

## TABLE OF CONTENTS

<b>SECTION 1</b>	<b>INTRODUCTION</b>	<b>40</b>
1.1	A BRIEF DESCRIPTION OF THE PROPOSED ACTIVITY	40
1.2	PPC PORT ELIZABETH	41
1.3	PPC PORT ELIZABETH CEMENT MANUFACTURING PLANT	42
1.4	THE LEGAL FRAMEWORK	44
	1.4.1 <i>Plan of Study for Scoping</i>	44
	1.4.2 <i>Process background and programme</i>	44
1.5	SCOPING REPORT	45
	1.5.1 <i>Methodology</i>	45
	1.5.2 <i>Specialist Studies</i>	46
	1.5.3 <i>General Terms of Reference</i>	47
	1.5.4 <i>The Environmental Consultant</i>	47
1.6	THE PROPONENT	48
	1.6.1 <i>History of PPC</i>	48
1.7	PROPONENT'S MOTIVATION AND OVERALL COMMITMENT FOR THE USE OF SECONDARY MATERIALS	49
<b>SECTION 2</b>	<b>THE CEMENT MANUFACTURING PROCESS</b>	<b>52</b>
2.1	A DETAILED DESCRIPTION OF THE CEMENT MAKING PROCESS AT PORT ELIZABETH	52
	2.1.1 <i>Primary Raw Materials</i>	54
	2.1.2 <i>Secondary Raw Materials</i>	55
	2.1.3 <i>Clinker burning</i>	55
	2.1.4 <i>Clinker</i>	58
	2.1.5 <i>Milling and Final Product (Cement)</i>	59
	2.1.6 <i>Cement dispatch</i>	59
	2.1.7 <i>Summary of inputs and outputs</i>	59
<b>SECTION 3</b>	<b>ENVIRONMENTAL ASPECTS OF SECONDARY MATERIALS CO-PROCESSING IN THE MAKING OF CEMENT</b>	<b>61</b>
3.1	INTRODUCTION TO SECONDARY MATERIALS CO-PROCESSING	61
	3.1.1 <i>Why is the Cement Kiln Suitable for Co-Processing of Secondary Materials?</i>	61
	3.1.2 <i>International use of Secondary Materials</i>	62
	3.1.3 <i>International Trends</i>	64
	3.1.4 <i>Specified limits on Secondary Material Inputs</i>	67
	3.1.5 <i>Use of Secondary Materials at PPC</i>	68
3.2	EMISSIONS TO ATMOSPHERE	68
	3.2.1 <i>Inherent Combustion Gas Cleaning Capability</i>	69
	3.2.2 <i>Nitrogen Oxides (NO<sub>x</sub>) Formation</i>	69
	3.2.3 <i>Carbon Monoxide (CO) Formation</i>	71
	3.2.4 <i>Organic Compounds</i>	72
	3.2.5 <i>Sulphur Compounds</i>	73
	3.2.6 <i>Behaviour of Volatile Components</i>	73
	3.2.7 <i>Evaporation and condensation in the kiln system (circulation) –</i>	74
	3.2.8 <i>Affinity between the Volatile Components</i>	74
	3.2.9 <i>Potential for Evaporation</i>	75
	3.2.10 <i>Molecular Ratio of sulphur and Alkalis</i>	75
	3.2.11 <i>Ammonia (NH<sub>3</sub>)</i>	75
	3.2.12 <i>Halogens (Cl and F)</i>	75
	3.2.13 <i>Metals</i>	75
	3.2.14 <i>Dioxins and Furans</i>	77
	3.2.15 <i>Dust</i>	80
3.3	CONSERVATION OF NATURAL RESOURCES	81
3.4	LIQUID EFFLUENT	82
3.5	POTENTIAL FOR SURFACE WATER, SOIL AND GROUNDWATER CONTAMINATION DURING TRANSPORTATION OF HAZARDOUS WASTES	82
3.6	POTENTIAL FOR SURFACE WATER, SOIL AND GROUNDWATER CONTAMINATION ON-SITE	83
3.7	GENERATION OF SOLID WASTE	83

<b>3.8</b>	GREENHOUSE GAS REDUCTION	83
<b>3.9</b>	REDUCTION OF WASTE SENT TO LANDFILL	84
<b>3.10</b>	POTENTIAL IMPACT ON WATER QUALITY DUE TO USE OF CEMENT MADE FROM SECONDARY MATERIALS INCLUDING PRODUCT LEACHING	85
<b>3.11</b>	PROCESS CONTROL AND KILN STABILITY	88
<b>3.12</b>	SELF-REGULATION AND QUALITY ASSURANCE	90
<b>3.13</b>	LEGISLATION APPLICABLE TO THE USE OF SECONDARY MATERIALS	91
3.13.1	<i>Occupational Health and Safety Act (Act 85 of 1993)</i>	91
3.13.2	<i>Environment Conservation Act, 1989 (Act 73 of 1989), National Water Act, 1998 (Act 36 of 1998) and the Water Services Act, 1997 (Act 108 of 1997)</i>	94
3.13.3	<i>Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (DWAF, 2nd edition, 1998)</i>	94
3.13.4	<i>CAPCO Limits and Design Criteria</i>	95
<b>3.14</b>	INTERNATIONAL EMISSIONS LIMITS	99
<b>SECTION 4</b>	<b>PPC'S SECONDARY MATERIALS CO-PROCESSING PROGRAMME</b>	<b>100</b>
<b>4.1</b>	SAMPLING AND ACCEPTANCE OF SECONDARY MATERIALS PRIOR TO PROCESSING	100
4.1.1	<i>Introduction</i>	100
4.1.2	<i>Initial Screening</i>	101
4.1.3	<i>Waste Identification Analysis</i>	102
4.1.4	<i>Sampling Protocols</i>	103
4.1.5	<i>Suitability for the Cement Kiln (Desktop Study)</i>	103
4.1.6	<i>Plant Trial</i>	104
4.1.7	<i>Implementation</i>	104
4.1.8	<i>Fingerprint confirmation Analysis</i>	106
4.1.9	<i>Regular Cross Check</i>	106
4.1.10	<i>External verification, auditing and reporting</i>	107
<b>4.2</b>	PHYSICAL OPERATION OF SECONDARY MATERIALS PROCESSING	110
4.2.1	<i>Collection from Generator and Transport to site</i>	110
4.2.2	<i>On-site storage</i>	111
4.2.3	<i>Feed to the kiln</i>	113
<b>4.3</b>	SELECTION OF INJECTION POINT	115
<b>4.4</b>	PROCESS MONITORING DURING OPERATION	115
<b>4.5</b>	EMISSIONS CONTROL AT PPC'S OPERATIONS	116
<b>4.6</b>	EMISSIONS MONITORING DURING OPERATION	116
<b>4.7</b>	AUDITING AND REPORTING DURING OPERATION	117
<b>4.8</b>	EMERGENCY PREPAREDNESS AND RESPONSE	117
<b>4.9</b>	HEALTH AND SAFETY	118
<b>4.10</b>	EMPLOYEE TRAINING	118
<b>4.11</b>	TRIAL BURN	119
4.11.1	<i>Schedule of trial burns</i>	119
4.11.2	<i>Waste to be sourced</i>	119
4.11.3	<i>Blending of Wastes for Trial Burn</i>	119
4.11.4	<i>Storage and Feed to Kiln</i>	120
4.11.5	<i>Process Monitoring</i>	121
4.11.6	<i>Independent audit</i>	121
4.11.7	<i>Emissions Monitoring and Reporting</i>	121
<b>SECTION 5</b>	<b>BASELINE DATA</b>	<b>123</b>
<b>5.1</b>	CLIMATE	123
5.1.1	<i>Rainfall and Temperature</i>	123
5.1.2	<i>Wind Direction</i>	124
<b>5.2</b>	GEOLOGY	124
<b>5.3</b>	TRAFFIC	125
<b>5.4</b>	HERITAGE	127
<b>5.5</b>	SURROUNDING LAND-USE	127
<b>5.6</b>	CURRENT EMISSIONS	129
5.6.1	<i>Dust emissions monitoring</i>	129
5.6.2	<i>Continuous Online Gas Emission Monitoring (Opsis)</i>	129

5.6.3	<i>External monitoring of emissions</i>	130
5.6.4	<i>Current emissions inventory</i>	130
5.6.5	<i>Dispersion Modelling for Current Emissions</i>	131
<b>5.7</b>	<b>BASILINE COMMUNITY HEALTH SURVEY</b>	<b>139</b>
5.7.1	<i>Limitations</i>	139
<b>SECTION 6</b>	<b>ALTERNATIVES</b>	<b>141</b>
<b>6.1</b>	<b>TYPES OF SECONDARY MATERIALS</b>	<b>141</b>
<b>6.2</b>	<b>INCINERATION VS. CEMENT KILN CO-PROCESSING</b>	<b>142</b>
<b>6.3</b>	<b>DISPOSAL TO LANDFILL VERSUS CEMENT KILN CO-PROCESSING</b>	<b>144</b>
<b>SECTION 7</b>	<b>PUBLIC PARTICIPATION</b>	<b>146</b>
<b>7.1</b>	<b>PUBLIC PARTICIPATION PERIOD</b>	<b>146</b>
7.1.1	<i>Background information document (BID)</i>	146
7.1.2	<i>Newspaper Advertisement</i>	146
7.1.3	<i>Site Notice</i>	146
7.1.4	<i>Identified Interested and Affected Parties</i>	149
7.1.5	<i>Public Participation Documents</i>	150
7.1.6	<i>Open Day and Registered Interested and Affected Parties</i>	150
<b>7.2</b>	<b>REGISTER OF INTERESTED AND AFFECTED PARTIES</b>	<b>154</b>
<b>7.3</b>	<b>ISSUES AND RESPONSE REGISTER</b>	<b>155</b>
<b>SECTION 8</b>	<b>ISSUES IDENTIFICATION</b>	<b>203</b>
<b>8.1</b>	<b>GEOLOGY</b>	<b>203</b>
<b>8.2</b>	<b>TRAFFIC</b>	<b>203</b>
<b>8.3</b>	<b>FAUNA, FLORA AND HERITAGE</b>	<b>204</b>
<b>8.4</b>	<b>GENERATION OF WASTE AND EFFLUENT</b>	<b>204</b>
<b>8.5</b>	<b>EMISSIONS</b>	<b>204</b>
<b>8.6</b>	<b>INCIDENTS AND ACCIDENTS</b>	<b>205</b>
<b>8.7</b>	<b>REDUCTION OF WASTE SENT TO LANDFILL</b>	<b>205</b>
<b>8.8</b>	<b>OCCUPATIONAL EXPOSURE TO CEMENT AND CONCRETE</b>	<b>205</b>
<b>SECTION 9</b>	<b>INVESTIGATION OF ISSUES</b>	<b>206</b>
<b>9.1</b>	<b>MASS BALANCES ACROSS THE KILN AND DETERMINATION OF ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY</b>	<b>206</b>
<b>9.2</b>	<b>ASSUMED OUTPUTS AND EMISSIONS FOR ENVIRONMENTAL RISK ASSESSMENT</b>	<b>208</b>
<b>9.3</b>	<b>SPECIALIST STUDIES FOR IMPACTS OF EMISSIONS</b>	<b>210</b>
<b>9.4</b>	<b>EMISSIONS DISPERSION MODELLING</b>	<b>211</b>
9.4.1	<i>Results for Criteria Pollutants</i>	212
<b>9.5</b>	<b>COMMUNITY HEALTH RISK ASSESSMENT</b>	<b>225</b>
<b>9.6</b>	<b>HAZOP STUDY</b>	<b>226</b>
9.6.1	<i>Interim HAZOP Conclusions</i>	227
<b>9.7</b>	<b>A REVIEW OF THE WASTE HIERARCHY AND A LIFE CYCLE APPROACH TO DISPOSAL BY CEMENT KILN</b>	<b>227</b>
9.7.1	<i>Cement kiln disposal in terms of DEAT's Waste Hierarchy</i>	228
9.7.2	<i>Market Forces</i>	229
9.7.3	<i>SA Policy and Legislation</i>	230
9.7.4	<i>Waste Disposal by Cement Kiln – A Comparative Approach</i>	231
9.7.5	<i>Conclusion from the Waste Disposal Study</i>	232
<b>9.8</b>	<b>PPC EXPERIENCE WITH SECONDARY MATERIALS</b>	<b>232</b>
<b>9.9</b>	<b>AEC SURVEYS &amp; TRIALS</b>	<b>232</b>
9.9.1	<i>Background</i>	232
9.9.2	<i>The Guideline Regulation Used for the AEC Studies</i>	232
9.9.3	<i>Baseline Survey</i>	233
9.9.4	<i>Test Burn</i>	233
9.9.5	<i>Trial Burn</i>	234
9.9.6	<i>Conclusions</i>	235
<b>9.10</b>	<b>XYLENE TRIAL BURN</b>	<b>236</b>
9.10.1	<i>Background</i>	236

9.10.2	<i>Regulatory Requirements</i>	236
9.10.3	<i>Risks Assessment</i>	237
9.10.4	<i>Emission Results</i>	237
<b>9.11</b>	<b>BACKGROUND TO SPL PROCESSING</b>	<b>238</b>
9.11.1	<i>Particulate, Fluoride and Cyanide Emissions,</i>	239
<b>9.12</b>	<b>SPL HAZARD &amp; OPERABILITY STUDY</b>	<b>240</b>
<b>SECTION 10</b>	<b>TABLE OF IMPACTS AND PROPOSED MITIGATION</b>	<b>242</b>
<b>10.1</b>	<b>INTRODUCTION TO TABLES</b>	<b>243</b>
<b>10.2</b>	<b>IMPACT STATEMENT</b>	<b>250</b>
10.2.1	<i>Construction Phase</i>	250
10.2.2	<i>Operational phase (including trial phase)</i>	250
<b>SECTION 11</b>	<b>CONCLUSIONS</b>	<b>252</b>
<b>11.1</b>	<b>ADVANTAGES OF CEMENT KILN DISPOSAL BY PPC</b>	<b>252</b>
11.1.1	<i>Regional presence</i>	252
11.1.2	<i>Cautionary approach</i>	253
11.1.3	<i>International trends</i>	253
11.1.4	<i>Cements kilns more favourable than incinerators and landfills</i>	253
11.1.5	<i>Elimination and positive use of waste</i>	253
11.1.6	<i>Process suitability</i>	253
11.1.7	<i>Inherent gas scrubbing ability</i>	254
11.1.8	<i>Product safety</i>	254
11.1.9	<i>Greenhouse gas reduction</i>	254
11.1.10	<i>Inherent quality assurance and process control</i>	255
11.1.11	<i>Acceptable community health risk</i>	255
11.1.12	<i>Liquid effluent</i>	255
<b>11.2</b>	<b>RISKS OF CEMENT KILN DISPOSAL BY PPC</b>	<b>256</b>
11.2.1	<i>Air emissions</i>	256
11.2.2	<i>Process Risks</i>	257
11.2.3	<i>Risks of hazardous waste handling, storage and transport</i>	258
11.2.4	<i>Variations in compositions of waste streams</i>	258
11.2.5	<i>Absence of empiric models</i>	258
11.2.6	<i>Absence of previous experience besides SPL</i>	258
<b>SECTION 12</b>	<b>RECOMMENDATIONS</b>	<b>260</b>
<b>12.1</b>	<b>COMPLIANCE WITH POLICIES</b>	<b>260</b>
<b>12.2</b>	<b>CAUTIONARY APPROACH</b>	<b>260</b>
<b>12.3</b>	<b>TRIAL BURNS</b>	<b>260</b>
<b>12.4</b>	<b>FULL-SCALE PRODUCTION</b>	<b>261</b>
<b>12.5</b>	<b>MONITORING AND MEASUREMENT</b>	<b>263</b>
<b>12.6</b>	<b>EXTERNAL AUDITS AND REPORTING</b>	<b>264</b>
<b>12.7</b>	<b>OTHER AUTHORISATIONS REQUIRED AFTER TRIAL BURNS BUT BEFORE FULL-SCALE PRODUCTION</b>	<b>264</b>
<b>12.8</b>	<b>SAMPLING AND ACCEPTANCE, TRANSPORTATION, HANDLING AND STORAGE OF WASTE STREAMS</b>	<b>265</b>
<b>12.9</b>	<b>HAZOP STUDIES</b>	<b>267</b>
<b>12.10</b>	<b>STAFF TRAINING AND AWARENESS</b>	<b>267</b>
<b>12.11</b>	<b>OCCUPATIONAL HEALTH AND SAFETY</b>	<b>267</b>
<b>12.12</b>	<b>EMERGENCY RESPONSE PLAN</b>	<b>268</b>

## LIST OF TABLES

Table 1-1:	List of relevant PPC Manufacturing Plants	41
Table 1-2:	Schedule included in the PoSS	44
Table 1-3:	PPC's Plants in South Africa	48
Table 3-1:	Typical Secondary Fuels in the manufacture of Portland Cement	64
Table 3-2:	Recent patterns in use of alternative fuels	65
Table 3-3:	Types of Alternative Fuels (2001) according to the WBCSD	66
Table 3-4:	Alternative Fuels and Raw Materials in the Japanese Cement Industry (thousand tons)	67
Table 3-5:	Example Limits on Compounds for Secondary Materials in Cement Kilns	67
Table 3-6:	Sources of NO <sub>x</sub> in a Cement Kiln	70
Table 3-7:	Metal emissions and Retention for kilns in the US. Note: PPC kilns will have slightly different values and these figures are included for reference purposes only.	76
Table 3-8:	Typical Heating Values of Secondary Materials	81
Table 3-9:	Metal Concentrations in Portland Cement Extracts	87
Table 3-10:	Constituents and Properties of the Secondary Materials and their environmental risks	90
Table 3-11:	ISO 11014 or ANSIZ400.1.1993 requirements for an MSDS	92
Table 3-12:	Classification of Hazardous Waste according to SANS 10228	93
Table 3-13:	Minimum Requirements for Waste Handling, Storage and Transportation	95
Table 3-14:	Comparative Emission Limits for Cement Kilns	99
Table 4-1:	Storage arrangements for Secondary Materials	110
Table 4-2:	On-site Storage Facilities for each waste stream	112
Table 4-3:	Feed systems for Secondary Materials	113
Table 4-4:	Emissions Control equipment at PPC's facilities	116
Table 4-5:	Waste Streams to be sourced for Trial Burn	119
Table 5-1:	Climatological information (Source – South African Weather Service)	123
Table 5-2:	Stack Monitoring at PPC Production Facilities	129
Table 5-3:	Stack gas parameters	131
Table 5-4:	Emissions Inventory for Kiln 4 (Current emissions and limits)	131
Table 6-1:	Process Alternatives investigated	141
Table 6-2:	Comparison of inputs and outputs to a cement kiln used for co-processing and dedicated incinerators	143
Table 6-3:	Air emission limit values for incineration and co-incineration of waste under Directive 2000/76/EC	144
Table 7-1:	Table showing the location and languages of site notices placed in and around the plant.	152
Table 7-2:	Issues and Response Register	156
Table 8-1:	Trip Generation Threshold Value for a Traffic Impact Study	203
Table 8-2:	Constituents and Properties of the Secondary Materials and their environmental risks	204
Table 9-1:	Inputs and Outputs from the cement manufacturing process	206
Table 9-2:	Secondary Materials emission limits	209
Table 9-3:	Identification of Specialist Studies	211
Table 9-4:	Legislation, policies and principles reviewed	230
Table 9-5:	Organic substances that composed the waste derived fuel for trial burn	234
Table 9-6:	Ash, water and elemental compositions of waste derived fuel and coal feed material for trial burn of pitch feed at Jupiter	235

<i>Table 9-7: TCDD equivalents and release rates (rounded-off values) for Jupiter trial burn of pitch feed</i>	235
<i>Table 9-8: Typical SPL Composition (ALCOA data)</i>	239
<i>Table 9-9: SPL Emission Trials 1999-2000</i>	240
<i>Table 10-1: Thresholds of Significance Tables</i>	242
<i>Table 10-2: Table of Impacts – Construction Phase</i>	244
<i>Table 10-3: Table of Impacts – Operational Phase</i>	246
<i>Table 11-1: Production and Environmental Risks as a result of various input components or properties</i>	257
<i>Table 12-1: Waste Streams to be sourced for Trial Burn</i>	261
<i>Table 12-2: Secondary Materials emission limits</i>	262
<i>Table 12-3: Feed systems for Secondary Materials</i>	263
<i>Table 12-4: Storage guidelines for specific waste streams</i>	266

## LIST OF FIGURES

Figure 1-1: The positions of the PPC Manufacturing Plants where the use of secondary materials is proposed.	41
Figure 1-2: Google Image of the PPC Port Elizabeth Manufacturing Plant, showing adjacent roads.	42
Figure 1-3: Topographical map showing locality of the PE manufacturing plant (Map not to scale)	43
Figure 2-1: Process Flow diagram of the cement manufacturing process at Port Elizabeth. Please note that PE has long dry kiln with no preheater stage.	53
Figure 2-2: Image showing a long dry kiln, ESP and kiln stack. The gases travel back through the kiln (1), through the ESP (2), where the dust is removed, and exit through the stack (3).	54
Figure 2-3: Photograph of the raw materials stockpiles at PE, the limestone can be seen in the background and clay and haematite in the foreground. Raw materials are stored undercover. At the quarry, the limestone is crushed to particles approximately 25mm in size and stored on stockpiles, where the material is homogenised prior to milling.	54
Figure 2-4: Photograph of the kiln at PE, showing the fans which cool the exterior of the kiln, and the control room housed in the background.	56
Figure 2-5: Photograph showing two long dry kilns.	57
Figure 2-6: Thermal zones within the kiln.	57
Figure 2-7: Kiln reaction profile for long dry kiln without calciner.	58
Figure 2-8: Photograph of cooled Clinker.	59
Figure 2-9: Flow diagram showing inputs and outputs in the cement manufacturing process	60
Figure 3-1: Relationship between CO and Excess Oxygen	72
Figure 3-2: Concentration of Dioxin as a function of Fuel Type	79
Figure 3-3: PCCD/F in Clean Gas as function of Cl Input for kiln in Austria	80
Figure 3-4: Reduction in overall emission by partial fuel replacement in cement kilns	84
Figure 3-5: Waste Management Hierarchy	85
Figure 3-6: SHE Control Hierarchy	92
Figure 4-1: Example of an Accept-Refuse Chart for SM use	101
Figure 4-2: Secondary Materials Sampling and Handling	108
Figure 4-3: Secondary Materials Transport Flowchart	109
Figure 4-4: Possible Feed Points for Secondary Material	113
Figure 5-1: Seasonal average wind roses (2001 – 2006)	124
Figure 5-2: Geological conditions	125
Figure 5-3: Major Roads in the City of Port Elizabeth and surrounds, the plant is indicated in red	126
Figure 5-4: Major transport routes around the plant	126
Figure 5-5: Map indicating cultural and heritage sites in close proximity to the PPC PE Plant	127
Figure 5-6: Map indicating land-use of areas in close proximity to the PPC PE Plant	128
Figure 5-7: Map showing PPC PE and the surrounding land use types (map taken from Google Maps). The plant is outlined in red.	128
Figure 5-8: Map showing sensitive receptors in the vicinity of the PPC PE Plant	129
Figure 5-9: OPSIS instrument installation in the inlet duct to a cement kiln stack	130
Figure 5-10: Maximum daily TSP dust fallout	133
Figure 5-11: Highest daily PM10 dust fallout	134
Figure 5-12: Highest daily NO <sub>x</sub> concentrations	135

Figure 5-13: Highest daily SO <sub>2</sub> ground level concentrations	136
Figure 5-14: Highest daily HF concentrations	137
Figure 5-15: Highest daily HCl concentrations	138
Figure 7-1: Faxed image of the (A) English and (B) Xhosa advertisements placed in The Herald.	151
Figure 7-2: Faxed image of the Afrikaans advertisement placed in Die Burger.	152
Figure 9-1: Mass Flow Scheme using Secondary Materials in Cement Manufacture	207
Figure 9-2: Relationship between secondary materials input and possible downstream receptors	210
Figure 9-3: Average daily predicted TSP	214
Figure 9-4: Highest daily predicted PM <sub>10</sub> concentrations	215
Figure 9-5: Highest daily predicted SO <sub>2</sub> concentrations	216
Figure 9-6: Highest 8-hourly predicted CO concentrations	217
Figure 9-7: Highest daily predicted Metals concentrations	218
Figure 9-8: Highest daily predicted Dioxin concentrations	219
Figure 9-9: Highest daily predicted HCl concentrations	220
Figure 9-10: Highest daily predicted HF concentrations	221
Figure 9-11: Highest daily predicted Hg concentrations	222
Figure 9-12: Highest daily predicted TOC concentrations	223
Figure 9-13: Highest daily predicted Cd and Ti concentrations	224
Figure 9-14: Roles in the Waste hierarchy	229
Figure 9-15: Waste Management Costs for Plastics	229
Figure 9-16: Waste Management Costs for Tyres	230
Figure 9-17: Xylene Trial burn: SK8 VOC Measurements by external monitoring group (Levego)	238

## GLOSSARY OF TERMS

Aggregates	Crushed stone, sand and gravel. Concrete and mortar are made by using aggregates mixed with cement and water.
Absorbent	Solid material that removes components from a gas or liquid.
Alkaline conditions	Condition of high pH where acidic compounds could be neutralized or acid-base reactions can take place.
Bag filter	Dust collection device using fabric filter bags for cleaning exhaust gas from a process plant.
Baseline emission level	The historical or normal emission level of an entity in a process without changes to input material or changes to the process.
Best practice	Internationally recognized, most efficient / effective techniques applied in manufacturing and production processes.
Biomass	A material of biological nature that is continuously generated by industrial processes or human activity.
Blending silo	Stores and blends finely ground materials
Bypass system	Arrangement whereby material or gas flow is directed around the normal process equipment, and not through it.
By-products	By-products are materials which are co-produced in manufacturing processes. Fly ash from coal combustion in electricity generation, and blast furnace slag from the production of iron are two examples.
Calciner	See "Pre-calciner"
Carbonaceous Spent Pot Lining (CSPL)	The carbonaceous portion of the SPL is the carbon lining that forms the cathode material that is used in the aluminium smelting process.
Carcinogens	Cancer causing substance or agent.
Cement (Portland Cement)	Hydraulic cement (that not only hardens by reacting with water but also forms a water-resistant product) produced by grinding clinker, (essentially calcium silicates), together with about 5% gypsum (calcium Sulphate, which is added to regulate the cement setting time). The name "Portland cement" is derived from the similarity in colour of cement after setting to the grey slate from Portland, UK.
Clinker	Nodular to powdery material produced in a rotary kiln by heating a blended, finely ground mixture of limestone (or calcium carbonate), shale (or other suitable material for silica and alumina), and a source of iron oxide to a temperature of approximately 1450°C
Coal mill	The plant required to dry and grind coal to produce a fuel for kiln firing.
Combustion	Reaction of a fuel with oxygen
Combustion efficiency	Indication of completeness of combustion of organic material (containing carbon) to carbon dioxide (CO <sub>2</sub> )
Condensation	Phase change of vapour to liquid
Cooler	Cools the clinker discharged from a cement kiln (at about 1100°C) to typically less than 200°C prior to transport to storage.
Cooler – Grate type	Cooling is achieved by cross-flow air blown through a clinker layer travelling slowly on a reciprocating grate which consists of perforated plates.

Cooler – satellite type	Nine to eleven tubes arranged peripherally at the discharge end of the rotary kiln. Hot clinker enters the tubes through inlet ports and passes through the tubes in counter current flow to cooling air. Also called a planetary cooler.
Co-processing	Utilization of alternative fuel and raw materials for the purpose of energy and resource recovery. Co-processing in cement manufacturing means substituting scarce primary energy and virgin raw materials with waste materials.
Counter current	Solid material and gas flowing in opposite directions. In all kiln systems the solid material moves counter current to the hot combustion gases.
“De novo” effect	The reformation of dioxins and furans is known to occur by “de novo” synthesis within the window of cooling from 450 to 200° C.
Effluent	A liquid waste stream.
Excess air	Ensures complete combustion of fuel due to the presence of excess oxygen (O <sub>2</sub> )
Extender (Pozzolanic)	See Pozzolan.
Extender (Filler)	See Non-Deleterious Materials
Flue gas	Exhaust gas from a combustion process.
Fly ash	A by-product from coal-fired power stations. Fly ash can be added to Portland cement as an extender or NDM (Non-Deleterious Materials)
Fossil fuel	A general term for combustible deposits of carbon in reduced (organic) form and of biological origin, including coal, oil, natural gas, and oil shale.
Greenhouse gases	Gases in the earth’s lower atmosphere that may contribute to global warming, of which CO <sub>2</sub> is a major component
Hazardous Waste	A material defined by regulation or legislation as flammable, explosive, corrosive or toxic, therefore requiring special handling or disposal
Heavy metals	All metals heavier than Titanium (4.51 g/cm <sup>3</sup> ) are termed heavy metals. The heavy metals make up a small proportion of the materials in the earth’s crust. Not all heavy metals are toxic and not all toxic heavy metals have the same toxicity.
Hydrocarbons	Chemical compounds consisting of the elements carbon and hydrogen used as building blocks in their structure
Incinerator	Plant used for the combustion of waste materials to yield a non-combustible residue or ash and exhaust gases, such as carbon dioxide and water.
Kiln dust	Particulate, solid material entrained in the exhaust gas from a cement kiln.
Kiln feed	Homogenised raw meal added to a rotary cement kiln at a controlled rate.
Leachate	Contaminated water or a solution with the potential to cause pollution, if the liquid is permitted to percolate through soil to ground water.
Lepol kiln	A kiln in which the feed is preheated on a horizontal travelling grate before entering the kiln.
Life cycle	Industrial processes involved in production including upstream extraction, manufacturing, distribution, use, and re-use or disposal of resulting waste materials

Limestone	Rock consisting essentially of carbonates with the most important constituents being calcite (CaCO <sub>3</sub> ).
Mineral additions	In blended (or “composite”) cements, a portion of the cement consists of materials (mineral additions) originating from natural or industrial sources such as blast furnace slag
Non-Deleterious Materials	Materials that can be added at the clinker grinding stage that do not have any negative effects on the cement performance. There are limits to the quantities of extenders that can be added to the cements based on the relevant SANS specification (SANS 50197).
Organic material	Chemical compound from natural sources with carbon as its core element
Oxidizing conditions	High oxygen content allowing complete oxidation of compounds (see excess air)
Physico-chemical absorption	Absorption due to chemical reaction and physical inclusion
Planetary Clinker Cooler	Refer to Cooler – satellite type
Pozzolan	A material that, although itself not cementitious, contains silica (and alumina) in a reactive form and is able to combine with lime in the presence of water to form compounds with cementitious properties.
Pre-calciner	A fluidized reaction vessel located above the feed end of the kiln which enables preheated kiln feed to be calcined before entering the kiln.
Preheater	Before entering the kiln, the kiln feed is preheated by suspension in the hot kiln exhaust gas stream in several cyclone stages (from 1 to 6) arranged vertically. The cyclone tower is known as the preheater.
Quarrying	Extracting raw materials from the earth.
Raw meal	Raw materials that are dried and ground in defined and well-controlled proportions in a raw mill
Raw mill	The plant for proportioning, drying and grinding the raw materials used for cement production.
Reducing conditions	Low oxygen content not allowing complete oxidation of compounds by oxygen
Refractory Spent pot lining (RSPL)	Waste refractory bricks which have been used for thermal protection of the pots at an aluminium smelter
Residues	Unwanted materials left by a manufacturing process.
Retention time	Time taken for material to pass through a process at the optimal operating conditions.
Rotary kiln	An inclined rotating steel cylinder lined with refractory bricks used to produce cement clinker.
Rotary kiln burner	Positioned at the kiln discharge end (firing end) to introduce fuel to the kiln process.
Scrubber	Equipment to remove impurities from a gas stream using a wet or dry process.
Secondary materials	Waste or by-products used in cement manufacturing as alternatives to fossil fuels and natural raw materials.
Shale	An argillaceous sedimentary rock
Sintering	Formation of clinker minerals in the cement kiln.
Stack	A chimney that exhausts gas from various stages in the cement manufacturing process.

Sustainable development	The ability of the present generation to continually meet its needs without compromising the ability of future generations to meet theirs.
Trace elements	Chemical elements present in minute quantities.
Turbulence	Condition under which intense and aggressive mixing and contact of materials occurs.
Volatility	Tendency of a chemical compound to form vapour under a given set of conditions.
Waste	An undesirable or superfluous by-product, emission, or residue of a process or activity which has been discarded, accumulated or stored for the purpose of further use by another process.

## ABBREVIATIONS

ACMP	Association of Cementitious Material Producers
AFR	Alternative fuels and raw materials
ANSI	American National Standards Institute
APPA	Atmospheric Pollution Prevention Act (No 45 of 1965)
BAT	Best Available Techniques
BCHS	Baseline Community Health Survey
BID	Background Information Document
BEP	Best Environmental Practice
CAPCO	Chief Air Pollution Control Officer
CHRA	Community Health Risk Assessment
DEAT	Department of Environmental Affairs and Tourism
DRE	Destruction and Removal Efficiency
DWAF	Department of Water Affairs and Forestry
EA	Environmental Assessment
EAP	Environmental Assessment Practitioner
EC	European Community
ECA	Environmental Conservation Act (Act 73 of 1989)
EIA	Environmental Impact Assessment
EMM	Emfuleni Metropolitan Municipality
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
ETR	Environmental technical Review
EU	European Union
FCC	Fluidized catalyst cracking
g	Gram
EC DEAET	Eastern Cape Department of Economic Affairs, Environment and Tourism
HAZOP	Hazard and operability study
HCS	Hazardous Chemical Substances
HM	Heavy metals
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
ISO	International Standards Organization
kg	Kilogram
kJ	Kilojoule
kPa	Kilopascal
LCA	Life Cycle Assessment

LOI	Loss on ignition
m <sup>3</sup>	Cubic meter
MES	Marsh Environmental Services
MHSA	Mine Health and Safety Act (No 29 of 1996)
MJ	Megajoule
MSDS	Material safety and data sheet
NDM	Non-Deleterious Materials
NEMA	National Environmental Management Act (Act 107 of 1998)
ng	Nanogram (1 x 10 <sup>-9</sup> grams)
Nm <sup>3</sup>	Normal or standard volume under standard conditions (0°C & 1.01 bar)
OEL	Occupational exposure limits
OH&S	Occupational Health and Safety
OSHAct	Occupational health and safety act (No 85 of 1993)
OSHAS	Occupational health and safety management systems (British)
pH	Acidity scale 1 to 14
PM10	Particulate matter smaller than 10 µm
POPs	Persistent organic pollutants
PoSS	Plan of Study for Scoping
ppb	Parts per billion
PPC	Pretoria Portland Cement
PPE	Personal protective equipment
PPM	Public Participation Meeting
ppm	Parts per million
PPP	Public Participation Process
RDF	Refuse derived fuels
SANS	South African National Standard
SHE	Safety, Health & Environment
SHEQ	Safety, Health, Environment & Quality
SK1	PPC equipment terminology (Plant & Kiln number, S=Slurry; PE=Port Elizabeth; DB=Dwaalboom; H=Hercules; D=De Hoek, K=Kiln)
SM	Secondary materials
SP	Suspension (or cyclone) preheater kiln
PC	Calciner kiln (which also has a cyclone preheater)
SPL	Spent Pot Lining
SR	Scoping Report
T	Temperature
TEQ	Toxicity Equivalent
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total organic carbon

UNEP	United Nations Environment Program
VOC	Volatile organic compound
WBCSD	World Business Council for Sustainable Development
WDF	Waste derived fuel
WUL	Water use Licence
µg	Microgram

S=Slurry; PE=Port Elizabeth; DB=Dwaalboom; H=Hercules; D=De Hoek.

## CHEMICAL ABBREVIATIONS

Ag	Silver
Al <sub>2</sub> O <sub>3</sub>	Aluminium oxide
As	Arsenic
Ba	Barium
Be	Beryllium
BTX	Benzene, toluene, xylene
C <sub>6</sub> H <sub>6</sub>	Benzene
CaCO <sub>3</sub>	Calcium carbonate
CaO	Calcium oxide
CaSO <sub>4</sub>	Calcium sulphate
CaSO <sub>4</sub> .2H <sub>2</sub> O	Gypsum
Cd	Cadmium
CFCs	Chlorofluorocarbons
CH <sub>4</sub>	Methane
CO	Carbon monoxide
Co	Cobalt
CO <sub>2</sub>	Carbon dioxide
Cr	Chromium
Cu	Copper
F	Fluoride
Fe <sub>2</sub> O <sub>3</sub>	Iron oxide
FeS <sub>2</sub>	Iron sulphide
H <sub>2</sub> O	Water
HCB	Hexachlorobenzene
HCl	Hydrogen chloride (hydrochloric acid)
HF	Hydrogen fluoride (hydrofluoric acid)
Hg	Mercury
K <sub>2</sub> O	Potassium oxide
MgO	Magnesium oxide
Mn	Manganese
Mn <sub>2</sub> O <sub>3</sub>	Manganese trioxide
NH <sub>3</sub>	Ammonia
N <sub>2</sub>	Nitrogen
Na <sub>2</sub> O	Sodium oxide
Na <sub>2</sub> SO <sub>4</sub>	Sodium sulphate
Ni	Nickel
NO <sub>x</sub>	Nitrogen oxides

O <sub>2</sub>	Oxygen
P <sub>2</sub> O <sub>5</sub>	Phosphorus pentoxide
PAH	Polyaromatic hydrocarbons
Pb	Lead
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzodioxins
PCDFs	Polychlorinated dibenzofurans
Pd	Palladium
Pt	Platinum
Rh	Rhodium
Sb	Antimony
Se	Selenium
SiO <sub>2</sub>	Silicon dioxide
Sn	Tin
SO <sub>2</sub>	Sulphur dioxide
SO <sub>3</sub>	Sulphur trioxide
SOx	Sulphur oxides
TCE	Trichloroethylene
TCM	Tetra-chloromethane
Te	Tellurium
Ti	Titanium
TiO <sub>2</sub>	Titanium dioxide
Tl	Thallium
V	Vanadium
Zn	Zinc
°C	Degrees Celcius