

US EPA ARCHIVE DOCUMENT

TABLE 1

**PROJECT XL CRITERIA:
EVALUATION SUMMARY**

**Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
King George County Landfill and Recycling Center, King George County, Virginia**

CRITERION	DOES PROPOSED PROGRAM MEET REQUIREMENT?	LOCATION IN APPLICATION WHERE REQUIREMENT IS ADDRESSED
A. Superior Environmental Performance		
a. Tier 1: Project Equivalence	yes	3.1.1
b. Tier 2: Superior Environmental Performance	yes	3.1.2
c. Measurement of Environmental Performance	yes	3.1.3
B. Flexibility and Other Benefits	yes	3.2
C. Stakeholder Involvement	yes	3.3
D. Innovation in Pollution Prevention	yes	3.4
E. Transferability	yes	3.5
F. Feasibility	yes	3.6
G. Evaluation, Monitoring, and Accountability	yes	3.7
H. Shifting of Risk Burden	yes	3.8

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TABLE 2**SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION AND BIOREACTOR PROJECTS**

(continued)

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Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
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PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Yorkshire, England Searner-Carr Landfill [Robinson and Maris, 1985]	Field-Scale Study	<ul style="list-style-type: none"> • 6.2-acre cell used as leachate recycle area. • Approximate 6-acre control area. • Cell lined with 100-mil HDPE with leachate collection system. • 13 ft of pulverized refuse placed in cells. • Leachate redistributed by spray pipe networks laid on top of refuse. • Furrows later dug into surface to reduce ponding. • Recirculation and monitoring period approximately 3 years. • 36,000 gallons of leachate storage available.
Delaware Solid Waste Authority Central Solid Waste Management Center Sandtown, Delaware [Vasuki, 1986]	Field-Scale Study	<ul style="list-style-type: none"> • Leachate recycle in 2 full-scale landfill cells. • 9-acre cell using recharge wells. • 18-acre cell using four wells and traveling spray irrigation system. • Total leachate storage capacity of 40,000 gallons. • Cells lined with 30-mil PVC synthetic liner with leachate collection systems. • Average refuse depth in cells is 30 ft.
Lycoming County Landfill Williamsport, PA [Natale and Anderson, 1986]	Full-Scale Operations with Study	<ul style="list-style-type: none"> • Three 10-acre leachate recycle cells. • 20-mil PVC used to line cells along with leachate collection systems. • Various leachate recycle strategies attempted but not detailed. • Authors observed recharge wells to work best. • Eight years of data collection included flow measurement (collect and recycle); rainfall; landfill surface conditions (monthly); and quarterly leachate quality monitoring.
Southwest Landfill Alachua County, Florida [Reinhart, 1996] [Townsend et al., 1996]	Full-Scale Operations with Study	<ul style="list-style-type: none"> • Composite lined area is 27 ac (10.9 ha). • Waste was first accepted in Spring 1988. • Receives 10,000 tons/month (9,070 Mg/month) of MSW. • Maximum waste thickness will be 65 ft (20 m). • Permitted to recirculate up to 60,000 gal/day (227 m³/day). • Storage tank capacity is 360,000 gal (1,364 m³). • From 1990-1992, over 8 million gal (30,000 m³) of leachate was pumped into infiltration ponds. • In 1993, began using horizontal injection trenches (horizontal spacing of 50 ft (15 m), vertical spacing of 20 ft (6 m)). • From March through September 1993, injected 200,000 to 780,000 gal/month (757 to 2,950 m³/month) of leachate into a total of 17 injection trenches.

TABLE 2

SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION AND BIOREACTOR PROJECTS

(continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Central Landfill Facility Worcester County, Maryland [Reinhart, 1996] [Kilmer, 1991]	Full-Scale Operations	<ul style="list-style-type: none"> Lined area consists of four 17-ac (6.9-ha) cells. Began operating in 1990. Maximum fill height will be 90 ft (27 m). Receives 200 tons/day (181 Mg/day) of MSW. Storage tank capacity is 400,000 gal (1,514 m³). Leachate is recirculated using one vertical discharge well for each 2-ac (0.8-ha) area.
Winfield Landfill Columbia County, Florida [Reinhart, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> Current lined area is 7 ac (2.8 ha), with plans to expand to 22 ac (8.9 ha). Began operating in 1992. Maximum fill height will be 54 ft (16.5 m). Receives 120 tons/day (109 Mg/day) of MSW. Aeration lagoon capacity is 50,000 gal (189 m³). Permitted to recirculate using surface ponds or spraying, provided spraying is limited to a 2-week duration at any one location.
Pecan Row Landfill Loundes County, Georgia [Reinhart, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> The ultimate lined area will be 40 ac (16 ha). Individual cells, 3.5 to 4 ac (1.5 to 1.6 ha) in area, are constructed approximately every 7 months. Maximum fill height will be approximately 60 ft (18 m). Receives 600 ton/day (544 Mg/day) of MSW. Lagoon capacity is 821,000 gal (3,100 m³). Horizontal leachate injection trenches are constructed on top of each waste lift; the previous lift of trenches is abandoned when each new lift of trenches is constructed. Cover soil is removed prior to subsequent waste placement.
Lower Mount Washington Valley Secure Landfill Conway, New Hampshire [Reinhart, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> Composed of eight hydraulically separated double-lined cells, each 0.75 to 1.0 ac (0.3 to 0.4 ha) in area. Receives 10,000 to 15,000 tons/yr (9,070 to 13,600 Mg/yr) of MSW Storage tank capacity is 10,000 gal (38 m³). Filling began in January 1992, and was temporarily discontinued in November 1993. Leachate was recirculated primarily by pre-wetting using a fire hose and also using a pipe manifold placed in a shallow excavation in daily cover.
Coastal Regional Solid Waste Management Authority Landfill Craven County, North Carolina [Reinhart, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> Consists of three hydraulically separated cells totaling 22 ac (8 ha) in area. Final waste height will be approximately 50 ft (15 m). Receives 350 tons/day (318 Mg/day) of MSW. Aeration lagoon capacity is 2.4 million gal (9,085 m³). Leachate is injected using a movable vertical injection system consisting of 12 10-ft (3-m) long perforated black iron probes inserted into the landfill and connected to a manifold. The system stays in one location for 2 to 8 days. Leachate is injected at a pressure of 45 psi (310 kPa). At the completion of each of the four planned lifts, horizontal trenches will be constructed in a pattern radiating from a central distribution box. Each lift of trenches will be abandoned when the subsequent lift of trenches is constructed.

TABLE 2

SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION AND BIOREACTOR PROJECTS
(continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Lemons Landfills Stoddard County, Missouri [Reinhart, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> • Ultimate fill area will be 75 ac (30 ha). • Maximum fill height will be 85 ft (26 m). • Receives 300 tons/day (272 Mg/day) of MSW. • Lagoon storage capacity is 867,800 gal (3,280 m³). • Leachate recirculation will be performed using vertical discharge wells located at 200-ft (61-m) intervals. • Leachate will be managed using two lagoons: the first lagoon will collect leachate until recirculation reduces leachate strength significantly, at which time leachate will be diverted to the second lagoon and used to irrigate closed areas of the landfill.
Mill Seat Landfill Monroe County, New York [Reinhart, 1996]	Full-Scale Operations with Study	<ul style="list-style-type: none"> • The bioreactor research project involves three hydraulically separated double composite lined cells varying from 5.4 to 7.4 ac (2.2 to 3 ha) in area. • One cell serves as a control (i.e., no recirculation); two different horizontal leachate injection systems are used in the other two cells. • Cell 2 has horseshoe-shaped injection trenches at three elevations, and a storage tank capacity of 20,000 gal (76 m³). • Cell 3 has horizontal trenches at two elevations containing pre-fabricated infiltrators, and a storage tank capacity of 20,000 gal (76 m³). • The relative moisture content of the waste will be monitored using gypsum blocks located in the waste.
Delaware Solid Waste Authority Southern Solid Waste Management Center Sussex County, Delaware [Maier and Vasuki, 1996]	Full-Scale Operations	<ul style="list-style-type: none"> • Leachate was recirculated in Cells 1 and 2 using vertical injection wells from 1985 to 1994. • For Cell 3, a horizontal integrated leachate recirculation and landfill gas extraction system is planned; lifts of separate injection and extraction trenches will be installed every 20 ft (3 m) vertically.
Charles City County Landfill Charles City County, Virginia [VADEQ Solid Waste Permit No. 531]	Full-Scale Operations	<ul style="list-style-type: none"> • Leachate is injected into horizontal trenches filled with shredded tires. • The landfill is operated by USA Waste.
Pine Bluff Landfill Cherokee County, Georgia [Georgia Solid Waste Permit No. 028-039 D (SL)]	Full-Scale Operations	<ul style="list-style-type: none"> • Leachate is injected into horizontal trenches. • The landfill is operated by USA Waste.
Quail Hollow Landfill Tulahoma, Tennessee [Tennessee Solid Waste Permit No. SNL-02-102-0101]	Full-Scale Operations	<ul style="list-style-type: none"> • Leachate is sprayed into the working face. • The landfill is operated by USA Waste.
Cedar Ridge Landfill Louisberg, Tennessee [Tennessee Solid Waste Permit Number SNL-59-102-0238 EXT]	Full-Scale Operations	<ul style="list-style-type: none"> • Leachate is sprayed into the working face. • The landfill is operated by USA Waste.

TABLE 2**SUMMARY OF FIELD-SCALE LEACHATE RECIRCULATION AND BIOREACTOR PROJECTS**
(continued)

PROJECT LOCATION AND REFERENCES	TYPE OF PROJECT	DESCRIPTION OF LANDFILL AND PERMITTED RECIRCULATION PRACTICES
Southern Sanitation Landfill Russelville, Kentucky [Kentucky Solid Waste Permit Number 071-00006]	Full-Scale Operations	<ul style="list-style-type: none">• Leachate is sprayed into the working face.• The landfill is operated by USA Waste.

TABLE 3

**SUMMARY OF BENEFITS:
LEACHATE RECIRCULATION AND BIOREACTORS**

**Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
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- Decreased Leachate Management Costs
- Increased Landfill Disposal Capacity
- Reduced Duration of Leachate Production
- Reduced Duration of Landfill Gas Generation
- Improved Leachate Quality in Long-Term
- Decreased Long-Term Threat of Leachate to the Environment
- Increased Total Landfill Gas Generation Quantity
- More Complete Degradation of Waste During Period of Active Waste Disposal

TABLE 4

**LEACHATE QUALITY IMPROVEMENT ILLUSTRATION:
CENTRAL SOLID WASTE MANAGEMENT CENTER
KENT COUNTY, DELAWARE**

**Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
King George County Landfill and Recycling Center, King George County, Virginia**

PARAMETER	CONVENTIONAL	RECIRCULATING
Iron (mg/L)	20 - 21,000	4 - 1,095
BOD (mg/L)	20 - 40,000	12 - 28,000
COD (mg/L)	500 - 60,000	20 - 34,560
Ammonia (mg/L)	30 - 300	6 - 1,850
Chloride (mg/L)	100 - 5,000	9 - 1,884
Zinc (mg/L)	6 - 370	0.1 - 66

Source: Watson, R. [1995].

TABLE 6

METHODS FOR MEASURING ENVIRONMENTAL PERFORMANCE OF LEACHATE RECIRCULATION PROGRAM

**Application for Project XL - Bioreactor Systems
 Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
 King George County Landfill and Recycling Center, King George County, Virginia**

CRITERIA	DESCRIPTION	APPLICATION AT MAPLEWOOD LANDFILL
Settlement	Measurement of total settlement of surface of waste over a period of time	Compare the surveyed elevation of the top surface of the landfill before landfill operation to the elevation during and after landfill operation
Leachate Quantity	Total volume of leachate collected from landfill cell	Measure leachate quantity from flowmeters in leachate riser houses located at each landfill cell
Leachate Quality	Chemical characteristics of leachate collected from a landfill cell	Perform laboratory analyses of the chemical characteristics of leachate from landfill cells
In-Place Density	Unit weight of waste in a landfill cell	Divide the total weight of waste placed in a landfill cell (based on scale records) by the total surveyed volume of the waste (i.e., difference in elevation between the bottom and the top of the landfill cell)
Odor Problems	Citizen complaints of odors	Track frequency of odor complaints during liquids application events
Seeps	Breakouts of leachate on sideslopes	Track occurrence of seeps and compare them to liquids application events
Operational Problems	Decreased ops. Efficiency caused by liquids application	Monitor the working face for occurrences of operational problems caused by liquids applications
Flowrate in Leak Detection Zone	Liquid quantity occurring in the detection zone	Compare liquid flowrate in detection zone during liquids application period to flowrate in detection zone before liquids application period

TABLE 5

DESIGN GOALS FOR BIOREACTOR LANDFILL

**Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
King George County Landfill and Recycling Center, King George County, Virginia**

GOAL	APPROACH FOR ACHIEVING GOAL
1. Apply leachate and stormwater in a quantity of at least eight million gallons per year at Maplewood and 8 million gallons per year at King George.	Design trenches to have a liquid application capacity of at least 8 million gallons.
2. Minimize Seeps	<ul style="list-style-type: none"> · Apply liquid at least 50 ft from edge of waste · Inspect landfill weekly for the presence of seeps · Repair seeps as quickly as possible
4. Provide several liquid delivery options	Provide different approaches for delivering liquid to the working face (e.g., pumped directly from leachate storage tanks or stormwater pond, temporarily stored in tanks near the working face, etc.).
5. Uniformly distribute liquid throughout waste	Design leachate application trenches and wells in a configuration that maximizes amount of waste affected by recirculated leachate.
6. Minimize uncontrolled release of landfill gas	Design and install a landfill gas collection system that can be operated throughout the active life of the bioreactor program.
7. Monitor performance of bioreactor program	Monitor performance of bioreactor program and report results of monitoring program semi-annually to VADEQ.

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TABLE 7

METHODS FOR MEASURING ENVIRONMENTAL PERFORMANCE OF LANDFILL BIOREACTOR PROGRAM

Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
King George County Landfill and Recycling Center, King George County, Virginia

CRITERIA	DESCRIPTION	APPLICATION
Settlement	Measurement of total settlement of surface of waste over a period of time	Compare the surveyed elevation of the top surface of the bioreactor before bioreactor operation to the elevation during and after bioreactor operation
Leachate Quantity	Total volume of leachate collected from bioreactor cell	Measure leachate quantity from flowmeters in leachate riser houses located at each bioreactor cell
Leachate Quality	Chemical characteristics of leachate collected from a bioreactor cell	Perform laboratory analyses of the chemical characteristics of leachate from bioreactor cells
In-Place Density	Unit weight of waste in a bioreactor cell	Divide the total weight of waste placed in a bioreactor cell (based on scale records) by the total surveyed volume of the waste (i.e., difference in elevation between the bottom and the top of the bioreactor cell)
Odors	Citizen complaints of odors	Track frequency of odor complaints during liquids application events
Seeps	Breakouts of leachate on sideslopes	Track occurrence of seeps and compare them to liquids application events
Operational Problems	Decreased ops. Efficiency caused by liquids application	Monitor the working face for occurrences of operational problems caused by liquids applications
Flowrate in Leak Detection Zone	Liquid quantity occurring in the detection zone	Compare liquid flowrate in detection zone during liquids application period to flowrate in detection zone before liquids application period

TABLE 10

DEMONSTRATION OF SUPERIOR ENVIRONMENTAL PERFORMANCE
(continued)

TABLE 8

PRELIMINARY OUTLINE FOR PROGRAM XL SEMI-ANNUAL REPORT

Application for Project XL - Bioreactor Systems
Maplewood Recycling and Waste Disposal Facility, Amelia County, Virginia
King George County Landfill and Recycling Center, King George County, Virginia

1. INTRODUCTION
 - 1.1 Terms of Reference
 - 1.2 Background
 - 1.3 Organization

2. SAMPLING AND ANALYSIS ACTIVITIES
 - 1.1 Field Sampling Activities
 - 1.1.1 Leachate Quality
 - 1.1.2 Landfill Gas Quality
 - 1.1.3 Surface Sampling for Landfill Gas

 - 1.2 Laboratory Analysis Program
 - 1.2.1 Leachate Quality
 - 1.2.2 Landfill Gas Quality

 - 1.3 Other Data
 - 1.3.1 Waste Receipt Quantity
 - 1.3.2 Precipitation
 - 1.3.3 Leachate Generation Quantities
 - 1.3.4 Quantity of Liquid Applied to Landfills
 - 1.3.5 Landfill Settlement
 - 1.3.6 Landfill Gas Volume

TABLE 10

DEMONSTRATION OF SUPERIOR ENVIRONMENTAL PERFORMANCE
(continued)

3. DATA ANALYSIS

2.1 Maplewood Recycling and Waste Disposal Facility

- 2.1.1 Leachate Quality and Quantity
- 2.1.2 Landfill Gas Quality and Quantity
- 2.1.3 Trends in Other Data
- 2.1.4 Control Cell Data

2.2 King George County Landfill and Recycling Center

- 2.2.1 Leachate Quality, Leachate and Stormwater Quantity
- 2.2.2 Landfill Gas Quality and Quantity
- 2.2.3 Trends in Other Data
- 2.2.4 Control Cell Data

4. CONCLUSIONS

- 4.1 Leachate Quality and Quantity
- 4.2 Landfill Gas Generation Quantity and Control
- 4.3 Relative Effectiveness of Trenches Versus Wells
- 4.4 Relative Performance of Leachate Recirculation Versus Bioreactor Landfill

Appendix A: Field Sampling Logs

Appendix B: Laboratory Test Results