

4th ICEG



# Environmental GEOTECHNICS

VOLUME 1

Edited by

Luiz Guilherme de Mello & Márcio Almeida

# Table of contents

<i>Preface</i>	XI
<i>Organization</i>	XIII
 <i>Section I</i>	
Batch and column tests for reactive barrier design <i>A.D. Gusmão, T.M.P. de Campos, M.M.M. Nobre &amp; E.A. Vargas Jr.</i>	3
Shear strength and hydraulic conductivity of oil-contaminated sand <i>E.C. Shin, M.T. Omar, A.A. Tahmaz, B.M. Das &amp; C. Atalar</i>	9
Geotechnical properties of a paper mill sludge from Brazil <i>F.A.M. Marinho, P.F. Teixeira, A.M. Vieira &amp; A.R. Cabral</i>	15
Landfill settlement calculations using a composite rheological model <i>A.C.M. Marques, G.M. Filz &amp; O.M. Vilar</i>	21
A numerical study of heavy metal transport in the dump area of the Municipal District of Viçosa, MG, Brazil <i>I.D. Azevedo, R.F. Azevedo, A.M. Germano &amp; C.A. Carvalho</i>	27
Experimental results and parameters obtained from leachate column clogging studies <i>J. VanGulck &amp; R.K. Rowe</i>	33
Diffusion of inorganic chemicals in some compacted tropical soils <i>A.L. Leite &amp; A.B. Paraguassú</i>	39
Phosphate uptake by a Brazilian soil, Iron-Rich™ and acidic fly ash <i>D.G. Grubb &amp; P.S. Hemsli</i>	47
Physical foundations of settlement behaviour of municipal solid waste <i>G. Ziehmman</i>	53
Shear strength properties of municipal solid waste <i>O.M. Vilar &amp; M.F. Carvalho</i>	59
An elastic-plastic framework to reproduce the MSW mechanical behaviour – Long term analysis <i>S.L. Machado, O.M. Vilar &amp; M.F. Carvalho</i>	65
Geo-environmental cone penetrometer with efficient ground water sampling <i>Y. Watabe, T. Tsuchida, M. Tanaka, Y. Oda &amp; Y. Sakai</i>	71
Polymer gel barriers for contaminant containment <i>M.I.M. Darwish, P.L.J. Zitha, J.R.C. van der Maarel, L. Pel &amp; H. Huinink</i>	77
Evaluating flow rates from leak detection layers of double composite liner systems <i>G.J. Foose</i>	83
Tank modeling test for the investigation of DNAPL migration processes <i>M. Kamon, K. Endo, T. Inui, J. Kawabata &amp; T. Katsumi</i>	89

Phosphate immobilization experiments involving Iron-Rich™ sludge <i>D.G. Grubb, W.E. Dising III &amp; P.S. Hemsí</i>	95
Determining the permeability of low pervious rocks <i>P. Finger, J. Fritz, U. Hekel, T. Kolb, J. Kowalewski, L. Krapp, K.-P. Salomo, R. Wagner &amp; R. Wunsch</i>	101
Points of zero charge and adsorption for a Brazilian residual soil <i>P.S. Hemsí, M.E.G. Boscov &amp; C.D. Shackelford</i>	105
Water balance models and programmes – Comparisons and calculation results <i>R.M. Zeh &amp; K.J. Witt</i>	113
Soil-moisture retention curve changes under leachate contamination for tropical residual soils <i>A.C.S. Corrêa, N.M. Souza &amp; J. Camapum de Carvalho</i>	119
Large filtration tests on drainage systems using leachate <i>A.R.L. da Silva, E.M. Palmeira &amp; G.R. Vieira</i>	125
Modeling containment capacity of tropical residual soils <i>A.C.S. Corrêa, N.M. Souza &amp; M.L.G. Ramos</i>	129
Knowledge-based system approach on decision of landfill site selection <i>K.W. Chau</i>	135
Sorption mechanism of arsenic on two soils of Northern India <i>I.C. Agarwal, R.K. Srivastava &amp; A. Agarwal</i>	141
Geotechnical monitoring program in Bogota's municipal solid waste landfill after the 1997 landfill slide <i>J.A. Rodríguez &amp; E. Velandia</i>	145
SOLAM – A numerical formulation for parabolic problems <i>P.I.B. de Queiroz &amp; D. de Mattos Vidal</i>	151
Dynamic strength characteristics of municipal solid waste <i>S. Singh</i>	157
Evaluation of long-term performance of geomembranes by oxidative induction time and weatherability tests <i>H.-Y. Jeon &amp; H.-K. Kim</i>	161
Sorption of inorganic ions from leachate and organic soil of Gramacho M.S.W. landfill <i>E. Ritter, J.C. Campos &amp; G. Giordano</i>	165
The landslide of Doña Juana landfill in Bogota. A case study <i>B. Caicedo, E. Giraldo, L. Yamin &amp; N. Soler</i>	171
Geomechanical properties of municipal solid waste in Doña Juana sanitary landfill <i>B. Caicedo, L. Yamin, E. Giraldo, O. Coronado &amp; N. Soler</i>	177
Effect of consolidation on contaminant transport parameters of compacted clays <i>F. Mazzieri, P.O. Van Impe, W.F. Van Impe &amp; D. Constaes</i>	183
A simulation model for consolidation and contaminant coupled flows in clay layers <i>F. Mazzieri, W.F. Van Impe, P.O. Van Impe &amp; D. Constaes</i>	189
Design and performance criteria for evapotranspirative cover systems <i>J.S. McCartney &amp; J.G. Zornberg</i>	195
Compressibility of a municipal waste landfill <i>A.G.H. Pereira, L. Sopeña &amp; M.T.G. Mateos</i>	201
Geotechnical characterization of a pulp and paper (deinking) residue used in cover systems <i>A.R. Cabral, F. Burnotte, G. Lefebvre &amp; C.T. Panarotto</i>	207
Multispecies chemical transport in unsaturated soil <i>H.R. Thomas, P.J. Cleall &amp; S.C. Seetharam</i>	213
A parametric study of settlements for urban solid waste <i>L.M.A. Dellabianca &amp; S.M.A. Dellabianca</i>	219

Compacted lateritic soils as hydraulic barriers in waste containment systems <i>K.J. Osinubi &amp; C.M.O. Nwaiwu</i>	225
Infiltration and adsorption of a phthalate plasticizer in a Brazilian tropical soil <i>S.M.C.M. Carrara &amp; D.M. Morita &amp; M.E.G. Boscov</i>	231
Coupled multigas, moisture and heat transfer in unsaturated soil <i>Z. Zhou, P.J. Cleall &amp; H.R. Thomas</i>	237
A parametric analysis of the impact of heterogeneities on PVD remediation systems <i>A.L. Welker</i>	243
Strength and consolidation characteristics of underwater vacuum consolidated dredged silt <i>W. Haegeman, P. De Schrijver &amp; J. Van Miegheem</i>	249
Sanitary landfill of Santo Tirso – municipal waste physical, chemical and mechanical properties <i>C. Gomes, A. Ernesto, M.L. Lopes &amp; C. Moura</i>	255
Gases monitoring methodology applied in Muribeca solid waste landfill <i>F.J. Maciel &amp; J.F.T. Jucá</i>	263
Geoenvironmental investigations for cemetery installation and its impact on the environment <i>L.A.L. Bello, S.F. Sadalla Neto &amp; W.M. Santos Filho</i>	271
Leachate recycling feasibility study for a municipal landfill <i>H.K. Moo-Young, A. Valiente &amp; T. McMonigle</i>	277
A coupled mechanical and biological model to estimate settlements in solid waste landfills <i>G.F. Simões &amp; T.M.P. de Campos</i>	283
 <i>Section 2</i>	
Monitoring erosion off unvegetated mine tailings facilities and natural slopes using high-resolution, digital stereo-photogrammetry <i>D.J. Williams, D.J. Stolberg, P. Soole &amp; G. Poropat</i>	291
Cover trials on saline tailings storage facilities compared with a natural salt pan analogue <i>D.J. Williams, D.J. Stolberg &amp; G.M. Bentel</i>	297
Tailing dams – practical problems of ageing <i>I. Vaníček</i>	301
Bioleaching of heavy metals from mining residues using <i>A. niger</i> <i>C.N. Mulligan, M. Kamali &amp; B.F. Gibbs</i>	305
Liquefaction potential of tailing dams <i>T.J. Espósito &amp; A.P. Assis</i>	311
Application of a dry cover system to remediate acid rock drainage generation in the uranium mining and milling site of Poços de Caldas, Brazil <i>H.M. Fernandes &amp; M.R. Franklin</i>	317
Geotechnical analysis of eroded sediments in a exhausted pit mine using CPTU tests <i>R.C. Gomes, L.H. Albuquerque Filho &amp; J.T.G. da Silva</i>	323
Evaluation of liquefaction potential of fine grained tailings <i>R.C. Gomes, E.L. Pereira &amp; L.F.M. Ribeiro</i>	329
Assessment of low alkalinity additives to minimize the environmental impact of solidified/stabilized sludge <i>M. Boutouil, M. Kamon, T. Inui &amp; J.H. Jeoung</i>	335
Underwater sediments and a procedure for the design of an embankment <i>R.D. Verástegui F., W.F. Van Impe &amp; M. Van den Broeck</i>	341
Problems and solutions for developing Malaysian ex-tin mining lands <i>R. Hashim</i>	347



Element dynamics of red oak ecosystems on ash-ameliorated acid-sulphurous mine soils: A chronosequence study <i>A. Embacher &amp; D. Knoche</i>	353
Practical knowledge of covering soft tailings and strengthening tailings impoundments for long-term stability by the remediation of tailings ponds at Wismut GmbH <i>R. Daenecke, K.D. Oswald, G. Heerten &amp; J. Horstmann</i>	359
Geotechnical studies of material characteristics of a mine waste soil cover <i>W.L. de Oliveira Filho, A.P.D. Botelho, D.R. Silva &amp; L.H. Albuquerque Filho</i>	365
The assessment of contaminated disused colliery sites in County Durham, England <i>S.C.F. McClure, R.A. Forth &amp; D. Beaumont</i>	371
Characterization of residues from coal processing <i>R.M.G. Mendonça, L.S. Borna &amp; P.S.M. Soares</i>	377

### Section 3

Sensitivity analyses of a risk assessment model applied to the rehabilitation of open cut coal mine spoil areas <i>D.J. Williams</i>	383
Preliminary assessment of mineral extraction – related activities in the urban area of Ouro Preto, MG <i>C.R. Alves, M.L. Calijuri, C.H. Silva, I.C.D. Azevedo &amp; J. Lorentz</i>	389
Simple sensor for determination of chromium in the ground using chemiluminescence detection technique based on reaction of silica-immobilized luminol and hydrogen peroxide <i>H. Sakai &amp; H. Tarumi</i>	395
Variations of leachate characteristics with time in an experimental waste cell <i>F.F. Junqueira &amp; E.M. Palmeira</i>	401
Selection of MSW landfill site by means of the analytic hierarchy process <i>H.Y. Nakahara, J.J.P. Oliveira Filho, M.E.G. Boscov &amp; P.C. Boggiani</i>	407
Aquifer vulnerability assessment in Resende basin, Brazil, with the DRASTIC method <i>T.C. Pizani, G.C. Silva Jr. &amp; C. Bettini</i>	413
Developing an expert-knowledge scoring system for evaluating reductive dechlorination at TCE sites <i>N.A. Stiber, M. Pantazidou &amp; M.J. Small</i>	419
Geo-environmental investigation of a PCB plume contamination in a mangrove area <i>M.S.S. Almeida, A.C. Mesquita, M.I. Miranda &amp; M.C. Barbosa</i>	425
Studies of channel sediments contaminated with organics and heavy metals <i>M.S.S. Almeida, M.C.A. Barbosa, J.L.S.S. Almeida &amp; D.F. Mariz</i>	431

### Section 4

Evaluation of ions retention capacity of a residual soil of Rio de Janeiro, Brazil <i>R.M.G. Mendonça, M.C. Barbosa &amp; F.J.C.O. Castro</i>	439
Evaluation of polymers' addition effect on sedimentation behaviour of dredged mud <i>A.C.B. Santos, F.J.C.O. Castro, M.C. Barbosa &amp; M.C.M. Alves</i>	447
Dissolution and reverse diffusion of metals in a compacted lateritic clay <i>J.K. Tsugawa, M.E.G. Boscov, K.L. Vello &amp; E. de Oliveira</i>	453
A strategy to determine if a landfill is the source of detected water pollution <i>A.B. Fourie</i>	459
DNAPL detection using cross-well radar <i>M. Farid, A.N. Alshawabkeh, C. Rappaport &amp; P. Kosmas</i>	465

Effective disposal of fly ash as a stabilizing agent of expansive soils <i>B.R. Phani Kumar, J.V. Phani Kumar &amp; N.S.V.V.S.J. Gandhi</i>	471
Neutralization of crushed cement-stabilized sludge by carbon dioxide <i>Y. Nabeshima &amp; T. Matsui</i>	475
Evaluation of the applicability of cohesive volcanic ash soils to the landfill disposal liner <i>A. Suzuki, Y. Kitazono, Y. Hayashi &amp; F. Hirose</i>	481
Coal ash treatment with cement or air cement <i>Y. Hayashi, A. Suzuki, Y. Kitazono, T. Akagi &amp; A. Kuwaki</i>	487
Investigation of red mud properties for use in road construction <i>A. Mouratidis &amp; G. Tsohos</i>	493
Use of power by-products in CEZ, a.s., Power Plant Ledvice, Czech Republic <i>O. Záleská, J. Záleský &amp; J. Kozák</i>	497
Road salt migration across a stormwater detention basin liner <i>D.G. Grubb &amp; D.P. Condo</i>	501
Comparison of soil pollution during waste deposit leaching and leachate infiltration on soil in a lysimeter <i>I. Alimi-Ichola</i>	509
Silica waste utilization in ground improvement: A study of expansive soil treated with LRHA <i>A.S. Muntohar &amp; R. Hashim</i>	515
Study on in-situ measuring system of subsurface contamination using Frequency Domain Reflectometry <i>M. Komatsu &amp; M. Nishigaki</i>	521
Traffic vibration decrement properties using ferrum-lime stabilization <i>M. Kamon, M. I &amp; T. Mizoguchi</i>	527
Strength of cement treated hedoro mixed with coal fly ash <i>S. Tomohisa, K. Sawa, K. Ito, S. Maruyama &amp; H. Tanaka</i>	533
Oxygen diffusion through a needle punched geosynthetic clay liner <i>F. Rahman, A. Bouazza &amp; J.K. Kodikara</i>	539
Contamination by heavy metals in Santo Amaro da Purificação, BA, Brazil <i>S.L. Machado, C.W.C. Delgado &amp; M.F. Carvalho</i>	545
Reuse of construction waste for backfill material sorted by self-sedimentation <i>H. Akagi, M. Ibaraki, M. Itoh, S. Kameda &amp; T. Ohwada</i>	551
Utilization of MSW incineration bottom ash and clay as a composite geomaterial <i>K. Omine, H. Ochiai &amp; N. Yasufuku</i>	557
Use of sewage sludge ash from sewage treatment plants as an addition in concrete <i>A.L.B. Geyer, D.C. Dal Molin &amp; N.C. Consoli</i>	563
An approach for the assessment of by-products eco-compatibility in road construction <i>D. François, M. Legret &amp; N. Delville</i>	567
Preliminary design of permeable reactive wall based on column studies <i>I.M.C. Lo &amp; K.C.K. Lai</i>	573
Laboratory evaluation of hydraulic performance of liners produced with lateritic sandy soil stabilized with lime and cement <i>R.A.V. Ribeiro &amp; J.A. Lollo</i>	579
Compacted liner at Red Pine sanitary landfill, Canada: construction practice, quality control and freeze thaw effects <i>P. Chiasson, É. Hickey &amp; M. Massiera</i>	585
The Karlsruhe cut-off wall testing unit (KTU) for monitoring in-situ permeability <i>A. Bieberstein &amp; U. Saucke</i>	591
The influence of cement type on the expansion of cement-stabilized phosphogypsum <i>A.R.K. Kobayashi &amp; A.B. Parreira</i>	597

Geotechnical reuse of waste expanded polystyrene as a light-weight geomaterial <i>N. Yasufuku, H. Ochiai, K. Omine &amp; D. Suetsugu</i>	603
Stabilization of surplus Ariake clay with cement and slag <i>C. Modmoltin, K. Onitsuka, T. Negami &amp; M. Kouno</i>	609
Utilization of coal ash as filling materials <i>J. Nishikawa, A. Sato &amp; K. Amano</i>	615
One-dimension compression behavior of sedimented coal fly ashes <i>D. Suetsugu, Y. Miyata &amp; K. Kogure</i>	619
Material properties of reservoir sludge re-using for embankment by cement treatment <i>M. Miyoshi, S. Yoshioka, S. Sakurada, H. Kuga, K. Shimizu, T. Goto, K. Suda &amp; M. Ono</i>	625
In situ embankment test by cement treated reservoir sludge <i>M. Miyoshi, S. Yoshioka, S. Sakurada, H. Kuga, K. Suda, M. Ono, K. Shimizu &amp; T. Goto</i>	631
Shape factors for single-well tests in soil-bentonite cutoff walls <i>J.P. Britton, G.M. Filz, J.C. Little &amp; W. Herring</i>	639
Planned corrective measures to reclaim an old waste disposal site in Sharjah <i>A. Shanableh, M. Omar, A. Tahmaz &amp; A. Bubakir</i>	645
Geotechnical stabilization of Zona Mansion in Dona Juana sanitary landfill. A case study <i>E. Giraldo, B. Caicedo, F. Montenegro, L. Yamin &amp; N. Soler</i>	651
Evaluation ex-post of the operation of a multicinema complex on a closed sanitary landfill <i>J.A. Bonifazi, R.G. Martín &amp; E.G. Silva</i>	655
Durability of compacted sludge landfill cover under wetting-drying cycle <i>M. Kamon, S. Inazumi, T. Inui &amp; T. Katsumi</i>	661
Mechanical properties incineration residue from municipal solid waste <i>K. Sato, K. Miyawaki, T. Shimaoka &amp; T. Hirao</i>	667
Reactive barriers for remediation of polluted soils: A case study <i>A. Tazioli, E. Fratolocchi &amp; E. Pasqualini</i>	673
Hydraulic performance of GCLs with different stress history <i>E. Fratolocchi</i>	679
Application of bottom ash from municipal solid waste as road construction materials <i>T. Shimaoka, T. Hirao, K. Miyawaki &amp; M. Hanashima</i>	685
Effect of compaction conditions and dry-wet cycles on the hydraulic conductivity of the self-sealing/self-healing material <i>S. Moon, J.Y. Kim, M. Chung, K. Nam &amp; J.J. Lee</i>	691
Natural attenuation of chlorinated solvents in soil and groundwater <i>R.C.M. Nobre &amp; M.M.M. Nobre</i>	697
Biodegradation of deinking residues leachate by interaction with different mine tailings <i>K. Markewitz, G. Lefebvre, A.R. Cabral &amp; C.T. Panarotto</i>	703
Analysis of groundwater flow and contaminant behavior in an industrial coastal area in Brazil <i>C.E. Braga, I.C. Lage, M.T.C. Zulian, G.C. Silva Jr. &amp; A.G. Pedroso</i>	709
Evaluation and monitoring of Bangu waste disposal site, RJ, Brazil <i>R.G.S. Costa, G.C. Silva Jr., J.R.S. Moura &amp; A.C. Monteiro</i>	713
Geohydrologic modeling for construction of tunnel through contaminated soils <i>S. Choi &amp; S. Sarkar</i>	717
Aspects on the current classification of MSW bottom-ash <i>E. Ott &amp; H.-G. Kempfert</i>	723
Multi-layered systems for waste disposals and remediation of polluted sites: four specific case histories <i>D. Alexiew</i>	729
<i>Author index</i>	735

## Table of contents

<i>Preface</i>	IX
<i>Organization</i>	XI
 <i>Section 5</i>	
Enhanced pilot-scale remediation of chromium by electrokinetics <i>D. Gent, S. Larson, C. Fetters, S. Granade, A.N. Alshawabkeh &amp; M. Bricka</i>	741
Sonication effect on NAPL removal by soil flushing method <i>Y.U. Kim &amp; M.C. Wang</i>	747
Field vapor extraction test and long-term monitoring at a PCE contaminated site <i>J.C. Chai &amp; N. Miura</i>	753
Enhanced soil vapor extraction using PV drains <i>O.M. Collazos, J.J. Bowders &amp; M. Bouazza</i>	761
Fuzzy inference model for remediation of contaminated groundwater <i>T. Hata, Y. Miyata &amp; K. Kogure</i>	767
Study on effects of soil vapor extraction with soil heating in low permeable ground <i>T. Shimizu, Y. Shigeno, S. Yabe &amp; M. Aoki</i>	773
Plasma conversion. A technology for vitrifying wastes and contaminated soils <i>R.A. Menezes &amp; M.A. Menezes</i>	779
Numerical simulation of field electrokinetic removal of heavy metal from saturated aquifer <i>S. Shiba, Y. Hirata, K. Yamaberi &amp; T. Seno</i>	787
Bioremediation of crude oil contaminated soil <i>A.C.L. Rizzo, R. Santos, A.U. Soriano, P.N. Seabra &amp; S.G.F. Leite</i>	793
Biological degradation analysis in Muribeca solid waste landfill associated with local climate, Recife, Brazil <i>V.E.D. Monteiro, M.C. Melo &amp; J.F.T. Jucá</i>	799
Sensitivity analysis for the evaluation of soil vapor extraction performance at an industrial site <i>M.M.M. Nobre, R.C.M. Nobre &amp; C.R.F. Costa</i>	805
In situ remediation of nitrate-contaminated groundwater using a permeable reactive barrier <i>T. Soejima, M. Itoh &amp; S. Imamura</i>	811
Landfill mining – a viable reclamation method for landfills. The case of the landfill “Jockey Clube”, Brasília DF <i>C. Marton &amp; N.M. de Souza</i>	817
Non-local equilibrium NAPL-gas mass transfer in air sparging <i>W.A.P. Waduge, K. Soga &amp; J. Kawabata</i>	823



Effect of flow direction on surfactant enhanced remediation of DNAPL <i>I. Kulasooriya, K. Soga, D. Dai &amp; T.H. Illangasekare</i>	829
Diesel and gasoline biodegradation by soil microorganisms under laboratory conditions <i>L.F. Spinelli, F. Schnaid, P.A. Selbach, J.R. Oliveira &amp; C.G. Teixeira</i>	835
An alternative treatment for oily slurry using geotextile filters <i>M.B. Mendonça, M.C. Cammarota, D.D.C. Freire &amp; M. Ehrlich</i>	841
Bioventing of a gasoline-ethanol contaminated undisturbed soil <i>P. Österreicher-Cunha, J.R.D. Guimarães, C.M.F. Nunes, E.A. Vargas Jr., D.M. Mano, T.M.P. de Campos, F.S. Antunes &amp; A. Costa</i>	845
Electrokinetic remediation of organic mixture contaminated soil with surfactant enhancement method <i>S.-S. Kim, S.-J. Han, Y.-S. Jang, G.-H. Kim</i>	851
Remediation of contaminated grounds by soil's ice segregation phenomena <i>Y. Ito, M. Kamon &amp; H. Hato</i>	859
Soil clean-up levels based on health risk assessment for two sites in Mexico <i>R.M. Flores-Serrano</i>	865
In situ flushing for soils contaminated with petroleum hydrocarbons <i>R. Iturbe-Argüelles, C. Chávez-López, L.G. Torres-Bustillos, C. Flores-Torres, J.L. Orantes-Gómez &amp; A. Ramírez-González</i>	871
Soil phytoremediation <i>J.C.M. Andrade, C.F. Mahler &amp; J.A. Oliveira</i>	875
Laboratory investigation of electroosmosis flow efficiency in a residual soil from gneiss <i>J.T. Araruna Jr., B.M.M. Rivas, A.J.P.P. Mergulhão, M.V. de Souza &amp; F.S. Antunes</i>	881
Cleaning debris from oil spills by thermal desorption <i>J.T. Araruna Jr., V.L.O. Portes, M.G. Silva, M.S. Sthel, D.U. Schramm &amp; S. Tibana</i>	887
 <i>Contributions</i>	
Stability of liners: some particular issues <i>E. Pasqualini, E. Fratolocchi &amp; M. Stella</i>	895
Influence of time on design parameters of MSW fills <i>L.G. de Mello &amp; M.E.G. Boscov</i>	913
Final covers for uranium mill tailings impoundments <i>M.S.S. Almeida, G.L.M. Leoni &amp; H.M. Fernandes</i>	923
Service life of landfill liner and cap components <i>R.G. Clark</i>	933
Engineering with tailings <i>M. Fahey, T.A. Newson &amp; Y. Fujiyasu</i>	947
Technical session PS2: Report of discussion leader <i>W.D. Carrier III</i>	975
Thickened tailings: is it a revolution in the making? <i>A.B. Fourie</i>	977
Risk assessment: some new challenges associated with PCBs, arsenic, and VOCs <i>R.K. Rowe, B.H. Kueper, K.J. Reimer &amp; H.M. Li</i>	987
Risk assessment: some views on current practice as evidenced by papers presented to conferences and symposia <i>W. Hachich</i>	1001
Questions for the future of risk assessment in environmental geotechnics <i>R.B. Gilbert</i>	1007

Management of contaminated sites <i>T. Katsumi &amp; M. Kamon</i>	1013
Can we identify sustainable remediation techniques for contaminated land? <i>S.A. Jefferis</i>	1039
Recovery of simulated LNAPL spills in sandpacks using ethanol <i>A.M. Palomino &amp; D.G. Grubb</i>	1059
NAPL source zone remediation – mass flux approach <i>K. Soga, J. Page &amp; N. Gowers</i>	1069
Remediation of contaminated sites <i>P. Jarre</i>	1083
Containment systems: lessons learned from North American failures <i>C.H. Benson</i>	1095
<i>Author Index</i>	1113