## GEOTECHNICAL SPECIAL PUBLICATION 142

# Waste Containment and Remediation

Akram Alshawabkeh, Ph.D., P.E. Craig H. Benson, Ph.D., P.E. Patricia J. Culligan, Ph.D. Jeffrey C. Evans, Ph.D., P.E. Beth A. Gross, P.E. Dhani Narejo, Ph.D. Krishna R. Reddy, Ph.D., P.E. Charles D. Shackelford, Ph.D., P.E. Jorge G. Zornberg, Ph.D., P.E. GSP 142:

Information

Contents

Author Index



EV 1

GS

RS



### GEOTECHNICAL SPECIAL PUBLICATION NO. 142

# WASTE CONTAINMENT AND REMEDIATION

#### PROCEEDINGS OF SESSIONS OF THE GEO-FRONTIERS 2005 CONGRESS

January 24–26, 2005 Austin, Texas

SPONSORED BY Geoenvironmental Engineering Committee of The Geo-Institute of the American Society of Civil Engineers Geoenvironmental Engineering and Technical Committee No. 5 on Environmental Geotechnics of theInternational Society of Soil Mechanics and Geotechnical Engineering (ISSMGE)

> EDITED BY Akram Alshawabkeh, Ph.D., P.E. Craig H. Benson, Ph.D., P.E. Patricia J. Culligan, Ph.D. Jeffrey C. Evans, Ph.D., P.E. Beth A. Gross, P.E. Dhani Narejo, Ph.D. Krishna R. Reddy, Ph.D., P.E. Charles D. Shackelford, Ph.D., P.E. Jorge G. Zornberg, Ph.D., P.E.





Published by the American Society of Civil Engineers

### Notices

#### ISBN 0-7844-0769-X

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document.

ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

Copyright © 2005 by the American Society of Civil Engineers. All Rights Reserved. ISBN 0-7844-0769-X Manufactured in the United States of America.

American Society of Civil Engineers ASCE International Headquarters 1801 Alexander Bell Drive Reston, VA 20191-4400 USA

Call Toll-Free in the U.S.: 1-800-548-2723 (ASCE) Call from anywhere in the world: 1-703-295-6300 Internet: http://www.pubs.asce.org

### Preface

Waste containment and remediation are primary components of geoenvironmental engineering, an interdisciplinary field that encompasses a broad range of practice areas, including the geotechnical and environmental engineering specialties of civil engineering, chemical engineering, geology, groundwater engineering, soil science, environmental science, and microbiology, among others. The first ASCE geotechnical special publication (GSP) that integrated these diverse areas of practice under the umbrella of geoenvironmental engineering umbrella was *Geoenvironment 2000*, edited by Yalcin B. Acar and David E. Daniel and published by ASCE in 1995. This current GSP comprises papers that address the geo-frontier of waste containment and remediation and, in particular, includes updates on several technologies that have evolved significantly in the past decade since the publication of *Geoenvironment 2000*, such as bioreactor landfills and evapotranspiration final cover systems.

This GSP contains 54 papers that were presented as part of the Waste Containment and Remediation Track at Geo-Frontiers 2005, an ASCE Geo-Institute conference held January 24–26, 2005 in Austin, Texas. Five of the nine sessions in this track were organized and sponsored by the ASCE Geo-Institute's Geoenvironmental Engineering Committee (chaired by Beth A. Gross). An additional session was coorganized and co-sponsored by the Geoenvironmental Engineering Committee and Technical Committee No. 5 (TC5) on Environmental Geotechnics of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE).

All papers included in this publication were peer-reviewed for technical quality and content. Each paper received two positive reviews before being accepted and was revised to conform to any mandatory revisions of the reviewers. All of the papers are eligible for discussion in the *Journal of Geotechnical and Geoenvironmental Engineering* and are eligible for ASCE and Geo-Institute awards.

The Editors would like to extend their appreciation to the many individuals who peerreviewed the papers contained in this GSP.

Editors

Akram Alshawabkeh, Northeastern University Craig H. Benson, University of Wisconsin - Madison Patricia J. Culligan, Columbia University Jeffrey C. Evans, Bucknell University Beth A. Gross, GeoSyntec Consultants Dhani Narejo, GSE Lining Technology, Inc. Krishna R. Reddy, University of Illinois - Chicago Charles D. Shackelford, Colorado State University Jorge G. Zornberg, University of Texas - Austin

### **Geotechnical Special Publications**

- 1 Terzaghi Lectures
- 2 Geotechnical Aspects of Stiff and Hard Clays
- 3 Landslide Dams: Processes, Risk, and Mitigation
- 7 Timber Bulkheads
- 9 Foundations & Excavations in Decomposed Rock of the Piedmont Province
- 11 Dynamic Response of Pile Foundations¥ Experiment, Analysis and Observation
- 14 Geotechnical Aspects of Karst Terrains
- **15** Measured Performance Shallow Foundations
- **16** Special Topics in Foundations
- 17 Soil Properties Evaluation from Centrifugal Models
- **18** Geosynthetics for Soil Improvement
- 19 Mine Induced Subsidence: Effects on Engineered Structures
- 21 Hydraulic Fill Structures
- 22 Foundation Engineering
- 23 Predicted and Observed Axial Behavior of Piles
- 24 Resilient Moduli of Soils: Laboratory Conditions
- 25 Design and Performance of Earth Retaining Structures
- 27 Geotechnical Engineering Congress
- 28 Detection of and Construction at the Soil/Rock Interface
- 29 Recent Advances in Instrumentation, Data Acquisition and Testing in Soil Dynamics
- 32 Embankment of Dams¥James L. Sherard Contributions
- 33 Excavation and Support for the Urban Infrastructure
- 34 Piles Under Dynamic Loads
- 35 Geotechnical Practice in Dam Rehabilitation
- 37 Advances in Site Characterization: Data Acquisition, Data Management and Data Interpretation
- **39** Unsaturated Soils
- 40 Vertical and Horizontal Deformations of Foundations and Embankments
- 41 Predicted and Measured Behavior of Five Spread Footings on Sand
- 42 Serviceability of Earth Retaining Structures
- 43 Fracture Mechanics Applied to Geotechnical Engineering
- 44 Ground Failures Under Seismic Conditions
- 45 In Situ Deep Soil Improvement
- 46 Geoenvironment 2000
- 47 Geo-Environmental Issues Facing the Americas

- 48 Soil Suction Applications in Geotechnical Engineering
- 49 Soil Improvement for Earthquake Hazard Mitigation
- 50 Foundation Upgrading and Repair for Infrastructure Improvement
- 51 Performance of Deep Foundations Under Seismic Loading
- 52 Landslides Under Static and Dynamic Conditions¥Analysis, Monitoring, and Mitigation
- 53 Landfill Closures ¥Environmental Protection and Land Recovery
- 54 Earthquake Design and Performance of Solid Waste Landfills
- 55 Earthquake-Induced Movements and Seismic Remediation of Existing Foundations and Abutments
- 56 Static and Dynamic Properties of Gravelly Soils
- 57 Verification of Geotechnical Grouting
- 58 Uncertainty in the Geologic Environment
- 59 Engineered Contaminated Soils and Interaction of Soil Geomembranes
- 60 Analysis and Design of Retaining Structures Against Earthquakes
- 61 Measuring and Modeling Time Dependent Soil Behavior
- 62 Case Histories of Geophysics Applied to Civil Engineering and Public Policy
- 63 Design with Residual Materials: Geotechnical and Construction Considerations
- 64 Observation and Modeling in Numerical Analysis and Model Tests in Dynamic Soil-Structure Interaction Problems
- 65 Dredging and Management of Dredged Material
- 66 Grouting: Compaction, Remediation and Testing
- 67 Spatial Analysis in Soil Dynamics and Earthquake Engineering
- 68 Unsaturated Soil Engineering Practice
- 69 Ground Improvement, Ground Reinforcement, Ground Treatment: Developments 1987-1997
- 70 Seismic Analysis and Design for Soil-Pile-Structure Interactions
- 71 In Situ Remediation of the Geoenvironment
- 72 Degradation of Natural Building Stone
- 73 Innovative Design and Construction for Foundations and Substructures Subject to Freezing and Frost

- 74 Guidelines of Engineering Practice for Braced and Tied-Back Excavations
- 75 Geotechnical Earthquake Engineering and Soil Dynamics III
- 76 Geosynthetics in Foundation Reinforcement and Erosion Control Systems
- 77 Stability of Natural Slopes in the Coastal Plain
- 78 Filtration and Drainage in Geotechnical/Geoenvironmental Engineering
- 79 Recycled Materials in Geotechnical Applications
- 80 Grouts and Grouting: A Potpourri of Projects
- 81 Soil Improvement for Big Digs
- 82 Risk-Based Corrective Action and Brownfields Restorations
- 83 Design and Construction of Earth Retaining Systems
- 84 Effects of Construction on Structures
- 85 Application of Geotechnical Principles in Pavement Engineering
- 86 Big Digs Around the World
- 87 Jacked Tunnel Design and Construction
- 88 Analysis, Design, Construction, and Testing of Deep Foundations
- 89 Recent Advances in the Characterization of Transportation Geo-Materials
- 90 Geo-Engineering for Underground Facilities
- 91 Special Geotechnical Testing: Central Artery/Tunnel Project in Boston, Massachusetts
- 94 Performance Confirmation of Constructed Geotechnical Facilities
- 95 Soil-Cement and Other Construction Practices in Geotechnical Engineering
- 96 Numerical Methods in Geotechnical Engineering: Recent Developments
- 97 Innovations and Applications in Geotechnical Site Characterization
- 98 Pavement Subgrade, Unbound Materials, and Nondestructive Testing
- 99 Advances in Unsaturated Geotechnics
- 100 New Technological and Design Developments in Deep Foundations
- 101 Slope Stability 2000
- **102** Trends in Rock Mechanics
- 103 Advances in Transportation and Geoenvironmental Systems Using Geosynthetics
- 104 Advances in Grouting and Ground Modification
- **105** Environmental Geotechnics
- 106 Geotechnical Measurements: Lab & Field

- 107 Soil Dynamics and Liquefaction 2000
- 108 Use of Geophysical Methods in Construction
- 109 Educational Issues in Geotechnical Engineering
- 110 Computer Simulation of Earthquake Effects
- 111 Judgment and Innovation: The Heritage and Future of the Geotechnical Engineering Profession
- 112 Soft Ground Technology
- 114 Soils Magic
- 115 Expansive Clay Soils and Vegetative Influence on Shallow Foundations
- 116 Deep Foundations 2002: An International Perspective on Theory, Design, Construction, and Performance
- 117 Discrete Element Methods: Numerical Modeling of Discontinua
- 118 A History of Progress: Selected U.S. Papers in Geotechnical Engineering
- 119 Soil Behavior and Soft Ground Construction
- 120 Grouting and Ground Treatment
- 121 Probabilistic Site Characterization at the National Geotechnical Experimentation Sites
- 122 Sinkholes and the Engineering and Environmental Impacts of Karst
- 123 Recent Advances in Materials Characterization and Modeling of Pavement Systems
- 124 GeoSupport 2004: Drilled Shafts, Micropiling, Deep Mixing, Remedial and Specialty Foundation Systems
- 125 Current Practices and Future Trends in Deep Foundations
- 126 Geotechnical Engineering for Transportation Projects
- **127** Recycled Materials in Geotechnics
- 128 Soil Constitutive Models: Evaluation, Selection, and Calibration
- 129 Advances in Designing and Testing Deep Foundations
- 130 Advances in Pavement Engineering
- 131 Contemporary Issues in Foundation Engineering
- 132 Advances in Deep Foundations: In Memory of Michael W. O'Neill
- 133 Earthquake Engineering and Soil Dynamics
- 134 Soil Dynamics Symposium in Honor of Professor Richard D. Woods
- 135 Erosion of Soils and Scour of Foundations
- 136 Innovations in Grouting and Soil Improvement

- 137 Legal and Liability Issues in Geotechnical Engineering
- 138 Site Characterization and Modeling
- 139 Calibration of Constitutive Models
- 140 Slopes and Retaining Structures Under Seismic and Static Conditions
- 141 International Perspectives on Soil Reinforcement Applications
- 142 Waste Containment and Remediation

### Author Index – GSP 142 Waste Containment and Remediation

Adeyefa, A.	Laboratory Investigation of TDR System to Monitor MSW Landfill Settlements
Akhtarshad, R.	Effect of Bentonite Migration in Geosynthetic Clay Liners on Contaminant Transport
Albright, W. H.	Field Data and Model Predictions for a Monolithic Alternative Cover
Allen, S. R.	The Use of an Accelerated Test Procedure to Determine the Creep Reduction Factors of a Geosynthetic Drain
Allen, Sam	A Geosynthetic Composite Surface for Large Temporary Car Parks
Alshawabkeh, Akram N.	Experimental Study of Nonreactive Solute Transport in Fine-Grained Soils under Consolidation
Alshawabkeh, Akram N.	Potential Use of Electrochemical Redox for In Situ Remediation of Benzene
Ananthanathan, Jude	Performance Monitoring and Model Verification for an Evapotranspirative Landfill Cover
Apinwantragoon, P.	Field Data and Model Predictions for a Monolithic Alternative Cover
Aran, Christophe	Bioreactor Monitoring: Assessment of Performances
Aran, Christophe	Modeling Reactive Transport within Landfill Bioreactors
Ashmawy, Alaa K.	Advection, Diffusion, and Sorption Characteristics of Inorganic Chemicals in GCL Bentonite
Ashmawy, Alaa K.	Polymer Treatment of Bentonite Clay for Contaminant Resistant Barriers
Bartelt-Hunt, S. L.	Hydraulic Conductivities and Effective Diffusion Coefficients of Geosynthetic Clay Liners with Organobentonite Amendments
Bartelt-Hunt, S. L.	Optimal Design of a Compacted Soil Liner Containing Sorptive Amendments
Baxter, D. Y.	Strength and Compressibility of Soil-Bentonite Mixtures for Cutoff Walls
Bennert, T. A.	Piezocone Evaluation of a Soil-Bentonite Slurry Wall
Benson, C. H.	Field Data and Model Predictions for a Monolithic Alternative Cover

Bohnhoff, G. L.	Field Data and Model Predictions for a Monolithic Alternative Cover
Borch, Robert	In-Situ Bioremediation of Perchlorate in Soil
Boscov, M. E. G.	Feasibility of Monolithic Covers for MSW Fills in Humid Climate
Bouazza, Abdelmalek	Field Performance of an Asphalt Barrier Test Pad
Bowders, John J.	Field Performance of an Asphalt Barrier Test Pad
Britton, J. P.	Slug Tests in Soil-Bentonite Cutoff Walls Using a Push-In Piezometer Tip
Bureau, Nathalie	Bioreactor Monitoring: Assessment of Performances
Burns, S. E.	Hydraulic Conductivities and Effective Diffusion Coefficients of Geosynthetic Clay Liners with Organobentonite Amendments
Burns, S. E.	Optimal Design of a Compacted Soil Liner Containing Sorptive Amendments
Cabral, Alexandre	Material Selection for the Design of Inclined Covers with Capillary Barrier Effect
Carey, Peter	Assessment of Maximum Allowable Strains in Polyethylene and Polypropylene Geomembranes
Chenu, Damien	Modeling Reactive Transport within Landfill Bioreactors
Choi, H.	Effect of Bentonite Migration in Geosynthetic Clay Liners on Contaminant Transport
Choi, H.	Plasticizer Retention in PVC Geomembranes
Cox, Evan	In-Situ Bioremediation of Perchlorate in Soil
Crausse, Pierre	Modeling Reactive Transport within Landfill Bioreactors
Criley, K.	Hydraulic Conductivity of Partially Prehydrated GCLs under High Effective Confining Stresses for Three Real Leachates
Culligan, P. J.	Numerical Simulation of In Situ Air-Sparging
Culver, T. B.	Optimal Design of a Compacted Soil Liner Containing Sorptive Amendments
Daniels, J. L.	Laboratory-Scale Aerobic Landfill Bioreactor: A Precursor to Modeling and Full-Scale Investigation

de Abreu, Ricardo C.	Facultative Landfill Bioreactors (FLB): Results of a Pilot-Scale Study
De Mello, L. G. F. S.	Feasibility of Monolithic Covers for MSW Fills in Humid Climate
Deitsch, James	In-Situ Bioremediation of Perchlorate in Soil
Diebel, P. W.	Plasticizer Retention in PVC Geomembranes
Dominijanni, Andrea	Modelling Osmosis and Solute Transport through Clay Membrane Barriers
Du, Y. J.	Evaluation on Potential Use of Ariake Clay in a New Barrier System
Elhajji, Darwish	Advection, Diffusion, and Sorption Characteristics of Inorganic Chemicals in GCL Bentonite
Evans, Jeffrey	Time-Dependent Strength Behavior of Soil-Bentonite Slurry Wall Backfill
Farfour, William M.	Performance Evaluation of Vertical Wells for Landfill Leachate Recirculation
Filho, J. J. P. Oliveira	Feasibility of Monolithic Covers for MSW Fills in Humid Climate
Filz, G. M.	Slug Tests in Soil-Bentonite Cutoff Walls Using a Push-In Piezometer Tip
Filz, G. M.	Strength and Compressibility of Soil-Bentonite Mixtures for Cutoff Walls
Foose, Gary J.	Chemical Compatibility and Durability of Soil-Bentonite Mixtures
Frempong, Eric M.	Geoenvironmental Assessment of Two Tropical Clayey Soils for Use as Engineered Liner Materials
Gabr, M. A.	Temperature Effect on Desorption Kinetics of Benzene on Various Soils
Gabr, M. A.	WIDE Application for Subsurface Hydraulic Head Control
Gabr, M. A.	Prediction of Municipal Solid Waste Landfill Settlement with Leachate Recirculation
Germaine, J. T.	Numerical Simulation of In Situ Air-Sparging
Glendinning, S.	New Applications for Smart Geosynthetics
Gokmen, Cuneyt	In-Situ Bioremediation of Perchlorate in Soil

Griffin, Leslie	In-Situ Bioremediation of Perchlorate in Soil
Hamada, Satoru	Environmental Acceptability of the Installation of Piles through the Bottom Clay Barrier at Coastal Landfill Sites
Hanak, Jeff	A Geosynthetic Composite Surface for Large Temporary Car Parks
Hansen, David L.	Access Terminal Design for Horizontal Landfill Conduits
Hanson, J. L.	Thermal Analysis of GCLs at a Municipal Solid Waste Landfill
Hayashi, S.	Evaluation on Potential Use of Ariake Clay in a New Barrier System
Haydar, Mazen M.	Leachate Recirculation Using Geocomposite Drainage Layers in Engineered MSW Landfills
Hébé, Isabelle	Bioreactor Monitoring: Assessment of Performances
Henry, Adam C.	Pore Occlusion in Compacted Mixtures of Sand and Kaolinite due to Bioclogging
Herring, W. E.	Slug Tests in Soil-Bentonite Cutoff Walls Using a Push-In Piezometer Tip
Heslin, G. M.	Strength and Compressibility of Soil-Bentonite Mixtures for Cutoff Walls
Hettiarachchi, C. H.	Towards a Fundamental Model to Predict the Settlements in Bioreactor Landfills
Hettiaratchi, J. P.	Towards a Fundamental Model to Predict the Settlements in Bioreactor Landfills
Hilger, H. H.	Laboratory-Scale Aerobic Landfill Bioreactor: A Precursor to Modeling and Full-Scale Investigation
Hossain, M. S.	Prediction of Municipal Solid Waste Landfill Settlement with Leachate Recirculation
Inui, Toru	Environmental Acceptability of the Installation of Piles through the Bottom Clay Barrier at Coastal Landfill Sites
Jafari, F.	Piezocone Evaluation of a Soil-Bentonite Slurry Wall
Jain, Pradeep	Performance Evaluation of Vertical Wells for Landfill Leachate Recirculation
Jones, C. J. F. P.	New Applications for Smart Geosynthetics
Jonnalagadda, Sreeram	Performance Evaluation of Vertical Wells for Landfill Leachate Recirculation

Kamon, Masashi	Environmental Acceptability of the Installation of Piles through the Bottom Clay Barrier at Coastal Landfill Sites
Katsumi, Takeshi	Environmental Acceptability of the Installation of Piles through the Bottom Clay Barrier at Coastal Landfill Sites
Khire, Milind V.	Leachate Recirculation Using Geocomposite Drainage Layers in Engineered MSW Landfills
Krisdani, Henry	Behaviour of Capillary Barrier System Constructed using Residual Soil
Kunberger, T.	Temperature Effect on Desorption Kinetics of Benzene on Various Soils
Kunberger, T.	WIDE Application for Subsurface Hydraulic Head Control
La Motta, Enrique J.	Facultative Landfill Bioreactors (FLB): Results of a Pilot-Scale Study
LaFountain, Les	Performance Monitoring and Model Verification for an Evapotranspirative Landfill Cover
Lamont-Black, J.	New Applications for Smart Geosynthetics
Leong, Eng-Choon	Behaviour of Capillary Barrier System Constructed using Residual Soil
Liberati, Michael R.	In-Situ Remediation of Chlorinated Solvents Using Zero Valent Iron and Clay Mixtures: A Case History
Loehr, J. Erik	Field Performance of an Asphalt Barrier Test Pad
Lorenzetti, R. J.	Hydraulic Conductivities and Effective Diffusion Coefficients of Geosynthetic Clay Liners with Organobentonite Amendments
Maher, A.	Piezocone Evaluation of a Soil-Bentonite Slurry Wall
Manassero, Mario	Modelling Osmosis and Solute Transport through Clay Membrane Barriers
Marchin, George L.	Pore Occlusion in Compacted Mixtures of Sand and Kaolinite due to Bioclogging
Martin, D.	UV Resistance in Thin Film Geomembranes: Accelerated and Natural Weathering Studies
McCartney, John S.	Effect of Geomembrane Texturing on GCL—Geomembrane Interface Shear Strength
McClure, Richard W.	In-Situ Bioremediation of Perchlorate in Soil
Mchaina, D. M.	Effective Oxygen Diffusion Coefficient and Field Oxygen Concentrations below a Geosynthetic Clay Liner (GCL) Covering Mine Tailings

McManis, Kenneth L.	Facultative Landfill Bioreactors (FLB): Results of a Pilot-Scale Study
McRory, Jessica A.	Polymer Treatment of Bentonite Clay for Contaminant Resistant Barriers
Meegoda, J. N.	Towards a Fundamental Model to Predict the Settlements in Bioreactor Landfills
Mills, C. W.	Geosynthetic Bunker Liners: A Proposed Design Methodology for Golf Course Improvement
Monteleone, Mike	In-Situ Bioremediation of Perchlorate in Soil
Muhammad, Naim	Advection, Diffusion, and Sorption Characteristics of Inorganic Chemicals in GCL Bentonite
Narejo, D.	Using Woven and Heat-Bonded Geotextiles in Geonet Geocomposites
Narejo, D.	Lamination Strength Requirements for Geonet Drainage Geocomposites
Neupane, Deepak	Field Performance of an Asphalt Barrier Test Pad
Ogorzalek, A. S.	Field Data and Model Predictions for a Monolithic Alternative Cover
Ogunro, V. O.	Laboratory-Scale Aerobic Landfill Bioreactor: A Precursor to Modeling and Full-Scale Investigation
Parent, Serge-Étienne	Material Selection for the Design of Inclined Covers with Capillary Barrier Effect
Peggs, Ian D.	Assessment of Maximum Allowable Strains in Polyethylene and Polypropylene Geomembranes
Peggs, Ian D.	A Geosynthetic Composite Surface for Large Temporary Car Parks
Pierce, C. E.	Laboratory Investigation of TDR System to Monitor MSW Landfill Settlements
Polivka, Basil Jr.	A Geosynthetic Composite Surface for Large Temporary Car Parks
Pugh, R. C.	New Applications for Smart Geosynthetics
Quaranta, J. D.	WIDE Application for Subsurface Hydraulic Head Control
Quintard, Michel	Modeling Reactive Transport within Landfill Bioreactors
Rahardjo, Harianto	Behaviour of Capillary Barrier System Constructed using Residual Soil

Ramsey, B.	Using Woven and Heat-Bonded Geotextiles in Geonet Geocomposites
Reddi, Lakshmi N.	Pore Occlusion in Compacted Mixtures of Sand and Kaolinite due to Bioclogging
Reinhart, Debra R.	Performance Evaluation of Vertical Wells for Landfill Leachate Recirculation
Renken, K.	Effective Oxygen Diffusion Coefficient and Field Oxygen Concentrations below a Geosynthetic Clay Liner (GCL) Covering Mine Tailings
Rowe, R. K.	Thermally Induced Desiccation of Geosynthetic Clay Liners in Landfill Basal Liner Applications
Ryan, Christopher	Time-Dependent Strength Behavior of Soil-Bentonite Slurry Wall Backfill
Sadlier, M. A.	Geosynthetics Aspects of a Methane Gas Storage Bladder
Sale, Thomas C.	In-Situ Remediation of Chlorinated Solvents Using Zero Valent Iron and Clay Mixtures: A Case History
Sarahney, Hussam	Potential Use of Electrochemical Redox for In Situ Remediation of Benzene
Schmader, M. B.	Laboratory-Scale Aerobic Landfill Bioreactor: A Precursor to Modeling and Full-Scale Investigation
Schmucker, Bruce	Assessment of Maximum Allowable Strains in Polyethylene and Polypropylene Geomembranes
Shackelford, C. D.	Field Data and Model Predictions for a Monolithic Alternative Cover
Shackelford, Charles D.	In-Situ Remediation of Chlorinated Solvents Using Zero Valent Iron and Clay Mixtures: A Case History
Sheahan, Thomas C.	Experimental Study of Nonreactive Solute Transport in Fine-Grained Soils under Consolidation
Smith, J. A.	Hydraulic Conductivities and Effective Diffusion Coefficients of Geosynthetic Clay Liners with Organobentonite Amendments
Smith, J. A.	Optimal Design of a Compacted Soil Liner Containing Sorptive Amendments
Somasundaram, Suji	Performance Monitoring and Model Verification for an Evapotranspirative Landfill Cover
Southen, J. M.	Thermally Induced Desiccation of Geosynthetic Clay Liners in Landfill Basal Liner Applications
Stark, T. D.	Effect of Bentonite Migration in Geosynthetic Clay Liners on Contaminant Transport
Stark, T. D.	Plasticizer Retention in PVC Geomembranes

Swan, Robert H.	Effect of Geomembrane Texturing on GCL—Geomembrane Interface Shear Strength
Swarbrick, G. E.	Thermal Analysis of GCLs at a Municipal Solid Waste Landfill
Tang, Guoping	Experimental Study of Nonreactive Solute Transport in Fine-Grained Soils under Consolidation
Tedder, R. B.	Use of Geosynthetic Drainage Materials at Landfills in Florida
Thiel, R.	Lamination Strength Requirements for Geonet Drainage Geocomposites
Thiel, R. S.	Hydraulic Conductivity of Partially Prehydrated GCLs under High Effective Confining Stresses for Three Real Leachates
Thomson, Robert A. Jr.	Chemical Compatibility and Durability of Soil-Bentonite Mixtures
Townsend, Timothy G.	Performance Evaluation of Vertical Wells for Landfill Leachate Recirculation
Tumuluri, Sailaja	Pore Occlusion in Compacted Mixtures of Sand and Kaolinite due to Bioclogging
Xu, Z.	Laboratory Investigation of TDR System to Monitor MSW Landfill Settlements
Yanful, E. K.	Effective Oxygen Diffusion Coefficient and Field Oxygen Concentrations below a Geosynthetic Clay Liner (GCL) Covering Mine Tailings
Yanful, Earnest K.	Geoenvironmental Assessment of Two Tropical Clayey Soils for Use as Engineered Liner Materials
Yesiller, N.	Thermal Analysis of GCLs at a Municipal Solid Waste Landfill
Zhu, Y.	Numerical Simulation of In Situ Air-Sparging
Zornberg, Jorge G.	Effect of Geomembrane Texturing on GCL—Geomembrane Interface Shear Strength