EXECUTIVE SUMMARY

PPC is proposing to minimise their use of coal by investigating the use of secondary materials in the cement manufacturing process. PPC Cement is currently utilising coal as their main source of energy required for the manufacturing of cement. Cement manufacture is an energy-intensive process, and therefore large amounts of coal (a non-renewable resource) are utilised.

There are many waste materials that are used in cement kilns elsewhere in the world, such as paper and wood wastes, household refuse and refuse-derived fuel, used oil, plastics and rubber residues, tyres, spent pot liners (from the aluminium smelting industry), and sewage sludge. PPC propose using waste streams from the following categories as secondary fuels in the cement kilns:

- Scrap tyres and rubber waste;
- De-watered, treated sewage pellets;
- Hydrocarbon waste (such as used oil, oil-contaminated general waste, oil-contaminated soil and coal fines);
- Plastic waste; and
- Biomass (such as paper waste, sawdust, wood chips and waste from bio-fuel production).

PPC DE HOEK

This application only refers to the PPC De Hoek Cement Manufacturing Plant is located approximately 3km outside Piketberg on the N7, on the West Coast of the Western Cape. Applications for the proposed activity for the other applicable PPC Plants have been submitted to the relevant provincial authorities.

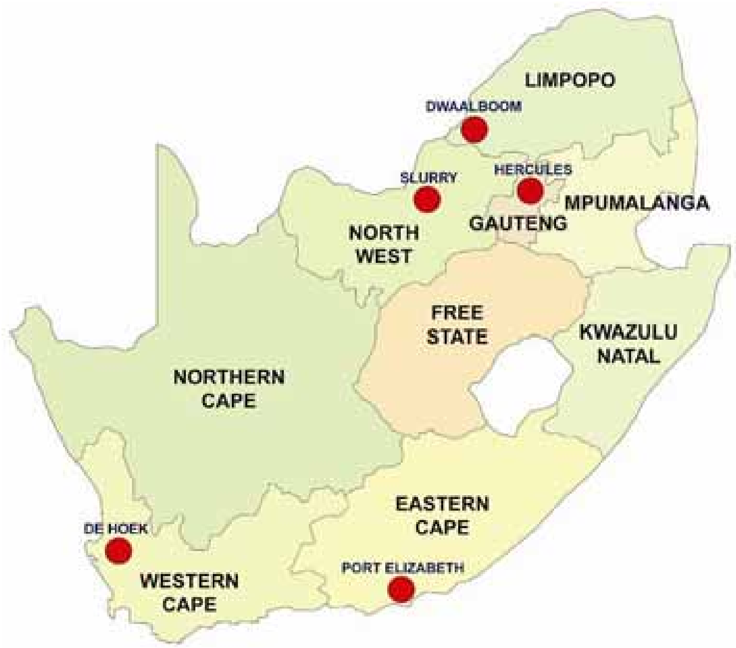

Figure 1: The positions of the PPC Manufacturing Plants where the use of secondary materials is proposed.

THE LEGAL FRAMEWORK

Marsh Environmental Services (MES) has been appointed by PPC to conduct the Environmental Impact Assessment relating to the proposed use of secondary materials to supplement the coal supply for the firing of the cement kilns. The proposed project is identified as an activity, which may have detrimental effects on the environment, thus requiring environmental assessment (Section 21: Listed Activity 1(c), 8 and 9 of the Environment Conservation Act, 1989 (ECA)).

Regulation 1182 promulgated in terms of Section 21 of the Environmental Conservation Act (Act 73 of 1989):

1. *The construction, erection or upgrading of-*

   (c) with regard to any substance which is dangerous or hazardous and is controlled by national legislation-
   - *(i) infrastructure, excluding road and rails, for the transportation of any such substance; and*
   - *(ii) manufacturing, storage, handling, treatment or processing facilities for any such substance.*

8. *The disposal of waste as defined in Section 20 of the Act, excluding domestic waste, but including the establishment, expansion, upgrading or closure of facilities for all waste, ashes and building rubble.*

9. *Scheduled processes listed in the Second Schedule to the Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965).*

SCOPING REPORT

Methodology

The purpose of the scoping process is to identify the range of issues and alternatives to be considered as well as the approach to the assessment that will follow, (DEA, 1992b, p.5)[1]. The content of the Scoping Report is dictated by the Regulations (Regulation 1183) promulgated in terms of the ECA.

Specialist Studies

A Baseline Community Health Survey was undertaken to establish the current potential health impacts of the current PPC emissions. The results of this study will form the baseline against which the impacts of secondary materials will be measured. Further, a request from key stakeholders to investigate the alternative waste disposal and treatment options for the various waste streams was received. As a result MES has also commenced with a Waste Disposal Study to determine the feasibility of waste treatment and disposal alternatives the findings of this study will be included with this report.

[1] *DEA (1992b) Guideline for Scoping, Department of Environmental Affairs, Pretoria*

ENVIRONMENTAL IMPACT REPORT

Methodology

The Environmental Impact Report (EIR) has been conducted in accordance with the guidelines as set out in the DEAT Integrated Environmnetal Management Series[2]. The function of the EIR is to help the responsible authority in making informed decisions, the public in understanding the likely impacts of the proposal, and the proponent in managing these impacts.

Specialist Studies

The following specialist studies will be undertaken as part of the EIR:

a) Environmental Technical Review

In principle this study attempts to define a relationship, if any, between the inputs and outputs of the process and associated process risks following the addition of secondary materials.

b) Air Dispersion Modelling

i) A baseline study; and

ii) Calculation of ground-level concentrations of criteria pollutants.

c) Community Health Risk Assessment

The paradigm that is followed by the consultant essentially divides human health risk assessment into a number of logical steps, from the emissions leaving the stack and plant, their impact on ground level air quality and community health. The study distinguishes between cancer and non-cancer risks and assesses exposure as central tendency and reasonable maximum exposure scenarios.

d) Waste Disposal by Cement Kiln – A Comparative Assessment

This specialist study included a Life Cycle Assessment (LCA), which is an environmental management tool that evaluates the environmental impact of a product or activity across its entire life cycle.

e) HAZOP Investigations

The objective of the HAZOP studies is to anticipate the operational hazards from the use of secondary materials, and to ensure these hazards are thoroughly addressed as part of the planning for use of secondary materials.

f) Additional Information

PPC are conducting further studies, which are not required for the Environmental Impact Assessment Process. The findings of these studies will assist in the development of risk and impact management.

i) Alternative transport routes for secondary materials;

ii) On-site storage of secondary materials;

iii) Disaster management;

iv) Training of drivers, operators and workforce; and

v) Monitoring and reporting.

[2] *DEAT (2002), Integrated Environmental Management Information Series, Department of Environmental Affairs and Tourism, Pretoria*

A DESCRIPTION OF THE CEMENT MAKING PROCESS AT DE HOEK

De Hoek has two kilns currently in operation, Kiln 5 commissioned 1974 and Kiln 6 commissioned 1980. Both kilns are equipped with 4-stage preheaters, conditioning towers and planetary clinker coolers. The limestone for De Hoek is mined at the adjacent Zoutkloof Quarry.

De Hoek has two raw mills (RM), used to grind raw materials into "raw meal" as well as two finishing mills (FM) which are used to grind clinker into cement. The De Hoek kilns are also equipped with planetary clinker coolers and both are fitted with conditioning towers for cooling of the hot exit gases. The kilns and finishing mills are equipped with electrostatic precipitators (ESP's). An ESP is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge.

Cement clinker is made by crushing, blending and fine milling of limestone (calcium carbonate) and other materials containing silica, alumina and iron oxides, which are then heated to temperatures as high as 1,450°C in a kiln where the compounds react chemically to form clinker. The clinker is then cooled and ground with small quantities of gypsum and other additives to produce cement. The heating process is performed in a rotary kiln, which is inclined at 3 - 4^{o} to the horizontal. The length and diameter of the kiln is dependent on the type of manufacturing process.

REVIEW

In terms of predicting the environmental effects of changing the raw materials and fuels inputs into the process through the introduction of secondary materials, one may view the kiln process in terms of simple inputs and outputs as follows:

Table 1: Inputs and Outputs from the cement manufacturing process

Inputs	Raw Materials (back end of kiln)	Limestone, Shale, Boiler Ash, Magnetite, etc.
	Fuels (flame side of kiln, or front end)	Coal Secondary Materials (such as solvents, hydrocarbons, sewage sludge, SPL, tyres)
Outputs	Product (via front end)	Clinker
	Wastes (via back end, air cleaning equipment and stack)	Emissions

Conventional chemical engineering approaches to such a problem are through mass balances: to model what happens in the kiln (i.e. in terms of physical and chemical reactions) and predict what the outcomes will be. MES' literature review concluded that this is not possible, and this was further confirmed by PPC's engineers. MES were unable to find any successful model at predicting the reaction kinetics of the kiln which would be able to accommodate the type of inputs contemplated in this application, either through literature review or consultation with PPC.

After due consideration, an emissions inventory was proposed which was deemed achievable by PPC and was acceptable to the company for all their kilns proposing to accept secondary materials. This is inventory is presented below.

Table 2: Secondary Materials emission limits

MAXIMUM ALLOWABLE EMISSION LIMITS	
POLLUTANT	**LIMIT**
Total dust	As per current APPA permits
CO	As per current emissions
HCl	10 mg/Nm^3
HF	1 mg/Nm^3
NO_x	As per current emissions
$S0_2$	As per current emissions
TOC	10 mg/Nm^3
Cd +Tl	0.05 mg/Nm^3
Hg	0.05 mg/Nm^3
Sb, As, Pb, Cr, Co, Cu, Mn,Ni + V	0.5 mg/Nm^3
Dioxins toxic equivalence	0.1 ng/Nm^3

This emissions inventory was developed on the following philosophy:

1. That the introduction of secondary materials should not affect the emission of particulates and therefore PPC's commitment is to continue to comply with their current APPA permits for each kiln. MES' literature review agrees that no increase in particulates accompanies the introduction of secondary materials.
2. That NO_x and CO levels should not increase as a result of the introduction of secondary materials. MES' literature review has identified that a reduction of NO_x normally accompanies the introduction of secondary materials. We therefore felt that it was in accordance with the precautionary principle of NEMA to propose that the current NO_x levels are used for our impacts assessment process.
3. That, for the other parameters, current EU limits are assumed. We believe, again, that this is in accordance with the principles of NEMA since Europe has a far greater industrial density than South Africa, and that the EU standards were developed in cognisance of a greater residential proximity to the cement kilns than that which occurs in general around PPC's facilities.

If PPC are unable to operate the kilns while adhering to these emissions, then the Secondary Materials program shall be either modified to achieve compliance, or ceased entirely. The findings of the review may be summarised in terms of the following benefits and risks to the environment and community:

1. Regional Presence: The geographic distribution of PPC Cement operations throughout South Africa provides a "localised" solution for hazardous waste disposal and a positive alternative to land filling for all major urban areas except KwaZulu-Natal.
2. Precautionary Approach: A conservative approach and gradual implementation to this project has been designed, based on international research but also the principles of the National Environmental Management Act of 1998. PPC shall embark on a gradual process of detailed baseline studies, trial burns, independent audits and reporting to government before commencing with full implementation of the use of the secondary materials applied for (subject to approvals from government). Detailed sampling and analysis of waste streams shall be performed prior to acceptance of waste streams by PPC.
3. Self-imposed emissions limits and policies: No empirical models exist to predict reliably the exact effect of waste streams on the emissions from a kiln. As a result, MES adopted an iterative approach to understanding the relationship between emissions changes and the effects on community health. PPC has adopted EU limits for those parameters which may be

affected by secondary materials co-processing. Current emissions levels for NO_x and dust will be adhered to.

4. If PPC is unable to attain these emissions limits, the burning of secondary materials will cease. In addition, PPC has in place many process controls to regulate the production of clinker, and the priority for the company will always be the production of cement, rather than the burning of waste. Thus, there exist self-imposed process control mechanisms to maximise the stability of the kiln and the circumstances under which the burning of waste will occur.

5. Risks of dioxin and furan formation: Together, the introduction of chlorides and organics with the raw materials into a kiln system may present pre-cursors for dioxin formation, and their input into the raw materials of the kiln should be limited. A suitable limit for Cl input into the kiln would need to be established for each kiln which would not prevent PPC from being able to adhere to their emissions commitments. 310 mg total input (fuel and raw materials) per kg clinker produced is used as a guideline in the industry. It is the opinion of MES that this risk does not exist for secondary material fuels introduced at the flame-side of the kiln (the front end) as the alkaline environment present inside a cement kiln allows the acid components of gases to be neutralized before combustion gas is released into the atmosphere.

6. Metals: The metals of concern, and whose input into the kiln should be limited are:

   a) The volatile and semi-volatile metals (Mercury, Thallium and Cadmium) for their potential to pass through the kiln system and any gas cleaning equipment without removal,

   b) Chromium for its ability to be oxidised to Cr VI and become incorporated in the final cement product, where it may present risks of it may present risks of dermatitis to sensitive skin should adequate protection not be worn by the user.

   Other principal emissions risks: Inorganic and organic Sulphur compounds introduced with the fuels will be subjected to the same internal cycle consisting of thermal decomposition, oxidation to SO_2 and reaction with alkalis or with calcium oxide. With this closed internal cycle, all the Sulphur which is introduced via fuels or via raw material Sulphates will leave the kiln chemically incorporated in the clinker, and will not give rise to gaseous SO_2 emissions. On the other hand, Sulphur entering the kiln via raw materials as pyrites may oxidise to SO_2 at between 370°C and 420°C and partly leave as in the stack.

   Gaseous emissions such as SO_2, VOC, dioxins and furans, are almost entirely determined by the chemical characteristics of the raw materials used, and not by the fuel composition. Emissions are lowest with raw materials which are low in volatile components, and injection of materials containing significant quantities of volatile components (Cl, S and carbon) should occur at the flame-side of the kiln.

7. The advantages of disposal by cement kilns over land filling or incinerators are numerous. The principal benefit, however, is that any calorific or mineralogical value in the waste stream is recovered and will reduce the consumption of coal and other raw materials which would have been used in the manufacture of cement, resulting in an overall reduction of greenhouse gas emissions. A significant additional benefit is the volume of waste which a kiln may accept. This implies that cement kilns have the potential to provide a meaningful contribution to the reduction of waste sent to landfill. Cement kiln disposal by PPC alone is, on a volumetric basis, equivalent to constructing another H:H landfill site without the capital costs and long-term environmental risks of landfill disposal.

   Any "waste ash" produced in the kiln becomes incorporated in the final cement.

8. Emergencies such as fire, explosions or spillage/leakage during transportation and storage are extremely rare in the cement industry and adequate control measures have been recommended in this report.

9. The emissions leaving the process are the largest potential source of environmental impact from the process, and the emissions that are of significance are nitrogen oxides (NO_x), Sulphur dioxide (SO_2) and dust. Other important emissions include carbon monoxide (CO), volatile organic compounds (VOC), dioxins (PCDD's), furans (PCDF's), and metals. The potential environmental effects of these emissions are of two principal categories:

   a) Community Health Effects:

      Respiratory impacts and possible toxic and carcinogenic effects may be related to the emissions of dust, CO, metals, VOC's and dioxins and furans in the gaseous phase.

   b) Environmental Effects:

      Emissions such as NO_x and SO_2 will contribute to acid deposition (also known as acid rain) in the regional context, and CO_2 to climate change in the global context. VOC's contribute to photochemical smog (subject to ultraviolet radiation degradation), which with dust, will also contribute to a visual impact if dispersion is poor. A minor degree of soil and surface water contamination may occur from dust settling out from the atmosphere. Current dust emissions result predominantly in an insignificant increase in pH of soil and surface water and possible increase in suspended solids in surface water courses. For dust, there may be an increase in metals accompanying the dust and an increase in the dioxins and furans possibly absorbed into the dust. This may result in toxicological (cancer and non-cancer) risks to receiving flora and fauna and the community.

BASELINE COMMUNITY HEALTH SURVEY

During the required Public Participation Process comments from the public and Non-Governmental Organisations included concerns regarding the cumulative / compounded health impacts on the communities living near PPC factories. In order to assess this, a Baseline Community Health Risk Assessment was undertaken to establish the current potential health impacts of the current PPC emissions. The results of this study will form the baseline against which the impacts of secondary materials will be measured. Further, a request from key stakeholders to investigate the alternative waste disposal and treatment options for the various waste streams was received. As a result MES has also commenced with a Waste Disposal Study to determine the feasibility of waste treatment and disposal alternatives the findings of this study will be included with this report.

The results of the Community Health Study show, however, that in the current situation, there is no information or study that demonstrates that PPC, in itself, has any negative effect on its surrounding communities. The available data cannot be utilized to make any conclusive decision as to whether PPC has a negative effect at any one of its sites. In order to do this, extensive epidemiological studies are needed. Even with such a study, clear association would be doubtful, as these studies often has fairly low specificity. This is evident in the myriad of publications in Occupational Medical literature 'suggesting' association. It is only H_2SO_4 (sulphuric acid) that has been classified as a human carcinogen on the basis of epidemiology alone.

ALTERNATIVES

Possible process alternatives	Reasons for considering alternative
Different types of secondary materials.	The composition of the secondary materials will affect the emissions generated by the kiln, as well the composition of the final cement.
Storage locations for the secondary	A centralised blending platform may provide more specialised

Possible process alternatives	Reasons for considering alternative
materials.	facilities for the storage and blending of waste streams at locations more central to the cement kiln.
Transportation alternative (road or rail).	Different routes and reliabilities of transporting hazardous waste and therefore different levels of risk.
Disposal of waste to landfill, incinerator and/or recycling (no-go option).	These may be considered as waste disposal and treatment alternatives in terms of the waste hierarchy as published by DWAF.

ISSUES IDENTIFICATION

Based on the environmental analysis and the comments received during the Public Participation Period, perceived environmental impacts are identified for further identification during the Environmental Impact Report. The purpose of this impact identification is to determine whether there are any "fatal flaws" associated with the proposed development portion and to provide a base for the identification of potential significant impacts that will require further investigation. The impacts register identifies the anticipated impacts expected during the construction and operation phases of the proposed development.

Construction Phase			
Issue	**General Impact**	**Specific Impact**	**Cause / Aspect**
Hydrology	Pollution	Potential storm water pollution.	Hydrocarbons, cement, or other fuels.
Soils	Pollution	Potential pollution of soils by hydrocarbon spills	Temporary fuel storage facilities on site.
Light pollution	Pollution / Disturbance	Light pollution by construction activities if carried out at night	Floodlights
Groundwater	Pollution	Potential pollution of groundwater through uncontrolled spills and other construction activities	Temporary fuel storage facilities on site.
Waste	Pollution	Potential pollution through litter	
		Potential pollution of soil, groundwater through the incorrect disposal of hazardous waste	Disposal of paints, hydrocarbons, etc.
Traffic	Disruption	Disruption of traffic flow during the construction phase due to heavy vehicles and deliveries	Delivery vehicles and construction plant.
Noise	Pollution	Potential increased noise levels due to construction activities	Blasting, drilling.
Socio-economic	Job creation	Potential increased employment opportunities during the construction phase	

Operational Phase			
Issue	**General Impact**	**Specific Impact**	**Cause / Aspect**
Emissions	Community Health	Cancer and non-cancer health effects on sensitive receptors in the community (i.e. children, sick and elderly) who are exposed to emissions at ground-level concentrations	Input of high Cl and VOC materials into preheater stages of kiln Input of SM containing volatile metals at either end of kiln
	Community Health, Air Quality	Particulate Matter falling out from dust emissions (Cement Kiln Dust) resulting respiratory ailments and visual pollution (from stack plume)	Operation of cement kiln
	Climate Change	Overall reduction in CO_2 emissions	Substitution of coal fuel feed with Secondary Materials
	Air Pollution	Acid Deposition resulting in acidification of soil and surface water	HCl, HF, NO_x, CO_2, and SO_2 emissions
	Community Health	CO emissions resulting toxic effects on blood	Calorific value of fuel too low, resulting in poor combustion. Incomplete combustion will result in elevated CO emissions
	Community Health, Air Pollution, Soil and Surface water pollution	Dust and gas releases	In case of fire, explosion, failure of kiln, spills and leaks from kiln
Groundwater & soil	Pollution	Sterilisation of soil (loss of biodiversity) and health effects on downstream water users of groundwater	Leaks and spills from waste storage areas seeping into soil and groundwater
Odour & air emissions	Air Pollution	Fugitive emissions of VOCs and odours	Storage of hazardous waste either in vented tanks (hydrocarbons) or open bunkers (sewage pellets)
Leaching of metals from concrete	Water Pollution (potable, surface and/or groundwater)	Public health and environmental health effects may result from the toxicity of the metals incorporated into clinker	Leaching of heavy metals from concrete products when in contact with water

Operational Phase			
Issue	**General Impact**	**Specific Impact**	**Cause / Aspect**
Dust from concrete or cement	Air Pollution	Occupational health effects from use of cement and concrete made from Secondary Materials (extent affected by sales and distribution of PPC cement)	Dust exposure from use of cement in construction activities, or concrete from demolition activities.
Waste Disposal	Groundwater Pollution	The secondary impacts of disposal of general and hazardous waste to landfill	Disposal of general and hazardous waste to cement kiln
	Loss of land use	Construction of further general and hazardous waste landfills	Disposal of general and hazardous waste to cement kiln
Traffic	Disruption, Dust and Noise along route	Impacts to communities resident along routes to De Hoek and Piketberg.	Increased traffic flow
	Soil and water Pollution	Contamination of surface water and soil with high pH, high COD waste streams	Spills and accidents during transport

INVESTIGATION OF ISSUES

Mass Balances across the kiln and determination of environmental risk assessment methodology

MES hypothetically determined an emissions inventory and clinker quality (following the application of secondary materials) and determine whether such represent an acceptable risk to the environment and community health. Once these are determined, control mechanisms can be put in place to ensure that such emissions and clinker quality are achieved.

There are other controls which have resulted from this study, but they are essentially expansions on these three concepts. It is worth noting, at this point, that these three controls have been recommended as conditions of any Record of Decision issued by the authorities, and that PPC have accepted such controls as reasonable and best practice.

Assumed outputs and emissions for environmental risk assessment

MES proposed an emissions inventory, which was deemed achievable by PPC and was acceptable to the company for all their kilns accepting secondary materials.

Table 3: Maximum Allowable Emission Limits

MAXIMUM ALLOWABLE EMISSION LIMITS	
POLLUTANT	**LIMIT**
Total dust	As per current APPA

	permits
CO	See note
HCl	10 mg/Nm^3
HF	1 mg/Nm^3
NO_x	See note
$S0_2$	As per current emissions
TOC	10 mg/Nm^3
Cd +Tl	0.05 mg/Nm^3
Hg	0.05 mg/Nm^3
Sb, As, Pb, Cr, Co, Cu, Mn,Ni + V	0.5 mg/Nm^3
Dioxins toxic equivalence	0.1 ng/Nm^3

(NOTE: No SA legislation is applicable to CO and NO_x emissions limits, and PPC shall therefore commit to adhering to current emissions for these gases for future operations with Secondary Materials. PPC, however, is committed to reduce NO_x to Internationally accepted standards with its on-going kiln upgrading programme.).

Specialist studies for impacts of emissions

MES established that three principal relationships exist in the secondary materials process which may pose impacts on the environment, and which may require specialised studies to better understand. These relationships are summarised as follows.

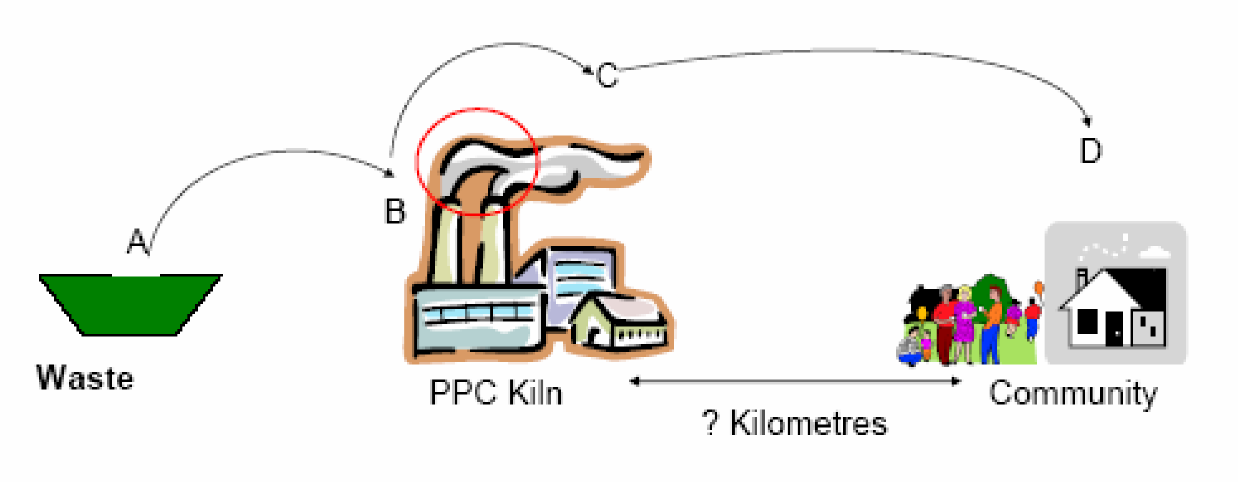

Figure 2: Relationship between secondary materials input and possible downstream receptors

Thus the need for four specialist studies for each kiln was identified and the results of which are contained in full in separate reports, but which have been summarised in Sections 8 of this report.

Emissions Dispersion Modelling

The terms of reference required to assess the impact of air pollution emanating from the current and proposed operations at PPC De Hoek, were as follows:

1. Obtain and analyse local meteorological data (wind speed, wind direction and ambient air temperature);
2. Carry out dispersion modelling;
3. Prepare isopleth plots of ground level concentrations for the site including:
   - The current impacts from all sources at the PPC De Hoek plant; and
   - Future impacts from all sources at the PPC De Hoek plant taking into account the change due to secondary materials usage.
4. Comparison of predicted concentrations to local and international guideline values and standards.

Results for Criteria Pollutants

Inhalable Particulates (PM10)

The future predicted ground level concentrations for PM10 were the same as for the current operations. All predicted concentrations complied with the standards at the plant boundary and were equal to the proposed SA standard at Piketberg for daily averages. Over annual averages the predicted concentrations complied with both standards. The PM10 emission rates from the two kilns remained unchanged since it were based on the APPA Registration Certificate limits and will not exceed these in future.

Oxides of Nitrogen (NO_x)

For future operations the predicted NOx concentrations remained the same as for current operations. This was expected since the emission rates remained the same (also based on the APPA Registration Certificate limits). Highest hourly, daily and annual average ground level concentrations were 124 µg/m³, 19.8 µg/m³ and 3.6 µg/m³, respectively falling within the SA Standards for the relevant averaging periods.

Sulphur dioxide (SO_2)

The future predicted ground level concentrations of SO_2 due to the use of secondary materials were predicted to be the same as current operations. The highest hourly and highest daily concentrations were predicted to be 26.7 µg/m³ and 4.3 µg/m³ and annual average was 0.77 µg/m³, respectively. These all occurred at Piketberg, ~1.5 km to the north of the De Hoek site. These predicted SO_2 concentrations are all well within the current and proposed SA Standards.

Carbon monoxide (CO)

The predicted ground level concentrations were within the hourly South African standard of 30 000 µg/m³. Highest hourly concentration was predicted to be 41 µg/m³ at the identified sensitive receptor (Piketberg). No change in the emission rates for CO between current and future operations were indicated resulting in the same ground level concentrations for the two scenarios.

Metals

Various metals such as antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), cadmium (Cd), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V), associated with the proposed operations were included in Scenario B for the future operations at PPC De Hoek. Even though target values (as published by the WHO) exist for As, Cd and Ni, the emissions rates were provided as a group emission rate and hence the screening criteria could not be applied. The same applied to the proposed SA Standards for lead concentrations. These predicted ground level concentrations have been assessed as part of the health risk assessment conducted by Infotox.

Dioxin Concentrations

No health screening guidelines exist for Dioxin concentrations and this will be assessed as part of the health risk assessment to be conducted by Infotox (Pty) Ltd. The highest off-site concentrations predicted were 1.47E-08 ng/m³, 2.34E-09 ng/m³ and 4.23E-10 ng/m³ for highest hourly, highest daily and annual averages respectively. The highest concentrations were predicted at Piketberg. The longer term averages correlates with the prevailing wind field of the site.

Halogen Compounds

The halogen compounds (i.e. hydrogen chloride (HCl) and hydrogen fluoride (HF)) were screened against the Californian OEHHA (Office of Environmental Health Hazard Assessment) Acute and Chronic RELs (Reference Exposure Levels) health screening criteria. Concentrations of HF were higher than for current operations, with the maximum predicted ground level concentrations of 0.15 µg/m³, 0.02 µg/m³ and 0.004 µg/m³ for highest hourly, highest daily and annual averages. Similar increases in HCl ground level concentrations were predicted with an average increase of 7.3 times. The concentrations have also been assessed as part of the health risk assessment conducted by Infotox.

Mercury (Hg)

Mercury associated with the proposed use of secondary materials was included in the future operations at PPC De Hoek. No screening criteria are available for concentrations of mercury and these have been assessed as part of the health risk assessment conducted by Infotox.

Community Health Risk Assessment

Hazop Study

PPC embarked on a high-level HAZOP study on the secondary materials project in early 2006. The general risk categories that the team identified were:

- Occupational Health;
- Safety;
- Air Pollution;
- Water pollution;
- Soil pollution;
- Process Stability;
- Product Quality;
- Community Impact;
- Impact on Plant & Equipment;
- Impact on Maintenance;
- Company Image;
- Infra-structure; and
- Special / Legal Requirements.

The distinct areas in the typical cement production process, where risk could occur, were identified as:

- Sourcing;
- Materials Handling (Offloading, Transport to storage and Storage);
- Processing (Transport to point of application, Feeding and Control, Kiln Operation (Normal), Kiln Operation (Abnormal), Kiln Operation (Emergency));
- Quality Assurance (Process QA, Product Quality (clinker)); and
- Measuring and monitoring.

Interim HAZOP Conclusions

The process followed is thorough enough to highlight definite problem areas both in terms of hazards and operability. For instance, the relatively innocuous alumina paper pulp, which was previously considered to be a viable replacement for fly-ash as a source of silica and alumina, was found to pose too much risk to the stability of the kiln operation and product quality. Similarly, the very high risks to safety, health and environment, posed by the failure of the correct sourcing procedures for hydrocarbon secondary materials, was highlighted. Tyres used as secondary material was found to be relatively low in environmental risks but would require special attention in handling and storage.

In general therefore the HAZOP process started by PPC is believed to be a valuable preparatory tool but should be completed at all levels of the company's operations. Details of specific sources of secondary materials should be used as a second level study, once the generic study has been concluded. Consideration should also be given to making the results accessible to interested and affected parties.

Further high-level studies will be performed by PPC prior to the commencement of the Secondary Materials programme. The recommendations of such studies will be included in any audits recommended in Section 11.

A review of the Waste Hierarchy and a Life Cycle Approach to Disposal by Cement Kiln

This study addressed the different perspectives through a review of **Waste Hierarchy,** examining the role that disposal by cement kiln may plays in each of the respective tiers; and includes a **Life Cycle Approach** discussion on the environmental footprint of disposal by cement kiln in comparison to other waste management options.

The Waste Hierarchy, which is generally divided into 5-7 tiers, is grouped into three broader tiers to better define the overall approach towards waste. These tiers, each based on a separate key principle of waste management are:

- Tier 1: Avoiding Waste Generation;
- Tier 2: Recovering the Value of Waste; and
- Tier 3: Treatment and Disposal.

The discussion on the waste hierarchy concludes that disposal by cement option is Tier 2, a preferred option to landfilling (Tier 3) where the reduction in waste (Tier 1) or recycling (Tier 2) of waste is not viable. Not only is the energy value of the waste utilised, thus replacing the need for other fossil fuels (coal), but the ash elements are needed and therefore incorporated into the production of cement.

The roles that PPC, the generator and the landfill operators play in the waste hierarchy are illustrated in the figure below.

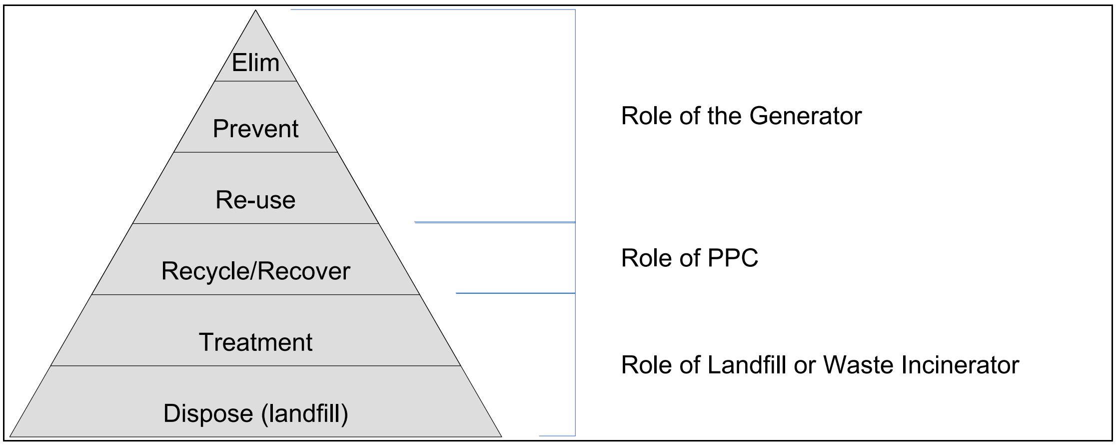

Figure 3: Roles in the Waste hierarchy

Market forces are shown to be favourable for the upper tiers of the waste hierarchy (reduction and recycling), thus ensuring that where viable, industries generating the waste will benefit more (financially) from any waste minimisation and avoidance programmes than disposal by cement kiln. The difference in savings and costs for the waste management options clearly indicate that disposal by cement kiln is not providing disincentive to recycling or reduction options.

The following legislation, policies and strategies of South Africa identified holds supports for cement kiln as a waste management option. International trends further indicate that this option is practised and supported in various other countries (Europe in particular).

Table 4: Legislation, policies and principles reviewed

Legislation / Policy / Principle	Year of publication/ promulgation
National Environmental Management Act - Waste Management Principles	Act no. 107 of 1998
Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste	2nd Edition (DWAF, 1998)
Polokwane Declaration	*September, 2001*
National Waste Management Strategy (NMWS-SA)	1999 adopted NWMS
White Paper on Integrated Pollution and Waste Management for South Africa	*DEAT, Planned in NWMS,* 2000
Gauteng Provincial Integrated Waste Management Policy	*March 2006, Draft*
Sewage Sludge Guidelines	*DWAF and WRC, March 2006*

Disposal by cement kiln, which reduces the use of natural resources by means of using wastes as an alternative fuel, together with reusing the wastes will result in waste being diverted from the landfill. The use of alternative fuels in cement kilns is therefore in alignment with the objectives set in Polokwane Declaration (reducing waste disposal), and to the holistic approach embodied in the NWMS. This option adhered to the objectives of the NWMS project, and to the Gauteng Policy (final draft), Policy no.10 (for the recovering and recycling of other materials).

In general, it was established that greater impacts are avoided for the recycling options compared to disposal by cement kiln or landfilling. Although additional resources and utilities are required for recycling operations (such as water for the washing of recyclable material or electricity for a shredder), the impacts of raw material production (which would be avoided for recycling) are generally higher than the impacts of the preparation of the waste materials to be used in recycling. Both recycling/use and disposal by cement kiln generally recover energy, avoid resource extraction (including non-renewable resources), and do not have an impact on land use, when compared to landfilling. There is a greater risk of ground and water contamination from landfilling (contaminants leaching to ground), and for the soil application of sewage sludge for agricultural purposes. The consumption of water and generation of wastewater are expected to be higher for recycling activities where substantial washing of the materials is required prior to being of use in the manufacturing process.

There is no single or ideal waste management strategy that will meet the needs of every community. In addition to assessing the impacts of the life cycle stages for the different waste management options, an integrated approach to waste management must incorporate the evaluation of the relevant economic, technical, political and social factors.

An integrated waste management strategy will therefore need to strike a balance between the various tiers and waste management approaches, and continue to push industry to assess opportunities higher up in the waste hierarchy. Disposal by cement kiln offers an additional waste management option, higher up in the hierarchy than landfilling. The cement kiln recovers energy and utilises the material value of the ash in the clinker. Waste materials less suitable for recycling and which have high calorific value should be processed through energy recovery rather than landfilling. Using such residual wastes as sources of energy displacing fossil fuels such as coal and can provide a reduction in GHG emissions. The availability of this option in South Africa is expected to divert a substantial amount of waste that would otherwise have been landfilled or illegally dumped, thus improving the status of waste management in South Africa.

Although source reduction provides the maximum benefit for many impacts, this practice does not always receive the attention it deserves, and the waste manager seldom has the opportunity to implement waste minimization programmes that would reduce wastes at source. However, the financial gains from source reduction are far greater than any other option, and therefore the option of disposal by cement kiln is not expected to provide a disincentive for industry considering minimisation options.

The practice of employing alternative fuels in cement plants does not hinder the establishment of a sound waste management industry. The practice can co-exist alongside a vigorous and thriving materials recovery and recycling and incineration industry, without distorting the essential principles of the waste management hierarchy.

PPC experience with Secondary Materials

In South Africa, PPC was the first cement company to investigate the feasibility of the use of secondary materials including waste material as a fuel supplement. From 1993 - 1994, Feasibility and Environmental Impact studies were carried out at the Jupiter cement manufacturing plant in Johannesburg, the results of which are discussed in the following sections.

Trial burns with chemical waste were also conducted and these showed that the addition of these secondary and waste materials had no negative effect on the stack emissions or on the health risk to the surrounding community. These trials also showed that the quality of the cement was not compromised. However, PPC did not continue the use of secondary materials at the Jupiter kiln due to temporary closure of the Jupiter kiln operation, due to low market demand.

AEC Surveys & Trials[3]

A baseline study and test burn using an organic compound that is known to be difficult to destroy (carbon tetrachloride) were conducted, as well as a trial burn with a pitch-derived secondary material. The aim was to provide information on the background distribution of metals and organic compounds in feed materials, emissions and the cement product, and to demonstrate the efficiency of incineration that can be achieved. These studies were to provide the background data for an assessment of the viability of co-processing of wastes in an actual trial burn. These studies were conducted in strict accordance with the USA Environmental Protection Agency (EPA) guidelines as governed under the Resource Conservation and Recovery Act.

Baseline Survey

The baseline survey was required to characterize the Jupiter production plant comprehensively in terms of the chemical composition of gaseous and particulate emissions, feed materials (raw meal and coal) electrostatic precipitator (ESP) dust and product (clinker). This data was to provide a baseline reference for the assessment of materials and emissions after the introduction of secondary materials. These tests included volatile and semi-volatile organic compounds, particulate emissions, BIF metals in stack gas, semi-volatile organics and metals in coal and raw meal, and metals in the kiln dust and clinker. Gaseous emissions of oxygen (O_2), sulphur dioxide (SO_2), nitrogen oxides (NO), carbon monoxide (CO) and carbon dioxide (CO_2) were also measured.

[3] *AEC Projects codes BAW 0815,0820,0823,& 0827:1993-1994*

Test Burn

The test burn to determine the typical destruction and removal efficiency (DRE) of the Jupiter kiln for organic compounds and the formation of dioxins was accomplished through the incineration of carbon tetrachloride (CCl_4). The purpose of a test burn is to demonstrate that an incinerator has the ability to destroy hazardous materials efficiently to levels of emission that would not pose risks of any significance to public health or the environment.

Trial Burn

A comprehensive trial burn was conducted using a pitch-type waste-derived fuel as a supplement to the coal feed. Over a five week period during mid-1993 some 900 tons of waste was consumed replacing on average 20% of the coal requirements of the plant.

Conclusions

- The DRE tests with CCl_4 confirmed that the Jupiter cement kiln has the ability to incinerate hazardous wastes efficiently to levels of emissions that are within the standards set by the United States of America Environmental Protection Agency. Dioxin measurements were not recorded for this test burn.
- DRE values based on the quantitative determination of CCl_4 in the emitted gas were greater than 99,9999 %. This value adequately meets the EPA requirements for hazardous waste incineration that has been conducted in the USA and elsewhere in cement kilns.
- CO and CO_2 levels indicated a combustion efficiency of better than 99,9 % throughout all of the tests.
- The higher sulphur levels in the secondary material did not result in any measurable SO_2 emissions.
- NO_x emissions were unaffected by the use of waste as a supplement to the coal fuel. Very little changes occurred in the level of emission of metals and organic substances. These were assessed in terms of environmental health impact.
- No evidence of compositional changes of kiln dust and clinker could be found that would support the possibility of a change in risk to humans or the environment when waste is used as a fuel supplement.
- Quantification of emissions from operation with conventional fuel and from the use of waste derived fuel indicated that the waste had no effect on both cancer and non-cancer health risks to the community. Emissions were well within the health-based standards for such facilities. Estimated cancer risks were less than one in a million. These are indeed extremely low risks.
- The TCDD values given in Table 10.6 above were used to estimate annual average ground level concentrations of dioxins and furans, using the EPA-based computer dispersion models. This data was subsequently used to quantify cancer risks to exposed communities due to dioxins and furans released from the Jupiter cement kiln when coal fuel is partly replaced with selected waste materials.
- The AEC reports clearly concluded that all calculated risks were insignificant.

Xylene Trial Burn[4]

To determine the viability of disposing of these materials in the clinker manufacturing process as well as gain experience in the correct transport, handling and storage thereof, PPC decided to conduct a trial burn with xylene-contaminated solvents (from the company Syngenta in Brits) at the Slurry facility on Kiln 8.

Stack emissions tests were conducted by an independent emission monitoring company (Levego CC) before and during the trials to determine any increase in emission of volatile organic compounds during the trial.

The conclusions made by PPC management team are as follows:

- The emissions during the test were within the limits set by the CAPCO of the Western Cape Province.
- Conclusive evidence regarding the destruction and removal efficiency of the burning process however was not possible mainly due to the (more than expected) variability in the quality of the feed material.
- Various process problems were highlighted during the trial and as a result on-site personnel gained valuable experience that will be applicable to the storage, handling and disposal of any future liquid waste materials.

SPL processing

PPC has been using small quantities of the hazardous waste called Spent Pot Lining (SPL) at several of its production facilities since 2001. The SPL arises at the Billiton Hillside and Bayside aluminium smelting plants at Richards Bay, and Mozal in Maputo. At the end of each campaign, aluminium electrolysis pots have to be shut down to replace the cathode and lining which is worn out and possibly damaged. After removing as much bath and metal as possible and separating out the cathode bars, the materials left are spent pot lining comprising carbonaceous materials (first cut) and refractory materials (second cut). SPL is impregnated with fluoride and sodium salts and contains impurities, including traces of cyanides (particularly in the first cut). It also contains aluminium and crystalline silica, both important clinkering compounds. It can therefore be viewed as both a secondary raw material and fuel in the cement process.

The following general conclusions were made:

- Dust emissions were not affected by the inclusion of SPL and were well below DEAT limits;
- Although gaseous fluoride emissions were well within DEAT limits, the value was 2.5 times higher than baseline tests done, indicating that the combination of higher inclusion rates of SPL does lead to elevated fluoride emissions, and
- No gaseous emissions of cyanide were detected.

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[4] *Xylene Trial Burn – PPC Slurry 07 July 2005: JJ Meyer*

SPL Hazard & Operability Study[5]

In June 2000 Marsh Risk Consulting conducted a risk assessment on the planned use/disposal of Spent Pot Lining (SPL) at PPC. The assessment included a consideration of risks associated with the following processes:

- Handling and storage of the SPL at BHP Billiton's Hillside aluminium smelter;
- Transport of the SPL to PPC sites, and
- Storage arrangements, crushing, milling and co-processing in cement/lime kilns at PPC Dwaalboom, Port Elizabeth, Slurry, Hercules and Lime Acres.

A Hazard and Operability (HAZOP) approach was used and the general findings were as follows:

- A fire involving SPL material will present risks, including toxic gas release.
- Contact with water/moisture could lead to an unacceptable increase in the rate of release of such harmful gases.
- Environmental impacts may result such as contamination of surface/groundwater and air emissions.
- Inadequate ventilation may lead to a build-up of explosive/toxic gases and a possible explosion.
- Non-conformance with procedures.
- Plant/equipment may be adversely affected by the processing of SPL e.g. possible reduction in refractory life, etc.
- Possible contamination of SPL and/or variability in SPL quality could significantly impact on product quality.
- The SPL could pose an increased risk to staff health, due to potential exposure to harmful dust/gases.

The recommendations from the assessment report were as follows:

- Adequate ventilation must be provided in all areas where a gas build-up may occur.
- All legal requirements relating to SPL usage must be met.
- Billiton should ensure that supplied SPL is strictly controlled to agreed specifications. Responsibilities and liabilities in this regard should be clearly specified in the contract.
- Certification/signing off systems should be implemented where responsibilities for the SPL are transferred e.g. from Billiton to PPC Logistics, and from PPC Logistics to PPC Cement/Lime. Responsibilities at transfer points must be clearly defined.
- Environmental parameters should be closely monitored, particularly air pollution and possible water contamination.
- Likely increases in operating/maintenance costs should be taken into account when setting a price for SPL disposal, and the contract should preferably allow for later price adjustments if costs differ from those anticipated.
- Measures must be put in place to ensure the SPL does not come into contact with water.

[5] *Risk Assessment of SPL Project-June 2000:Marsh Risk Consulting*

- Occupational hygiene assessments must be performed to assess staff exposure to SPL material and associated gases.
- Plant maintenance trends/costs should be monitored to confirm continued feasibility of SPL use/disposal.
- PPC should implement a checking system to ensure the above.
- Procedures must be put in place to ensure staff are not exposed to toxic gases/dust, particularly during maintenance activities/hot work/confined space entry, and in the event of a fire.
- Product quality management should be viewed as a priority in areas where SPL is used.
- The abovementioned risks should be carefully managed in order to ensure the success of the SPL project.
- When evaluating the overall benefit of the SPL project, the above-mentioned risks should not be viewed in isolation from the benefits (financial as well as environmental) of the proposed process.
- Written procedures and staff training should be viewed as a priority in SPL processing areas.

TABLE OF IMPACTS AND PROPOSED MITIGATION

Construction Phase

Relative to the operational phase, the impacts of the construction phase will be minor. Issues are largely limited to the construction of the waste storage area (bunkers for solid waste and bunded tanks for liquids and sludges). The final location of the waste storage area is not yet determined but the risk assessment assumed that it will be on exposed soil. It will, however be within the plant boundary and will therefore present minimal risk to surrounding land owners and the environment outside of the plant. The only negative impacts worth mentioning, post mitigation, are the potential for increased traffic and noise due to construction vehicles and machinery, and the positive impact of job creation in the area.

Operational phase (including trial phase)

The impacts associated with the operations of a secondary materials programme may be defined as follows:

1. The impact of highest significance relates to the expected emissions from the Secondary Materials Co-Processing Programme.

   When the cement kiln is operated without secondary materials, the most significant emissions are:

   - Cement kiln dust (visual and community health effects),
   - NO_x (which contributes to acid deposition),
   - Carbon Monoxide (community health effects),
   - VOC's (volatile organic compounds, which result in photochemical smog and other forms of community health risks and air pollution) and
   - CO_2 (which contributes to climate change).

   It is our professional opinion that these impacts are not affected by the addition of secondary materials as the quantity of these emissions will not be increased.

These negative impacts will be largely due to the change in emissions which may result from the burning of hazardous waste, which may result in impacts on community health and the surrounding (ambient) air quality. These emissions include sulphur dioxide (SO_2), dioxins and furans, acids (such as hydrochloric and hydrofluoric acid) and metals (especially the volatile and semi-volatile metals such as Mercury, Thallium and Cadmium).

The mitigation measures accepted by PPC aim to limit the inputs of certain chemicals which may generate these emissions and to perform trial burns before moving to full-scale burning of waste streams to confirm that these emissions are within acceptable limits. PPC's commitment is to adhere to stringent and self-imposed emissions limits which comply with existing air pollution certificates and European Union limits. If these emissions limits are adhered to, then the resulting impact on the health of the community, according to various specialist studies, is negligible and legal compliance against SANS standards is achieved.

In addition to accepting emissions limits, PPC has agreed to a programme of external monitoring, auditing and reporting in addition to their normal legal compliance and ISO 14001 audits.

2. Another significant risk is that of process accidents or incidents, including fires, explosions or spills and leaks from the kiln when the kiln contains uncombusted hazardous wastes. Although the occurrence of such is very rare in the cement industry, a Hazop study will be undertaken by PPC to consider all of the possible risks. For the purposes of this study, the trial burn will determine the Maximum Safe Feed Rate of waste at which kiln stability is maintained and the emissions limits are achieved. Thus the gradual addition of waste to the kiln will be performed during the trial burn to ensure no unstable kiln operation results.

3. The storage of large volumes of waste (especially the liquid hydrocarbons) will present risks to soil, surface water and groundwater during storage, unloading, transport and transfer to the kiln. Comprehensive mitigation measures have been proposed to ensure containment or emergency response to accidents and risks of leaks and spills. It is believed that these are industry norms and will be adequate to bring these impacts to an acceptable level. The same applies to fugitive emissions of dust, vapours and gases from the transfer and storage of these waste streams on-site. Again, mitigation measures which are standard to the industry will prevent unacceptable impacts from arising, such as vapour recovery systems or similar, and protection of the stored dry waste from wind and rain.

4. Several concerns have been raised by I&AP's and our internal risk assessment process regarding the end-use of the final product. This includes the leaching of toxic components from the final cement (i.e. concrete) or when users of the cement (i.e. the public or workers in construction companies) are exposed to cement dust which has been made from secondary materials. The reason for this concern is that the final product which is made from secondary materials may have higher concentrations of metals than the 'normal' cement made currently. While it is expected that higher metals concentrations will be present in secondary material cement, the impact of metals leaching into water cement water pipes and reservoirs (the 'worst case scenario') has been dismissed by international literature as negligible, as long as the concentration of Chrome VI (hexavalent chromium) is limited. PPC will therefore limit the amount of chromium added to the kiln through waste streams to ensure that the chrome VI content in secondary materials cement is the same as for 'normal' cement. With regards to dust emissions during the use of secondary materials cement, it is always recommended, as with normal cement, that personal protective equipment (i.e. dust masks be worn) as normal cement also contains metals. The unprotected exposure to cement dust is always a health risk,

whether or not the cement is made from secondary materials or not (although the health risk of secondary materials cement, due to its higher metals content, is believed to be higher).

5. The positive impacts arising from this proposal is the potential diversion of significant quantities of waste streams from the Western Cape's landfills to PPC, whereby the mineral and energy value of the waste stream is recovered. If these waste streams continue to be disposed of to landfill, then the construction of future landfills is expedited (accompanied by the risks of groundwater contamination from landfills) and the value of the waste remains buried underground. Furthermore, the replacement of coal (a non-renewable fossil fuel, which has to be transported even greater distances than the waste) results, implying an improvement in the energy efficiency of the cement industry.

All of the impacts are sufficiently mitigated by the proposed control actions as required in terms of the National Environmental Management Act, thereby reducing the significance of each impact.

CONCLUSIONS

A summary some of these perceived or possible benefits include:

1. For the company:
   - Substituting expensive raw materials and fuel requirements with renewable and cheaper alternative resources.

2. For South Africa:
   - Extending the life of landfill sites and the associated land requirement as well as reducing the risks of pollution posed by disposal sites;
   - Offering an alternative for disposal of hazardous materials to expensive processes like incineration;
   - Preserving natural recourses i.e. fossil fuels and mineral deposits, and
   - Reducing the risk of unwanted dumping of waste.

3. Globally:
   - Contributing to a net decrease in CO_2 and other greenhouse gases emission.
   - Making a positive contribution to international commitment of waste reduction including targets set in Agenda 21 of the "Earth Summit" in Rio de Janeiro (1992), the Johannesburg Declaration on Sustainable Development (2002), and the Millennium Development Goals as well as international environmental agreements, namely the Basel and Stockholm Conventions.

In our opinion, co-processing of hazardous and non-hazardous waste presents a positive alternative to landfilling and incineration, and does not present a financial disincentive to the preferred alternative of recycling. Where recycling is not an established option in terms of the South African market, cement kiln disposal is the preferred means of disposal if the components of the waste stream are suitable to the cement process. The five waste streams included in this EIA application have been chosen on this basis.

Based on the extensive research contained in this document, the advantages of the proposed project outweigh the risks. If the recommendations outlined in the next section are complied with, the risks of secondary material co-processing by PPC are sufficiently mitigated so as not to present a significant risk to the environment and community health.

Advantages of cement kiln disposal by PPC

Regional presence

PPC has operational kilns in the Western Cape, Eastern Cape, North West, Limpopo and Gauteng Provinces. Thus the technology development and experience gained from this project shall be replicated at all kilns, but, more importantly, such regional presence enables cement kiln disposal to become a national alternative to landfilling an incineration. One of the concerns of the introduction of new technology is the concentration of the risk onto one area or region. For example, if De Hoek were the only site to receive authorisation, then concerns may be raised about the long-term transport of hazardous wastes from around the country to the one kiln, and the risks of large volumes of waste being stored and processed at one facility. PPC's proposal therefore mitigates this risk and provides a local solution to disposal of the five waste streams included in this proposal.

Cautionary Approach

PPC will only implement (i.e. from trial burn to full operation) the secondary materials programme at one kiln at a time, thus providing as opportunity to rectify any problems during commissioning prior to beginning at another plant.

International trends

In the last 20 years the use of secondary materials in cement kilns has become common practice internationally due to the general benefits as listed above and the ideal chemical and physical conditions in a cement kiln for such utilization. The main development within the cement industry globally in the last century has been that of combustion of secondary materials, and has been the most researched topic by independent organisations. In some circumstances, governments in Europe and Japan have specifically requested cement companies to dispose of problematic waste streams such as that from mad-cow disease, contaminated soil and tyres.

Cement kilns more favourable than incinerators and landfills

Until the market responds with more economically efficient means of recovering the value from the waste streams, cement kiln disposal at least provides an efficient means of recovering 100% of the energy and mineral value of waste streams for which there are currently no other feasible recycling alternatives in South Africa. This is particularly true of hydrocarbon wastes and tyres, where the predominant quality of the waste stream is its high calorific value per ton.

A significant additional benefit is the volumes of waste which a kiln may accept. This implies that cement kilns have the potential to provide a meaningful contribution to the reduction of waste sent to landfill. Cement kiln disposal by PPC alone is, on a volumetric basis, equivalent to constructing another H:H landfill site without the capital costs and long-term environmental risks of landfill disposal.

Because they are existing facilities, there is usually less public opposition to citing of cement kilns, and the capital expenditure required is only about 10% of that needed to build a dedicated chemical incinerator.

Elimination and positive use of waste

Secondary materials combustion in a cement kiln is a no-waste process, as the ash is a component of the clinker. Thus the ash from the waste becomes part of an end-product: cement. Waste streams from other industries are becoming widely used as replacements for the natural raw materials, thus implying reduced impacts from mining activities.

Process suitability

Full combustion of secondary fuels is achieved because of the high temperatures to which wastes streams are exposed inside such kilns, high gas stream speed and the turbulent mixing with the waste and clinker materials, and the long time during which particles remain in the gas stream at these elevated temperatures. Addition of secondary materials has been show to reduce the NO_x levels in kiln emissions and monitoring of CO is a normal process control at all kilns currently. Non-volatile metals remain completely within the product and leave the kiln system fully incorporated in the mineral structure of the clinker.

Cement kilns operate on a continuous basis, therefore the temperature of the material and its distribution within the kiln are stable in time, and due to a kiln's high heat capacity even in a case of emergency stoppage, and an excess oxygen environment, the temperature does not fall very quickly and total combustion of any materials inside the kiln is guaranteed.

Inherent gas scrubbing ability

The alkaline environment present inside a cement kiln allows the acid components of gases to be neutralized before combustion gas is released into the atmosphere. In all kiln systems the solid material moves counter currently to the hot combustion gases. This counter current flow affects the release of pollutants, since it acts as a built-in circulating fluidised bed. Many components that result from the combustion of the fuel or from the transformation of the raw material into clinker remain in the gas phase only until they are absorbed by, or condensed on, the raw material which is flowing counter-currently. The adsorptive capacity of the material varies with its physical and chemical state. This in turn depends on its position within the kiln system. For instance material leaving the calcination stage of a kiln process has high calcium oxide content and therefore has a high absorptive capacity for acid species, such as HCl, HF and SO_2 which reduces the risk of detrimental air emissions.

The high efficiency of combustion gas purification and direct incorporation in clinker eliminates metal emissions with the exception of highly volatile mercury. Metals are condensed in the dust particles captured by the air pollution control device, returned into the process and, in the end, bonded by the clinker.

Product safety

Cement produced using secondary materials does not present any risk to the environment or public health, as long as the chromium content is minimised. Regarding the leaching of toxic elements from the final cement product:

1. The potential for any additional negative environmental impact due to product leaching or direct water contamination when using secondary materials is not considered significant.
2. The threat to human health due to leaching when using secondary or conventional materials is minimal and well within health standards.
3. In cases where the concentration of heavy metals exceeds the normal range found in cements made without secondary material, leaching tests should be conducted.

PPC monitors the Cr levels in cement on a regular basis although there exists no formal limit in terms of the SABS standards. The critical species is water-soluble Cr (6+), which is typically at ppm levels (less than 10ppm).

Greenhouse gas reduction

With the substitution of fossil fuels by (renewable) secondary fuels, the overall output of thermal CO_2 is reduced ("CO_2 neutrality"). A thermal substitution rate of 40% in a cement plant with an annual production of 1 million tons of clinker reduces the net CO_2 generation by about 100,000 tons. This comparison assumes that the renewable fuel or waste is alternatively incinerated in a dedicated incinerator. The same basic principle would be valid when the waste should decompose in a landfill site or for instance digested in a biological treatment plant. The "greenhouse" gases would also include methane, for instance. Even more important is the substitution of clinker by mineral additions as both thermal CO_2 from fossil fuels and CO_2 from the decarbonation of raw materials are reduced. Therefore, the use of secondary fuels, raw materials and mineral additions can contribute significantly to national schemes for the reduction of greenhouse gases.

Inherent quality assurance and process control

An important corrective mechanism regarding this proposal is the process self-regulation: PPC is required to produce clinker which conforms to defined quality requirements.

In operating a kiln, a balance is maintained between the feed rate (which is linked to kiln rotational speed), the fuel firing rate (coal, which may be partially replaced by selected secondary fuel materials), and the combustion air supply (which is drawn into the kiln by the ID (induced draught) fan). Continuous analysis (for O_2 and CO) of the kiln exit gas stream ensures that there is sufficient excess air present for complete combustion of the kiln fuel. Clinker of the correct quality will not be produced if this balance is not maintained, or if the required temperature profile over the kiln system is not maintained.

Clinker quality is assessed by means of chemical testing on an hourly basis. The continuous monitoring of kiln operation effectively results in a continuous check on clinker quality.

It is therefore in the cement company's interest to avoid unnecessary disturbances to the kiln production due to the addition of secondary materials. This is an inherent control over the relationship between the input materials and the two outputs from a kiln system, namely: the emissions leaving the kiln/preheater stack, as well as the final product (clinker). The only limitation to this self-regulatory mechanism is that there may be ingredients in the secondary materials which will not affect either kiln stability or clinker quality, but which will present a risk to environmental and community health. This pertains mainly to mercury, and is discussed in section 3.2.15.

This self-imposed level of control does not exist with incinerators. Indeed, PPC should, if the measures recommended in the following section are implemented, exceed the standards set by the Department of Environmental Affairs and Tourism for the operation of a Class 1 incinerator (in terms of Scheduled Process No. 39 of the Atmospheric Pollution Prevention Act of 1965).

Acceptable community health risk

Legislation exists that govern emission limits when utilizing secondary materials specifically for cement kiln in various countries. In South Africa no such legislation exists and self regulation within related acts must be established. If PPC comply with their self-imposed emissions inventory (Table 9-2), it has been indicated that the additional risk of cancer and non-cancer effects on sensitive receptors in the community is negligible.

Liquid effluent

The cement production process does not produce liquid effluents. All water consumed (mainly for gas cooling purposes) is released to the atmosphere as water vapour. This situation will not change as a result of the introduction of secondary materials.

Risks of cement kiln disposal by PPC

Air emissions

Particulate and gaseous emissions to the atmosphere i.e. dust, SO_2, NO_x, VOC in raw material, and CO_2, comprise the major environmental impacts in the manufacture of clinker and cement. Gaseous emissions – except for NO_x – are mainly caused by the chemical characteristics of the raw materials, and not of the fuels. Other gaseous emissions such as hydrochloric acid or hydrofluoric acid are nearly completely captured by the inherent and efficient alkaline scrubbing effect of the cement kiln system, and are far below the regulatory limits.

Certain types of cement kiln configurations are not ideal for the use of secondary materials. For long dry kilns, or for kilns with preheater stages and no conditioning tower, the chloride and carbon contents of materials introduced as secondary raw materials (i.e. at the kiln back end) have to be limited and dioxin emission levels established during trial burns. Chloride compounds are seen to have a high evaporation factor. At approximately 800°C these compounds are melted and at 1,200-1,300°C they are almost entirely evaporated. Similarly, volatile organic compounds will be volatilised in the early stages of heating in a long-dry or preheater kiln. Together, the chlorides and VOC's present pre-cursors for dioxin formation, and their input into the back-end or preheater section of the kiln should be limited. A suitable limit for total Cl would be 310 mg total input (fuel and raw materials) per kg clinker produced, with the majority being fed as fuels. The effect of this on dioxin/furan formation would need to be verified during the proposed trial burns.

It is our opinion that this risk does not exist for secondary material fuels introduced at the flame-side of the kiln (the front end).

Gaseous emissions such as SO_2, VOC, CO, dioxins and furans, are to a large extent determined by the chemical characteristics of the raw materials used, and not by the fuel composition. Emissions are lowest with raw materials which are low in volatile components and injection of materials containing significant quantities of volatile components (Cl, S and carbon) should occur at the flame-side of the kiln.

The results of an air dispersion model run on De Hoek, using the self-imposed emissions inventory show negligible effects on community health. On the other hand, the EU limits for HF limits are met for SPL processing (which is a waste high in F content). As to whether these EC emissions are achievable at De Hoek, Table 5-3 shows that that compliance with the EC limits is achievable for the measured parameters, as long as input controls are maintained. It is, however acknowledged that no current emissions data exists for TOC, metals and dioxins. Dioxins and volatile metals will be managed by controlling input quantities through the sampling and analysis procedure (see Section 4.1), and TOC is expected to be controlled through the introduction of most of the organics at the same time to the kiln, where a destruction rate efficiency of 99.9999% is expected to be achieved.

Latest technology monitors are being installed at all facilities to monitor critical emissions on-line, in addition to the current dust monitors. For dioxin emissions, a sufficiently thorough monitoring campaign has been designed. Furthermore, independent auditing and reporting to authorities has been agreed to by PPC to ensure transparency regarding air emissions in particular.

Process Risks

A summary of the production and environmental risks of various input components or properties is outlined in the table below.

Table5: Production and Environmental Risks as a result of various input components or properties

Constituent or Property	Production Risk	Environmental Risk
Chlorides	Build-up in kiln system resulting in process blockages	HCl or dioxin emissions if introduced in raw material in excessive quantities, and in the presence of VOC's
Fluorides	Kiln instability due to lowering temp required to achieve sintering	HF emissions
Sulphur in fuels	Build-up in kiln system resulting in process blockages	SO_2 emissions
Non-volatile metals	Quality of clinker	None (absorbed in clinker)
Calorific Value of fuel	Too low – reduction of flame intensity Too high – overheating of kiln resulting in gas change at back-end	CO emissions (but fully oxidised in riser) None
Moisture	Weak flame and gas flow changes	None (CO fully oxidised in riser)
Fuel particle size	Slow rate of combustion & incomplete combustion	CO emissions

Risks of hazardous waste handling, storage and transport

Spills and accidents may occur wherein large quantities (up to 30,000 l per load) may be released to the soil and surface water bodies. Although the nature of these risks are the same as the risks of transportation of these waste streams to a hazardous landfill site, the risk may be amplified due to the longer transportation distances required to bring these wastes to the kiln. The nature of the 5 waste streams considered by PPC in this application do, to a degree, limit the impacts from such an incident. Paper, sludge pellets, plastic and tyre waste are considerably inert and may only present a litter/physical and visual impact on any sensitive receiving environment before being cleaned up. Pulp and paper sludges (with a high pH and corrosive in nature) and hydrocarbons (with toxic components, i.e. metals and possible PCB's, high chemical oxygen demand and flammability) present a different risk and therefore require specific emergency response plans. These will be compiled in accordance with the relevant SANS codes under the National Road Traffic Act (i.e. SANS 10232-1 to 3). Any contaminated soil arising from any clean-up exercises could be disposed of to the same kiln for which the waste load was originally intended (subject, of course, to the necessary approvals).

Variations in compositions of waste streams

The variety of possible secondary materials that could be used is vast and the composition could vary infinitely making generalization of results difficult. All additions of secondary materials to the cement kiln operation result in more complexity of process control, thereby increasing the chances of upset conditions. This will be managed partially by the cautious approach listed above, but also by the comprehensive sampling and analysis programme (prior to waste acceptance) listed in Section 4.1 of this report.

Absence of empiric models

No readily-available mathematical predictions of the fate of elements in a cement kiln exist. Most European countries use concentration limits for the pollutants in the exhaust gas from cement plants to limit the emission impact to an acceptable degree but input limits ensure operation within these limits must be obtained empirically.

Absence of previous experience besides SPL

No actual benchmark or best practice information is available in South Africa for continuous use of secondary materials, apart from the SPL used by PPC. On the other hand, PPC has been investigating secondary materials application for more than a decade. Various trial burns, DRE tests, risk analyses, and investigations by external consultants have been completed. PPC also started utilizing spent pot liners (SPL) as a secondary material on a small scale in 2001. Valuable information and data has been acquired concerning the handling, use and monitoring of secondary materials. The results from these studies mostly confirm the international findings and suitability of the use of certain secondary materials and that cement kilns can achieve the same destruction rates as purpose-built incinerators.

RECOMMENDATIONS

It is our recommendation that any authorisation for PPC to burn the secondary materials listed in this document should be granted subject to the following conditions:

Compliance with Policies

PPC comply with its own Secondary Materials Policy, as well as the ACMP Policy on Secondary Materials.

Cautionary approach

PPC may only proceed with one waste stream category at a time from trial burn to full-scale production. Only once stable operation is attained for cement production for the first waste stream, will PPC consider application of a second waste stream category (which will be one of the other 5 waste streams included in this application). This second waste stream will commence with a trial burn, following the same monitoring, measurement and auditing procedures as required. Only once authorisation is granted for the second waste stream, in addition to the first, will full-scale implementation of both streams commence. This process shall be repeated for each additional waste stream. Thus PPC shall implement a cautionary, step-by-step process of gradually adding a waste stream through the “trial burn-approval-stabilising of kiln” process before commencing the same process with another waste stream. Under no circumstances will a new waste stream be introduced without stable kiln operation (whether or not waste streams are currently being burnt), a proper trial burn and reporting to the authorities and independent audit.

Trial Burns

a) Trial burns are to be conducted prior to full-scale implementation of any new secondary material category per kiln and per waste stream.

b) The emissions from the trial burn shall be reported, and full-scale production will only commence once the emissions profile and the other conditions in this section are met.

c) For the purposes of the trial burn, PPC may perform preparation of the waste streams in order to facilitate the safe feeding and metering of such to the kiln. Such preparation will be limited to physical preparation in such a manner as to avoid the generation of noxious or offensive gases and any chemical alteration of the waste streams.

d) Given the minor quantity of wastes to be burnt in the trial burn, a dedicated storage area shall be constructed adjacent to the kiln facility according to guidelines set out by DEAT.

e) The waste streams shall be present on-site for no longer than 90 days, and residual waste not consumed in the trial burn shall be removed from site and disposed of to a suitably permitted facility within 7 days of completion of the trial burn.

f) The feeding of the waste streams to the kiln during the trial burn shall occur by means of formal and controlled feeding equipment to the kiln only. Temporary or informal conveying systems to these feed systems shall be employed only for the trial burn.

g) Full baseline and emissions monitoring, and independent auditing shall be performed and reported on to the authorities. Only once written approval of these results has been received from the authorities, may full-scale production commence.

h) If dioxin emissions measured during the trial burn warrant it, then PPC shall install suitable mitigation measures. A repeat of the trial burn employing such measures shall be performed before full-scale implementation may proceed.

i) Specific limits for compounds and elements tolerated in waste materials should be determined and published as the “Acceptance Criteria” for each kiln. This shall be submitted as part of the Trial Burn report to the authorities within 90 days of the trial burn occurring, and shall specifically be approved by the authorities prior to full-scale implementation for that waste stream commencing.

j) In order to ensure that the waste streams to be burnt in the trial burn are representative, as far as practicable, of the normal operational scenario, PPC will ensure the following:

Table 6: Waste Streams to be sourced for Trial Burn

Waste Stream	Source of Waste Stream
Waste tyres	As the chemical composition of tyres does not deteriorate significantly with time, there are no specific requirements relating to the age of the sample.
Sewage Sludge Pellets	Fresh (i.e. 1 month old) pellets shall be prepared off-site by an independent contractor/municipality from a normal sample of sewage over several days. The preparation process shall be inspected by the independent auditor for the presence of any other contaminants or pre-treatment.

Waste Stream	Source of Waste Stream
Pulp and Paper Waste:	Industrially produced paper waste will be sourced or paper waste generated at De Hoek, and prepared to the requirement of the kiln concerned.
Plastic waste:	Unrecyclable plastic waste will be sourced from municipalities after being sorted. The material will be shredded and analysed to ensure that the waste is suitable for the kiln process.
Hydrocarbon sludges and liquids:	Fresh arisings from an industrial source will be used.

k) It is important that the coal and feed material quality remains constant during the entire trial burn so as to avoid introducing any variables into the process. PPC will therefore ensure the consistency of such feed in advance (such as moisture content of feed, etc) by monitoring weather and preparation conditions.

l) During the trial burning exercise, the waste shall be fed at a constant rate, most closely resembling that of anticipated operating conditions or until a feed rate is established which complies with the predicted emissions rate.

m) No further burning of waste streams applied for in this application may occur until:

- Written confirmation has been received from the authorities to proceed with full-scale operations;
- Formal storage and feed systems have been constructed and tested on site.

Full-Scale Production

a) Secondary Materials combustion will cease if PPC is unable to meet the emissions inventory (measured as dry and at 10% O_2) as follows:

Table 7: Secondary Materials emission limits

MAXIMUM ALLOWABLE EMISSION LIMITS	
POLLUTANT	**LIMIT**
Total dust	As per current APPA permits
CO	As per current emissions
HCl	10 mg/Nm^3
HF	1 mg/Nm^3
NO_x	As per current emissions
$S0_2$	As per current emissions
TOC	10 mg/Nm^3
Cd +Tl (sum of elements)	0.05 mg/Nm^3
Hg	0.05 mg/Nm^3
Sb, As, Pb, Cr, Co, Cu, Mn,Ni + V (sum of elements)	0.5 mg/Nm^3
Dioxins toxic equivalence	0.1 ng/Nm^3

b) An automatic cut-off device must at all times be installed in the feed line of secondary materials to enable immediate discontinuation of feed during upset conditions. Feed should only be possible again once the kiln operation is stable again under normal loads. This device should be linked to a continuous carbon monoxide monitor.

c) In general, a “failsafe” design philosophy on control instrumentation should be adopted for SM utilization. Feed of secondary materials shall be cut off when instability exists or kiln stoppages occur. Secondary fuels are only utilized if the kiln is operating above 70% of kiln rated production. (This limit is only an indication, and is different from kiln to kiln and will have to be established for each kiln independently). This excludes the current practice of using waste oil for kiln start-up purposes. In most cases, waste fuels should not be used during start-up and shut-down of kilns, except where kiln temperatures are achieved to produce clinker that meets quality standards. Waste fuels should not be used during failure of the air pollution control devices (i.e. ESP at the stack of the kiln). This does not apply to CO purging.

d) When using hazardous waste such as hydrocarbons as a secondary material, dual flow measurement should be considered, to prevent undetected incorrect feed rates.

e) For quality assurance reasons, a limit for Cl content in total feed (fuel and raw material) would be 310 mg total input (fuel and raw materials) per kg clinker produced. The majority of this chlorine (i.e. > 90%) should only be used on the fuel input for preheater/calciner kilns, such as the two kilns at De Hoek, to ensure low PCDD/F emissions. This limit will, however, be reviewed subject to emissions monitoring results during trial burns and commissioning.

f) When using secondary raw materials which contain volatilisable organics, these must be fed to the kiln on the fuel path (and not on the raw material path). PPC must establish the maximum organic carbon content for all secondary materials to be considered as secondary raw materials.

g) In cases where the concentration of Cr VI exceeds the normal range found in cements made without secondary materials, leaching tests should be conducted.

h) PPC shall employ the approaches detailed in the following table to feeding the various waste streams into the kiln:

Table 8: Feed systems for Secondary Materials

Waste Stream	Method of Feed to Kiln
Waste tyres:	
	Back end of preheater of calciner kiln. Mid kiln injection of tyres to long dry kin.
Sewage Sludge Pellets:	
	Feed through main burner. In calciner of preheater kilns, the sewage sludge can be fed to secondary firing point.
Pulp and Paper Waste:	
Dry	Feed to the calciner or back end.
Plastic waste:	
Dry	Small granules fired through the main burner. Larger pellets to the back end or the calciner.
Hydrocarbon sludges and liquids:	

Waste Stream	Method of Feed to Kiln
Received in drums	Drums are decanted into a feed system that can feed the material to the back end, calciner or the main burner depending on the characteristics of the liquid or sludge.
Received in tankers	Unloaded into a liquid feeding system for use at the main burner or back end of the kiln.

Monitoring and measurement

a) A full baseline assessment shall be conducted prior to the introduction of the waste streams in the trial burn, using normal fuels (i.e. coal) and feed material.

b) No burning of secondary materials will occur post trial-burn until Opsis monitors are installed and calibrated. The Opsis monitor will measure the following parameters: NO, NO_2, SO_2, HCl, HF, CO and benzene. The Codel monitors currently installed at each stack will continue to monitor the particulates concentrations on-line.

c) Any measurement of emissions will have to be reported at a specified oxygen level (typically 10%) and dry (i.e. no water vapour). PPC will need to ensure that this is communicated to any external specialists performing such measurement, and that their Opsis on-line emission monitors will be able to accommodate such. The conversion formulae back to 10% O_2 will need to be approved by CAPCO.

d) All monitoring shall include isokinetic sampling and analysis at SANAS or equivalent accredited laboratories according to ISO, EPA or ASTM methods for the following parameters:

   i. CO, CO_2,

   ii. NO_x, SO_2,

   iii. HCl, HF,

   iv. All metals (as per standard ICP analysis) and Mercury and Thallium,

   v. Total Chromatographable Organics or TCO (which includes all VOC's and SVOC (semi-volatile organics)),

   vi. Dioxins and furans, PCB's, PAH (polycyclic aromatic hydrocarbons). This is compulsory for the baseline and trial burn monitoring, but for further monitoring, please refer to the next point (e).

   vii. Total Particulate Matter (TPM, or cement kiln dust).

   With the exception of dioxins, TCO, PCB's and PAH's (see next point), the monitoring frequency for the above, post-trial burn, will be one month after full production secondary materials co-processing ***per waste stream***, and annually thereafter. If a new waste stream is added to the secondary material programme, then the monitoring schedule resets itself, and monitoring should be performed one month after full production recommences with the new waste stream, etc.

e) TCO, PCB's and PAH measurements, given their cost, will be performed only when required, i.e. if these compounds are present in the secondary materials being fed to the kiln. Dioxin measurements will only be performed if the secondary materials contain chlorides ***or*** carbon in any quantities above detection limits, ***and*** are being introduced into the back-end (i.e. the raw material feed side) of the kiln. When dioxin measurements are required on this basis, the following dioxin monitoring schedule be adhered to for each waste stream introduced to the kiln:

   i. Before (i.e. baseline) and during the trial burn, as well as

ii. After one month of running full scale secondary materials consumption, and

iii. Annually thereafter.

f) All the above scenarios will be performed with the raw mill running and the raw mill down (in the case of in-line mill system) for the first year of sampling. The emissions monitoring exercise conducted for the baseline assessment shall be repeated for the trial burn in exactly the same fashion as for the baseline monitoring.

External audits and reporting

a) PPC shall employ an independent environmental auditor to audit the operations against the conditions of the Record of Decision and legal requirements, on the following frequency:

- During the trial burn (please refer to Section 4);
- Commencement of full-scale production;
- 6 months after commencement of full-scale production;
- One year after commencement of full-scale production, and
- Annually thereafter.

b) The scope of the audit shall cover all operations and supporting paperwork of the sourcing, sampling and analysis, acceptance, transportation, storage and preparation on site, operation, monitoring, reporting, staff training, emergency preparedness and response procedures and processes.

c) The acceptance of a new waste stream (i.e. from a new waste source, or a new waste category or type within the 5 listed in terms of this application) shall be reported to the authorities (Provincial Environmental Department) with full details regarding its source, quantity and composition 14 days prior to the planned combustion thereof.

d) All external analysis results shall be provided directly from the emissions sampling contractor to the independent auditor, along with original laboratory results. The auditor shall then compile a report on the trial burn, and provide this to the authorities within 30 days of the date of the trial burn.

Other authorisations required after trial burns but before full-scale production

a) All new applications of secondary materials not included in the list of waste materials included in this application shall be subject to a separate EIA application.

b) All relevant legal requirements must be met and specifically assessment in terms of the OSH Act concerning “Major Hazard Installation Regulations” must be submitted to the Department of Labour prior to commencing with full-scale production.

c) PPC will need to register their waste storage facilities as a Waste Disposal Site in terms of the Environment Conservation Act, 1989 (Act 73 of 1989), section 20, and ensure compliance with DWAF’s Minimum Requirements for temporary storage of hazardous waste.

d) PPC must apply for and comply with the requirements of Scheduled Process No. 39 of the Atmospheric Pollution Prevention Act of 1965 as applicable to Class 1 incinerators, subject to guidance from DEAT in terms of the APPA review process current at the time of writing.

Sampling and acceptance, transportation, handling and storage of waste streams

a) PPC shall comply with a stringent sampling and analysis protocol for all waste samples prior to acceptance, as described in Section 4.1. Specialized analytical facilities and resources for such will be required at PPC Jupiter, and PPC shall demonstrate compliance of such to SANS 17025 and SANAS accreditation of such centralised facilities. Satellite laboratories will be available at De Hoek for fingerprint confirmation. Thus an "accept-refuse" model for secondary materials based on known information concerning limits and restraints as well as principles as set out in PPC's policy should be developed.

b) Due cognizance should be given to possible incompatibility of secondary materials during handling and transport in accordance with SANS 10232-1, Annexure F. Liquid streams shall be stored separately to solid wastes. Flammable liquids (i.e. hydrocarbon sludges) shall be stored separately to substances with a high oxidizing potential. Waste streams with toxic components (such as metals, PCB's) shall be stored separately from other toxic waste streams.

c) Where hazardous wastes are to be used as secondary materials, assessment of all their safety & health hazards will be required and MSDS information will be compulsory.

d) Procedures governing the transportation of hazardous waste will be compiled in accordance with the relevant SANS codes under the National Road Traffic Act (i.e. SANS 10232-1 to 3). These procedures, as well as the Sampling and Acceptance Procedure detailed in section 12, shall be included in all audits recommended by this report.

e) The appointment of the waste transport contractor shall be subject to the contractor complying with the following:

- Compliance with all requirements of the National Road Traffic Act and associated SANS codes for Transportation of Dangerous Goods.
- All Emergency Response equipment as stipulated in the Transport Emergency Card (as prescribed by SANS 10232-4) shall be carried on the vehicle.
- All drivers carry a Professional Driver's Permit and are trained in HAZMAT response.
- All documentation relevant to the load is accurate and complete.
- The contractor has contracted adequate emergency response facilities along the route from the Generator to the PPC plant.
- All placarding and emergency information relevant to the load is displayed by the transport contractor.

f) Establish suitable and safe transfer systems from transportation to the storage area to avoid SHEQ risks from spillage such as fugitive emissions or vapour displacement. Suitable vapour filtration and capture equipment should be in place to minimize impact to the reception point and surrounding areas from unloading activities.

g) Assure that storage facilities fit their purpose. Appropriate storage for liquids should meet relevant safety and design codes for storage pressures and temperatures.

h) Solid materials handling systems should have adequate dust control systems.

i) Storage design should be appropriate to maintain the quality of the materials: for solids, prevent build-up of old materials; for liquids, mix or agitate to prevent settlement, etc.

j) Design transfer and storage areas to manage and contain accidental spills into rainwater or firewater, which may be contaminated by the materials. This requires appropriate design for isolation, containment and treatment. Appropriate storage for liquids should have adequate secondary containment.

k) There should be written procedures and instructions in place for the unloading, handling, and storage of the solid and liquid fuels and raw materials used on site.

l) Designated routes for vehicles carrying specified fuels and raw materials should be clearly identified within the site.

m) Appropriate signs indicating the nature of materials should be in place at storage, stockpiling, and tank locations. Storage halls should be fitted with water sprinkler systems and be vented to control accumulation of solvent vapours (which could be sent to the kiln).

n) Tanks containing hydrocarbons should be fitted with an explosion safety device. Additional devices may be considered such as atmosphere control (e.g. N_2 inertisation) and temperature control (e.g. shell cooling), etc. depending on the results of the HAZOP study.

o) Equipment should be grounded and appropriate anti-static devices and adequate electrical devices selected (e.g. motors, instruments, etc.).

p) All dry material should be stored in protected warehouses and liquid material in engineered and bunded storage facilities. In particular, transfer of wastes from the transporter should occur within an enclosed or bunded area.

q) Emergency Response Plans will be developed for any accidents and incidents, and spill kits should be maintained on-site.

r) The storage areas of hazardous waste should be as close to the points of application to the kiln as possible, but far enough away to prevent being heated by the radiant heat from the kiln and to allow truck delivery access.

s) Pumps and piping systems for liquid and sludge transfers should be able to tolerate varying viscosities and solid particles (or filters should be installed to remove such). Adequate maintenance of these pumping systems needs to be performed to prevent pipe bursts.

t) Transfer of dry materials (especially paper, sewage pellets and plastic) should be enclosed to prevent wind-blown litter.

u) Only pre-sorted or waste that does not require separation will be accepted.

v) The general principles of storage and handling are detailed in Table 12.4.

Table 9: Storage guidelines for specific waste streams

Waste Stream	Storage Facility	Environmental Risk
Waste tyres:		
	Whole Tyres Stock pile on a walled concrete slab with storm water control Tyre chips Stockpile in open, walled bunkers on a concrete slab. Ensure proper storm water runoff.	Fire risk, and for whole tyres, rodents and mosquitoes.
Sewage Sludge Pellets:		
	Store in a dry ventilated place under roof on concrete floor. Ensure fugitive dust control. Keep away from water	Fire risk, soil and surface water contamination Self heating when in contact with water

Waste Stream	Storage Facility	Environmental Risk
Pulp and Paper Waste:		
Dry	Store in a dry ventilated place under roof on concrete floor. Ensure fugitive dust control. Keep away from water.	Dust (occupational), Litter, Surface Water
Wet	Will not use due to high moisture content.	Surface Water and Soil contamination
Plastic waste:		
Dry	Stockpile in open bunkers on a concrete bed. Ensure proper storm water runoff.	Dust (occupational), Litter, Surface Water
Wet	Will not use due to high moisture content.	Surface Water and Soil contamination
Hydrocarbon sludges and liquids:		
Received in drums	Store in a dry ventilated place under roof on concrete floor.	Fire, explosions, air emissions (VOC's), contaminated soil and surface water
Received in tankers	Well designed tank installation with bunds, fire protection and water management system.	

HAZOP studies

a) The HAZOP studies should be concluded prior to trial burns commencing. These studies would apply for all possible facility/material combinations envisaged and rolled down to plant level for further detailed investigation.

b) Specific sources of secondary materials should be used as a second level HAZOP study, once the generic study has been completed.

Staff training and awareness

Appropriate training and certification in hazardous operations for new workers and sub-contractors should be given before commencement of co-processing.

Occupational Health and Safety

a) Air monitoring: A measurement programme must be established to determine the airborne concentration of any hazardous chemical in the workplace. This programme should include an air quality survey which is to be performed by an approved independent inspection authority in order to determine whether occupational exposure limits (OEL) are exceeded. The prescribed OEL's of substances is part of this Act under Regulations for Hazardous Chemical Substances, 1995.

b) Medical surveillance: Where employees may be exposed to potentially hazardous chemical substances, a comprehensive medical surveillance programme must be established.

c) Respiratory zone: Where OEL's may be exceeded in the workplace, a clearly demarcated zone should exist where the use of suitable respiratory equipment is compulsory.

d) Record keeping: Apart from the records of the previously mentioned required programmes, i.e. training, air quality surveys and medical surveillance, a complete record of all material safety data sheets (MSDS) should be kept.

e) Adequate personal protective equipment should be made available to employees and contractors, and to individuals visiting the installation. Its use should be required. This includes but is not limited to: helmet, glasses, gloves, hearing protection, safety shoes, respiratory protection, and other protective equipment specified in the Safety Data Sheets.

f) Storage areas should be kept clear of uncontrolled combustible materials. Clear safety warnings, no smoking, fire, evacuation route, and any procedures signs should be posted.

g) An emergency shower and eye washing station should be clearly marked and located near the storage of liquid alternative fuels.

h) A fire protection system must be available at all times and should meet all standards and specifications from local authorities (e.g. local fire department).

i) Adequate alarms should be provided to alert all personnel about emergency situations. Communications equipment (e.g. telephone) should be maintained at the site so that the site control room and the local fire department can be contacted immediately in case of a fire.

j) Adequate systems and procedures should be in place to minimize the risk of unauthorized access to hazardous materials used on-site.

k) Carefully consider plant layout to ensure access for day-to-day operations, emergency escape routes, and maintainability of the plant and equipment.

l) Modifications to installations and equipment shall be documented.

m) Automated handling equipment should be used wherever possible.

n) Special procedures, instructions, and training should be in place for such routine operations as:

- Working at height, including proper tie-off practices and use of safety harnesses;
- Confined space entry where air quality, explosive mixtures, dust, or other hazards may be present;
- Electrical lock-out, to prevent accidental reactivation of electrical equipment undergoing maintenance, and
- “Hot works” (i.e. welding, cutting, etc.) in areas that may contain flammable materials.

Emergency response plan

A plan shall be developed prior to the trial burns which:

a) Identifies potential spill or contamination areas;

b) Defines clean-up procedures;

c) Identifies areas of high risk on site or in the local community;

d) Provides written instructions in the event of an emergency;

e) Documents equipment required in the event of an emergency;

f) Assigns responsibilities to employees and local officials;

g) Details emergency response training requirements, and

h) Describes reporting and communication requirements both within the company and with interested external stakeholders.

i) The emergency response plan shall be reviewed with relevant external emergency services.

j) Emergency drills shall be arranged with the local community emergency response services to ensure a coordinated response under emergency conditions.