/storm debris, on the other hand, cannot be accommodated in this area, so another storm debris storage area will be needed.

Incoming Waste Processing

As I understand it, the City's contractor will mobilize on-site to grind accumulated yard waste every week. Based on average monthly waste receipt volumes, approximately 1,150 cubic yards of ground material will be produced weekly (based on an 5-day work week).

Grinding Area

A. Available space: 95' W x 200' L =	19000	SF

B. Average monthly grinding conditions:

Avg. monthly volume =	4625.7	CY/month
Grinding days / month =	20	days/month
Avg. daily grinding volume =	231.3	CY/day
Weekly grind volume =		
231.3 CY/day x 5 days/week =	1156.4	CY/week

Ground material storage requirements

Assume 10' H x 20' W piles, 160' long
A 10' x 20' pile has a capacity of 4.93 CY/LF
(Source: NRAES-114, p. 13)

Linear footage needed:		
(1,156.4 CY/wk / 4.93 CY/LF) =	234.6	LF/wk
Number of piles needed weekly:		
638.9 LF/wk / 160' =	1.47	use 2 piles
Area Needed Weekly:		
Assume 25' aisles		
Piles: 2 x 20' x 160' =	6400	SF
Aisles: 1 x 25' x 160' =	4000	SF
Total =	10400	SF/wk
Capacity:		
Assume 2,000 SF needed for grinder		
Net remaining area = 17,000 SF		
17,000 SF / 10,400 SF/wk =	1.6	weeks

C. Peak monthly grinding conditions:

Peak monthly volume =	9480.0	CY/month
Grinding days / month =	20	days/month
Avg. daily grinding volume =	474.0	CY/day
Weekly grind volume =		
474.0 CY/day x 5 days/week =	2370.0	CY/week

Ground material storage requirements

Assume 10' H x 20' W piles, 160' long
A 10' x 20' pile has a capacity of 4.93 CY/LF
(Source: NRAES-114, p. 13)

Linear footage needed:		
(2370 CY/wk / 4.93 CY/LF) =	480.7	LF/wk
Number of piles needed weekly:		
480.7 LF/wk / 160' =	3.00	use 3 piles
Area Needed Weekly:		
Assume 25' aisles		
Piles: 3 x 20' x 160' =	9600	SF
Aisles: 2 x 25' x 160' =	8000	SF
Total =	17600	SF/wk
Capacity:		
Assume 2,000 SF needed for grinder		
Net remaining area = 17,000 SF		
17,000 SF / 17,600 SF/wk =	0.97	weeks

The grinding area has enough room to store about 1.5 weeks' worth of grinding production for average monthly volume conditions, but less than one weeks' worth of volume under peak conditions. This material should be moved from the grinder discharge belt and formed into piles using a front-end loader (FEL) with a large capacity bucket. The City's contractor will have to build two (2) piles (10' tall x 20' wide x 160' long) each week. In the event of a peak month (as in May, 2003), approximately 3 similarly-sized piles will have to be built each week. The City may wish to consider using additional front-end loaders to move material in the event of peak waste receipts.

Compost Area Sizing

The recommended process design for the City's facility is a three (3) month active composting period, followed by a three (3) month curing period. Following curing, compost would be screened (to a ½" or 5/8" particle size) for sale. The City will turn windrows with a straddle-type turner, so it is assumed windrows will be 7' tall by 14' wide. This size windrow has a capacity of 1.81 cubic yards of compost per linear foot of windrow.

The available area for windrow composting has been set by NCDENR. This analysis examines how much of the yard waste stream could be handled in this area:

A. Available area: 266' L x 220' W =	58595	SF
Deduct 25' at each end for windrow machine turning radius		
Net available area: [(266'-25'-25') x 220'] =	47520	SF
B. Windrow Configuration:		
Assume 7' H x 14' W windrows, placed 2' apart		
Width of windrow + aisle = 14 + 2 =	16	ft
Area occupied by a single windrow:		
16' W x 216' L =	3456	SF
Number of windrows on pad:		
47,520 SF / 3456 SF/windrow =	13.75	
Assume pad can be expanded to accommodate 14 windrows		
C. Windrow Area #1		
Volume of a single windrow (at initial formation):		
V = A x L = [(0.667 x H x B) x L		
V = [(0.667)(7)(14)] x 216 =	14119.06	CF
Convert to Cubic Yards	522.93	CY
Daily production from grinding area:		
1,154.6 CY/week / 5 days/wk	231.3	CY/day
Time required to build one windrow:		
522.9 CY / 231.3 CY/day =	2.3	days
Time required to build 14 windrows =	31.7	days
Not enough time to allow combining of windrows		
due to volumetric shrinkage to free up more pad space		

D. How much yard waste can be handled in Windrow Area #1

Incoming material from grinding	231.3	CY/day
Composting + curing residence time	180	days
Theoretical total volume of YW on pad for average monthly grinding production =		
231.3 CY/ day * 180 day res. =	41631.05	CY
Theoretical linear footage of new windrows needed		
41,631 CY / 1.81 CY/LF =	23000.58	LF
Theoretical area needed for windrows + aisles		
23,000.6 LF x 16' W =	368009.3	SF
Actual space available:	47520	SF
Percentage capacity of pad =	12.9%	
Average monthly grinding production =	4625.7	CY/month
Capacity of Windrow Area #1 -	**597.3**	**CY/month**
	29.9	**CY/day**

The area of Windrow Area #1 is only sufficient to compost about 600 CY/month (~ 150 tons/month) of yard waste. Windrow Area #1 can hold 13 windrows. The City could divert about 30 CY/day to composting and divert the rest (200 CY/day) to boiler fuel, or as a feedstock to another composting facility in the region.

Product Storage Area

The designated product storage area could be used for both screening and product storage. Alternatively, screening could be done near Windrow Area #1 and the Product Storage Area used solely for storage. Given the inability of Windrow Area #1 to absorb more than 12-13% of the incoming yard waste stream, the City should consider using the Storage Area solely for Product Storage.

The following analysis assumes the storage area is used for storage of both finished compost and for storage of ground yard waste destined for boiler fuel or for another destination:

A. Available area = ~ 140' x ~ 164' = 25544 SF

B. Assume area is divided into compost storage and boiler fuel storage

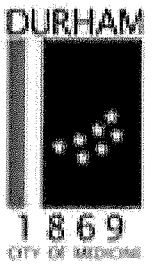
C. Compost Storage
1. Allow for 6 months storage volume
2. Compost production will be ~ 50% of incoming volume = 15 CY/day
3. Storage capacity needed:
   15 CY/ day x 20 days/mo x 6 mos. = 1800 CY
4. Store in 10' H x 20' W piles
   Capacity = 4.93 CY/LF
5. Pile footage needed:
   1800 CY / 4.93 CY/LF = 365 LF
6. Plan on three (3) 120' long piles
7. Area needed:
   3 [120 x 20] = 7200 SF
8. Area remaining for boiler fuel storage + equipment access:

	18344	SF
D. Boiler Fuel Storage		
1. Subtract for 20' W x 160' L equipment access road		
18,344 SF - 3,200 SF =	15144	SF
2. Use 10' H x 20' W x 160' L piles		
Ground area of each pile =	3200	SF
3. Allow for 25' spacing between piles for fire access		
4. For pile width of 20' and access width of 25':		
15,144 SF / 45' =	336.5	LF
5. Volume capacity available =		
336.5 LF x 4.93 CY/LF =	1659.1	CY
6. Inventory storage time =		
1659.1 CY / 200 CY/day production =	8.3	days

Under this scenario, the storage area will only have capacity for about 8 days production of ground yard waste to be used as boiler fuel, although it would have capacity for six months' compost storage.

Appendix D

Adverse Weather Plan



CITY OF DURHAM

DEPARTMENT

OF

SOLID WASTE MANAGEMENT

WINTER WEATHER PLAN

UPDATED: OCTOBER 4, 2006

APPROVED: _____

Donald Long, Director

Department of Solid Waste Management

GENERAL PROVISIONS

Effective Date: October 7, 2004

A Winter Weather Plan has been developed for planning and service coordination effective October 7, 2004, to be execution when directed by the City Manager or the Solid Waste Management Director.

PRIORITIES (RESIDENTIAL/COMMERCIAL)

Refuse collection services provided during adverse winter weather conditions will be conducted in the following priorities to ensure the safety, welfare and health of the citizens of Durham:

FIRST: Priority collection service will be given to hospitals, rest homes and restaurants.

SECOND: Collection will be provided to residents that are along major thoroughfares that can be traveled by collection vehicles.

THIRD: Collection will be provided to the remaining homes on the basis of safe travel along city streets.

NOTE: Service to exempt residents cannot be provided when snow and ice prevent safe collection.

PRIORITIES (TRANSFER STATION)

Adverse weather conditions at the Solid Waste Management Transfer Station and along the route to the City's transfer station may affect disposal operations in Durham. When the adverse conditions are in Durham, the collection of waste is prioritized. Operations that provide refuse disposal in adverse winter weather conditions will be conducted in the following priorities to ensure the safety, welfare and health of the citizens of Durham:

FIRST: Priority disposal service will be given to waste collected from hospitals, rest homes and restaurants. This type of waste is considered top priority for the community.

SECOND: The second priority adds the acceptance of household waste to the list of hospital, rest home and restaurant waste. No commercial, construction or industrial waste will be accepted until full disposal capacity has returned.

SCOPE

The primary responsibility for solid waste collection lies with the Solid Waste Management Department under the general supervision of the Director. The Solid Waste Assistant Director of Operations is assigned the responsibility of the direct supervision of the adverse winter weather collection plan.

The adverse winter weather plan is designed to effectively utilize and commit City personnel and equipment resources to provide the collection service during/after adverse winter weather conditions.

The type and extent of collection service will be dependent on the type of adverse winter weather, road conditions and the known or expected future weather conditions. As a general rule, the collection service will be provided to the maximum amount of collection points that can be reached safely in limited road conditions by City employees and vehicles. Response to specific conditions will be recommended by the Assistant Director of Operations and approved by the Department Director and/or City Manager.

The type and extent of disposal service will be dependent on the type of adverse weather, road conditions and the known or expected future weather conditions locally, at the receiving Transfer Station and along the route to the Transfer Station. As a general rule, the disposal service will be provided to as many vehicles as possible that are bringing waste that has been accepted according to the priorities above, and that can be transported safely during periods of hazardous road conditions by City and contractor employees and vehicles. Response to specific conditions will be coordinated with the Transfer Station Manager, the local CCC contractor representative, and approved by the Director or the Assistant Director of Solid Waste Management.

PRE-STORM PREPARATION

During periods of questionable weather, the Assistant Director of SWM operations will monitor local weather forecasts and communicate with the Public Works Department Street Maintenance Superintendent. When forecasts indicate the possibility of adverse winter weather, preparations will include, but are not limited to the following:

- ***Notification of key personnel as designated at; See page 11.***
- ***Notification and alert procedures for operating personnel.***
- ***Fueling to full, maintenance check and operational check of all equipment and radio communications.***
- ***Contact Public Information Office Beeper Number to be on standby for release of information.***

NOTIFICATION PLAN

The Adverse Winter Weather Plan is activated when weather conditions affect the normal operation of the Solid Waste Management Department. Employees need to be notified of the status of service provision in order to make preparations for work and arrangements for transportation to work. Notification follows the plan below.

EMPLOYEE NOTIFICATION

1. *The Director will notify Assistant Directors, Assistant to the Director, and Safety Officer.*
2. *Assistant Directors notify Commercial Supervisor, Management Assistant, Administrative Assistants and Supervisors.*
3. *Supervisors notify the Crews.*
4. *Employees without telephones should contact his/her supervisor ' if weather is questionable prior to the start of the regular shift.*

PUBLIC

1. *The Director calls/notifies the Office of Public Affairs and the City Manager's office or designee.*
2. *Recycling contractor is notified*
3. *Major private haulers are notified*
4. *Copies of the information for Press release shall be provided to the staff.*
5. *The Office of Public Affairs notifies media, coordinates information on the Info line and on the internet/intranet page.*
6. *Public Information includes information about changes in delivery of service schedule, as well as service of dead end streets, alleys and steep hills, etc.*

SAFETY PLAN

Employee Safety

1. *No backyard service.*
2. *No pickup of recyclables or yard waste.*
3. *Carts must be curbside and accessible.*
4. *Motor graders/bobcats must be used to clear entrance to the Transfer Station and the administration facilities.*
5. *Employees must be provided the appropriate PPE for winter weather operations.*
6. *Employees must be trained on operations during winter weather.*

Vehicle Safety

1. *Wipers must not be used until windshield is defrosted.*
2. *Drivers must clear all windows and mirrors on vehicles before operations.*
3. *Assistant Director of Operations and Supervisors determine which vehicles will be dispatched for collection services.*
4. *All Equipment Operators will perform vehicle and equipment Preventive Maintenance Checks and Services (PMCS) before, during, and after operations.*

Citizen & Property Safety

To ensure citizen safety and diminish loss of property, Solid Waste Management Department drivers must:

1. *Be alert to vehicles that are blocking roadways.*
2. *Avoid steep inclines.*
3. *Avoid dead end streets.*
4. *Be alert to children playing in snow and ice.*
5. *Know that alley pickups are prohibited.*
6. *SWM Department safety Officer will ensure snow and ice removal efforts are initiated for SWM property and facilities.*
7. *Sanding and salting of steep inclines at Transfer Station facility must be done by Solid Waste Management Transfer Station staff.*

EVALUATION OF ROAD CONDITIONS

1. *The Director of Solid Waste Management will check with Emergency Management and the Public Works Department regarding road conditions.*

2. *If road conditions are determined to be too hazardous, the Director will initiate the appropriate notification process for a possible delay of collection services. The Director, Assistant Director, Safety Officer and designated Solid Waste Supervisors will immediately assess the condition of collection routes and continue the assessment of these routes until collection operations are complete.*

ROUTE/SERVICE DETERMINATION

Schedule Changes:

Changes in employee schedules may be necessary to comply with changed collection schedules by customers.

Solid Waste Collection/Recycling Makeup Schedule:

If collection is canceled	**Makeup Collection Day**
Monday	Wednesday
Tuesday	Wednesday
Thursday	Saturday
Friday	Saturday

1. *If collection is canceled for more than one day there will be no make collection. Service will resume the following week.*
2. *The Transfer station will close if there have been no customers by 12:00 noon. The on site staff must notify The Director no later than 11:30 a.m. of status. The Director will determine the time of closure for the Transfer Station.*
3. *For adverse winter weather that develops during the day, the Director/Assistant Director will decide the degree of service and operating conditions.*
4. *If the winter weather event occurs and has an adverse impact on the Transfer Station facility operations, on Saturday, the Transfer Station Manager, Assistant Director/Director will determine whether the facility will be open or closed. Prior notification of this decision will be provided to the City Mangers office and office of Public Affairs.*

ALTERNATIVE COLLECTION OPTIONS

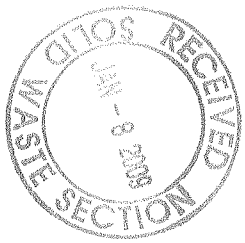
If collection is cancelled for two days, the following alternative collection option is available:

- Citizens who bring their waste to the Transfer Station during the week of reduced collection services will not be charged. The Solid Waste Management Department will cover these charges.

EMERGENCY CONTACT NUMBERS - SOLID WASTE MANAGEMENT

Name	Title	Work #	Home #	Mobile #
Donald Long	Director	(919) 560-4186	(919) 381-1882	201-0258
Thomas Ayers	Assistant Director	(919) 560-4186	(919) 544-7461	201-3169
Jay Reinstein	Assistant Director	(919) 560-4186	(919) 844-8987	961-4577
Christina Cates	Operations & Evaluations	(919) 560-4186	N/A	N/A
Phillip White	Safety & Training Officer	(919) 560-4186	(919) 231-1817	201-2911
Larry Webb	Commercial Collections Manager	(919) 560-4186	(919) 477-8078	605-5518
Stacey Poston	Clean City Division Manager	(919) 560-4186	N/A	452-1125
Corenta Evans	Acting Residential Collections Manager	(919) 560-4186	(919) 598-5455	201-3351
Waste Industries		(919) 405-1483		
Brunswick Waste Mgt.		804-848-9277		
Tidewater Fabric		(919) 957-8803		

Durham Yard Waste Compost Facility
Wastewater Management



Site Address:
2115 E. Club Blvd.
Durham, NC 27704

Prepared By:

KCI Associates of NC, P.A.
4601 Six Forks Road
Landmark Center II, Suite 220
Raleigh, NC 27609

KCI Associates of NC, P.A.
October, 2008

KCI

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WASTEWATER MANAGEMENT PLAN

1.0 Project Description

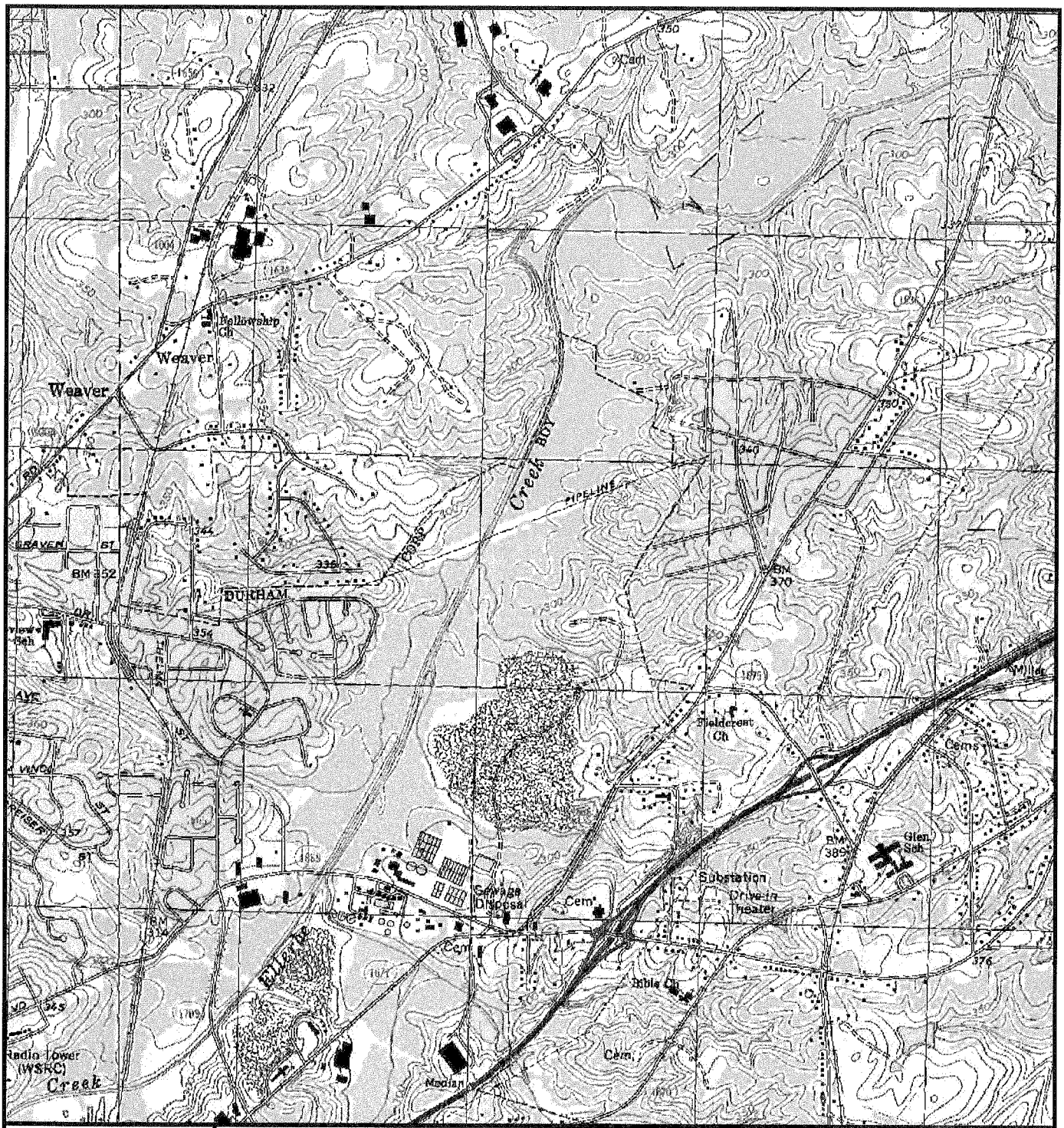
The project site, approximately 26.2 acres, is an existing developed site located in the northeast section of the City of Durham. The project is located in the Neuse River Basin. The nearest body of water to the project site and the ultimate receiving water for this project site is Ellerbe Creek. Ellerbe Creek is approximately 0.25 miles away from the project site. (See Figure 1). The project site is accessed from a service road located northwest of the intersection of Glenn Road and E. Club Boulevard. The project site is an existing yard waste facility. The scope of this project is to re-develop the site by establishing defined composting and curing areas for processing the yard waste into compost for retail distribution. DWQ has classified the stormwater runoff generated from the yard waste compost as wastewater; see Appendix E for the wastewater analysis provided by DWQ from a similar yard waste compost site. Wastewater pond will be constructed to retain the stormwater runoff of the 100-yr 24-hr storm event. There is no discharge from the pond. An Industrial Pump and Haul permission adhering to the criteria stated in regulation number 15A NCAC 02T.1000 is being requested to allow transport of the wastewater to the City of Durham WWTP located on site.

Approximately 4.1 acres of the northwest corner of the site is located in the 100-year floodplain of Ellerbe Creek as shown on the FIRM # 0843 370086J. The 100-year floodplain elevation at sections 287 & 297 are 288.4 & 288.9 respectively. Ellerbe Creek is classified as a Class C, NSW, and WS-IV water body. (See Appendix A). The remainder of the site is above the floodplain elevation.

The site is presently open-graded with the land covered by 12" of compost in the processing areas and a brush-weed-grass mixture for the remainder of the site. Essentially all surface runoff originates within project area with approximately 4.4 acres of off-site runoff from high ground east of the project site. (See Aerial Photo shown in figure 2). There are no existing perennial, intermittent or ephemeral streams within the project site.

The project site is located in the uplands of the Piedmont Region of North Carolina. The native soil in this area is White Store-Creedmoor as shown on the soil survey map for Durham County, North Carolina. The White Store-Creedmoor soils have fine sandy loam particles which makes them moderately well drained with a very firm clay layer underneath. White Store soils belong to the hydrologic soil Group D. Since over 85% of the site is above the 100-year floodplain, the site does not have a high water table and the site does not stay inundated. Therefore the site was categorized in the hydrologic soil group C, with moderate slopes of 6.5 to 10 percent. The existing compost has a very high absorption rate and therefore will be categorized the same as the brush-weed-grass mixture listed in Table 2-2c of TR-55. (Appendix B). Approximately 0.85 acres along the eastern border of the site is bedrock, with a high runoff rate.

Vicinity Map
Figure 1



Durham Yard Waste Composting Facility - Vicinity Map

KCI ASSOCIATES OF NC

Approximate Site Location

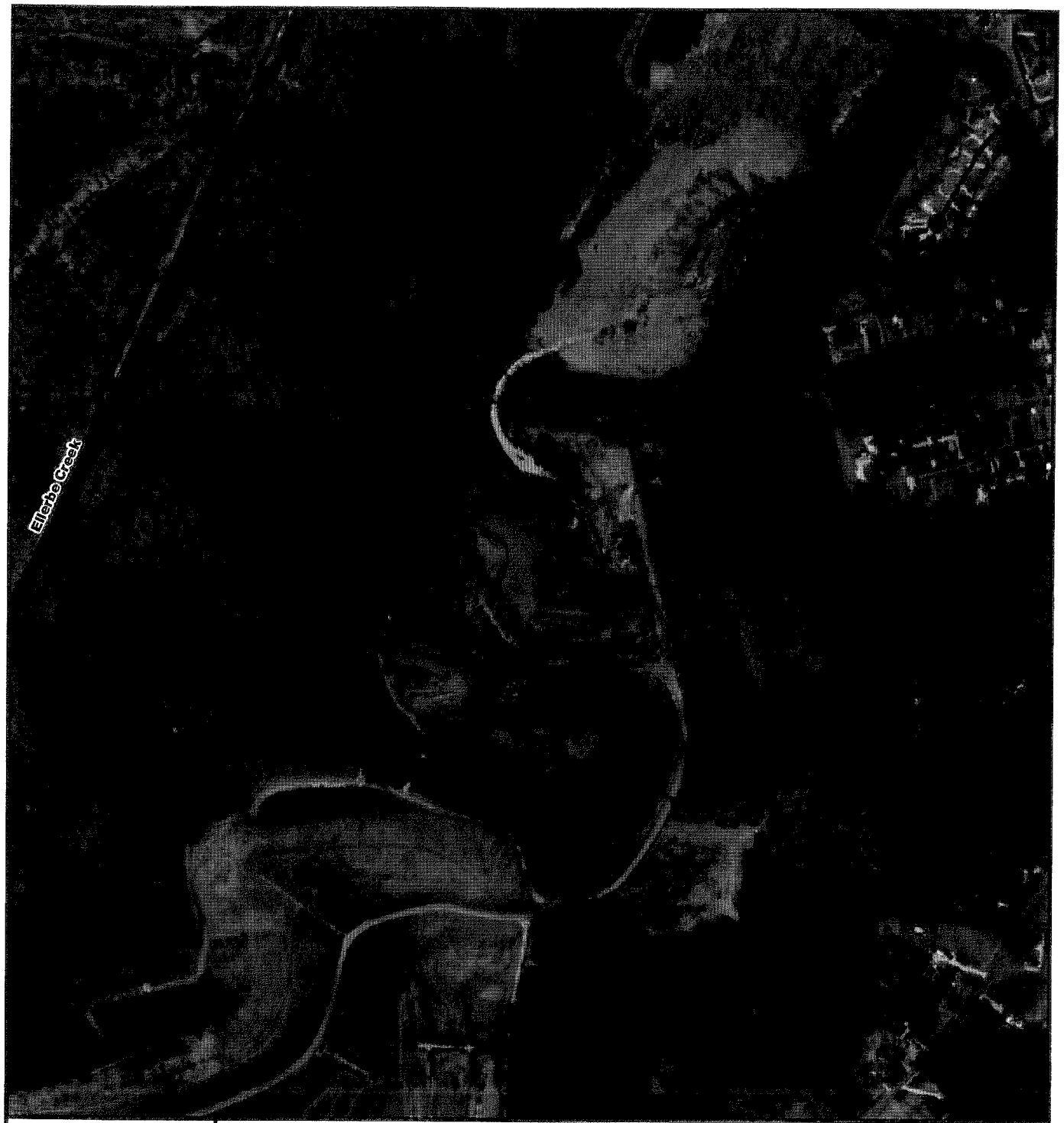
N
W E
S

1:24,000
1 inch equals 2,000 feet

2,000 1,000 0 2,000 Feet

Image Source: USGS Topographic Quadrangles
Northeast Durham (1987) and Northwest Durham (1987)

Aerial Photo
Figure 2



KCI ASSOCIATES OF NC

Durham Compost Site

Streams

Approximate Site Boundary

N
W E
S

1:6,000
1 inch equals 500 feet

500 250 0 500 Feet

Source: City of Durham GIS, Orthoimagery 2005

2.0 Proposed Development

The project involves the grading of one (1) new windrow areas, a new grinding area, the re-grading of a screening area and the re-grading of one (1) product storing area. The existing road will be widened from 15' to 25' and a stretch of new road will be constructed where there is no road presently. Approximately 10.87 acres (41%) of the total site area of 26.2 acres will be disturbed as part of the proposed development. The project will result in an impervious area of 2.0 acres (7.8%), which includes the gravel roads of 1.2 acres and a gravel waste receipt area of approximately 0.8 acres. NCDENR Solid Waste Management Section has established a 1.95 acre section of the site that cannot be developed.

A gravel access road will be constructed along the perimeter of the site and will act as a dam along the western edge adjacent to the floodplain. No major changes to the existing drainage pattern are proposed by this development. No *major* grading is proposed for this site. The composting processing requires the establishment of windrow areas and storage areas. The maximum grade for these areas is 6%. The majority of the site is already at 6.5% slope, with a small portion of the site along the northeast edge sloped at 10%. .

3.0 Hydraulic Analysis Procedures

The wastewater pond is proposed along the western edge of the site, to collect all the wastewater generated by the composting process on site. The pond volume was designed using the urban hydrology and detention pond modeling software Hydraflow. The pond is sized to capture the 100-year peak discharge and store the 100-year 24-hour storm event. An emergency spillway has been designed to allow safe passage of an extreme storm event.

The precipitation data was taken from the NOAA's National Weather Service Atlas 14 for Durham, North Carolina, (Appendix C). The 24-hour precipitation depths were used in the NRCS Runoff Curve Number Method to create the Runoff Hydrographs. The CN value of 65 was derived from the existing land cover condition described in section 1.0 paragraph 4 of this report. This value will be used for both the pre and post development conditions. The yard waste compost is very absorptive and behaves similar to the brush-weed-grass mixture originally covering the site. A CN value of 98 has been assigned to the areas developed into roads and the product receiving area.

The runoff from the project site including the gravel roads will be directed to two custom sediment basins during construction, which will be converted to the full build out of the wastewater pond once construction is complete and the site is stable. All surface runoff will either sheet flow into the pond or be collected in constructed channels and directed to the pond. Drainage Area 'A' is considered clean water and will run to roadside ditches and diverted around the project area, see the drainage area plan sheet in Appendix D.

The routing method used for the design of the wastewater pond was the "Discharge In equals Discharge Out". This method is based on the continuity equation. It processes the average inflow, interpolates between elevations to compute values of storage during a 0.05hour time increment to yield an average outflow. The pond will retain all runoff from the site and the stormwater (wastewater) will be transported to the WWTP via Pump and Haul tanker truck on a routine schedule. The peak inflow, peak outflow, maximum water surface elevations and storage volumes for the pond are summarized in Appendix D.

4.0 Wastewater Pond Design

Based on the calculated runoff, the new impervious roadway and waste receipt areas have increased the 25-year post-development discharge by 38% on average. However, the stormwater runoff rate will be controlled by the proposed wastewater pond located along the western edge of the site. The pond will retain the runoff up to and including the 100-year storm and the water used for irrigation of the compost within the facility. See Appendix D for a complete set of computations for the wastewater pond.

The embankment of the pond will be built-up to an elevation of 304'. The embankment of the Pond #1 is 15' above the 100-year floodplain elevation of 289'. The emergency spillway of Pond #1 will be set at 303' which is 0.25' above the 100-yr water surface elevation in the pond. The pond requires a geosynthetic liner at the bottom and along the sides up to the emergency spillway elevation to prohibit seepage out of the pond.

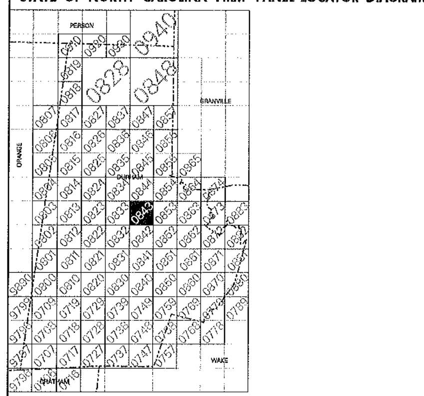
All applicable Neuse River Buffer Rules were accommodated. There is no net increase in the 1-year 24-hour post peak discharge. There are no oils or chemical (fertilizer) pollutants associated with the runoff from the yard waste composting facility. There are no concentrated discharges into the buffer zones of Ellerbe Creek. Ellerbe Creek is more than 0.25 miles away. The runoff from the impervious surfaces is being retained in the wastewater pond.

5.0 Pond Maintenance Plan

The specifications for the pond liner are shown in Appendix F. The pond will require regular maintenance. The two primary maintenance activities involve removing accumulated sediment from the bottom of the pond to maintain the designed storage volume. Direct access is provided to the pond from the newly graded roads.

APPENDIX A

STATE OF NORTH CAROLINA FIRM PANEL LOCATOR DIAGRAM



DATUM INFORMATION

The **projection** used in the preparation of this map was the North Carolina State Plane (FIPSZONE 3200). The **horizontal datum** was the North American Datum of 1983, GRS80 ellipsoid. Differences in datum, ellipsoid, projection, or Universal Transverse Mercator zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdictional boundaries. These differences do not affect the accuracy of this FIRM. All coordinates on this map are in U.S. Survey Feet, where 1 U.S. Survey Foot = 1200/3937 Meters.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. An average offset between NAVD 88 and the National Geodetic Vertical Datum of 1929 (NGVD 29) has been computed for each North Carolina county. This offset was then applied to the NGVD 29 flood elevations that were not revised during the creation of this statewide format FIRM. The offsets for each county shown on this FIRM panel are shown in the vertical datum offset table below. Where a county boundary and a flooding source with unrevised NGVD 29 flood elevations are coincident, an individual offset has been calculated and applied during the creation of this statewide format FIRM. See Section 6.1 of the accompanying Flood Insurance Study report to obtain further information on the conversion of elevations between NAVD 88 and NGVD 29. To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the North Carolina Geodetic Survey at the address shown below. You may also contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at www.ngs.noaa.gov.

North Carolina Geodetic Survey
121 West Jones Street
Raleigh, NC 27601
(919) 733-3836
www.ncgs.state.nc.us

County Average Vertical Datum Offset Table

County	Vertical Datum Offset (ft)
Durham	– 0.83
Example: NAVD 88 = NGVD 29 + (–0.83)	

All streams listed in the **Flood Hazard Data Table** below were studied by detailed methods using field survey. Other flood hazard data shown on this map may have been derived using either a coastal analysis or limited detailed riverine analysis. More information on the flooding sources studied by these analyses is contained in the Flood Insurance Study report.

FLOOD HAZARD DATA TABLE

Cross Section	Stream Station[1]	Flood Discharge (cfs)	1% Annual Chance (100-year) Water-Surface Elevation (feet NAVD 88)	Floodway Width (feet) Left/Right Distance From the Center of Stream to Encroachment Boundary (Looking Downstream) or Total Floodway Width
ELLERBE CREEK				
198	19,828	NA	273.6	708
207	20,666	NA	274.4	688
214	21,403	NA	275.2	765
222	22,189	NA	276.3	705
227	22,676	NA	277.0	910
237	23,668	NA	278.1	796
242	24,242	NA	278.8	670
247	24,678	NA	279.0	225
256	25,561	NA	284.5	197
265	26,470	NA	286.9	700
272	27,183	NA	287.7	815
278	27,803	NA	288.0	955
287	28,720	NA	288.4	1,000
297	29,670	NA	288.9	1,306
301	30,099	NA	289.0	1,230
307	30,681	NA	289.3	1,259
315	31,466	NA	289.6	1,072
322	32,215	NA	290.1	1,161

[1] Feet above confluence with Neuse River

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~~513~~~ Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(012) Cross section line
(23)-----(23) Transect line
97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4276000 M 1000-meter Universal Transverse Mercator grid ticks, zone 17
1 477 500 FEET 2500-foot grid values: North Carolina State Plane coordinate system (FIPSZONE 3200, State Plane NAD 83 feet)
BM5510 × North Carolina Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).
BM5510 ⊗ National Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).
• M1.5 River Mile

GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

250 0 500 1000 FEET
150 0 150 300 METERS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data, Limited Detailed Flood Hazard Data, and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of **regulatory floodways** shown on the FIRM for flooding sources studied by detailed methods were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data for flooding sources studied by detailed methods as well as **non-encroachment widths** for flooding sources studied by limited detailed methods are provided in the FIS report for this jurisdiction. The FIS report also provides instructions for determining a floodway using non-encroachment widths for flooding sources studied by limited detailed methods.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 4.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

Base map information and geospatial data used to develop this FIRM were obtained from various organizations, including the participating local community(ies), state and federal agencies, and/or other sources. The primary base for this FIRM is aerial imagery acquired by Durham County. The time period of collection for the imagery is 1999. Information and geospatial data supplied by the local community(ies) that met FEMA base map specifications were considered the preferred source for development of the base map. See geospatial metadata for the associated digital FIRM for additional information about base map preparation.

Base map features shown on this map, such as **corporate limits**, are based on the most up-to-date data available at the time of publication. **Changes in the corporate limits may have occurred since this map was published**. Map users should consult the appropriate community official or website to verify current conditions of jurisdictional boundaries and base map features. This map may contain roads that were not considered in the hydraulic analysis of streams where no new hydraulic model was created during the production of this statewide format FIRM.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

If you have **questions about this map**, or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at www.fema.gov.

An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the **North Carolina Floodplain Mapping Program** website at www.ncfloodmaps.com, or contact the **FEMA Map Service Center** at 1-800-358-9616 for information on all related products associated with this FIRM. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at www.msc.fema.gov.

MAP REPOSITORY

Refer to listing of Map Repositories on Map Index or visit www.ncfloodmaps.com.

EFFECTIVE DATE OF FLOOD INSURANCE RATE MAP PANEL
MAY 2, 2006

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to statewide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent, the North Carolina Division of Emergency Management or the National Flood Insurance Program at the following phone numbers or websites:

NC Division of Emergency Management (919) 715-8000 www.nccrimecontrol.org/nfip
National Flood Insurance Program 1-800-638-6620 www.fema.gov/nfip

Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

www.ncfloodmaps.com

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0843J

FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA

PANEL 0843

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
DURHAM, CITY OF	370086	0843	J
DURHAM COUNTY	370085	0843	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
MAY 2, 2006

MAP NUMBER
3720084300J

State of North Carolina
Federal Emergency Management Agency
~~~

WATERSHED CLASSIFICATION ATTACHMENT (FORM: WSCA 10-06)

Applicant's name: CITY OF DURHAM

Site/Field ID	County	Latitude	Longitude	Location Datum	Location Method Code	Location Accuracy	Waterbody Subbasin and Stream Index No.	Current and Proposed Class	
Durham Yard Waste/ Compost Facility	Durham	36° 02′ 19″	78° 51′ 08″	NAD 83	MAP	Nearest Second	Ellerbe Creek Neuse Watershed 27-5 (0.3), (0.7), (2)	C, NSW	WS-IV

I, AUDREY BURNETTE, PE, attest that this attachment form has been prepared by me and is accurate and complete to the best of my knowledge. I understand that if all required parts of this attachment are not completed and that if all required supporting information is not included, this application package will be returned as incomplete.

Signature Audrey Burnette Date 2/26/08

APPENDIX B

Soil Map–Durham County, North Carolina
(DURHAM YARD WASTE FACILITY)

Map Unit Legend

Durham County, North Carolina (NC063)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AlA	Altavista silt loam, 0 to 2 percent slopes	5.3	2.7%
Ch	Chewacla and Wehadkee soils	13.8	7.0%
CrC	Creedmoor sandy loam, 6 to 10 percent slopes	4.6	2.3%
Gu	Gullied land, clayey materials	9.8	5.0%
IrB	Iredell loam, 2 to 6 percent slopes	0.6	0.3%
IrC	Iredell loam, 6 to 10 percent slopes	6.5	3.3%
MfC	Mayodan sandy loam, 6 to 10 percent slopes	0.5	0.2%
Ro	Roanoke silt loam	34.9	17.8%
Wh	Wahee loam, alkaline subsoil variant (Hornsboro)	17.4	8.9%
WsB	White Store sandy loam, 2 to 6 percent slopes	30.0	15.3%
WsC	White Store sandy loam, 6 to 10 percent slopes	41.5	21.1%
WsE	White Store sandy loam, 10 to 25 percent slopes	31.7	16.1%
Totals for Area of Interest (AOI)		196.6	100.0%

Exhibit A: Hydrologic Soil Groups for the United States

WAUBERG	D
WAUCHULA	B/D
WAUCHULA, Depressional	D
WAUCOBA	D
WAUCONDA	B
WAUKENA	D
WAUKENABO	B/D
WAULD	C
WAURIKA	D
WAUTOMA	B/D
WAVELAND	B/D
WAVELAND	D
WAWAKA	B
WAWASEE	B
WAWINA	A
WAX	C
WAXPOOL	D
WAYCUP	B
WAYLAND	C/D
WAYMET	B
WAYMOR	B
WEA	A
WEALTHWOOD	A/D
WEASH	C
WEATHERFORD	B
WEATHERWAX	D
WEAVER	C
WEAVERVILLE	B
WEBB	C
WEBBRIDGE	B
WEBBTOWN	C
WEBFOOT	C
WEBILE	C
WECHECH	D
WEDDERBURN	B
WEDGE	A
WEDGEMONT	B
WEEDING	D
WEEDMARK	B
WEEDPATCH	C
WEEDZUNIT	B
WEEKIWACHEE	D
WEEKS	C
WEENA	D
WEEPAH	C
WEESATCHE	B
WEETOWN	B
WEEZWEED	B
WEGERT	A
WEGLIKE	A
WEIDER	B
WEINBACH	C
WEIR	D
WEIRMAN	D
WEISBURG	C
WEISSENFELS	C
WEITAS	B
WEITCHPEC	C
WELAKA	A
WELCH	B
WELCHLAND	B
WELCOME	B
WELDA	C
WELEETKA	D
WELLESLEY	B
WELLIE	A
WELLINGTON	D
WELLMAN	B
WELLROCK	B
WELLS	B
WELLSBENCH	B
WELLSCREEK	B
WELLSDAM	C
WELLSED	C
WELLSFORD	D
WELOY	C
WELSUM	D
WELTER	D
WEMPLE	B
WENAS	C/D
WENATCHEE	C
WENDANE	B/C
WENDELL	C
WENGLER	A
WENONAH	B
WENOTA	D
WENZEL	B
WEOGUFKA	C
WEOTT	D
WEPO	C
WERELD	B
WERITO	C
WERNOCK	B
WESFIL	D
WESIX	D
WESKA	D
WESLEY	B
WESPAC, Sandy Substratum Alkali	C
WESPAC, Alkali	D
WESSEL	C
WESTBEND	B
WESTBORO	D
WESTBROOK	D
WESTBUTTE	B
WESTERVILLE	B
WESTFORK	D
WESTGATE	C
WESTINDIAN	C
WESTLAKE, Thin Surface	C
WESTLAKE	D
WESTMION	D
WESTMORE	C
WESTOLA	B
WESTON	D
WESTOVER	B
WESTPHALIA	B
WESTPLAIN	D
WESTPORT	A
WESTPORT, Thin Surface	B
WESTSHORE	D
WESTSIDE	C
WESTSUM	D
WESTVACO	C
WESTVIEW	B
WESTVILLE	B
WESTWEGO	D
WESWIND	C
WESWOOD	B
WETA	D
WETBETH	C
WETHEY	A/C
WETHEY	C
WETSAW	C
WETTERDON	B
WETZEL	D
WEWELA	B
WEWOKA	C
WEYANOKE	C
WEYERS	C/D
WEYMOUTH	B
WHAKANA	B
WHALESHEAD	B
WHALEY	D
WHATCOM	C
WHATELY	D
WHEATBELT	D
WHEATON	B
WHEATWOOD	B
WHEELER	B
WHEELERPEK	D
WHEELERVILLE	B
WHEELON, Cool	B
WHEELON	D
WHEELRIDGE	A
WHEELS	D
WHERRY	D
WHETSOON	C
WHETSTONE	C
WHICHMAN	B
WHIDBEY	C
WHILPHANG	D
WHIPP	D
WHIPPANY	C
WHISK	D
WHISKEY	B
WHISKEYCREEK	C
WHISKLAKE	C
WHISPERING	C
WHISTLE	B
WHITE STORE	D
WHITE SWAN	D
WHITEARTH	C
WHITEBIRD	D
WHITECAP	D
WHITECLOUD	B
WHITEDEER	B
WHITEFACE	D
WHITEFIELD	D
WHITEFORD	B
WHITEHALL	B
WHITEHORN	D
WHITEHORSE	B
WHITEKNOB	B
WHITEMARSH	C/D
WHITEOAK	B
WHITEPEAK	D
WHITEPINE	D
WHITERIVER	C
WHITEROCK	D
WHITESBORO	C
WHITESBURG	C
WHITESIDE	B
WHITESON	D
WHITETHORN	B
WHITEWATER	D
WHITEWOOD, Nonflooded	B/D
WHITEWOOD	C/D
WHITEWRIGHT	C
WHITEYE	D
WHITING	B
WHITINGER	C
WHITLEY	B
WHITNEY	C
WHITSON	D
WHITTEMORE	C/D
WHITVIN	D
WHITWELL	C
WHORLED	C
WICHITA	C
WICKAHONEY	D
WICKENBURG	D
WICKERSHAM	B
WICKETT	C
WICKIUP	C
WICKSBURG	B
WICKWARE	B
WICUP	C
WIDEN	C
WIDOWSPRING	B
WIERGATE	D
WIFFO	B
WIFTON	B
WIGTON	A
WILAHA	B
WILBANKS	D
WILBUR	B
WILCO	C
WILCOX	D
WILCOXSON	C
WILDALE	C
WILDCAT	D
WILDER	A
WILDGEN	B
WILDHILL	C
WILDHORSE	A
WILDMESA	C
WILDORS	C
WILDROSE	C
WILE	C
WILHOIT	B
WILKESON	B
WILL	B/D
WILLABY	C
WILLAKENZIE	C
WILLAMETTE	C
WILLANCH	D
WILLAPA	C
WILLARD	B
WILLETTE	A/D
WILLHILL	C
WILLHO	D
WILLIAMSBURG	B
WILLIAMSPORT	C
WILLIAMSTOWN	C
WILLIAMSVILLE	C
WILLIMAN	B/D
WILLISTON	C
WILLOSIPPI	C
WILLOW CREEK	B
WILLOWDALE	B
WILLOWFORK	D
WILLSPRINGS	C
WILLYNAT	B
WILMA	C
WILMER	C
WILMONT	B
WILMONTON	B
WILPAR	C
WILPOINT	D
WILSALL	D
WILSHIRE	A
WILSON	D
WILSONGULCH	B
WILSONVILLE	D
WILSOR	B
WILSPRING	C
WILST	C
WILT	B
WILTON	B
WIMPEY	C
WINADA	C
WINBERRY	C
WINBLOW	C
WINCHUCK	C
WIND RIVER	B
WINDCOAT	D
WINDCOMB	D
WINDEGO	B
WINDER	D
WINDERE	B
WINDERNOT	B
WINDICREEK	A
WINDLASS	C
WINDMILL	B
WINDRY	D
WINDTHORST	C
WINDWHISTLE	B
WINDYBUTTE	B
WINDYHOLLOW	C
WINDYPOINT	B
WINEDALE	D
WINEG	B
WINEGAR	C
WINEVADA	C
WINFALL	B
WINFIELD	B
WING	D
WINGATE	B
WINGDALE	D
WINGINA	B
WINGINAW	D
WINGROCK	B
WINGVILLE	D
WINKLEMAN	D
WINKLER	B
WINKLO	C
WINLER	D
WINLO	D
WINN	C
WINNEBAGO	B
WINNEMUCCA	C
WINNETT	C
WINNETT	D
WINNIPEG	B
WINNSBORO	C
WINOM	D
WINOOSKI	B
WINOPEE	B
WINRIDGE	D
WINSAND	B
WINSTON	B
WINT	D
WINTERCANYON	C
WINTERIM	C
WINTERMUTE	C
WINTERS	C
WINTERSBURG	B
WINTERSET	C
WINTLEY	B

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

APPENDIX C

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

North Carolina 36.0425 N 78.9625 W 498 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Tue Oct 23 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs | U.S. Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.41	0.65	0.81	1.11	1.38	1.66	1.77	2.13	2.52	2.93	3.44	3.83	4.40	5.00	6.66	8.29	10.53	12.68
2	0.47	0.76	0.95	1.32	1.65	1.99	2.12	2.56	3.02	3.54	4.14	4.58	5.24	5.94	7.85	9.75	12.33	14.77
5	0.54	0.87	1.10	1.56	2.01	2.43	2.60	3.13	3.73	4.41	5.11	5.63	6.35	7.12	9.27	11.31	14.11	16.64
10	0.60	0.96	1.22	1.77	2.30	2.82	3.03	3.66	4.38	5.09	5.85	6.43	7.22	8.05	10.40	12.53	15.51	18.09
25	0.66	1.06	1.34	1.99	2.65	3.28	3.55	4.32	5.22	6.00	6.83	7.52	8.40	9.30	11.96	14.14	17.34	19.94
50	0.71	1.13	1.43	2.15	2.92	3.66	3.99	4.88	5.95	6.72	7.60	8.38	9.33	10.28	13.18	15.38	18.75	21.34
100	0.75	1.19	1.50	2.30	3.17	4.02	4.42	5.44	6.69	7.44	8.38	9.25	10.28	11.28	14.41	16.61	20.13	22.69
200	0.78	1.24	1.56	2.43	3.41	4.38	4.86	6.02	7.48	8.19	9.16	10.14	11.24	12.29	15.68	17.84	21.51	24.00
500	0.81	1.29	1.62	2.58	3.70	4.85	5.43	6.80	8.55	9.21	10.22	11.35	12.56	13.66	17.41	19.48	23.34	25.69
1000	0.84	1.33	1.67	2.70	3.94	5.25	5.94	7.48	9.51	10.01	11.05	12.30	13.60	14.73	18.75	20.75	24.74	26.95

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

North Carolina 36.0425 N 78.9625 W 498 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Tue Oct 23 2007

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | Docs | U.S. Map

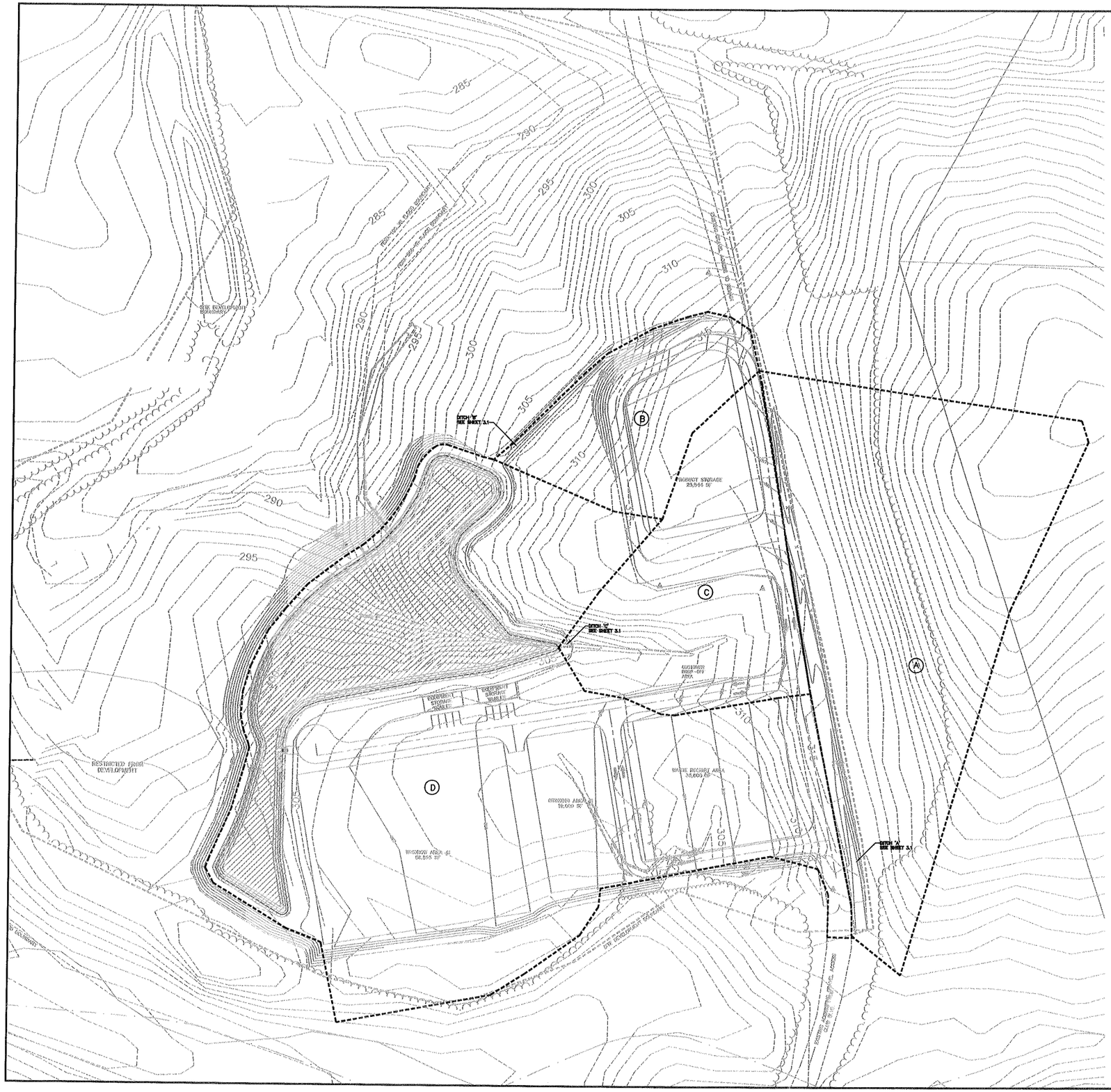
Precipitation Intensity Estimates (in/hr)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	4.86	3.88	3.23	2.22	1.38	0.83	0.59	0.36	0.21	0.12	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01
2	5.69	4.55	3.82	2.63	1.65	0.99	0.71	0.43	0.25	0.15	0.09	0.05	0.03	0.02	0.02	0.01	0.01	0.01
5	6.53	5.23	4.40	3.13	2.01	1.22	0.87	0.52	0.31	0.18	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01
10	7.25	5.79	4.88	3.54	2.30	1.41	1.01	0.61	0.36	0.21	0.12	0.07	0.04	0.03	0.02	0.02	0.01	0.01
25	7.97	6.35	5.37	3.97	2.65	1.64	1.18	0.72	0.43	0.25	0.14	0.08	0.05	0.04	0.02	0.02	0.02	0.01
50	8.51	6.77	5.72	4.30	2.92	1.83	1.33	0.82	0.49	0.28	0.16	0.09	0.06	0.04	0.03	0.02	0.02	0.01
100	8.96	7.13	6.00	4.60	3.17	2.01	1.47	0.91	0.56	0.31	0.17	0.10	0.06	0.05	0.03	0.02	0.02	0.02
200	9.36	7.42	6.24	4.86	3.41	2.19	1.62	1.01	0.62	0.34	0.19	0.11	0.07	0.05	0.03	0.02	0.02	0.02
500	9.78	7.73	6.49	5.16	3.70	2.43	1.81	1.14	0.71	0.38	0.21	0.12	0.07	0.06	0.04	0.03	0.02	0.02
1000	10.13	7.97	6.67	5.40	3.94	2.62	1.98	1.25	0.79	0.42	0.23	0.13	0.08	0.06	0.04	0.03	0.02	0.02

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

APPENDIX D

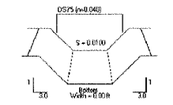


Rational Method Rainfall Frequency .		10 year(s) Storm			
Area Description	Area ac	Coef	Tc min	Intensity in/hr	Flow cfs
A	3.9251	0.3500	5.0000	7.2500	9.9599
B	1.0720	0.4000	5.0000	7.2500	3.1089
C	1.7000	0.4000	5.0000	7.2500	4.9300
D	7.6396	0.4000	5.0000	7.2500	22.1550

DITCH 'A'

HYDRAULICS:

Discharge (cfs)	Peak Flow Period (yrs)	Velocity (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.0	0.1	2.49	4.02	0.55	1.16



Not to Scale

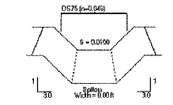
LINER RESULTS:

Reach	Rating Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	D575	Unvegetated					1.55	0.72	2.15	STABLE
	Staple D									

DITCH 'B'

HYDRAULICS:

Discharge (cfs)	Peak Flow Period (yrs)	Velocity (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.1	0.1	1.62	1.92	0.38	0.69



Not to Scale

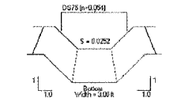
LINER RESULTS:

Reach	Rating Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	D575	Unvegetated					1.55	0.50	3.11	STABLE
	Staple D									

DITCH 'C'

HYDRAULICS:

Discharge (cfs)	Peak Flow Period (yrs)	Velocity (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.9	0.1	2.50	1.95	0.43	0.55



Not to Scale

LINER RESULTS:

Reach	Rating Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	D575	Unvegetated					1.55	0.87	1.78	STABLE
	Staple D									

GRAPHIC SCALE

60' 0 60' 120'

(IN FEET)
1 inch = 60 ft.

CITY OF DURHAM
PUBLIC WORKS DEPARTMENT
APPROVED

ENGINEERING _____ DATE _____
STORM WATER _____ DATE _____
TRANSPORTATION _____ DATE _____
_____ DATE _____
_____ DATE _____

FINAL DESIGN-NOT FOR CONSTRUCTION

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A			
B			

KCI Associates of North Carolina, PA
Engineers • Planners • Scientists • Construction Managers
4601 Six Forks Road, Landmark Center II, Suite 220
Raleigh, NC 27609-5210
Phone (919) 783-9214
Fax (919) 783-9266
http://www.kci.com

DURHAM YARD WASTE CONSTRUCTION PLANS

CITY OF DURHAM
DURHAM COUNTY

DRAINAGE AREA MAP & DITCH CALCULATIONS

HORZ SCALE:	
VERT SCALE:	
DRAWN BY:	ACL
CHECKED BY:	FR
DATE:	08-25-08
PROJECT NO.	12065870A
SHEET NO.	C-3.1
SHEET	OF

Table of Contents

25 - Year

100 - Year

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	21.52	10	730	87,551	----	------	------	EXISTING
2	SCS Runoff	29.69	10	730	119,146	----	------	------	PROPOSED
4	Reservoir	0.000	10	0	0	2	301.98	119,146	POND 1
6	Reservoir	0.000	10	0	0	2	301.52	119,146	POND 2

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

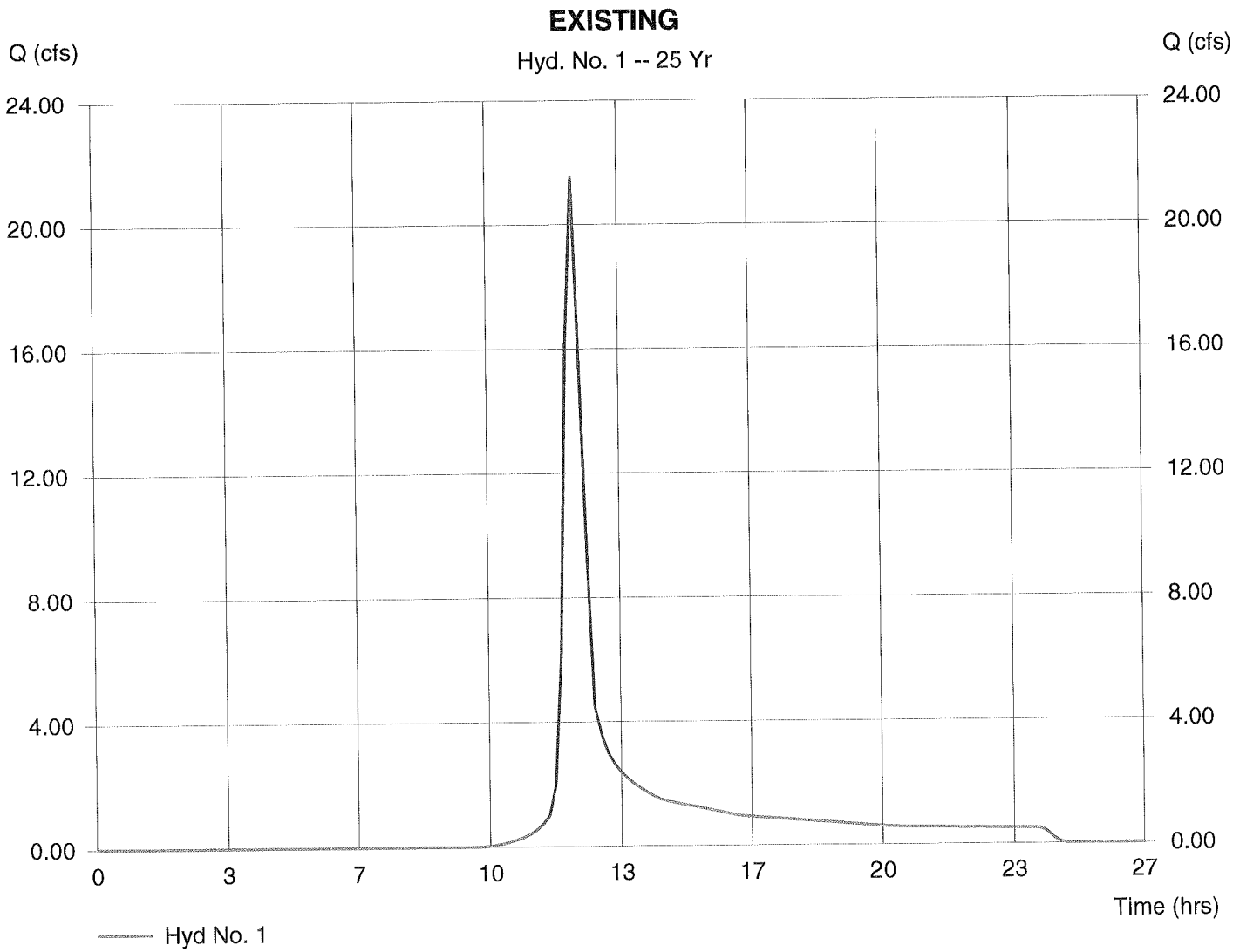
Friday, Oct 3 2008, 1:49 PM

Hyd. No. 1

EXISTING

Hydrograph type	= SCS Runoff	Peak discharge	= 21.52 cfs
Storm frequency	= 25 yrs	Time interval	= 10 min
Drainage area	= 11.770 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 87,551 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

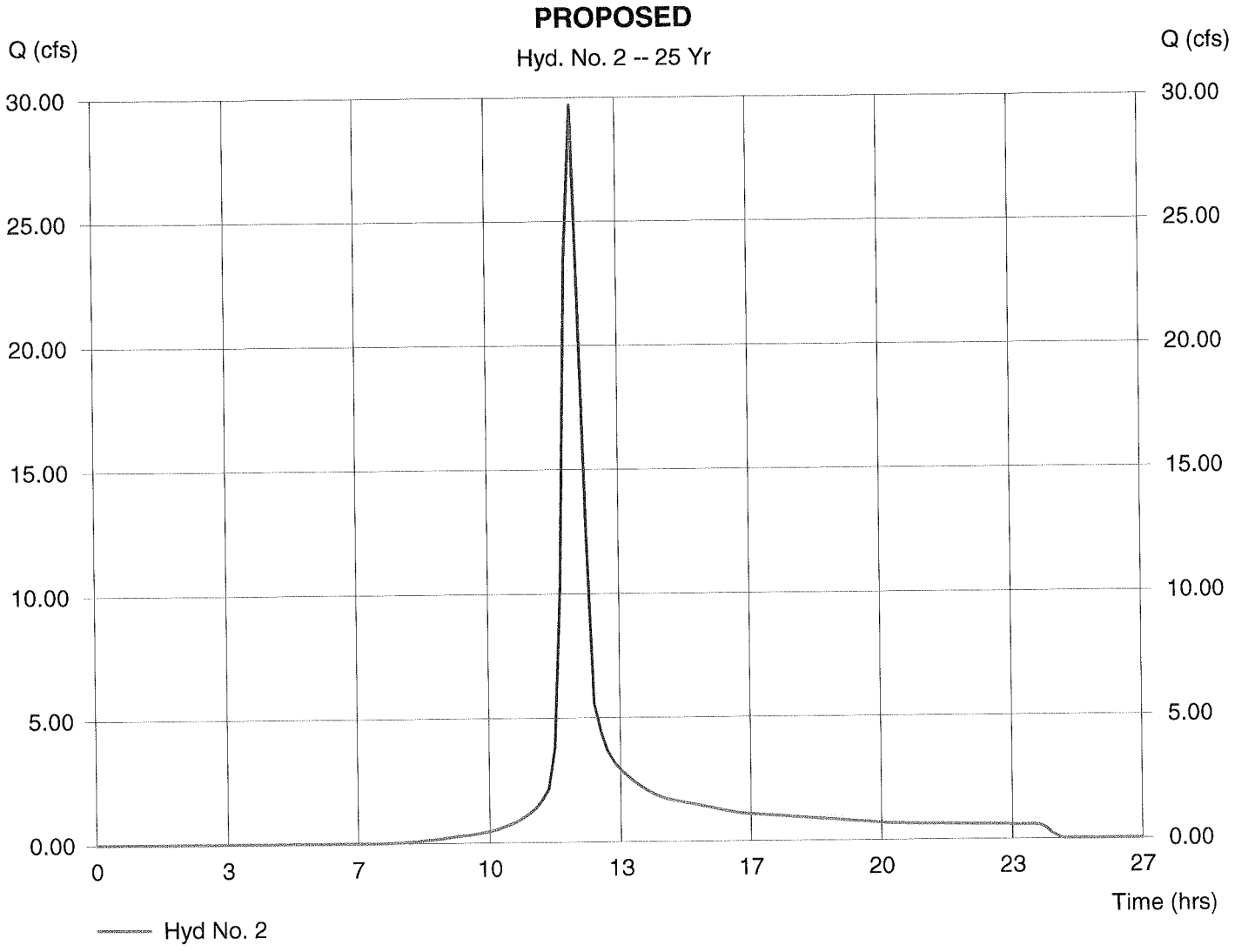
Friday, Oct 3 2008, 1:49 PM

Hyd. No. 2

PROPOSED

Hydrograph type	= SCS Runoff	Peak discharge	= 29.69 cfs
Storm frequency	= 25 yrs	Time interval	= 10 min
Drainage area	= 11.770 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.00 min
Total precip.	= 5.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 119,146 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Friday, Oct 3 2008, 1:49 PM

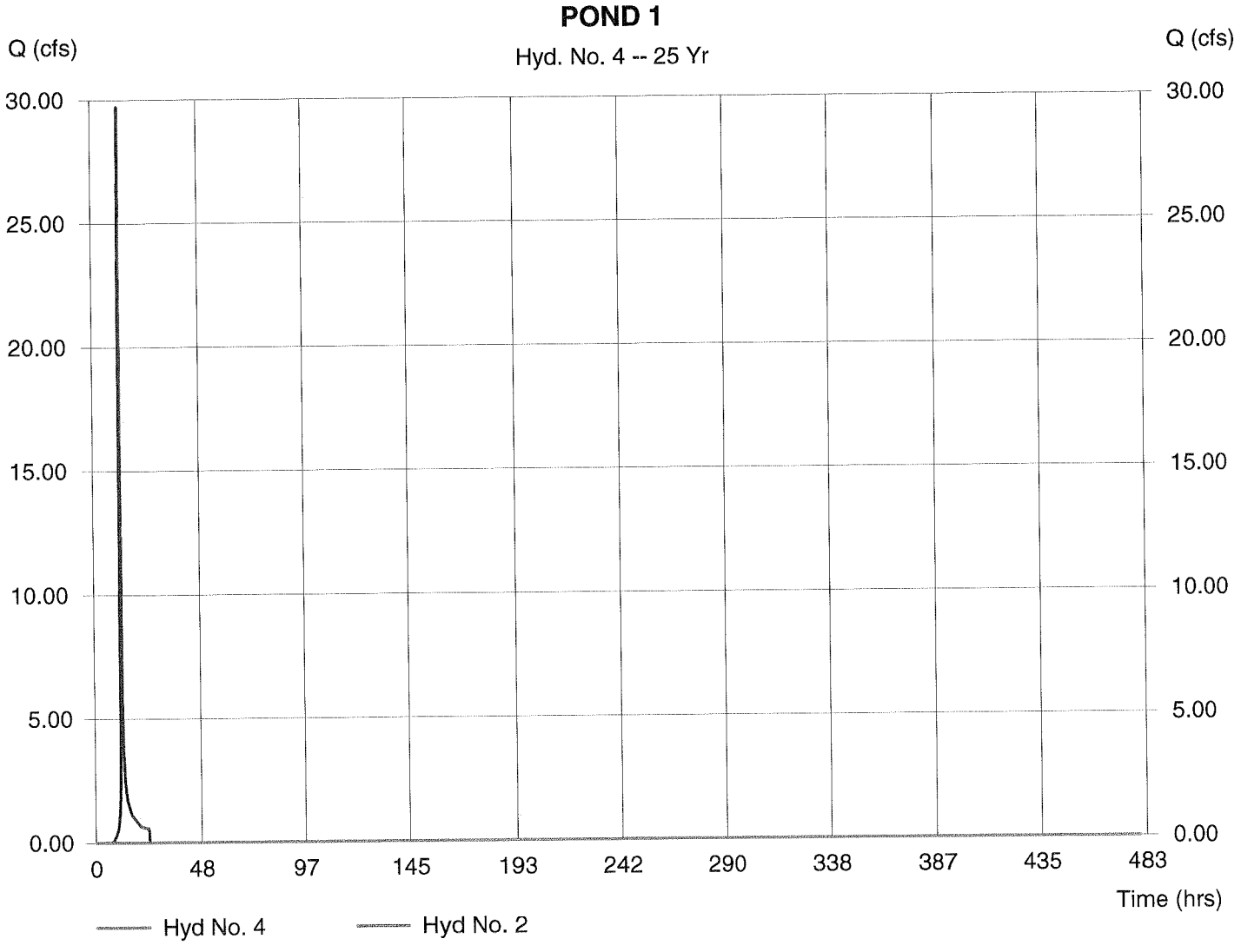
Hyd. No. 4

POND 1

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time interval	= 10 min
Inflow hyd. No.	= 2	Max. Elevation	= 301.98 ft
Reservoir name	= POND 1- OPTION 1	Max. Storage	= 119,146 cuft

Storage Indication method used.

Hydrograph Volume = 0 cuft



Pond Report

Pond No. 1 - POND 1- OPTION 1

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	300.00	55,133	0	0
1.00	301.00	60,217	57,675	57,675
2.00	302.00	65,393	62,805	120,480
3.00	303.00	70,630	68,012	188,492
4.00	304.00	75,924	73,277	261,769
5.00	305.00	81,275	78,600	340,368

Culvert / Orifice Structures

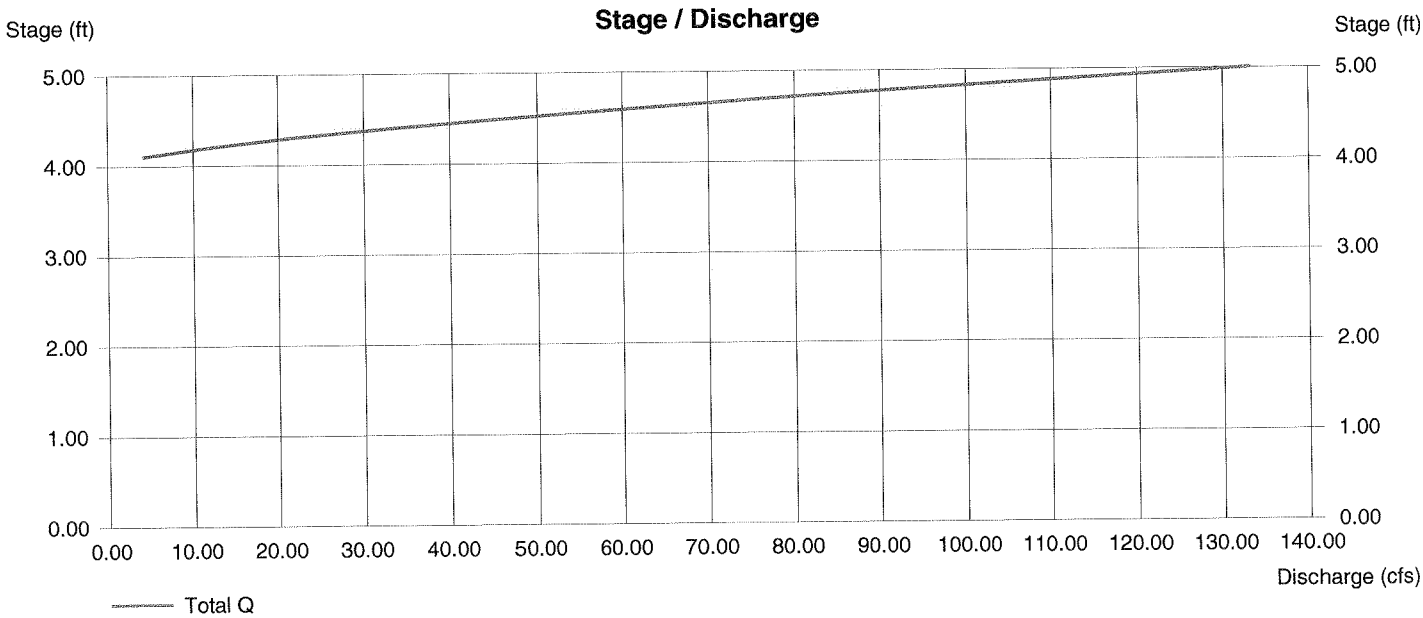
	[A]	[B]	[C]	[D]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 40.00	0.00	0.00	0.00
Crest El. (ft)	= 304.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	33.35	10	730	134,021	----	------	------	EXISTING
2	SCS Runoff	42.53	10	730	171,571	----	------	------	PROPOSED
4	Reservoir	0.000	10	0	0	2	302.75	171,571	POND 1
6	Reservoir	0.000	10	0	0	2	302.09	171,571	POND 2

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

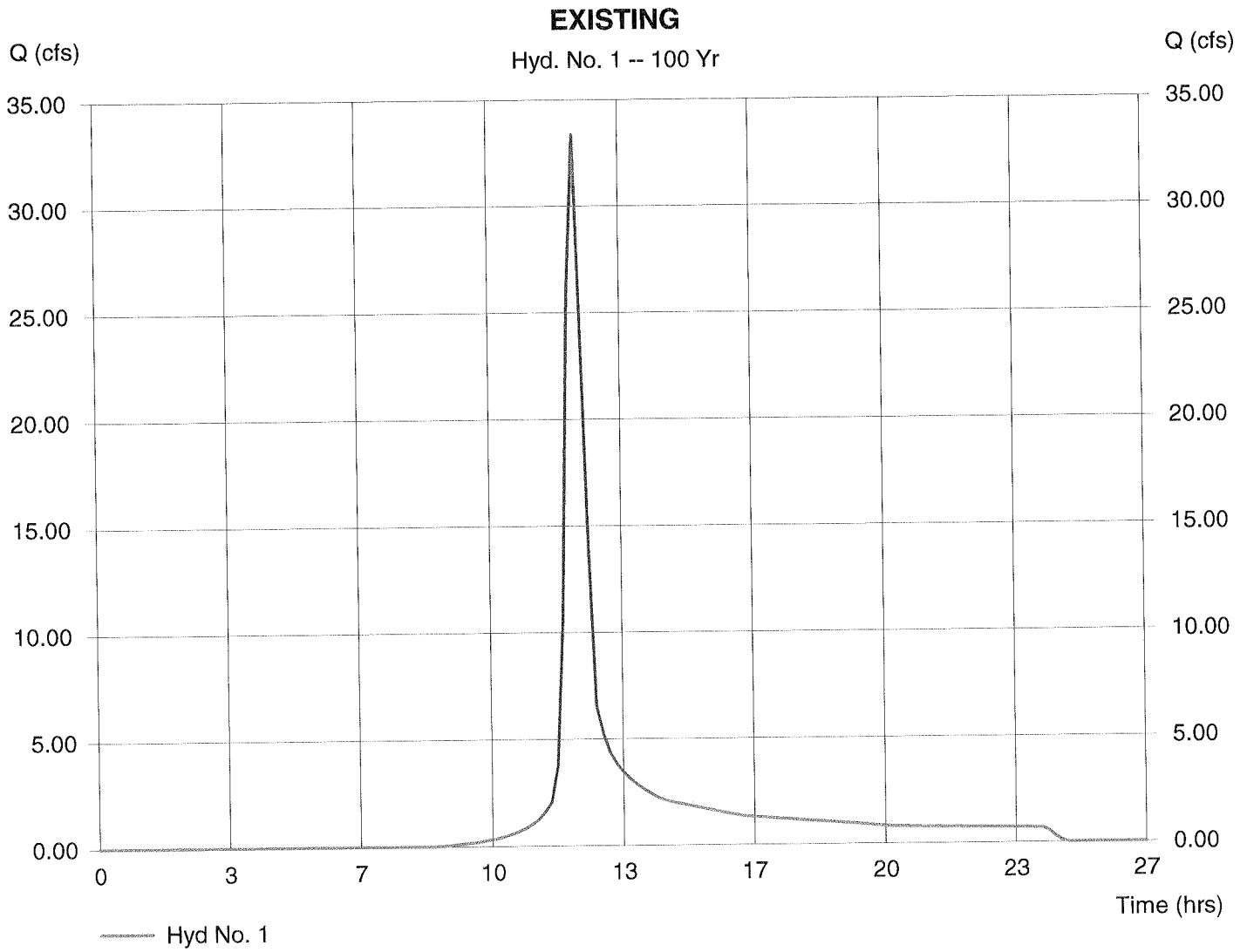
Friday, Oct 3 2008, 1:49 PM

Hyd. No. 1

EXISTING

Hydrograph type	= SCS Runoff	Peak discharge	= 33.35 cfs
Storm frequency	= 100 yrs	Time interval	= 10 min
Drainage area	= 11.770 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.00 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 134,021 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

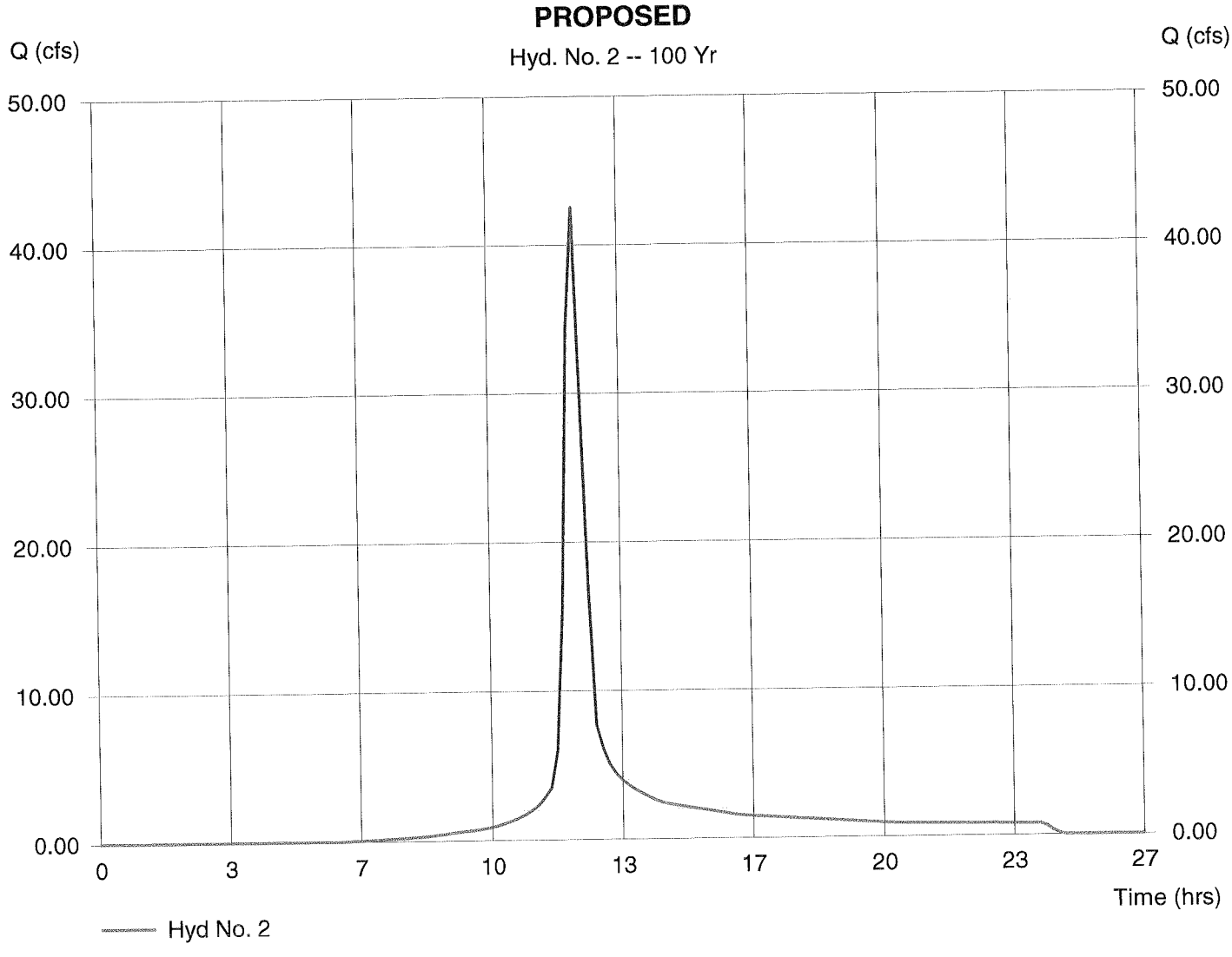
Friday, Oct 3 2008, 1:49 PM

Hyd. No. 2

PROPOSED

Hydrograph type	= SCS Runoff	Peak discharge	= 42.53 cfs
Storm frequency	= 100 yrs	Time interval	= 10 min
Drainage area	= 11.770 ac	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.00 min
Total precip.	= 6.67 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Volume = 171,571 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Friday, Oct 3 2008, 1:49 PM

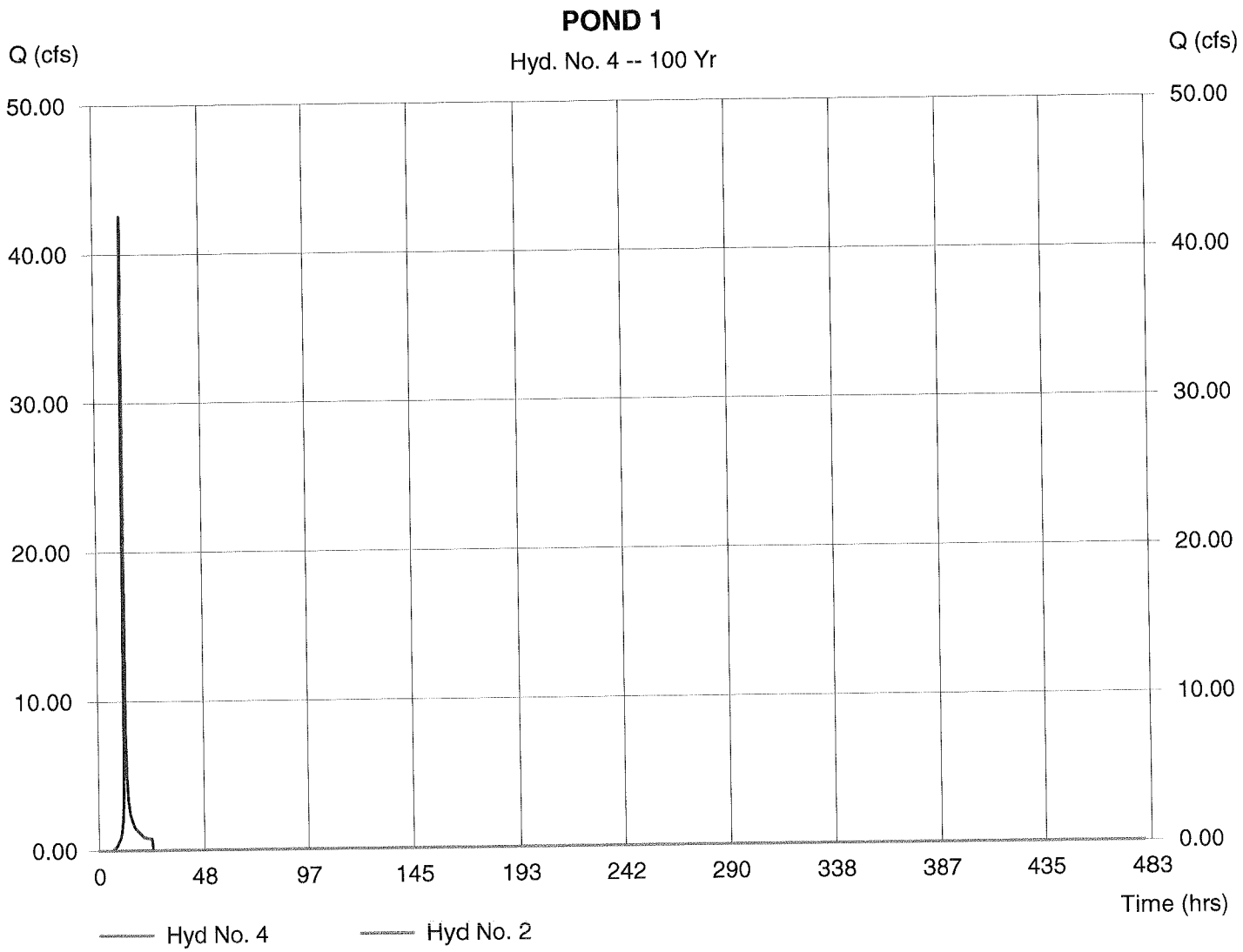
Hyd. No. 4

POND 1

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time interval	= 10 min
Inflow hyd. No.	= 2	Max. Elevation	= 302.75 ft
Reservoir name	= POND 1- OPTION 1	Max. Storage	= 171,571 cuft

Storage Indication method used.

Hydrograph Volume = 0 cuft



Pond Report

Hydraflow Hydrographs by Intelisolve

Friday, Oct 3 2008, 1:49 PM

Pond No. 1 - POND 1- OPTION 1

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	300.00	55,133	0	0
1.00	301.00	60,217	57,675	57,675
2.00	302.00	65,393	62,805	120,480
3.00	303.00	70,630	68,012	188,492
4.00	304.00	75,924	73,277	261,769
5.00	305.00	81,275	78,600	340,368

Culvert / Orifice Structures

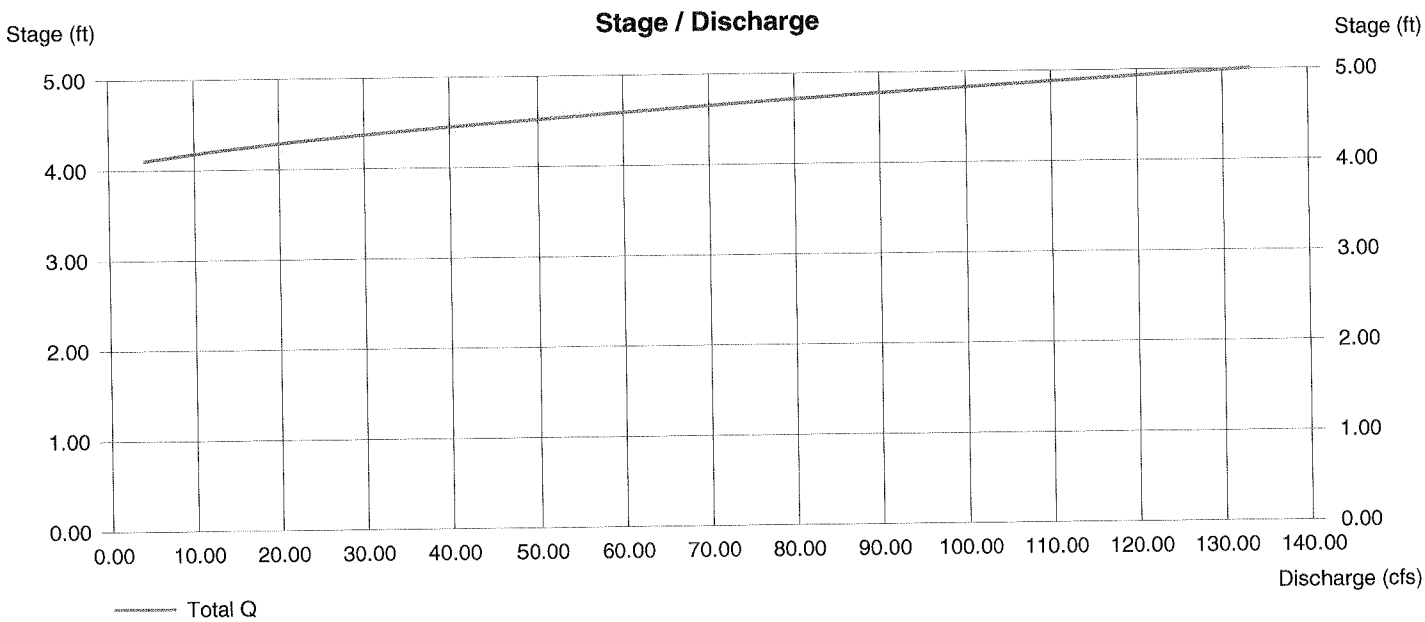
	[A]	[B]	[C]	[D]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 40.00	0.00	0.00	0.00
Crest El. (ft)	= 304.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



APPENDIX E

Durham Yard Waste Facility
Potential Evapotranspiration using Thornthwaite method
Durham, North Carolina

$PET=1.6*L_d*(^{10*TC}/I)^a$

PET = Potential Evaportranspiration
L_d=daytime hours in units of 12
TC=average monthly temperature in degrees C
Note: mean montly temperature
I=annual heat index
i_j=monthly heat index for month j

1979	AveT (F)	AveT (C)	Daylight	L_d	i_j	I	*a*		**PET (cm/mo)**	**PET (in/mo**
Jan	36.8	2.67	9.96	0.83	0.39	64.39		1.53	0.34	0.14
Feb	33.4	0.78	10.80	0.90	0.06	64.39		1.53	0.06	0.02
Mar	49.3	9.61	11.88	0.99	2.69	64.39		1.53	2.92	1.15
Apr	60.1	15.61	13.08	1.09	5.61	64.39		1.53	6.76	2.66
May	65	18.33	14.04	1.17	7.15	64.39		1.53	9.28	3.65
Jun	70.2	21.22	14.64	1.22	8.92	64.39		1.53	12.11	4.77
Jul	75.3	24.06	14.40	1.20	10.79	64.39		1.53	14.43	5.68
Aug	76.1	24.50	13.56	1.13	11.09	64.39		1.53	13.97	5.50
Sep	68.6	20.33	12.48	1.04	8.36	64.39		1.53	9.67	3.81
Oct	57.4	14.11	11.28	0.94	4.81	64.39		1.53	5.00	1.97
Nov	52.2	11.22	10.32	0.86	3.40	64.39		1.53	3.22	1.27
Dec	41.7	5.39	9.72	0.81	1.12	64.39		1.53	0.99	0.39
									78.75	**31.00**

1996	AveT (F)	AveT (C)	Daylight	L_d	i_j	I	*a*		**PET (cm/mo)**	**PET (in/mo**
Jan	37.1	2.83	9.96	0.83	0.42	72.46		1.66	0.28	0.11
Feb	41.8	5.44	10.80	0.90	1.14	72.46		1.66	0.90	0.35
Mar	45.1	7.28	11.88	0.99	1.77	72.46		1.66	1.60	0.63
Apr	59	15.00	13.08	1.09	5.28	72.46		1.66	5.83	2.30
May	69	20.56	14.04	1.17	8.50	72.46		1.66	10.56	4.16
Jun	77.3	25.17	14.64	1.22	11.55	72.46		1.66	15.41	6.07
Jul	79.9	26.61	14.40	1.20	12.57	72.46		1.66	16.63	6.55
Aug	77.2	25.11	13.56	1.13	11.51	72.46		1.66	14.22	5.60
Sep	72.7	22.61	12.48	1.04	9.82	72.46		1.66	11.00	4.33
Oct	61.3	16.28	11.28	0.94	5.97	72.46		1.66	5.76	2.27
Nov	46.8	8.22	10.32	0.86	2.12	72.46		1.66	1.70	0.67
Dec	45.3	7.39	9.72	0.81	1.81	72.46		1.66	1.34	0.53
									85.21	**33.55**

2003	AveT (F)	AveT (C)	Daylight	L_d	i_j	I	*a*		**PET (cm/mo)**	**PET (in/mo**
Jan	34.6	1.44	9.96	0.83	0.15	64.21		1.53	0.14	0.05
Feb	38.2	3.44	10.80	0.90	0.57	64.21		1.53	0.56	0.22
Mar	49.4	9.67	11.88	0.99	2.71	64.21		1.53	2.96	1.16
Apr	55.4	13.00	13.08	1.09	4.25	64.21		1.53	5.12	2.02
May	64.3	17.94	14.04	1.17	6.92	64.21		1.53	9.00	3.54
Jun	71.5	21.94	14.64	1.22	9.39	64.21		1.53	12.75	5.02
Jul	76.3	24.61	14.40	1.20	11.17	64.21		1.53	14.95	5.88
Aug	76.5	24.72	13.56	1.13	11.24	64.21		1.53	14.17	5.58
Sep	68.8	20.44	12.48	1.04	8.43	64.21		1.53	9.76	3.84
Oct	57.4	14.11	11.28	0.94	4.81	64.21		1.53	5.01	1.97
Nov	54.2	12.33	10.32	0.86	3.92	64.21		1.53	3.73	1.47
Dec	38.7	3.72	9.72	0.81	0.64	64.21		1.53	0.56	0.22
									78.70	**30.98**

APPENDIX F

STORMWATER DISCHARGE OUTFALL (SDO)
MONITORING REPORT

Permit Number: NC S000382 or
Certificate of Coverage Number: NCG_____

FACILITY NAME Compost Central
PERSON COLLECTING SAMPLE(S) P. Ronald Eubanks
CERTIFIED LABORATORY(S) Mecklenburg County Lab # 192
Lab #_____

SAMPLES COLLECTED DURING CALENDAR YEAR: 2003
(This monitoring report shall be received by the Division no later than 30 days from the date the facility receives the sampling results from the laboratory.)
COUNTY Mecklenburg
PHONE NO. (704) 336-5500

(SIGNATURE OF PERMITTEE OR DESIGNEE)
By this signature, I certify that this report is accurate complete to the best of my knowledge.

Part A: Specific Monitoring Requirements

Outfall No.	Date Sample Collected	50050 Total Flow	Biochemical Oxygen Demand	Chemical Oxygen Demand	Total Kjeldahl Nitrogen	Nitrate+Nitrite Nitrogen	Ammonia Nitrogen	Total Phosphorus	Fecal Coliform
	mo/dd/yr	MG	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	colonies/100ml
SDO 1	12/17/03	0.14	22.3	842	19	0.24	0.42	10.4	44,000
SDO 2	12/17/03	0.42	31.4	247	5.8	0.25	0.77	1.95	43,000

Does this facility perform Vehicle Maintenance Activities using more than 55 gallons of new motor oil per month? __yes __no
(if yes, complete Part B)

Part B: Vehicle Maintenance Activity Monitoring Requirements

Outfall No.	Date Sample Collected	50050 Total Flow	00556 Oil and Grease	00530 Total Suspended Solids	00400 pH	New Motor Oil Usage
	mo/dd/yr	MG	mg/l	mg/l	unit	gal/mo
SDO 1	12/17/03	0.14	<6	51	7.65	>55
SDO 2	12/17/03	0.42	<6	34	7.73	>55

STORM EVENT CHARACTERISTICS:

Date 12/17/03
Total Event Precipitation (inches): 0.20
Event Duration (hours): 3.0

(if more than one storm event was sampled)

Date _____
Total Event Precipitation (inches): _____
Event Duration (hours): _____

Mail Original and one copy to:
Division of Water Quality
Attn: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

_____ 12/17/03
(Signature of Permittee) **(Date)**

STORMWATER DISCHARGE OUTFALL (SDO)
MONITORING REPORT

Permit Number: NC 5000382 or
Certificate of Coverage Number: NCG_____

FACILITY NAME Compost Central
PERSON COLLECTING SAMPLE(S) P. Ronald Eubanks
CERTIFIED LABORATORY(S) Mecklenburg County Lab # 192
_____ Lab #_____

SAMPLES COLLECTED DURING CALENDAR YEAR: 2002
(This monitoring report shall be received by the Division no later t han 30 days from the date the facility receives the sampling results from the laboratory.)
COUNTY Mecklenburg
PHONE NO: (704) 336 - 5500

(SIGNATURE OF PERMITTEE OR DESIGNEE)
By this signature, I certify that this report is accurate complete to the best of my knowledge.

Part A: Specific Monitoring Requirements

Outfall No.	Date Sample Collected	50050 Total Flow	Biochemical Oxygen Demand	Chemical Oxygen Demand	Total Kjeldahl Nitrogen	Nitrate +Nitrite Nitrogen	Ammonia Nitrogen	Total Phosphorus	
	mo/dd/yr	MG	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
SDO1	12/13/02	0.031	143	486	15	0.14	0.61	3.61	
SDO2	12/13/02	0.094	50.8	244	5.3	0.59	0.10	1.76	

Does this facility perform Vehicle Maintenance Activities using more than 55 gallons of new motor oil per month? ✓ yes __no
(if yes, complete Part B)

Part B: Vehicle Maintenance Activity Monitoring Requirements

Outfall No.	Date Sample Collected	50050 Total Flow	00556 Oil and Grease	00530 Total Suspended Solids	00400 pH	New Motor Oil Usage
	mo/dd/yr	MG	mg/l	mg/l	unit	gal/mo
SDO1	12/13/02	0.031	< 5	285	8.19	> 55
SDO2	12/13/02	0.094	< 5	47	7.06	> 55

STORM EVENT CHARACTERISTICS:

Date 12/13/02
Total Event Precipitation (inches): 0.95
Event Duration (hours): 15.0

(if more than one storm event was sampled)

Date _____
Total Event Precipitation (inches): _____
Event Duration (hours): _____

Mail Original and one copy to:
Division of Water Quality
Attn: Central Files
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in ac cordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitte d is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

(Signature of Permittee)

12/13/02
(Date)

NUTRIENT MOVEMENT FROM A WINDROW OF DAIRY BEDDING/LEAF MULCH COMPOST

Rose Mary Seymour[1] and Michael Bourdon[2]

AUTHORS: [1]Public Service Assistant, Biological and Agricultural Engineering Department, University of Georgia,1109 Experiment St., Griffin, GA 30223; and [2]Former Graduate Research Assistant, Ecology and Environmental Sciences, University of Maine Orono, ME 04469.
REFERENCE: Proceedings of the 2003 Georgia Water Resources Conference, held April 23-24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. To evaluate movement of nutrients from compost windrows, a test bed was designed to capture the runoff from and effluent leaching (leachate) through a moderate size compost windrow. For six natural rain events, discharge volume over time was measured for leachate and runoff from a windrow created on top of the test bed along with rainfall intensity. Samples from leachate and runoff were analyzed for chemical constituents of nitrate-nitrogen, ammonium-nitrogen, total Kjeldahl nitrogen, dissolved phosphorus and pH. Nutrient concentrations from the compost effluents varied greatly for the six rainfall events. Nitrate-N concentration in leachate varied from 1.8 to 120 mg/L for the rainfall events. Nitrate-N concentrations from runoff ranged from 0.1 to 6.7 mg/L. Phosphorus concentrations were consistently higher in the leachate than in the runoff. The concentration of the nutrients in the leachate for some of the rain events were high enough to warrant concern for the pollution potential of large windrows placed directly on soils.

INTRODUCTION

There is little to no data available on the effects of rainfall on nutrient movement from composting windrows. Large uncovered windrows placed directly on soil surfaces or where runoff is not controlled can be a source of pollution from nutrients leaving the windrows in runoff or leachate infiltrating into soil during and after a rain event.

Composting is a recommended practice for dairy waste solids and for municipal leaf waste. Because the composting organic material has a high level of nutrients, the compost windrows may create a potential pollution problem from runoff and water leaching below the compost windrow into subsurface soils. For actively composting materials in a given setting, the amount of nutrients and mechanisms for movement of nutrients during rain events is poorly understood. Thus, the potential for pollution from composting windrows is unknown.

Without a better understanding of nutrient movement from compost windrows, improved practices to prevent the loss of nutrients from windrows cannot be sensibly recommended. A study was designed to measure nutrient movement from composting windrows due to natural rainfall. Samples of runoff and leachate were taken from composting windrows of dairy bedding (manure, urine and wood shavings) and municipal leaf waste. Chemical constituent concentrations of the effluent samples were measured, and the hydrology of the water movement through and over the windrows was quantified.

BACKGROUND AND RELATED WORK

Field studies to measure movement of nutrients from composting windrows have looked at different composting mixtures and constituents. In a study of different composting windrow mixtures of manure and straw, Ulen (1993) found elevated nitrogen (N) concentrations in leachate and increased concentrations of other nutrients such as phosphorus (P) and potassium (K) in runoff. Richard and Chadsey (1990), took water samples with suction lysimeters at various depths below municipal leaf waste composting in windrows. Nitrate and potassium levels in the soils below the compost site were higher than surrounding soils. Warman and Termeer (1996) studied leachate from various mixtures of composting racetrack manure, grass clippings and municipal biosolids. They concluded that the grass clippings contain elevated nitrates due to lawn fertilization and when the grass cell walls rupture during decomposition, the nitrates could quickly leach from the windrow. Elevated macronutrient levels were observed only for the windrows containing grass clippings. Controlling excess losses of nitrate and phosphorus would require either decreasing the quantity of grass clippings or adding more of some other substrate with a higher C:N ratio. Eghball et al. (1997) sampled effluent from a concrete pad that held composting dairy manure and found the runoff from the windrows could contribute nutrients in concentrations high enough to pollute surface and ground waters.

METHODS

The study was set up at a farm composting facility on the Witter Farm in Old Town, Maine. A test bed with dimensions of 3.3 m X 15.2 m was established for the study. The test bed consisted of a gravel filled trench with an impermeable barrier below the gravel and a tile drain pipe at the bottom of the trench to capture the leachate coming out of the compost. The impermeable barrier was attached to PVC pipes cut in half and placed like gutters around the perimeter of the bed to capture runoff.

Runoff and leachate flow through the pipes were measured by ISCO flow meters. The flow meters also signaled ISCO automated samplers to take samples during the rainfall events according to the volume of water passing by the flow meters. Samples were taken at 50 L intervals during rainfall events. Samples were removed at the end of a rainfall event. Hydrologic data and effluent samples were collected from four different windrows that were established consecutively on the test bed. The number of samples varied from event to event and ranged from two samples to eight samples taken during an event. There were a total of six measured events.

Each sample was analyzed for nutrient concentrations. Chemical concentration results presented are the averaged concentrations of all samples taken for each event. Samples were filtered through a 2 micron filter. Chemical analysis of the filtrates included nitrate-N, ammonium-N, total Kjeldahl nitrogen (TKN), total dissolved phosphorus and pH for both the leachate and runoff. The detection limit for the TKN was 60 mg/L. For the nitrate-N and ammonium-N the detection limits were 0.05 mg/L.

The windrows were built to cover the entire collection pad with dimensions of 15.2 m X 3.3 m X 1.22 m. A tractor with a bucket formed the windrows. After the windrow was formed, a windrow turner mixed the substrates further.

The dairy manure was a heterogeneous mixture of manure and wood shavings used as animal bedding. This material was used in all windrows so the term 'manure' is used to describe the above mixture.

The yard waste was material collected from the University of Maine Campus and five surrounding municipalities and delivered to the composting site. This material was comprised primarily of fallen leaves (> 95% by volume), though there was some cut brush and other organic residuals. To provide proper C:N ratio (35:1) and moisture content (50 %) for composting, a volumetric ratio of 3:1, yard waste to manure was determined for the composting mix.

Each windrow was on the test bed for only 28 days. This length was chosen to focus on the initial composting phase because this is when the most rapid organic breakdown occurs during composting (NRAES 1992).

Temperature changes were used to determined when the windrow needed turning and mixing. The temperature was measured with a probe inserted into the center of the cross section of the windrow at three locations along the length of the windrow. The temperature was checked twice a week, and the windrow turned if the temperature reached or exceeded 66° C or when the temperature declined below 32° C. If neither of these conditions were met the windrow was turned 14 days from the last turning. The turning was carried out with a windrow turner attached to the side of a tractor.

RESULTS

Table 1 provides summary runoff and leachate discharge and rain data for the six events. The number of rain events and the amount of data collected were limited by a drought during the months the study was conducted. However, the results provided valuable information on some aspects of the hydrology and nutrient movement from the composting windrows. The observed characteristics were a unique combination for each rainfall event. The average rainfall intensity for an event ranged from 1.8 to 8.2 mm/hr. The duration of the rain events

Table 1. Summary of the rainfall, leachate and runoff data and the number of days since the compost windrow was established until the particular rainfall event occurred

Date and Pile ID	Total Time*	Age of Compost#	Cumulative Volume mm			Ratio of Effluent to Rain %		Rain in Windrow %	Max Rain mm/hr	Ave Rain mm/hr
			Rain	Leachate	Runoff	Leachate /Rain	Runoff/ Rain			
5/20/99-A	11:15	17	19.1	10.1	2.3	52.8	12.3	34.8	6.1	2.3
5/24/99-A	9:00	21	9.9	9.1	6.7	92.2	68.4	----	8.1	2.4
6/7/99-B	10:30	2	30.8	10.5	7.5	34.1	24.3	41.6	49.8	8.2
6/8/99-B	14:15	3	18.1	7.9	4.5	43.6	24.7	31.7	9.1	2.6
7/10/99-C	3:15	1	6.0	1.0	5.4	16.0	89.9	----	3.0	1.8
8/10/99-D	22:45	4	57.2	26.1	19.0	45.6	33.2	21.3	26.4	7.3

*Format of time interval is hours:minutes.
Age of compost is the number of days between when the pile was first established and the rainfall event occurred.

ranged from 3 hours and 15 minutes to 22 hours and 45 minutes.

On the gravel test bed, the percentage of rainfall that permeated the windrows was higher than the percentage that ran off the outside of the windrow for all but the lowest intensity event. The ratios of leachate to rain and runoff to rain were not related to average or maximum intensities of the rainfall. For all rain events, more of the total rainfall became runoff or leachate than was and held in the windrow mixture.

Unexpectedly, there were two events where the volumes of runoff and leachate together exceeded the volume of rainfall measured. The two rain events on May 24 and July 10 had the lowest total precipitation and were low intensity events, but there was more total volume of leachate and runoff from the windrow than the total volume of rainfall that fell on the windrow.

On May 24, 60 % of the total of the effluents was leachate. This excess leachate was due to the antecedent moisture conditions of the windrow, the windrow temperature and the ambient weather conditions just before and during the rain event. Just 3 days previously, on May 20, there had been rain that had left the windrow saturated. This windrow had been in place for 21 days and was past the hottest part of the composting process. There was little to no heat within the windrow to drive evaporation of the excess water from the windrow. Because it was late May and weather was overcast between May 20 and 24, the ambient conditions would not have created much evaporation from the windrow either for those three days. In this case, the runoff and leachate volumes together were 160 % of the estimated total rainfall volume that fell on the windrow.

The rain event on July 10 had a total of runoff and leachate that was 6 % more than the measured volume of rainfall for the event. While the rain gauge for measuring the rain was within 3 m of the windrow test bed, rain intensity is spatially highly variable. This 6+ % discrepancy was some combination of instrument error for the discharge measurements and error due to spatial variability of rain intensity at the site.

For the events where the total of leachate and runoff volumes were less than the total rain volume, the longer the storm duration the higher the percentage of the rain that became leachate and runoff. The rain event duration had more effect on the percentage of rain that became effluents than the rain intensities which showed no correlation with the percentage of rain that became leachate or runoff.

Tables 2 and 3 show the nutrient concentrations for the runoff and leachate samples, respectively. Nutrient concentrations were much lower in the runoff samples than the leachate samples for all events. Nitrate-N was over the drinking water standard concentration of 10 mg/L in leachate for all events except the largest rainfall intensity event. Nitrate-N in runoff was never over the drinking water standard. Ammonium-nitrogen did not have consistently higher concentrations for either runoff or leachate samples. Phosphorus was higher in the leachate than in the runoff for all but the longest lasting storm.

DISCUSSION

Results indicated that nitrogen can move out of composting windrows at concentrations that exceed drinking water standards under some rain conditions. The high concentrations of nitrate-N results from water moving out of and through the windrow due to wetting from rain. This leachate can infiltrate directly into soil below a windrow or with impervious surfaces, it would become a part of the runoff. However, proper design of the surface area where large scale composting will take place can minimize or prevent this problem.

An impermeable liner or compacted clay placed at or below a composting facility surface would prevent the leachate from windrows from moving deeper into the soil. The liner or clay would need to have some additional materials such as gravel or woodchips on top to allow for capture and drainage of the surface so that heavy turning

Table 2. Nitrogen and phosphorus concentrations and pH of runoff samples from compost windrows for six rainfall events

Date	NH4-N mg/L	NO3-N mg/L	TKN mg/L	P mg/L	pH
5/20	2.1	0.1	<60	12.0	7.6
5/24	6.3	0.8	<60	7.4	8.2
6/7	10.6	6.7	430	15.0	7.7
6/8	5.1	4.8	<60	11.1	7.7
7/10	7.7	1.4	181	16.3	8.6
8/10	38.6	1.8	284	27.8	8.3

Table 3. Nitrogen and phosphorus concentrations and pH of leachate samples from compost windrows for six rainfall events

Date	NH4-N mg/L	NO3-N mg/L	TKN mg/L	P mg/L	pH
5/20	1.4	34.1	83	20.3	8.0
5/24	0.6	12.0	73	20.7	8.2
6/7	28.4	21.0	171	20.6	8.7
6/8	34.3	11.0	190	26.0	8.6
7/10	2.2	120	185	17.0	8.9
8/10	0.3	1.8	235	19.0	8.1

oading equipment could move over the surface after rain events.
wever, this would result in more water collected on irface and an increase in runoff as well as an ise in the nutrient concentrations in the runoff. To nt the increase in nutrient concentration in the f, windrows can be covered with impermeable s. Care must be taken in doing this so that the s do not inhibit the flow of air into the windrows to ain oxygen levels for the composting process. is odor problems could arise if the covers nted air movement into the windrows.
ernatively, windrows could remain uncovered and noff from the composting area could be captured. aptured runoff could be re-applied to the windrows they needed moisture or it could be treated through ructed wetlands or other natural means and allowed w into nearby streams after treatment.

RECOMMENDATIONS

e study presented was limited in duration and only with one mix ratio of dairy bedding and leaf waste. mixtures and composting materials would have ent nutrient concentrations and characteristics, so compost substrates need to be evaluated in similar es.
e study only looked at the first 28 days of the ow composting process. NRAES (1992) states the maturing phase of the compost process npanies an increase in nitrate concentrations in the ost. Also, Inbar et al. (1991) found increasing ntrations of nitrates in compost occurred after the phase of the composting process. This suggests at later stages there would be higher nitrate ntrations in both runoff and leachate from rows. This hypothesis needs to be investigated as as further studies on the mechanisms of nutrient ment throughout the composting process.
ther poorly understood issue with the movement of nts from open composting windrows is how the soil biology below the windrows are affected. vledge of soil microbiology changes that occur compost windrow facilities could provide insight he movement of nutrients in the soil and subsoil v windrow facilities.

ACKNOWLEDGEMENTS

is study was funded by the Maine Agricultural riment Station located at the University of Maine, o, Maine.

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APPENDIX G

Geosynthetic Research Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

Rev. 6: June 23, 2003
Revision schedule on pg. 14

GRI Test Method GM13*

Standard Specification for

"Test Properties, Testing Frequency and Recommended Warranty for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

1.5 This specification also presents a recommended warrant which is focused on the geomembrane material itself.

1.6 The recommended warrant attached to this specification does not cover installation considerations which is independent of the manufacturing of the geomembrane.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

GM 11 Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device

GM 12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet

Note 6: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 7: There are several GRI tests currently included in this standard. Since these topics are not covered in ASTM standards, this is necessary. They are the following:

- UV Fluorescent Light Exposure
- Asperity Height Measurement

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

11. Warranty

11.1 Upon request of the purchaser in the contract or order, a manufacturer's warrant of the quality of the material shall be furnished at the completion of the terms of the contract.

11.2 A recommended warranty for smooth and textured HDPE geomembranes manufactured and tested in accordance with this specification is given in Appendix A.

11.3 The warranty in Appendix A is for the geomembrane itself. It does not cover subgrade preparation, installation, seaming, or backfilling. These are separate

operations that are often beyond the control, or sphere of influence, of the geomembrane manufacturer.

Note 9: If a warrant is required for installation, it is to be developed between the installation contractor and the party requesting such a document.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,00 lb
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 63 lb/in. 114 lb/in. 12% 700%	 84 lb/in. 152 lb/in. 12% 700%	 105 lb/in. 190 lb/in. 12% 700%	 126 lb/in. 228 lb/in. 12% 700%	 168 lb/in. 304 lb/in. 12% 700%	 210 lb/in. 380 lb/in. 12% 700%	 252 lb/in. 456 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 1603 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	GM 11 D 3895 D 5885	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule

for

HDPE Specification per GRI-GM13

"Test Properties, Testing Frequency and Recommended Warrant for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.