

LANDFILL LEACHATE RECIRCULATION SYSTEMS:
MATHEMATICAL MODELING AND VALIDATION

by

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Abstract

Bioenhanced operation of municipal solid waste (MSW) landfills can accelerate the stabilization of the organic fraction of the waste. Such enhancement promotes biogas energy production while reducing the potential for long-term adverse environmental impacts. Bioenhancement has also been considered as a source reduction technique at problematic landfills. Bioenhancement primarily involves moisture control using leachate recirculation through the landfill, but also may include nutrient and buffer addition, aerobic decomposition within the landfill for temperature control, and MSW composition control.

Because leachate recirculation has been found to be the most practical approach to moisture content control, full-scale bioenhancement efforts tend to focus on this technique. Proper design and operation of the leachate recirculating landfill requires a more in-depth understanding of the hydraulics of leachate transport within the landfill than is presently available. Consequently, the objectives of the study were to evaluate the effect of leachate recirculation on the moisture saturation levels of the waste in the landfill, determine the area influenced by different recirculation methodologies, and to develop a design strategy. A modified form of SUTRA (Saturated-Unsaturated Transport), a United States Geological Survey (USGS) unsaturated flow and solute transport program was used to meet these objectives. Two of the most common types of leachate recirculation methodologies (trench infiltration and vertical wells) were modeled. The variables evaluated included leachate input rates, frequency of operation

of the recirculation system, the permeability of intermediate cover materials, permeability of the waste, and heterogeneity effects. Modeling results indicated that lateral spreading increased with decreasing permeabilities and increasing application rates. However, as permeability decreased, the upward movement of leachate increased which could result in surface seep problems. Waste mass anisotropies may result in an increase in lateral spreading and thus the impact area but may also cause side seep problems. The study of waste mass heterogeneities indicated preferential flow through high permeability areas and around low permeability materials but did not significantly affect lateral movement. The use of low permeability daily cover materials may significantly impede leachate movement. Therefore, low permeability materials should be avoided or breached prior to the placement of the next waste layer.

In addition to studying hypothetical leachate recirculation scenarios, four leachate recirculation field studies were modeled; the Mill Seat Landfill, Monroe County, New York, the Delaware Solid Waste Authority's Leachate Recirculation Test Cells, the Yolo County Landfill Demonstration Project, and the University of Central Florida - Environmental Protection Agency (UCF/EPA) Test Cell. Predicted leachate production was compared to measured values. This effort at model verification indicated channeled flow is a major leachate movement mechanism which must be studied and accounted for in future models. Results also indicated that increased data collection efforts are imperative to develop and applying models to full-scale operations.

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TABLE OF CONTENTS

LIST OF TABLES	vi
LIST OF FIGURES	ix
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 LITERATURE REVIEW	4
2.1 Leachate Recirculation	4
2.1.1 Recirculation Methodologies	13
2.2 Leachate Collection System	26
2.3 Hydraulic Characteristics of Municipal Solid Waste	34
2.3.1 Permeability	34
2.3.2 Unsaturated Flow Properties	36
2.3.3 Moisture Flow Patterns	42
2.4 Geotechnical Properties of Municipal Solid Waste	48
2.5 Mathematical Models	50
CHAPTER 3 METHODOLOGY	60
3.1 Program Information	60
3.2 Conceptual Modeling	66
3.2.1 Horizontal Trench	67
3.2.2 Daily Cover Material Effects	73
3.2.3 Anisotropic Waste Mass	74
3.2.4 Vertical Well	75
3.3 Stochastic Modeling	78
3.4 Verificational Modeling	83
3.4.1 Mill Seat Landfill, Monroe County, New York	83
3.4.2 Delaware Solid Waste Authority	87
3.4.3 Yolo County Landfill, California	91
3.4.4 UCF/EPA Test Cell, Orange County Landfill, Florida	96
CHAPTER 4 CONCEPTUAL AND STOCHASTIC MODELING RESULTS	101

4.1 Horizontal Trench	101
4.1.1 Constant Operation Results	103
4.1.2 Intermittent Operation Results	108
4.1.3 Discussion	113
4.2 Vertical Well	116
4.2.1 Constant Operation Results	117
4.2.2 Intermittent Operation Results	122
4.2.3 Discussion	126
4.3 Daily Cover Material Effects	129
4.4 Anisotropic Waste Conditions	137
4.5 Heterogeneous Waste Conditions	142
 CHAPTER 5 VERIFICATIONAL MODELING	 153
5.1 Mill Seat Landfill, Monroe County, New York	154
5.1.1 Pressurized Leachate Recirculation Loops	156
5.1.2 Deep Trench Recirculation	164
5.2 Delaware Solid Waste Authority	174
5.3 Yolo County Landfill, California	183
5.4 UCF/EPA Test Cell	194
5.5 Discussion	200
 CHAPTER 6 LEACHATE RECIRCULATION SYSTEM DESIGN	 202
6.1 New Installations	202
6.2 Retro-fitting Existing Facilities	207
6.3 Construction and Operation Concerns	212
6.4 Monitoring	215
 CHAPTER 7 CONCLUSIONS	 219
 CHAPTER 8 RECOMMENDATIONS	 222
8.1 Waste Hydraulic Properties	222
8.2 Modeling Efforts	224
8.3 Field Studies	228
 LIST OF REFERENCES	 232

LIST OF TABLES

2.3.1.	Summary of Material Property Data (Zeiss and Major, 1992).	43
2.3.2.	Summary of Hydraulic Property Data (Zeiss and Major, 1992).	44
3.1.1.	Physical Significance of Terms in the SUTRA Governing Equation 3.1.1.	61
3.3.1.	Permeability assignments for the two ‘dog-bone’ PDF scenarios modeled.	82
3.4.1.	DSWA test cell simulation lateral boundaries.	90
3.4.2.	Simulation mass balance results for initial saturations of 20, 30, and 40 percent after 34 days.	95
3.4.3.	Leachate application schedule for the UCF/EPA test cell.	99
4.1.1.	Maximum lateral movement for constant and intermittent leachate application via the horizontal trench.	113
4.1.2.	Maximum upward movement for constant and intermittent leachate application via the horizontal trench.	114
4.2.1.	Maximum lateral movement for constant and intermittent leachate application via the horizontal trench.	127
5.3.1.	Simulation mass balance results for initial saturations of 20, 30, and 40 percent after 34 days.	185
5.3.2.	Leachate pumping schedule for the Yolo County Recirculation System.	186
5.3.3.	Comparison between collected data and simulated data (40%	189

initial saturation) for the Yolo County Project.

LIST OF FIGURES

2.1.1.	Typical below ground landfill cross-section.	6
2.1.2.	Leachate recirculation flow schematic.	9
2.1.3.	Horizontal leachate recirculation leach field.	18
2.1.4.	Horizontal leachate infiltration trench.	18
2.1.5.	Saturated flow zone surrounding a horizontal injection well flow system under steady conditions.	22
2.1.6.	Sectionalized vertical leachate recirculation well.	24
2.2.1.	Schematic diagram of a composite liner system.	27
2.3.1.	Comparison of unsaturated flow relationships for MSW.	42
3.1.1.	Diagram of a finite element mesh (elements numbers are bold, node numbers are italic).	64
3.2.1.	Cross-section of the waste matrix simulated for the horizontal trench .	68
3.2.2.	Percent error in mass balance versus time factor for horizontal trench simulations.	73
3.2.3.	Diagram of continuous (a) and breached (b) daily cover layers simulated.	74
3.2.4.	Diagram of flux nodes which simulate the vertical well.	75
3.3.1.	Probability density functions used to simulate a heterogeneous	79

	waste mass.	
3.3.2.	Histogram used to simulate the ‘dog-bone’ probability distribution	81
3.4.1.	Schematic diagram of the cross-sections modeled for the pressure loop (a) and deep trench (b) recirculation systems.	85
3.4.2.	Cumulative leachate volumes generated and recirculated for the pressure loop recirculation system.	86
3.4.3.	Cumulative leachate volumes generated and recirculated for the deep trench recirculation system.	87
3.4.4.	Cumulative leachate volumes generated and recirculated for the DSWA’s leachate recirculation test cell.	88
3.4.5.	Co-ordinate Schematic for the DSWA Test Cell Simulations.	89
3.4.6.	Areal diagram of the Yolo County leachate recirculation test cell.	92
3.4.7.	Location of gypsum moisture sensors used in the UCF/EPA test cell.	97
3.4.8.	Daily and cumulative leachate addition to the UCF/EPA test cell.	100
3.4.9	Percent error between leachate volume stored in waste mass and actual leachate application for the three different waste permeabilities modeled.	100
4.1.1.	Schematic depicting the calculation method for the lateral and upward movement, leachate applied continuously at $8 \text{ m}^3/\text{m}/\text{day}$ for one week, waste permeability = $1 \times 10^{-3} \text{ cm/s}$.	102
4.1.2.	Maximum lateral movement versus permeability for constant leachate injection.	103
4.1.3.	Maximum upward movement versus permeability for constant leachate injection.	104
4.1.4.	Lateral Movement Versus Flow Rate for Constant Leachate Injection.	105
4.1.5.	Upward Movement Versus Flow Rate for Constant Leachate	105

Injection.

4.1.6.	Saturation iso-clines for the horizontal trench operated continuously at a rate of $4 \text{ m}^3/\text{m}/\text{day}$ for waste mass permeabilities of 10^{-3} (a), 10^{-4} (b), and 10^{-5} (c) cm/s, one week elapsed time.	107
4.1.7.	Maximum lateral movement versus permeability for intermittent leachate injection (8 hr on/16 hr off).	108
4.1.8.	Maximum upward movement versus permeability for intermittent leachate injection (8 hr on/16 hr off).	109
4.1.9.	Lateral Movement Versus Flow Rate for Intermittent Leachate Injection (8 hr on/16 hr off).	110
4.1.10.	Upward Movement Versus Flow Rate for Intermittent Leachate Injection (8 hr on/16 hr off).	110
4.1.11.	Saturation iso-clines for the horizontal trench operated intermittently (8 hr on /16 hr off) at an average rate of $4 \text{ m}^3/\text{m}/\text{day}$ for waste mass permeabilities of 10^{-3} (a), 10^{-4} (b), and 10^{-5} (c) cm/s, one week elapsed time.	112
4.1.12.	Saturation iso-clines for the horizontal trench operated constantly (a) and intermittently (b) at an average rate of $4 \text{ m}^3/\text{m}/\text{day}$ after one week. Waste permeability = 10^{-3} cm/s.	115
4.2.1.	Calculation of lateral movement, leachate applied intermittently (8 hr on/16 hr off) at $10 \text{ m}^3/\text{m}/\text{day}$ for 3 weeks, waste permeability = 1×10^{-3} cm/s.	117
4.2.2.	Lateral movement versus flow rate for one to four weeks of constant leachate application to a waste mass with a permeability of 10^{-3} cm/s.	118
4.2.3.	Lateral movement versus flow rate after one week of constant leachate application.	119
4.2.4.	Lateral movement versus flow rate after two weeks of constant leachate application.	119
4.2.5.	Lateral movement versus flow rate after three weeks of constant	120

leachate application.

4.2.6.	Saturation iso-clines for the vertical well operated continuously at a rate of $10 \text{ m}^3/\text{day}$ for waste mass permeabilities of 10^{-3} (a), 10^{-4} (b), and 10^{-5} (c) cm/s, three weeks elapsed time.	121
4.2.7.	Lateral movement versus flow rate for one to three weeks of intermittent leachate application (8 hr on/16 hr off) to a waste mass with a permeability of 10^{-3} cm/s.	122
4.2.8.	Lateral movement versus flow rate after one week of intermittent leachate application (8 hr on/16 hr off).	123
4.2.9.	Lateral movement versus flow rate after two weeks of intermittent leachate application (8 hr on/16 hr off).	124
4.2.10.	Lateral movement versus flow rate after three weeks intermittent leachate application (8 hr on/16 hr off).	124
4.2.11.	Saturation iso-clines for the vertical well operated intermittently (8 hr on /16 hr off) at an average rate of $10 \text{ m}^3/\text{day}$ for waste mass permeabilities of 10^{-3} (a), 10^{-4} (b), and 10^{-5} (c) cm/s, three weeks elapsed time.	125
4.2.12.	Saturation iso-clines for the vertical well operated constantly (a) and intermittently (b) at an average rate of $10 \text{ m}^3/\text{day}$ for three weeks. Waste permeability = 10^{-3} cm/s.	128
4.2.13.	Saturation iso-clines for the vertical well operated constantly (a) and intermittently (b) at an average rate of $10 \text{ m}^3/\text{day}$ for three weeks. Waste permeability = 10^{-5} cm/s.	129
4.3.1.	Comparison of leachate routing in a landfill with a low permeability daily cover material (permeability = 10^{-5} cm/s) with intermittent leachate application at a daily rate of 2, 4, and $8 \text{ m}^3/\text{m}/\text{day}$ (a, b, and c respectively). Waste permeability = 10^{-3} cm/s.	132

4.3.2.	Comparison of leachate routing in a landfill with a low permeability daily cover material (permeability = 10^{-4} cm/s) with intermittent leachate application at a daily rate of 2, 4, and 8 $m^3/m/day$ (a, b, and c respectively). Waste permeability = 10^{-3} cm/s.	133
4.3.3.	Comparison of leachate routing in a landfill with a high permeability daily cover material (permeability = 10^{-2} cm/s) with intermittent leachate application at a daily rate of 2, 4, and 8 $m^3/m/day$ (a, b, and c respectively). Waste permeability = 10^{-3} cm/s.	134
4.3.4.	Comparison of leachate routing in a landfill with a low permeability daily cover material (permeability = 10^{-5} cm/s) with intermittent leachate application at a daily rate of 2, 4, and 8 $m^3/m/day$ (a, b, and c respectively). Waste permeability = 10^{-4} cm/s.	135
4.3.5.	Comparison of leachate routing in a landfill with a high permeability daily cover material (permeability = 10^{-3} cm/s) with intermittent leachate application at a daily rate of 2, 4, and 8 $m^3/m/day$ (a, b, and c respectively). Waste permeability = 10^{-4} cm/s.	136
4.4.1.	Leachate routing for an anisotropic waste mass with a longitudinal permeability of 10^{-3} cm/s and a transverse permeability of 10^{-2} cm/s (a) or 10^{-4} cm/s (b) after one week of operation. Leachate applied eight hours per day at a rate of 4 m^3/m of trench/day.	138
4.4.2.	Leachate routing for an anisotropic waste mass with a longitudinal permeability of 10^{-4} cm/s and a transverse permeability of 10^{-3} cm/s (a) or 10^{-5} cm/s (b) after one week of operation. Leachate applied eight hours per day at a rate of 4 m^3/m of trench/day.	139
4.4.3.	Leachate routing for an anisotropic waste mass with a longitudinal permeability of 10^{-4} cm/s and a transverse permeability of 10^{-3} cm/s after one (a), two (b), and three (c) weeks of operation. Leachate applied eight hours per day at a rate of 2 m^3/m of trench/day.	141

4.5.1.	Comparison of leachate routing for homogeneous waste masses with permeabilities of 10^{-3} (a) and 10^{-4} (b) cm/s after one week of operation. Leachate applied eight hours per day at a rate of $4 \text{ m}^3/\text{m}$ of trench/day.	143
4.5.2.	Three possible leachate routings after one week of leachate recirculation for a waste mass with a normal permeability distribution and an average permeability of 10^{-3} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day.	145
4.5.3.	Three possible leachate routings after one week of leachate recirculation for a waste mass with a normal permeability distribution and an average permeability of 10^{-4} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day.	146
4.5.4.	Three possible leachate routings after one week of leachate recirculation for a waste mass with an exponentially increasing permeability distribution and a permeability range of 10^{-1} to 10^{-5} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day. 4 days elapsed time.	147
4.5.5.	Three possible leachate routings after one week of leachate recirculation for a waste mass with an exponentially increasing permeability distribution and a permeability range of 10^{-2} to 10^{-6} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day.	148
4.5.6.	Three possible leachate routings after one week of leachate recirculation for a waste mass with an exponentially decreasing permeability distribution and a permeability range of 10^{-1} to 10^{-5} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day.	150
4.5.7.	Three possible leachate routings after one week of leachate recirculation for a waste mass with an exponentially decreasing permeability distribution and a permeability range of 10^{-2} to 10^{-6} cm/s. Leachate applied eight hours per day at an average rate of $4 \text{ m}^3/\text{m}$ of trench/day.	151

5.1.1.	Predicted and measured leachate generation rates for the Mill Seat pressurized leachate recirculation loop system.	157
5.1.2.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 10 (a) and 20 (b) days.	159
5.1.3.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 30 (a) and 40 (b) days.	160
5.1.4.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 50 (a) and 60 (b) days.	161
5.1.5.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 70 (a) and 80 (b) days.	162
5.1.6.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 90 (a) and 100 (b) days.	163
5.1.7.	Saturation iso-clines for the Mill Seat Landfill pressure loop leachate recirculation system at elapsed times of 110 (a) and 120 (b) days.	164
5.1.8.	Predicted and measured leachate generation rates for the Mill Seat deep trench leachate recirculation system.	166
5.1.9.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 10 (a) and 20 (b) days.	167
5.1.10.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 30 (a) and 40 (b) days.	168
5.1.11.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 50 (a) and 60 (b) days.	169

5.1.12.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 70 (a) and 80 (b) days.	170
5.1.13.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 90 (a) and 100 (b) days.	171
5.1.14.	Saturation iso-clines for the Mill Seat Landfill deep trench leachate recirculation system at elapsed times of 110 (a) and 120 (b) days.	172
5.2.1.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 5 days of operation.	176
5.2.2.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 10 days of operation.	177
5.2.3.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 15 days of operation.	177
5.2.4.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 20 days of operation.	178
5.2.5.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 25 days of operation.	178
5.2.6.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 30 days of operation.	179
5.2.7.	Saturation iso-clines for waste permeabilities of 8.1×10^{-3} cm/s (a) and 0.1 cm/s (b) after 35 days of operation.	179
5.2.8.	Saturation iso-clines for a waste permeability of 0.1 cm/s after 65 (a) and 95 (b) days of operation.	180
5.2.9.	Cumulative leachate volumes versus time for the DSWA's recirculation test cell.	182
5.3.1.	Cumulative leachate volumes simulated for the Yolo County Project based on an initial saturation of 40%.	187

5.3.2.	Cumulative leachate volumes measured at the Yolo County Project.	187
5.3.3.	Predicted saturation iso-clines for a Yolo County Demonstration Project trench after one (a) and two (b) weeks of operation. Daily application rates are shown in Table 5.3.2.	190
5.3.4.	Predicted saturation iso-clines for a Yolo County Demonstration Project trench after three (a) and four (b) weeks of operation. Daily application rates are shown in Table 5.3.2.	191
5.3.5.	Predicted saturation iso-clines for a Yolo County Demonstration Project trench after five (a) and six (b) weeks of operation. Daily application rates are shown in Table 5.3.2	191
5.3.6.	Predicted saturation iso-clines for a Yolo County Demonstration Project trench after seven (a) and eight (b) weeks of operation. Daily application rates are shown in Table 5.3.2.	192
5.3.7.	Predicted saturation iso-clines for a Yolo County Demonstration Project trench after nine (a) and ten (b) weeks of operation. Daily application rates are shown in Table 5.3.2.	192
5.4.1.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after one week of operation.	196
5.4.2.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after two weeks of operation.	196
5.4.3.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after three weeks of operation.	197
5.4.4.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after four weeks of operation.	197
5.4.5.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after five weeks of operation.	198
5.4.6.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after six weeks of operation.	198

5.4.7.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after seven weeks of operation.	199
5.4.8.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after eight weeks of operation.	199
5.4.9.	Simulated saturation iso-clines and measured saturations for the UCF/EPA test cell after thirteen weeks of operation.	200
6.2.1.	Hydraulically equivalent liner designs, note that the discharge through each liner is the same.	209
8.2.1.	Theoretical leachate movement and storage processes.	227