NATIONAL POLLUTANT INVENTORY

KALGOORLIE NPI TRIAL

Department of
Environmental Protection

**WESTERN AUSTRALIAN DEPARTMENT OF
ENVIRONMENTAL PROTECTION**

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Foreword

The Kalgoorlie NPI Trial to test the parameters of the National Pollutant Inventory (NPI) in a regional mining environment has been a successful partnership between Environment Australia, WMC Resources Limited and the Western Australian Department of Environmental Protection.

The trial results provide a comprehensive picture of the emissions of NPI substances within the Kalgoorlie region. These emissions were estimated from major industrial sources, as well as minor sources, including motor vehicles, aircraft, locomotives, commercial premises and households. Members of the community in Kalgoorlie now have access to information that not only gives them a greater understanding of sources of pollution in their local environment, but also enables them to see how they contribute to those emissions.

The challenges faced and overcome by the trial participants in complying with the NPI reporting process have helped pave the way for a smooth introduction of the NPI in other parts of Australia. The trial tested methodologies and emission factors presented in a range of Emission Estimation Technique Manuals during their development phase. It provided a realistic appraisal of these manuals from a user perspective. In many of the facilities, results obtained using emission factors were compared with direct monitoring data, highlighting areas where further work on emission factors is required. Results from the trial also gave an indication of emission sources that were found to be very significant and those which had a much lesser impact.

The transfer of wastes within the region were investigated and emissions were estimated against the full reporting list of 90 substances, providing a useful source of information for a future review of the NPI National Environment Protection Measure.

On behalf of the Department of Environmental Protection I would particularly like to thank the industries of Kalgoorlie for volunteering to participate in the trial and for their generous help and co-operation. The Department is also grateful for the contribution from other government departments, schools and non-government organisations.

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Executive Summary

The National Pollutant Inventory (NPI) is a database that is being developed to provide information on emissions of pollutants to air, land and water. It is being developed by the Commonwealth, States and Territories on a co-operative basis through the National Environment Protection Council (NEPC). The Kalgoorlie NPI Trial was a partnership between WMC Resources, the Western Australian Department of Environmental Protection and Environment Australia. This trial followed other NPI trials that have been conducted in Newcastle, Port Pirie, Dandenong, Launceston and South-East Queensland.

The purpose of the Kalgoorlie NPI Trial was to develop and test all the parameters of the proposed NPI in a mining environment. The trial was conducted over a 1600 square kilometre area centred on the twin mining cities of Kalgoorlie-Boulder. The population base of approximately 31,000 people is almost entirely confined within an 18 square kilometre region. Nickel and gold mining and processing are the major regional activities and they are supported by a well-developed infrastructure.

The study estimated point source and aggregated emissions for the full NPI reporting list of 90 substances for the six-month period from July to December 1998. As the study was conducted in a semi-arid region that did not contain a permanent watercourse, it was only possible to estimate emissions to air and land. An attempt was also made to estimate the transfer of wastes for all 90 NPI substances.

A separate consultancy was let to undertake the aggregated emissions and transfers estimation study. Their findings are presented in a separate report (Coffey, 1999), although the emission results derived from that study are included in the data analysis section of this report. The estimation of aggregated emissions included mobile, area-based, biogenic and natural sources. These emissions were found to be a significant component of the total emissions within the region. Information on transfers of wastes from non-reporting and sub-threshold facilities was very limited and the consultants concluded that a comprehensive estimate of transfer activity from these sources could not be made at this time.

The four mining companies that participated in the trial were WMC Resources, Kanowna Belle Gold Mines, Kalgoorlie Consolidated Gold Mines and Normandy Kaltails Pty Ltd. The other types of facilities within the region that triggered the NPI reporting threshold and elected to participate in the trial included; power stations (2), fuel storage depots (4), a sewage treatment plant, a regional hospital, an asphalt plant and a quicklime producer. A range of approaches were required to identify the NPI reporting facilities including:

- Searching for licensed and registered premises on the DEP licence database;
- Discussions with DEP staff at the Goldfields Regional Office;
- Searching Worksafe boiler registrations;
- Discussions with Western Power staff about power generation plants in the region;

- Analysis of a report “Information Relating to the Emission, by NSW Industry, of Pollutants on the Draft NPI Reporting List” produced for the NSW EPA by AN MEA (1997);
- A study of the Kalgoorlie-Boulder Community Business Directory listing of businesses in the region;
- Discussions with chemical suppliers on industry types that used specific NPI chemicals; and
- A Yellow Pages Internet search on industries for a given industry sector.

The largest of the facilities in each industry type was identified and then visited in order to determine if they triggered the NPI reporting threshold. Only 20 facilities in Kalgoorlie were found to be NPI reporters. There was a high participation rate in the trial (80%).

The level of staff resources required to estimate the emissions of NPI substances from mining operations was significantly higher than initial expectations. The identification and estimation of emissions required intimate knowledge of the particular operations, and the involvement of environmental, metallurgical, electrical, chemical and stores staff at the respective mine sites was critical. The lack of mining staff resources in particular was responsible for delays in submission of emissions data, resulting in delays to the completion of the trial. The trial team coordinated the approach and provided support by way of interpretation of the relevant Emission Estimation Technique manuals and decision paths to be followed for the purposes of the trial. The mining companies were generally reluctant to directly involve the trial team in emission determinations, as this required access to company records and possibly sensitive information. A consultant was engaged by a number of the participating mining companies and they in effect acted as a third party, providing the resources and expertise required to estimate the emissions.

The environmental staff at each mining operation were ultimately responsible for NPI reporting. It was necessary for them to become familiar with as many as 8 different Emission Estimation Technique Manuals in order to identify and estimate all NPI emissions from their facility. The complexity of estimating emissions from mining sites was found to be far more than an issue relating to the overall scale of the operation. During the process of attempting to comply with NPI reporting a large number of questions were raised in relation to the application of emission estimation techniques and interpretation of the NPI Measure. The trial team and mining environmental staff were required to make many assumptions in order to “best estimate” the emissions.

The estimation of emissions from non-mining operations although not straightforward was comparatively easy and in most cases was done by the trial team, with the relevant information being provided by the company manager.

The trial attempts to present an overview of the difficulties and problems encountered in complying with NPI reporting in a mining environment, rather than the specific details of minor issues. For example, the best method of estimating PM_{10} emissions from a conveyor transfer point has little meaning if the whole methodology of estimating fugitive PM_{10}

emissions is flawed. In addition attempts were made to identify the emission sources that were significant and highlight those that could be ignored because the emission was negligible or within the error band of the larger source. Also, where possible a comparison was made between direct monitoring data and emission estimates obtained using emission factors found in the Emission Estimation Technique Manuals.

Conclusions and Recommendations

The trial team arrived at a number of conclusions through experience gained in identifying and estimating NPI emissions, from discussions with the trial participants, and from an analysis of the emissions data. The main conclusions were as follows:

1. The reporting facilities were found to be the major source of estimated SO_2, NO_X and PM_{10} emissions in the study region. They were also a significant source of CO emissions, but made a negligible contribution to the regions total VOC emissions. However, the area-wide fugitive PM_{10} emissions could not be estimated and therefore were not included in the aggregated estimation.

2. There were no emission factors for many of the NPI substances. Of particular concern are the 2a and 2b substances:

   2a Substances: fluoride, hydrochloric acid, and PAHs.
   2b Substances: chromium (VI), magnesium oxide fume, nickel and compounds, nickel carbonyl, nickel subsulfide, polychlorinated dioxins and furans.

3. The EET manuals were found to contain some gaps, providing no emission factors for about 25% of the NPI substances that triggered reporting (particularly substances only in Table 2 of the NEPM). It seemed extremely difficult for a facility to report on those particular emissions, without undertaking extra monitoring. However, the “missing” emission factors were generally for emissions considered to be minor or insignificant at their facility. These particular emissions were also likely to be expensive to estimate by direct monitoring. A number of the emission estimation techniques provided were found to be difficult to apply as they required either broad assumptions to be made or there was an implied reliance upon sample analysis or direct measurement. The emphasis in the manuals was on emissions to air and a more detailed discussion on emissions to land and water would be beneficial.

   Recommendation: Reconsider the requirement for facilities to report on emissions for substances that do not have an emission factor provided in the relevant manuals. The emphasis should be to further develop the manuals.

4. The category 2b reporting threshold for energy consumption (60,000 MWhrs) or potential power consumption (20 MWs) was confusing. The 2a and 2b substances tend to relate to emissions from the combustion of fuels. Clearly the facilities are required to report only emissions generated at their site and not emissions relating to the electricity consumed on site, but generated elsewhere. Some facilities however, have interpreted

this threshold incorrectly and sought emission details from their power supplier for the enery consumed at their site. This approach leads to double counting and a false indication of the source of those particular emissions. Large solar energy or wind generated power stations could also trigger this threshold as it is currently worded and be required to report combustion type emissions.

Recommendation: Modify the 60,000 MWhr energy consumption and 20 MW potential power consumption threshold to:

- **specify onsite generation of electricity only;**
- **to capture a particular type of operation, such as electric arc furnaces; and**
- **clarify references to "energy" in the definition.**

5. The cost for mining operations to comply with NPI reporting was substantial, being approximately \$20,000 - \$50,000 and involving up to 600 hours in staff time. For non-mining facilities the cost was only \$1,000 - \$2,000 and approximately 20 hours of staff and trial team time. Reporting cost are expected to be significantly lower in successive years once the process for data collection has been established.

6. The staff at most mining facilities did not believe the work load required to identify and estimate emissions for the full reporting list of 90 substances (Table 2) to be significantly greater than for the 36 substances (Table 1). This was partly due to the fact that a reasonable proportion of the "table 2 only" substances were not estimated because emission factors were not available.

7. The transfer of wastes by the reporting facilities was found to be mostly limited to the NPI components of waste oils and greases, scrap steels, sewage pond sludge and effluent water. The transfers of wastes from mine sites to landfill were not speciated, as resources were fully committed to emissions estimations. No specific large transfer of waste was identified as taking place during the trial, although large consignments of waste lead and arsenic trioxide are known to be transferred occasionally.

Recommendation: Investigate transfers further before considering their inclusion in the NPI.

8. Industry expressed concern about submitting data that they did not consider to be sufficiently accurate. Emission estimations by direct monitoring were generally felt to be a far more rigorous methodology than the use of emission factors. In spite of the NPI Measure stating that no extra monitoring is required, industry believed there was a need for direct measurement to ensure the data was reliable and to validate the emission factors that have been provided in the manuals.

9. The estimation of fugitive dust generated PM_{10} emissions at mine sites required considerable resources, requiring up to 85% of the overall effort in emissions estimations. The numbers generated could be considered as a guess or at best, order of

magnitude estimates only. The estimations cannot be validated without long term direct monitoring, but vastly different results were obtained when using a range of emission factors and methodologies presented in the manuals. It was also not possible to obtain area-wide estimates of fugitive dust PM_{10} emissions to place the facilities emissions in context. Particulate emissions from combustion sources were considered to provide more meaningful data.

> **Recommendation: Consider estimating particulate emissions from combustion sources only at this stage or report them separately to fugitive dust generated PM_{10} emissions. Further direct monitoring studies are required to determine the validity of fugitive dust PM_{10} emission factors.**

10. The participating mining companies were not required to estimate the transfer of NPI substances to their Tailing Storage Facilities (TSFs). A desktop study on transfers to and emissions from TSFs was conducted by a consultant and will be reported separately. During the course of the trial it became apparent that emissions from TSFs were extremely difficult to estimate with sufficient accuracy and results obtained generally appeared low. However, transfers to the TSFs were found to be comparatively easy to determine. All of these NPI substances transferred are either emitted from the TSF, degrade or remain in the TSF at the end of its life. It is expected that the mining industry will need to demonstrate a better application of existing environmental data to meet NPI reporting requirements. Consideration may need to be given to other ways of dealing with TSFs and the best methods of reporting to the community.

11. The mining facilities were found to trigger reporting mainly through; fuel burning, metal content of ores handled, fuel storage and the usage of cyanide and acids. A total of about 20 – 30 NPI substances were reportable.

12. NPI substances are contained within a myriad of products found within the stores inventory. It proved to be unnecessary to collate all the NPI components within minor supplies to determine NPI triggers and emissions. It is considered beneficial from a staff resource perspective, to apply a filter on the stores inventory so that only the larger stores items containing significant quantities of NPI substances are included in trigger and estimation calculations.

> **Recommendation: Consider filtering out the minor NPI stores items from the trigger and emission estimations. Stores items with say an annual usage of less than 100 kilogram's and containing less than 10% of NPI substances could be excluded from the facilities' estimations.**

13. Defining a "facility" in the context of a mining operation that covers all possible situations was found to be difficult. The trial team has provided a definition that can be applied to give general guidance, but some situations will require individual discussions with mine site staff in order to agree on the facility boundary.

14. Emissions from diesel storage were found to be negligible when compared with the more volatile fuels such as petrol. The definition adopted by the trial team for VOCs excluded diesel due to its relatively low vapour pressure. As the determination of total VOCs using the “Tanks” programme is complex and time consuming, it should only be used where VOC emissions are significant.

    Recommendation: Reconsider the need to estimate the reporting of total VOC emissions to air from diesel storage tanks, except for large installations, say with capacity greater than 25,000 tonnes of diesel.

15. The bulk fuel storage depots were not required to report total VOC emissions as their design capacity was below 25,000 tonnes (Measure, clause 10.2). These facilities were however, found to exceed the 10 tonne reporting threshold for specific VOC components contained within the fuels, such as benzene and toluene. It was necessary to determine total VOCs as a first step to estimating component VOC emissions from these facilities. For consistency bulk fuel storage depots should be treated similarly to fuel storage installations at mine sites or power stations and the design capacity threshold should be removed (for non-diesel fuels).

    Recommendation: Consider removing the 25,000 tonne design capacity threshold for reporting total VOC’s from bulk storage depots unless diesel is the only fuel stored.

16. The “Austanks” programme produced unreliable emission estimates when compared with the “Tanks” programmes. “Austanks” was no help in speciating total VOC emissions into individual component VOC emissions (eg benzene and toluene). “Tanks” was also unreliable in this regard, leaving facility occupiers to speciate emissions using complex algorithms that were not covered in the EET Manual for Fuel and Organic Liquid Storage. Consequently, the bulk fuel storage facility occupiers may need to rely on the parent fuel companies to estimate their emissions for them.

    Recommendation: Austanks should not be used by facilities to estimate total VOC emissions.

    Recommendation: The development of a spreadsheet would be beneficial to facilitate the speciation of total VOC emissions into component NPI VOCs that are contained within “Typical Australian Fuels”.

17. NPI definitions are required for total VOCs, PAHs and polychlorinated dioxins and furans. The definitions of these substances are open to interpretation and facilities need clear guidance to ensure a consistent approach to reporting.

    Recommendation: Define total VOCs, PAHs and polychlorinated dioxins and furans for NPI reporting.

18. Many smaller facilities operating boilers will trigger the 2a threshold. The Combustion in Boilers EET Manual is reasonably difficult to use and contains US terminology. Some smaller facilities are not likely to have in-house expertise to estimate emissions.

    Recommendation: **Staff within each jurisdiction need to develop a reasonable understanding of the Combustion in Boilers EET Manual in order to help small facilities comply with NPI reporting requirements.**

19. Facilities generally found completing Worksheet 3 a repetitive task. The “Substance Emission Information” may better be presented in a table arrangement to facilitate reporting of numerous substances. An electronic report form is likely to be the best long-term option.

    Recommendation: **Streamline the current report sheet and progress development of an electronic reporting tool for facilities.**

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WMC Resources – Kalgoorlie Nickel Smelter
Kalgoorlie Consolidated Gold Mines
Kanowna Belle Gold Mines
Normandy Kaltails
Kalgoorlie Regional Hospital
Western Power Goldfields Power Station
Parkeston Power Station
Loongana Lime
City of Kalgoorlie- Boulder Sewage Treatment Plant
Boral Asphalt
Kalgoorlie Shell Fuel Depot
Kalgoorlie Ampol Fuel Depot
Kalgoorlie Mobil Fuel Depot
Kalgoorlie BP Fuel Depot

The trial team would also like to thank PPK Environment & Infrastructure Pty Ltd and Coffey Geoscience Pty Ltd for their contribution.

Abbreviations

ABS	Australian Bureau of Statistics
AIP	Australian Institute of Petroleum
AMG	Australian Map Grid
AMIRA	Australian Mineral Industries Research Association Ltd
ANZSIC	Australian New Zealand Standard Industrial Classification
BMS	Business Management Systems (WA) Ply Ltd
BP	British Petroleum
CB	Combustion in Boilers
CE	Combustion in Engines
CME	Chamber of Minerals and Energy (WA)
DEP	Department of Environmental Protection (WA)
EAD	Equivalent Aerodynamic Diameter
EEA	European Environment Agency
EET	Emission Estimation Technique
EF	Emission Factor
EFR	Emission Factor Rating
FFEPG	Fossil Fuel Electric Power Generation EET Manual
F&OLS	Fuel and Organic Liquid Storage EET Manual
GOP	Gold Ore Processing EET Manual
HMAM	Hot Mix Asphalt Manufacturing EET Manual
HAP	Hazardous Air Pollutant
KBGM	Kanowna Belle Gold Mines
KCGM	Kalgoorlie Consolidated Gold Mines
KNS	Kalgoorlie Nickel Smelter
KRH	Kalgoorlie Regional Hospital
L&DM	Draft Lime and Dolomite Manufacturing EET Manual
LL	Loongana Lime
MSDS	Material Safety Data Sheet
NA	Not Applicable
NCS&R	Nickel Concentrating, Smelting and Refining EET Manual
ND	No Data
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
NGO	Non-Government Organisations
NK	Normandy Kaltails Pty Ltd
NPI	National Pollutant Inventory
PAH	Polycyclic Aromatic Hydrocarbons
PP	Parkeston Power
PPK	PPK Environment & Infrastructure Pty Ltd
PR	Petroleum Refining EET Manual
S&WT	Sewage and Wastewater Treatment EET Manual

PPSS	Photochemical Smog Study
TSF	Tailing Storage Facility
TSP	Total Suspended Particulates
VOC	Volatile Organic Compounds
WMC	WMC Resources Ltd
WP	Western Power
WWTP	Wastewater Treatment Plant
USEPA	United States Environmental Protection Authority

Definitions

Acceptable Reliability: The emission has been estimated using an EET approved by the relevant environmental authority or obtained from the appropriate EET manual.

Aggregated Data: Refers to quantities of NPI substances emitted from non-point sources such as petrol stations, dry cleaners, vehicles etc. The State Authority, or consultants working on their behalf estimate these emissions. Aggregated emissions are useful for placing point source emissions in context.

Anthropogenic: Originating from human sources or activities.

Contextual Data: Provides background information about individual NPI substances such as the:

- the Chemical Abstract Series Registered (CASR) number of the substance and common synonyms and product names for the substance;
- chemical characteristics and intrinsic properties of these substances;
- the health and environmental effects of the substance, including toxicity profiles, environmental impacts, likely fate and transport of the substance, in the environment, and other relevant effects;
- information on common uses of the substances including products or processes reliant on the substance; and
- information on common anthropogenic and other sources of the substance. toxicology, environmental effects etc.

Criteria Pollutants: VOC, CO, NO_X, SO_2 and PM_{10} .

Emission Factor Rating Code: An emission factor rating system developed by the USEPA and the European Environment Agency (EEA) and is included in some EET manuals. The rating relates to the degree of certainty that a given emission factor is representative of the source type. The main criterion affecting the uncertainty of an emission factor is the degree of similarity between the equipment/process selected in applying the factor and the target equipment/process from which the factor was derived. The EFR system is:

A – Excellent
B – Above Average
C – Average
D – Below Average
E – Poor
U - Unrated

Emission: Release of a substance to air, land or water.

Facility: Any building or land from which a substance may be emitted, together with any machinery, plant, appliance, equipment, implement, tool or other item used in connection with any activity carried out at the facility; and includes an offshore facility.

PM_{10}: atmospheric suspended particulate matter having an aerodynamic equivalent diameter of less than approximately 10 microns. Particles in this size range make up a large proportion of dust that can be drawn deep into the lungs. Larger particles tend to be trapped in the nose, mouth or throat.

Reporting List: Table 2 of the NPI NEPM.

Reporting Threshold: A facility can trigger NPI reporting for a given substance by exceeding an annual usage threshold, fuel consumption threshold or in the case of N and P, an emission to surface waters threshold.

Total VOC: Total Volatile Organic Compounds were defined as:

> *Any organic compound which participates in atmospheric photochemical reactions. These organics include all carbon-containing compounds except methane, carbonates, metallic carbides, carbon monoxide, carbon dioxide and carbonic acid. The compounds have a vapour pressure greater than 1mm of mercury at 25 degrees Celsius.* (Carnovale, 1998).

Transfer of Wastes: The transfer of wastes was defined as:

- The deposit of wastes into landfill;
- Discharges of wastes to sewers; and
- Any other removal of wastes from a facility for the purposes of disposal, treatment, recycling, reprocessing, recovery or purification.

Trial Team: The Western Australian Department of Environmental Protection staff working on the Kalgoorlie NPI Trial.

Use: The use of a substance is defined in the Measure as the handling, manufacture, import, processing, coincidental production or other use of the substance.

1 Introduction

1.1 Background to the National Pollutant Inventory

Information on emissions of pollutants to air, land, and water in Australia is currently limited, inaccessible or unavailable to the public. The National Pollutant Inventory (NPI) will provide improved information on these emissions to assist better environmental management by government, industry and the community. The overall objectives of the NPI are to catalogue and detail the types and amounts of pollutants entering different areas of the environment, to enable trends in these emissions to be identified and to highlight areas where data gaps exist. This improved information will help provide the policy basis for measures to improve the Australian environment through the reduction of pollutant releases to the environment. The National Pollutant Inventory aims to:

- Provide information to enhance and facilitate policy formulation and decision-making for environmental planning and management;

- Satisfy the communities right-to-know through the provision of publicly accessible and available information, on a facility-specific and catchment basis, about specified pollutants released to the environment, especially those pollutants of a hazardous nature or involving significant impact; and

- Promote and facilitate waste minimisation, cleaner production, and energy and resource savings programs for industry, government, and the community.

The Inventory is being developed by the Commonwealth, States, and Territories on a co-operative basis through the National Environment Protection Council (NEPC), a statutory body with legislative powers. A draft National Environment Protection Measure (NEPM) for the National Pollutant Inventory was issued by the NEPC for public discussion in June 1997. Following the public consultation process, a revised draft of the NEPM was issued for further comment. Based on this series of comments, the amended NEPM was then submitted to the NEPC for ratification and was endorsed by Council in late February 1998.

Under the NPI, there is a requirement for occupiers of facilities that trigger a reporting threshold, to submit emissions data that will be displayed on the NPI public database. Emissions from all other sources (aggregated data) are estimated by each jurisdiction in order to provide a complete inventory of emissions in a given air shed or water catchment. Whilst individual emissions from aggregated sources may be relatively minor, collectively they can be a significant contributor of pollutants into the receiving environment.

1.2 Trial Purpose

The Kalgoorlie NPI Trial was a partnership between WMC Resources Ltd (WMC), the Western Australian Department of Environmental Protection (DEP) and Environment Australia (EA). The trial had two purposes –

- The major purpose was to develop and test all the parameters of the NPI in a regional mining environment. As such the trial was to include point source and aggregated emissions to air, land and water.

- The secondary purpose was to provide information that could be utilised during the October 1999 review of the NPI NEPM. The trial therefore included the full NPI reporting list of 90 substances (Table 2 of the NPI NEPM, see Appendix A) and the transfer of waste materials.

This project follows NPI air emission trials that have already been successfully conducted in Newcastle, Dandenong, Port Pirie and Launceston and the fully integrated trial in South-East Queensland. Methodologies developed by these trials and the Perth Photochemical Smog Study (PPSS) were followed and further developed where possible.

1.3 Study Area

The trial was conducted over a 1600 square kilometre region, centered on the twin mining cities of Kalgoorlie-Boulder. The study area is located in the Goldfields region of Western Australia, approximately 600 kilometres east of Perth (see Figures 1 and 2). The geographical boundary for the trial was set to ensure the inclusion of all major industries and mining operations in the region that were considered to have the potential to impact upon Kalgoorlie-Boulder by their emissions to air, land or water.

The study region has a population of approximately 31,000, and is almost entirely located within the Kalgoorlie-Boulder township area of about 18 square kilometers. The township owes its existence to the discovery of gold in the 1890's and continued growth in the 1960's, due to the discovery of nickel. The nickel and gold mining industries continue to be major activities supporting the infrastructure. Kalgoorlie is well serviced by approximately 2200 commercial complexes and is the center for the regional and interstate road and rail network. Local government authorities within the region are the City of Kalgoorlie-Boulder and the Coolgardie shire.

Figure 1: Kalgoorlie Trial Study Area Location

Figure 2: Kalgoorlie-Boulder Study Area, Facility Locations

The region is best described as semi-arid, having an average annual rainfall of only 260 mm per annum. Vegetation in the area is mostly limited to saltbush, woodland and scrubland. There are no permanent water courses in the region and the community is dependant upon potable water being piped from dams in the Perth water catchment. Gribble Creek is the main watercourse in the region and although normally dry, it can carry a large quantity of water for short periods of time after cyclonic rains or the occasional thunderstorm. Waters drain into Hannan’s Lake, a normally dry salt lake located approximately 10 kilometres south-east of Kalgoorlie-Boulder. The area is naturally dusty and on occasions can be a significant background source of particulate emissions.

1.4 Project Structure

The project was a partnership between WMC Resources (WMC), the Western Australian Department of Environmental Protection (DEP) and Environment Australia (EA). The trial was managed by the DEP and jointly funded by WMC and EA.

The DEP Director – Pollution Prevention Division was the project owner and a Project Manager was appointed to coordinate and oversee the trial. WMC’s Environmental Advisor – Nickel, was initially nominated to liaise with the DEP and EA and to project manage all aspects of the trial relating to WMC. A steering committee was formed with a representative from each of the project partners.

The structure of the trial is shown in Figure 3.

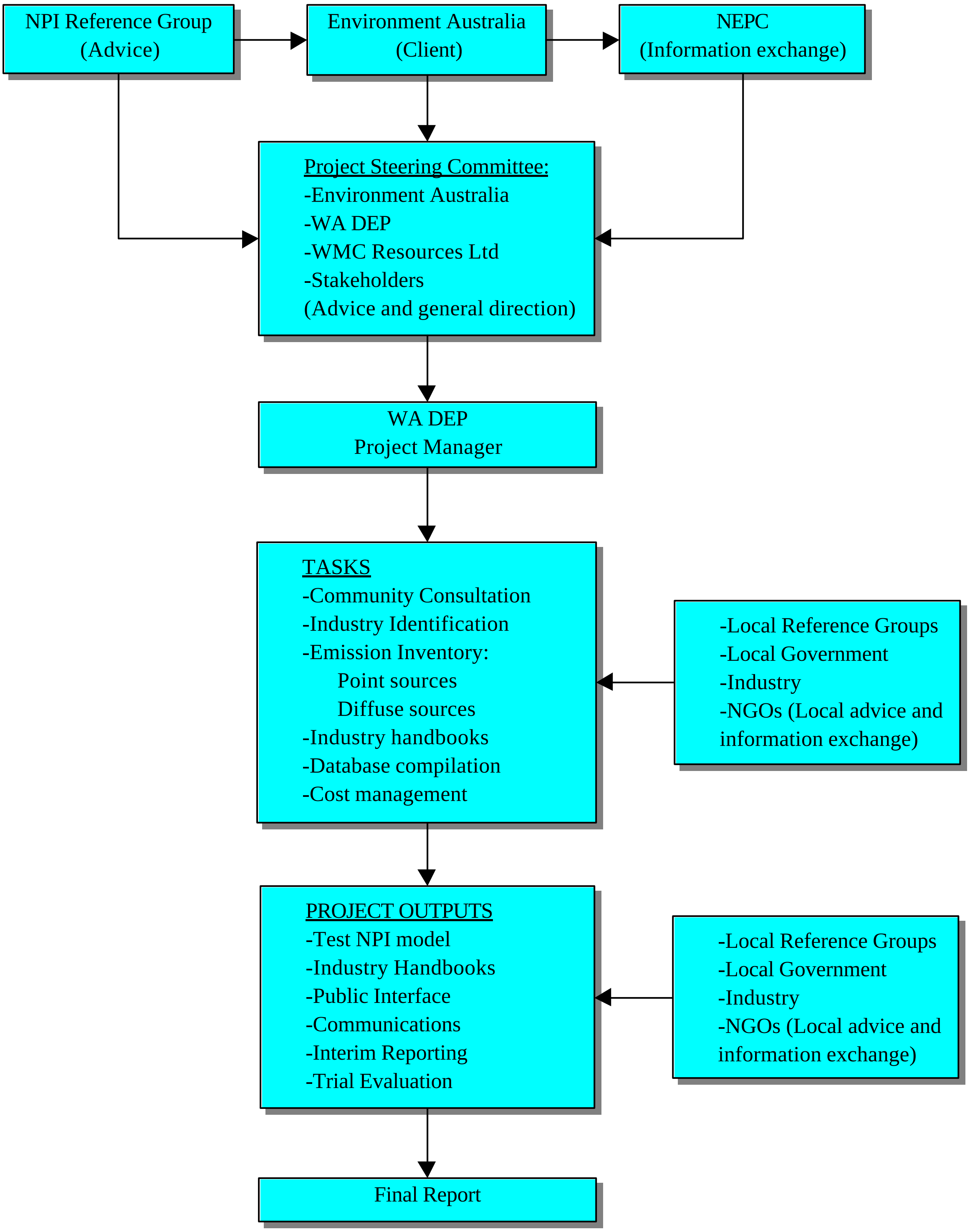

Figure 3: Kalgoorlie Mining Trial Structure

(Modified from VIC EPA, 1996)

1.5 Project Scope

1.5.1 Point Source Emissions

The nickel and gold mining companies in the Kalgoorlie region that expressed initial interest in participating in the trial were Kalgoorlie Consolidated Gold Mines (KCGM), Kanowna Belle Gold Mines (KBGM), Normandy Kaltails (NK) and the project partner WMC. Non-mining operations located within the study area and found to trigger the reporting threshold were also invited to participate in the trial. Participation in the trial was on a voluntary basis, relying on the good will of the companies approached. There was an expectation of these companies that involvement would better prepare them for NPI reporting as well as be an opportunity to provide feedback on the NPI from their perspective

1.5.2 Aggregated Emissions

Aggregated emissions were estimated for each square kilometre grid of the 1600 square kilometre study region, providing a context for the point source emissions. It was also an opportunity to test the current estimation methodologies in a regional mining environment. Aggregated emissions included the following components:

- Mobile Sources – motor vehicles, off-road vehicles, locomotives and aircraft.
- Area Based Sources – households, commercial premises, exempted and sub-threshold facilities.
- Natural Sources – vegetation and soils.

A consultancy was let to Coffey Geoscience Pty Ltd (Coffey) to perform the aggregated emissions work.

1.5.3 Emissions and Transfers Data

The emissions estimated in this study were to air and land only. Although the region has a well-developed water catchment, it is normally dry and as such emissions directly to water are a rare occurrence. The NPI does not consider the subsequent fate of emissions, as would be the case after a significant rainfall event in the catchment. Eutrophication is not considered an issue in regions without permanent watercourses and the modeling of nitrogen and phosphorus fates is expected to be complex and unnecessary.

Transfers of wastes for the trial were defined as:

- The deposit of wastes into landfill;
- Discharges of wastes to sewers; and

- Any other removal of wastes from a facility for the purposes of disposal, treatment, recycling, reprocessing, recovery or purification.

The discharge into or the contents of tailings storage facilities (TSFs) were excluded, although emissions from them were reportable.

Emissions and transfers of wastes were for the full NPI reporting list of 90 substances as per Table 2 of the NEPM (see Appendix A).

1.5.4 Timing

The project commenced in April 98 after receiving approval for Commonwealth funding and was anticipated to take 16 months to complete. Emissions data for point source emissions was collected for a six month period from July 1998 to December 1998. Aggregated emissions were estimated for the full 12 month period from July 98 to June 99. However, only aggregated emissions data for July 1998 to December 1998 was forwarded for display on the trial database so that a direct comparison could be made with the point source emissions data.

1.5.5 Cost

EA and WMC funded the project to a maximum of $420,000, as well as $50,000 in-kind support from WMC. The budget for the project wages component for the DEP Kalgoorlie Trial staff was estimated to be $188,000. A further $29,900 was provided by the Commonwealth to develop Emission Estimation Technique Manuals for the nickel and gold industry.

1.6 Project Objectives

The primary purpose of the Kalgoorlie Mining Trial was:

> *"To develop and test all the parameters of the proposed NPI in a mining environment."*

The subsidiary objectives originally identified in the trial project proposal were as follows:

- Assess the value and effectiveness of newly developed industry handbooks for the mining and other relevant local industry and seek industry expertise to modify these handbooks or recommend the development of new industry handbooks if required;
- Develop a collaborative transparent process with project partners, the community and local industry through the implementation of the trial;
- Explore the issues and difficulties associated with the reporting of transfers data.

The tasks identified to meet the project objectives being:

- Refine the methodology for identifying the specific industries that are likely to trigger NPI reporting thresholds;
- Refine the methodology for distribution of the NPI Facility Report Form and subsequent data collection from the facilities;
- Test the adequacy of the existing DEP database to process NPI data, and to recommend/develop the appropriate infrastructure and process;
- Test the interface between the DEP database and Environment Australia's network;
- Evaluate the cost of the trial with a view to estimating the cost and level of resources required for implementation of the NPI throughout the State;
- Evaluate the cost and requirements of the mining and related industries to attain the proposed NPI reporting standards;
- Investigate emissions from non-combustion particulate sources (PM_{10} emissions);
- Investigate emissions from tailings dams; and
- Investigate the transfers of wastes.

1.7 Deliverables

The major project deliverables specified in the project proposal include:

- Purchase of an NPI server to ensure sufficient network capacity to operate a NPI database within the DEP;
- Partly fund the upgrade of the licensing database to Oracle to facilitate data transfer between licensing and NPI databases;
- A tailings study to better understand emissions and transfers associated with tailings storage facilities;
- A particulates study to provide information on background PM_{10} emissions in order to place the point source emissions in context;
- A transfers study that tests the concept of including a transfers of wastes component in the NPI NEPM in the future;
- Develop new industry handbooks to help the mining industry meet NPI reporting requirements;
- Transmit emissions data to ERIN, testing the interface with the Commonwealth's database;
- Forward an initial set of NPI emissions data and submit a progress report; and
- Forward all emissions data (point source and aggregated) and submit a final report.
- During the course of the trial it was agreed that trial funds be used to develop a series of spreadsheets to complement the relevant EET manuals for the mining industry.

Subsequent agreement was obtained from the Kalgoorlie Trial Steering Committee that the Aggregated Emissions Data and Report would be accepted as the initial data set and progress report.

2 Project Methodology

2.1 Identification of Reporting Facilities

At the commencement of the project, the trial team had little understanding about the size or types of industries in Kalgoorlie-Boulder that would trigger the NPI reporting thresholds. The process used to identify reporting facilities was:

1. Determine which industry sectors or Australian New Zealand Standard Industrial Classification (ANZSIC) codes of industry used significant quantities of NPI substances.

2. Contact a representative sample from each industry sector in order to determine the largest operations within the study area. The company managers generally had a good understanding of the relative sizes of industries and business in their industry sector and were able to direct us to the largest facility.

3. Visit the largest facilities in each industry sector to establish approximate quantities of NPI substances used in a year.

Most businesses identified in Kalgoorlie as using NPI substances proved to be well below the reporting thresholds. Approximately half of the reporting facilities were large industries or mining operations and were already subject to DEP licensing. Some of the types of industries identified as being potential NPI reporters are listed in Table 1. Other businesses contacted were clearly below the reporting thresholds and could be discounted as being potential reporters, after a cursory visit or quick phone call.

A range of approaches were necessary to locate potential reporting facilities. They are outlined in the following section.

Table 1: Small Industries in Study Area

INDUSTRY	SIZE	SUBSTANCES	QUANTITIES	COMMENTS
Asphalt Plant	700 tonnes per week of product. (36,000 tonnes per year)	-LPG -Diesel/kero. mix -Settling pond solids and waste asphalt	- 60-80 tonnes/yr - 1200 litres/yr - 150 tonnes/week	Information on stack emissions required. Triggered on total VOC's.
Concrete Manufacture		-Particulates	- Unknown	Dusty operation.
Carbon Stripping	2 employees	-Cyanide -LPG -Diesel -Carbon Waste	- 2 tonnes/yr - 20,000 litres/yr - 12,000 litres/yr - 20 tonnes/yr	Emissions from carbon stripping and carbon waste required
Abrasive Blasting		-Particulates -Paints -Thinners -Diesel (compressor)	- 288 tonnes/yr spent garnet - 3500 litres/yr - 2400 litres/yr - 24000 litres/yr	Spent garnet can have a variety of contaminants e.g. Red lead. Some facilities enclosed with bag filter.
Laundry & Dry Cleaner	5 employees	-LPG -Tetrachloro-ethylene	- 14.3 tonnes/yr - Unknown	Not visited
Laundry		-LPG -Wash Water	- 120 tonnes/yr	
Drum Steam Cleaning	2 employees	-Diesel -Wastewater	- 2 tonnes/yr Mostly fuel & oil contaminants	Water runs into licensed pit & evaporates or seeps into ground.
Explosives Manufacture		-Diesel burner -Ammonium -nitrate -Diesel (ANFO) -Emulsifier (heavy oil)	- 150 tonnes/yr - Confidential	Raw materials incorporated into product, spillage recovered as stored on concrete pad.
Bakery		-Diesel -Boiler inhibitor	- 50,000 litres/yr - 200 litres/yr	detergent based cleaning agents used
Bakery		-LPG -Diesel -Lubrication (vegetable oils)	- 40 tonnes/yr - 45,000 litres/yr - 2400 litres/yr	Alkali based floor cleaner, wash water down leach drain
Slaked Lime Industry	2 employees			Lime in sealed units until slaked, no dust

Table 1: Small Industries in Study Area (cont.)

INDUSTRY	SIZE	SUBSTANCES	QUANTITIES	COMMENTS
Motor Vehicle Repairs		-LPG -Thinners -Hydrocarbons -Fiberglass resin -Helacryl (polymeric isocyanate & -hydrocarbons) -Paints	- 2.2 tonnes/yr - 2000 litres/yr - 120 litres/yr - 240 litres/yr - 500 litres/yr - 120 litres/yr	LPG used for baking oven, no waste oils, old metal car parts to tip
Powder Coating	1 employee	-Hydrocarbons -Fluoride salts -Petroleum spirits	- 60 litres/yr - 60 litres/yr - 140 litres/yr	
Chrome Plating		-Chromic trioxide -Sulfuric Acid	- 0.6 tonnes/yr - Insignificant	Liquid waste to liquids tip, solids retreated in Perth
Printing		-Mineral Turps -Hydrocarbons	- 200 litres/yr - 200 litres/yr	Changed chemicals recently
Hospital	400 employees	-Acetone -Glutaraldehyde -Lead -Methanol -Phosphates -Xylene	- small quantities - small quantities - small quantities - small quantities - small quantities - small quantities	The hospital triggered reporting on fuel consumption.
Domestic Cleaning	130 employees (full/part time)	-Ethylene glycol	- Insignificant	Safety data sheets available & viewed
Rubber Splicing	30 employees	-Acetone --Trichloro-ethylene	- 1 tonnes/yr - 5tonnes/yr	50 meters of waste rubber goes to the tip each year.

2.1.1 Successful Methodologies

1. Licensed Premises

A search was conducted on the DEP Licence Database to obtain a listing of the facilities in Kalgoorlie that were either licensed or registered. The department's licensing database contains the details of all Works Approvals, Registrations and Licences held by the DEP. The large mining and industrial operations in the region were licensed and triggered NPI reporting, but registered facilities were found to be below the reporting threshold. The distinction between licensed and registered premises is as follows:

- Licensed Premises - Premises that are licensed are subject to an annual fee and have certain licence conditions on their operations. Conditions can address monitoring requirements including emission discharges. Premises that are licensed are those considered from experience to have the greater potential to pollute.

- Registered Premises - Premises subject to registration are not subject to an annual fee or site specific environmental conditions. Control is through regulations for their industry type eg Environmental Protection (Fibre Reinforced Plastics) Regulations 1998.

2. Kalgoorlie DEP

Discussions were held with DEP staff at the Goldfields Regional Office to identify the large operations in the region, as well as, any whose emissions had been the subject of complaints by the community.

3. AN MEA Report

A report titled "Information Relating to the Emission, by NSW Industry, of Pollutants on the Draft NPI Reporting List" was produced for the NSW EPA in 1997 by AN MEA Environmental Management Services. This report provided a list of anthropogenic sources and the corresponding ANZSIC code for each NPI substance (draft NPI Reporting List). The report was analysed to obtain the total listing of industry sectors (by ANZSIC code) that were likely to be a source of NPI substances. A business Register Count for Kalgoorlie-Boulder was obtained from the Australian Bureau of Statistics (ABS). They provided a search on the number and size (by employee numbers) of industries in the study zone for each ANZSIC code. The results are shown in Table 2.

Unfortunately individual facility details were confidential and this information was not available from ABS. The ABS data therefore only provided an overview of the number of facilities in the study area that could be considered potential NPI reporters. The ABS data was for a given post code or shire rather than Australian Map Grid (AMG) zones and as such did not accurately reflect the study region. The business statistics were expected to be reliable, as they are all located within the township, which lies within both the study region and Kalgoorlie-Boulder Shire. The mining industry numbers however, are likely to be incorrect due to the poor correlation between the two areas. Businesses contacted following this methodology were generally found to have quantities of substances well below the reporting threshold.

4. Fuel Consumption – Boilers

A search was conducted to determine if industries with onsite boilers trip the fuel usage threshold. Boilers from non-mining operations are registered with Worksafe, while the Department of Mines maintains a register of boilers, turbines and furnaces located at mining facilities. As the mining operations were already known from DEP licence records, only the Worksafe listing was pursued. The only non-mining facilities in Kalgoorlie-Boulder with registered boilers were:

Table 2: Kalgoorlie ABS Data (derived from AN MEA, 1997)

Code	DESCRIPTION	EMPLOYMENT SIZE					
		<5	5-9	10-19	20-49	50-99	> 100
1314	Gold Ore Mining	28	2	2	2	4	2
1319	Metal Ore Mining[1].	1					
1511	Petroleum Exploration	1					
2161	Bread Manufacturing		1		1		
2179	Food Manufacturing[1].	1					
2313	Timber Resawing & Dressing	1					
2323	Wooden Structural Component Manufacturing	2					
2329	Wooden Product Manufacturing	3					
2412	Printing	3					
2413	Services to Printing	1	2				
2421	Newspaper Printing or Publishing		1		1		
2532	Industrial Gas Manufacturing	1					
2533	Synthetic Resin Manufacturing	1					
2541	Explosive Manufacturing	1					1
2549	Chemical Product Manufacture[1].	1					
2559	Rubber Product Manufacturing[1].			1			
2610	Glass & Glass Product Manufacturing	1					
2621	Clay Brick Manufacturing	1					
2633	Concrete Slurry Manufacturing	1		1			
2634	Concrete Pipe & Box Culvert Manufacturing	1					
2635	Concrete Product Manufacture[1].	1					
2640	Non-Metallic Mineral Product Manufacturing	4		1			
2711	Basic Iron & Steel Manufacturing	1					
2729	Basic Non-Ferrous Metal Manufacturing						1
2741	Structural Steel Manufacturing	2					
2742	Architectural Aluminum Product Manufacturing			2			
2759	Sheet Metal Product Manufacturing[1].	1	1	1			
2762	Spring & Wire Product Manufacturing	1					
2769	Fabricated Metal Product Manufacturing[1].	15	1	1			
2819	Automotive Component Manufacturing[1].	2	2				

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[1] Not classified elsewhere.

Table 2: Kalgoorlie ABS Data (derived from ANMEA, 1997) (cont.)

Code	DESCRIPTION	EMPLOYMENT SIZE					
		<5	5-9	10-19	20-49	50-99	> 100
2824	Aircraft Manufacturing	1					
2841	Computer & Business Machine Manufacturing			1			
2851	Household Appliance Manufacturing	1	1				
2854	Electric Light & Sign Manufacturing			1			
2859	Electric Component Manufacturing[1].			1			
2862	Mining & Construction Machinery Manufacturing	3	1		2		
2864	Machine Tool & Part Manufacturing	1			1		
2866	Pump & Compressor Manufacturing		2				
2869	Industrial Machinery & Equipment Manufacturing	3	1				
2921	Wooden Furniture & Upholstered Seat Manufacturing	3					
2949	Manufacturing[1].	1	1				
3610	Electric Supply		1		1		
4111	House Construction	26	1				
4121	Road & Bridge Construction	1			1		
4122	Non-Building Construction [1].	6	2	1	1	1	2
4232	Electric Services	27	4	1			
4233	Air Conditioning & Heating Services	4	2				
4259	Construction Services[1].	4	2		2		
4521	Petroleum Product Wholesaling	4	2	1	1		
4523	Chemical Wholesaling	2					
4799	Wholesaling[1].	4	2	2			
5269	Household Equipment Repair Services [1].	1					
5329	Automotive Repair & Services[1].	37	9		1		
6110	Road Freight Transport	59	9	2	4		
6630	Services to Air Transport	1	1				
6709	Storage[1].	4					
7111	Postal Services	2					
7810	Scientific Research	2					
7823	Consulting engineering Services	38					
8611	Hospitals (Except Psy Hospitals)	1					
8621	General Practice Medical Services	1					
8622	Specialist Medical Services	6					

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[1] Not classified elsewhere.

- Bakery (2);
- Hospital;
- Laundry (2); and
- Drum steam cleaning.

The hospital was subsequently found to use sufficient fuel to trigger the category 2a threshold. The other facilities were all well below this reporting trigger.

5. Western Power
Western Power provided information on their power generating equipment and the contacts for other privately owned power-generating operations in the region.

6. Kalgoorlie-Boulder Chamber of Commerce & Industry
The local Chamber of Commerce & Industry produced a Community Business Directory that provided a comprehensive list of businesses in Kalgoorlie-Boulder. Although no new reporting facilities were identified from the listing it was a useful source of information for developing the aggregated emissions study.

7. Chemical Suppliers
Three chemical supply agents were identified in the region. One of the suppliers provided useful information on the types of industries that used specific NPI chemicals.

8. Yellow Pages Search
A yellow pages search on website (http://www.yellowpages.com.au) provided limited information on the identification of industries for a nominated industry sector in Kalgoorlie. A total of 50 companies were listed when searching for “mining company” in “Kalgoorlie”.

9. Minedex
A Department of Mines database, “Minedex”, included the site coordinates of mining operations and was useful in identifying which mines were actually located in the study region.

2.1.2 Unsuccessful Methodologies

1. Telstra Business Finder
The Telstra business finder provides a listing of premises in Australia and includes their ANZSIC code and location. A facility search can be conducted by ANZSIC code for a given region. While the concept is good, the data is poor and it appears to have been set up with little understanding of the code. No distinction was made between the manufacture, retail or distribution industry sectors when the code was applied. A typical example of the

poor level of information is the listing of 22 industries in Kalgoorlie as being a source of nickel carbonyl, including fencing contractors and a diesel service centre.

2. Transport of Dangerous Goods

The Department of Minerals and Energy database (DEXIS) has a listing of about 2000 different chemicals, although it is mostly restricted to flammable liquids. To trigger on the database a company must store over 0.5 tonne. Although acetone is used in reasonable quantities as industrial surface coatings, thinners and solvents, no company appeared to hold sufficient in storage to register on the database.

2.1.3 Reporting Facilities

All companies identified as reporting facilities eventually decided to participate in the trial, with the exception of two assay laboratories and one mining operation. Occupiers of these facilities elected not to be involved, due to insufficient staff or a concern that competitors may be able to benefit once knowing their NPI emissions and transfers data. The staff at the assay laboratories believed competitors could estimate their market share from the quantity of waste lead transferred, by calculating the number of lead assay determinations performed.

It was also decided not to seek involvement of a newly constructed nickel processing plant that was being commissioned during the trial.

The other companies all agreed to participate, particularly if they felt there was an opportunity to comment and voice any concerns or make recommendations that may help smooth the NPI implementation process.

The following companies were identified as NPI reporting facilities and kindly agreed to participate in the trial:

- WMC Resources Ltd, Kalgoorlie Nickel Smelter[1]
- Kalgoorlie Consolidated Gold Mines[1]
- Kanowna Belle Gold Mines[1]
- Normandy Kaltails[1]
- Kalgoorlie Regional Hospital
- Western Power Goldfields Power Station[1]
- Parkeston Power Station[1]
- Loongana Lime [1]
- City of Kalgoorlie- Boulder Sewage Treatment Plant[1]
- Analabs Assay Laboratories[2]

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[1] DEP Licensed Premises

[2] Emissions subsequently not estimated

- Shell Fuel Depot
- Ampol Fuel Depot
- Mobil Fuel Depot
- BP Fuel Depot
- Boral Asphalt

2.2 Aggregated Emissions

The estimation of the aggregated emissions within the study region was seen as an important component of the trial, particularly by the mining industry, as it enabled emissions from reporting facilities to be viewed in context. The somewhat isolated regional city was seen as an excellent opportunity to verify the accuracy of the methodologies presented in the range of NPI workbooks developed by the Queensland trial.

Consulting expertise was sought to estimate the aggregated emissions with a view to building upon the existing methodologies used in previous inventories. There was limited prior knowledge about transfers of wastes, particularly from non-reporting facilities. It was expected that the consultant’s findings would provide direction and a basis for methodologies to be followed, should transfers eventually be incorporated into the NPI.

The “Aggregated Emissions Study” investigated emissions in each of the three following categories:

1. Mobile Sources:
    - Motor vehicles;
    - Aircraft;
    - Locomotives; and
    - Off-road vehicles.

2. Area-Based Sources:
    - Domestic and commercial / light industrial fuel combustion;
    - Surface coatings and thinners;
    - Service station and refueling;
    - Domestic/commercial solvent use and degreasing;
    - Lawn mowing;
    - Domestic/commercial aerosols use;
    - Sub-reporting facilities – solvent and process emissions;
    - Natural gas leakage;
    - Cutback bitumen;
    - Domestic waste combustion; and
    - Dry cleaning.

3. Natural Emissions:

- Biogenic VOCs;
- NO_X from soils; and
- Fugitive PM_{10}.

The findings from the aggregated emissions study have been reported separately (Coffey, 1999), although the aggregated emissions data have been included in the “Analysis of Results” section of this report.

2.3 Data Base Development

During the development phase of the trial (Nov 1997) there was an understanding that a NPI/Licensing database would be required by the DEP. It was expected that there would be a high degree of overlap between NPI facilities and licensed premises and that much of the demographic data would be common. The existing licensing database had been developed in 4D. A proportion of the trial funds ($50,000) was therefore devoted to partly funding the rewriting of the licensing database in “Oracle” so that the NPI data requirements could then be encompassed in the new system. Incorporating the NPI and Licensing components into the one database was also seen as having the advantage of providing a reality check on the NPI emissions data by enabling easy comparison with the licence information.

Oracle Corporation (Australia) Pty Ltd was engaged to undertake an analysis in order to define the project scope and cost of developing an Oracle Designer/2000 NPI/Licensing database. The total project cost was expected to be approximately $135,000 and the traditional approach outlined in Table 3 was recommended.

Table 3: Data Base Development Process

Phase	Detail
Definition and Analysis	• Confirmation of project mechanics • Confirmation of the data model • Confirmation of the functional requirements • Confirmation of technical environment • Definition of Entity-Relationship and Function-Hierarchy diagrams in Oracle Designer/2000 • Definition of strategies for data conversion, interfacing, archiving, backup/recovery etc
Design	• Definition of Data Model in Oracle Designer/2000 • Definition of Module Definitions in Oracle Designer/2000
Build	• Generation of Oracle data model • Generation of screens and reports • Generation/Development of business rules • Development of utilities • Development of interfaces
Transition	• Conversion of data • Development of documentation • Delivery of training
Production	• Go live • Monitor progress

The “Definition and Analysis” phase of the project was completed at a cost of $19,635 and the findings were presented as a Functional Specification that outlined the process to develop the database.

As the trial unfolded and the NPI developed it became clear that it would be premature to develop a local NPI/Licensing database at this stage for the following reasons:

- There was minimal overlap between NPI facility and Licensed premise information including demographic information;
- There were differences between NPI facility and Licensed premise boundaries;
- The functional specification indicated that the development of the NPI/Licensing database would now be significantly more expensive than the original quotation;
- There was no urgency to proceed as the reporting tool developed by ERIN was found to successfully store and transmit reporting facility data and the aggregated emissions data was successfully forwarded in a text format (combination of tagged file and tab delimited format); and
- Canberra’s database structure was not final and changes were likely to be made to the storage of aggregated emissions data and context and substance tables.

Oracle Corporation advised that we pursue a cheaper option and recommended the services of Business Management Systems (WA) Pty Ltd. (BMS). A range of options were provided that utilised the MS Access Reporting Tool and a mirror of Canberra's database, along with the inclusion of a data query tool to analyse and graphically display the NPI data. BMS recommended waiting for ERIN to finalise their database structure before proceeding. To proceed independently at this stage could result in an incompatible system that would require further work to modify the Oracle scripts. There may also be duplication of work that may be undertaken by Canberra. At this stage the only apparent outstanding requirement for the NPI data is the provision of a query tool. A National approach to this would be advantageous so that it can be tied in with any ongoing modifications or upgrade of the NPI database

2.4 Community and Industry Consultation

2.4.1 Background

The project objectives within the Kalgoorlie NPI Trial Project Proposal included the following subsidiary objective:

> *"develop a collaborative transparent process with project partners, the community and local industry through the implementation of the trial."*

This section outlines how this objective was addressed.

2.4.2 Local Industry

As the primary focus of the trial was to test the NPI in a mining environment, the bulk of consultations involved the trial team and participating mining companies. During the data collection phase, meetings were held bi-monthly in Kalgoorlie. These meetings served as a forum for:

- Technical problems with the various mining EET manuals;
- Interpretations of the Measure and NPI Guide; and
- General issues associated with data collection, emissions estimation and reporting.

A "Log of Issues" was compiled from issues raised during these meetings and can be found in Appendix B.

On-going meetings with the individual non-mining reporting facilities were held throughout the trial. In most cases the trial team ultimately estimated the emissions from these sites. Where this was the case, the following steps were followed:

- Discuss operational processes with facility manager;

- Identify substances triggered and input variables required in order to determine emissions;
- Data collection by facility personnel (usually the manager);
- Estimation of emissions by the trial team, including where possible comparison of emission factors (EFs) with direct monitoring data; and
- Data accuracy check and completion of worksheets by facility personnel.

Throughout the reporting process, facility operators were asked a series of questions relating to:

- cost and resources required to report;
- problems and issues that arose during reporting;
- personnel involved in reporting;
- evaluation of the relevant EET manuals;
- possible extra monitoring required to complete reporting;
- process followed to determine the triggering of thresholds;
- transfers of wastes; and
- reporting worksheets.

A copy of the questions typically asked of facilities during the reporting process is contained in Appendix C.

The consultants undertaking the aggregated emissions study, (Coffey), contacted many of the small industries in the study area in an attempt to determine emissions from these non-reporting facilities. This was seen as an important process in helping to raise the awareness of the NPI within the business community of Kalgoorlie-Boulder. In addition, the local Chamber of Commerce and Industry, and the Kalgoorlie-Boulder City Council were informed of the consultant’s activities.

2.4.3 Industry Associations

Chamber of Minerals and Energy (CME)

The CME was involved throughout the trial with the development of the Nickel Concentrating, Smelting and Refining EET Manual, the Gold Ore Processing EET Manual and the mining spreadsheets, as well as, being informed of trial progress through the steering committee minutes. They were also provided with the log of issues that evolved from meetings between the trial team and mining companies.

Australian Institute of Petroleum (AIP)

The trial team had discussions with the AIP during the early phases of securing project partners. The talks aimed to try and ascertain a standard industry approach to reporting. Whilst this was not achieved as part of the trial, the trial did aid in clarifying the issues faced by the petroleum companies in reporting for the NPI and hopefully present some possible solutions.

2.4.4 Schools

The trial team approached two schools and a tertiary institution located within the study area for inclusion in the trial. All agreed to participate. Their inclusion was an attempt to raise awareness of the NPI and highlight the possibility of the database being used as a learning tool by students at high school, TAFE, or University.

The institutions outlined below, all acted as complete reporting facilities and all emissions associated with the running of the schools were taken into account. This included emissions from:

- power stations used to generate electricity;
- vehicles and buses used to transport the students and teachers to and from school;
- lawn mowing; and
- chemicals used in the school laboratories and workshops.

Curtin University of Technology

Discussions were held with academic staff at Curtin’s Technical College, about the possibility of using the NPI reporting process as a teaching tool for Environmental Chemistry students. This proposal was well received and the college agreed to participate in the trial, acting as a mock reporting facility. Estimations by the students included the distances travelled to and from the college each day. This information was used to determine vehicle exhaust emissions associated with the college.

Two presentations on the NPI were given to the students over the study period. The first was an introductory talk by Curtin’s Environmental Technology lecturer, the second was presented by trial participants at Kanowna Belle Gold Mine and covered data collection methods as well as a critique of the NPI.

When the database is launched, Curtin will have their own location on the internet, providing an incentive for students and staff to visit the site.

High Schools

Principals and teachers at the two high schools, John Paul College and Eastern Goldfields Senior High School, were notified of the NPI. Following discussions about the potential uses of the NPI as a learning tool for the students, it was agreed that both schools would act as mock reporting facilities and have their emissions data displayed on the trial database. This was an effective way of raising awareness of the data base within the community and providing incentive for students to visit the site.

2.4.5 General Public

A proportion of the public was directly introduced to the NPI via the Coffey Aggregated Emissions Study. One hundred Kalgoorlie-Boulder residents were contacted by phone in order to obtain an estimate of the emissions from households. Respondents were informed of the purposes of the NPI and the role that their answers would play in the whole NPI framework.

A greater level of public interest is anticipated subsequent to the public launch of the trial data on the NPI database.

2.4.6 Press Releases

The key NPI messages used in press releases were:

- Community right to know.
- Environmental aid to planning for government and industry.
- Promoting waste minimisation, cleaner production, and energy and resource savings.
- Internet Access to environmental information.
- DEP - WMC collaboration.

A copy of a press release printed in The Kalgoorlie Miner on 20 June 1997 is in Appendix D. Two trial articles were included in the May 1999 NPI Update and another one featuring the Launch is planned for the next NPI Update. An article was also run in the DEP Environmental Protection News.

2.5 Handbook Development

The need for a uniform approach in estimating the emissions of the participating mining companies was recognised at the commencement of the trial. This led to the development of two EET manuals, one for Gold Ore Processing (GOP) and the other for Nickel Concentrating, Smelting and Refining (NCS&R). These manuals formed a basis for testing methodologies, with the view to improving and refining the approaches recommended.

Estimation of emissions from gold and nickel processing operations was not available from the USEPA AP-42 website or from other known sources of information. A consultant familiar with the mining industry was contracted to develop EET manuals for the nickel and gold industry. Expertise was sought from environmental and metallurgical staff from both within the industry and from industry regulators. “Industry Reference Groups” or working parties were formed to draw upon a range of expertise and to collectively develop methodologies that incorporate the best available emission factors. The mining companies and organisations involved in the development of the manuals are listed in appendix E.

Environmental monitoring associated with TSFs is currently focussed on impact identification and operation of pollution control features. Additional interpretative work will be required to attempt to adopt such information to suit NPI reporting formats.

The approach taken was to proceed with the development of the required methodologies and emission factors. However, there is likely to be a reasonably high degree of uncertainty involved in formulating appropriate emission factors to suit the diverse TSF circumstances encountered throughout the Australian minerals industry.

Some sections of the mining industry and associated peak bodies expressed strong interest to minimise these uncertainties. Their view was that estimating emissions from TSFs with any degree of accuracy was extremely difficult at this stage due to:

- The complex nature of chemical reactions taking place in the tailings dams; and
- The variable nature of tailings solids and mineralogy of the TSF base material.

The expectation is that NPI reporting will initiate further studies to better quantify these processes, leading to refinements in the techniques and improvements in emission factors. Long-term studies (2 year) initiated by Australian Mineral Industries Research Association Ltd (AMIRA) are currently underway and are expected to provide a greater understanding of applying NPI reporting formats for TSF emissions.

The NCS&R and GOP EET Manual development process experienced similar difficulties to those encountered during the development of the Mining EET Manual. During the process of identifying NPI reporting substances and developing emission estimation techniques a number of complex broader NPI issues surfaced and were constructively debated with mining companies and their peak bodies. While valuable, this communication phase led to delays in the completion of the manuals. However, it was apparent that the onus to comply with NPI reporting resides with the facility occupier and the development of the manuals would help facilitate this reporting process. Although information on emission estimation techniques was limited, the manuals were completed as “best endeavors” to collate emissions information that were available from the nickel and gold industry and government sources.

3 Kalgoorlie Reporting Facilities

An overview of the operation of each reporting facility, along with their emissions data and the study findings at their particular site is presented in the following sections of the report. A summary table of emissions from all facilities is presented in Section 14. The emphasis of the trial was on the mining operations and as such the nickel smelting operation and three gold mining operations are presented separately. Non-mining reporting facilities that fall into a similar category, such as power generation, have been grouped together.

Kalgoorlie NPI Trial Reports have kindly been submitted by Kanowna Belle Gold Mines, Normandy Kaltails Pty Ltd and Kalgoorlie Consolidated Gold Mines and are presented in their entirety as an addendum to this report. The main issues presented in their reports have been summarised in the following sections of this report, along with conclusions and recommendations that have been formed by the trial team during the course of the trial. The sections entitled “Industry Comments” have been provided by the companies involved and are **not necessarily** the view of the trial team. Comments from mining companies relate to “draft versions” of some EET manuals and issues may have been addressed prior to their final publication.

All data is for the six month period from 1 July 98 to 31 December 99. The facilities however, were deemed to trigger NPI reporting based on 12 months of operation. Emissions data has been reported to three significant figures for consistency. However, in many cases the accuracy of the data is unknown or poor. Some emission factors presented in the manuals were found to give order of magnitude estimates only. Emissions were reported as zero if an emission factor was not available in the relevant EET manual and there was considered to be no other means of estimating the emission apart from undertaking direct measurement. A number of facilities provided emission estimates for NPI substances that didn’t trigger the reporting threshold, in order to help provide a more comprehensive overview of emissions from their particular facility.

It should be understood that each industrial process and scale of operation is quite different and care must be taken if comparing emissions data. It should also be noted that some of the trial participants appear to be relatively high emitters of certain substances within the study region. In some instances this can be attributed to diligent reporting by that particular facility, while other facilities were either not able to estimate or possibly underestimated the emission of those particular substances.

As the trial was voluntary, the data was generally accepted as provided, even if emissions data from some sections of a particular operation was missing or not all the supporting information was available. The trial team was also not always in full agreement with the approach that was taken and main differences are discussed in the report. An attempt was made to undertake a “sensible” approach to the estimation of emissions. There was general agreement that it would be a poor use of resources to estimate minor fugitive emissions that were clearly within the error band of large point source emissions.

The trial team was closely involved in emissions estimation from non-mining facilities and generally performed the emission factor (EF) calculations on their behalf. There was less direct involvement with the estimation of mining company emissions. The trial team met regularly with the participants in Kalgoorlie to discuss issues and provided advice by phone on methodologies to be followed. However, the team was not privy to the records and data required for the determination of emissions. Also the input required for a mining facility to comply with reporting was significant and beyond the resources and ability of the trial team. It was essential to draw upon the expertise of staff intimately familiar with the operations.

The mining companies while committed to the trial, also found the project to be greater than anticipated and mostly lacked the staff resources required, particularly at a time of down turn within the mining industry. A number of the participants decided to draw upon the expertise of a consulting company (PPK), who was familiar with the EET manuals and the gold industry. PPK worked with the trial team and the mining companies to complete the task.

The list of trial reporting facilities was as follows:

- Kalgoorlie Nickel Smelter
- Kalgoorlie Consolidated Gold Mines – Fimiston Plant[1]
- Kalgoorlie Consolidated Gold Mines – Gidji Roaster[1]
- Kanowna Belle Gold Mines
- Normandy Kaltails
- Kalgoorlie Regional Hospital
- Western Power Goldfields Power Station
- Parkeston Power Station
- Loongana Lime
- City of Kalgoorlie- Boulder Sewage Treatment Plant
- Analabs Assay Laboratories[2]
- Boral Asphalt
- Shell Fuel Depot
- Ampol Fuel Depot
- Mobil Fuel Depot
- BP Fuel Depot

The results and study findings for each of these facilities are presented in the following sections of the report.

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[1] KCGM operations treated as two facilities.

[2] Emissions not estimated.

4 WMC Resources

A detailed report will be submitted by WMC Resources Ltd at a later date.

4.1 Background

WMC’s Kalgoorlie Nickel Smelter (KNS) is located 13 km south of Kalgoorlie and consists of four separate process plants:

- A flash furnace that operates at about 1350^0C and separates nickel from the iron and sulfur components of the nickel sulfide concentrate;
- A Sulfuric Acid Plant that converts sulfur dioxide emissions from the flash furnace into sulfuric acid;
- An Effluent Treatment Plant where weak acid and wastewater is processed and recycled; and
- A Water Recovery Plant that was not operational during the trial.

4.2 Methodology and Trigger Determination

WMC estimated their emissions in-house and appointed a study team to identify emission sources, collect data, determine the appropriate emission technique and calculate the emissions. The team included the Environmental Manager (Nickel & Gold), Environmental Advisor–Projects, Safety Environment and Quality Manager, and the site Environmental Scientist. Additional technical advice was also obtained from senior production personnel.

A total of 35 substances triggered the reporting thresholds.

A total inventory from the stores database was obtained to identify products or materials that contained NPI substances. The stores inventory was cross-referenced to the site Chem Alert and MSDS reference programmes to identify potential NPI substances in proprietary mixtures. Detailed process maps of the smelter and acid plant were used to identify actual and potential fugitive emissions. Process spillage details were collated from internal pollution incident reports. A series of in-house spreadsheets were developed specifically to track emissions of given NPI substances from various parts of the operation. These provided the basis for collating substance triggering information rather than the NPI Guide worksheets.

4.3 Results

All emissions from WMC were to air. There were either no emissions to land, or no EETs available to calculate these emissions. Emissions were estimated using a range of techniques including mass balance, direct monitoring, production data and emission factors from EET manuals.

Table 4: NPI Air Emissions From WMC

NPI Substance	Emission to Air (kg)
CO	29,800
NO_x	247,000
PM_{10}	186,000
SO_2	22,700,000
[t] **Total VOC's**	4,820
[t] **Acetaldehyde**	323
[t] **Ammonia**	553
[t] **Antimony & compounds**	1.88
Arsenic & compounds	740
Benzene	389
[t] **Beryllium & compounds**	0.266
[t] **Boron & compounds**	5.53
1,3 Butadiene	16.2
Cadmium & compounds	329
[t] **Chromium (III) compounds**	10.2
Chromium (VI) compounds	N/D
Cobalt & compounds	5.9
[t] **Copper & compounds**	123
[t] **Formaldehyde**	729
[t] **n- Hexane**	525
[t] **Hydrogen sulfide**	0.05
Lead & compounds	699
[t] **Magnesium oxide fume**	19.6
[t] **Manganese & compounds**	31.1
Mercury & compounds	0.446
[t] **Nickel & compounds**	4,780
Nickel carbonyl	N/D
Nickel subsulphide	N/D
[t] **Polychlorinated dioxins and furans**	N/D
PAH	70.1
[t] **Selenium & compounds**	0.463
Sulfuric acid	0
Toluene	170
Xylenes	126
[t] **Zinc & compounds**	15.7

[τ] Substances **only** on Table 2 of the Measure.

4.4 Data Accuracy

There was no opportunity to compare direct monitoring data with that generated by emission factors (EFs). However, it was generally considered that the methodology for estimating PM_{10} emissions lacked rigour as the results obtained were dependent upon assumptions that were made. An extremely detailed inventory list (16 pages) of stores items containing NPI substances was analysed by WMC, but most items were found to have a negligible contribution to emissions.

WMC was the first facility to commence data collection and discovered problems with the Austanks programme, including negative VOC emissions from standing losses and a lack of response when changing fuel level input data. VOC emissions were subsequently estimated using Tanks 3.1 as for other facilities. KNS used 8500 tonnes of coke during the trial, but were unable to estimate emissions from this raw feed as EFs were not available. The PM_{10} emissions may be high as they include the sand mining operation, which is located 30 kilometres from the smelter. Under NPI reporting this operation would now be considered as a separate facility and as such not trigger reporting.

It was not possible for the trial team to comment on the accuracy of the data without having intimate knowledge of the process. However, it was felt that the data should indicate a minor emission of sulfuric acid mist to air from the sulfuric acid plant, rather than be included as part of the sulfur dioxide emission.

4.5 Transfers

Transfers data was not provided due to the commitment required in emission estimations from KNS. Transfers to the KNS industrial landfill ceased prior to the commencement of the trial and a contractor now disposes of all solid (non-process) wastes at the Kalgoorlie Yarri Road Landfill.

4.6 Manuals

A total of 8 EET Manuals was identified as covering the processes applicable to the smelter. They were in a draft form (October to December 1998) during the calculation period of the trial. The manuals were:

- Mining;
- Nickel Concentrating, Smelting and Refining;
- Fuel and Organic Liquid Storage;
- Combustion Engines;
- Inorganic Chemical Manufacture;
- Fossil Fuel Electric Power Generation;
- Explosives Detonation and Firing Ranges; and

- Combustion in Boilers.

WMC found the manuals generally to be useful in providing emission estimations where measurements are not made. The two main problems encountered were:

- Inconsistencies in structure and emission factors for the same type of emission found in different manuals, leading to confusion when determining the most appropriate factors to use.
- Variation in the quality of the manuals, which affected the users ability to interpret and apply them to the reporting process.

Mining

The definitions for equipment types in Table 4 of the Mining EET Manual require clarification, and EFs for certain activities in Table 1 are absent.

Nickel Concentrating, Smelting and Refining

The manual was generally user friendly, and information that was lacking on some EETs were usually available in other manuals. The fugitive emission estimation method was found to be flawed and not used. An EF for the burning of coke was missing.

Fuel and Organic Liquid Storage

Some of the inputs required for the Austanks programme appeared to be of little value.

Combustion Engines

Many of the engine descriptions in Table 1 of this manual appeared to relate to airport equipment. The mixing of units made the tables difficult to use.

Inorganic Chemical Manufacture

EFs for Acid Plant SO_3 emissions are missing and there is excessive coverage to fugitive emissions from flanges and pumps.

Fossil Fuel Electric Power Generation

No specific comments as power is now generated by another company.

Explosive Detonation and Firing Ranges

No specific comments, as this manual had little application at KNS.

Combustion in Boilers

This manual was found to be inadequate and WMC decided to discontinue its use. It proved to be difficult to follow and required information on equipment types that were not generally available. It duplicated the emissions estimations included in other manuals.

4.7 Costs

WMC introduced "Time Activity Logs" to track staff resources ultilised in implementing the NPI Trial at KNS. A total of 592 hours were accrued which equates to a cost of over $45,000 based on the standard charge out costs for company personnel. This includes over 30 hours of consulting time to develop KNS site specific spreadsheet for NPI reporting. Time spent by senior staff in assisting in the development of the NCS&R Manual was not included in the above cost estimate.

4.8 Industry Comments

- The absence of simple electronic calculation spreadsheets for each manual was considered to be an impediment to the successful implementation of the NPI. The development of electronic spreadsheets to complement the EET manuals is considered essential.
- Integration of the NPI into existing environmental reporting systems should be considered in the review of the NEPM.
- The trial data needs to include adequate contextual data on the database to ensure the users are correctly informed.
- At the commencement of NPI reporting it is necessary to appoint a multidisciplinary site team that is responsible for NPI data collection, monitoring and verification.
- The measurement, estimation and reporting of PM_{10} emissions was found to be difficult and expensive and the data was considered to be highly variable and inaccurate.
- Transfers were not considered to be part of the NPI, as they don't constitute an actual emission to the environment. The inclusion of such data is considered to be meaningless and a waste of resources.
- The financial ($45,000) and staff resource (592 hours) cost of NPI reporting was found to be significantly higher than expected. The ongoing costs of preparing for NPI annual reporting also reflects this high level of costs.
- The process of collecting data from stores inventory was time consuming and cumbersome and did not add significantly to the NPI emissions data. A filter would be useful so that stores items that contain less than 10% composition of NPI substances are not included.
- A stores inventory system that allows cross linkages with MSDS and Chem Alert databases would help identify usage of NPI substances.
- Reviews of the manuals should aim to present low cost, time efficient and accurate methods of estimations.
- There is a general lack of background PM_{10} emissions data or knowledge of metals concentrations in total suspended particulates (TSP) and additional monitoring is required to estimate these accurately. Background PM_{10} emissions are considered to be significant in semi-arid environments.
- The Kalgoorlie community did not appear to show interest in the trial or its outcomes at KNS.

- Direct measurement is required to validate the EFs that have been provided, which is contrary to the commitment given in the NEPM that no additional monitoring would be required.
- There was no clear definition of a number of aspects of the NPI, including facility boundary and the transfer of solid or liquid wastes.

4.9 Conclusions

- WMC was the first mining facility to estimate their site emissions and they paved the way for other facilities. A number of approaches were subsequently handled differently for other facilities.
- WMC required a multidisciplinary team from both the KNS site and Perth Office to complete NPI reporting requirements.
- Only emissions to air were estimated by WMC.
- Estimating NPI triggers and emissions from stores inventory lists was found to be resource intensive and a minor component of the overall site emissions. Stores items with low annual consumption should be filtered out so that those comprising less than 10% of NPI substances are excluded from NPI reporting.
- The cost of reporting was substantial, being $45,000 including 592 hours of staff time.
- The estimation of PM_{10} emissions at WMC was found to be difficult and resource intensive. Their was concern about the accuracy of the results obtained.
- There is a lack of information on background PM_{10} emissions, even though they are expected to be a significant component of the overall emissions in semi-arid regions. It is considered unlikely to estimate these accurately without undertaking additional monitoring.
- Simple electronic spreadsheets would help to ensure the successful implementation of the NPI in a mining environment.
- Direct measurement should be undertaken to validate some of the EFs that have been provided.
- Transfers of wastes information was not available from WMC.
- A definition of facility boundary is required.
- WMC consider contextual (background) information critical to interpreting the NPI database.

4.10 Recommendations

4.1 Consider excluding the NPI component of minor stores items from trigger and estimation determinations, possibly by filtering out those comprising less than 10% of NPI substances.

4.2 Encourage direct monitoring in order to validate and refine emission factors, particularly for fugitive dust generated PM_{10} emissions.

4.3 Develop electronic spreadsheets that incorporate the EETs in the relevant manuals to simplify and automate emission estimations.

4.5 Provide mining companies with clear guidance on a facility boundary. A suggested approach is presented in Section 16.2 of this report.

5 Kanowna Belle Gold Mines

A detailed report by Kanowna Belle Gold Mines (KBGM) is presented separately, as an addendum.

5.1 Background

Kanowna Belle is a gold mining operation located 18 km north east of Kalgoorlie-Boulder. It is a joint venture between North Gold (WA) Ltd. (50%) and Delta Gold NL (50%). The operation consists of an open cut mine, an underground mine and a processing plant. All were located within close proximity of each other and therefore considered as one reporting facility. The processing plant includes the following operations:

- Crushing and Grinding;
- Flotation;
- Filtration;
- Roasting;
- CIL Circuit; and
- Gold Room (electrowinning).

5.2 Methodology and Trigger Determination

KBGM contracted the services of a consultancy (PPK) to assist with the identification of NPI substances, determination of the appropriate EETs and calculation of the emissions.

A review of all substances used and produced at KBGM was undertaken to determine those that were on the NPI reporting list. The information was sourced from:

- Annual greenhouse reporting information[1];
- Chemical and supply inventories;
- Mining and processing methods/operations;
- Interviews with site managers; and
- Review of NPI EET manuals for “Gold Ore Processing” and “Mining”.

The list of substances that triggered NPI reporting can be seen in KBGM’s report. It includes metals (14), criteria pollutants from fuel combustion, hydrochloric acid, cyanide, carbon disulfide and PAHs.

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[1] Greenhouse spreadsheets were developed for the North Group for both Greenhouse Gas Challenge and public reporting.

The quantities of substances used were identified to determine if they triggered the NPI reporting threshold. The methodology used was as follows:

- Fuel consumption: data already compiled in Greenhouse Reporting spreadsheets.
- Chemicals: Review of all MSDS's for quantities of NPI substances. The "Chem Alert" on-line system provided the chemical composition of substances or a percentage range of the materials present. The Greenhouse spreadsheets list the quantities of chemicals used for substances where the consumption rate is greater than 100kg per year. The majority of the chemicals containing NPI substances were below the 100kg usage and therefore their constituents were not included in the tally.
- Ore: Raw ore analysis was taken directly from assay information (a greater suite of results will be required in future to cover all NPI metals eg. for Cr, Sr and Se). Mass of ore handled per year is documented in the Greenhouse Reporting spreadsheet.
- Products produced: Greenhouse Reporting spreadsheet.
- Bulk fuel storage: Supply Department records.
- Power consumption: Electrical Engineering Superintendent.

KBGM triggered reporting on 26 of the 90 NPI reporting substances.

5.3 Results

Table 5: NPI Emissions From KBGM

NPI Substance	Emissions to Air (kg)	Emissions to Land (kg)	Total Emissions (kg)
CO	26,700	0	26,700
NO$_x$	63,700	0	63,700
PM$_{10}$	236,000	0	236,000
SO$_2$	12,000,000	0	12,000,000
[t]**Total VOC's**	5,070	0	5,070
Arsenic & compounds	251	0	251
[t]**Beryllium & compounds**	0.02	0	0.02
[t]**Carbon disulfide**	9,550	0	9,950
Chromium (total)[1]	1.27	7.6	8.87
[t]**Copper & compounds**	10.1	40.8	50.9
Cyanide (inorganic) compounds	203,000	22.5	203,000
Fluoride	ND	ND	ND
[t]**n-Hexane**	0.21	0	0.21
[t]**Hydrochloric acid**	ND	ND	ND
Lead & compounds	48.3	0	48.3
[t]**Magnesium oxide fume**	ND	ND	ND
[t]**Manganese & compounds**	160	117	277
Mercury & compounds	0.95	222	223
[t]**Nickel & compounds**	0	22.3	22.3
Nickel carbonyl	0	0	0
Nickel subsulfide	0	0	0
[t]**Poly chlorinated dioxins and furans**	0	0	0
Polycyclic aromatic hydrocarbons	0	0	0
Xylene	39.1	0	39.1

[t] Substances **only** on Table 2 of the Measure.

[1] Cr (III) and Cr (VI) reported as total Cr.

5.4 Data Accuracy

The commitment required to estimate emissions using the most appropriate EET was found to be greater than anticipated and it was therefore not reasonable or practical to test a range of EETs. There was no opportunity to compare results obtained using EFs with those from direct monitoring. However, a comparison was made of results using different EFs for some estimations. Direct measurement or mass balance EETs were used where possible. If this was not economically viable KBGM resorted to using EFs provided in the EET manuals.

The two areas of most concern in relation to data accuracy were the estimation of PM_{10} and TSF emissions. Other estimations generally seemed reasonable to the trial team. However, intimate knowledge of the operation is required to really question any of the broad assumptions that KBGM were required to make in order to estimate their emissions.

Seepage rates from TSFs were estimated using a mass balance equation, but could not be determined by KBGM with a great degree of accuracy due to the variable evaporation rate. A seepage collection trench will be installed to improve accuracy in the future. TSF emissions to ground water (land) were estimated using concentration values for cyanide and metals obtained from monitor bore analyses. Dilution of the TSF seepage by ground water may significantly reduce the concentrations of metals and cyanide leading to a low estimation of these emissions.

An examination of the calculations used to estimate PM_{10} emissions reveals that large variations could be obtained for some sections of their operation depending on the equation used and whether generic values were applied. Invariably the methodology resulting in the lowest emission was generally adopted, as there was no basis for determining which result was actually the closest to reality, e.g. estimation of PM_{10} emissions from truck loading gave a 300% variation between the two EF methodologies (KBGM, p18). See Section 16.3.6 of this report for more examples.

A lack of technical rigour with the estimation process is also demonstrated by the following examples of assumptions that KBGM was required to make in order to estimate PM_{10} emissions:

- Control of emissions due to water application to roads – 50%;
- Proportion of vehicle travel in underground mine – 50%; and
- Proportion of vehicle travel on sealed roads – 50%.

KBGM stated that estimation of metals in TSPs was likely to be inaccurate due to differences in ore body characteristics and any figures relating to metals emitted cannot assumed to be representative of the entire ore body.

KBGM know the total annual fuel consumption for the site, but they found it difficult to determine the exact quantity used by individual vehicles. Fuel consumed by contractor vehicles was also uncertain and was estimated from the average monthly operation of the machinery (hrs) and an estimated hourly fuel consumption rate for the vehicle.

5.5 Transfers

The main transfers of NPI wastes off site, occur as constituents of the general mining industry wastes such as waste oils, grease and scrap steel. In the past, arsenic trioxide has been transferred from KBGM to an intractable waste disposal facility. It is currently being stored in containers on site and will be either transferred in the future or possibly undergo further processing so that approval can be granted for onsite disposal. While quantities of substances transferred were not available at the time of the trial, a recycling yard is being developed that will facilitate future recording of transfers information including those that contain NPI substances.

Transfers of NPI wastes from KBGM include:

- Waste oil – collected by Loongana Lime for burning in their kiln.
- Waste grease – transferred to Port Hedland for incineration.
- Batteries – removed for recycling
- Scrap steel – collected by scrap merchant.
- General rubbish including empty spray cans, paint tins and solvent containers are transferred to the local landfill.

Contractors service the vehicle fleet and are held responsible for the removal of all wastes including old tyres.

5.6 Manuals

The overriding problem with the manuals was that they didn’t provided estimations for all NPI emissions and a number of those provided were considered not to be realistic. As a result direct measurement was considered to be the only method available to estimate certain emissions. This was seen by KBGM to be contrary to the commitment of the NPI that no additional monitoring would be required. Specific issues were not identified by KBGM, but as noted in the data accuracy section, there was concern with the methodology for estimating PM_{10} emissions, volatilisation of cyanide and the estimation of cyanide and metals emissions to land through seepage from TSFs.

5.7 Costs

The following costing (Table 6) was provided by KBGM based on the number of hours spent by the various departments on NPI data collection and reporting and on the cost of the consultancy service to estimate the emissions.

Table 6: Costs of NPI Reporting for Kanowna Belle Gold Mine

Cost Centre	Hours	Cost ($)
PPK Environmental Consultants	NA	6,000
Environmental Department	350	12,600
Metallurgy Department	6	230
Supply Department	2	72
Mining Department	4	173
Geology Department	2	72
Finance Department	1	38
Survey Department	1	36
Extras		
Flights/Accommodation		1,200
Total		**$20,421**

The variables that need to be monitored on a regular basis are now known and a spreadsheet can be set up in parallel to the "Greenhouse Reporting" spreadsheet to allow data to be entered on a monthly basis. This more efficient system is expected to reduce ongoing NPI reporting costs significantly.

5.8 Industry Comments

- The mining lease is a licensed parcel of land that is required to meet numerous environmental conditions and any emissions within the boundaries of the site will be remediated or rehabilitated in agreement with the licence conditions. Accordingly only emissions that exit the mine lease and directly effect the community should be reported.
- There is a reliance on direct measurement as an emission estimation technique. Emission factors do not exist for a number of substances that trigger 2a and 2b reporting and direct monitoring is therefore the only option to estimate those particular emissions. These emissions were generally considered to be minor in nature.
- The NPI process relies heavily upon averages to represent emissions across operations and the industry, which leads to inherent errors in the interpretation of results. Representation of errors should be provided with the results.
- Some emissions that are listed for reporting are simply not possible or relevant to measure. For example, cyanide may volatilise from the processing area, or a TSF, but will then break down into ammonia and carbon dioxide within moments. In this situation the NPI requires the amount of cyanide volatilised to be reported, even though for all practical purposes it could be considered that ammonia and carbon dioxide are actually being emitted.
- Estimation of PM_{10} from a facility would result in significant errors e.g. generation of PM_{10} from tailings will vary enormously depending on current tailings quality, moisture content, ambient conditions and prevailing weather conditions.

- The promotion of waste minimisation, cleaner production and energy/resource savings will not solely be achieved by the presentation of emissions data in the NPI. The goal would be better accomplished if companies were required to report on greenhouse strategies, waste minimisation and energy saving targets that have been established or are being implemented. This would lead to greater integration of the NPI with Greenhouse Reporting and Environmental Performance details supplied as part of public reporting commitments.
- The inclusion of the extra 54 substances was considered to have little impact on the total emissions of the operations. Of the 26 NPI substances identified at KBGM's operations, only 10 came from a scan of the extra substances on Table 2. However, many of these additional substances (5) were found not to have EFs available and therefore the emissions could not be estimated.

5.9 Conclusions

- KBGM didn't have the staff resources to collect NPI data and calculate the emissions and they decided to make use of consulting expertise.
- KBGM triggered reporting on 26 of the 90 NPI substances, but EFs were not available for 7 of these substances, 5 of which were Table 2 only substances. Emissions of the substances without EFs were expected to be negligible, yet expensive to determine by direct monitoring.
- Chem Alert and KBGM Greenhouse Reporting spreadsheets were helpful in identifying substances that trigger NPI reporting.
- Stores items with an annual usage below 100kg were ignored.
- Estimations of some emissions appeared to lack technical rigour e.g. dust generated PM_{10} emissions and emissions from TSFs.
- There were found to be gaps in the EET manuals and it was necessary to make a number of broad assumptions during the process of estimating the emissions.
- Transfers information was limited, but there appeared to be no significant transfer of NPI wastes during the trial period.
- KBGM believed the extra burden of reporting for the 90 NPI substances was minimal. However emission factors were not available for half of the "Table 2 only" NPI substances that triggered the reporting threshold.
- The cost of NPI reporting for KBGM was estimated to be $20,421.
- KBGM believe the lack of certain emission factors and concerns about the accuracy of others will force the industry to undertake direct monitoring.

5.10 Recommendations

5.1 Consider excluding minor stores items (say, below 100 kilograms) from trigger and estimation determinations.

5.2 Aim to further progress development of EET manuals to refine emission factors and cover all NPI substances in Table 2, particularly category 2a and 2b substances.

5.3 Consider not requiring industry to report on NPI substances if a suitable EET is not provided in the relevant EET manuals.

6 Kalgoorlie Consolidated Gold Mines

A detailed report is presented separately by Kalgoorlie Consolidated Gold Mines (KCGM), as an addendum.

6.1 Background

KCGM is the largest gold producing operation in Australia and is jointly owned by Normandy Mining and Homestake Gold of Australia Ltd. KCGM has two quite separate and distinct operations within the study zone, Fimiston and Gidji and were treated as separate NPI reporting facilities.

Fimiston: KCGM have a mining and mineral processing operation located on the outskirts of Kalgoorlie-Boulder which includes:

- Open pit mining (Super Pit);
- Waste rock disposal;
- Underground Mining (Mt Charlotte);
- Underground exploration (Chaffers);
- Mineral processing (Fimiston Mill), refractory sulphide ore (Super Pit) and free-milling sulphide (Mt Charlotte);
- Tailings disposal;
- Electrowinning and refining (Fimiston Mill); and
- Exploration.

Gidji: KCGM have a roaster located at Gidji, 17 Kilometres north of Kalgoorlie, which treats all the sulphide concentrate produced by the Fimiston Mill.

Both operations are subject to independent DEP licensing.

6.2 Methodology and Trigger Determination

The services of a consulting company (PPK) was also engaged to complete the emissions calculations and generation of their report. KCGM's Manager – Environment, Health and Safety and Senior Environmental Officer, coordinated the data collection, with the assistance of a large number of site staff including:

- Mining Engineer;
- Mechanical Engineer;
- Civil Engineer;
- Drill and Blast Engineer;

- Metallurgist;
- Supply Officer;
- Environmental Officer – Rehabilitation Planning;
- Site Works Contractor;
- Gold Room Supervisor;
- Electrical Supervisor;
- Maintenance Supervisor;
- Underground Supervisor;
- Project Supervisor; and
- Maintenance Supervisor.

The methodology followed to determine category 1 reporting triggers at the Fimiston and Gidji facilities was:

- Materials Consumed: The Chem Alert database was used to identify the stores materials used on site that contain NPI substances. Materials that were stored or consumed in small quantities (eg Araldite) were considered to have a negligible contribution to overall emissions and were ignored. While a definite cutoff limit was not applied, the “rule of thumb” approach was that any store item was considered insignificant if the annual usage contained less than 20 kilograms of NPI substances.
- Ore and Waste Rock Handling: KCGM’s ore assay data was averaged to determine the masses of NPI substances handled during the movement of over 42 million tonnes of ore and waste rock during the trial period. The composition of ore and waste rock was assumed to be the same for the purpose of NPI reporting.
- Gidji Concentrate: The mass of roaster feed was assumed to be the total quantity of concentrate transferred to Gidji and analysis data was used to estimate the quantities of NPI substances.
- Coincidental Production: NPI substances produced coincidentally were identified from EET manuals, process flow diagrams and in-house knowledge.
- Diesel: NPI substances were calculated from diesel composition data.

Fimiston triggered the category 2b threshold through fuel usage, while Gidji triggered the 2a threshold. No category 3 thresholds were triggered as there were no permanent surface waters on KCGM sites and losses to seasonal waters were well below trigger thresholds.

A total of 32 substances was found to trigger reporting at Fimiston and 15 at Gidji. The substances that triggered reporting along with the triggering mass are presented in KCGM’s report.

6.3 Results

6.3.1 NPI Emissions from Fimiston Mining

Table 7: NPI Emissions from KCGM's Mining and Mineral Processing Operations

Substance	Category Triggered	Emissions to Air (kg)	Emissions to Land (kg)	Total Emissions (kg)
CO	1, 2a	275,00	0	275,000
NO_x	2a	596,000	0	596,000
PM_{10}	2a	2,420,000	0	2,420,000
SO_2	1 , 2a	34,500	0	34,500
[τ]**Total VOC**	1a , 2a	39,300	0	39,300
[τ]**Antimony & compounds**	1	0	0	0
Arsenic & compounds	1 , 2b	46.6	0.27	46.9
[τ]**Beryllium & compounds**	1 , 2b	0	0	0
[τ]**Boron & compounds**	1	0	0	0
Cadmium & compounds	1 , 2b	0	0	0
Chromium (total) compounds[1]	1 , 2b	90.2	0	90.2
Cobalt & compounds	1	27.1	0	27.1
[τ]**Copper & compounds**	1 , 2b	40.7	0	40.7
Cyanide(inorganic) compounds	1	N/D	48.8	48.78
[τ]**Ethylbenzene**	1	0	0	0
Fluoride compounds	1 , 2a	0	0	0
[τ]**n-Hexane**	1	0	0	0
Hydrochloric acid	1 , 2a	0	0	0
Lead & compounds	1 , 2b	0	0	0
[τ]**Magnesium oxide fume**	1 , 2b	0	0	0
Mercury & compounds	1 , 2b	0	0	0
[τ]**Nickel & compounds**	1 , 2b	67.6	0	67.6
Nickel carbonyl	1 , 2b	0	0	0
Nickel subsulfide	1 , 2b	0	0	0
[τ]**Polychlorinated dioxins and furans**	2b	0	0	0
Polycyclic aromatic hydrocarbons	2a	0	0	0
[τ]**Selenium & compounds**	1	0	0	0
Toluene (methylbenzene)	1	0	0	0
Xylenes (individual or mixed isomers)	1	0	0	0

Substance	Category Triggered	Emissions to Air (kg)	Emissions to Land (kg)	Total Emissions (kg)
$^{\tau}$Zinc and compounds	1	67.6	0	67.6

$^{\tau}$ Substance **only** in Table 2 of the Measure.

[1] Cr (III) and Cr (VI) reported as total Cr.

6.3.2 NPI Emissions from Gidji Roaster

Table 8: NPI Emissions from Gidji Roaster

Substance	Category Triggered	Emissions to Air (kg)	Emissions to Land (kg)	Total Emissions (kg)
CO	2a	63.8	0	63.8
NO_x	2a	228	0	228
PM_{10}	2a	198,000	0	198,000
SO_2	1, 2a	68,100,000	0	68,100,000
$^{\tau}$Total VOC	1a, 2a	0	0	0
Arsenic & compounds	1	1,030	0	1,030
Chromium (total) & compounds[1]	1	1,010	0	1,010
Cobalt & compounds	1	36.4	0	36.4
$^{\tau}$Copper & compounds	1	718	0.85	719
Cyanide (inorganic) compounds	1	N/D	21.0	21.0
Fluoride compounds	2a	0	0	0
Hydrochloric acid	2a	0	0	0
$^{\tau}$Nickel & compounds	1	832	0	832
Polycyclic aromatic hydrocarbons	2a	0	0	0
$^{\tau}$Zinc and compounds	1	337	0	337

$^{\tau}$Substances **only** on Table 2 of the Measure.

[1] Cr (III) and Cr (VI) reported as total Cr.

6.4 Data Accuracy

KCGM used available analysis data and the EETs believed to be the most accurate. The accuracy of the data was felt to be compromised whenever site specific data was not available, requiring a reliance on generic data from the EET manuals, such as moisture and silt content. KCGM disagreed with a number of emission factors and methodologies presented in the EET manuals and for those emissions they elected to undertake a different approach. Their methodology and rationale for the approach taken was well documented. Emissions totaling less than 10 kg were reported as zero by KCGM as they believed there was a large inherent error associated with the emissions estimation process.

KCGM estimated that only 0.1% of xanthates degraded to carbon disulfide, rather than the 100% value as presented in the GOP Manual and as a result KCGM didn't trigger reporting of this substance. KCGM basis for this assumption was that in their process most xanthate adheres to the mineral particles and only a small proportion remains in the aqueous phase. KCGM also stated that not all carbon disulfide formed is released to the atmosphere, but a proportion degrades to carbonate and thiocarbonate salts. KCGM's approach is based on research work that has previously been conducted at their facility. This approach is clearly different to that taken by the Mining and GOP Manuals and supporting data from the research work would need to be viewed before it could be endorsed.

Seepage emissions were calculated using a combination of mass balance and modeling. The concentration of NPI substances emitted was taken from monitor bore analysis with deductions being made for background concentrations. The background concentrations were estimated from ground water samples obtained from monitor bores believed to be outside the influence of any seepage from TSFs. The trial team believe monitor bore analysis results to be a poor indication of the concentration of NPI substances seeping from the TSF and emissions estimates appeared to be low (i.e. cyanide emission to land was estimated to be 0.005% of usage). The concentration of cyanide and metals in the TSF return water is believed to be a more realistic approach (Gold Ore Processing EET Manual, 1999, p.25).

Sulfur dioxide emissions are expected to be reasonably accurate as they were obtained from measured stack emission determinations.

KCGM believe the EFs for the calculation of PM_{10} and TSP emissions not to be representative of actual emissions due to double counting of redeposited TSP and overestimating TSP transport. KCGM made the following three assumptions:

1. The wheel generated dust emissions are accounted for by wind blown dust emissions. This assumption was based on the following:
   - KCGM has a stringent dust management policy for the minimisation of dust generation;
   - Vehicles must comply with speed restrictions;
   - Ore and waste transportation areas are constantly watered with saline water when in use and little or no visible wheel dust generation occurs;
   - Areas not in use may generate wind blown dust, but due to the crusting effect of the hyper-saline water, resulting emissions will be minimal;
   - Road surfaces that are not watered are used infrequently and carry a small percentage of the total vehicle load; and
   - Areas included in wind blown dust estimations include all transportation corridors.
2. 90% of the TSP generated was considered by KCGM to be re-deposited at or near the source so only 10% of the calculated TSP is emitted.
3. 100% of the PM_{10} estimation will remain suspended and therefore be an emission.

The trial team observed the mining operations at the Super Pit on a number of occasions and found there to be little or no visible wheel-generated dust. While KCGM's argument is subjective, it can be reasonably expected their PM_{10} emissions would be over estimated if the EFs in the Mining Manual were applied. The trial team is also of the opinion that a proportion of the TSP is re-deposited near the source. However, the EET manuals and other references generally assume about 40% of the TSP is PM_{10}, and this, rather than 10% would be a more realistic value for the TSP emission.

Combustion emissions were calculated for total VOCs, sulfur dioxide, PM_{10} emissions, oxides of nitrogen and carbon monoxide, using the EFs in the Mining Manual. KCGM assumed this manual incorporated all relevant emissions and therefore didn't use the Combustion Engines EET Manual (CE) to estimate emissions of other NPI products of combustion, such as benzene, formaldehyde and PAHs. Site emissions of these types of substances are therefore expected to be underestimated.

Emissions from the general consumption of stores items containing NPI substances was not calculated by KCGM due to insufficient data being available. Chem Alert often only provided concentration ranges such as < 60% or 10 – 30%. The Mining EET Manual assumes that all volatile solvents used, become an emission to air unless there is a vapour recovery system. While KCGM agree with the assumption that 100% of the NPI VOCs in the stores solvents are emitted during use, they do not believe it appropriate to assume 100% of the VOCs contained within all the materials consumed onsite are emitted. This approach would have resulted in total VOC emission of 45,000 kilograms. It seems reasonable to the trial team to include VOC emissions only from the stores items that are clearly volatiles, such as paints, thinners and solvents used for cleaning purposes.

Cyanide emissions to air were not included in KCGM's data as they were still reviewing the techniques and calculations.

6.5 Transfers

KCGM elected at the commencement of the trial to investigate only the emission of NPI substances, therefore no comment or data was provided on the transfer of wastes from their facilities.

6.6 Manuals

The main concern with the EET manuals related to their ease of use and lack of external and internal cross-referencing. It was necessary to search entire manuals to find a single EF or EET. In some instances alternate techniques for the same emission calculation may be found in the same or another manual (e.g. vehicle emissions) without any reference to the other technique(s). Some of the terminology used in the manuals was not clear or relevant to Australia, for example mining vehicle types are based on US descriptions of mining equipment and have little meaning to Australian operators.

Gold Ore Processing Manual
The tabulation of EFs was found to be useful, but cross-references to EFs in other manuals were not provided. The manual should:

- Account for the complexing of cyanide into “non-free forms” (eg bound in metal complexes) in mass balance calculations for cyanide emissions during the gold recovery process; and
- Clarify that hydrochloric acid is neutralised during elution or at the TSF.

Combustion Engines
The manual does not provide EFs for a number of 2a and 2b category substances, namely: fluoride, hydrochloric acid, magnesium oxide fume, nickel and compounds, nickel carbonyl, nickel subsulphide, arsenic, beryllium, cadmium, chrome, copper, lead, mercury and cobalt.

6.7 Costs

The following costing was provided by KCGM and is the total cost for both facilities to comply with NPI reporting.

Table 9: Costs of NPI Reporting for Kalgoorlie Consolidated Gold Mine

Site	Emissions Area	Data Collection (hrs)	Calculations Required	Calculation (hrs)	Total (hrs)
Fimiston	Triggers	N/A	N/A	5	5
	Wind blown dust	1.5	TSP/PM_{10}	3	4.5
	Machinery	11.67	Combustion Gases	10	42.67
			Wheel dust	13	
			Dust from ore/waste handling	8	
	Blasting	0.5	TSP/PM_{10}	1	1.5
	Explosives	0.5	Combustion Gases	1	1.5
	CIL/Elution	4	Cyanide	6	10
	TSF seepage	5	Metals/Cyanide	3	8
	LPG combustion	2	Combustion Gases	3	5
	Processing	1	TSP/PM_{10}	5	6
	Fuel Storage	6	Vapour emissions	6	12
	Stores lists	50	Various	4	54
Gidji	Triggers	1	N/A	3	4
	Roasting/Stack	6	Gases/PM_{10}	8	14
	CIL/CIP	1.1	Cyanide	3	4.1
	TSF seepage	4	Metals/Cyanide	1	5
	Machinery	2.75	Combustion Gases	4	8.75
			Wheel dust	2	
	Fuel storage	1.5	VOC	2	3.5
	Roasting Preheat	0.67	Combustion Gases	1	1.67
	Vacant Land	0.5	TSP/PM_{10}	0.5	1
	Wheel dust	0.25	TSP/PM_{10}	0.5	0.75
	Stores list	23	Various	2	15
Sub totals		**123**	**N/A**	**95**	**218**
Both			Data collection, worksheet development and manual interpretation		120
			Report generation		210
Total					**548**

PPK provided the following assistance to KCGM for the Kalgoorlie NPI Trial:

- introduction to NPI principles and data definition;
- emissions calculation; and

- report generation.

The cost of PPK's services was approximately $16,000 and the total cost for NPI reporting was estimated to be between $40,000 and $50,000.

6.8 Industry Comments

- Chromium (III) and chromium (VI) are rarely analysed as separate species and the generic ore assays data in the manuals only provide total chromium. It is recommended that they be treated as one substance.
- Formal NPI definitions of the size criteria of silt and TSP is required.
- Units used in emissions equations should be consistent and Australian terminology adopted for describing mining equipment and vehicles
- A formal NPI definition of VOCs, PAHs and polychlorinated dioxins and furans is required that:
  - lists the substances included or excluded; or
  - provides the criteria by which a substance is disregarded or included.
- The EET error rating system should be quantified to provide a basis on which EETs can be compared and it would also provide greater credibility to the emission estimates.
- Further clarification between a transfer and emission is required, perhaps by introducing the concept of the potential for pollutants to do harm.
- Hotlinks from the NPI database to reporting facilities websites are considered important to give viewers a better understanding of the context of emissions.
- Contextual information on NPI substances should include background levels and average household emissions.
- All operations greater than 7 kilometres apart should be treated as separate facilities.
- The delineation between emissions of licensed vehicles for facility reporting and aggregated emissions calculations needs further clarification.
- Worksheets and database for data collection and calculation should be developed.
- Allow facilities to report on the full list of 90 substances if desired.
- The materials composition provided by Chem Alert and MSDS was considered inadequate for emissions estimation purposes. A generic composition of main materials used at facilities would be useful.

6.9 Conclusions

- KCGM engaged the services of a consultancy to calculate their emissions.
- KCGM reported as two facilities (Fimiston and Gidji), being distinctly different operations and separated by 17 kilometres.
- A large number of KCGM staff were involved in data collection.
- The Fimiston facility triggered reporting on 32 NPI substances and the Gidji facility triggered reporting on 15 substances.
- A clear definition to identify the facility boundary is considered important.

- Industry has requested that hotlinks be made available from the NPI database to reporting facilities.
- Formal NPI definitions of “total VOCs”, “polychlorinated dioxins and furans”, “PAHs” and the size criteria of silt or total suspended particulates (TSP) was not available.
- The EET manuals would be improved by providing external and internal cross-referencing. There is a need to standardise units used in equations and adopt Australian terminology to describe mining equipment.
- KCGM did not accept all EFs presented in the manuals as being valid and elected to take a different approach to estimate the emissions of carbon disulfide, PM_{10} emissions, TSP metals, volatile stores items, combustion emissions and emissions to land from TSFs. The trial team agreed with some, but not all of their assumptions.
- KCGM did not estimate transfers of wastes from their facilities.
- The cost of NPI reporting for the two facilities was very high, the total being between $40,000 and $50,000.
- The EET emission factor ratings should be quantified to provide a better understanding of the uncertainty associated with the emissions data.
- Chromium (III) and chromium (VI) are rarely analysed as separate species at present.

6.10 Recommendations

6.1 Consider replacing “chromium (III) compounds” and “chromium (VI) compounds” with “chromium compounds” until emission factors can be provided.

6.2 Consider quantifying the EET error rating system.

6.3 Links that provide alternate techniques for estimating emissions for a common single activity (such as mining vehicles) should be considered during revision of EET manuals.

6.4 Standardise units used in manuals and provide clearer descriptions for types of mining equipment in Table 4 of the Mining Manual.

6.5 Provide formal NPI definitions for “total VOCs”, “polychlorinated dioxins and furans”, “PAHs”, and the size criteria of “silt” and “total suspended particulates” (TSP).

6.6 Provide industry with the opportunity to hotlink from the NPI website to their own web address.

7 Normandy Kaltails Pty Ltd

A detailed report is presented separately by Normandy Kaltails Pty Ltd (NK) as an addendum.

7.1 Background

Normandy Kaltails (NK) is a hydraulic mining operation that utilizes high pressure water to ‘mine’ gold bearing tailings for processing. The old tailings heaps being retreated by NK are from various mining leases located immediately south-east of Kalgoorlie-Boulder. The process involves:

- Directing high pressure water jets at the mining face to form a slurry that flows via gravity through open trenches to a pumping station;
- Pumping screened tailings to a Carbon in Pulp (CIP) process plant for processing using cyanide leaching; and
- Redepositing processed tailings into a single TSF.

7.2 Methodology and Trigger Determination

NK had a workforce of 72 employees, six of whom were involved in identifying and estimating emissions. Consulting expertise (PPK) was also utilised to identify substances triggered and to estimate emissions.

The Environmental Officer and Environmental Technician identified all NPI substances used on site using a database of chemical products (Chem Alert) that is maintained as part of the site safety management programme. Site knowledge was required to identify substances not in the Chem Alert register, such as those produced by coincidential production.

A total of 49 NPI substances was identified, of which 21 were subsequently found to trigger the reporting threshold. These substances were identified as follows:

- A number of category 1 substances (13 metals) tripped the threshold on annual throughput of tailings to the processing plant.
- Category 2a substances were triggered through the quantity of fuel burnt.
- Ammonia through coincidental production.
- Only cyanide and hydrochloric acid triggered the category 1 threshold through the Chem Alert database search. Chemicals with an annual usage of less than 100 kilograms were ignored.

- Fuel usage triggered reporting of total VOCs, but not component species such as benzene and toluene;
- There were no emissions to water, which immediately discounted category 3 substances.

Emissions were estimated by:

- Using EFs from the relevant EET manuals;
- Obtaining limited data on the metal content of tailings;
- Conducting a site water balance to estimate TSF seepage volumes;
- Utilising cyanide analysis from monitor bore water; and
- Mass balance to calculate ammonia emissions.

7.3 Results

Table 10: NPI Emissions from Normandy Kaltails

Substances	Emissions to Air (kg)	Emissions to Land (kg)	Total Emissions (kg)
Ammonia	0	0	0
Antimony	0	0	0
Arsenic	0	0	0
[t] **Boron & compounds**	0	2.86	2.86
Carbon monoxide	2540	0	2540
Chromium (III) compounds	0	0.11	0.11
[t] **Chromium (VI) compounds**	ND	0	0
Cobalt & compounds	0	1.76	1.76
[t] **Copper & compounds**	0	0.26	0.26
Cyanide (inorganic) compounds	36100	8.3	36100
Fluoride	ND	0	0
[t] **Hydrochloric Acid**	0	0	0
Lead	0	0	0
[t] **Manganese & compounds**	0	1.99	1.99
[t] **Nickel & compounds**	0	0.44	0.44
Oxides of Nitrogen	9480	0	9480
Particulate Matter 10.0 um	750	0	750
Polycyclic aromatic hydrocarbons	0.13	0	0.13
Sulphur dioxide	515	0	515
[t] **Total Volatile Organic Compounds**	1140	0	1140
[t] **Zinc and compounds**	0	1.32	1.32

[τ] Substances **only** on Table 2 of the Measure.

Metals listed in Table 10 that had zero emissions, triggered the reporting threshold based on the annual throughput of tailings. There were zero emissions of these substances because:

- NK assumed that no PM_{10} emissions occurred from the disturbed land or from TSFs (see Section 2.4.1.4 of Normandy's Report for a justification of this assumption); and
- No EFs existed for these metals, as products of combustion.

There were zero emissions of hydrochloric acid, as this was neutralised in the process.

EFs were not available for the category 2a substances of fluoride compounds and hydrochloric acid.

7.4 Data Accuracy

NK considered the accuracy of their data was very good for some emission estimations, but poor for others. However, limited direct monitoring data was available and therefore comparisons could not be made with values obtained using EFs. The direct monitoring data was used to determine metals concentrations in plant feeds and cyanide concentrations in monitor bores.

Emissions from fuel combustion were believed to be reasonably accurate. NK's main areas of concern were the estimation techniques for PM_{10} emissions and the determination of seepage from TSFs.

The trial team felt the main limitations with the data were:

- PM_{10} emissions were likely to be underestimated as they were based on the assumption that emissions from sources other than fuel combustion, were zero. It is understood that the movement of tailings at this operation is a wet process and that the use of hypersaline water is effective in reducing ground surface emissions, but some non-combustion PM_{10} emissions would be expected at the site. However, it is apparent that for their operation, applying the EFs in the EET manuals would be likely to significantly over estimate their PM_{10} emissions.
- The cyanide emissions to land seemed low, being only 0.001% of the total cyanide used. The use of monitor bore cyanide concentrations rather than TSF cyanide concentrations as recommended in the Gold Ore Manual is one reason. Also emissions to land are dependent on the seepage figure from the TSF which is not easily determined. Similarly emissions of metals to ground through seepage from the TSF appeared to be low.

NK believed their cyanide and metals emissions data from the TSF represent the 'worst case' scenario as they assumed 50 % of seepage water recovered was native groundwater.

The metals emissions figures were based on an extensive testing programme to determine the concentrations of water-soluble metals found within the tailings.

It would appear that further research work on TSFs in general is required before the concentration of cyanide and metals in monitor bores could be used with some degree of confidence as a means to estimate the emissions of these substances from the TSF.

7.5 Transfers

The only transfers of wastes identified by NK as leaving the site were waste oil (700 L), mercury (0.108 kg) and scrap steel (6,000 kg). The waste oil and scrap steel were sent for recycling and the mercury (which could also be considered a product) was sold to local prospectors and small treatment operators.

Generic speciation data for waste oils was used by the trial team to provide an idea of the quantities of NPI substances transferred (Table 11). The trial team didn't estimate the quantities of NPI substances contained within the scrap steel as they were expected to be insignificant.

Table 11: Transfer of NPI Substances from Normandy Kaltails

Substance	**Transfer of NPI Substance using Loongana Lime Oil Speciation Data[1] (kg)**	**Transfer of NPI Substance using CONCAWE[2] and NSW Water Database[3] (kg)**
Cadmium	0.000623	ND
Chlorine	0.0077	0.1869
Chromium	0.003115	Traces
Copper	0.01869	Traces
Hydrocarbons	ND	70
Lead	0.097188	0.3115
Mercury (total)	0.0000105	ND
Nickel	ND	Traces
PAH's	ND	0.5607
Phenolic compounds[4]	ND	0.0035
Phosphorus	ND	0.46725
Polychlorinated biphenyl's[4]	0.0001246	ND
Sulfur	4.6102	ND
Tin	ND	Traces
Zinc	0.332059	0.0035

[1] Speciation data provided to the DEP by Loongana Lime and is a composite of waste oil in the Kalgoorlie region.

[2] CONCAWE (1996)

[3] NSW Water Database as referenced in Coffey (1999).

[4] Assumed to be at the detection limit.

As can be seen from Table 11, NPI substances contained in the transferred waste oil is minor.

7.6 Manuals

The EET manuals used at NK to determine emissions were:

- Mining (Dec 1998);
- Gold Ore Processing (Feb 1999);
- Combustion Engines (Jan 1999); and
- Combustion in Boilers (Jan 1999).

The following comments on these manuals were provided by NK.

Mining Manual

As the NK operation is “unconventional” in its mining method, many of the EETs in the mining manual were not considered applicable. The PM_{10} emission estimation techniques are believed to be in need of urgent review. The equipment type descriptions in the manual (Table 4) require conversion to Australian terminology or silhouette diagrams should be provided to aid interpretation. EFs for PAHs were not provided, but could be obtained from the Combustion Engines Manual. EETs are also required for hydrochloric acid and fluoride emissions from fuel usage.

Gold Ore Processing Manual

- The EETs were directly related to NK operation and were applied without the need for modification.
- An EET is required for incidential ammonia from the elution circuit.
- Seepage from TSFs are site specific and a uniform procedure for calculating seepage from TSFs should not be proposed.

Combustion in Engines

- Table 4 and 5 of the CE Manual were used to estimate uncontrolled emissions from diesel powered gensets.
- Table 1 appears to be more relevant to airport utilities.

Combustion in Boilers Manual

This manual was used to determine emissions from the regeneration kiln and elution column boilers by considering them to be commercial boilers. The main problem being the absence of an EF for PAHs.

7.7 Costs

The following costing was provided by NK based on the number of hours required to complete each task.

Table 12: Cost of NPI Reporting for Normandy Kaltails

Item	Staff Member	Time	Estimated Cost ($ per annum)
Tailings Sample Collection	Metallurgist	1 day per month	3,000
Multi element analysis	Analysis by external laboratory	NA	7,200
Seepage volume data	Environmental Officer	1 hour per week	1,500
Diesel Consumption	Environmental Officer	1 day per annum	250
LPG Consumption	Environmental Officer	1 day per annum	250
Cyanide analysis	Chemist	½ day per month	1,500
Stores Inventory	Stores Supervisor	1 day per annum	250
Power Consumption	Environmental Officer	½ day per month	1,500
Analysis of Data	Environmental Officer	1 week per annum	1,250
Report compilation and distribution	Environmental Officer	2 weeks per annum	2,500
Total			**$19,200**

These costs are exclusive of those associated with the development of spreadsheets and other activities related to the introduction of NPI reporting.

7.8 Industry Comments

- A procedure should be developed for the common sense filtering of NPI substances that are used at reporting facilities, but are highly unlikely to trigger reporting. An arbitrary annual usage cutoff limit of say, 100 kg should be applied. Stores inventory chemicals found to contain NPI substances should be ignored if the quantities consumed are below the set threshold.
- A clear definition of a facility boundary is required. This should be in the form of some agreed existing boundary such as mining tenements or licenced premises.
- If transfers become part of the NPI, techniques will be required to estimate the NPI components of generic materials such as waste oil and scrap metal.
- Electronic submission of NPI data should be considered.

- Government and industry should seek to continually improve emission estimation techniques and the techniques for PM_{10} and cyanide should be high priorities.
- The incremental impact of increasing the NPI reporting list from 36 to 90 substances would not be great for NK.
- Resources to compile NPI data are expected to be a continuing problem.
- Public inquiries are expected in response to the NPI data and it is important that it is presented together with suitable contextual information.
- The original intention of the NPI NEPM that no additional monitoring is required is considered unrealistic, especially for estimations of metal emissions.

7.9 Conclusions

- NK identified 49 of the 90 NPI substances on site, of which 21 triggered the reporting threshold.
- NK noted that the incremental impact of reporting for the full 90 substances was not great for their operation.
- The only transfers of wastes identified were small quantities of waste oil, mercury and scrap steel.
- Limited direct monitoring data was available and NK believe implementing the NPI without additional monitoring to be unrealistic.
- NK believed the emission estimations from fuel combustion were reasonably accurate. However, seepage from TSFs is believed to be site specific and therefore a uniform estimation procedure should not be proposed. There is also a need to review the PM_{10} EFs.
- The trial team was of the opinion that NK's PM_{10} emissions to air and cyanide emissions to land were low. Further research work is required that compares direct monitoring results with those obtained using EFs, before the factors could be used with confidence.
- The cost of NPI reporting was estimated by NK to be $19,200.

7.10 Recommendations

7.6 Consider developing an electronic reporting tool to enable facilities to send data (as per Worksheet 3) to the relevant jurisdiction, in a format compatible with Environment Australia's data transfer protocols.

8 Bulk Fuel Storage Facilities

8.1 Background

Four wholesale bulk fuel storage facilities in Kalgoorlie participated in the trial: Shell, BP, Ampol, and Mobil. Boral Energy (LPG) was also contacted as part of the trial but were found to be well below the threshold and consequently were not considered any further. The products stored on the sites were as per Table 13.

Table 13: Products Stored at Bulk Fuel Facilities

Substance	Ampol	BP	Mobil	Shell
Distillate fuel (diesel)	Yes	Yes	Yes	Yes
Gasoline (leaded and unleaded)	Yes	Yes	No	Yes
Aviation fuel	No	Yes	No	No
Jet fuel (kerosene)	Yes	Yes	No	No
Oil (lubricating and waste oils)	Yes	Yes	Yes	Yes

Each of the facility occupiers acted solely as distributors for the fuel companies, with the fuels and lubricants remaining the property of the petroleum companies. There was some initial confusion as to who would undertake reporting. The distributor did not have the expertise to undertake the analysis; whereas the fuel companies were not legally responsible for reporting, yet possessed the required skills. For the purposes of the trial, the fuel companies agreed to estimate the emissions on behalf of the distributor, with the exception of Mobil, for whom the facility operator agreed to estimate emissions. Following an initial meeting with Mobil, it became apparent that the facility operator was not capable of estimating their own emissions, as their computer was not powerful enough to run the Austanks program. At this point the trial team agreed to undertake emissions calculations on Mobil’s behalf.

8.2 NPI Trigger Determination

The bulk fuel storage facilities all clearly trigger the category 1 (10 tonne) usage threshold for a number of specific NPI substances within the fuels. Whether the facilities triggered the category 1a (25 tonne) usage threshold for total VOCs was open to some interpretation, as the application of the design capacity threshold was not clear. The definition presented in Section 10.(2) of the Measure, states:

> *“The reporting threshold for a category 1a substance is only exceeded for a bulk storage facility if their design capacity* ***also*** *exceeds 25 kilotonnes”.*

The NPI guide states that a facility should report emissions of total VOCs if the facility:

- *uses more than 25 tonnes in a year;* ***or***

- *a design capacity of 25 kilotonnes for bulk storage facilities.*

The interpretation in the Measure clearly indicated that these facilities would not trigger the 1a threshold. However, total VOCs have been presented in this report as this estimation was required before other specific NPI VOCs within the fuels (such as xylene and toluene) could be estimated.

Fuel speciation data was kindly provided by BP (Table 14) and was used by the trial team to determine triggers and emissions estimates from Mobil. Shell and Ampol used their own fuel speciation data. At the time of writing the Australian Institute of Petroleum (AIP) was discussing the possibility of developing generic fuel speciation tables for use by all companies for determining NPI triggers and speciating total VOC emissions.

Table 14: NPI Substances in Selected Fuels

	% Volume			
VOC	**Premium Unleaded Petrol**	**Unleaded Petrol**	**Leaded Petrol**	**Diesel**
Benzene	3.5	2.73	3.02	0.029
Ethylbenzene	1.1	1.4	1.52	0.141
Cumene	0.21	0.19	0.16	
Cyclohexane	0.08	0.18	0.15	<0.01
1,2-Dibromoethane	<0.01	<0.01	0.09 g/l	<0.01
n-Hexane	2.3	2.52	2.19	
PAH*	0.11	0.13	0.45	0.212
Stryene	N/D	N/D	N/D	0.0012
Toluene	8.05	7.59	9.82	0.16
Xylene	4.67	6.00	6.73	0.795

*Naphthalene only
N/D: no data

The NPI substances that tripped the reporting thresholds are listed in Table 15. The variation in substances that triggered reporting at each of the facilities is due to two main reasons:

1. Different fuels stored; and
2. Differences in the speciation profiles used by each of the fuel companies.

Until generic speciation tables are generated by the AIP, this variance will continue to occur.

Table 15: NPI Substances Triggered by Bulk Fuel Facilities

NPI Substance	BP	Ampol	Shell	Mobil
Benzene	Yes	Yes	Yes	No
Ethylbenzene	Yes	No	No	Yes
n-Hexane	Yes	No	No	No
Toluene	Yes	Yes	Yes	Yes
Xylenes	Yes	Yes	Yes	Yes

8.3 VOC Estimation Techniques

Total VOC emissions were estimated using the USEPA program Tanks 3.1 (Tanks 4.0 now available) and the Australian equivalent, Austanks (Version 27). The fuel companies, mining companies and trial team found problems with Austanks and it was decided that the data to be submitted for display on the database by the bulk fuel depots would be derived using the Tanks 3.1 program. A discussion of the problems with Austanks is presented in the following section.

From a depot operator’s perspective, both programs are quite difficult to use. Whilst both programs can provide emission estimates for various fuel types, neither demonstrated the ability to accurately provide a generic speciation of the individual VOCs within the fuels. See Section 8.3.4 for examples and further explanation.

The Fuel and Organic Liquid Storage EET Manual (F&OLS) (final version) did not provide direction on how to estimate emissions of specific NPI VOCs using the Austanks program. Total VOC emissions were speciated in accordance with Raoults Law as described in Section 4.4.2 of the Petroleum Refining EET Manual (PR) (final version). This method of speciation was chosen as it conforms with the methodologies set out in AP-42. Unless support is provided by the parent petroleum companies, this method is likely to be too difficult for use by depot operators.

8.3.1 Problems with Austanks

Until the glitches in Austanks are rectified, the FOLS is considered to be of limited benefit for bulk fuel storage operators. The following problems with Austanks were identified by Shell, BP, Coogee Chemicals, Ampol and the trial team:

- There were significant variation between Austanks and Tanks 3.1 for total VOC emission estimates for fixed roof tanks. BP trials also showed that Austanks produced significantly lower total VOC emissions than BP’s internal reporting protocol;
- Austanks results compared poorly when emissions were calculated using monthly and annual meteorological data (Table 23);

- Austanks regularly estimated negative 'standing loss' emissions;
- There were no changes in emissions estimates when the average daily temperature was changed from 24^0C to 100^0C;
- The meteorological data was only on an average annual basis, not on a monthly basis as is the case with Tanks. This may be important in places like Kalgoorlie where there is a marked seasonal temperature variation;
- There was no data on wind speed, or solar insulation factors;
- Various results were obtained from the program depending on the inputs to the previous runs. This error occurs whether or not the user exited the program after a calculation run. It also suggested that the input parameters were not correctly reset before a subsequent run;
- Austanks did not save tank specifications to file, requiring complete tank data profiles to be re-entered each time emissions from a tank were calculated;
- Approximately 10% of the fuel tanks are below ground or semi-buried, yet Austanks does not estimate emissions from below ground tanks;
- It was not possible to save output data without saving the entire program;
- The average ambient temperature for Kalgoorlie defaults to 16.4^0C for vertical fixed roof tanks and 30^0C for horizontal fixed roof tanks. These temperature inputs were suspected to be incorrect; and
- The printout of the output worksheet was not in a report format. The inputs used in the calculations were not included and the output units were unclear.

8.3.2 Using Tanks 3.1

Tanks 3.1 is used to determine the total VOC emissions from the organic liquid storage tanks. The variables required to determine total VOC emissions from the fixed roof tanks used by the trial participants were:

- Fuel usage (annual throughput, average liquid height in tank, number of turnovers);
- Storage tank details – (dimensions, paint condition, pressure settings, roof type and dimensions); and
- Meteorological data – (monthly maximum, minimum, and average temperatures, average monthly atmospheric pressure, average monthly wind speed, and monthly solar insulation factors).

8.3.3 Problems with Tanks 3.1

The main problems identified with the use of Tanks 3.1 were:

- Users are required to input information in imperial units of pounds, degrees Fahrenheit, gallons and feet. This necessarily complicates data inputs for facility operators;

- Tanks 3.1 contains meteorological data for American cities, although it is possible to enter site specific weather data. The trial team used both site specific information obtained from the Bureau of Meteorology as well as data for Bakersfield California which had similar average temperature variations to Kalgoorlie. There was very little difference (0.01kg) in the total VOC estimates using the different meteorological data. As a cautionary note, when using American meteorological data for part year calculations, facilities should be aware of the difference in seasons between the northern and southern hemispheres; and
- Tanks 3.1 is purported to be able to do a partial speciation of the VOCs for the particular fuel. The user is able to provide compositional data (as a percentage of total liquid weight) for those species (e.g. xylenes, toluene and benzene) for which they require emissions estimates. The remainder of the fuel is unspecified. The total vapour pressure of the liquid is that of the specified petroleum product (e.g. diesel or gasoline). However, Tanks 3.1 did not satisfactorily speciate the total VOC emissions in accordance with manual calculations using Raoults Law. In addition, Tanks provided an inflated total VOC estimate for a partially speciated fuel relative to an unspeciated fuel (e.g. diesel or gasoline). An example of this is contained in Table 16.

8.3.4 Difference Between Tanks 3.1 and 4.01

Tanks 4.01 was released late in the trial, after emissions estimates for each of the companies had been made. The most striking difference between Tanks 3.1 and 4.01 is that Tanks 4.01 is now a windows based application, with data stored in Access 2.0 databases, replacing the DOS based Tanks 3.1. Emissions estimates from Mobil used both Tanks 3.1 and 4.01, returning lower emissions estimates for Tanks 4.01 than 3.1. The reasons for this are unclear but may in part be due to the following changes that have been made to Tanks 4.01 (USEPA, 1999):

- The meteorological database has been updated;
- The number of days in each month is now used to calculate standing losses;
- Tanks 4.01contains maximum and minimum values for the vapour pressures for the liquid, whereas Tanks 3.1 only had the average;
- It is possible to perform monthly calculations for all tanks when the chemical or mixture is selected from the chemical database;
- It is only possible to do a "vapour weight speciation" with Vertical or Horizontal Fixed Roof Tanks. The summary of changes presented by Tanks 4.01 states:
  "If you enter 100 percent of the vapour component information for a tank using this speciation option, individual compound emissions will be calculated using the vapour component information. You also may select the mixture from the chemical database and specify less than 100 percent of the components of the vapour. Individual compound emissions will be calculated using percent compositions of the vapour for specified components."
  However, this did not appear to be the case, the Tanks 3.1 and 4.01 speciated results being approximately twice as large as the manually speciated emissions, as

can be seen in Table 16 below. This table also shows the variation in results obtained when using Tanks 3.1 and Tanks 4.01;

Table 16: Comparison of Tanks 4 Emissions Techniques - Mobil

Method Used	Substance			
	Total VOC (kg)	Ethyl Benzene (kg)	Toluene (kg)	Xylene (kg)
Tanks 4.01: Total VOC Analysis Total VOC calculated using Tanks 4.01 before being speciated in accordance with Section 4.4.2 of the Petroleum Refining EET Manual.	33.9	0.706	1.73	5.54
Tanks 3.1: Total VOC Analysis Total VOC calculated using Tanks3.1 before being speciated in accordance with Section 4.4.2 of the PR Manual.	47.6	0.992	2.44	7.78
Tanks 4.01: Mixture Partial speciation of Distillate oil No. 2, containing: 0.14% Ethylbenzene 0.16% Toluene; and 0.79% Xylenes (ratio -m: -o = 1:1)	70.8	2.46	8.09	10.4
Tanks 3.1: Mixture Partial speciation of Distillate oil No. 2, containing: 98.91% Distillate oil No. 2 0.14% Ethylbenzene 0.16% Toluene 0.79% Xylenes (ratio -m: -o = 1:1)	101.8	3.5	11.6	15.0

Other changes made to Tanks 4.01 (USEPA, 1999):

- Generic liquid speciation profiles for hazardous air pollutant (HAP) compounds in crude oil and several petroleum products have been added. It is possible to add your own product profiles if specific data is available; and
- It is now possible to add deck seam loss factors for internal floating roofs to the database.

8.3.5 Speciating Total VOCs

The information presented in Table 17 was required in order to determine emissions of specific NPI VOCs using Raoult's Law. Possible sources of this data are also suggested.

Table 17: Sources of Data Required to Speciate Total VOC Emissions

Variable	Source
$Z_{i,L}$ - liquid weight fraction of the NPI component in fuel (kg/kg)	Petrol Company, or sometimes available on MSDS's
M_I - mol. weight of NPI component (kg/mol)	Tanks, MSDS
M_L - mol. weight of liquid stock (kg/mol)	Tanks
M_v - mol. weight of vapour stock (kg/mol)	Tanks and Austanks
P - vapour pressure of pure NPI component (kPa)	Weast 1986, MSDS's
P_{VA} - total vapour pressure of liquid stock (kPa)	Tanks, Petrol Company
L_T - total emission rate from liquid stock (kg/yr)	As calculated by Tanks, Austanks or equivalent

The speciation of total VOCs into the individual NPI VOCs was undertaken using Raoult's Law, as defined in Section 4.4.2 of the Petroleum Refining Manual. The speciation was undertaken on the total VOC estimate. The trial team and the fuel companies involved in the trial used this method to estimate the emissions of component VOCs within the fuels.

8.4 Results

Table 18 presents a summary of emissions from the bulk fuel facilities.

Table 18: Total NPI Emissions From Bulk Storage Facilities

Substance	Emission (kg)				
	Mobil	Shell	BP	Ampol	Total
Total VOCs	47.6	3,570	6,190	6,300	16,100
Benzene	N/A	32.1	53	41	126
Cumene	N/A	N/A	45.5	N/A	45.5
Cyclohexane	N/A	N/A	5.0	N/A	5.0
1,2 - Dibromoethane	N/A	N/A	N/A	0.05	0.05
Ethylbenzene	0.992	N/A	2.5	N/A	3.49
n-Hexan	N/A	N/A	68.5	N/A	68.5
Lead and Compounds	N/A	0.06	N/A	N/A	0.06
PAH's	N/A	N/A	N/A	0.79	0.79
Toluene	2.44	36.4	45.5	36.4	121
Xylenes	7.78	9.4	8	9.96	35.1

N/A: data was either not available or was not applicable for the substance at the particular facility.

Figures 4 to 7 represent the contribution of each bulk fuel facilities to the emissions of total VOC, benzene, toluene and xylenes (respectively) relative to other reporting facilities in the study area. Whilst the bulk fuel storage facilities may contribute significant proportions of VOCs relative to other reporting facilities, it should be noted that they collectively are estimated to contribute less than 1% of the specific and total VOCs from all sources in the study area. The major source of specific VOC emissions being from mobile sources (benzene 50%, toluene 61% and xylene 65%) and other aggregated sources (benzene 47%, toluene 39% and xylene 30%).

Mobil was the only bulk fuel storage facility in the study that stored only diesel. The emissions of specific and total VOCs from this facility was clearly negligible when compared with other reporting facilities that store more volatile fuels. As already stated the reporting facilities collectively were estimated to be minor contributors to VOCs in the study region.

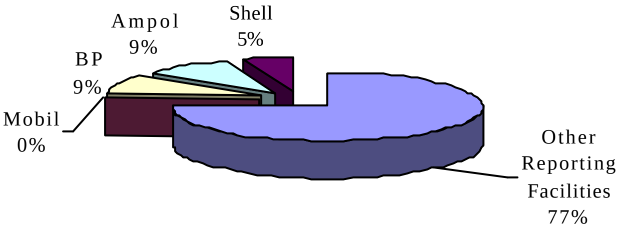

Figure 4: Total VOC Emissions from Fuel Depots

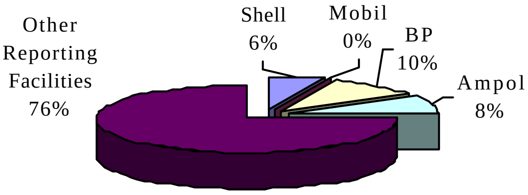

Figure 5: Emissions of Benzene from Bulk Fuel Storage Facilities Relative to Other Reporting Facilities

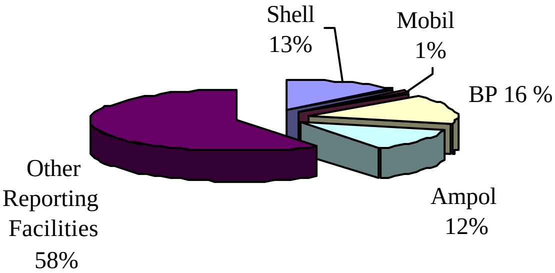

Figure 6: Emissions of Toluene from Bulk Fuel Storage Facilities Relative to Other Reporting Facilities

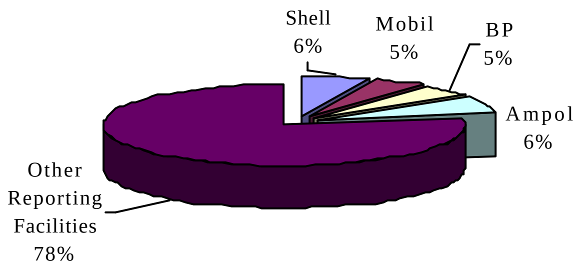

Figure 7: Emissions of Xylenes from Bulk Fuel Storage Facilities Relative to Other Reporting Facilities

8.4.1 Mobil

Mobil's diesel usage of 8 million litres per year triggered NPI reporting for ethylbenzene, toluene, and xylenes. The depot had a single fixed roof diesel storage tank and ten smaller lubricant storage tanks ranging in size from 55,000 L to 160,000 L. The operator had no information on the speciation of the lubricants beyond what was contained in the MSDS sheets. The vapour pressures of all the lubricants were well below 0.1mm mercury at 15°C, indicating that volatilisation under ambient temperatures would be minimal. Consequently, these lubricants were not included in the threshold determination calculations or in emission estimates.

VOC emission estimates presented on the database were estimated using Tanks 3.1 (Table 19). Tanks 3.1 was chosen over Tanks 4.01, in order to conform with the other trial participants. Austanks was not chosen due to the issues already discussed in Section 8.3.1.

Table 19: NPI Air Emissions From Mobil

NPI Substance	Tanks 3.1 (kg)	Tanks 4.01 (kg)	Austanks (kg)
Total VOCs	**47.6**	33.9	44.5
Ethylbenzene	**0.992**	0.706	0.926
Toluene	**2.44**	1.73	2.28
Xylenes	**7.78**	5.54	7.27

8.4.2 Shell

Shell estimated emissions from the NPI NEPM Table 1 substances only. Based on their own speciation lists, diesel did not contain significant quantities of the NPI substances. The vapour pressure of the distillate is 0.7mm Hg at 15°C, and $1x10^{-4}$ for their lightest base oil (Shell, 1999). Consequently neither of these products were included in total VOC calculations and their contribution to total VOCs would be well inside the error band of emissions from the volatile fuels.

Due to proprietary reasons, Shell did not wish to make fuel throughput information publicly available. Substances that triggered reporting based on their compositions in the fuels were benzene (72 tonnes), toluene (308 tonnes), and xylene (465 tonnes).

Shell also estimated emissions of lead and compounds, which was present in the fuel as tetraethyl lead at concentrations of 0.1-0.2 g/litre. Whilst lead did not trigger the threshold at the Kalgoorlie facility, it was included by Shell to demonstrate the extremely low levels of this substance emitted from a fuel storage facility.

Shell estimated total VOC emissions using both Tanks 3.1 and Austanks. Austanks generated estimates approximately twice as high as those generated using Tanks. Shell used Gasoline RVP 7 Distillate Fuel Oil No.2 as the fuel types in Tanks 3.1 to generate total VOC estimates. It should be noted that Distillate Fuel Oil No.2 is believed to be a lighter product than typical Australian diesel fuel.

Table 20: NPI Air Emissions From Shell

NPI Substance	Austanks (kg)	Tanks 3.1 (kg)
Total VOC	6,100	3,570
Benzene	N/D	32.1
Toluene	N/D	72.8
Xylene	N/D	36.4
Lead[1]	N/D	0.06

[1] Did not trigger NPI reporting.

Table 21 presents the total VOC emissions from each of the Shell storage tanks.

Table 21: Total VOC Emission and Tank Types at Shell Kalgoorlie.

Source	Tank Type	Total VOCs (kg)	
		Austanks	Tanks3.1
Diesel	Vertical Fixed Roof	136	29.9
Diesel	Vertical Fixed Roof	56.5	69
Diesel	Vertical Fixed Roof	120	73.5
Diesel	Vertical Fixed Roof	57.5	70.5
Diesel	Underground Storage	85	14.8
Total Diesel		**456**	**258**
Unleaded Petrol	Underground Storage	**4,220**	**2,270**
Leaded Petrol	Underground Storage	**1,410**	**1,045**
Total Emissions		**6,100**	**3,570**

8.4.3 BP

Total VOCs were estimated by BP using three methods – BP Protocol, Tanks 3.1 and Austanks. In addition to estimating emissions from the storage of fuels, BP also estimated loading emissions from the gantry, which are included in their total VOC emission figure. All tanks included in the trial had fixed roofs and ranged in capacity from 82 - 460m^3.

As a means to describing BP's Estimation Protocol, the following excerpt has been taken from a report written to the trial team from BP:

> *"The primary difference between the NPI and BP methodologies is in the required level of knowledge of the tank and its operation. According to API (and USEPA) methodology, the following three approaches to emission estimation may be made:*
>
> *a) Apply estimation methodology to each individual storage tank, using a detailed inventory of tank fittings, measured values of liquid physical properties and bulk liquid temperature, annual average ambient conditions (from local measurement or from data supplied by the nearest meteorological station), etc.*
>
> *b) Apply estimation methodology to each individual storage tank, using default, calculated and/or estimated values rather than measured or actual values – e.g. for tank fittings (defaults provided within the API publication), estimated values of liquid physical properties, calculated bulk liquid temperature, annual average ambient conditions (from local measurement or from data supplied by the nearest meteorological station), etc.*
>
> *c) Apply the estimation methodology to a range of tanks, with different sizes and complement of fittings, and derive equations relating emissions to tank diameter and period under standard conditions. The emissions from a tank is then calculated from the annual average true vapour pressure of the stored liquid and the emission equation for the type and size of tank.*
>
> - *The NPI methodology appears to aim for the level of detail outlined in approach a). Therefore, the user is required to input detailed data regarding tank and fitting specifications. This detail is difficult (and time consuming) to obtain. If estimates are used due to the difficulty in obtaining this information, then the reliability of this method must be questioned.*
> - *BP methodology follows the approach outlined in c), whereby realistic estimates are obtained without requiring the level of detail requested by NPI. For a company such as BP with many tanks across Australia, this approach appears more robust, easier to implement and less open to errors resulting from obtaining or estimating incorrect detail required by approaches a) and b)."*

Table 22: NPI Air Emissions from BP

NPI Substance	BP Protocol				Tanks 3.1	Austanks
	AvGas	Jet Fuel	Gasoline	Total	All Fuels	All Fuels

NPI Substance	BP Protocol				Tanks 3.1	Austanks
	AvGas	Jet Fuel	Gasoline	Total	All Fuels	All Fuels
Total VOCs	379	4	6,000	6,350	6,700	8,200
Benzene	1.61	0.04	51.5	53	N/D	N/D
Cyclohexane	0	0	4.95	4.95	N/D	N/D
Ethylbenzene	0	0.215	2.52	2.73	N/D	N/D
n-Hexane	0	0	68.5	68.5	N/D	N/D
Toluene	0.505	0.415	44.8	45.7	N/D	N/D
Xylene	0.085	1.79	6.15	8.0	N/D	N/D

N/D: No Data.

It can be seen from Table 23 that there is a close comparison for Tanks 3.1 and the BP Protocol on both the monthly and annual emissions estimates. Austanks is comparable with these emissions estimates only on the annual basis. The Austanks results calculated on a monthly basis (3,500 kg) are less than 50% of those calculated using annual data (8,200), further confirming problems with the Austanks programme.

BP’s protocol also estimated emissions from gantry loading operations. As can be seen from Table 23, emissions from this source are relatively significant. Neither Tanks nor Austanks estimate emissions from this source. Loading emissions were not included in the total VOC emissions presented on the database.

Table 23: Comparison of Total VOC Emissions using Tanks 3.1, Austanks, and BP's Protocol at BP Kalgoorlie.

Period	Throughput (L)		Storage Emissions (kg)			Loading Emissions (kg)
	MS[1] and AVG[2]	Jet[3]	BP Protocol	Tanks 3.1	Austanks	BP Protocol
Annual	4,425,042	644,097	6,350	6,700	8,200	3,180
	0	0	0	0	0	0
January	393,851	47,825	720	705	317	318
Febuary	404,344.5	50,150	710	685	335	317
March	430,198	35,360	700	670	372	314
April	422,532	64,209	605	590	350	289
May	375,125	43,935	472	468	250	250
June	398,891	39,520	455	482	328	247
July	350,257	48,125	393	442	227	228
August	441,370	53,475	497	560	413	260
September	421,008	73,935	530	595	355	268
October	380,290	55,905	545	600	287	269
November	381,660	48,795	605	650	259	285
December	25,513	82,862	146	244	0.5	139
Total of Monthly Emissions			6,400	6,700	3,500	3,000

[1] MS: Motor Spirit (leaded and unleaded)

[2] AVG: Avgas

[3] Jet: Kerosene / Jet fuel.

8.4.4 Ampol

Ampol estimated emissions using Tanks 3.1. The fuels used to generate a total VOC estimate within Tanks 3.1 were gasoline RVP10 and distillate fuel oil no.2.

Table 24: NPI Air Emissions From Ampol

NPI Substances	Tanks 3.1	Austanks
Total VOCs	6,290	10,000
Benzene	41.1	N/D
Toluene	34.8	N/D
Xylene	9.96	N/D
1,2 – Dibromoethane	0.05	N/D
PAH's	0.79	N/D

N/D: do data

Total VOC emissions from each of the different fuels stored on site was calculated using both Tanks 3.1 and Austanks. A comparison of these emission estimates is presented in Table 24 and 25. Due to proprietary reasons, Ampol did not wish to make total throughputs of each of the fuel types available to the Trial team.

Table 25: Total VOC Emissions From Different Tanks at Ampol Kalgoorlie.

Source	Tank Type	Total VOCs (kg)	
		Tanks 3.1	Austanks
Unleaded Petrol	Vertical Fixed Roof	4,510	7,000
Leaded Petrol	Vertical Fixed Roof	1,750	2,895
Kerosene	Vertical Fixed Roof	1.15	0.05
Diesel	Vertical Fixed Roof	302	107
Total Emissions		**6,290**	**10,000**

8.5 Evaluation

8.5.1 Time and Resources

Costs incurred by the bulk storage facilities in estimating their emissions for the trial are listed in Table 26, with a further cost breakdown being provided for each facility in the following sections. The fuel companies are aware that ongoing reporting costs will be relatively small compared to initial set up costs. All depots participating in the trial had fixed roof tanks. Facilities with floating roof tanks may take considerably longer to calculate emissions estimates due to the additional tank details required.

Table 26: Set-up Reporting Costs for Bulk Storage Facilities

	Mobil ($)	Shell ($)	Ampol ($)	BP ($)
Time (hrs)	32	44	40	N/D
Cost ($)	3,200	4,900	5,000	5,800
Projected set up cost (Aust – wide)	N/D	650,000	850,000	N/D

8.5.2 Mobil

Time spent developing emissions estimations for Mobil by the trial team were partitioned as per Table 27, and calculated at a charge out rate of $100 per hour.

Table 27: Estimated Costs of NPI Reporting for Mobil Kalgoorlie

Item	Time (hours)	Recurrent	Costs ($)
Meeting Facility operator	1	no	100
Collecting fuel data	**1**	**yes**	**100**
Downloading and installing Tanks 3.1	3	no	300
Learning to use programs	10	no	1,000
Collecting meteorological data	1	no	100
Collecting data for VOC speciation equations	4	no	400
Estimating and comparing different techniques[1]	12	no	1,200
Speciating total VOC	1	yes	100
Reporting emissions	1	yes	100
Total	**34**		**3,400**
Total Recurrent Costs	**3**		**300**

[1] Does not include the speciation of total VOC into individual NPI substances that have triggered the reporting threshold.

The estimated cost of reporting for Mobil depot in Kalgoorlie was calculated as $3400. Initial set up costs were $2900, with ongoing reporting costs set at $300. The ongoing reporting costs assume that the same staff will be retained for following reporting years, and that there are no changes to the tank configurations at the facility. The depot used in the trial only had a single above ground fixed roof tank. Facilities with multiple tanks and/or with floating roof tanks would take considerably longer to calculate emissions estimates and set up reporting requirements.

8.5.3 Shell

The resources required for the preparation of NPI emissions estimates and a summary report are displayed in Table 28.

Table 28: Estimated Costs of NPI Reporting for Shell Kalgoorlie

Item	Time (hours)	Recurrent	Costs($)
Consultancy	20	Yes	2,500
Laboratory Services	24	No	2,400
Total	**44**		**4,900**
Total Recurrent Costs			**2,500**

Shell has 130 depots, as well as, 130 airfields from which it markets or distributes its products in Australia. Recurrent costs of preparing NPI reports for these sites was estimated by Shell to be $650,000 per annum. Shell suggested an integrated approach, which incorporates product vapor emissions speciation and provides electronic lodgment of the NPI report. This would significantly reduce the cost to the industry. Alternatively, it was suggested that emissions approximations could be used for sites such as depots and airfields based on a limited number of standard tank types, product throughput and average ambient temperature. Discussions on this issue were being held with the AIP at the time of writing.

8.5.4 Ampol

The cost of NPI reporting for Ampol was estimated to be $5,000. There are 170 depots through which Caltex-Ampol's products are distributed. Initial costs for the preparation of the Tanks model for all sites was estimated at $850,000. It was acknowledged that the ongoing reporting costs would be considerably lower than this, as the model would only require updating the annual fuel throughputs or when there were changes to the site's tank configurations.

8.5.5 BP

The cost of NPI reporting for the Trial for BP was $5,800, as shown in Table 29.

Table 29: Estimated Costs of NPI Reporting for BP

BP Internal Costs ($)	Consultants ($)	Total Cost ($)
1,800	4,000	6,400

8.6 Definition of VOCs

The Tanks 3.1 and Austanks calculate the total VOC emission from fuel storage tanks without actually defining total VOCs. A definition was not provided in either the Fuel and Organic Liquid Storage EET Manual or the Petroleum Refining EET Manual.

For the purpose of the trial, the definition of total VOC was:

- Any organic compound which participates in atmospheric photochemical reactions. These organics include all carbon-containing compounds except methane, carbonates, metallic carbides, carbon monoxide, carbon dioxide and carbonic acid. The compounds have a vapour pressure greater than 1mm of mercury at 25 degrees Celsius. (Carnovale, 1999).

This simplified approach is favoured over other definitions (e.g. that used by USEPA, see appendix G) that exclude certain organic compounds that are considered not to participate in atmospheric photochemical reactions. The exclusion list of VOC compounds is complicated by amendments and in numerical terms there is generally little difference in the final figure regardless of the definition used. The Table 2 NPI substances that are classed as total VOCs according to the above definition are listed in Table 30.

Using this definition diesel, having a vapour pressure of 0.7 mm Hg at 20^0C (Shell, 1999), is not classed as a VOC. Total and specific VOC emissions from diesel were found to be insignificant when compared with emissions from petrol and other volatile fuels.

Table 30: NPI VOCs

Substance	CASR Number	Substance	CASR Number
Acetaldehyde	75-07-0	Ethylene oxide	72-21-8
Acetic acid (ethanoic acid)	64-19-7	Di-(2-Ethylhexyl) phthalate (DEHP)	117-81-7
Acetone	67-64-1	Formaldehyde (methyl aldehyde)	50-00-0
Acetonitrile	75-05-8	Glutaraldehyde	111-30-8
Acrylonitrile (2-propenenitrile)	107-13-1	n- Hexane	110-54-3
Aniline (benzenamine)	62-53-3	Methanol	67-56-1
Benzene	71-43-2	2- Methoxyethanol	109-86-4
Benzene hexachloro- (HCB)	608-73-1	2- Methoxyethanol acetate	110-49-6
Chloroethane (ethyl chloride)	75-00-3	Methyl ethyl ketone	78-93-3
Chloroform (trichloromethane)	67-66-3	Methyl isobutyl ketone	108-10-1
Cumene (1-methylethylbenzene)	98-82-8	Methyl methacrylate	80-62-6
Cyclohexane	110-82-7	4,4- Methylene bis 2,4 aniline (MOCA)	101-14-4
1,2- Dibromoethane	106-93-4	Methylenebis (phenylisocyanate)	101-68-8
1,2- Dichloroethane	107-06-2	Styrene (ethenylbenzene)	100-42-5
Dichloromethane	75-09-2	1,1,1,2- Tetrachloroethane	630-20-6
Ethanol	64-17-5	Tetrachloroethylene	127-18-4
2- Ethoxyethanol	110-80-5	Toluene (methylbenzene)	108-88-3
2- Ethoxyethanol acetate	111-15-9	1,1,2- Trichloroethane	79-00-5
Ethyl acetate	141-78-6	Trichoroethylene	79-01-6
Ethyl butyl ketone	106-35-4	Vinyl Chloride Monomer	75-01-4
Ethylbenzene	100-41-4	Xylenes (individual or mixed isomers)	1330-20-7

8.7 Industry Comments

- There was a concern raised by Shell's Senior Environmental Adviser that the ability to compare NPI data that is developed over time would be lost if different companies all use different reporting protocols (Bowman of Shell, pers.com., 1999). There was also the concern that if companies used their own reporting tool, that they would need to go to six different State Authorities to obtain approval. It was therefore suggested that all companies should use the same reporting tool, be it Tanks or Austanks.

- The fuel companies were all concerned that their competitors could use the emissions data to determine market share in a given region.
- The onus for NPI reporting rests with the facility occupier, but it is clear that in general, the distributor at the site doesn't have the expertise or computing power to determine their emissions using tanks 3.1 or Austanks. The responsibility is likely to reside with the fuel companies that own, or have equity in, the facilities.
- Shell thought it unnecessary to report on substances such as lead and compounds which might trigger reporting due to the presence of tetra ethyl lead. They argue that the emission of this substance is insignificant and does not warrant the effort required to estimate the emission.
- The cost of reporting Australia wide was estimated by Shell and Ampol to be in the order of $650,000 and $850,000 respectively. During the process of learning to use the various programs, the trial team had talks with Coogee Chemicals, who have been using the programs for many years. Coogee Chemicals import a range of fuels and have a total of 18 storage tanks. In order to develop their internal reporting protocols to comply with the NPI, Coogee Chemicals employed a 3rd year Environmental Engineering student, who worked full time for four months solely on the NPI. The reporting protocol was still only approximately 90% complete at the end of this period.

8.8 Conclusions

- Emissions from diesel stored at fuel depots were estimated to be insignificant and likely to be less than the error associated with estimation of emissions from petrol and other volatile fuels.
- The Austanks programme was found to have problems and the F&OLS Manual was no help in estimating emissions from fuel tanks.
- The F&OLS Manual and Austanks only provide estimates for total VOCs. However, many industries with fuel storage depots on site will trigger reporting for NPI substances contained within the fuels, such as benzene, toluene, xylenes and ethylbenzene. The F&OLS Manual does not outline any methodology for estimating these fuel speciated emissions. The methodology is contained in the PR Manual, but it is very complex and likely to be too difficult to be used by depot operators.
- Clarification of the 25,000 tonne capacity threshold of bulk fuel storage depots is required (NPI NEPM sec. 10.2). If fuel depots are not required to report total VOCs because they are below the 25,000 tonne design capacity, then it would seem reasonable that they are also not required to report specific VOC components within the fuels such as benzene and xylene. Many of the category 1 substances are a significant component of fuels and the 10 tonne reporting threshold is easily exceeded. For example, a bulk fuel depot will trigger reporting of benzene (approximately 2.73% of ULP) if it exceeds an annual throughput (usage) of 273 tonnes.

- Tanks 3.1 or 4.01 can be used successfully to estimate total VOC emissions as long as Australian meteorological data is entered (or a suitable US surrogate city is used) and the appropriate conversions between imperial and metric units are made.
- The facility occupiers of bulk fuel depots are often just distributors for the fuel companies. They are unlikely to have the ability to determine their emissions using Tanks or Austanks programmes and will need to rely on the expertise of the major petroleum companies. NPI reporting for a given fuel companies was estimated to be up to $850,000.

8.9 Recommendations

8.1 The VOC emissions from diesel storage tanks were estimated to be less than 1% of the overall emissions from fuel storage depots[1] and considered to fall well within the error bands associated with estimating emissions from the more volatile fuels such as Aviation fuel and Motor Spirit. It is recommended that consideration be given to excluding diesel as a VOC or setting a separate reporting threshold for diesel (say 25,000 tonne storage capacity) that captures only the major distributors and refineries.

8.2 Clarification of the 25,000 tonne design capacity reporting threshold for wholesale bulk storage facilities is required. It is recommended that consideration be given to treating these facilities in a similar manner to other industries that store and use fuel on site i.e. if the 25 tonne total VOC usage threshold (regardless of design capacity) is triggered the facility should report. If however, wholesale bulk storage facilities are not expected to report total VOCs, then it is reasonable that they are also not required to estimate specific VOC emissions as a result of tripping the 10 tonne usage threshold on NPI substances contained within the fuels.

8.3 Consider developing summary tables that calculate the quantity of a fuel (e.g. unleaded motor spirit) that would need to be “used” for a facility to trigger NPI reporting. A cautionary note needs to be given that these tables would assume that the depot only used one fuel type.

8.4 Consider completing modifications to the Austanks programme as a replacement for the Tanks program as it will simplify the emissions estimation process by:

- removing the need to convert between imperial and metric units; and
- providing Australian meteorological data.

8.5 Consider developing a spreadsheet tool for speciating VOCs from common fuels into the NPI substances. The spreadsheet may be best placed within the Austanks program or similar, and should contain default values for the following variables:

- $Z_{i,L}$, liquid weight fraction of NPI component (kg/kg);
- M_i, mol. weight of NPI component (kg/kgmol);
- M_L, mol. weight of liquid stock (kg/kgmol);
- M_v, mol. weight of vapor stock (kg/kgmol);
- P, vapour pressure of pure component (kPa);
- P_{VA}, total vapour pressure of liquid stock (kPa);
- y_i, vapour mole fraction of NPI component; and
- $Z_{i,v}$, vapour weight fraction of NPI component (kg/kg).

8.6 Consider including in the F&OLS Manual the background data for speciating VOC emissions that is found in the PR Manual.

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[1] Based on results from Ampol. Emissions of VOCs from diesel were less than 1% despite diesel storage being an order of magnitude greater than all other fuels.

9 Electricity Generation

9.1 Background

There are two electric power generation plants operating in Kalgoorlie that supply electricity into the main power grid - Western Power (WP) and Tech Operations (Parkeston Power Station). Several other power generation plants operate within the study region which are attached to mine sites and their emissions were included in the emissions calculations for the respective mines.

Western Power’s Gas Turbine Station only operates when there is a break to Kalgoorlie’s normal power supply from the Perth grid. The station is an unmanned, remotely operated plant, consisting of two distillate fueled gas turbines (37MW and 25MW). The power station was operated for 54 hours during the reporting period consuming 373 tonnes of diesel at a rate of 6.9 tonnes per hour. Western Power estimated their emissions for the NPI trial.

Tech Operations operate a natural gas fired gas turbine plant at Parkeston (PP). This facility also has the potential to supplement Kalgoorlie’s power supply in case of emergencies. Under normal conditions the Parkeston Power Station supplies power to KCGM, Gidji roaster, and Jubalee Gold Mine. The plant operates three LM6000 single cycle gas turbines, each rated at 37.5MW. The trial team estimated the emissions for Parkeston Power Station.

9.2 Methodology

Similar methodologies were used by both facilities to estimate NPI emissions. These were as follows:

- Site visit to view operations and discuss usage of NPI chemicals;
- Examine historical fuel analysis records and stack emission records;
- Collect other relevant information pertaining to transfers and the 2b substances;
- Estimate emissions based on Tables 19, 20 and 21 of the Fossil Fuel Electric Power Generation EET Manual (FFEPG) (December 1998 Draft). Results were only reported for substances that had emission factors within these tables;
- Comparisons between EFs and estimations using direct monitoring data where possible; and
- Data checking and reporting.

9.3 NPI Trigger Determination

The power rating of both facilities was greater than 20MW, automatically requiring the facilities to report on all 2b substances. It should also be noted that while Western Power did not burn 400 tonnes of fuel during the reporting period, it easily exceeded the 1 tonne per hour fuel consumption rate, therefore also tripping the 2a threshold. Parkeston Power's fuel consumption automatically triggered both 2a and 2b thresholds.

Historical fuel analysis records were examined to determine if any individual NPI substances within the fuels would trigger the category 1a reporting threshold. With the exception of total VOCs, the natural gas used by Parkeston Power did not contain any NPI substances in sufficient quantities to trigger reporting[1]. Western Power's fuel usage was too low to trigger on individual NPI substances within the fuel.

Operations at the facilities were reviewed to determine if either facility triggered on other substances used on site, including cooling water treatment chemicals and solvents. Neither facility was found to trigger reporting of other substances by this manner.

9.4 Results

The results presented in Table 31 relate to the consumption of 0.017 PJ[*] (373 tonnes) of diesel by Western Power and 2.3 PJ (46,800 tonnes, or 5.77 x 10^7 m^3) of natural gas by Parkeston Power.

The FFEPG Manual had emission factors for 14 of the 21 reporting substances triggered by the 2a and 2b threshold. Substances without emission factors are shown in bold in Table 31, their emissions being reported as 'zero' on the NPI database. The EF rating (emission factor rating) in Table 31 refers to the degree of confidence that the EF estimate is representative of the actual emission. A rating of 'A' represents high level of confidence whilst 'E' is poor. A rating of 'U' represents an unrated EF. All EFs, whether rated 'A-E' or 'U', are deemed by the NPI to be of "acceptable reliability".

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[1] Natural gas is a VOC according to the definition used by the trial team.

[*] PJ (petajoule) is 10^{15} Joules

Table 31: NPI Air Emissions From Electricity Generation

Substance	**Category Threshold**	**Western Power**		**Parkeston Power**	
		Emission (kg)	**EF Rating**	**Emission (kg)**	**EF Rating**
CO	2a	300	E	7,870	DM[a]
NO_x	2a	5,100	C	1,060,000	DM[a]
SO_2	2a	2,700	B	231	B
PM_{10}	2a	400	D	42,200	E
[t] **Total VOCs**	2a	120	E	0-263[b]	DM[a]
[t] **Antimony & compounds**	1	0.161	E	0[c]	N/A
Arsenic & compounds	2b	0.036	E	0[c]	N/A
[t] **Beryllium & compounds**	2b	2.4 x 10^{-3}	E	0[c]	N/A
[t] **Boron & compounds**	1	0.48	E	0[c]	N/A
Cadmium & compounds	2b	3.1 x 10^{-2}	E	0[c]	N/A
[t] **Chromium (III) compounds**	2b	0.34	E	0[c]	N/A
Chromium (VI) compounds	**2b**	**N/D**	**N/A**	**N/D**	**N/A**
Cobalt & compounds	1	0.066	E	0[c]	N/A
[t] **Copper & compounds**	2b	9.5	E	0[c]	N/A
Fluoride	**2a**	**N/D**	**N/A**	**N/D**	**N/A**
[t] **Hydrochloric acid**	**2a**	**N/D**	**N/A**	**N/D**	**N/A**
Lead & compounds	2b	0.0043	E	0[c]	N/A
[t] **Magnesium oxide fume**	**2b**	**N/D**	**N/A**	**N/D**	**N/A**
[t] **Manganese**	1	2.6	E	0[c]	N/A
Mercury & compounds	2b	0.00066	E	0[c]	N/A
[t] **Nickel and compounds**	2b	8.8	E	0[c]	N/A
Nickel carbonyl	**2b**	**N/D**	**N/A**	**N/D**	**N/A**
Nickel subsulfide	**2b**	**N/D**	**N/A**	**N/D**	**N/A**
[t] **Polychlorinated dioxins and furans**	**2b**	**N/D**	**N/A**	**N/D**	**N/A**
Polycyclic aromatic hydrocarbons[1]	**2a**	**N/D**	**N/A**	**N/D**	**N/A**
[t] **Selenium & compounds**	1	0.039	E	0[c]	N/A
[t] **Zinc & compounds**	1	4.9	E	0[c]	N/A

[τ] Substances **only** on Table 2 of the Measure.

[a] Direct Measurement

[b] Total VOCs were below the detection limit of 0.03 kg/hr. On the database this was reported as zero, but could more accurately be described as 0-263kg.

[c] Footnote to Table 21 of the manual states that emissions of trace elements from natural gas are negligible.

N/D no data.

N/A non-applicable as there was no EF for this substance.

9.5 Transfers

Information provided by Western Power indicated that during the 6 month reporting period, they removed 50 tonnes of dirty rainwater containing an estimated 50 litres of hydrocarbons. The plant drain water collected in the main drain sump and was disposed of by a septic waste contractor.

Parkeston Power had approximately 900 litres of waste oil removed in the reporting period for recycling by a contractor. In future, the oil will be sent to Loongana Lime to be burnt in their new vertical shaft kilns.

Estimates of NPI substances contained in the waste oil and oily wastewater are presented in Table 32. These estimates are primarily based on data obtained from a report by the Oil Companies European Organisation for Environment, Health and Safety (CONCAWE, 1996). Additional information on NPI substances in oily wastewater was sourced from the Sydney Water database, which provides information on the sampling of selected substances in the effluent stream of more than 1400 industrial activities (Coffey, 1999). These estimates of NPI substances in the waste transfers are indicative only and may well be the worst case scenario, emissions may actually be zero or negligible for some or all of the substances listed.

Table 32: Transfer of NPI Substances from Power Stations

Substance	Concentration	Quantity NPI Substance Transferred in Western Power's Oily Washdown Water (kg)	Quantity NPI Substance Transferred in Parkeston Power's Waste Oil (kg)
Lead and compounds[a]	500 ppm of Hydrocarbons	0.025	0.45
Zinc and compounds[a]	5 mg/L of washdown water	2.5	-
Phosphorus[a]	750 ppm of Hydrocarbons	0.0375	0.675
Chromium and compounds[a]	Traces	Traces	Traces
Nickel and compounds[a]	Traces	Traces	Traces
Copper and compounds[a]	Traces	Traces	Traces
Tin and compounds[a]	Traces	Traces	Traces
Chlorine[a]	300 ppm of Hydrocarbons	0.015	0.27
PAH[a]	900 ppm of Hydrocarbons	0.045	0.81
Phenolic compounds[b]	5mg/L of washdown water	2.5	-

[a] CONCAWE, (1996).
[b] NSW Water database as referenced in Coffey, (1999).

As can be seen from Table 32, the quantities of NPI substances in transfers from these facilities is minor. It is also unlikely that facilities would have access to sufficient information to determine the quantities of NPI substances within their waste oil. This is almost entirely due to a shortage of waste stream speciation data. Section 12 of the Coffey Report (1999) provides a more detailed discussion of problems with estimating transfers of NPI substances.

While not the case at Kalgoorlie, the NPI substances contained within the exhaust gas from some power generation stations could be considered as a transfer. At some industrial sites the hot gas turbine exhaust from power generating units is used as a source of process heating by a neighbouring facility that reports separately to the NPI.

It should be noted that the FFEPG Manual (p9) considers ash disposal to a dam as a transfer. There were no coal fired power stations in the region and therefore this potential transfer was not investigated as part of this study, but may need to be considered as part of any future transfers study.

9.6 Evaluation

9.6.1 Data Accuracy

Both Parkeston Power and Western Power undertook a comparison of the emission factors against direct monitoring data. The results of these comparisons are presented in Table 32.

Table 33: Comparison of EFs versus Direct Monitoring at Power Stations

Substance	Western Power (diesel)			Parkeston Power (natural gas)		
	Direct Monitoring (kg)	Emission Factors (kg)	Table[a]	Direct Monitoring (kg)	Emission Factors (kg)	Table[a]
CO	<600	300	19	231	627	19
NO_x	7,100	5,100	19	1,060,000	4,76,000	20
SO_2	250	2700	19	7,870	586	20
VOCs	negligible	120	19	0-263[b]	6,000	20

[a] Refers to the EF source table in the FFEPG Manual.
[b] Total VOC's were below the detection limit of 0.03 kg/hr. On the database this was reported as zero, but could more accurately be described as 0-263kg.

As can be seen from Table 33, Western Power's direct monitoring results for diesel fueled gas turbines compared well with the emission factors in the manual. Western Power have signaled their approval of the EFs and a willingness to use Table 19 for future NPI reporting of emissions from the Kalgoorlie Gas Turbine Station (South, P., of Western Power, pers. com., 1999).

Parkeston Power’s direct monitoring results compared poorly with the EFs. The emission estimates for CO and VOCs were 22 and 15 times greater than the respective direct measurement results. Whereas the estimates of NO_x and SO_2 were 2 and 13 times less than the respective direct measurement results. Parkeston Power aim to continue using their direct monitoring data for NPI reporting. EFs will only be used for substances where direct monitoring data is not available.

9.6.2 Manuals

As noted in Section 9.4 above, a third of the substances triggered by the 2a and 2b threshold did not have an EF. The more notable exceptions were the category 2a substances: fluoride; hydrochloric acid; and PAHs.

WP indicated that there was generally a shortfall in all the EET manuals in regard to emissions to land and water (Mandyczewsky, R., of Western Power, pers. com. 1999). This shortfall was seen to indicate that the NPI would mainly be effective in providing an inventory of emissions to air. There was scope in the EET manual for discussion of chemicals used in cooling water towers, which may have the potential to trigger reporting in large facilities and would therefore require EETs.

WP was generally satisfied with the emission factors for emissions to air contained in both the FFEPG Manual and the CB Manual.

WPs main criticism of the manual was the lack of standardisation of units and the need to convert between units to use the EFs. For example, fuel must be in PJ (peta joules) in order to use the EFs, whereas fuels such as natural gas are generally purchased in cubic metres and diesel in litres or tonnes. Whilst converting between units may not pose problems for the utility companies, it is more likely to cause problems for other facilities that generate electricity as a small part of their overall operations, such as mining companies. The manual would benefit from the inclusion of generic conversion tables to for fuels used in different regions of Australia. The tables should include both the high heating values and the specific gravity of the local fuels.

Parkeston Power and the trial team were generally satisfied with the layout and usability of the FFEPG Manual for estimating emissions.

9.7 Costs

It was estimated that reporting for the trial cost WP approximately $1000 in staff time. Staff at WP had some involvement in the development phase of the NPI NEPM and therefore had a good understanding of reporting requirements. They were able to provide in-house support to the regional reporting division resulting in reduced reporting costs.

A breakdown of the costs incurred by Parkeston Power including the trial team time is contained in Table 34. The ongoing costs of reporting are estimated to be $600, significantly less than the initial cost of $2,120. Existing direct monitoring data was used to estimate emissions.

Table 34 Cost of NPI Reporting For Parkeston Power

Task	DEP Time (hours) At $100/hr	PP Time (hours) At $150/hr	Recurrent	Cost ($)
Initial Meeting	2 (2 people)	1	No	350
Correspondence	2	2	No	500
Data collection	1[a]	1[b]	Yes	250
Developing understanding of relevant EET Manuals	5		No	500
Estimating emissions	1.5[b]		Yes	150
Checking/Editing emissions estimates	1[a]	0.5[b]	Yes	175
Reporting	0.5[a]	1[b]	Yes	200
Total	**13**	**6**		**2,120**
Total Recurrent Costs For LL[a]		**4**		**600**

[a] Not included in the recurrent cost estimates.

[b] Includes recurrent costs incurred by both the DEP and WWTP. Recurrent costs are all charged out at the facility charge out rate of $150

The ongoing costs of reporting for regional power stations using a mixture of direct monitoring and EFs can be expected to be between $600 and $1000.

9.8 Industry Comments

The following are some of the main issues raised by Western Power.

- The 60,000 MW trigger is confusing. Facilities that **consume** more than 60,000 MWhrs have contacted Western Power to obtain information in order to report the emissions associated with the **generation** of the energy.
- Solar Farms and Wind Generators could potentially trigger the 60,000 MWhrs or 20MW reporting threshold as it currently stands. Reporting emissions of category 2a and 2b substances for these facilities is considered to be pointless.
- EET manuals in general should provide more information on emissions to land and water.
- A workable definition of total VOCs is needed before being required to report this substance.

- Direction is required concerning the quantity of a NPI substance that is reportable. Is there any point reporting 0.000007 mg of Arsenic just because it can be measured?
- An electronic reporting form would help facilitate NPI reporting.
- What does a facility report if there is no EF in a manual or any other estimation technique available?

9.9 Conclusions

- EFs in the FFEPG Manual were found to compare well with direct monitoring estimates for the diesel fueled gas turbines at WP, but poorly for natural gas fueled gas turbines at PP.
- Facilities should be encouraged to use existing direct monitoring data and compare emission estimates with EFs provided in the EET manuals with a view to refining the factors provided.
- The following substances did not have an EF:
  2a: fluoride compounds; hydrochloric acid and PAHs.
  2b: chromium (VI) compounds; nickel carbonyl; nickel subsulfide; and polychlorinated dioxins and furans.
- The transfer of NPI substances in waste oil and oily washdown water was found to be insignificant.
- The 2b trigger of 60,000 MWhrs was found to be confusing and ambiguous. The intent of this trigger needs to be clarified.
- The initial cost of reporting for Parkeston Power was $2,120, with recurrent costs of $600. Western Power spent $1000 in estimating their emissions.

9.10 Recommendations

9.1 Consider more emphasis in the EET manuals on potential emissions to land and water.

9.2 Consider the inclusion of generic conversion tables in the FFEPG Manual so facilities can easily convert their fuel data into the correct units to use the EFs. The tables should contain the high heating values and specific gravity of “typical” fuels found in different regions of Australia.

9.3 Consider changing the 2b, 60 000 MWhrs reporting threshold to more clearly reflect its intention. This issue needs to be clarified to ensure that facilities such as wind generators and solar farms are not required to report all the 2b (products of combustion) substances and that facilities do not report emissions on energy consumed, but generated elsewhere.

10 Loongana Lime

10.1 Background

Loongana Lime (LL) is a quicklime producer operating 5km to the north of Kalgoorlie. The plant is supplied with crushed limestone from Loongana on the Nullabor and coal from Collie. The limestone is converted to quicklime in a coal fired fluidised bed kiln. The facility employs 20 full time staff, and consumed 1800 tonnes of coal to produce approximately 9000 tonnes of quicklime during the reporting period.

10.2 Methodology

The general steps taken in estimating emissions for Loongana Lime were:

- Initial meeting between trial team and LL General Manager to determine triggers and explain the approach for NPI reporting;
- The General Manager was the only person on site able to estimate emissions. After approximately 2 months, it became apparent that the General Manager did not have the time to estimate emissions, but agreed to collect data in order for the trial team to calculate emissions on LL's behalf;
- The trial team estimated emissions using Lime and Dolomite Manufacturing EET Manual (February 1999 draft) (L&DM), Mining (final version), and Combustion Engines (CE) (final version); and
- LL checked the emissions estimates.

10.3 NPI Trigger Determination

Loongana Lime consume 3600 tonnes of coal per year triggering the 2b threshold. A basic coal speciation list was provided by LL, but did not include any of the relevant NPI substances other than sulfur (used to estimate SO_2 emissions). NPI substances would have been required to be present in coal at levels greater than 0.28%, in order to trigger the 10 tonne threshold during 12 months of operation.

No other NPI substances were used at LL in quantities sufficient to trigger reporting.

In future years, LL will be operating two additional kilns, fueled by waste oil. Table 37 displays the results of analysis of a composite sample of waste oil currently stored on-site.

The mining and crushing of the limestone is undertaken at Loongana, on the Nullabor Plain, before being transported 500km by rail to Kalgoorlie for processing. It was clear that the LL processing plant is a separate reporting facility to the Loongana mine site, even though they were both part of a single operation. For further discussion of facility boundaries, refer to Section 16.2.

10.4 Results

Table 35 contains a summary of the emissions to air. The main emission sources were the kiln and loading vehicles as well as general fugitive PM_{10} emissions. The facility disposed of the bag house rejects on-site. This flyash may have contained NPI substances, such as heavy metals, however, estimates of emissions to ground could not be made, as analysis data was not available.

Table 35: NPI Air Emissions from Loongana Lime.

Substance	**Forklift and 928 Loader (kg)**	**Kiln (kg)**	**Totals (kg)**
CO	197	1980	2,180
NOx	345	4320	4,670
PM_{10}	32	693	7,960[a]
SO2	101	7470	7,480
[t] **Total VOCs**	49.2	0	49.2
Arsenic, [t] Beryllium, Cadmium, Chromium (III), [b]Chromium (VI), [t] Copper, [t] Hydrochloric Acid, [b]Fluoride, Magnesium [b]Oxide Fumes, Mercury, [t,b]Nickel and Compounds, [b]Nickel Carbonyl, [b]Nickel Subsulfide, Lead, Total PAH's, [t] Total Dioxins, [t] Total Furans.	0[b]	0[b]	0[b]

[t] Substances **only** on Table 2 of the Measure.

[a] This total includes fugitive sources of PM_{10}'s. See Table 36 for more information.

[b] No EET's available.

The trial team found that a large proportion (approximately 85%) of the time taken to estimate emissions from the site was spent on estimating the fugitive PM_{10} emissions. The estimation of PM_{10} emissions required the use of 3 different EET manuals and 6 tables. The complexity of estimating PM_{10} emissions is shown in Table 36 which presents all the sources of PM_{10} considered at the site (10 non-combustion and 3 combustion sources). Loongana Lime is currently expanding their plant, which when completed, will lead to approximately 18 additional fugitive dust sources of PM_{10} emissions.

Table 36: PM_{10} Emission Estimates For Loongana Lime

Source	**Total PM_{10} Emissions (kg)**	**Assumptions Made and Source of Emission Factors**
Fugitive PM_{10} Emissions		
Equipment traffic	5840	Table 1 - EET Manual for Mining. Average speed of 20km/h 2hr a day 182 days per year.
Kiln Stockpile	0	Table 10, EET manual for Lime and Dolomite Manufacturing. Enclosed stockpile, with 100% control of emissions.
Coal stockpile	26	Using EF for coal stockpiles from Table 1 of EET Manual for Mining. 1 tonne of material occupies 1m^3 of space and average height of stock piles is 2.5m (9000tonne)
Product loading, enclosed truck (lime)	1320	Table 9, EET Manual for Lime and Dolomite Manufacturing. 9000 tonne of product handled
Product transfer and conveying	45	Table 9, EET Manual for Lime and Dolomite Manufacturing. 99% control achieved through a bag house filter. 9000 tonne of product handled
Secondary crusher	1.80	Table 10, EET Manual for Lime and Dolomite Manufacturing. Crushing with use of a fabric filter. 9000 tonne of product handled
Crushed material conveyor transfer with fabric filter	2	Table 9, EET Manual for Lime and Dolomite Manufacturing 9000 tonne of product handled
Total Fugitive PM_{10} Emissions	**7230**	
Combustion Emissions		
Calcinating, Cooling, and Hydrating	693	Table 4, EET Manual for Lime and Dolomite Manufacturing. 9000 tonne of Quicklime produced
928 Loader Emissions	29	Table 4, for Wheeled Tractor, EET Manual for Mining Operates 2 hr/day 182 days in reporting period
Emissions from Forklift	3	Table 1, and equation 3, EET Manual for Combustion Engines. Operates 2 hr/day 182 days in reporting period
Total Combustion PM_{10} emissions	**725**	
Total	**7960**	

The results obtained using the EFs indicate that vehicle movement generated 73% of the fugitive PM_{10} emissions emitted from the site. A summary of these PM_{10} sources is presented in Figure 8. Combustion sources of PM_{10} emissions accounted for only 9% of total PM_{10} emissions at LL.

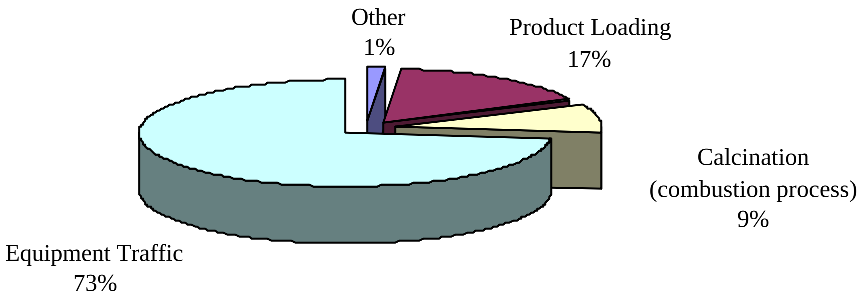

Figure 8: Major PM_{10} Sources from Loongana Lime.

10.5 Transfers

Loongana Lime stated that the only substances taken off site were their products of limestone and quicklime. Bag house rejects are disposed of on-site. In future, these rejects will be blended into the product.

LL was in the process of constructing two new vertical shaft kilns that were to be fueled by waste oil. Estimates of some NPI substances in the waste oil were provided by LL, and are listed in Table 37. The waste oil analysis was a composite of oils transferred **to** LL from many sources and may be used as a generic analysis for NPI substances in waste oil transferred **from** other sites in the region.

Table 37: NPI Substances in Composite Waste Oil Sample.

Substance	Concentration
Cadmium	1 mg/kg
Chlorine	11 mg/L
Chromium	5 mg/kg
Copper	30 mg/kg
Lead	156 mg/kg
Mercury (total)	0.015 mg/L
Polychlorinated biphenyl's	<0.2 mg/kg
Sulfur	0.74 %w/w
Zinc	533 mg/kg

10.6 Evaluation

10.6.1 Data accuracy

All emissions estimates were calculated with emission factors rated as D, E or U. Consequently, it can be assumed that the data is *'of acceptable reliability'*, but of uncertain accuracy.

Direct monitoring of the stack gases, NO_x, SO_2, and CO, was undertaken at the site in 1997 to comply with DEP licence requirements. These results are displayed along with estimates using EFs in Table 38. The EF generated data was forwarded for display on the internet database as the direct monitoring results were obtained after the emissions data had been signed off by LL.

Table 38: Comparison of EFs versus Direct Monitoring

Substance	Direct Monitoring (kg)	Emission Factor (kg)
CO	24,206	1,980 (19,980)[b]
NO_x	31,174	4,320 (5,220)[b]
SO_2	6,487	7,470 (12,735)[b]
PM_{10}	1,085[a]	693

[a] Upper limit of licence was used (250mg/m^3) as no monitoring data available for PM_{10}.

[b] Numbers in brackets are the results obtained if EFs for both Table 5 and 6 of the manual are summed. Units for Ttable 6 EF assumed to be; kg per tonne of quicklime produced.

Table 38 indicates there is a significant variation between the direct monitoring estimates and those generated using emission factors. The draft L&DM Manual was unclear regarding the use of EFs to estimate the emissions of criteria pollutants from kilns (see following section). It was not apparent to the trial team or LL whether to use EFs just from Table 5[1] in the manual or to sum the results obtained using Tables 5 and 6[2] (bracketed results in Table 38, above). It was decided to use EFs from Table 5 only, due to a lack of units for the EF in Table 6, and an inability to locate the source of the original table in the AP-42 website. There was poor agreement between the EF estimates and the direct monitoring results when either of the above approaches were used.

The emissions of substances from the forklift and 928 loader was 5-10% of the total PM_{10}, CO and NO_X emissions from the kiln. The vehicles used only 0.3% as much fuel as the kiln and so their emissions seem disproportionately high.

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[1] "Emission Factors for Lime Manufacturing – Coal and Gas Kilns"

[2] "Emission Factors for Lime Manufacturing – Raw Material Calcining"

10.6.2 Manuals

Most emissions for the facility were estimated using the February 1999 draft L&DM EET Manual.

Loongana Lime operates one of only two coal fired fluidised bed kilns in Australia. AP-42, from which the relevant manual was derived, stated that *"other, much less common, kilns include ... fluidised bed kilns... can achieve high production rates but cannot operate on coal"* [emphasis added] (AP-42, 11.17-1, 1998). Consequently there were no emission factors for LL's fluidised bed kiln for NO_X, SO_2, or CO. Other emission factors presented in the manual were generic, in that they were averages of many kilns in America, using various fuels and various kiln types. While these EFs could be used for LL's kiln, being of such a generic nature the results obtained may not be very reliable.

Loongana Lime's emissions were calculated by the trial team. Neither the trial team nor LL were able to determine the reason for, or difference between Table 5: "Emission Factors for Lime Manufacturing - Coal and Gas Kilns", and Table 6 "Emission Factors for Lime Manufacturing - Raw Material Calcining". Both tables contained EFs for SO_2, NO_X, and CO, for different kiln types. Neither table contained EFs relating to fluidised bed kilns used by LL. Table 6 appeared to be an unnecessary duplication of Table 5. Table 5 is referenced to Section 11.17 of AP-42 (1996), however; there was no table in the 1998 version of AP-42, Section 11.17, corresponding to Table 6 of the EET manual. Consequently, no emission estimates were made using Table 6. In addition, there were no units for the emission factors presented in Table 6 and it was unclear whether to multiply the EF by the total product produced, or by the total coal consumed.

Tables 7 and 8 of the manual contained EFs for inorganic and organic substances respectively, based on the amount of clinker produced. LL does not produce any clinker, which forms at temperatures over 1400^{o}C (Esubiyi, 1996). There was no explanation of clinker in the handbook and it was assumed that these emissions did not relate to LL's operations.

The manual did not contain relevant EFs for some category 2 substances. Table 39 below, indicates the substances for which EFs or other estimation techniques were available in the manual, as well as an indication of whether or not these emission factors were relevant for LL. In some cases, the EFs considered by the trial team not to be relevant were still used, as they were the only means of gaining any estimation of those emissions.

Table 39: Relevant Emission Factors Available for Substances Triggered by Loongana Lime

2b Substances	Relevant EF	Other NPI Substances	Relevant EF
Arsenic	yes	Acetone	no
Beryllium	yes	Ammonia	yes
Cadmium	yes	Benzene	yes
Carbon monoxide	no	Carbon disulfide	no
Chromium	yes	Chlorine	yes
Copper	yes	Ethylbenzene	no
Fluoride	no	Formaldehyde	yes
Hydrochloric acid	yes	Manganese	no
Lead	yes	Methyl ethyl ketone	no
Magnesium oxide fumes	no	Phenol	no
Mercury	yes	Selenium	yes
Nickel	yes	Sulfuric acid	yes
Nickel carbonyl	yes	Styrene	no
Nickel subsulfide	yes	Toluene	no
Oxides of Nitrogen	no	Zinc	yes
Particulate Matter 10.0*um*	Not for Combustion		
Sulfur dioxide	no		
Sulfur trioxide (SO_2 equivalent)	yes		
Total PAH's			
Total polychlorinated dioxins	yes		
Total polychlorinated furans	yes		
Total VOC's	no		

The manual also has no emission factors for kilns that burn waste oil, which will be required by LL when they convert from coal burning.

10.7 Costs

Time spent on the NPI reporting process is as depicted in Table 40. The charge out rates of $100 per hour for trial team time and $150 per hour for LL time was selected to maintain consistency with the charge out rates of consultants that have been working on the NPI and with cost estimates by other facilities. The recurrent cost of reporting for Loongana Lime was estimated at $860 (5.75 hours), considerably less than the initial setup cost of $2150 (19.25 hours).

Table 40: Cost of NPI Reporting For Loongana Lime.

Task	DEP Time (Hours) At $100/hr	LL Time (Hours) At $150/hr	Recurrent	Cost ($)
Initial Meeting	2 (2 people)	1	No	350
Correspondence	2	1	No	350
Data collection	1	1[b]	Yes	250
Developing understanding of relevant EET Manuals	5		No	500
Estimating emissions	3[b]		Yes	300
Checking/Editing emissions estimates	0.75	0.75[b]	Yes	187
Reporting	1[b]	0.75	Yes	212
Total	**14.75**	**4.5**		**2,150**
Total Recurrent Costs For LL[a]		**5.75**		**860**

[a] Includes recurrent costs incurred by both LL and the trial team. Recurrent costs are all charged at LL's charge out rate of $150/hr.

[b] Time included is recurrent cost estimate.

10.8 Industry Comments

No specific comments were provided by LL.

10.9 Conclusions

- The February 1999 draft Lime and Dolomite Manufacturing EET Manual did not cover the fluidised bed process used by Loongana Lime, nor the combustion of waste oils in vertical shaft kilns (required by LL in the future). The manual was found to be difficult to use and was considered not to provide clear guidance on selecting the right tables to determine kiln emissions to air.
- Direct monitoring results for the criteria pollutants were significantly different to estimates obtained using EFs.
- No NPI wastes were identified as being transferred off site, although the facility is currently storing waste oil transferred **from** other industries, for use as a fuel in their new kilns.
- Approximately 85% of the time taken to estimate the emissions for the site was utilised in determining the fugitive sources of PM_{10} emissions.
- The recurrent cost of reporting for Loongana Lime was estimated to be $860 (5.75 hours) with initial setup costs for the first years reporting estimated at $2150 (19.25 hours).

10.10 Recommendations

10.1 The draft Lime and Dolomite Manufacturing EET Manual requires some changes to make it more workable.

11 Boral Asphalt

11.1 Background

Boral Asphalt operates a drum mix asphalt plant in Kalgoorlie that produces approximately 10,000 tonnes of bitumen per year.

11.2 Methodology

Emission estimates were undertaken by the trial team, with the State Manager for Boral Asphalt responsible for collecting the required data.

In order to use the emissions factors presented within the February 1999 draft EET Manual for Hot Mix Asphalt Manufacturing (HMAM), the following information was required:

- Quantity of Asphalt produced;
- Process type (batch mix or drum asphalt plant); and
- Type and quantity of fuel used.

11.3 NPI Trigger Determination

The Boral Asphalt Kalgoorlie plant used approximately 30 tonnes of LPG to produce nearly 5000 tonnes of asphalt in the reporting period. LPG is almost entirely C3 and C4 hydrocarbons (99.8%), and fall within the “trial” definition for total VOCs (see Section 8.6). Boral therefore triggered the 25 tonne, 1a, threshold. An analysis of LPG indicated that there were no appreciable quantities of any other NPI substances.

Asphalt is made up of roughly 5% bitumen and 95% fill material (Johnson, S. of BP, pers. com., 1999). The bitumen is the crude fraction remaining from the distillation of oil and is a cementitious material composed principally of high molecular weight hydrocarbons (Kroschwitz, 1992). Boral did not have a speciated profile of the asphalt that was required for the determination of the quantities of NPI substances present in the bitumen. A profile was, however, provided by BP as displayed in Table 41. Also depicted is the quantity of bitumen that would need to be ‘used’ at a facility in order to trigger a reporting threshold.

Table 41: Bitumen Analysis and Usage Required to Trigger NPI Reporting

Substance	Concentration (ppm)	Minimum Bitumen 'Usage' Required to Trigger Reporting
Arsenic	<5	2,000,000 tonnes
Chromium	<2	5,000,000 tonnes
Cobalt	<0.1	10,000,000 tonnes
Lead	<5	2,000,000 tonnes
Mercury	<0.5	20,000,000 tonnes
PAHs	14.4[a]	Combustion of 400 tonnes of fuel, or 1 tonne per hour.

[a] This was the highest value obtained from several analyses.

In summary, Boral Asphalt only triggered the reporting of total VOCs. Estimations of other substances from the facility were included in the trial in order to gain a broader understanding of different reporting facilities and to further explore the issues of suitable threshold levels and transfers.

11.4 Results

Estimates of all NPI emissions for which emission factors were available are presented in Table 42. All emissions are to air. No EETs were available to estimate fugitive emissions of total VOCs from the LPG pressure tanks. Emissions from this source were assumed to be zero in accordance with comments made in the EET manual for Fuel and Organic Liquid Storage that:

> *"under ideal conditions, high pressure tanks can be used with little or no operating losses…"(p. 9).*

Table 42: NPI Air Emissions from Boral Asphalt.

Substance	**Category**	**Emissions From Dryer[a] (kg)**	**Emissions From Combustion[a] (kg)**	**Total Emissions [a,b] (kg)**
CO	2a	13.5	111	125
NOx	2a	7.24	811	818
PM_{10}	2a	1060	23.2	1,090
SO_2	2a	0.821	0.101	0.922
[t] **Total VOCs**	1a and 2a	0.852	483	484
Acetone	1	0	ND	0
Arsenic	1 and 2b	0	ND	0
Benzene	1	0.290	1.16	1.45
[t] **Beryllium**	1 and 2b	nd	ND	nd
Chromium (total)	1 and 2b	0.003	ND	0.003
[t] **Copper**	1 and 2b	0.001	ND	0.001
[t] **Cyclohexane**	1	ND	0.290	0.290
[t] **Dioxins and Furans**	2b	ND	ND	ND
Fluoride	2a	ND	ND	ND
[t] **Formaldehyde**	1	0.381	2.32	2.70
[t] **n-Hexane**	1	ND	0.290	0.290
[t] **Hydrochloric Acid**	2a	ND	ND	ND
Lead	1 and 2b	0.001	ND	0.001
[t] **Manganese**	1 and 2b	0.003	ND	0.003
Mercury	1 and 2b	0	ND	0
[t] **Nickel and Compounds**	1 and 2b	0.004	ND	0.004
Nickel Carbonyl	2b	ND	ND	ND
Nickel Subsulfide	2b	ND	ND	ND
PAHs	2a	0.036	ND	0.036
[t] **Selenium**	1 and 2b	ND	ND	ND
Toluene	1	0.048	0.579	0.628
Xylenes	1	0.097	ND	0.097
[t] **Zinc**	1 and 2b	0.010	ND	0.010

[t] Substances **only** on Table 2 of the Measure.

[a] All emission factors are rated E.

[b] Sum of emissions from the dryer and from LPG combustion

11.5 Transfers

Approximately 100 tonnes of waste was transferred off site in the reporting period. Most waste is generated at the beginning and end of each production run and consists of aggregate, cold bitumen and dust collected from the wet scrubber. Table 43 presents an estimate of the quantities of NPI substances transferred off site assuming:

- Asphalt consists of 5% bitumen and 95% fill, i.e. 5 tonnes of the transferred waste was bitumen; and
- The quantities of NPI substances in the bitumen was at the detection limit of the speciation profile provided by BP (i.e. Arsenic = 5ppm if reported as <5ppm).

Table 43: Transfer of NPI Substances From Boral Asphalt

Substance	Concentration (ppm)	Quantity of Substance Transferred (kg)
Arsenic	<5	0.025
Chromium	<2	0.01
Cobalt	<0.1	0.0005
Lead	<5	0.025
Mercury	<0.5	0.0025
PAH's	14.4*	0.072

The bulk of the "waste transfer" was donated to the local sporting clubs (e.g. the go-cart club) for use as road base. The balance was used as fill material at the Kalgoorlie landfill site. Given that bitumen is generally taken off site for use as road base, there appears to be no advantage in speciating this "waste bitumen" and counting it as a transfer. The low levels of NPI substances contained within the waste supports this notion.

11.6 Evaluation

Table 44 presents a comparison between emissions from Boral, which triggered reporting only on total VOCs, and two other relatively small operations (Western Power, and Kalgoorlie Regional Hospital) that triggered the 2a or 2b thresholds. All three facilities only estimated PM_{10} emissions from combustion processes and not from vehicle movement/windblown sources.

The facilities used in the comparison consumed the following quantities of fuels:

- Kalgoorlie General Hospital – 350 tonnes of diesel in 6 month reporting period;
- Western Power - 393 tonnes of diesel in 6 month reporting period; and
- Boral Asphalt: 30 tonnes LPG in 6 month reporting period and use of 5000 tonnes of bitumen.

Table 44: Comparison of Emissions From Boral Asphalt, Western Power and Kalgoorlie Regional Hospital.

Facility	Substance (kg)				
	CO	SO_2	NO_x	PM_{10}	Total VOCs
Boral Asphalt	125 (19%)[a]	0.92 (0%)	819 (12%)	1090 (71%)	484 (78%)
Western Power	300 (45%)	2700 (44%)	5100 (74%)	400 (26%)	120 (19%)
Kalgoorlie Regional Hospital	238 (36%)	3381(56%)	954(14%)	47.7 (3%)	16 (3%)

[a] Numbers in brackets indicate the relative percentage of the total emissions from these three facilities.

The data from Table 44 is summarised in Figure 9 below.

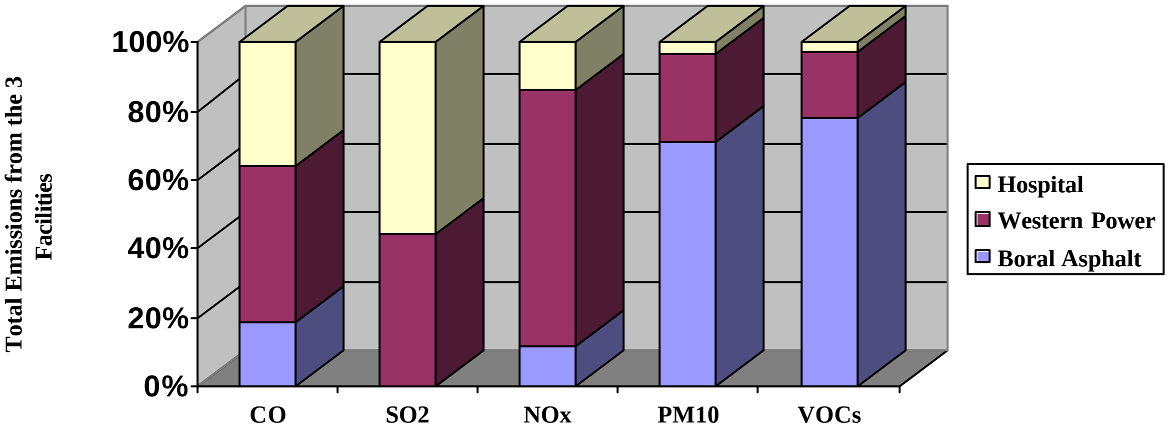

Figure 9: Comparison of Emissions from Boral Asphalt, Western Power and Kalgoorlie Regional Hospital.

Boral Asphalt, although not required to report VOCs, CO and NO_X, and PM_{10} emissions with the current threshold limits, was estimated to emit similar quantities of these substances to the reporting facilities of WP and KRH.

11.6.1 Data accuracy

The emissions estimates for Boral Asphalt were all undertaken using EFs rated E. In addition, estimates of PM_{10}, CO, NO_x, and SO_2, were all based on a natural gas fueled plant as EF were not available for LPG which is used at Boral. No direct monitoring data was available to compare with the EF estimates.

11.6.2 Manuals

Neither the HMAM (February draft) nor the F&OLS (final version) EET Manuals present methods for determining fugitive emissions of LPG from pressure tanks.

The emission factors for, CO, NO_x, SO_2 and PM_{10} emissions were limited to a choice of only two fuels, natural gas and oils. As Boral Asphalt used LPG, the EF for natural gas was used. The accuracy of this approach is not known.

Whilst it may be spelt out in the Measure that mobile sources of emissions do not need to be included in emissions estimates, this issue is not clear in the HMAM EET Manual. This manual makes reference to diesel generators *"used in portable hot mix asphalt plants to provide electricity."* The reader is referred to the Combustion Engines EET manual, indicating that emissions from this source need to be calculated. Section 9. (5) (a), of the Measure indicates *that a mobile emission source operating outside the boundaries of a fixed facility* would not be required to report under the NPI[1].

The process flow diagram at the beginning of the manual displays the likely emission points of NPI substances, however the manual does not appear to correlate well with this diagram. The diagram indicates that PM_{10} emissions are emitted from the 'reclaimed asphalt pavement bin and conveyor', 'cold aggregate bins', 'screening', 'collector' and 'storage or transport offsite'. The manual only provides an EF from the dryer. As such, it is likely that the estimates of PM_{10} emissions have been underestimated.

11.7 Costs

The costs of reporting for this facility were lower than most of the other facilities as all EFs pertaining to the site were contained in a single EET manual. The costs associated with the estimating and reporting of emissions for the trial was $1475, as detailed in Table 45. The charge out rates of $100 per hour for trial team time and $150 per hour for Boral Asphalt time was selected to maintain consistency with the charge out rates of consultants that have been working in the NPI and with cost estimates by other facilities.

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[1] Section 9. (5)of the Measure states:
In this clause "facility" does not include:
(a) a mobile emission source (for example, an aircraft in flight or a ship at sea) operating outside the boundaries of a fixed facility;

Table 45: Costs of NPI Reporting for Boral Asphalt Kalgoorlie.

Task	DEP Time (hrs)	Boral Time (hrs)	Recurrent	Cost ($)
Initial meeting (DEP and Boral State Manager)	2 (2 people for 1 hour)	1	No	350
Data Collection (Boral State Manager)	0	1[b]	Yes	150
Developing understanding of EET manual	4	0	No	400
Emissions estimation (DEP Technical Officer)	2[b]	0	Yes	200
Editing/checking emissions estimates	1	1[b]	Yes	250
Reporting (Boral State Manager)	0.5	0.5 [b]	Yes	125
Total	**9.5**	**3.5**		**1,475**
Total Recurrent[a]		**4.5[a]**		**675[a]**

[a] Includes recurrent costs incurred by both the trial team and Boral. Recurrent costs are all charged out at the facility charge out rate of $150.

[b] Time included in recurrent cost estimates.

11.8 Industry Comments

Boral did not have information on NPI substances contained in asphalt.

11.9 Conclusions

- Boral Asphalt did not trigger the 2a threshold, but could be considered a ‘significant’ emitter of a number of criteria pollutants when compared to several of the other smaller facilities that triggered reporting of these substances.
- Boral triggered reporting on VOCs. Emission factors are not available for emissions from LPG high pressure tanks in either the HMAM or the F& OLS manuals, although it is referenced that emissions from high pressure tanks are minimal under ideal conditions.
- EFs were not available for LPG operated plants.
- Only small quantities of NPI substances (<0.075kg) were identified in wastes transferred.
- The initial cost of reporting was $1475, with the recurrent costs estimated at $675.

11.10 Recommendations

11.1 Consider including in the HMAM Manual the NPI substances found in bitumen and the quantities generally required to trigger reporting.

11.2 A review of the HMAM Manual should include EFs for other fuel types, such as LPG. It is also considered Section 3.2 of the manual relating to generator emissions from portable hot mix asphalt plants should be deleted.

12 Kalgoorlie Regional Hospital

12.1 Background

This site is a general public hospital employing approximately 400 people. The Kalgoorlie Regional Hospital (KRH) triggered the category 2a threshold through the combustion of diesel in their boilers. The hospital operated one 150 kilowatt and two 75 kilowatt boilers, all of which were over 35 years old. It was expected that all three boilers were to be replaced with fully automated gas turbines within the next reporting year.

12.2 Methodology

The trial team estimated all emissions on behalf of Kalgoorlie Regional Hospital, as the hospital did not have the staff for this task. The following steps were taken in estimating emissions:

- Initial meeting with the hospital Administrator to identify: likely triggers; boiler type and configurations; and approach to reporting.
- The hospital staff conducted a stores inventory check for NPI substances.
- Purchasing officer identified records of diesel usage in the reporting period.
- The trial team estimated emissions using Tables 30-34 of the EET Manual for Combustion in Boilers (final version).
- Confirmation of emission estimates with Manager of Business Services.

12.3 NPI Trigger Determination

The hospital uses just over 700 tonnes of diesel per year triggering reporting of 2a substances. A stores inventory check revealed that the hospital held only small quantities of other NPI substances and clearly would not trigger reporting of individual category 1 substances.

12.4 Results

The emission estimates presented in Table 46 relate to 2a substances and were derived using emission factors presented in the Combustion in Boilers (CB) EET Manual.

Table 46: NPI Air Emissions from Kalgoorlie Regional Hospital

Substance	Emission (kg)	Table	Emission Factor Rating
CO	238	31	A
NO_x	954	30	A
PM_{10}	47.7	32	E
SO_2	3,380	30	A
[t] **Total VOCs**	15.9	31	A
Fluoride Compounds	ND	33	-
[t] **Hydrochloric acid**	ND	-	-
PAH's	0.057	34	E

[τ]Substances **only** in Table 2 of the Measure.

12.5 Transfers

No data was available on the transfer of NPI substances from the hospital, although it is known that some wastes are taken to the local landfill for disposal. As the hospital did not trigger reporting for any category 1 substances, it was clear that any transfer of a given NPI wastes would also be less than 10 tonnes per year and therefore not be reported if the same thresholds are applied.

12.6 Evaluation

In order to place the emissions estimates in context, a comparison was made between Western Power, which used comparable quantities of fuel in the reporting period (373 tonnes of diesel versus 354 tonnes of diesel for the hospital). Western Power also serves as a good point of comparison as they used direct monitoring data. It needs to be noted that there is an inherent difference between the two sites, in that the hospital operates diesel-fired boilers, whereas Western Power operates diesel-fired gas turbines. This comparison simply serves to show that emissions from the hospital are significant when compared with the emergency operated power station[1].

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[1] The power station only operated for 54 hours in the reporting period.

Table 47: Comparison of Kalgoorlie Regional Hospital and Western Power

Substance	Emission (kg)			
	Hospital	EF Rating	Western Power	EF Rating
CO	238	A	300	E
NO_x	954	A	5,100	C
PM_{10}	47.7	E	400	D
SO_2	3,380	A	2,700	B
Total VOCs	15.9	A	120	E
Fluoride Compounds	N/D	-	N/D	-
Hydrochloric acid	N/D	-	N/D	-
PAH’s	0.057	E	N/D	-

12.6.1 Data accuracy

The EFs for boilers were mostly rated as ‘A’, which was generally higher than EFs used elsewhere in the trial. There was no direct monitoring data available to validate the EFs.

12.6.2 Manuals

The EET Manual for Combustion in Boilers (published version) was not easy to use and it took some time to identify the relevant emission factors. Specific problems encountered whilst determining the emission factors included:

- A general understanding of the combustion process was required to determine if the boilers had a low NO_x burner, tangential or normal firing, atomising or vapourising space heaters, post or pre NSPS wall-fired boilers etc. More information in the CB Manual on those alternate configurations would help categorise the boilers. The 2a reporting threshold can be triggered by small facilities that do not have the on-site residential expertise required to classify their boiler. The trial team after some investigation did this on behalf of KRH.
- Fuel oil was classified into distillate and residual, with further grading into numbers. 1, 2, 4 5 and 6 (bunker C). The relevance of these classifications in the Australian context was questioned. Some further explanation on fuel categories was required.
- The CB Manual includes some American terminology, such as: residential furnaces (a boiler category) and further explanation is required to help the user.
- Facilities are required to convert between energy units to estimate emissions. Many facilities will not have the resources to do this. The manual would benefit from the inclusion of generic conversion tables for different regions of Australia. The tables should include both the high heating values and the specific gravity of the local fuels.
- The use of initials to describe equipment made it difficult to follow e.g. SCR, FBC etc.
- Example calculations may be better placed in an appendix.

- Some discussion on emissions to land and water, including emissions from chemicals commonly added to the cooling water system would be beneficial.
- It was not clear whether there was a difference between a 'normal fired' and 'large wall fired' boiler (CB Manual, Table 2, p.3).

12.7 Costs

The costs of reporting were partitioned as per Table 48.

Table 48: Costs of NPI Reporting for Kalgoorlie Regional Hospital

Task	DEP Time (hrs)	Hospital Time (hrs)	Recurrent	Cost ($)
Initial meeting (trial team and Hospital Administrator)	2	1	No	350
Data Collection (Purchasing Officer)	0	0.5	Yes	50
Developing understanding of EET manual (trial team Technical Officer)	3	0	No	300
Emissions estimation (trial team Technical Officer)	1	0	Yes	100
Editing/checking emissions estimates	0.5[a]	0.5	Yes	125
Reporting (Manager of Business Services)	0.5[a]	0.5	Yes	125
Total	**7**	**2.5**		**1,050**
Total Recurrent [b]	**3[b]**			**350[b]**

[a] Not Included in recurrent cost calculations.

[b] Includes recurrent costs incurred by both the trial team and Boral. Recurrent costs are all charged out at the facility charge out rate of $150.

12.8 Conclusions

- A significant number of small facilities that have a boiler are likely to trigger the category 2a reporting threshold. It was evident from the trial that the boilers can be very old (35 years at KRH) and difficult to categorise due to limited information on design type and virtually no on-site expertise. The trial team initially experienced difficulty in applying the appropriate EFs until some understanding of boiler types was gained. It would be advantageous for regulators to have a reasonable understanding of the CB Manual to help small facilities comply with NPI reporting.
- Within the context of the study the hospital boiler was not an insignificant emitter of category 2a substances.

- The CB EET Manual was considered to be difficult to use and more explanation on boiler types using Australian terminology would be beneficial.
- The hospital did not appear to have the on-site expertise to estimate NPI emissions from their boiler.
- The hospital was found to be below the threshold for reporting the transfer of wastes and no data was collected.
- The initial cost of reporting was estimated to be $1,050 (9.5 hours), with subsequent years costing approximately $350 (3 hours).

12.9 Recommendations

12.1 During the next review of the Combustion in Boilers EET Manual a more user – friendly approach would be beneficial, in keeping with the fact that many of the users of this manual may have limited knowledge of boiler specifications and configurations.

12.2 It would be advantageous for regulators to have a reasonable understanding of the Combustion in Boilers EET Manual to help small facilities comply with NPI reporting.

13 South Boulder Wastewater Treatment Plant

13.1 Introduction

Kalgoorlie Boulder City Council operates two wastewater treatment plants in the study area, of which, South Boulder Wastewater Treatment Plant (WWTP) participated in the trial. The WWTP is a 6 mega liter per day lagoon oxidation plant, consisting of 6 lagoons spread over 30 hectares. A large proportion of waste entering the system was primarily from domestic sources as most industrial facilities in the region use septic tanks. Discharges from the lagoons either overflow into Gribble Creek or are treated and used for irrigation purposes around Kalgoorlie Boulder.

13.2 Methodology

The following methodology was used to estimate emissions from the facility:

- The trial team and Kalgoorlie Boulder City Council jointly identified reporting requirements.
- Facility staff collected data on throughputs and pond area.
- The trial team collected single samples of influent and effluent waters for analysis.
- The trial team collected information on net evaporation in Kalgoorlie to determine losses from the system.
- Developed site specific spreadsheets to estimate triggers and emissions and compare estimations using different methodologies.
- Editing and revising emission estimates.
- Data verification by WWTP staff.

13.3 Identification of Reporting List

After treatment in the settling ponds, effluent from the WWTP either overflows into Gribble Creek or is treated with chlorine and used for reticulation purposes around Kalgoorlie - Boulder. As Gribble Creek is normally dry apart from the WWTP effluent, the emissions were deemed as going to land. Gribble Creek drains to a large salt lake.

The trial team identified a list of substances with the potential to trigger reporting based on Tables 1, 3 and 4 of the February 1999 draft EET Manual for Sewage and Wastewater Treatment (S&WT). An analysis of the influent and effluent waters was undertaken based on this list (Table 49). The EFs used for comparison in Table 49 relate to published EET Manual for S&WT, which was not available when initial sampling, was undertaken.

In addition to the substances in Table 49, the facility also used approximately 4.5 tonnes of chlorine to disinfect the effluent water prior to irrigation on the race course and other parks around Kalgoorlie – Boulder.

Table 49: Concentration and Quantities of NPI Substances in Wastewater Treatment Plant Influent Water.

Substance	Influent Conc. (mg/L)		Mass of NPI Substance in Influent (kg)	
	Monitoring Data	Emission Factors	Monitoring Data (kg)	Emission Factor (kg)
Ammonia	21	26.1	22,900	28,500
Antimony	0.001	0.0022	1.09	2.40
Arsenic	0.003	0.005[a]	3.28	0 – 5 [b]
Boron	0.4	0.227	437	248
Beryllium	0.001[a]	0.0006	0 - 1 [b]	0.655
Cadmium	0.001[a]	0.002	0 - 1 [b]	2.184
Chlorine	0.1[a]	N/D	0 – 1[b]	N/D
Chromium	0.02[a]	0.066	0 - 20[b]	72.1
Chromium (VI)	N/D	0.066	N/D	72.1
Cobalt	0.05[a]	0.0039	0 – 55 [b]	4.26
Copper	0.1	0.123	109	134
Cyanide	0.01	N/D	10.9	N/D
Fluoride	0.5	N/D	546	N/D
Lead	0.005	0.06	5.46	65.5
Manganese	0.06	0.144	65.5	157
Mercury	0.0005[a]	0.0006	0 - 0.5[b]	0.655
Nickel	0.05[a]	0.023	0 - 55 [b]	25.1
Selenium	0.001[a]	0.0057	0 - 1[b]	6.22
Zinc	0.12	0.213	131	233
Formaldehyde	N/D	0.0002	N/D	0.218
Phenols	N/D	0.024	N/D	26.2
Total Nitrogen [c]	34	N/D	23,500	N/D
Total Phosphorus [c]	13	N/D	9,000	N/D

[a] Analysis detection limit
[b] Maximum value obtained using analysis detection limit conc.
[c] Nitrogen and phosphorus only trigger reporting for emissions to water.

As can be seen from Table 49, the EFs closely correlate with the direct monitoring data. However, it should be noted that this facility received very little industrial waste, and thus it may be atypical of urban wastewater treatment plants.

Ammonia was found to be the only substance that triggered NPI reporting.

13.4 Results

In order to determine the quantity of NPI substances in the effluent, monitoring data was considered essential. An alternative methodology mentioned in the manual involved using an efficiency factor for the treatment system that estimates the removal of each substance from the water through biological action or deposition. The efficiency of the WWTP was unknown and the trial team was not able to obtain any generic values that could be reliably applied.

Emission estimates in Table 50 were obtained from direct monitoring data. It assumes the effluent discharged to the dry Gribble Creek bed (34%) constituted an emission to land and the effluent used for irrigation purposes (66%) a transfer. Table 50 contains the complete list of substances analysed in the effluent, however only the emission of ammonia is displayed on the database, being the only one that triggered the reporting threshold.

It should be noted that emission estimates of Total Nitrogen and Phosphorus are included in Table 50 to provide an indication of the quantities of these substances that overflow from the facility. As the emissions of N and P do not flow into surface waters, they would normally be recorded as zero and therefore are not included in the total point source emissions for the region.

The spreadsheet used to calculate net flows and emissions is contained in Appendix H.

Table 50: NPI Emissions (to Land) From Wastewater Treatment Plant

Substance	Monitoring Data: Effluent Conc. (mg/L)	Monitoring Data: Mass of NPI Substance in Effluent (kg)
[t] **Ammonia**	0.86	203
[t] **Antimony**	0.001[a]	0.237[b]
Arsenic	0.002	0.473
[t] **Boron**	0.54	128
[t] **Beryllium**	0.001[a]	0.237[b]
Cadmium	0.001[a]	0.237[b]
[t] **Chlorine**	0.1[a]	23.7[b]
[t] **Chromium**	0.02[a]	4.73[b]
Chromium (VI)	N/D	0
Cobalt	0.05[a]	11.8[b]
[t] **Copper**	0.02	4.73
Cyanide	0.01[a]	2.37[b]
Fluoride	0.6	142
Lead	0.001[a]	0.237[b]
[t] **Manganese**	0.06	14.2
Mercury	0.0005[a]	0.118[b]
[t] **Nickel**	0.05[a]	11.8[b]
[t] **Selenium**	0.001[a]	0.237[b]
[t] **Zinc**	0.02[a]	4.73[b]
Total Nitrogen [c]	34	8040
Total Phosphorus [c]	13	3080

[t] Substances **only** on Table 2 of the Measure.
[a] Analysis detection limit
[b] Maximum value obtained using analysis detection limit conc.
[c] Nitrogen and phosphorus emissions are to land and therefore not reportable.

13.5 Transfers

The lagoon sludge is transferred to the landfill, or blended with soils as a conditioning agent, depending on pollutant levels. None of these transfers occurred during the study period.

The facility had no data on the typical concentrations of NPI substances in the sludge. However, an analysis of sludge from 15 lagoon wastewater treatment plants around Western Australia was obtained from the WA Water Corporation. These results are presented in Table 51. Median values were used rather than averages, as the results from some facilities were significantly different to the normal.

The quantity of sludge removed, and frequency with which ponds are desludged is dependent on the particular facility. The WWTP used in the study was estimated to generate no more than 250 tonnes of sludge every two years (Mofflin, P. of Kalgoorlie Boulder City Council, pers. com., 1999). The Water Corporation estimated that a regional facility would remove less than 1000 tonnes every 10 years (Penny, N. of Water Corporation, pers. com., 1999). Table 51 estimates the quantities of NPI substances that would be removed from an oxidation pond based on the more conservative figure of 125 tonnes of sludge removed per year.

Table 51 also estimates the total quantity of NPI substances that are transferred with biosolids annually Australia wide. The figure of 250,000 dry tonnes of wastewater sludge produced annually is based on an estimate in the National Water Quality Management Strategy: Draft Guidelines for Sewage Systems Sludge (Biosolids) Management (1997) report.

Table 51: NPI Substances Contained in Irrigation Water and Sewage Sludge Transferred From Oxidation Lagoons

Substance	Transferred in Irrigation Water (kg)	Median Conc. In Sludge (mg/kg - dry weight)	NPI Substance in Transfer of 125 tonnes/yr Sludge (kg)	NPI Substances Transferred Annually Aust. Wide in Sludge (kg)
Ammonia	392	7,200	900	1,800,000
Antimony	0.455			
Arsenic	0.911	2.3	0.288	576
Boron	246			
Beryllium	0.455			
Cadmium	0.455	1.95	0.243	486
Chlorine	45.5			
Chromium (total)	9.11	33	4.13	8,260
Cobalt	22.8			
Copper	9.11	795	99.4	199,000
Cyanide	4.55			
Fluoride	273			
Lead	0.455	36	4.25	8,500
Manganese	27.3			
Mercury	0.228	0.6	0.075	150
Nickel	22.8	17	2.125	4,250
Selenium	0.455	2	0.250	500
Total Nitrogen	15,500	35,500	4437	88,70,000
Total Phosphorus	5,920	5,700	713	1,430,000
Zinc	9.11	595	74.4	149,000

Whilst all substances for which data was available for transfers from oxidation ponds has been presented in Table 51, only ammonia triggered reporting. Ammonia is likely to be the only substance to trigger reporting at regional treatment plants in Western Australia.

A typical transfer of lagoon sludge from the wastewater treatment plant is considered to be one of the larger transfer of NPI substances in the study region.

All effluent water used for irrigation purposes around Kalgoorlie-Boulder was classed as a transfer. The WWTP is attempting to obtain approval to sell (to industry) the remaining discharge of effluent water currently overflowing into Gribble Creek. In this situation the movement of NPI substances through sewage systems will not be captured unless transfers from the facility are reportable.

If the NPI were to include the reporting of the transfers of wastes from a WWTP, there is potential for the following double counting to occur:

- discharges to sewers reported by individual reporting facilities as a transfer;
- substances in influent water at the WWTP included in an aggregated emissions study; and
- transfers from the WWTP reported by the WWTP.

13.6 Evaluation

13.6.1 Data Accuracy

As direct monitoring data was used, the results are expected to be reasonably accurate. There was also found to be a close correlation between direct monitoring results and EFs for the influent concentration data. This data was used to determine the NPI substances that trigger reporting. With the exception of N and P the S&WT manual didn’t provide a definitive EF methodology for estimating emissions in the effluent. The direct monitoring results for Total Nitrogen and Total Phosphorus at the WWTP were in the approximate range value provided in the S&WT Manual for lagoon treatment plants (Table 52).

Table 52: Comparison of Direct Monitoring and EFs For N and P at the Wastewater Treatment Plant

Nutrient	Effluent Analysis (mg/L)	Nutrient Emission Factor (mg/L)
Total Nitrogen	34	20 – 50
Total Phosphate	13	6 – 12

13.6.2 Manuals

The S&WT Manual was well set out, easy to use and very useful for identifying reportable substances. The manual also dealt with relevant issues such as the reporting of NPI substances contained in irrigation water. However, emission factors were not available for estimating emissions of category 1 substances to water and land.

Table 2 of the S&WT Manual was both accurate and useful. The influent flow rates required to trigger reporting streamlined the identification of likely triggers.

Limitations of the manual were considered to be as follows:

- To estimate emissions it was necessary to know either the efficiency of the WWTP in removing pollutants, or to undertake direct monitoring. As the reduction efficiency was not known at WWTP, it was necessary to sample and analyse the influent and effluent.
- The manual states that" *if the biodegradability of the organic compound cannot be measured, or is not known, reporting facilities should assume that all substances remain in the wastewater or are adsorbed into the sludge*" (p 16, EET Manual for Sewage and Wastewater Treatment). This seems to provide a facility with an exceptional amount of latitude. It is possible to report zero emissions of a substance by assuming that it was all adsorbed in the sludge and thereby ignoring any of the NPI substances that remain in the effluent overflow. Disposal of the sludge on site would then be an emission to land, while removal of the sludge off site to a landfill or for use as a soil conditioner could be considered a transfer.
- There was insufficient guidance on whether effluent water used for irrigation purposes constituted an emission to land or a transfer. The trial team concluded that the treated water was a transfer as it left the WWTP site, which was then utilised by the City of Kalgoorlie-Boulder for the purposes of irrigating numerous parks and playing fields throughout the city. Treating this irrigation effluent water as an emission from the WWTP would not represent a true picture of the emissions actually occurring at their site.

As the WWTP was well below the VOCs reporting trigger no attempt was made to estimate these emissions using WATER8.

13.7 Costs

Time spent on the NPI reporting process is as depicted in Table 53. The charge out rates of $100 per hour for trial team time and $150 per hour for WWTP time were selected to maintain consistency with the charge out rates of consultants that have been working in the NPI and with cost estimates by other facilities. The recurrent cost of reporting for the WWTP was estimated at $600 (4 hours), considerably less than the initial setup cost of $2370 (14.25 hours plus monitoring costs).

The analysis cost of the influent and effluent water samples from the facility was $700 and included a reasonably broad suite of analyses. A determination was only necessary for ammonia at WWTP. This cost is not expected to be recurrent, as it was apparent that the facility was extremely unlikely to trigger thresholds for any other substances in the future.

Many wastewater treatment facilities are likely to trigger reporting of category 3 substances. Analysis costs per sample for these substances were:

Total Nitrogen (inorganic and organic) = $24
Total Nitrogen (inorganic – gives rise to nitrate/nitrite ion) = $15
Total Phosphate = $24
Soluble Reactive Phosphate = $15

These facilities will generally be required to sample their effluent for nitrogen and phosphorus as part of their licence conditions.

Table 53: Cost of NPI Reporting for Wastewater Treatment Plant

Task	**DEP (hours)**	**Kalgoorlie Council (hours)**	**Recurrent**	**Cost ($)**
Meetings	1.5	1.5	No	375
Correspondence	0.5	0.5	No	135
Monitoring	1.5	0.75	No	963[a]
Developing understanding of EET manual	3	0	No	300
Estimating Emissions	2	0	Yes	200
Checking/Editing emission estimates	1[b]	1	Yes	250
Reporting	1[b]	1	Yes	250
Total	10.5	**4.75**		**2,470**
Total Recurrent Costs for WWTP[c]	**4[c]**			**600[c]**

[a] Includes $700 analysis costs.

[b] Not included in the recurrent cost estimates.

[c] Includes recurrent costs incurred by both the trial team and WWTP. Recurrent costs are all charged out at the facility charge out rate of $150

13.8 Conclusions

- The EFs in the manual correlated well with the direct monitoring data for influent water for the facility. However, the manual did not contain EFs for **emissions** to land and water. Users need to either sample the effluent stream, or assume all of the NPI substances are adsorbed in the sludge. If the latter is assumed, then an emission only occurs where there is a disposal of the sludge to land. Any disposal of the sludge to landfill would be considered a transfer.
- Effluent sampling is considered necessary unless the reduction efficiency is known for a WWTP.
- NPI substances in the lagoon overflow emitted to the dry creek bed were treated as an emission to land. Lagoon effluent water used in irrigation was considered to be a transfer.

- The recurrent cost of reporting for the WWTP is expected to be $600 (4 hours), while the initial cost was $2,470 (15.25).
- The transfer of NPI wastes from this facility may be a composite of lagoon sludge and effluent water. The lagoon sludge is occasionally used as a soil conditioner and as such could be considered a transfer. Similarly the effluent water that is used for irrigation (and may soon be sold to industry) is a transfer. The public has a right to know the approximate concentration of the sludge constituents, particularly if it is being sold as a soil conditioning agent. The public also needs to be assured that the effluent water meets Health Department requirements. The total annual estimate of the NPI wastes transferred will not provide the public with information that will enlighten them on either of the above potential health issues.

14 Study Results

This section presents a summary of the emission estimations from participants in the Kalgoorlie Trial. All results have been presented to 3 significant figures. Results are presented in the following order:

- Table 54 - Total aggregated and point source emission estimations.
- Table 55- Total and individual point source emission estimations.
- Table 56 – Total aggregated and individual facility emission estimations as a percentage of the total emission estimations within the study region.
- Figures 11 to 16 – Pie charts showing the major point source emissions of criteria pollutants.
- Table 58 - NPI wastes transferred from point sources (limited data provided).

The emissions of NPI substances to air and land are displayed separately in Appendix F.

14.1 Total Emissions In Study Area

Table 54: Total Emissions in the Kalgoorlie Study Area

Substance	Total Aggregated Emissions (kg)	Total Point Source Emissions (kg)	Total Emissions (kg)[1]
Acetaldehyde	5,180	323	5,500
Acetic acid (ethanoic acid)	2,410	0	2,410
Acetone	8,130	0	8,130
Acrylic acid	0.0000278	0	0.0000278
Ammonia (total)	64,700	959	65,700
Antimony & compounds	0.10	2.28	2.38
Arsenic & compounds	0.02	2,070	2,070
Benzene	18,500	517	19,100
Beryllium & compounds	0.01	0.53	0.53
Boron & compounds	0	137	137
1,3- Butadiene (vinyl ethylene)	2,010	16.3	2,030
Cadmium & compounds	43.7	329	373
Carbon disulphide	0.00	9,550	9,550
Carbon monoxide	3,850,000	345,000	4,190,000
Chlorine	930	23.7	954
Chloroform (trichloromethane)	7.05	0	7.05
Chlorophenols (di, tri, tetra)	0.000805	0	0.000805
Chromium (III) compounds	2,170	1,120	3,290
Chromium (VI) compounds	8.80	0	8.80
Cobalt & compounds	0	83.1	83.1
Copper & compounds	1,830	948	2,780
Cumene (1-methylethylbenzene)	785	45.5	830
Cyanide (inorganic) compounds	4,870	239,000	244,000
Cyclohexane	20,300	5.29	20,300
1,2- Dibromoethane	0	0.05	0.05
1,2- Dichloroethane	0.05	0	0.0486
Dichloromethane	1,870	0	1,870
Ethanol	33,300	0	33,300
2- Ethoxyethanol acetate	1,220	0	1,220
Ethyl acetate	4.92	0	4.92
Ethylbenzene	3,900	3.49	3,900
Ethylene glycol (1,2-	605	0	605

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[1] Totals have been rounded.

Substance	Total Aggregated Emissions (kg)	Total Point Source Emissions (kg)	Total Emissions (kg)[1]
ethanediol)			

Table 54: Total Emissions in the Kalgoorlie Study Area (cont.)

Substance	Total Aggregated Emissions (kg)	Total Point Source Emissions (kg)	Total Emissions (kg)[1]
Ethylene oxide	248	0	249
Fluoride compounds	0.72	142	143
Formaldehyde (methyl aldehyde)	12,800	732	13,600
n- Hexane	27,700	594	28,300
Hydrochloric acid	0.01	0	0.01
Hydrogen sulphide	59.0	0.05	59.1
Lead & compounds	2,990	719	3,710
Magnesium oxide fume	0	19.6	19.6
Manganese & compounds	0.69	314	315
Mercury & compounds	0.05	223	223
Methanol	8,650	0	8,650
Methyl ethyl ketone	8,050	0	8,050
Methyl isobutyl ketone	615	0	615
Methyl methacrylate	1.08	0	1.08
Nickel & compounds	75.1	5,720	5,800
Oxides of Nitrogen	662,000	1,990,000	2,650,000
Particulate Matter 10.0 um	1,630,000	3,090,000	4,720,000
Phenol	24.70	0	24.7
Polychlorinated dioxins and furans	6.05	0	6.05
Polycyclic aromatic hydrocarbons	3,280	71.1	3,350
Selenium & compounds	0	0.74	0.74
Styrene (ethenylbenzene)	494	0	494
Sulphur dioxide	38,700	103,000,000	103,000,000
Tetrachloroethylene	2,750	0	2,750
Toluene (methylbenzene)	38,700	290	39,000
Total Nitrogen	0	0	0
Total Phosphorus	0	0	0
Total Volatile Organic Compounds	4,930,000	67,100	5,000,000
Trichoroethylene	5,950	0	5,950
Vinyl Chloride Monomer	0.06	0	0.06
Xylenes (individual or mixed isomers)	31,100	162	31,200
Zinc and compounds	21,600	431	22,100

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[1] Totals have been rounded.

14.2 Point Source Emissions

Table 55: Total and Individual Facility Emissions

Substance	Emissions From All Point Sources (kg)															
	Total Point Source Emissions[1]	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Acetaldehyde	323	323														
Acetic acid (ethanoic acid)	0															
Acetone	0															
Acetonitrile	0															
Acrylamide	0															
Acrylic acid	0															
Acrylonitrile	0															
Ammonia (total)	959	553						ND							406	
Aniline (benzenamine)	0															
Antimony & compounds	2.28	1.88						0.161							0.237	
Arsenic & compounds	2070	740	251		46.87	1030		0.036							0.473	
Benzene	517	389								1.45		53	41	32.1		
Benzene hexachloro- (HCB)	0															
Beryllium & compounds	0.53	0.266	0.02					0.0024		ND					0.237	
Biphenyl (1,1-biphenyl)	0															
Boron & compounds	137	5.53		2.86				0.48							128	
1,3- Butadiene (vinyl ethylene)	16.3	16.3														
Cadmium & compounds	329	329						0.031							0.237	
Carbon disulphide	9550		9550													
Carbon monoxide	345000	29900	26700	2540	275000	63.8	2180	300	7870	125						238
Chlorine	23.7														23.7	
Chlorine dioxide	0															

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[1] Totals have been rounded.

Table 55: Total and Individual Facility Emissions (cont.)

Substance	Emissions From All Point Sources (kg)															
	Total Point Source Emissions[1]	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Chloroethane (ethyl chloride)	0															
Chloroform (trichloromethane)																
Chlorophenols (di, tri, tetra)	0															
Chromium (III) compounds	1120	10.2	8.87	0.11	90.2	1010		.34		0.003					4.73	
Chromium (VI) compounds	0	ND	ND	ND	ND	ND	ND	ND	ND							
Cobalt & compounds	83.1	5.97		1.76	27.1	36.4		0.066							11.8	
Copper & compounds	948	123	50.9	0.26	40.7	719		9.5		0.001					4.73	
Cumene (1-methylethylbenzene)	45.5											45.5				
Cyanide (inorganic) compounds	239000		203000	36100	48.8	21									2.37	
Cyclohexane	5.29									0.29		5				
1,2- Dibromoethane	0.05												0.05			
Dibutyl phthalate	0															
1,2- Dichloroethane	0															
Dichloromethane	0															
Ethanol	0															
2- Ethoxyethanol	0															
2- Ethoxyethanol acetate	0															
Ethyl acetate	0															
Ethyl butyl ketone	0															
Ethylbenzene	3.49										0.992	2.5				
Ethylene glycol (1,2-ethanediol)	0															
Ethylene oxide	0															
Di-(2-Ethylhexyl) phthalate (DEHP)	0															
Fluoride compounds	142	ND	ND	ND	ND	ND	ND	ND	ND						142	ND
Formaldehyde (methyl aldehyde)	732	729						ND		2.7						

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[1] Totals have been rounded.

Substance	Emissions From All Point Sources (kg)															
	Total Point Source Emissions[1]	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Glutaraldehyde	0															

Table 55: Total and Individual Facility Emissions (cont.)

Substance	Emissions From All Point Sources (kg)															
	Total Point Source Emissions[1]	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
n- Hexane	594	525	0.21							0.29		68.5				
Hydrochloric acid	0															
Hydrogen sulphide	0.05	0.05														
Lead & compounds	719	699	19.4					0.0043		0.001				0.06	.237	
Magnesium oxide fume	19.6	19.6	ND	ND	ND	ND	ND	ND	ND							
Manganese & compounds	314	31.1	264	1.99				2.6		0.003					14.2	
Mercury & compounds	223	0.446	223					0.00066							.118	
Methanol	0															
2- Methoxyethanol	0															
2- Methoxyethanol acetate	0															
Methyl ethyl ketone	0															
Methyl isobutyl ketone	0															
Methyl methacrylate	0															
4,4- Methylene bis 2,4 aniline (MOCA)	0															
Methylenebis (phenylisocyanate)	0															
Nickel & compounds	5720	4780	22.3	0.44	67.6	832	ND	8.8		0.004					11.8	
Nickel carbonyl	0	ND	ND		ND	ND	ND	ND	ND							
Nickel subsulphide	0	ND	ND		ND	ND	ND	ND	ND							
Nitric acid	0															

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[1] Totals have been rounded.

Substance	**Emissions From All Point Sources (kg)**															
	Total Point Source Emissions[1]	**WMC**	**Kanowna Belle**	**Normandy**	**KCGM Mining**	**KCGM Gidji**	**Loongana Lime**	**Western Power**	**Parkeston Power**	**Boral Asphalt**	**Mobil**	**BP**	**Ampol**	**Shell**	**WWTP**	**Kalgoorlie Regional Hospital**
Organo-tin compounds	0															
Oxides of Nitrogen	1990000	247000	63700	9480	596000	228	4670	5100	1060000	818						954
Particulate Matter 10. um	3090000	186000	236000	750	2420000	198000	7960	400	42200	1090						47.7
Phenol	0															
Phosphoric acid	0															
Polychlorinated dioxins and furans	0	ND	ND		ND	ND		ND								
Polycyclic aromatic hydrocarbons	71.1	70.1		0.13				ND	ND	0.036			0.79			0.057
Selenium & compounds	0.74	0.463						0.039		ND					0.237	

Table 55: Total and Individual Facility Emissions (cont.)

Substance	**Emissions From All Point Sources (kg)**															
	Total Point Source Emissions[1]	**WMC**	**Kanowna Belle**	**Normandy**	**KCGM Mining**	**KCGM Gidji**	**Loongana Lime**	**Western Power**	**Parkeston Power**	**Boral Asphalt**	**Mobil**	**BP**	**Ampol**	**Shell**	**WWTP**	**Kalgoorlie Regional Hospital**
Styrene (ethenylbenzene)	0															
Sulphur dioxide	103000000	22700000	12000000	515	34500	68100000	7480	2700	231	0.922						3380
Sulphuric acid	0															
1,1,1,2- Tetrachloroethane	0															
Tetrachloroethylene	0															
Toluene (methylbenzene)	290	170								0.628	2.44	45.5	34.8	36.4		
Toluene-2,4-diisocyanate	0															
Total Nitrogen	0															
Total Phosphorus	0															
Total Volatile Organic Compounds	67100	4820	5070	1140	39300		49.2	120		484	47.6	6190	6300	3570		15.9
1,1,2- Trichloroethane	0															

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[1] Totals have been rounded.

Substance	**Emissions From All Point Sources (kg)**															
	Total Point Source Emissions[1]	**WMC**	**Kanowna Belle**	**Normandy**	**KCGM Mining**	**KCGM Gidji**	**Loongana Lime**	**Western Power**	**Parkeston Power**	**Boral Asphalt**	**Mobil**	**BP**	**Ampol**	**Shell**	**WWTP**	**Kalgoorlie Regional Hospital**
Trichoroethylene	0															
Vinyl Chloride Monomer	0															
Xylenes (individual or mixed isomers)	162	126	0.02							0.097	7.78	8	9.96	9.94		
Zinc and compounds	431	15.7		1.32	67.6	337		4.9		0.01					4.73	

14.3 Relative Emissions

Table 56: Proportion of Emissions from Aggregated and Facility Sources (%)

Substance	Proportion of Total Emissions (%)																
	Total Agregated Emissions	Total Point Source Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Acetaldehyde	94.1	5.9	5.9														
Acetic acid (ethanoic acid)	100	0															
Acetone	100	0															
Acrylic acid	100	0															
Ammonia (total)	98.5	1.5	0.8													0.6	
Antimony & compounds	4.4	95.6	78.9						6.8							9.9	
Arsenic & compounds		100	35.8	12.1		2.3	49.8										
Benzene	97.3	2.7	2.0										0.3	0.2	0.2		
Beryllium & compounds	1.4	98.6	49.9	3.8					0.5							44.5	
Boron & compounds		100	4.0		2.1				0.4							93.5	
1,3- Butadiene (vinyl ethylene)	99.2	0.8	0.8														
Cadmium & compounds	11.7	88.3	88.2													0.1	
Carbon disulphide		100		100													
Carbon monoxide	91.8	8.2	0.7	0.6	0.1	6.6		0.1		0.2							
Chlorine	97.5	2.5														2.5	
Chloroform (trichloromethane)	100	0															
Chlorophenols (di, tri, tetra)	100	0.0															
Chromium (III) compounds	65.9	34.1	0.3	0.3	0.0	2.7	30.7									0.1	
Chromium (VI) compounds	100	0															
Cobalt & compounds	0.0	100	7.2		2.1	32.6	43.8		0.1							14.2	
Copper & compounds	65.9	34.1	4.4	1.8		1.5	25.9		0.3							0.2	
Cumene (1-methylethylbenzene)	94.5	5.5											5.5				
Cyanide (inorganic) compounds	2.0	98.0		83.2	14.8												

Table 56: Proportion of Emissions from Aggregated and Facility Sources (%) (cont.)

Substance	Proportion of Total Emissions (%)																
	Total Aggregated Emissions	Total Point Source emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Cyclohexane	100	0.0											0.025	0.0			
1,2- Dibromoethane	0	100												100			
1,2- Dichloroethane	100	0															
Dichloromethane	100	0															
Ethanol	100	0															
2- Ethoxyethanol acetate	100	0															
Ethyl acetate	100	0															
Ethylbenzene	99.9	0.1											0.1				
Ethylene glycol (1,2-ethanediol)	100	0															
Ethylene oxide	100	0															
Fluoride compounds	0.5	99.5														99.5	
Formaldehyde (methyl aldehyde)	94.6	5.4	5.4														
n- Hexane	97.9	2.1	1.9										0.2				
Hydrochloric acid	100	0							ND								
Hydrogen sulphide	99.9	0.1	0.1														
Lead & compounds	80.6	19.4	18.8	0.5													
Magnesium oxide fume	0	100	100														
Manganese & compounds	0.2	99.8	9.9	83.9	0.6				0.8							4.5	
Mercury & compounds	0	100	0.2	99.7												0.1	
Methanol	100	0															
Methyl ethyl ketone	100	0															
Methyl isobutyl ketone	100	0															
Methyl methacrylate	100	0															
Nickel & compounds	1.3	98.7	82.4	0.4		1.2	14.3		0.2							0.2	
Oxides of Nitrogen	25.0	75.0	9.3	2.4	0.4	22.5		0.2	0.2	40.0							
Particulate Matter 10.0 um	34.5	65.5	3.9	5.0		51.3	4.2	0.2		0.9							
Phenol	100	0															

Table 56: Proportion of Emissions from Aggregated and Facility Sources (%) (cont.)

Substance	Percentage of Total Point Source Emissions (%)																
	Total Agregated Emissions	Total Point Source Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Polychlorinated dioxins and furans	100	0															
Polycyclic aromatic hydrocarbons	97.9	2.1	2.1														
Selenium & compounds	0	100	62.7						5.3							32.1	
Styrene (ethenylbenzene)	100																
Sulphur dioxide		100	22.1	11.7			66.2										
Tetrachloroethylene	100																
Toluene (methylbenzene)	99.3	0.7	0.4										0.1	0.1	0.1		
Total Nitrogen		100														100	
Total Phosphorus		100														100	
Total Volatile Organic Compounds	98.7	1.3	0.1	0.1		0.8							0.1	0.1	0.1		
Trichoroethylene	100	0															
Vinyl Chloride Monomer	100	0.0															
Xylenes (individual or mixed isomers)	99.5	0.5	0.4										0.026				
Zinc and compounds	98.0	2.0	0.1			0.3	1.5										

14.4 Criteria Pollutants

Figures 11 to 16 present emission estimates for criteria pollutants. Figures present firstly, the percentage that point sources comprise of the total emissions, and secondly, which facilities are responsible for these emissions (as a percentage of point source emissions).

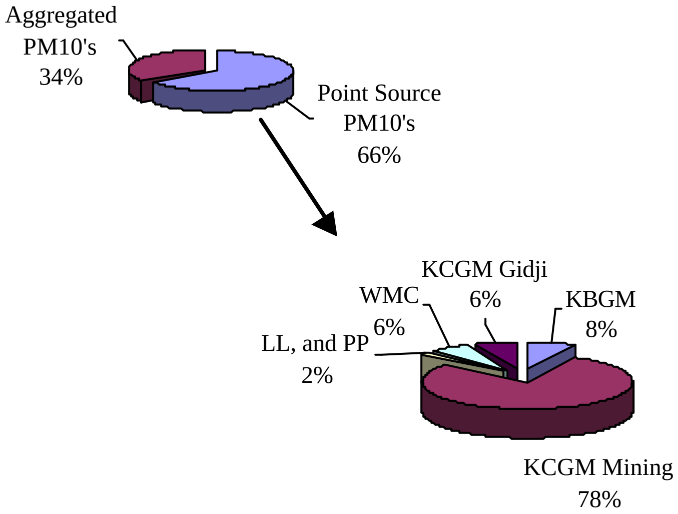


Figure 10: Major Emission Points for Particulate Matter (PM_{10})

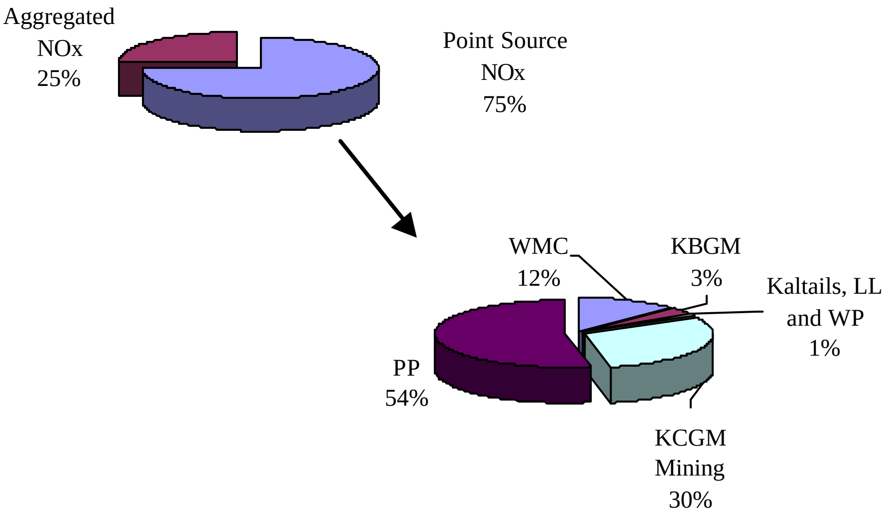


Figure 11: Major Emission Points for Oxides of Nitrogen (NO_X)

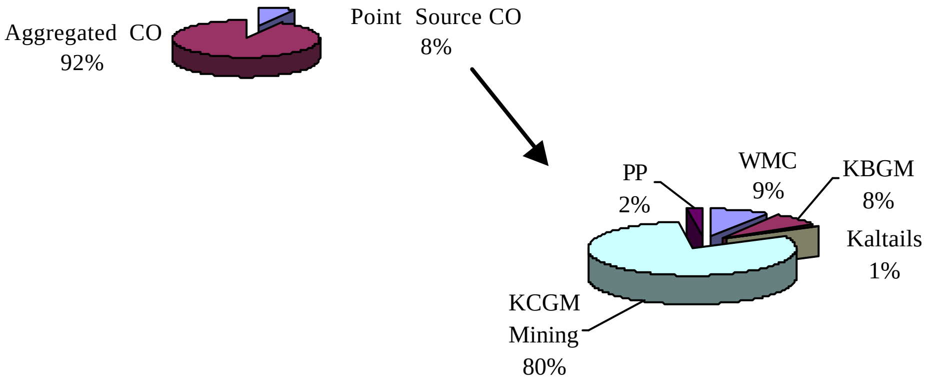


Figure 12: Major Emission Points for Carbon Monoxide (CO)

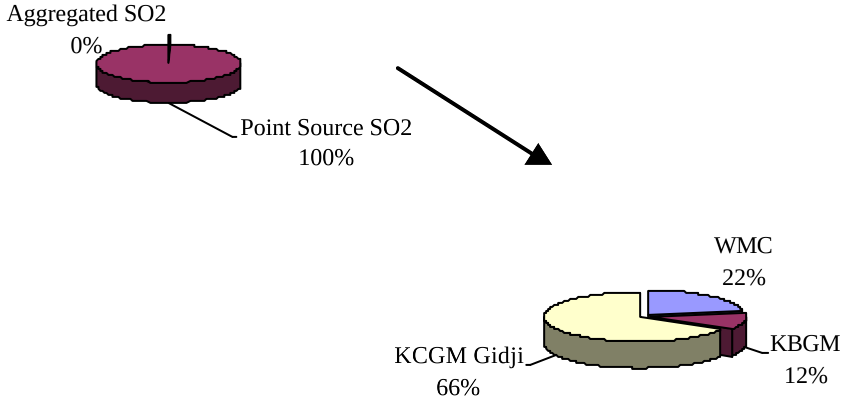


Figure 13: Major Emission Points of Sulfur Dioxide (SO_2)

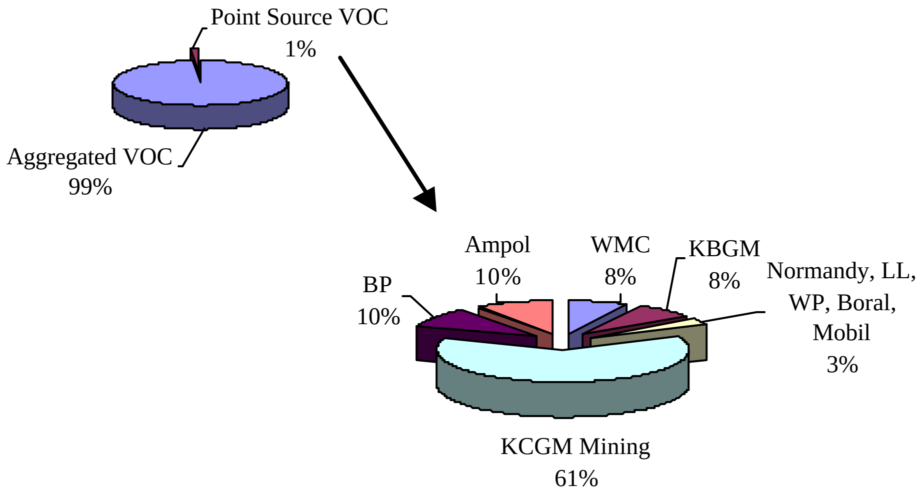


Figure 14: Major Emission Points for Total VOCs

Table 57 displays the quantities of NPI wastes that were transferred off site in the reporting period from facilities that supplied transfers data. Data on transfers of wastes was available waste oil, sewage sludge, effluent water, and asphalt. A further discussion of this issue is presented in Section 16.1.1.

Table 57: NPI Substances Transferred From Trial Participant (kg)

Substance	Facility and Source of NPI Substance. (All Emissions in Kilograms)					
	WWTP		Boral Asphalt	Western Power	Parkeston Power	Normandy
	Irrigation Water	Sludge	Asphalt	Oily Waste Water	Waste Oil	Waste Oil
Ammonia	392	900				
Antimony	0.455					
Arsenic	0.911	0.288	0.025			
Boron	246					
Beryllium	0.455					
Cadmium	0.455	0.243				0.000623
Chlorine	45.5			0.015	0.27	0.0077
Chromium (total)	9.11	4.13	0.01	Traces	Traces	0.00312
Cobalt	22.8		0.0005			
Copper	9.11	99.4		Traces	Traces	0.0187
Cyanide	4.55					
Fluoride	273					
Lead	0.455	4.25	0.025	0.025	0.45	0.0972
Manganese	27.3					
Mercury	0.228	0.075	0.0025			0.0000105
Nickel	22.8	2.125		Traces	Traces	Traces
Polychlorinated biphenyl’s						0.000125
Phenolic Compounds				2.5	-	0.0035
PAH's			0.072	0.045	0.81	0.561
Selenium	0.455	0.25				
Total Nitrogen	15,500	4440				
Total Phosphorus	5,920	713		0.0375	0.675	0.467
Zinc	9.11	74.4		2.5	-	0.332

15 Summary of Costs

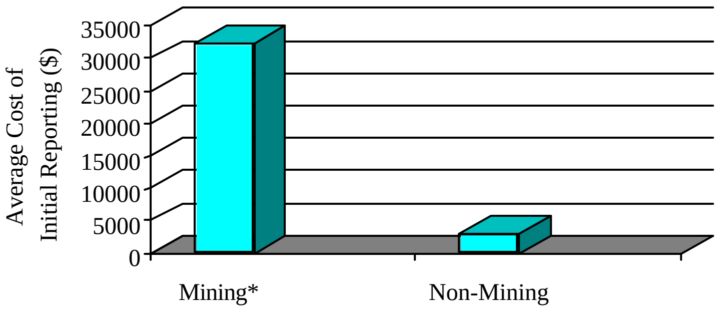
Table 58 Initial and Ongoing Costs of NPI Reporting – All Facilities

	Facility	Set-Up Costs ($)	Ongoing Costs ($)
Mining	WMC[1]	45,000	ND
	KBGM	20,421	ND
	KCGM*	45,000	ND
	Normandy Kaltails	19,200	ND
Bulk Fuel	Shell	4,900	2,500
	BP	6,400	ND
	Mobil	3,400	300
	Ampol	5,000	ND
Power	Western Power	1,000	ND
	Parkeston Power	2,120	600
Other	Loongana Lime	2,150	860
	Boral Asphalt	1,475	675
	Waste Water Treatment Plant	2,470	600
	Hospital	1,050	350
Totals	**Average Cost for Mining**	**32,400**	**ND**
	Average Cost for Bulk Fuel Storage	**4,900**	**ND**
	Average Cost for Power Generation	**1560**	**ND**
	Average Cost of All Non-Mining Facilities	**3,000**	**ND**
	Average of All Facilities	**11,400**	**ND**

*The cost of reporting for KCGM refers to reporting cost for the two facilities: Gidji Roaster and Fimiston Mining operations

[1] Includes Kalgoorlie Trial costs.

As is evident from Table 58 and Figure 15 (below), the average expense of NPI Reporting for the mining companies was found to be greater than for other NPI reporting facilities.

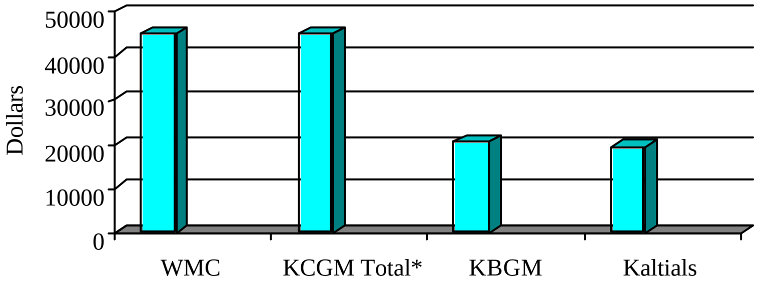


*average cost based on KCGM as one facility.

Figure 15: Average Cost of Initial NPI Reporting for Mining versus Non-Mining Facilities

The average cost of reporting for the Trial for the mining companies was $32,400. This figure is likely to be higher than the expected ongoing reporting costs for mining companies generally. This is because:

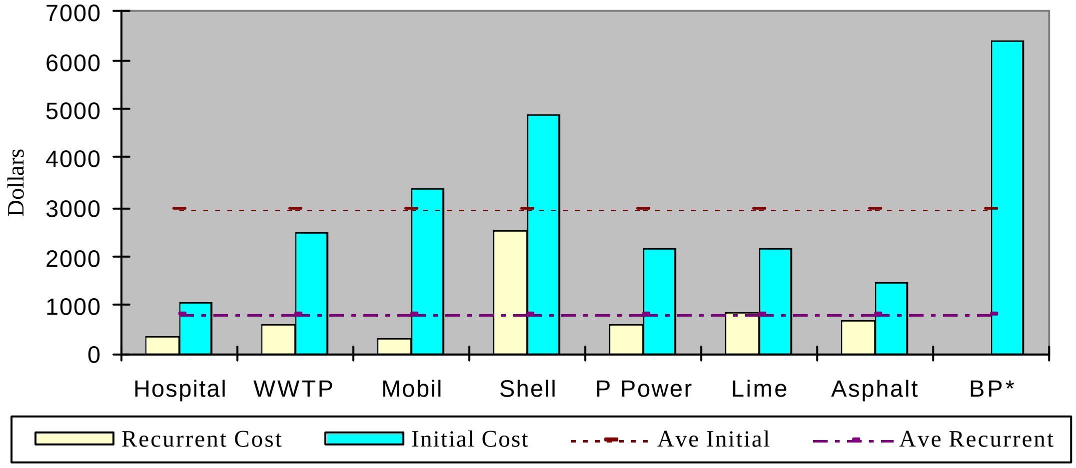
- Participants in the trial produced detailed reports evaluating the NPI process which required considerable time and resources;
- Cost estimates for KCGM related to both facilities – Gidji Roaster, and the Mining Operations. The trial team did not feel justified in dividing the cost evenly between the two facilities, consequently the costs were skewed upwards; and
- The cost of NPI reporting in the initial year is considerably greater than ensuing years due to time spent developing an understanding of the EET manuals and developing data collection systems.



*Cost estimates for KCGM presented as one facility

Figure 16: Average Cost of Reporting for Mining Companies

Figure 17 presents the estimated initial cost of NPI reporting as well as projected ongoing costs. The reduction in the cost of NPI reporting in ensuing reporting years, after systems have been put in place, is clearly evident in figure 17.



*BP did not present a recurernt cost estimate.

Figure 17: Initial and Recurrent Cost of Reporting for Non-Mining Facilities.

16 Major Issues

16.1 Transfers

The Kalgoorlie NPI Trial was the first of the NPI trials to attempt to estimate the transfers of wastes from all sources within the study region. The following definition of transfers was presented in (Coffey, 1999), and was sourced from the USEPA:

> “Transfers are defined as the transfer of toxic chemicals in wastes to a facility that is geographically or physically separate. The reported quantities represent the movement (transfer) of the chemical away from the reporting facility. For example, this means that reporting chemicals contained within a waste which is being transferred to landfill are not recorded as entering the landfill, but rather as coming from a facility.”

Transfers of wastes for the trial were defined as:

- The deposit of wastes into landfill;
- Discharges of wastes to sewers; and
- Any other removal of wastes from a facility for the purposes of disposal, treatment, recycling, reprocessing, recovery or purification.

The definition is derived from the general exclusion component of the “emission” definition in the NPI NEPM.

The process used to estimate the transfer of wastes within the study region was:

- Reporting Facility Transfers – a number of reporting facilities volunteered information on the types and quantities of wastes transferred. The trial team then estimated the NPI components contained within the generic wastes.
- Aggregated Transfers - consultants (Coffey) were engaged to undertake a study to estimate the transfer of wastes from sub-threshold and non-reporting facilities, including the discharge of wastes to sewer and deposit of wastes into landfill.
- Tailing Storage Facility Transfers – the estimation of the transfer of NPI substances into TSFs was not part of the project brief. These transfers were therefore not estimated by any of the participating mining companies. A separate desktop TSF study conducted by consultants (PPK) investigated the transfers to and emissions from TSFs.

16.1.1 Transfers from Reporting Facilities

The estimates of NPI wastes transferred from reporting facilities were found to be relatively minor when compared with the emissions estimates. While every effort was made to ensure the accuracy of the transfers estimates, the quantities were generally “best guesses” provided by the facility operator.

Transfers from mining companies were based on the information that was provided. The categories of substances transferred were generally known, however, quantities were less well defined. Mining companies also have the capacity to dispose of wastes on site. Sources within the industry indicate that at some of these sites the TSF is used for disposal of some NPI wastes.

A summary of transfers of wastes from facilities is listed below:

- WMC: No transfers data provided.
- Normandy Kaltails: 700 kL of Waste oil was transferred for recycling. Recovered mercury (0.108 kg) was sold, although it could be considered to be a product rather than a waste. Approximately 6000 kg of scrap steel containing minor quantities of NPI substances was transferred for recycling.
- KBGM: Transfers were limited to waste oils and grease, scrap steel, batteries and general rubbish disposed at the local landfill. Arsenic trioxide is transferred occasionally to an intractable waste disposal facility, although not during the study period.
- KCGM: Transfers not included in study.
- Wastewater treatment plant: NPI substances contained in treated effluent used for irrigation and in the sludge removed from the oxidation lagoons, although only ammonia triggered reporting.
- Power Stations: Waste oil (900 L) and plant drain water containing minor amounts of hydrocarbons was transferred. Coal fired power stations would also be required to dispose of fly ash which contains NPI substances.
- Loongana Lime: No transfers during the trial.
- Boral Asphalt: Approximately 100 tonnes of waste product containing traces of NPI substances.
- Kalgoorlie Regional Hospital: Small quantities of waste containing NPI substances were transferred to landfill and sewer, however, as the hospital only triggered the 2a threshold, all transfers were well below the reporting threshold.
- Analabs: lead (approx 10 tpy) is transferred to Port Pirie for recovery, although no transfer occurred during the study period.

Considerable effort is required to speciate transferred products, such as waste oil, into NPI substances. Current knowledge of NPI substances in waste streams is limited, making speciation too difficult a task for many facilities. Generic speciation data for the common wastes transferred would be beneficial. The estimation of NPI substances contained within the wastes was undertaken by the trial team on behalf of all the facilities.

A list of NPI substances transferred from these facilities is displayed in Table 57 of the data analysis section. All speciation data is included, with a distinction being made for substances that trigger the existing reporting threshold. While it is unlikely that all transfers of NPI substances have been captured, it is clear that transfers are minimal when compared with emissions in the region.

It should be noted that there is a significant movement of materials containing NPI substances within the study region. The movement of materials consists mostly of ores and other raw materials for processing, roasting or further refining and the transport of final products. Examples of materials movements in the region include:

- Gold ore from mine sites to roasters;
- Sulfuric acid from acid plants to nickel operations;
- Coal for fuel burning in a lime works kiln; and
- Nickel matte transferred for refining.

These types of movements of materials were not considered to be "transfers", as the contents were not classed as wastes. There is also the potential for minor emissions of NPI substances during the transport of the materials between facilities, which may be taken into account as part of an aggregated emissions study.

16.1.2 Transfers from Aggregated Sources

Coffey Geoscience were engaged to estimate transfers of NPI substances from aggregated sources. They concluded " *that insufficient data is available to enable reliable estimates of transfers from non-reporting facilities to be made at this time*" (Coffey, 1999, p. 59).

The following is a direct exert from Section 12 of the Coffey Report (1999) and relates to the difficulties of reporting transfers and the potential for double counting that it poses. More detailed information is found in their report.

- There is a lack of local data relating to the transfer of reporting substances, due mainly to:

    - Generally poor knowledge of specific chemical substances, particularly in the smaller businesses and industries;
    - Traditionally different methods of characterising waste streams (especially solid waste streams);
    - Record keeping is either non-existent, or has been developed for different purposes, so records do not easily reflect the specific requirements of the NPI.

- There is a lack of generic data for undertaking general or industry wide estimates of reporting substances, due to:
    - Traditionally different methods of characterizing waste streams;
    - Similar registers elsewhere in the world limit their data to reporting facilities, which are generally large industries and comprise only a small percentage of the total number of industries;
    - Industrial classification systems are different between states, and countries, and it is difficult to provide a uniform comparison.

- At present, it is not considered possible to provide any comprehensive or meaningful estimates for transfers from non-reporting facilities in the Kalgoorlie-Boulder study area.

Potential for Double Counting

It is possible that a substance that is used and reused at different facilities can be counted a number of times during its life cycle. In this case estimation techniques using mass balance calculations would be inappropriate and inaccurate. To illustrate this, lead-acid batteries can be used as an example as shown in Table 59.

Table 59: Potential for Double Counting

Activity	Reporting Substance – Lead (tonnes/yr)	Media (air/water/land emission, or transfer)
Company uses batteries containing 10t lead in fleet	Nil	
Batteries are scrapped and sent to waste recycler	10	Transfer to recycler
Recycler sorts and then sends batteries to lead smelter	10	Transfer to smelter
Smelting process to obtain metallic lead (some emissions to atmosphere)	0.5	Emission to air
Smelter sells 9.5t of lead to battery manufacturer	Nil	
Company purchases batteries to use in fleet (10t lead)	Nil	
Company scraps batteries	10	Transfer to recycler
Total emissions	**0.5**	**Air**
Total transfers	**30**	**Transfer**

The transfers from the 10.5t of lead which is in circulation in the example above, are estimated to be 30t. With further recycling the difference becomes even greater. Therefore, if one were to use the mass balance estimate of usage to determine transfers, double counting would need to be considered.

In-situ Data

It is evident that small industries and businesses are not capable of, or do not have the resources available to prepare detailed reports of substance transfers and emissions. Should there be a requirement to extend the NPI to include all businesses, there would be a need to develop a reporting protocol, such as the sector specific estimation manuals, which have been developed. The existing workbooks concentrate largely on the estimation of air emissions, but could be extended to provide advice on measuring or estimating transfers.

Generic Data

Internationally, little research has been done in the determination of the transfer of substances, specifically in solid waste. Other similar inventories have relied on industry to provide an estimate of substances within solid waste or effluent streams, however, these inventories have only captured the “large” industry sector, where specific chemical knowledge may be known about the wastes produced. Expanding the concept to smaller industries, businesses and even households creates the barrier in that most managers do not know what chemical they use (only the product brand names), and have little inclination to research chemical emissions from their businesses unless it provides an income, or becomes a legal obligation.

A broad estimate of transfers over a range of small industries and businesses undertaken by the lead agency (EPA, DEP, etc.), would probably provide better information than a long and protracted interview of each individual business. However, estimation techniques for performing this estimate are not currently available. The main reasons for this are as follows:

- Waste has generally been classified according to its origin (domestic, commercial, garden, etc.), its properties (hazardous, sludge, organic, etc), or its recyclability (percentage of paper, glass, plastics, etc.), rather than its chemical composition;
- Although the concept of developing indices, or estimation techniques, for waste generation from different industrial activities has been touted, there are no such techniques or indices available across the board. Where they are available they are very specific;
- The quantity of waste generation is largely dependent on the operating and housekeeping practices of the business, and is thus very variable.

16.1.3 Transfers from Tailing Storage Facilities

Consultants are preparing a report on the management of TSFs in the gold industry. The discussion will include a comparison of the transfer of NPI substances to and the emission of NPI substances from TSFs. The following points relating to TSF transfers and emissions issues are made based on the experience of the trial team gained during the study period.

- The transfer of NPI substances into TSFs is far easier to estimate than emissions from TSFs.
- Emission factors for NPI substances from TSFs are complex and difficult to define, particularly in relation to seepage into ground water.
- Due to the extreme variability of the nature of TSFs and the subsoil between various sites, the EFs developed gave only very approximate estimates of emissions to air, water and land. There was a general feeling that it was not possible to provide factors at all for some emissions. *"The estimation of some factors is simply not possible, and the only way of 'evaluation' will be by direct measurement"* (per.comm CME 1998)
- Mining companies and their peak bodies expressed concern about providing emissions data that appears to lack technical rigour. It was also expressed throughout the trial that some emissions couldn't be accurately determined by any means. *"Seepage from Tailings - the estimation of loads to known pathways such as drainage is a complex process requiring extensive study. The estimation of loads through ground water losses is impossible and would involve significant range of errors so as to render the information inappropriate."* (per comm, CME, 1998).
- As cyanide is an expensive reagent, many mining companies have estimates of the quantity of liquor transferred to and from TSFs as well as concentrations of some metals and certain forms of cyanide.
- TSFs are designed to facilitate consolidation of the tailings. All TSFs seep, however, management of the seepage is an integral part of the TSF. Management of TSF seepage varies according to design features of the particular TSF and site specific requirements.
- Licence conditions on TSFs relate to cyanide concentration limits on monitor bore water samples.
- All cyanide used at a facility is ultimately:
  - lost as an emission to air, land or water;
  - degraded into other substances; or
  - contained as a "complex" in the TSF and its seepage control management facilities.
- Some references indicate that not all of the cyanide breaks down into harmless products. These products may not be included as part of cyanide emission estimations from TSFs. *"Mining and regulatory documents often state that cyanide in water rapidly breaks down – in the presence of sunlight – into largely harmless substances, such as carbon dioxide and nitrate or ammonia. However, cyanide also tends to react readily with many other chemical elements, and is known to form, at a minimum, hundreds of different compounds (Flynn and Haslem, 1995). Many of these breakdown compounds, while generally less toxic than the original cyanide, are known to be toxic to aquatic organisms. In addition, they may persist in the environment for long periods*

of time, and there is evidence that some forms of these compounds can be accumulated in plant (Eisles, 1991) and fish tissue. (Heming, 1989)" (Moran, 1998).

16.1.4 Transfer Recommendations

16.1.1 The recommendations from Coffey (1999) are reproduced below.

As a result of insufficient information being available for estimating transfers from non-reporting facilities in Kalgoorlie, it is recommended that one or more of a number of methodologies be developed to enable adequate data collection or estimation to be achieved in future.

Ideally the proposed methodology should be:

- Simple to calculate, in order to avoid incurring excessive expenditure in obtaining the estimates;
- Based on reliable source data;
- An order of magnitude estimate (the more accuracy required the greater the cost).

A selection of possible methodologies are:

- *Educate facility operators in the correct data collection methods* so that data can be readily extracted and synthesized. A suggested approach would be to get businesses to provide an annual mass balance register of their usage of different substances. All chemicals ordered should be provided with their MSDS (Material Safety Data Sheet) which would provide a list of the concentration of chemical substances within a product. Estimates of air emissions can be made from existing emission estimation workbooks. This approach however will only be possible if the provision of this information from businesses is legislated and enforced.
- *Develop industry specific transfer indices,* which can be used to estimate transfers based on the size of the industrial activity. This approach would require specific research to be undertaken into wastes and pollutant substances produced by specific industrial activities, and could be combined with the existing industrial sector estimation manuals for air emissions. An example of the resultant output would be; for ANZSIC code 2541, Explosive Manufacturing, transfers in effluent = Ammonium Nitrate (110 kg/employee per year, or 1kg/$1000turnover/year, or similar).
- *Develop speciation profiles for different waste categories.* Most solid waste is categorised in the traditional manner, so to avoid changing the generally accepted waste classification, it is proposed that a series of speciation profiles be developed for different waste classifications, in order to link the usual classification with the requirement for reporting substances. Due to the heterogeneous nature of waste these profiles would necessarily have to be averaged, and therefore not as accurate as other methods, however they would be depicted in tables which could relatively easily and cheaply be

applied countrywide. The process would involve the laboratory analysis of the full suite of reporting substances for a statistical sample of each selected waste type.

A manual which details the various uses and application of each substance in the different industries, and provides examples of its potential emission routes, will provide a basis for industries and businesses to start evaluating the information required for the NPI.

16.1.2 The mining industry advised of the difficulties and limitations involved in formulating general emissions factors to comply with NPI reporting requirements from TSFs at this stage. They will need to demonstrate a better application of existing environmental data to meet NPI reporting requirements for TSFs. Consideration may need to be given to other ways of dealing with TSFs and the best methods for reporting these emissions to the community.

16.2 Facility Boundary

The boundary of a facility is not clear in a mining context. The facility boundary should be defined so that the emissions data displayed on the NPI database best reflects the actual source of the emissions. As such a member of the public "clicking" onto a particular reporting facility expects that the emissions information actually relates to emissions occurring at or near that particular location. The complexities of applying facility boundary in a mining context include the following issues:

- Mining leases can be extensive and the lease boundary is generally considered as "the boundary" by most mining companies.
- A given mining operation can include a number of separate and clearly distinct processes or activities including:
  - open cut mining;
  - underground mining;
  - processing plant;
  - tailings storage facility (TSF);
  - waste rock dump;
  - roasting; and
  - power generation.
- These activities may all be closely located or separated by up to hundreds of kilometers.
- A number of different companies may own these activities.
- Emissions from one activity may be transferred to another activity i.e. the waste heat (and emissions) from a power generation gas turbine may be used as a source of heat for a processing plant.
- A common exit stack may be used by a number of activities.

- Companies may be involved in “toll treating” i.e. a company process ore owned by another company.

Given that there are so many issues involved, it is unlikely that a facility boundary definition can be provided that covers all situations as well as being practical to apply. Certain mining operations will clearly be considered as one facility and other operations will just as clearly be classed as two or more facilities. It is proposed that any definition allows the facility occupier some latitude in its application, for those situations that could be considered to fall into a “borderline” category.

Proposed guidance as to what constitutes a boundary for a **mining operation** is as follows:

- Different facility **occupiers** (as defined in the Measure) of a mining operation trigger NPI reporting separately e.g. a power station on the mine site that is owned by a separate company reports to the NPI independently of the mining activities.
- Facility occupiers with separate activities (as defined above) within a mining operation:
  - **Must** be treated as one facility if they are less than 2km apart;
  - **May** be treated as one or separate facilities, if they are more than 2km apart and less than 10km apart; and
  - **Must** be treated as separate facilities if more than 10 km apart.
- A given activity cannot be broken into more than one facility i.e. an open cut mine that extends for 20 kilometers is one facility, but two small mines separated by 20 kilometers are two facilities.
- A TSF is **always** part of the processing plant and cannot be considered as a separate facility.

The definition provides initial direction only to reporting facilities and many anomalies that arise will require further clarification from the relevant jurisdiction. Those operations that have activities falling into the “boundary borderline” can determine whether their emissions are all depicted on the database as one facility or as two or more separate “smaller” facilities. It was found to be more work to report activities within a mining operation separately and it is believed unlikely that many operations will aim for more “smaller” facilities, purely as a means to reduce the number of substances that trigger NPI reporting.

Two other boundary type issues that surfaced during the trial relate specifically to the emission of fugitive PM_{10} emissions and emissions from TSFs. The NPI Implementation Working Group (IWG) clarified that emissions are considered to be from the point of generation, and not what is actually emitted beyond the facility boundary or mining lease. Therefore:

- PM_{10} Emissions: These emissions are to include all PM_{10} emissions generated at a facility and not the fraction that is considered to escape from the facility boundary.

- TSF Emissions (to ground water): Emissions should include all metals and cyanide that seep from the TSF liner (generally clay). Any emission that is subsequently recovered via a recovery bore should be subtracted from the overall TSF emission.

There is an understanding in sections of the mining community that the ground water mound under the TSF should be included within the boundary of the TSF. However, the trial team believes that if a substance is lost from the TSF structure itself, it should be regarded as an emission to land (ground water).

16.2.1 Boundary Recommendation

16.2.1 Consider adopting, further developing or modifying the definition of facility boundary proposed by the trial team in order to help clarify reporting requirements for mining facilities.

16.3 PM_{10} Emissions

16.3.1 The Region

Kalgoorlie is a naturally dusty place due to the limited vegetation cover, fine soils and dry climate. The clearing of land, storage of mine tailings near the city, unsealed roads and general mining activities have contributed to the overall dust problem. As a consequence nuisance dust emissions have been a concern to the community over the years. A Goldfields Dust Abatement Committee (GDAC) was formed in 1973 with a view to monitoring dust levels and implementing programmes to reduce dust levels (GDAC, 1986). The dust monitoring programme is now managed by KCGM. “High Volume”(Hi Vol) dust samplers have been placed near sources that have the potential to generate nuisance levels of dust for the local residents. They sample and measure ambient air “Total Suspended Particulates” (TSP).

The estimation of PM_{10} emissions in the study region was considered an important aspect of the trial. The mining industry in particular was keen that PM_{10} emissions from fugitive dust sources, as well as other aggregated sources, be determined in order that emissions from industrial point sources can be evaluated within a proper context.

16.3.2 Definitions

Common terms relating to “particulates” are defined as follows:

- Particulate matter – *a generic term applied to a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a range of particle sizes.* (McClellan, 1997, p.3)
- Total Suspended Particulates (TSP) - particles with an EAD (see below) of less than approximately 50 microns (Standards Australia, 1984). '*TSP consists of particles that remain suspended in the atmosphere but are not necessarily inhalable into the human body where they may cause health problems*"(BHP, 1996, p.10). It generally defines the highly visible nuisance dust impacts.
- Equivalent Aerodynamic Diameter (EAD) – the diameter of a spherical particle of density 1000kg/m^3 which exhibits the same aerodynamic behaviour as the particle in question (Standards Australia, 1984).
- PM$_{10}$ – atmospheric suspended particulate matter having an EAD of less than approximately 10 microns (Standards Australia, 1990). These particles are from a wide range of natural and anthropogenic sources, including combustion, road dust, pollen and sea salt spray. The particles are small enough to get into the lungs and cause respiratory related health problems.
- PM$_{2.5}$ - fine suspended particulate matter having an EAD of less than approximately 2.5 microns. These particles are most often generated from motor vehicle exhausts, combustion processes and chemical reactions taking place in the air (British Columbia Ministry of Health, 1995). *"There is growing consensus among the scientific community that the fine fraction of PM$_{10}$ is relatively more toxic than the coarse fraction and is responsible for the majority of* [health] *effects observed.*"(Air Quality Management Plan, 1996, p.9 *). "This fine fraction can remain in the air for days to weeks and can penetrate deeply into the lungs, collecting in the alveoli."* (British Columbia Ministry of Health, 1995, p.).
- Silt **-** Silt refers to a size fraction and is defined as follows in the Australian Standard A/S 1289.3.6.1 – 1995:

Table 60: Definition of Silt Particle Size

Particle	Size Range (microns)
Clay	1 – 2
Silt	2 – 60
Sand	60 – 2,000

A value is required for silt in a number of the PM$_{10}$ calculations. Generic values are usually provided, but the result obtained for PM$_{10}$ varies significantly with the value for silt and an analysis of particle size would increase the accuracy. The approximate cost of analysis is as follows:

2 – 75 microns	$100 per sample (combined clay and silt fraction).
75 – 53,000 microns	$55 per sample.

The cost of any pretreatment required is about $50 per hour.

16.3.3 Aggregated PM_{10} Emissions

Coffey Geoscience were engaged to determine emissions of PM_{10} from all non-point sources within the region as part of their “Aggregated Emissions Study.” Their findings are presented in a separate “Aggregated Emissions Report” (1999) for the Kalgoorlie NPI Trial. The aggregated PM_{10} emissions was to include an estimation of emissions from:

- Mobile sources – motor vehicles, aircraft, locomotives and off-road vehicles;
- Area-based sources – non-reporting and sub-threshold facilities and households; and
- Natural dust sources – area-wide fugitive dust emissions from paved and unpaved roads, TSF heaps and general wind blown dusts.

The study concluded that it is not possible to provide meaningful estimates of fugitive dust generated PM_{10} emissions within the region, purely through the application of emission factors. Methodologies developed by the USEPA for estimating fugitive dust emissions are applicable to specific industry-related operations, rather than area-wide estimates of emissions (Coffey, 1999). Emission estimates rely heavily on local characteristics and with the uncertainties involved, any estimates of overall fugitive dust emissions may be misleading (Coffey, 1999).

All the “Hi Vol” dust samplers in the region were located in “dusty hotspots” and were unable to provide long-term data on TSP emissions from natural sources. It was also recognised that any relationship between the TSP and PM_{10} fraction of dust is soil specific and cannot be accurately determined without an analysis of the TSP sample. A reliable estimation of natural PM_{10} emissions is believed to require a well developed ambient dust monitoring strategy involving high volume sampling over a duration of up to 2 years to capture the range of meteorological conditions. In the case of Kalgoorlie this would require monitoring to be done in an undisturbed region near Kalgoorlie so as not to skew the results from any emissions related to anthropogenic sources. An undertaking of this type was conducted near Port Hedland by BHP Iron Ore Pty Ltd, prior to construction of their Hot Briquetted Iron plant at Boodarie.

Coffey estimated emissions of PM_{10} emissions from vehicular travel over paved and unpaved roads and from disturbances to old tailings dams within the study area. In each case the values were calculated using empirical expressions developed by the USEPA (1995). The results obtained for the 6-month study period are listed in Table 61.

Table 61: Fugitive Emissions of PM_{10}

Source	PM_{10}’s Emitted (kg)
Paved roads	160,000
Unpaved roads	1,330,000
Historic tailings dams	950
Total Fugitive Dust*	**1,500,000**

* Does not include area-wide sources of fugitive dust.

PM_{10} emissions from all aggregated sources within the region are listed in Table 62.

Table 62: Aggregated Emissions of PM_{10}

Source	PM10's Emitted (kg)
Mobile Sources	22,600
Area-Based Sources	110,000
Fugitive Dust*	1,500,000
Total Aggregated	1,600,000

* Does not include area-wide sources of fugitive dust.

Clearly fugitive dust is the major source of aggregated PM_{10} emissions even though the area-wide dust generated component could not be estimated and therefore was not included in the total fugitive PM_{10} estimation.

16.3.4 Point Source (Facility) PM_{10} Emissions

Point source PM_{10} emissions were estimated using the relevant EET manuals (draft & final format) and are comprised of combustion emissions from stacks and on site fugitive emissions generated by mining and other activities. Emissions from combustion sources were generally easy to determine, with industries having a degree of confidence with the results obtained when using the emission factors provided in the manuals. The resources needed to estimate PM_{10} emissions from fugitive dust sources at mine sites was significant, requiring up to 85% of the total time and effort associated with NPI reporting. There was considered to be a high level of uncertainty associated with the estimates. The total PM_{10} emissions from reporting facilities results are shown in Tables 63 and 64.

Table 63: PM_{10} Emissions from Reporting Facilities

Reporting Facilities	PM_{10}'s Emitted (kg)
WMC Resources	186,000
Kanowna Bell Gold Mines	236,000
Kalgoorlie Consolidated Gold Mines - Fimiston	2,420,000
Kalgoorlie Consolidated Gold Mines - Gidji	198,000
Normandy Kaltails	750
Parkeston Power	42,00
Western Power	400
Loongana Lime	7,960
Boral Asphalt	1,090
Kalgoorlie Regional Hospital	50
Total Point Source	**3,090,000**

Table 64: Total PM 10 Emissions

Source	PM_{10}'s Emitted (kg)
Point Source Emissions	**3,090,000**
Aggregated Emissions*	1,600,000
Total PM10	**4,690,000**

* Does not include area-wide sources of fugitive dust.

16.3.5 Analysis of Results

Although only a proportion of fugitive dust emissions could be estimated, the results indicate that this is a major source of PM_{10} emissions in a regional mining town. It was expected that had it been possible to estimate the area wide total fugitive PM_{10} emission for the 40x40 square kilometre study zone, it may have dwarfed the point source emissions. It should be noted that comparing total aggregated PM_{10} emissions (that are spread over a wide area) with point source emissions tells little about the relative concentration effects at a given location.

Some understanding of the fugitive dust generated PM_{10} emissions can be obtained through the general observation of dust, based on the assumption that PM_{10} is a reasonably constant fraction of the visible fugitive dust for a given region. The trial team made the following observations while in Kalgoorlie:

- Emissions of dusts from mining operations on a relatively calm day were minimal.
- Emissions from unpaved roads appeared significant during dry conditions, although unpaved roads on mining leases were generally well watered leading to significantly reduced emissions of dust.
- Dust clouds sweep through the region on dry windy days, originating from any bare patch of earth and are so widespread and general in nature that it seemed impossible to

identify a particular source or whether it originated within or outside of a given facility boundary.

- Mining and other human activity is indirectly responsible for much of the background dust due to the clearing and general infrastructure developed. Dust from virgin bush in the region would be expected to be significantly lower due to the presence of the vegetation cover.
- The dustiest operation that was observed within the town-site was from land being cleared for residential development.
- Dust generated from the use of explosives was not observed, although believed to be significant at times according to information from local residents.

16.3.6 Data Accuracy

Mining companies involved in the trial, along with other mining companies have expressed concern about the estimation of fugitive PM_{10} emissions. Not only is it a resource intensive part of NPI emission estimation, but there is a general lack of confidence in the numbers produced through the application of emission factors provided in the EET manuals. The trial team also believe that time and resources devoted to estimating PM_{10} emissions is substantial and that the numbers generated are likely to be only order of magnitude estimates.

There was a significant variation in PM_{10} emission results obtained, depending on assumptions made and the particular EFs used. Assumptions required for estimating fugitive PM_{10} emissions include – vehicle speed, PM_{10}/TSP ratios, silt content and efficiency of dust control technologies. Facilities understandably tend to use the approach and general assumptions that produce the lowest emission estimation.

Outlines below are two examples of the vastly different PM_{10} emission estimates that can be generated using different EFs presented in the manuals.

Example 1

Wheel generated dust can be determined using several methods, all of which produce markedly different estimates. Estimates of wheel generated dust from a mining operation in Western Australia, using different EET methods are shown in Table 65. A description is then given of each method.

Table 65: Example of Wheel Generated PM10's Emission Estimates

Vehicle	No. Wheels	VKT[1]	Vehicle Mass (tonne)	Method 1	Method 2	Method 3
Utilities and Others	4	804,400	4	89,578	321,760	443,302
Loaders	4	351,844	30	39,181	140,738	434,113
Trucks	6	10,760	75	4,953	4,304	19,153
Trucks	16	3,745	80	53,382	1,498	6,841
Trucks	22	1,500	100	65,176	600	2,996
Trucks	60	295,037	120	429,462,366	118,015	633,801
Total				429,714,636	586,915	1,540,206

[1] VKT: Vehicle Kilometers Travelled in the reporting period.

Method One refers to the equations for "Wheel Generated Dust" outlined on page 41 of the EET Manual for Mining:

$$E = 0.0019w^{3.4} L^{0.2} \text{ kg/VKT} \qquad (1)$$

Where:

E = Emission Factor (kg/VKT)
w = number of wheels
L = road surface silt content in (g/m^2) – default of 80g/m^2 was used
VKT = vehicle kilometres traveled (km).

Method Two uses a default value for E of 0.4 kg/VKT, as described on page 42 of the EET Manual for Mining.

Method Three uses the following equation and constants taken from Section 9.2 of the Coffey Report (1999):

$$E = \frac{k(s/12)^a(W/3)^b[(365-p)/365]}{(M_{dry}/0.2)^c}$$

Where:

E = size specific emission factor (g/VKT)
k = constant for PM$_{10}$ of 733
a = constant for PM$_{10}$ of 0.8
b = constant for PM$_{10}$ of 0.4
c = constant for PM$_{10}$ of 0.3
W = average weight of vehicles (tonnes)

M_{dry} = surface material moisture content under dry, uncontrolled conditions (%). Default of 10 % used.
p = the dumber of days with at lest 0.254mm of precipitation per year. Default of 131 used.

The equation used by the Coffey report (1999) was taken from the USEPA (1995) Compilation of Air Pollutant Emission Factors. Vol. 1. Stationary Point and Area Sources 5th Edition.

Each of the methods used resulted in significantly different PM_{10} emission estimates, often with one or more orders of magnitude difference. Emission estimates for a 60 wheeled truck of 1.5 tonnes per VKT gave a clearly erroneous estimate.

The total combustion PM_{10} emissions from the same facility amounted to 7802 kg, which is insignificant in comparison to wheel generated dust.

Example 2

Emissions of TSP from open areas, stockpiles and disturbed land for KBGM were determined using two methodologies. Results obtained using the equation (1) shown below from the mining EET manual (p.43) gave results about twice that obtained using the generic factor in equation (2).

$$E = 1.9 * (s/1.5) * 365 * ((365-p)/235) * (f/15) \qquad (1)$$

Where
E = emission factor (kg/ha/yr)
s = silt content (%)
p = number or days when rainfall is greater than 0.25 mm
f = percentage of time that wind speed is greater than 5.4 m/s at the mean height of the stockpile.

$$E = 0.4 \text{ kg/ha/hr} \qquad (2)$$

These examples reinforce the findings that PM_{10} estimates are likely to be an order of magnitude estimates only at this stage. This is coupled with the findings that the overall wind blown dust generated PM_{10} emissions is likely to be a very significant component of the total regional PM_{10} emissions, but also extremely difficult to estimate without direct monitoring. It is considered little value is gained utilising resources to estimation these emissions with the current level of accuracy.

It should also be noted that even accurate estimations of PM_{10} emissions from mining facilities would not necessarily convey information to the public about the efficiency of their operation. A large well-run operation is still likely to have a larger total PM_{10} emission that a small dusty operation. The PM_{10} concentration in the vicinity of the large site may however, be expected to be less the PM_{10} concentration near the smaller less efficient operation.

16.3.7 USEPA

The USEPA is generally considered leaders in the field of particulates and are considering setting concentration limits for $PM_{2.5}$ as well as PM_{10} (Anderson, 1997). This statement is qualified in the quote from Anderson (1997):

> *"Toxicological research with test animals and knowledge of human physiology suggests that it is fine particles, those 2.5 microns in diameter or less, that do most of the damage to health". For that reason the USEPA now proposes to add a new standard for $PM_{2.5}$* (Anderson, 1997, p.3)

The USEPA is currently proposing to set the following limits for $PM_{2.5}$ emissions:

- Annual average concentration of 15 micrograms per cubic meter of air.
- Maximum 24-hour concentration of 50 micrograms per cubic meter.

The USEPA has set the following limits for PM_{10} emissions:

- Annual average concentration of 50 micrograms per cubic meter of air.
- Maximum 24-hour concentration of 150 micrograms per cubic meter.

The USEPA believes that coarser particles, between 2.5 and 10 microns, can cause serious damage at high concentrations" and proposes to retain the present PM_{10} rules as well as adding new $PM_{2.5}$ limits (Anderson, 1997, p.3).

It should be noted that the coarse fraction of PM_{10} emissions is most closely related to natural sources while the fine fraction ($PM_{2.5}$) mostly relates to emissions from combustion sources and chemical reactions taking place in the air (British Colombia Ministry of Health, 1995. Similarly "U*nlike PM_{10} particulates, which generally consist of dust and other windblown matter, $PM_{2.5}$ particulates tend to result directly or indirectly from combustion products from such sources as diesel-fueled vehicles, sulfur-emitting utility plants, and other industries*"(Reichhardt, 1996).

In line with the overseas findings and results from the current study the trial team suggests that particulates as products of combustion be reported separately to particulates generated from fugitive dust sources.

16.3.8 Conclusions

- It is considered to be impossible to estimate with a reasonable degree of accuracy the total PM_{10} emissions from a regional centre, without conducting a long-term monitoring programme.
- The estimation of dust generated PM_{10} emissions from mining operations resource intensive and the results are likely to be order of magnitude estimates only.
- The PM_{10} emission estimation component of the NPI is not held in high regard by industry.
- It is considered unlikely that PM_{10} emissions in a regional setting will be estimated with sufficient accuracy through the application of emission factors, to indicate trends.
- Emissions from combustion processes ($PM_{2.5}$) are reasonably well characterised and may be more significant than PM_{10} from a long-term health perspective.
- The PM_{10} annual emission figure from a mining operation may provide little indication of any impact on health or the efficiency of the operation. A large well run operation is likely to have a larger total PM_{10} emission than small dusty operation, even though the PM_{10} concentration on the large mine site may be significantly lower.
- The current 2a trigger for PM_{10} operations doesn't catch the small operations that generate significant quantities of dust from materials handling such, as concrete batching. These operations can be located near the residents of regional centers.

16.3.9 Recommendations

16.3.1 Consider estimating only emissions from combustion sources ($PM_{2.5}$) at this stage. The estimation of fugitive PM_{10} emissions, particularly from mining operations is resource intensive and the estimations are considered to be poor.

16.3.2 If PM_{10} emissions are to be determined, then it is recommended that methodologies are developed to estimate fugitive dust PM_{10} emissions from aggregated wind generated sources, as they are likely to be a major contributor in semi-arid mining environments.

16.3.3 If PM_{10} emissions are to be determined, then consider reporting combustion particulates separately to fugitive dust generated particulates. A separate reporting threshold could then be applied to capture the emission of fugitive dust from classes of industries known to be dusty operations, but below the 2a threshold.

16.4 Reporting Forms

The electronic reporting form was not available in a suitable form to the trial team and therefore its usefulness could not be evaluated. However, it was apparent that there is a very real need for such a reporting tool for use by reporting facilities.

Individual facilities submitted their data using a variety of means. The most practical and efficient format was to complete the front and back pages of ‘Worksheet 3’, and then to attach a signed and dated table summarising the details required on page two of ‘Worksheet 3’. This approach removed the necessity to complete up to 40 completed copies of the worksheet.

The issue of accuracy and reporting of very small emissions caused some problems. For example, one facility may have reported an emission of 0.000021 kg of Arsenic, whereas a second facility may have reported the same emission as zero. A consistent approach is required.

16.4.1 Recommendation

16.4.1 Clear direction is recommended in relation to significant figures (as distinct form decimal places). A section in each EET manual on significant figures would be beneficial. The trial team recommends the estimates to be no more than 2 significant figures.

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Appendix A

Table 1 and Table 2

National Environmental Protection
Measure for the
National Pollutant Inventory

Table 1

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Acetone	67-64-1	1	10 tonnes per year
	Arsenic & compounds	7440-38-2	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Benzene	71-43-2	1	10 tonnes per year
	Benzene hexachloro- (HCB)	608-73-1	1	10 tonnes per year
1,3-	Butadiene (vinyl ethylene)	106-99-0	1	10 tonnes per year
	Cadmium & compounds	7440-43-9	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Carbon monoxide	630-08-0	1	10 tonnes per year
			2a	400 tonnes per year, or 1 tonne per hour
	Chromium (VI) compounds	7440-47-3	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Cobalt & compounds	7440-48-4	1	10 tonnes per year
	Cyanide (inorganic) compounds	N/A	1	10 tonnes per year
1,2-	Dibromoethane	106-93-4	1	10 tonnes per year
	Dichloromethane	75-09-2	1	10 tonnes per year
2-	Ethoxyethanol	110-80-5	1	10 tonnes per year
2-	Ethoxyethanol acetate	111-15-9	1	10 tonnes per year
	Ethylene glycol (1,2-ethanediol)	107-21-1	1	10 tonnes per year
	Fluoride compounds	N/A	1	10 tonnes per year
			2a	400 tonnes per year, or 1 tonne per hour
	Glutaraldehyde	111-30-8	1	10 tonnes per year
	Lead & compounds	7439-92-1	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Mercury & compounds	7439-97-6	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Methanol	67-56-1	1	10 tonnes per year
	Methyl ethyl ketone	78-93-3	1	10 tonnes per year
	Methyl isobutyl ketone	108-10-1	1	10 tonnes per year
	Methyl methacrylate	80-62-6	1	10 tonnes per year
	Nickel carbonyl	13463-39-3	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Nickel subsulphide	12035-72-2	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts

Table 1 (cont.)

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Oxides of Nitrogen	N/A	2a	400 tonnes per year, or 1 tonne per hour
	Particulate Matter 10.0 um	N/A	2a	400 tonnes per year, or 1 tonne per hour
	Polycyclic aromatic hydrocarbons	N/A	2a	400 tonnes per year, or 1 tonne per hour
	Selenium & compounds	7782-49-2	1	10 tonnes per year
	Styrene (ethenylbenzene)	100-42-5	1	10 tonnes per year
	Sulphur dioxide	7446-09-5	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Sulphuric acid	7664-93-9	1	10 tonnes per year
	Tetrachloroethylene	127-18-4	1	10 tonnes per year
	Toluene (methylbenzene)	108-88-3	1	10 tonnes per year
	Toluene-2,4-diisocyanate	584-84-9	1	10 tonnes per year
	Total Nitrogen	N/A	3	15 tonnes per year
	Total Phosphorus	N/A	3	3 tonnes per year
	Total Volatile Organic Compounds	N/A	1a 2a	25 tonnes per year, or a design capacity of 25 kilotonnes for bulk storage facilities 400 tonnes per year, or 1 tonne per hour
1,1,2-	Trichloroethane	79-00-5	1	10 tonnes per year
	Xylenes (individual or mixed isomers)	1330-20-7	1	10 tonnes per year

Table 2

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Acetaldehyde	75-07-0	1	10 tonnes per year
	Acetic acid (ethanoic acid)	64-19-7	1	10 tonnes per year
	Acetone	67-64-1	1	10 tonnes per year
	Acetonitrile	75-05-8	1	10 tonnes per year
	Acrylamide	79-06-1	1	10 tonnes per year
	Acrylic acid	79-10-7	1	10 tonnes per year
	Acrylonitrile (2-propenenitrile)	107-13-1	1	10 tonnes per year
	Ammonia (total)	N/A	1	10 tonnes per year
	Aniline (benzenamine)	62-53-3	1	10 tonnes per year
	Antimony & compounds	7440-36-0	1	10 tonnes per year
	Arsenic & compounds	7440-38-2	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Benzene	71-43-2	1	10 tonnes per year
	Benzene hexachloro- (HCB)	608-73-1	1	10 tonnes per year
	Beryllium & compounds	7440-41-7	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Biphenyl (1,1-biphenyl)	92-52-4	1	10 tonnes per year
	Boron & compounds	7440-42-8	1	10 tonnes per year
1,3-	Butadiene (vinyl ethylene)	106-99-0	1	10 tonnes per year
	Cadmium & compounds	7440-43-9	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Carbon disulphide	75-15-0	1	10 tonnes per year
	Carbon monoxide	630-08-0	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Chlorine	7782-50-5	1	10 tonnes per year
	Chlorine dioxide	10049-04-4	1	10 tonnes per year
	Chloroethane (ethyl chloride)	75-00-3	1	10 tonnes per year
	Chloroform (trichloromethane)	67-66-3	1	10 tonnes per year
	Chlorophenols (di, tri, tetra)	N/A	1	10 tonnes per year
	Chromium (III) compounds	7440-47-3	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts

Table 2 (cont.)

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Chromium (VI) compounds	7440-47-3	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Cobalt & compounds	7440-48-4	1	10 tonnes per year
	Copper & compounds	7440-50-8	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Cumene (1-methylethylbenzene)	98-82-8	1	10 tonnes per year
	Cyanide (inorganic) compounds	N/A	1	10 tonnes per year
	Cyclohexane	110-82-7	1	10 tonnes per year
1,2-	Dibromoethane	106-93-4	1	10 tonnes per year
	Dibutyl phthalate	84-74-2	1	10 tonnes per year
1,2-	Dichloroethane	107-06-2	1	10 tonnes per year
	Dichloromethane	75-09-2	1	10 tonnes per year
	Ethanol	64-17-5	1	10 tonnes per year
2-	Ethoxyethanol	110-80-5	1	10 tonnes per year
2-	Ethoxyethanol acetate	111-15-9	1	10 tonnes per year
	Ethyl acetate	141-78-6	1	10 tonnes per year
	Ethyl butyl ketone	106-35-4	1	10 tonnes per year
	Ethylbenzene	100-41-4	1	10 tonnes per year
	Ethylene glycol (1,2-ethanediol)	107-21-1	1	10 tonnes per year
	Ethylene oxide	72-21-8	1	10 tonnes per year
	Di-(2-Ethylhexyl) phthalate (DEHP)	117-81-7	1	10 tonnes per year
	Fluoride compounds	N/A	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Formaldehyde (methyl aldehyde)	50-00-0	1	10 tonnes per year
	Glutaraldehyde	111-30-8	1	10 tonnes per year
n-	Hexane	110-54-3	1	10 tonnes per year
	Hydrochloric acid	7647-01-0	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Hydrogen sulphide	7783-06-4	1	10 tonnes per year
	Lead & compounds	7439-92-1	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Magnesium oxide fume	1309-48-4	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts

Table 2

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Manganese & compounds	7439-96-5	1	10 tonnes per year
	Mercury & compounds	7439-97-6	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Methanol	67-56-1	1	10 tonnes per year
2-	Methoxyethanol	109-86-4	1	10 tonnes per year
2-	Methoxyethanol acetate	110-49-6	1	10 tonnes per year
	Methyl ethyl ketone	78-93-3	1	10 tonnes per year
	Methyl isobutyl ketone	108-10-1	1	10 tonnes per year
	Methyl methacrylate	80-62-6	1	10 tonnes per year
4,4-	Methylene bis 2,4 aniline (MOCA)	101-14-4	1	10 tonnes per year
	Methylenebis (phenylisocyanate)	101-68-8	1	10 tonnes per year
	Nickel & compounds	7440-02-0	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Nickel carbonyl	13463-39-3	1	10 tonnes per year
			2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Nickel subsulphide	12035-72-2	1 2b	10 tonnes per year 2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Nitric acid	7697-37-2	1	10 tonnes per year
	Organo-tin compounds Oxides of Nitrogen	N/A N/A	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Particulate Matter 10.0 um	N/A	2a	400 tonnes per year, or 1 tonne per hour
	Phenol	108-95-2	1	10 tonnes per year
	Phosphoric acid	7664-38-2	1	10 tonnes per year
	Polychlorinated dioxins and furans	N/A	2b	2,000 tonnes per year, or or 60,000 megawatt hours, or rated at 20 megawatts
	Polycyclic aromatic hydrocarbons	N/A	2a	400 tonnes per year, or 1 tonne per hour
	Selenium & compounds	7782-49-2	1	10 tonnes per year
	Styrene (ethenylbenzene)	100-42-5	1	10 tonnes per year

Table 2 (cont.)

prefix	COLUMN 1 SUBSTANCE	COLUMN 2 CASR No.	COLUMN 3 THRESHOLD CATEGORY	COLUMN 4 THRESHOLD
	Sulphur dioxide	7446-09-5	1 2a	10 tonnes per year 400 tonnes per year, or 1 tonne per hour
	Sulphuric acid	7664-93-9	1	10 tonnes per year
1,1,1,2-	Tetrachloroethane	630-20-6	1	10 tonnes per year
	Tetrachloroethylene	127-18-4	1	10 tonnes per year
	Toluene (methylbenzene)	108-88-3	1	10 tonnes per year
	Toluene-2,4-diisocyanate	584-84-9	1	10 tonnes per year
	Total Nitrogen	N/A	3	15 tonnes per year
	Total Phosphorus	N/A	3	3 tonnes per year
	Total Volatile Organic Compounds	N/A	1a 2a	25 tonnes per year, or a design capacity of 25 kilotonnes for bulk storage facilities 400 tonnes per year, or 1 tonne per hour
1,1,2-	Trichloroethane	79-00-5	1	10 tonnes per year
	Trichoroethylene	79-01-6	1	10 tonnes per year
	Vinyl Chloride Monomer	75-01-4	1	10 tonnes per year
	Xylenes (individual or mixed isomers)	1330-20-7	1	10 tonnes per year
	Zinc and compounds	7440-66-6	1	10 tonnes per year

Appendix B

Kalgoorlie Mining Log of Issues

Appendix B: Kalgoorlie Mining Log of Issues

PURPOSE

This working log is to keep a record of issues that arise during the course of the trial, which need clarification or further investigation. It is also a record of decisions made and a means of communication to provide a consistent approach between trial participants.

METHOD OF OPERATION

Issues can be directly entered in this log by WMC Resources, Kanowna Bell Gold Mines, Kalgoorlie Consolidated Gold Mines, Normandy Mining, or the Department of Environmental Protection. The DEP will administer the log and seek to pursue issues raised and gain consensus where required.

No	DATE	ISSUE	ACTION
1	30/11/98	Need to define transfers	For the trial transfers is defined as: "the transfer of wastes for the full reporting list of 90 substances and includes, deposit of a substance into landfill (onsite or offsite), discharge of a substance to a sewer or the removal of a substance from a facility for destruction, treatment, recycling, reprocessing, recovery or purification."
2	30/11/98	Calculation of EETs especially PM_{10} is tedious and time consuming, requires a spreadsheet similar to Tanks 3.1.	Spreadsheet needs to be developed by the DEP
3	30/11/98	Develop communication package.	DEP / WMC to develop.
4	30/11/98	Workshop on NPI to include Regional Environmental Officers.	Greg Mueller is briefing as part of general NPI implementation process.
5	10/12/98	Co-allocation – what is the reporting requirement on a facility such as Olympic Dam, which mines and processes gold, copper and uranium when only the gold handbook will be available in the first reporting year?	Environment Australia (EA) informed. Only an issue in the first reporting year and doesn't impact on the Kalgoorlie Trial.
		PPK report – General issues and NPI guide	
6	16/12/98	If a facility triggers on fuel consumption, it is required to estimate all PM_{10} emissions including the PM_{10} component of dust, while a very dusty operation which doesn't trigger on fuel consumption does not report	EA informed. Include in trial report for NPI NEPM review.

No	DATE	ISSUE	ACTION
		PM_{10}.	
7		Clarification of category 1a is required. Does usage of 25 tonnes of fuel trigger VOC reporting?	Seeking clarification from IWG.
8		Include a list of VOCs in the guide.	VOC currently being defined for NPI. Will probably be similar to the following "any organic compound which participates in atmospheric photochemical reactions. These include all carbon-containing compounds except methane, carbonates, metallic carbides, carbon monoxide, carbon dioxide and carbonic acid." There will probably also be a reference to the compound having a vapour pressure greater than 1mm of mercury at 20 degrees Celsius. It's more straightforward to list the exclusions rather than the VOCs. It includes petroleum and products, natural gas, LPG.
9		Useful to include a list of common use or occurrence for each substance under Table 1 & 2 in the NPI guide.	Detailed substance information is to be provided as contextual information and will be displayed on the NPI database.
10		Mine sites don't have data separating Chromium (111) and Chromium (V1) and is not provided in the generic ore concentrations in the EET manuals.	Agreed. Needs further investigation. Does one form predominate or are both significant?
		PPK report - Mining EET Manual	
11		Are tailings that are being retreated considered as ore under the NPI? Needs to be stated.	Yes. Reporting trigger is usage and as such processing old tailings triggers NPI reporting.
12		For underground mining, are PM_{10} emissions from fuel consumption assumed to be 100% controlled?	Yes, but emissions of VOCs and other fuel combustion products are assumed to be 100% emitted.
13		Are other emissions from fuel consumption all assumed to be emitted to air?	Generally all occur to air, but spillage of fuel etc can be an emission to water or land.
14		The mining manual would be more useful with a table of NPI substances likely to be triggered as per Table 1 in the Gold Manual.	National consultation has closed on this handbook, but could be considered when reviewed. This recommendation can be included in the trial report.
15		The Mining Manual should include a flow chart indicating points of usage or emissions as per Fig 2 in the Gold Manual.	A handbook review issue.
16		Excavators need to be included in the fuel emission factors table in the mining handbook.	Agreed, use factors that are available.

No	DATE	ISSUE	ACTION
17		Tracked bulldozers need to be included in the dust emission factors table.	Agreed.
18		Fuel consumption by light vehicles is not included in the Mining Manual. Need to reference the relevant manual.	National handbooks will be developed for mobile sources including motor vehicles and will contain the relevant emission factors.
19		Beneficial to clarify the coverage of the Mining Manual in relation to the other manuals.	Agreed.
20		There is unnecessary overlap between the Mining Manuals and others.	Yes, trial to highlight inconsistencies and areas of overlap.
21		Emission factors are not given for metals and trace substances for fuel emission EETs.	Requires further investigation.
22		Fuel consumption emissions for say diesels are broken down into vehicle types, which is more detailed than for the Greenhouse Challenge where only total consumption is used.	Noted. Trial can also report on reporting difficulties faced by the industry and the value of a holistic approach.
		PPK report - Gold EET Manual	
23		Need emission factors for NH_3 and HCN in electrowinning and carbon regeneration process in Gold Manual.	Seek to include if available. Whilst no emission factors were found, Section 5.2.2 has been amended and recommends the use of mass balance for these emissions. *"Cyanide losses will occur in the carbon regeneration, elution and electrowinning areas. While this cyanide rapidly degrades to form ammonia the original emission form is as HCN and as such is reported as a cyanide emission. No attempt is made to differentiate between the masses emitted from these areas due to the difficulties inherent in their individual estimation."*
24		Include some discussion of fate of acid added to the process, e.g. HCl mostly neutralised and discharged as salts.	Agreed. No changes made to date.
25		An emission factor required for metals and SO_2 at the gold smelting stage or indicate if emissions are insignificant.	Needs further investigation. No emission factors presented.
26		In Section 6.2.2 on the volatilisation of cyanide from	Can use either, can we test both in the trial?

No	DATE	ISSUE	ACTION
		TSF surfaces - two emission factors are given. Need guidance on factor to be used.	
27		Cyanide emissions to air via electrowinning and carbon regeneration are relatively large, but emission is likely to be NH_3 and CO_2 rather than HCN.	Needs further investigation. See point 23 above.
28		Guidance is required on which water assay data (or emission factor) should be used for determining aqueous metals emitted in TSF seepage, e.g. decant water assay verses near proximity monitor bores.	Use metal concentrations in TSF return water, unless have more detailed information from a groundwater modeling study that has been conducted.
		PPK report - IC Engines EET Manual	
29		Emission factors are not given for metals and trace substances for fuel emission EETs.	Noted.
30		Is off-site light vehicle travel excluded from emission estimates for a facility?	Yes, should be picked up from traffic count data etc and be included in general aggregated emission data.
31		Light vehicle EETs seem unnecessarily complex and differ from methods used for heavy vehicles (Mining Manual).	Yes - ideally need a large spreadsheet for all forms of combustion engines (mobile and stationery) which will calculate values when the relevant data is entered. Cost and feasibility to be investigated.
32		Light vehicle emission estimates require the user to determine control factors - should be given in the manual.	Noted - any examples of control factors, do we have information from equipment manufacturers etc?
		PPK report Power Generation EET Manual	
33		Emission factors are not given for metals and trace substances for fuel emission EETs (Covered in Combustion in Boilers Manual).	Noted.
		PPK report – Combustion in Boilers EET Manual	
34		For LPG or diesel-fired kilns or furnaces e.g. carbon regeneration kilns, roaster startups, does the Combustion in Boilers EET Manual apply?	Yes, includes LPG combustion etc.
		PPK report - Transfers	
35		What is the reporting trigger for transfer of waste oil, grease, tires etc?	For trial, report all these transfers and it will provide information concerning the transfer triggering issue.
36		How are NPI substances present in transfers such as to	Provide DEP with quantities of transferred material and the process

No	DATE	ISSUE	ACTION
		waste oil, grease, tires etc., determined?	from which it has been derived. The DEP will determine NPI substances in accordance with the methodology outlined in the "Aggregated Emissions Report" by Coffey.
37	9 Feb	How do we break down the concentrations of NPI substances in transfers of wastes such as waste oil and paints?	See 36 above.
38	9 Feb	At what point does a mine need to report separately from the processing plant, or from other neighbouring mines operated by the same company? A mine may be located 10-100's of km from a the processing mill, and therefore effectively be a separate operation. When does a facility need to report in its own right? For example, the Gidji roaster should be presented separately from other KCGM mine operations, otherwise KCGM will appear on the database to be emiting a large quantity of SO2 near the centre of Kalgoorlie. Using an arbitrary distance, say 5km, as the defining point may not work especially in urban/industrial areas where a company may have two entirely separate facilities near each other.	Collect trigger and emissions data assuming sites will be separate. Will aim to provide an answer during analysis of the data.
39	9 Feb	The Gidji plant has a roaster for oxidising sulfides. There are no emission factors for this kind of roaster. Do they use the Combustion in Boilers Manual?	Assume all S converted to SO_2,
40	9 Feb	Is WMC's super heater a boiler or a power generation unit - which manual is used?	Currently unclear.
41	9 Feb	The two manuals - Fossil Fuel for Power Generation, and Combustion in Boilers - should they be joined into one manual?	No, general feedback is that they serve a different purpose.
42	9 Feb	There is the need to have standardised units both within each manual and between manuals. Conversion factors also need to be provided, as many facilities collect data in different units to those used in the manuals.	Sam Wilkinson to provide conversion tables

No	DATE	ISSUE	ACTION
43	9 Feb	Many terms are based on US terminology - such as tractors. This needs to be rectified. There is also nothing specifically for trucks as used in mining.	Use closest vehicle type to that described in either the Mining Manual or the Combustion Engines Manual.
44	9 Feb	Definitions of vehicle types – especially “tractors” is unclear. Some form of definition of the vehicle types needs to be given, be it in written form, or as a shadow picture.	Acknowledged, good idea.
45	9 Feb	Other vehicles that need clarification or inclusion are: excavators; drilling rigs; and trucks (or are they tractors under US definition)	DEP to pursue emission factors
46	23 Feb	Need to provide contextual data for situations such as the use of hypersaline groundwater or the seepage of TSFs into hypersaline water. Need to determine baseline values for hypersaline water before reporting seepage from TSFs. This will prevent reporting abnormally high seepage levels of pollutants and metals that may be naturally present in the groundwater.	Acknowledged. However, the background metals concentration levels in hypersaline groundwater are expected to be insignificant when compared with concentration in TSF seepage.
47	23 Feb	Who should be responsible for reporting emissions from TSFs after they have been decommissioned? Do mining companies report all its contents at closure? Continue to report TSF seepage at a depreciated rate for the next x years? Report emissions from the TSF only whilst it is operational? Other options?	While this is an issue that has arisen in the trial, it will not have to deal with directly in the trial. New WA regulations on contaminated sites state that occupiers will need to determine if the groundwater into which seepage is occurring is going to be of beneficial use after TSF closure to other users in the future. Occupiers will then be required to monitor and report on the emissions from TSFs until the emissions are at a level suitable to the beneficial use. If, for example, the water should be hypersaline and only suitable for use as mining process water, or, where the plume extends into an area where the water cannot even be used for agricultural purposes, then reporting on emissions from seepage from the TSF after closure may not be necessary. If, on the other hand, seepage is occurring into potable water, then companies should continue to report (as per contaminated sites regulations) to the NPI, any ongoing emissions to groundwater.

No	DATE	ISSUE	ACTION
			There are five categories of ‘beneficial use’ of water based on the Australian/NZ water use guidelines.
48	23 Feb	There is the need to make a distinction between transfers of NPI substances and the transfer of material such as from the open pit to the overburden stockpiles.	The transfers of material such as from the open pit can be considered as an “internal movement” as opposed to a “transfer”.
49	23 Feb	Estimating fugitive emissions from the entire plant is an extremely time consuming and laborious process, that is likely to provide emissions smaller than the error associated with the major emissions	There is little point in estimating insignificant fugitive emissions. However, for the purposes of the trial, could each company do a complete analysis of fugitive emissions for at least one substance to highlight the issue?
50	23 Feb	Kaltails is running an operation on a KCGM lease. Who reports it, KCGM or Kaltails?	In this instance Kaltails would qualify as the ‘occupier’ of the ‘facility’. The “*occupier in relation to any facility means a person who is in occupation or control of the facility whether or not that person is the owner of the facility”* The ‘facility’ is any building or land from which a substance is emitted together with any machinery, plant, appliance, equipment, implement, tool.....
52	23 Feb	If a facility uses decant water for dust suppression, would they need to report metals in this water as emissions to water	Report the percentage of decant water that is used on normal access road surfaces, but not on land that will later be mined.
53	23 Feb	What constitutes an emission to land? The slag from the nickel refining containing high levels of manganese is disposed of on site. The manganese is a waste product of the process but is effectively bound up and may not affect other biota. Yet the slag itself is inhospitable and requires covering with soil in order to allow for growth. Does the Manganese fraction constitute an emission to land? The main point in question is in the definition of "emission" which begins "an emission is an emission...". i.e. to emit does the slag need to produce a Manganese rich leachate into the ground, or is it's physical presence on the ground enough to constitute an emission?	Noted, emission definition is not clear.
54	23 Feb	In following, a better working definition of "emission"	Yes, noted.

No	DATE	ISSUE	ACTION
		that accounts for the limitations of an "emission is an emission..." is required.	
55	23 Feb	Are VOCs in degreasers and other store products meant to be included in the emissions estimates?	Yes.
56	23 Feb	Magnesium oxide fumes, what is it? They have magnesium oxide, but not sure about the fumes.	The word “fumes” seems to indicates it must be a product of combustion.
57	23 Feb	Who estimates VOCs from vegetation?	Coffey study.
58	23 Feb	What number of significant figures should be used for the emissions estimates?	Data should be presented to 2 or 3 significant figures, settle on 3 significant figures for the trial.

Appendix C

Questions Asked of Non-Mining Reporting Facilities

Questions Asked of Non-Mining Reporting Facilities

The trial team asked the following series of questions when visiting the non-mining facilities.

Can you please provide me with some information regarding your Process Description?

How many Personnel were involved in the collection of data?

Position of personnel involved (e.g. environmental, engineers, chemists, etc)

How many Personnel were involved in the overall reporting?

How did you define your facility boundary (if applicable)?

How did you identify which substances triggered reporting?

Which EET's were chosen?	Why did you choose this EET?	How did this EET affect the data collection process?

How was the data collected? For example, did you need to get others in the organisation to collect the data, was extra monitoring required, or was it all readily available?

How did you collect the "transfers of wastes" data, i.e. transfers for reprocessing, recycling or disposal? Did you need others in the organisation to collect the data, was extra monitoring required, or was it all readily available?

Costs associated with data collection?
How did you report the data? Using the worksheets provided or the MS Access database?

Please provide information on any problems experienced for each of the points listed below (if applicable) in order to help other facilities learn from your experience?

Handbooks:

Identifying which substances trigger reporting

Data collection

Data accuracy

Transfers

General Problems and Issues

Appendix D

Press Releases

Appendix E

Companies that Contributed to Development of the Nickel and Gold Manuals

Companies that Contributed to Development of the Nickel and Gold Manuals

Nickel Concentrating, Smelting and Refining:

- WMC Resources;
- Murrin Murrin Operations Pty Ltd;
- Outukumpu;
- Bulong;
- Black Swan; and
- Queensland Nickel Refinery.

Gold Ore Processing:

- WMC Resources;
- Kalgoorlie Consolidated Gold Mines;
- Kanowna Belle Gold Mines;
- Normandy Kaltails Pty Ltd;
- Paddington Gold;
- Sons of Gwalia;
- Acacia Resources;
- Aurora;
- Placer – Granny Smith;
- Centaur;
- Newcrest;
- Hedges;
- Bronzewing; and
- Worsley Alumina.

Valuable input was also obtained from:

- AMIRA;
- NT DME;
- WA DME;
- CSIRO; and
- WA Chemistry Centre

Appendix F

Total Emissions from Aggregated and Individual Facilities in the Kalgoorlie Study Area

Tables presented in this appendix:

Table F.1: Total Emissions to Air in Kalgoorlie Study Area

Substance	Total Aggregated Emissions to Air (kg)	Total Point Source Emissions To Air (kg)	Total Emissions To Air (kg)[1]
Acetaldehyde	5,180	323	5,500
Acetone	8,130	0	8,130
Acrylic acid	0.0000278	0	0.0000278
Ammonia (total)	11,700	756	12,500
Antimony & compounds	0	2.04	2.04
Arsenic & compounds	0	2,070	2,070
Benzene	18,500	517	19,100
Beryllium & compounds	0	0.29	0.29
Boron & compounds	0	6.01	6.01
1,3- Butadiene (vinyl ethylene)	2,010	16.3	2,030
Cadmium & compounds	0.09	329	329
Carbon disulphide	0	9,550	9,550
Carbon monoxide	3,850,000	345,000	4,190,000
Chloroform (trichloromethane)	7	0	7
Chromium (III) compounds	0	1,110	1,110
Cobalt & compounds	0	69.5	69.5
Copper & compounds	0	901	901
Cumene (1-methylethylbenzene)	784	45.5	830
Cyanide (inorganic) compounds	4,870	239,000	244,000
Cyclohexane	20,300	5.29	20,300
1,2- Dibromoethane	0	0.05	0.05
1,2- Dichloroethane	0.03	0	0.03
Dichloromethane	1,870	0	1,870
Ethanol	2,500	0	2,500
2- Ethoxyethanol acetate	1,220	0	1,220
Ethyl acetate	4.92	0	4.92
Ethylbenzene	3,890	3.49	3,900
Ethylene glycol (1,2-ethanediol)	605	0	605
Ethylene oxide	248	0	248
Fluoride compounds	0.10	0	0.10
Formaldehyde (methyl aldehyde)	12,800	732	13,600
n- Hexane	27,700	594	28,300
Hydrochloric acid	0.01	0	0.0124

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[1] Totals have been rounded.

Table F.1: Total Emissions to Air in Kalgoorlie Study Area (cont.)

Substance	Total Aggregated Emissions to Air (kg)	Total Point Source Emissions To Air (kg)	Total Emissions To Air (kg)[1]
Hydrogen sulphide	59	0.05	59.1
Lead & compounds	950	718	1,670
Magnesium oxide fume	0	19.6	19.6
Manganese & compounds	0.69	181	181
Mercury & compounds	0	1.04	1.04
Methanol	8,650	0	8,650
Methyl ethyl ketone	8,050	0	8,050
Methyl isobutyl ketone	615	0	615
Methyl methacrylate	1.08	0	1.08
Nickel & compounds	0.06	5,690	5,690
Oxides of Nitrogen	662,000	1,990,000	2,650,000
Particulate Matter 10.0 um	1,630,000	3,090,000	4,720,000
Phenol	24.1	0	24.1
Polychlorinated dioxins and furans	6.05	0	6.05
Polycyclic aromatic hydrocarbons	3,280	71.1	3,350
Selenium & compounds	0	0.50	0.50
Styrene (ethenylbenzene)	494	0	494
Sulphur dioxide	38,700	103,000,000	103,000,000
Tetrachloroethylene	2,750	0	2,750
Toluene (methylbenzene)	38,600	290	38,900
Total Volatile Organic Compounds	4,900,000	67,100	4,960,000
Trichoroethylene	5,950	0	5,950
Xylenes (individual or mixed isomers)	28,200	162	28,400
Zinc and compounds	0	425	425

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[1] Totals have been rounded.

Table F.2: Total Emissions to Land in Kalgoorlie Study Area

Substance	Aggregated Emissions to Land (kg)	Point Source Emissions to Land (kg)	Total Emissions to Land (kg)[1]
Acetic acid (ethanoic acid)	2,410	0	2,410
Ammonia (total)	53,000	203	53,200
Antimony & compounds	0.104	0.237	0.341
Arsenic & compounds	0.0221	0.743	0.765
Benzene	0.0585	0	0.0585
Beryllium & compounds	0.0076	0.237	0.245
Boron & compounds	0	131	131
Cadmium & compounds	43.6	0.237	43.8
Chlorine	930	23.7	954
Chloroform (trichloromethane)	0.0458	0	0.0458
Chlorophenols (di, tri, tetra)	0.000805	0	0.000805
Chromium (III) compounds	2,170	12.4	2,180
Chromium (VI) compounds	8.8	0	8.8
Cobalt & compounds	0	13.6	13.6
Copper & compounds	1,830	46.6	1,880
Cyanide (inorganic) compounds	0	103	103
1,2- Dichloroethane	0.0158	0	0.0158
Dichloromethane	0.695	0	0.695
Ethanol	30,800	0	30,800
Ethylbenzene	0.0915	0	0.0915
Fluoride compounds	0.615	142	143
Lead & compounds	2,040	0.237	2,040
Manganese & compounds	0	133	133
Mercury & compounds	0.0545	222	222
Nickel & compounds	75	34.5	110
Phenol	0.6	0	0.6
Selenium & compounds	0	0.237	0.237
Toluene (methylbenzene)	77.5	0	77.5
Total Nitrogen	0	0	0
Total Phosphorus	0	0	0
Total Volatile Organic Compounds	33,700	0	33,700
Vinyl Chloride Monomer	0.063	0	0.063
Xylenes (individual or mixed isomers)	2,810	0	2,810
Zinc and compounds	21,600	6.05	21,700

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[1] Totals have been rounded.

Table F.3: Total Aggregated and Facility Emissions to Air in the Kalgoorlie Study Area (kg)

Substance	Total Agregated Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Acetaldehyde	5180	323														
Acetone	8130															
Acrylic acid																
Ammonia (total)	11700	553													203	
Antimony & compounds		1.88						.161								
Arsenic & compounds		740	251		44.6	1030		0.036								
Benzene	18500	389								1.45		53	41	32.1		
Beryllium & compounds		0.266	0.02					0.0024								
Boron & compounds		5.53						0.48								
1,3- Butadiene (vinyl ethylene)	2010	16.3														
Cadmium & compounds		329						0.031								
Carbon disulphide			9550													
Carbon monoxide	3850000	29900	26700	2540	275000	63.8	2180	300	7870	125						238
Chloroform (trichloromethane)	7															
Chromium (III) compounds		10.2	1.27		90.2	1010		0.34		0.003						
Cobalt & compounds		5.97			27.1	36.4		0.066								
Copper & compounds		123	10.1		40.7	718		9.5		0.001						
Cumene (1-methylethylbenzene)	785											45.5				
Cyanide (inorganic) compounds	4870		203000	36100												
Cyclohexane	20300									0.29		5				
1,2- Dibromoethane													0.05			
1,2- Dichloroethane																
Dichloromethane	1870															

Table F.3: Total Aggregated and Facility Emissions to Air in the Kalgoorlie Study Area (kg) (cont.)

Substance	Total Agregated Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Ethanol	2500															
2- Ethoxyethanol acetate	1220															
Ethyl acetate	5															
Ethylbenzene	3900										0.992	2.5				
Ethylene glycol (1,2-ethanediol)	605															
Ethylene oxide	249															
Fluoride compounds		ND		ND	ND	ND	ND	ND	ND							ND
Formaldehyde (methyl aldehyde)	12800	729								2.7						
n- Hexane	27700	525	0.21							0.29		68.5				
Hydrochloric acid		ND						ND								ND
Hydrogen sulphide	59	0.05														
Lead & compounds	950	699	19.4					0.0043		0.001				0.06		
Magnesium oxide fume		19.6	ND		ND	ND	ND	ND	ND							
Manganese & compounds	1	31.1	147					2.6		0.003						
Mercury & compounds		0.446	.595					0.00066								
Methanol	8650															
Methyl ethyl ketone	8050															
Methyl isobutyl ketone	615															
Methyl methacrylate	1															
Nickel & compounds		4780			67.6	832	ND	8.8		0.004						
Oxides of Nitrogen	662000	247000	63700	9480	596000	228	4670	5100	1060000	818						954

Table F.3: Total Aggregated and Facility Emissions to Air in the Kalgoorlie Study Area (kg) (cont.)

Substance	Total Agregated Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Particulate Matter 10. um	1630000	186000	236000	750	2420000	198000	7960	400	42200	1090						47.7
Phenol	24															
Polychlorinated dioxins and furans	6	ND	ND		ND	ND		ND								
Polycyclic aromatic hydrocarbons	3280	70.1		0.13				ND	ND	0.036			0.79			0.057
Selenium & compounds		0.463						0.039		ND						
Styrene (ethenylbenzene)	494															
Sulphur dioxide	38700	22700000	12000000	515	34500	68100000	7480	2700	231	.922						3380
Tetrachloroethylene	2749															
Toluene (methylbenzene)	38600	170								0.628	2.44	45.5	34.8	36.4		
Total Volatile Organic Compounds	4900000	4820	5070	1140	39300		49.2	120		484	47.6	6190	6300	3570		15.9
Trichoroethylene	5950															
Xylenes (individual or mixed isomers)	28300	126	0.02							0.097	7.78	8	9.96	9.94		
Zinc and compounds		15.7			67.6	337		4.9		0.01						

Table F.4: Total Aggregated and Facility Emissions to Land in the Kalgoorlie Study Area (kg)

	Aggregated Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Acetic acid (ethanoic acid)	2420															
Ammonia (total)	530000														203	
Antimony & compounds	0.104														0.237	
Arsenic & compounds	0.0221				0.27										0.473	
Benzene	0.0585															
Beryllium & compounds	0.00760														0.237	
Boron & compounds	0			2.86											128	
Cadmium & compounds	43.6														0.237	
Chlorine	930														23.7	
Chloroform (trichloromethane)	0.0458															
Chlorophenols (di, tri, tetra)	0.0008															
Chromium (III) compounds	2170		7.6	0.11											4.73	
Chromium (VI) compounds	8.80															
Cobalt & compounds	0			1.76											11.8	
Copper & compounds	1830		40.8	0.26		0.85									4.73	
Cyanide (inorganic) compounds	0		22.5	8.3	48.8	21									2.37	
1,2- Dichloroethane	0.0158															
Dichloromethane	0.695															
Ethanol	30800															
Ethylbenzene	0.0915															
Fluoride compounds	0.615														142	

Table F.4: Total Aggregated and Facility Emissions to Land in the Kalgoorlie Study Area (kg) (cont.)

	Agregated Emissions	WMC	Kanowna Belle	Normandy	KCGM Mining	KCGM Gidji	Loongana Lime	Western Power	Parkeston Power	Boral Asphalt	Mobil	BP	Ampol	Shell	WWTP	Kalgoorlie Regional Hospital
Lead & Compounds	0		117	1.99											14.2	
Manganese & compounds	0															
Mercury & compounds	0.0545		222												0.118	
Nickel & compounds	75.0		22.3	0.44											11.8	
Phenol	0.600															
Selenium & compounds	0														0.237	
Toluene (methylbenzene)	77.5															
Total Nitrogen	0														0	
Total Phosphorus	0														0	
Total Volatile Organic Compounds	33700															
Vinyl Chloride Monomer	0.0630															
Xylenes (individual or mixed isomers)	2820															
Zinc and compounds	21700			1.32											4.73	

Appendix G

Definitions of Total VOCs

Appendix G: Definitions of Total VOCs

USEPA Code of Federal Regulation Title 40 (Protection of the Environment)
On June 16, 1995, the USEPA finalized the definition of volatile organic compounds (VOCs), focusing on their role in the formation of ozone. Any organic compound which participates in atmospheric photochemical reactions except those designated by EPA as having negligble photochemical reactivity. The definition contains a list of exempted VOCs, those exhibiting negligible ozone-forming activity.

The following list of chemicals are defined as "non-VOCs" in both federal regulations at 40 CFR 51.100, and in state regulations at LAC 33:III.2117. The non-VOC list has been updated to reflect the most recent amendments which added acetone and methyl acetate to the list.

Volatile organic compound (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

The following list of chemicals are non-VOCs --- compounds which do NOT participate in atmospheric photochemical reactions.

Table G.1: Non-VOCs Under 40 CFR 51.100 and LAC 33:III.2117

methane
ethane
methylene chloride (dichloromethane)
1,1,1-trichloroethane (methyl chloroform)
1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113)
trichlorofluoromethane (CFC-11)
dichlorodifluoromethane (CFC-12)
chlorodifluoromethane (HCFC-22)
trifluoromethane (HFC-23)
1,2-dichloro 1,1,2,2-tetrafluoroethane (CFC-114)
1,1,1-trifluoro 2,2-dichloroethane (HCFC-123)
1,1,1,2-tetrafluoroethane (HFC-134a)
1,1-dichloro 1-fluoroethane (HCFC-141b)
1-chloro 1,1-difluoroethane (HCFC-142b)
2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
pentafluoroethane (HFC-125)
1,1,2,2-tetrafluoroethane (HFC-134)
1,1,1-trifluoroethane (HFC-143a)
1,1-difluoroethane (HFC-152a)

Table G.1: Non-VOCs Under 40 CFR 51.100 and LAC 33:III.2117 (cont.)

	parachlorobenzotrifluoride (PCBTF)
	cyclic, branched, or linear completely methylated siloxanes
	acetone
	perchloroethylene (tetrachloroethylene)
	3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)
	1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)
	1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee)
	difluoromethane (HFC-32)
	ethylfluoride (HFC-161)
	1,1,1,3,3,3-hexafluoropropane (HFC-236fa)
	1,1,2,2,3-pentafluoropropane (HFC-245ca)
	1,1,2,3,3-pentafluoropropane (HFC-245ea)
	1,1,1,2,3-pentafluoropropane (HFC-245eb)
	1,1,1,3,3-pentafluoropropane (HFC-245fa)
	1,1,1,2,3,3-hexafluoropropane (HFC-236ea)
	1,1,1,3,3-pentafluorobutane (HFC-365mfc)
	chlorofluoromethane (HCFC-31)
	1chloro-1-fluoroethane (HCFC-151a)
	1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a)
	1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane (C4F9OCH3)
	2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane
	((CF3)2CFCF2OCH3)
	1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane (C4F9OC2H5)
	2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane
	((CF3)2CFCF2OC2H5)
	methyl acetate and perfluorocarbon compounds which fall into
	these classes:
	(i) Cyclic, branched, or linear, completely fluorinated
	alkanes;
	(ii) Cyclic, branched, or linear, completely fluorinated
	ethers with no unsaturations;
	(iii) Cyclic, branched, or linear, completely fluorinated
	tertiary amines with no unsaturations; and
	(iv) Sulfur containing perfluorocarbons with no
	unsaturations and with sulfur bonds only to carbon and
	fluorine.

Appendix H

Spreadsheet Used for WWTP Calculations

Spreadsheet Used for WWTP Calculations

Table H1

Unit Meausured	**Unit / description**
Evaporation	
10.3	mm per day in November
7.3	mm ave for year
2664.5	mm ave annual evaporation
1.33225	m evap. for 6months
Pond Area	
30	ha
300000	m2
Evaporation for 6 Months	
399675	m3 evap for 6 months[a]
Throughput in 6 Months	
6000	m3 daily throughput
182	days on reporting period
1092000	m3 of water in 6 months
Irrigational Use	
3000	m3 per day
546000	m3 in 6 months if 3000m3 used for irrigation
Total Water Going to Land	
692325	m3 in 6 months (throughput - evaporation)
Overflow to Hannans Lake Equal to: **Throughput - (Evaporation + Irrigation)**	
146325	m3 in 6 months if 3000m3 used for irrigation
804	m3 per day if 3000m3 used for irrigation

Assume **550ML** (550000m3) of water used for **irrigation**

Therefore assume that 1**50ML** (150000m3) of water is **overflow** and goes directly to Gribble Creek

[a] Assumes zero seapage

Table H2

Substance	Actual Influent Conc (mg/L)	Emisison Factors for Influent (mg/L)	Actual Effluent Conc. (mg/L)	Actual Quantitiy in Influent (influent conc*influent volume)(kg)	Emisison Factor Estimate for Influent (kg)	Actual Quantity in Effluent To Creek and Irrigation ((influent minus evaporation)*Effluent conc) (kg)	Actual Quantity in Effluent to Creek (kg) Assuming 3ML used for Irrigation daily	Quantity Transferred (Effluent to Creek - Effluent to Creek and Irrigation) (kg)
Ammonia	21	26.1	0.86	22932	28501.2	595	203	392
Antimony	0.001	0.0022	0.001	1.092	2.4024	0.692	0.237	0.455
Arsenic	0.003	0.005	0.002	3.276	5.46	1.38	0.473	0.911
Boron	0.4	0.227	0.54	436.8	247.884	374	128	246
Beryllium	0.001	0.0006	0.001	1.092	0.6552	0.692	0.237	0.455
Cadmium	0.001	0.002	0.001	1.092	2.184	0.692	0.237	0.455
Chloride	0.1	nd	0.1	109.2	nd	69.2	23.7	45.5
Chromium	0.02	0.066	0.02	21.84	72.072	13.8	4.73	9.11
Chromium (IV)	0	0.066	0	0	72.072	0	0	0
Cobalt	0.05	0.0039	0.05	54.6	4.2588	34.6	11.8	22.8
Copper	0.1	0.123	0.02	109.2	134.316	13.8	4.73	9.11
Cyanide	0.01	nd	0.01	10.92	nd	6.92	2.37	4.55
Fluoride	0.5	nd	0.6	546	nd	415	142	273
Lead	0.005	0.06	0.001	5.46	65.52	0.692	0.237	0.455
Manganese	0.06	0.144	0.06	65.52	157.248	41.5	14.2	27.3
Mercury	0.0005	0.0006	0.0005	0.546	0.6552	0.346	0.118	0.228
Nickel	0.05	0.023	0.05	54.6	25.116	34.6	11.8	22.8
Selenium	0.001	0.0057	0.001	1.092	6.2244	0.692	0.237	0.455
Zinc	0.12	0.213	0.02	131.04	232.596	13.8	4.73	9.11
Total Nitrogen			34	0	0	23528	8044	15484
Total Phosphorus			13	0	0	8996	3076	5920
Formaldehyde		0.0002		0	0.2184	0	0	0
Phenols		0.024		0	26.208	0	0	0
Poly Aromatic Hydrocarbons (PAH's)		5		0	5460	0	0	0
Sulfate		1500		0	1638000	0	0	0
Sulphite		15		0	16380	0	0	0