AIR QUALITY
IMPACT ASSESSMENT

Prepared for

AFRO FISHING (PTY) LTD

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1 INTRODUCTION

Messrs Afro Fishing (Pty) Ltd (Afro Fishing) operates a pilchard cannery in the harbour precinct of Mossel Bay in the Western Cape Province. Details of the site layout and surrounding are given in graphical format in Appendix A to this report. The location of sensitive receptors in the area surrounding Afro Fishing's operations is shown in Appendix B.

The pilchards are normally harvested off South African shores, but due to dwindling availability in local waters, most of the pilchards used nowadays are imported.

Waste materials from fresh fish processing prior to canning is removed from site and transported to a waste disposal facility in Atlantis in the Western Cape.

To supplement their operations in Mossel Bay, Afro Fishing is considering the possibility of harvesting pelagic (industrial) fish, e.g. anchovy, red-eye herring, etc., from local waters for the sole purpose of producing fishmeal and fish oil. Afro Fishing is also planning to process the waste materials from their canning plant on site. The proposed site of the plant is adjacent premises that previously served a fish processing factory.

The design capacity of the proposed plant is a maximum of 1 000 tons of fresh fish material per day and will consist of the following three fishmeal production lines:

Line 1: The maximum design capacity is 475 tons industrial fish per day and will be installed first. This line will only operate as and when fresh fish product is harvested.

Line 2: The maximum design capacity is 475 tons industrial fish per day and will be installed a year later, depending on the availability of fresh fish. This line will only operate as and when fresh fish product is harvested.

Line 3: The maximum design capacity is 50 tons per day and will deal with the fish waste products currently generated in the canning plant, i.e. essentially fish heads and tails with low protein content. This will produce a low-grade fishmeal product. This line will operate continuously in conjunction with the canning process. As the canning plant processes fresh and/or frozen materials, the waste materials can also be regarded as fresh, i.e. will not generate excessive odours.

Afro Fishing is thoroughly aware of the fact that they are located very close to the centre of the town of Mossel Bay and some of its residential areas, albeit in the precinct of a commercial harbour. Although it is well known that fish meal processing can easily lead to odorous emissions, modern, state-of-the-art fishmeal production technology is planned. This includes regenerative thermal oxidation (RTO) treatment of all vapours generated in the fishmeal production process to prevent any odorous emissions from escaping from the plant. This is currently the best available technology for odour reduction in fishmeal plants.

Afro Fishing appointed Cape Environmental Assessment Practitioners (Cape EAPrac) to facilitate the process of obtaining environmental authorisation for the planned fishmeal production process. Fishmeal production is included in the *List of Activities That Result in Atmospheric Emissions* published by the Department of Environmental Affairs and an atmospheric emission license (AEL) is required to operate the process. The AEL may only be considered once the environmental authorisation has been obtained.

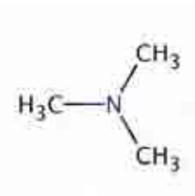
An application for an AEL of this nature must be accompanied by a specialist air quality impact assessment and, on recommendation by Cape EAPrac, Afro Fishing appointed Lethabo Air Quality Specialists (Pty) Ltd (LAQS) for this purpose.

This report discusses the steps taken by LAQS in assessing the potential impact that emissions from Afro Fishing's site may have on the area surrounding their site. Particular attention was paid to estimated ground-level concentrations in the residential areas most likely to be affected by emissions. As odorous emissions are by far the most problematic environmental issue associated with fishmeal production, LAQS focused on odour impacts, but also included products of combustion from the boilers that will be in service.

2 ODOROUS GASES

Natural decomposition of fish species result in the formation of trimethylamine (TMA) and hydrogen sulphide (H_2S), both of which are odorous. According to the USA's Environmental Protection Agency (USEPA), approximately 20 to 30 times more TMA is generated than H_2S. Both of these compounds are included in the USA's Occupational Safety and Health Organisations (OSHA) list of potentially dangerous compounds. Relevant information is given below.

TMA is a product of the natural decomposition of fish species. Its chemical formula is $(CH_3)_3N$ and its molecular structure is:



2.1 EXPOSURE LIMITS

2.1.1 Occupational Health Standards

As stated previously no ambient air quality standards have been set for TMA and H_2S. The American Conference of Industrial Hygienists (ACGIH) and the USA's National

Institute of Occupational Safety and Health (NIOSH) both defined threshold limits for the exposure of workers to these two gases. Two levels are defined. These are:

Time-weighted average (TWA)

The TWA concentration is the level of a chemical substance to which a worker can be exposed to for 8 hours per day, day after day for a working lifetime without adverse effects

Short-term exposure limit (STEL)

STEL is the concentration to which workers may be exposed continuously for a short period of time (typically 15 minutes) without suffering from irritation, chronic or irreversible tissue damage, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

	TWA		STEL	
	ppm	mg/m^3	ppm	mg/m^3
TMA	5	12 (12 000 $\mu g/m^3$)	15	36 (36 000 $\mu g/m^3$)
H_2S	1	1.4 (1 400 $\mu g/m^3$)	5	7.0 (7 000 $\mu g/m^3$)

Table 1: Occupational Health Exposure Limits

Taking its definition into account, the TWA values are of note as they specify the levels to which workers may be exposed day after day without any adverse effects.

2.1.2 General Public Exposure

The United States of America Environmental Protection Agency's National Center for Environmental Assessment operates the Integrated Risk Information System (IRIS). The IRIS system defines reference dosages (RfD) and reference concentrations (RfC) for various substances.

The inhalation Reference Concentration (RfC) is analogous to the oral RfD and is likewise based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis. The inhalation RfC considers toxic effects for both the respiratory system (portal-of-entry) and for effects peripheral to the respiratory system (extra-respiratory effects). It is expressed in units of mg/m^3. In general, the RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Inhalation RfCs were derived according to the Interim Methods for Development of Inhalation Reference Doses (EPA/600/8-88/066F August 1989) and subsequently, according to Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry (EPA/600/8-90/066F November 1994). These values are revised from time to time.

The RfC for H_2S is set at $2x10^{-3}$ mg/m^3 (2 $\mu g/m^3$). No RfC has been defined for TMA.

The highest annual average H_2S concentration estimated by the dispersion model is 0.092 $\mu g/m^3$ at a point approximately 200 metres west of the centre of Afro Fishing's operations. This maximum concentration is well below the RfC value with the result that LAQS is of the opinion that it is unlikely that health risks due to H_2S emissions would exist.

2.2 ODOUR DETECTION

LAQS conducted a literature search for information of the odour detection limits of the odorous compounds associated with fish processing as minimisation of emission of odours is regarded as a critical part of the planned operation. According to the United States of America's Environmental Protection Agency, the main contributors to odours associated with fishmeal processing are hydrogen sulphide (H_2S) and trimethylamine (TMA).

The following sources and relevant information were studied:

1 *Odor thresholds and irritation levels of several chemical substances: A review. Ruth JH. 1986. Am Ind Hyg Assoc J 47:142-151.*

2 *Occupational exposure to hydrogen sulfide in the sour gas industry: Some unresolved issues. Guidotti TL. 1994. Int Arch Occup Environ Health 66:153-160.*

3 *Odour Complaints Checklist*; *Health Protection Agency, UK; 2011.*

4 *Odor Threshold Determinations of 53 Odorant Chemicals; Gregory Leonardos, et al. Journal of the Air Pollution Control Association, 19:2, 91-95*

5 *Odor perception and physiological response. Iowa State University, University Extension, PM 1963a, May 2004.*

6 *Odor & Flavor Detection Thresholds in Water, Leffingwell & Associates. http://www.leffingwell.com/odorthre.htm*

Odour detection thresholds contained in these references showed substantial variation.

- The odour detection limits (the concentration where an odour can be detected, but not necessary recognised) for H_2S are all below 1 µg/m^3. The odour recognition thresholds (the concentration where the odour can be identified as H2S) varied between 6.7 and 42.6 µg/m^3. For the sake of this study LAQS assumed an odour detection limit of 0.7 µg/m^3 (700 ng/m^3), the lowest odour detection limit found, even though it is much lower than the reported odour recognition thresholds.
- The reported odour detection limits for TMA varied from 0.8 to 2.6 µg/m^3. For the sake of this study LAQS assumed an odour detection limit of 0.8 µg/m^3 (800 ng/m^3), although LAQS believes that an odour threshold limit of 2 µg/m^3 is accepted in Europe.

The ability to perceive an odour varies widely among individuals. More than a thousand-fold difference between the least and the most sensitive individuals in acuity have been observed in studies conducted by the Iowa State University in the USA. Differences between individuals are, in part, attributable to age, smoking habits, gender, nasal allergies, head colds, etc. In addition, their surroundings may influence the perceived odour, e.g. scented air fresheners used in homes may mask some odours. As a result it is quite common for members of the same community to experience odours differently and report accordingly, usually resulting in a wide spread of odour descriptors and intensities. This is particularly common when odours are detected by untrained persons.

Generally, the olfactory sensory nerves atrophy from the time of birth to the extent that only 82% of the acuity remains at the age of 20; 38% at the age of 60 and 28% at the age of 80. Consequently, olfactory acuity and like or dislike of an odour decrease with age.

Some investigators have defined odour threshold as the point where there is a detectable difference from background. Another definition of an odour threshold value (OTV) is the minimum identifiable odour or recognition threshold.

Both may be properly considered odour thresholds. However, experience has shown that the *detection threshold* (first change from background) is less reliable and difficult to reproduce as it often relies on a poorly defined judgment of the observer. Often there is confusion as to the definition of the first change as well as changes that can occur in the background odour.

The *recognition odour threshold* can be defined as the concentration at which 50 percent of the human panel can identify the odorant or odour and such concentrations may be orders of magnitude higher than the detection threshold values.

Different compounds have different OTVs. Some OTVs may be very low, e.g. low parts per billion (ppb) range, while others are substantially higher, e.g. parts per million (ppm) range.

It is possible for an odorous compound with a relatively high odour threshold to be present in concentrations above that level, thus masking the presence of other odorous compounds. As the gases travel through, and disperse into, the atmosphere, the concentration of that compound may reduce to a level below its odour threshold at which point it may no longer be detected and other odorous compounds may come to the fore. As a result the perceived odours may change over distance and time.

2.2.1 Odour Characteristics

Odours are usually described by the following four parameters:

-- **Odour detection threshold** is the lowest odorant concentration necessary for detection by a certain percentage of the population, normally 50%. This concentration is defined as 1 odour unit.

-- **Odour intensity** is the perceived strength of an odour above its threshold. In the USA it is usually determined by an odour panel and is described in categories which progress from “not perceptible”, then “very weak”, through to “extremely strong”.

-- **Hedonic tone** is the degree to which an odour is perceived as pleasant or unpleasant. Such perceptions differ widely from person to person, and are strongly influenced, inter alia, by previous experience and emotions at the time of odour perception.

-- **Odour character** is basically what the odour smells like. It allows one to distinguish between different odours.

2.2.2 Hedonic Evaluation

Panels of trained observers were used in the USA to characterise various odours and classify them on a scale ranging from "highly unpleasant" to "very pleasant". The scale used for these evaluations ranged from -4 (highly unpleasant) to +4 (very pleasant).

The following odour descriptors and equivalent evaluations resulted:

Cadaverous (dead animal)	-3.75
Putrid, foul, decayed	-3.74
Sewer odour (typically H_2S)	-3.68
Cat urine	-3.64
Faecal (like manure)	-3.36
Rancid	-3.14
Fermented (rotten fruit)	-2.76
Ammonia	-2.47
Sulphurous	-2.45
Fishy	-1.98

A substantial degree of correlation between odours and unpleasantness resulted from similar studies conducted in the UK.

2.2.3 Odour Detection Limits

According to research conducted on emissions from animal feeding operations by the Iowa State University in the USA, the following odour threshold values and odour recognition values apply to H_2S, ethyl mercaptan, methyl mercaptan and TMA:

Compound	Detection limit, ppm		Recognition limit, ppm	
	ppm	µg/m^3, 25°C	ppm	µg/m^3, 25°C
Hydrogen sulphide	0.00047	0.7	0.0047	7.0
Ethyl mercaptan	0.0003	1.4	0.001	2.5
Methyl mercaptan	0.0011	1	0.0022	2.2
Trimethylamine		0.8		0.8(*)

(*): Assumed by LAQS

Table 2: Odour Threshold Values

The following can be derived from the table:

-- Hydrogen sulphide has an extremely low odour detection limit (equivalent to 0.7 µg/m^3 at 25°C) and its recognition threshold is only one order of magnitude higher at approximately 7 µg/m^3 at 25°C. This implies that an average person may detect its typical rotten egg odour at fairly low concentrations.

-- Equally, ethyl mercaptan has an extremely low odour detection limit, but its odour recognition level is lower than that of H_2S.

-- While the odour detection limits of methyl mercaptan is relatively high when compared to the others, its odour recognition level is also lower than that of H_2S.

-- With its distinctive fishy odour, TMA is both detected and recognised at very low concentrations.

3 ODOUR FORMATION IN FISHMEAL PRODUCTION

Post-mortem, the regulatory mechanisms of the fish which, among other, prevent invasion of the tissues by bacteria ceases to function. Bacteria then invade the fish body through the skin, the body cavity and belly via intestines, and penetrate the gill tissue and kidney by way of the vascular system. (Fraser, 1998)

The characteristic foul 'fishy' odour associated with fish and fish related activities, is attributed to the odorous compound trimethylamine (TMA). TMA is the product of bacterial reduction of TMAO (trimethylamine oxide) found in fish muscle where it acts as an osmo-regulant. Gram-negative bacteria can obtain energy from TMAO by reduction to TMA. (Fraser, 1998).

Examples of bacteria that can reduce TMAO to TMA include: Aeromonas spp., psychrotolerant Enterobacteriaceae, Photobacterium phosphoreum, Shewanella putrefaciens-like organisms and Vibrio spp. (Fraser, 1998 and Heising, 2014)

The pathways for the formation of TMA are complex due to the involvement of different microbial activity and other factors, but macroscopic effects have been studied and are somewhat understood.

To generalise across a much more complex field, one can simplify the formation rate of TMA to adhere to some form of sigmoid or logarithmic response. This is a common description for the response of many compounds and other parameters. The key characteristic of this response can be summarised as:

Stage	General Response	Physical association
1	Initial delay where the parameter stays near zero	The multiplication of the relevant bacteria that produce TMA increases to significant levels during this stage, although their effect is not yet noticeable
2	A rapid increase in the parameter and the rate at which it increases.	This occurs as the relevant bacteria population continuous to grow and multiply. Exponential growth is common.
3	A decrease in the rate at which the parameter increases	After the TMAO availability becomes limiting to the growth of the bacteria, the reaction rate will slow down until the available TMAO is depleted.
4	A maximum after which the parameter will not increase any more with time.	Once all the TMAO has been converted to TMA. No more TMA will be produced.

Table 3: Key characteristics of TMA formation

In their study, "Mathematical models for the trimethylamine (TMA) formation on packed cod fish fillets at different temperatures", J.K.Heising, et al, 2014, the authors state that there are several complex models to define the formation of TMA as a function of time and at various temperatures. Their simplified model for doing so is:

$$C_{TMA} = \frac{C_{max} - C_{min}}{1 + e^{k(t_d - t)}} \text{ where} \qquad \text{(Equation 1)}$$

C_{TMA} = concentration at time t (mg TMA – N per 100 g fish)

t = time (hours)

t_d = inflection point (hours)

C_{max} = upper asymptote concentration at time t (mg TMA – N per 100 g fish)

C_{min} = lower asymptote concentration at time t (mg TMA – N per 100 g fish)

K = growth rate coefficient ($hours^{-1}$); $= Ae^{-E_a/RT}$ where

A = $1.77e^{-15}$ $hours^{-1}$

R = 8.314 J/mol K

T = Temperature, K

E_a = 88 300 J/mol

Figure 1 shows the production rate of TMA measured from Cod (Gadus morhua) fillets. The fish were gutted at sea and stored on ice until they arrived at the auction. The fish was then auctioned to a wholesaler who skinned the fillet and transported it to the laboratory (±3 hours). There it was prepared for analysis and storage and the trial started (Heising, 2014). One can assume a period of at least 4 to 6 hours, if not more, has passed since the fish were caught.

After 24 hours at the laboratory at 5° C the model predicts a TMA formation rate of 0.1 mg N/100 g fish. It is clear from Figure 2 that storage and transport conditions are critical in delaying the formation of TMA.

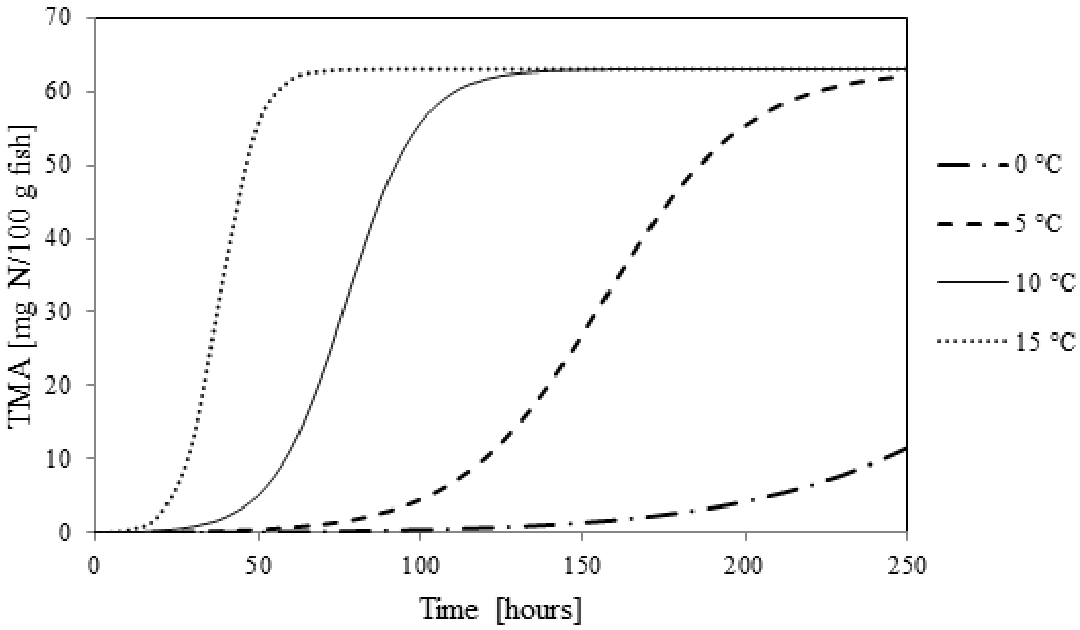


Figure 1: TMA production as described by adapted Howgate model on experimental data (Reproduced from Heising, 2014)

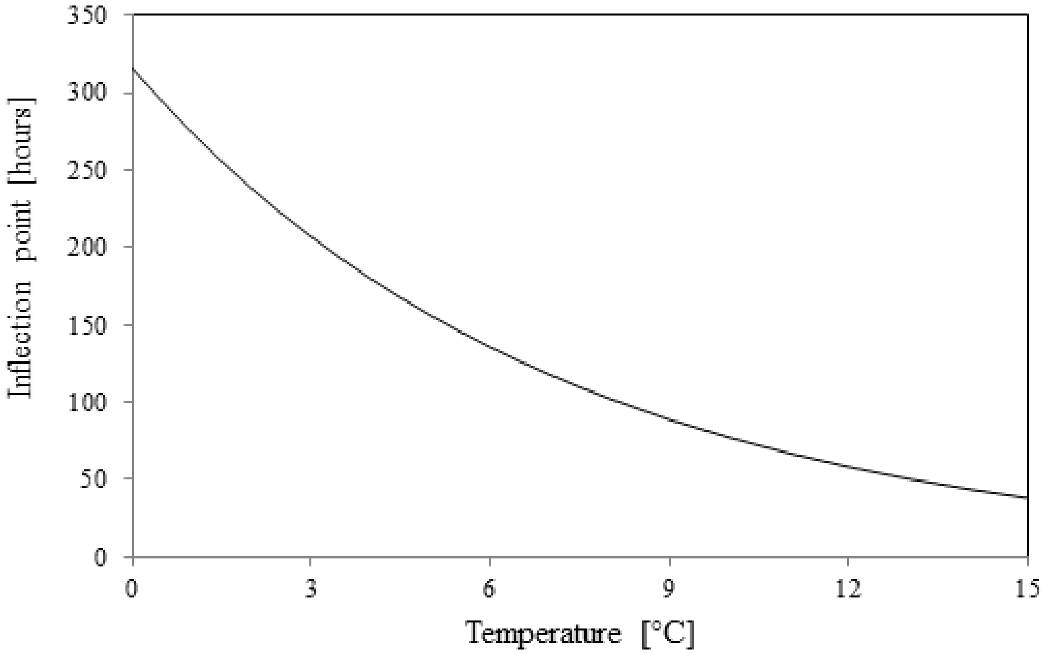


Figure 2: Temperature effect on the inflection point of the adapted Howgate model (Reproduced from Heising, 2014)

In conclusion:

-- There exists a period during which fish is "fresh" and will not generate the foul fishy odour

-- Proper storage conditions and transport conditions are critical in determining this period.

According to the Food and Agricultural Organisation of the United Nations, the following should apply:

-- Fish should be fresh-caught and transported to the facility under chilled conditions. (FAO)

-- Whole fish should be landed before they are stale and be delivered to the factory from the quayside as soon as possible after landing, preferably within 12 hours. (FAO)

The time limit of 12 hours stated by FAO can be derived from Figure 1 and equation 1 which show that the rate of generation of TMA within the first 12 hours is negligible. The rate of TMA generation then increases exponentially as a function of temperature and will still be extremely low at the planned delivery temperature of 4 – 8 ºC.

4 RELEVANT GOVERNMENT REGULATIONS

The following Government Regulations apply to this air quality impact assessment and are referred to in the report where applicable.

1. "*National Ambient Air Quality Standards*" as published in Government Notice 1210 of 24 December 2009 (GN1210)
2. "*Declaration of Small Boilers as Controlled Emitters and Establishment of Emission Standards*" as published in Government Notice 831 of 1 November 2018 (GN831)
3. "*List of Activities That Result in Atmospheric Emissions*" as published in Government Notice 893 of 22 November 2018 (GN893)
4. "*Regulations Regarding Air Dispersion Modelling*" as published in Government Notice GN R.533 of 11 July 2014 (GN R.533)

5 PROPOSED FISHMEAL PLANT

Processing of fresh fish is of prime importance to Afro Fishing for the following two reasons:

-- Processing fresh fish minimises the chance of development of odorous emissions. Please see Section 5.2 below.

-- The quality of the produced fish meal and fish oil is directly proportional to the freshness of the fish, i.e. the fresher the fish, the higher the product quality.

5.1 PROCESS DESCRIPTION

Afro Fishing plans to install three fishmeal production lines, all of which will operate in the same way and will be subject to the same odour control procedures. Of these planned lines, two will have a combined processing capacity of 950 tons per day and will process freshly harvested industrial fish as and when available. The third line will have a design capacity of 50 tons per day and will process fish waste products generated in their canning plant. The third line will, therefore, run in parallel with the canning plant.

The fishmeal production process utilises the following steps:

-- Fish delivery
-- Fish storage
-- Cooking
-- Pressing
-- Liquid-solid separation
-- Indirect steam drying
-- Waste heat evaporation

-- Oil-liquid separation
-- Cooling / milling / bagging
-- Boilers for steam generation
-- Odour abatement

As some of the products that will be produced are destined for human consumption, Afro Fishing will apply the same levels of health and hygiene used in their canning process to the fishmeal production process.

Fish delivery:

Freshly harvested fish will be delivered by boat within 24 hours of being caught. The fish will be kept chilled while on board. The temperature of the fish currently delivered for canning purposes (human consumption) is measured as an indication of the freshness prior to the fish being off-loaded. Should the temperature exceed the minimum level it is rejected and not off-loaded.

Afro Fishing will use a similar approach in accepting fish for the production of fishmeal and will reject catches based on the landed temperature of the fish.

Once accepted, the fish load will be pumped into stainless steel tanks located on-land after separating the cooling water. The total capacity of the tanks is 600 m^3, i.e. about 600 tons. Once transferred to the tank, fish will be pumped directly to a cooker on a continuous basis, thus minimising the time between catching and processing of the fish.

Waste materials from the canning process will be pumped to the cooker on a continuous basis. As the fish processed in the canning plant is either fresh or frozen, the waste materials can be regarded as fresh as well and will not generate offensive odours.

Cooking:

The fresh fish will then be pumped from the storage tanks into the cooker feed hopper. If required, the fish will be mashed and metal will be removed using electromagnets. The maximum cooking capacity will be no more than 1000 tons per day. Cooker heating will be by inner rotor and outer jacket steam application. Cookers will be designed for 6 bar steam and able to cook fish to a maximum temperature of 90-95 °C. The cooking time depends on the steam pressure, the speed of rotation and the level that the cooker is filled. The average cooking time to achieve a temperature of 80 °C is about 20 minutes. During the cooking the fish protein is coagulated and fish oil is liberated together with water soluble protein. The cooked fish will exit the cooker into a dewatering conveyor or rotating strainer. The dewatering screens will remove the free liquid from the solids. This liquid is tanked and pumped to the decanters.

Pressing:

The wet solids will then be conveyed into a press. The press consists of two rotary screws that compress the feed thereby removing the liquid. The press cake that exits the press has an average of 50% water content. The liquid will be pumped into the decanter feed tank.

Solid – Liquid Separation:

The liquid from the press and the dewatering screen will be put through a decanter to separate the suspended solids from the liquid phase. These solids (grax) will be added to the solids from the press. The liquid, along with oil, will be pumped to the tanks feeding the centrifugal separators. The liquid will be centrifuged in a liquid-liquid centrifuge. The water with approximately 10% solids content will be removed from the oil and stored in a stick water tank. The oil will be polished (purified) with hot water in another liquid-liquid centrifuge and pumped into oil storage tanks. The stick water will be pumped to a tank feeding the water evaporation plant.

Water Processing:

The blood-water from the fish storage tanks will be pumped from drainage sumps to a steel tank and cooked. This blood-water is normally combined with the cooker feed and worked as expeditiously as possible. The stick-water resulting from the separation processes therefore consists of valuable water-soluble proteins. This will be concentrated in falling film waste heat evaporators. The stick-water will be concentrated from a solids content of 10% to approximately 38% and the resultant concentrate added back to the press cake prior to drying. A double or triple effect falling film evaporator will be installed which will use the waste heat from the steam dryers to evaporate the water at low temperatures and under vacuum.

Steam Drying:

The grax from the decanters and the press cake from the presses will be conveyed via screw conveyors to the steam dryers. The concentrated process water from the evaporation plant will be mixed in with the press cake. This mixture will be dried to a moisture content below 10% in the indirect steam driers. The dryers will apply outer jacket heating plus internal heating discs and designed for steam pressures of 6 to 10 bar.

Odour control:

Up to this point all process steps can be regarded as "wet" steps from where odorous emissions may occur. All processing units listed above will be enclosed and all odorous vapours will be extracted via a custom-designed extraction manifold system. The extracted vapours will be treated in a regenerative thermal oxidiser (RTO) which is described in detail in Section 5.3 below.

Cooling, milling and bagging:

Fishmeal coolers located in a separate enclosed area will be used to cool down the fishmeal to room temperature using air as cooling medium. The cooling air will be passed through a seawater scrubber to remove any particulate matter that may be entrained during the cooling stage.

Grinders equipped with electromagnets will be used to produce a fine fish meal free of metal. Rolling sieves will remove any coarse material and the final product bagged by means of automatic packing. Bulk bags and 50 kg bagging capability will be catered for. Anti-oxidant dosing, using the chemical Ethoxyquin, will be added to the fishmeal to stabilize the finished product, prevent lipid peroxidation and prevent odorous emissions.

The grinding and bagging steps may result in the release of particulate matter into the area and an extraction system will extract air from this area for treatment in the sea water scrubber, thus preventing fugitive emissions from the building. The scrubber will be designed to deal with the combined volume of air.

As the particulate matter that will be collected in the scrubber consists of high-protein materials that are not harmful to aquatic life, it will be returned to the sea within the limitations of Afro Fishing's coastal discharge permit.

Steam generation:

Two new boilers will be used to generate the steam required for the fishmeal processing. Condensate will be recovered from the cookers and dryers in order to reduce water and fuel consumptions and increase boiler efficiencies.

Low sulphur oil (LSO) with a sulphur content of 1.5% will be used to fire the two boilers and excess capacity will be provided so that the boilers never run on full capacity.

Oil and meal storage:

Fish oil will be stored in oil storage tanks. The fish oil will be loaded in bulk tankers and bulk containers. The fish oil will be pumped from the storage tanks through a loading pipe directly into tankers or into bladders in a shipping container. Antioxidant is added to certain loads of oil to stabilize the product.

Fishmeal will be stored in polypropylene bags in the warehouse. Pest control and the normal quality management practices for human consumption food items will be maintained in the stores.

5.2 ODOUR MANAGEMENT

In their Compilation of Air Pollutant Emission Factors, generally referred to as AP-42, the United States of America's Environmental Protection Agency (USEPA) states that chlorinator scrubbers have been found to be 95 to 99 percent effective in controlling odours from cookers and driers.

Afro Fishing plans to reduce odours from their planned process in two ways. The first is to treat odorous vapours generated in the fishmeal production process and the second is to remove particulate matter from the air inside the meal grinding and packaging area.

Firstly, Afro Fishing will use a regenerative thermal oxidation (RTO) process to thermally treat odorous emissions from the various processing units, as step which, according to AP-42, achieves virtually 100 percent odour control.

A flow chart of the complete process is given below. From the flow chart it can be seen that an extraction system will extract gaseous odours from all of the processing steps in the fishmeal generation process, i.e.:

-- Fish collection tank
-- Cooker
-- Press
-- Drier (via condenser)

All of these process units will be enclosed in Afro Fishing's operation and, because of the extraction system, under negative pressure, thus preventing the escape of odorous gases into the working environment (inside the building) and, hence to atmosphere as fugitive emissions.

The extracted gases, expected to be a total of 14 000 m^3/h, will be ducted directly to the RTO unit via filter in which entrained particulate matter will be collected. It is of paramount importance that this extraction system is properly designed and that the RTO unit is sized to the total gas volume extracted.

Figure 4 below shows the typical RTO operation.

Secondly, a two-stage scrubber system will be installed to remove particulate matter and odorous compounds from the meal grinding and packaging area in general, thus also ensuring sufficient ventilation in the building. The expected air flow rate is 60 000 m^3/h.

The first stage of the scrubber will make use of seawater as scrubbing medium and spent seawater will be returned to the sea as part of Afro Fishing's coastal discharge permit.

The second stage will make use of chemicals aimed at collecting potential odorous compounds from the air. As the concentration is expected to be very low (according to the USEPA), spent chemical compounds will be discharged into the municipal sewer system under Afro Fishing's current permit.

5.3 PROCESS FLOW DIAGRAM

The material flow in the proposed process can be seen from the diagram below.

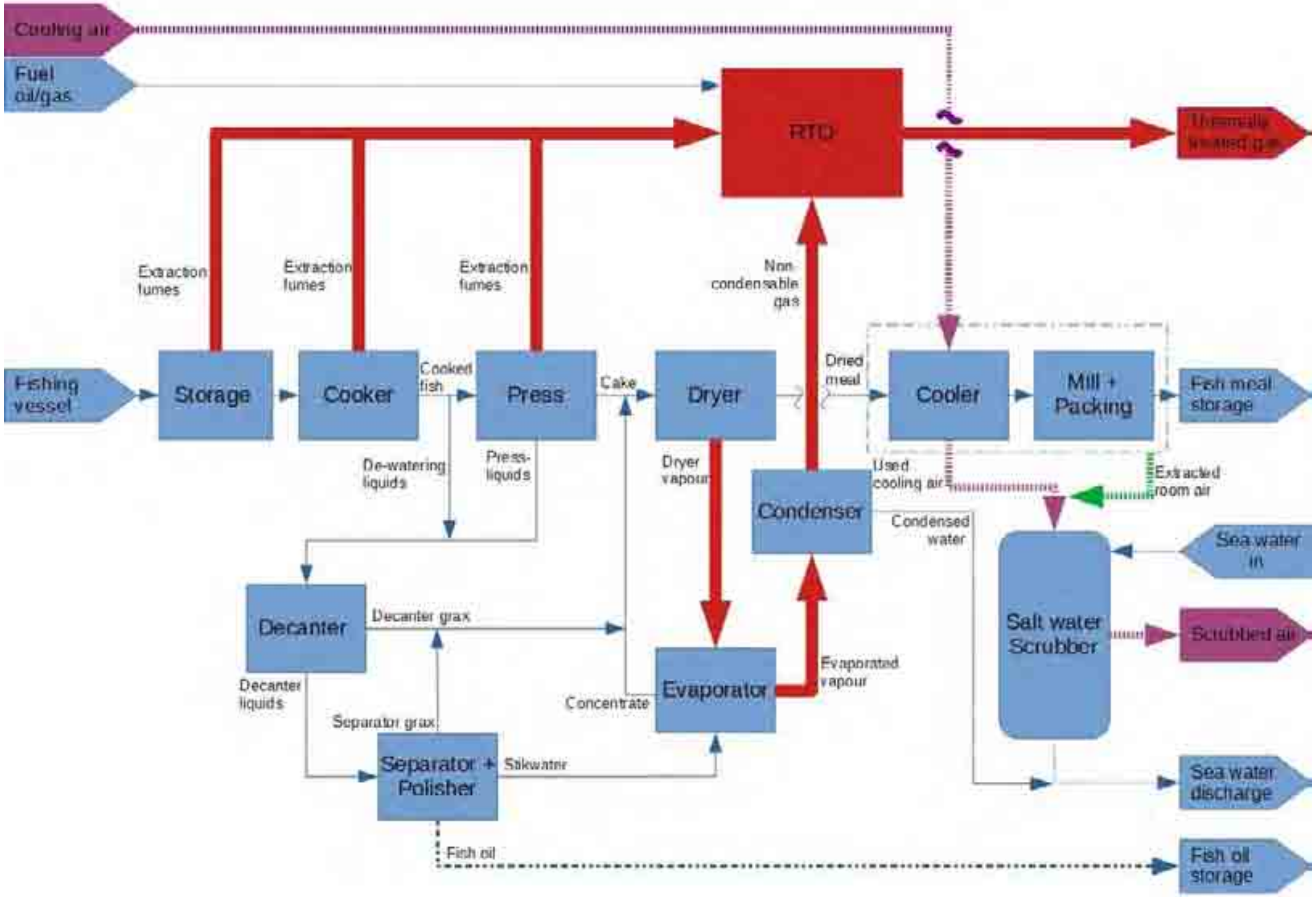


Figure 3: Process Flow Diagram

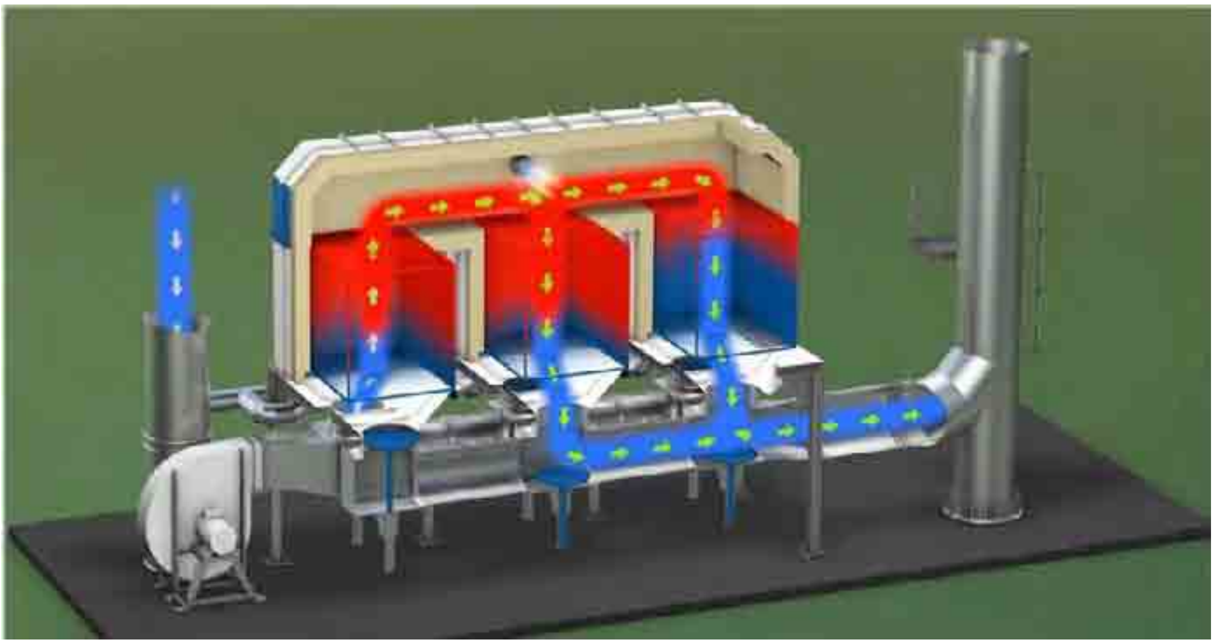


Figure 4: RTO Operation

The RTO unit essentially consists of three beds packed with blocks of ceramic material. Figures 5 and 6 show the material used.

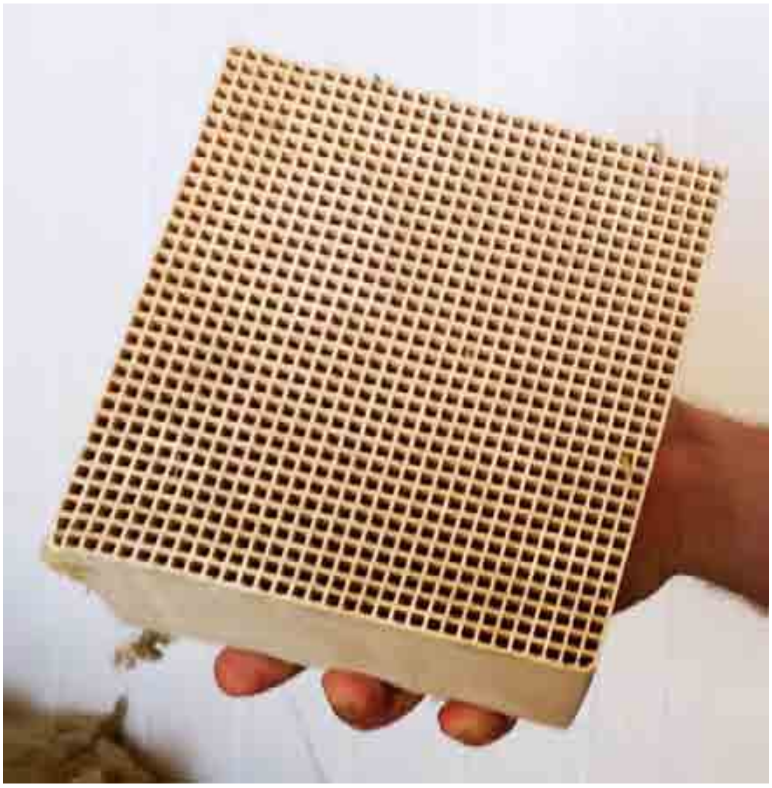


Figure 5: Ceramic material

Figure 6: Packed bed of ceramic blocks

At any given moment, the extracted gases pass through one of three beds of ceramic materials in which the gas stream is pre-heated. In the process this bed of ceramic materials cools down.

The gas stream then passes through an open LPG-fired flame in which is heated to about 850 ºC after which the gas stream is split prior to passing through two beds of ceramic materials which are heated in the process.

When the temperature of the first bed drops below a set point, a valve switches the inflowing gas stream through the hottest of the remaining two ceramic beds where the gas stream is pre-heated. After the gas burner the gas stream is split to now also flow through the cooled ceramic bed, thus heating it up again.

In this process the extracted gas stream is always pre-heated, passes through an open flame and is exhausted from the RTO unit through two beds of hot ceramic materials. The retention time of the gas in the hot zone of the RTO is approximately 1.5 seconds.

The flame zone and hot ceramic surfaces act as energy source and catalysts in breaking down TMA and H_2S to its basic organic compounds of CO_2, NO_2, H_2O and SO_2.

After passing through the RTO unit the gases are exhausted to atmosphere through a stack at approximately 120 ºC by means of an induced-draught (ID) fan. It is important to note that odorous gases cannot escape in the process and must pass through the RTO system, thus preventing odorous fugitive emissions.

The second odour control step is as follows:

From the process description above it can be derived that the fishmeal is hot after the drying stage. Up to that point the process steps are best described as "wet" steps that all have the potential to generate odours. These odours are, however, extracted and treated in the RTO system

At this stage the dry fishmeal is too hot for packaging and it will be cooled down by means of an air cooler using ambient air as cooling medium. This will occur in a separate enclosed area where the fishmeal will also pass through a grinding process to reduce particle size. In the process particulate emissions may occur, resulting in odours similar to pet foods.

To reduce these odours, a seawater scrubber will be used to remove particulates entrained during the cooling and grinding stage. The scrubber will be over-designed so that the air from the whole area is also extracted and treated to remove suspended particulates, thus assisting in the ventilation of the building.

Collected solids will be discharged to the sea and will occur within the current coastal discharge permit.

5.4 PROCESS OPERATION

Start-up:

On start-up, the RTO is preheated prior to feeding fish products into the process as the whole process of odour reduction depends on the correct RTO operating temperatures. This implies that the extraction fan system is also switched on so that hot air is circulated through the RTO to facilitate heating of the system

While the RTO is heated up, the cooker heating process is also started so that the cooker is at temperature when fish product is introduced. No fish will be fed to the cooker until the RTO has reached operating temperature.

All other units are switched on, e.g. pumps, condenser, etc. prior to introducing fish product to the cookers

Shut-down:

The reverse of the procedure above is followed, i.e. feed to the cooker is stopped, its heating system is only switched off after all material has passed through the cooker and the RTO system is only switched off when the last material has passed through the drier stage.

Thereafter all other process units can be switched off.

Upset Conditions:

Plant upsets, e.g. breakdowns, can occur from time to time, but preventative maintenance can minimise the occurrence. A fishmeal factory in Portugal has been using the same technology for about 10 years and. has never experienced a breakdown, purely due to their preventative maintenance efforts. Nevertheless, breakdowns may occur and can be classified into one of two groups, i.e. process breakdowns and RTO breakdowns.

Should a process unit break down, e.g. the drier feed motor breaks down, the condenser pump breaks down, etc., the processing of fish will stop accordingly, but the RTO will continue to run. This implies that vapour extraction from each process unit will continue and these vapours will continue to be treated in the RTO, thus preventing the emission of odours.

The three main potential breakdowns that can occur in an RTO unit are:

-- Loss of gas to burners. Should this occur the whole production line will stop and the gas feed restored after which the production line will proceed.

-- Failure of the extraction fan. In the case of a fan failure, a standby fan will be switched on automatically, this minimising the impact of a fan failure

-- Leaking valve seals. Annual preventative maintenance, entailing inter alia the replacement of valve seals, will reduce valve seal failure to an absolute minimum.

5.5 PROCESS CONTROL

The whole fishmeal process is controlled by a programmable logic controller (PLC). For the purpose of this report the control of the odorous reduction system will be highlighted.

The PLC monitors the key parameters associated with RTO operation:

-- Flow rate of gas to the burner
-- Gas temperature after the burner
-- Gas temperatures in each of the three ceramic beds inside the RTO
-- Gas temperature in the stack
-- Gas pressure inside the RTO
-- Gas pressure in the stack
-- Gas pressures in each duct of extracted air leading to the RTO

Interlock settings raise an alarm when any one of the parameters reaches a value that requires attention. Should the alarm be ignored the PLC will shut down the fish processing plant, thus allowing for the required attention to the problem.

All data monitored is logged on the PLC system for subsequent diagnostics, included on-line assistance from the manufacturer of the RTO system.

As an example: If one of the extraction ducts starts to block up, the pressure inside the RTO will decrease due to the downstream ID fan. The alarm will sound and the relevant faulty signal identified. The operator can then inspect the pressures in all of the contributing ducts and identify the line that is in the process of blocking so that it can be cleaned.

Should the alarm be ignored, the PLC will shut down the fishmeal process, but keep the RTO operational. The process can then only be restarted once the blockage has been cleared, that particular signal returned to within operating limits and the operator activating the restart process.

5.6 PROCESS OPERATION VARIATION

For the purposes of dispersion modelling it was assumed that the process will run continuously at full capacity, 24 hours per day and day after day for 330 days per year. This is done specifically so that emissions would occur continuously, including during those periods when weather conditions result in poor dispersion of pollutants. These conditions would be synonymous with very low wind speeds, cool stable air, etc.

This assumption implies that sufficient fish will be available to sustain a continuous operation, but actual operating variations are expected to differ significantly for the following reasons:

-- The supply of fish is dependent on the availability of industrial fish that will be harvested. Normally fishing conditions only come together for, maybe, 30 fishing days in the year. On these days the boats are able to catch their full tally. On such days the plant will be full and both production lines will process at full capacity to work away the catch.

-- Outside of these prime harvesting days, the quantities of fish caught are highly variable. Depending on the catch quantity, a decision will be made as to whether to only operate with one production line or both. These variable days will total 60 to 90 days. A total of 120 processing days are therefore expected if one adds together the prime plus variable fishing days expected.

-- Fishing license limitations imply that the process will not operate from approximately mid-December to mid-January, i.e. the prime holiday season in Mossel Bay. It is highly likely that no operation will take place during these two months.

It must be borne in mind that the third, smaller processing line will operate more regularly as it will deal with offal generated in the fish canning plant (maximum of 50 tons per day).

6 DISPERSION MODELLING STUDY

This study focuses on the emissions from Afro Fishing's proposed fishmeal production plant to show the impact that their emissions may have on air quality in the harbour and surrounding area.

The dispersion modelling study was carried out with EnviMan, a GIS-based emissions management software suite produced by Opsis AB in Sweden. The dispersion modelling component of the suite consists of the following four modules:

Mapper: A map manipulation tool
Emissioner: An extensive, relational emissions data base
Envimet: A meteorological data management program
Planner: The actual dispersion model

6.1 MAPPER

Mapper is a digital map compiler. It is used to define GIS data sets and map sets to be used by all EnviMan GIS modules. It can import a variety of digital maps and structure the data in suitable forms, e.g. sheets, objects, etc.

It is the basis of the EnviMan GIS suite as it defines all co-ordinates for subsequent use by the various EnviMan modules.

6.2 EMISSIONER

Emissioner is a comprehensive, relational emissions data base that locates emission sources at fixed co-ordinates on the map compiled with Mapper. Sources are placed on the map by the user and the co-ordinates are automatically generated by Mapper.

Emissioner can handle particulate and gaseous emissions from the following sources:

-- Point sources, e.g. industrial stacks
-- Area sources, e.g. landfill sites
-- Grid sources, e.g. complete informal settlement areas
-- Line sources, e.g. motor vehicle emissions

Of these, point sources are applicable to this study.

6.3 ENVIMET

Envimet uses meteorological data collected at ground level to calculate boundary scaling data sets used in dispersion modelling studies. Of primary importance are those parameters that define scaling of the boundary air layer. These minimum requirements are:

-- Wind speed
-- Wind direction
-- Temperature

-- Solar radiation

These parameters are used by Envimet to calculate all of the parameters, e.g. stability of the air boundary layer, mixing heights, climate sets, etc., which are required by Planner in calculating the dispersion of pollutants from a source.

6.4 PLANNER

Planner is the dispersion module of the EnviMan suite and links with Mapper, Emissioner and Envimet to carry out dispersion modelling activities. It is designed to run simulations of air quality based on emission data created in Emissioner for the following scenarios:

-- Hypothetical weather definitions, i.e. user-supplied information about temperature, wind speed, wind direction, cloud cover, etc.

-- True weather period, i.e. using recorded data from a weather monitoring station to simulate plume dispersion hour-by-hour over a defined period

-- Statistical weather period, i.e. using a pre-calculated sample of various weather conditions that typically occur during a year. This allows the creation of annual air quality maps for comparison against national guidelines and limit values.

Of these scenarios, the statistical period is applicable to the study of plume dispersion from the proposed fishmeal plant.

Planner makes use of three different dispersion models, two of which are aimed at motor vehicle emissions. The third is the Aermod dispersion model and is used for calculating the dispersion of emissions from point, area and grid sources. Aermod is an USEPA-approved Gaussian plume dispersion model and is capable of simulating dispersion of pollutants over a distance up to approximately 50 km from the source. Aermod is also accepted as a suitable model for the purpose of this project by the South African Department of Environmental Affairs, as discussed in "*Regulations Regarding Air Dispersion Modelling*", published in Government Notice R.533 of 11 July 2014 (GN R.533).

7 INPUT DATA

7.1 MAPPER

A digital map of the area was imported into Mapper and it covers an area of approximately 6 km x 4 km with Afro Fishing's operation set at the approximate centre of the map. The maps are shown in Figure 7 below.

The emissions data base (Emissioner) links with the map and places emission sources on specific locations, as defined by the user.

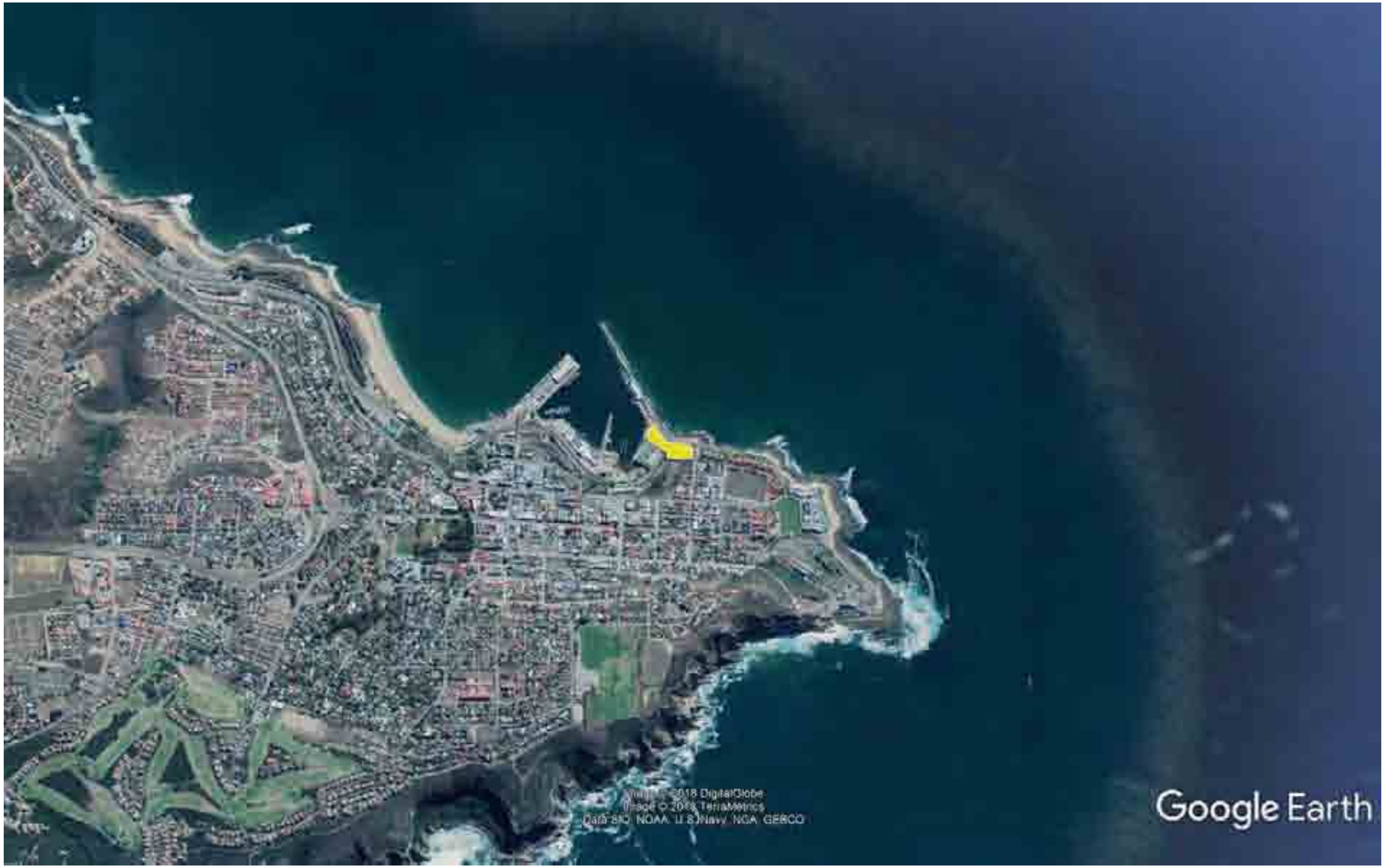


Figure 7: Map of 6 km x 4 km indicating the location of Afro Fishing's planned developments

7.2 EMISSIONER

In calculating emissions from point sources, GN R.533 stipulates that maximum emission rates, as defined in atmospheric emission licences, should be used. Emission factors may be used in cases where no emissions limits have been specified, e.g. as published in AP-42. Alternatively, design data or measured data can be used to estimate annual emissions.

As stated above, point and area sources are applicable to emissions from the sources of odorous emission identified for this project.

Compulsory information required for point source emissions are:

-- Stack height
-- Stack diameter
-- Flue gas velocity
-- Flue gas temperature
-- Dimensions (height, width) of structures immediately adjacent to each stack
-- Definition of pollutants
-- Annual mass emission rates of pollutants

7.2.1 Boiler Stacks

As stated in Section 5, two boilers will be used in Afro Fishing's expanded operations. The boilers will use low sulphur oil (LSO) with a low sulphur content of 1.5% by mass.

The expected firing rate of LSO is 1.92 tons per hour in total, i.e. 0.96 tons per boiler. Based on a lower heating value of 43.25 MJ/kg, the net input energy per boiler is calculated to be 11.5 MW which is above the threshold input energy of 10 MW for a small boiler to be regarded as a controlled emitter in terms of GN831. The rounded off quantity if LSO that will be burned per year is estimated to be 9 600 tons, based on 24 hours per day and 330 days' operation per year.

As a controlled emitter, the following emission limits will apply to the two new boilers:

-- TPM 100 mg/Nm^3 at 3% O_2
-- SO_2 500 mg/Nm^3 at 3% O_2

Following the requirements of GN R.533, these limits were used to calculate annual emissions of the two pollutants from each of the two boilers. Based on emission factors published by the USEPA in their Compilation of Air Pollutant Emission Factors, generally referred to as AP-42, 86% of the TPM emissions can be regarded as PM10 particles and this factor was used to estimate the annual PM10 emissions.

LAQS made use of AP-42 emission factors to estimate expected emissions of other pollutants for which ambient air quality standards have been published, i.e. NO_2 and CO, to calculate annual emissions of these two pollutants from the two boilers.

The relevant emission factors are:

-- NOx: 9.09 kg/kl
-- CO: 2.27 kg/kl

As the NOx emission essentially consist of NO, which is oxidised to NO_2 in ambient air by the presence of ozone, LAQS converted the NOx emissions to NO_2 equivalent values by multiplying the NOx value by 0.8, as is stipulated in GN R.533

As the plant has not yet been designed in detail, Afro Fishing provided estimated details of the boiler stacks and LAQS assumed a stack height of 15 metres. The stack parameters were thus obtained:

-- Stack height: 15 m
-- Stack diameter: 1.1 m
-- Flue gas temperature: 180 ºC
-- Flue gas velocity: 10 m/s

LAQS subsequently calculated the expected flue gas volumes and, together with the emissions limits and emission factors listed above, calculated the following annual mass emissions per boiler stack:

-- PM10: 14.0 tons per annum
-- SO_2: 81.6 tons per annum
-- NO_2: 13.3 tons per annum
-- CO: 5.6 tons per annum

These emissions will occur essentially uncontrolled, as it is not normal for such small boilers to be fitted with sophisticated air pollution abatement equipment. However, should emissions prove to be in excess of emission limits, abatement steps may be required.

Incidentally, based on AP-42 emission factors, the annual PM10 and SO_2 emissions will be approximately 1.11 and 79 tons per annum respectively. These estimations show a good correlation between estimated SO_2 emissions while the AP-42 emission factors take cognisance of the fact that the LSO has a very low ash content, hence the lower PM10 emission estimation.

Compared to the two new boilers, emissions from the existing boiler providing steam to the fish canning operations are very low and the following values have been estimated from AP-42 emission factors:

-- PM10: 0.02 tons per annum
-- SO_2: 1.28 tons per annum
-- NO_2: 0.22 tons per annum
-- CO: 0.09 tons per annum

The existing boiler was included in the dispersion model's emissions database.

7.2.2 RTO Stack

The volume of gas emitted to atmosphere through the RTO stack is a function of the following:

Air extracted from the various process steps:

-- The design specifications state that 18 000 m^3 per hour will be extracted from the various process points. The expected average temperature of this gas is approximately 65 ºC.

Products of LPG combustion:

-- The RTO system design specifies that 29.1 Nm^3/h of LPG gas will be burned in the RTO.

From these design values LAQS calculates that the gas flow rate through the RTO stack will be approximately 22 000 m^3/h at a stack temperature of 120 ºC.

Based on a flue gas velocity of 10 m/s, the internal diameter of the stacks is expected to be 0.88 metres.

Emissions:

TMA Emissions:

No official limit of the TMA concentration in fishmeal processing plants have been defined, but it is believed that emission limits of 5 mg/Nm^3 exists in France and Switzerland.

LAQS requested that the actual emissions of TMA in two fishmeal plant in Europe (Spain and Portugal) be measured to obtain information about the typical concentrations of TMA in such systems. The measured concentrations were 0.712 mg/m^3 and 0.189 mg/m^3 respectively, both at flue gas temperatures of 115 – 125 ºC.

In order to follow a conservative approach, LAQS used the higher measured value to calculate annual emissions of TMA from AF's process. In addition, LAQS assumed that the plant will operate for 24 hours per day and 330 days per year, resulting in total TMA emissions of 0.124 tons per annum.

This calculated annual emission is substantially lower than the value of 0.223 tons per annum previously estimated by LAQS from USEPA emission factors and an assumption of the efficiency of thermal treatment of TMA of 95%. An efficiency of 97.5% seems more prudent.

H_2S Emissions:

In the absence of reliably measured H_2S emissions, USEPA emission factors were used to estimate the annual H_2S emissions from the process. The value estimated is 0.008 tons per annum, assuming a RTO destruction efficiency of 95%.

7.2.3 Seawater Scrubber Stack

As stated in Section 5.2, a seawater scrubber will be used to treat the fishmeal cooling air and ventilation air extracted from the dry fishmeal processing plant. This plant will, therefore, operate under a negative pressure to prevent emission of fishmeal odours from the plant into the ambient air.

The design capacity of the extraction system entails extracting approximately 32 000 m^3/h of fishmeal cooling air at about 40 ºC and approximately 60 000 m^3/h of plant area air at approximately 25 ºC, resulting in a total volumetric flow rate of approximately 82 880 m^3/h of air at NTP (0 ºC and 101.325 kPa).

It is expected that a total particulate matter (TPM) emission limit of 50 mg/Nm^3 will be placed on emissions from this scrubber, resulting in estimated annual emissions of 32.8 tons of TPM, assuming that the process will operate of 24 hours per day and 330 days per year.

This calculated annual emission is substantially lower than the value of 74.25 tons per annum previously estimated by LAQS from USEPA emission factors and an assumption of a scrubber efficiency of 95%.

Assuming a stack velocity of 10 m/s, the calculated volumetric flow entails that the diameter of the stack is expected to be 1.8 metres.

As no particle size distribution data is available, LAQS assumed that all of the particulate emissions meet PM10 requirements. This is an over-estimation of emissions as PM10 particulates form a sub-set of TPM.

7.2.4 Other Sources

A discussion of other sources of air pollutants in and around Mossel Bay are given in Appendix C to this report.

7.3 WEATHER DATA

The minimum data required by Envimet is given in Section 6.3 above.

GN R.533 states that locally measured meteorological data is the preferred source of data for dispersion modelling purposes. Should such data not be available, alternative sources of data can be used, provided that some criteria are met.

The Garden Route District Municipality (GRDM) operates a weather station located in Mossdustria. This station records data for, inter alia, wind speed, wind direction, wind direction standard deviation, temperature and solar radiation and GRDM kindly made this data available for this study.

Data for the period from 17 August 2016 to 21 October 2019 was provided to meet the data period requirements of GN R.533 (minimum 1 year).

7.4 PLANNER

Planner does not require any user input as it extracts data from Mapper, Emissioner and Envimet.

8 RESULTS

The approach to the project was to estimate the following ground-level concentrations of all of the pollutants discussed above:

-- Annual average concentrations of all pollutants

-- 99-percentile concentrations (the level below which concentrations can be expected to occur for 99% of the time) for all pollutants

All simulations were carried out for a receptor height of 2 metres above ground level and a plume dispersion period of 60 minutes. This simulation period ensured that very low winds, e.g. below 1 m/s, would carry pollutants some distance from the plant.

8.1 GRAPHIC RESULTS

Graphic presentation of the dispersion of pollutants is shown in Figures 8 to 19 below.

Figures 8 and 9 show the estimated annual average and 99-percentile daily PM10 concentrations.

Figures 10 and 11 show the estimated annual average and 99-percentile SO_2 concentrations.

Figures 12 and 13 show the estimated annual average and 99-percentile NO_2 concentrations.

Figures 14 and 15 show the estimated annual average and 99-percentile 8-hour CO concentrations.

Figures 16 and 17 show the estimated annual average and 99-percentile H_2S concentrations.

Figures 18 and 19 show the estimated annual average and 99-percentile TMA concentrations.

Figure 8: Annual Average PM10 Concentrations; micrograms per cubic metre
Scale range from 2 $\mu g/m^3$ (blue) to 40 $\mu g/m^3$ (AQ standard) (burgundy)

Figure 9: 99-percentile daily average PM10 Concentrations; micrograms per cubic metre
Scale range from 35 µg/m^3 (blue) to 75 µg/m^3 (AQ standard) (burgundy)

Figure 10: Annual Average SO_2 Concentrations
Scale range from 2 µg/m^3 (blue) to 50 µg/m^3 (AQ standard) (burgundy)

Figure 11: 99-percentile hourly SO_2 Concentrations
Scale range from 35 $\mu g/m^3$ (blue) to 350 $\mu g/m^3$ (AQ standard) (burgundy)

Figure 12: Annual Average NO_2 Concentrations
Scale range from 0.5 µg/m^3 (blue) to 40 µg/m^3 (AQ standard) (burgundy)

Figure 13: 99-percentile NO_2 Concentrations
Scale range from 10 µg/m^3 (blue) to 200 µg/m^3 (AQ standard) (burgundy)

Figure 14: 8-hour Average CO Concentrations
Scale range from 0.1 μg/m³ (blue) to 10 μg/m³ (burgundy) (AQ standard is 10 000 μg/m³)

Figure 15: 99-percentile CO Concentrations
Scale range from 5 µg/m^3 (blue) to 100 µg/m^3 (burgundy) (AQ standard is 30 000 µg/m^3)

Figure 16: Annual Average H_2S Concentrations; micrograms per cubic metre
Scale range from 0.1 ng/m^3 (blue) to 2 ng/m^3 (burgundy)
Odour detection threshold is 700 ng/m^3

Figure 17: 99-percentile H_2S Concentrations; micrograms per cubic metre
Scale range from 2 ng/m^3 (blue) to 20 ng/m^3 (burgundy)
Odour detection threshold is 700 ng/m^3

Figure 18: Annual Average TMA Concentrations; micrograms per cubic metre
Scale range from 2 ng/m^3 (blue) to 20 ng/m^3 (burgundy)
Odour detection threshold is 800 ng/m^3

Figure 19: 99-percentile TMA Concentrations; micrograms per cubic metre
Scale range from 50 ng/m^3 (blue) to 800 ng/m^3 (odour threshold) (burgundy)
All estimated concentrations are below the odour detection threshold

8.2 SUMMARISED RESULTS

The results of the dispersion modelling study are summarised in Table 4 below.

The maximum and annual averaged ground-level concentrations of the various pollutants under different air pollution abatement scenarios are given, as well as where these concentrations may occur. In addition, the equivalent concentrations in the residential areas to the south-east and west of Afro Fishing's operations are given.

Maximum production capacity						
	Annual average			99-percentile		
	AQ Standards	Max	where	**AQ Standards**	Max	where
PM10, $\mu g/m^3$	**50**	5.8	250-300 m E	**75**	46.9	250-300 m E
SO_2, $\mu g/m^3$	**50**	5.2		**350**	141.3	
NO_2, $\mu g/m^3$	**40**	0.8		**200**	23	
CO, $\mu g/m^3$	**10 000**	0.4	150 m NE	**30 000**	9.1	150 m NE
H_2S, ng/m^3	**--**	0.2		**--**	6	
TMA, ng/m^3	**--**	6.5		**--**	135.5	
Nearest residential areas						
	AQ Standards	SE	W	**AQ Standards**	SE	W
PM10, $\mu g/m^3$	**50**	1	1	**75**	24.5	28.1
SO_2, $\mu g/m^3$	**50**	1.6	1.7	**350**	54.2	66.5
NO_2, $\mu g/m^3$	**40**	0.1	0.1	**200**	8.4	11
CO, $\mu g/m^3$	**10 000**	0.1	0.1	**30 000**	3.6	4.8
H_2S, ng/m^3	**--**	0.1	0.1	**--**	3.8	3.9
TMA, ng/m^3	**--**	2.1	2.7	**--**	70.5	99.1

Table 4: Summarised ground-level concentrations; All units are $\mu g/m^3$

None of the values exceed the ambient air quality standards or odour threshold. Please see Section 10 below.

9 EXPECTED CONCENTRATIONS

The results shown above can be regarded as a worst-case scenario as it is based on the assumption that the fishmeal production facility will operate continuously for 24 hours per day and 330 days per year.

That is a highly unlikely scenario due to the following reasons:

- Fishing licenses are issued in January, which implies that virtually no processing will happen during this month of the year.
- The availability of pelagic fish for the production of fishmeal and fish oil is subject to seasonal variations in the availability of the fish. High season, i.e. the time of a year during which the fish can be expected to be available in sufficient quantities to warrant full product capacity, is during the months of February to April. Thereafter the availability of fish declines and processing will then be solely dependent on the availability of fish.

To show a more realistic scenario LAQS estimated the impact that processing would have under the following conditions:

- Full production during high season, i.e. 1000 tons per day
- 50% of full production for the months of May to November
- No processing during December and January

Under this scenario annual emissions of the various pollutants are estimated to be:

--	PM10:	8.9 tons per annum
--	SO_2:	52.0 tons per annum
--	NO_2:	8.5 tons per annum
--	CO:	3.5 tons per annum
--	TMA:	0.079 tons per annum
--	PM10 from meal cooler	20.9 tons per annum
--	H_2S:	0.005 tons per annum

Graphic presentation of the dispersion of pollutants is shown in Figures 20 to 27 below.

Due to the very low H_2S emissions and the very high ambient air quality standards for CO, these two compounds have been excluded from this comparison.

Figure 20: Expected conditions: Annual Average PM10 Concentrations; micrograms per cubic metre
Scale range from 2 µg/m^3 (blue) to 40 µg/m^3 (AQ standard) (burgundy)

Figure 21: Expected conditions: 99-percentile daily average PM10 Concentrations; micrograms per cubic metre
Scale range from 20 µg/m^3 (blue) to 75 µg/m^3 (AQ standard) (burgundy)

Figure 22: Expected conditions: Annual Average SO_2 Concentrations
Scale range from 2 µg/m^3 (blue) to 50 µg/m^3 (AQ standard) (burgundy)

Figure 23: Expected conditions: 99-percentile hourly SO_2 Concentrations
Scale range from 35 µg/m^3 (blue) to 350 µg/m^3 (AQ standard) (burgundy)

Figure 24: Expected conditions: Annual Average NO_2 Concentrations
Scale range from 0.5 µg/m^3 (blue) to 40 µg/m^3 (AQ standard) (burgundy)

Figure 25: Expected conditions: 99-percentile NO_2 Concentrations
Scale range from 10 µg/m^3 (blue) to 200 µg/m^3 (AQ standard) (burgundy)

Figure 26: Expected conditions: Annual Average TMA Concentrations; micrograms per cubic metre
Scale range from 2 ng/m^3 (blue) to 20 ng/m^3 (burgundy)
Odour detection threshold is 800 ng/m^3

Figure 27: Expected conditions: 99-percentile TMA Concentrations; micrograms per cubic metre
Scale range from 50 ng/m^3 (blue) to 800 µg/m^3 (odour threshold) (burgundy)
All estimated concentrations are below the odour threshold

9.2 SUMMARISED RESULTS

Maximum production capacity						
	Annual average			99-percentile		
	AQ Standards	Max	where	**AQ Standards**	Max	where
PM10, µg/m^3	**50**	3.7	250-300 m E	**75**	29.4	250-300 m E
SO_2, µg/m^3	**50**	3.3	150 m NE	**350**	84.1	150 m NE
NO_2, µg/m^3	**40**	0.5		**200**	14.3	
TMA, ng/m^3	**--**	3.8		**--**	94.4	
Nearest residential areas						
	AQ Standards	SE	W	**AQ Standards**	SE	W
PM10, µg/m^3	**50**	0.6	0.6	**75**	14	15.7
SO_2, µg/m^3	**50**	0.8	1	**350**	25.2	32.3
NO_2, µg/m^3	**40**	0.1	0.1	**200**	3.9	5.4
TMA, ng/m^3	**--**	1.2	1.7	**--**	51.3	62.5

Table 5: Summarised ground-level concentrations; All units are µg/m^3

None of the values exceed the ambient air quality standards or odour threshold. Please see Section 10 below.

10 DISCUSSION

The results of any computer model are only as reliable as the quality of the input data.

10.1 EMISSIONER

LAQS made use of design data and measured TMA concentrations to estimate emissions from the fishmeal processing plant. Use was made of USEPA emission factors to estimate emissions from the two new LSO boilers.

As a result there is a degree of uncertainty in the estimated emissions used in this study. The following must be noted:

-- LAQS assumed that the measured TMA emissions reported in Section 7.2.2, i.e. 0.712 mg/m^3, will also apply the Afro Fishing's plant.

-- LAQS assumed that the H_2S emission factor given by AP-42 is correct and based its calculation of total annual H_2S emissions on the basis that Afro Fishing processes fresh fish material only.

-- LAQS focused on odorous emissions originating only from Afro Fishing's operations. Other sources of odorous gases may exist within the Mossel Bay harbour precinct as it is a commercial harbour. These sources may be small, but they were not included in this study, although their localised emissions may results in odours from time-to-time that cannot be connected to Afro-Fishing's operations.

-- The volume of gas generated in the combustion of any fuel is dependent on the composition of that fuel, its combustion rate, the completeness of combustion and the quantity of excess air introduced to the combustion zone.

LAQS based its calculations on the expected combustion rate of LSO of 1.92 tons per hour as obtained from Afro Fishing's mass balance. The calculated volumes will, therefore, vary as fuel composition combustion rate changes.

-- LAQS assumed the flue gas conditions, i.e. velocity and temperature, for the boiler stacks, based on its experience with boilers in general. LAQS assumed a typical stack height of 15 metres. Lower stacks will result in less time for dispersion of pollutants and will result in higher maximum ground-level concentration closer to the source. Taller stacks will have in opposite effect, i.e. lower maximum ground-level concentrations further from the source.

All of the emissions on which this study is based must be regarded as worst-case conditions due to the following reasons:

-- LAQS assumed that Afro Fishing's processes to its maximum planned capacity, i.e. processing 1 000 tons per day of fresh fish, burning 1.92 tons of LSO per hour, operating for 24 hours per day and for 330 days per year. This is the worst-case that is expected to occur as the production of fishmeal from industrial fish is directly related to the availability of such fish.

This is not sustainable as it makes no provision for regular process interruptions for essential hygiene control measures.

-- As is normal, an over-design factor has been included by the vendors to allow for some spare capacity. LAQS based all of its estimations on the maximum design capacities, thus overestimating emissions.

  Suffice to state that there is a linear relationship between emissions and ground-level concentrations in the sense that any change in emission will result in an equal change in ground-level concentrations, i.e. halving the emission will result in halving the ground-level concentrations.

-- Afro Fishing will operate the fishmeal production process according to the rate at which fish is caught by the fishing fleet. If there is no consistency in the catch rate there will not be consistency in the fishmeal processing rate. Due to the expected variability of fish deliveries, there is no expected trend in operations that can be defined clearly with the result no seasonal variation in emissions can be defined in the dispersion model. LAQS assumed, therefore, that processing will occur continuously as if a supply of fish will be available accordingly.

-- Industry generally schedules a period during the operation year for routine maintenance. The planned annual shutdown is during December and no processing of fish will occur during this period. Annually renewed fishing licenses are issued in January which implies that there is very little chance that processing will commence before the middle of the month. It is more likely that full production will only commence in February.

10.2 ENVIMET

The wind and temperature data provided by the Garden Route District Municipality is comprehensive and only a few minor gaps exist in the data set. It is, therefore, regarded as a reliable meteorological data set.

The distribution of winds at the monitoring station located in Mossdustria is shown graphically in Figure 28 below. It shows that the predominant wind directions are easterly and westerly, which implies that pollutants will disperse mainly in these two directions from the sources included in this study.

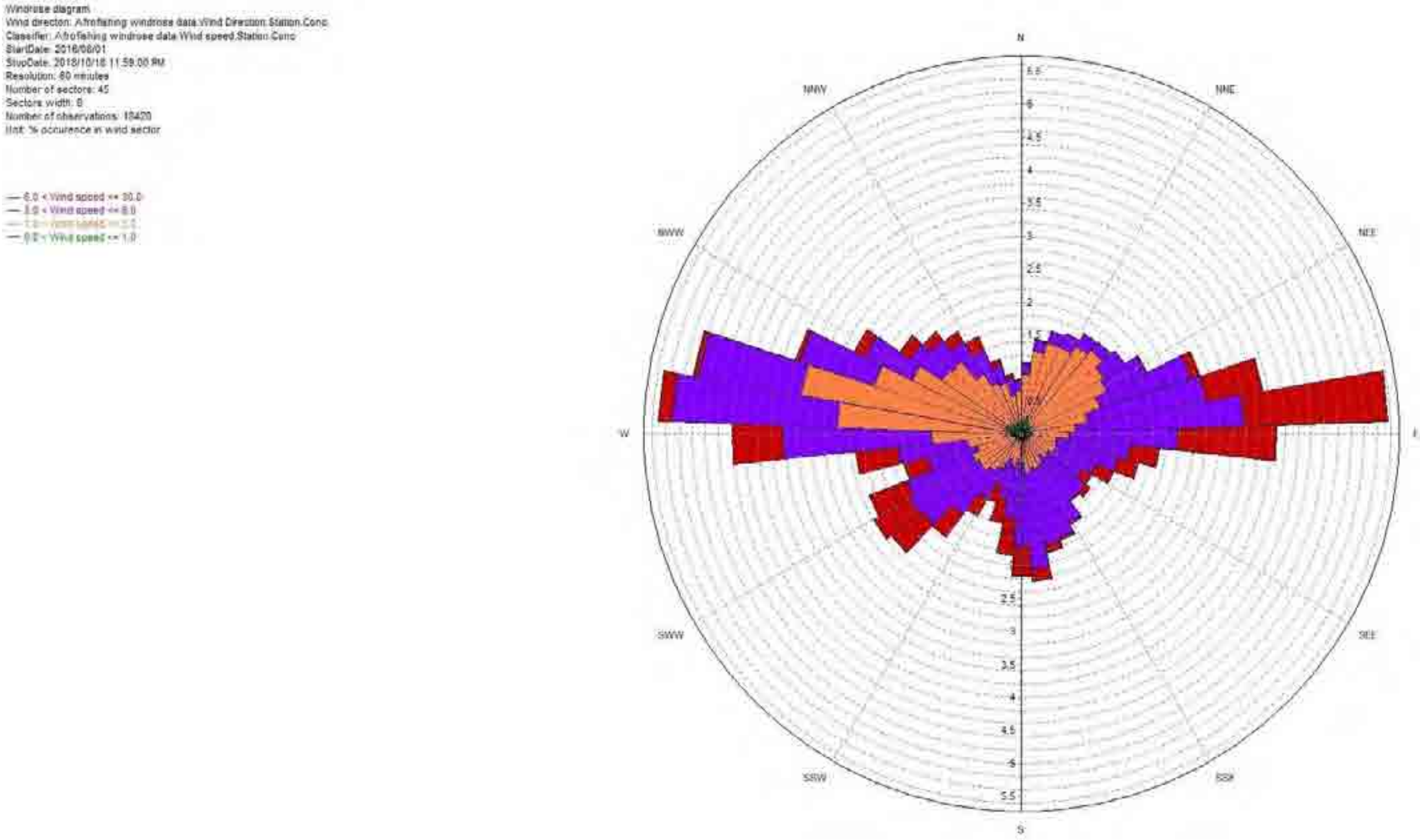


Figure 28: Mossel Bay Wind Rose

10.3 PLANNER

As was stated previously, the user provides no direct data input to Planner. It uses Aermod, the latest USEPA approved Gaussian plume dispersion model, and there is no reason to doubt the reliability of the dispersion calculations.

11 IMPACT ON OVERALL AIR QUALITY

Ambient air quality standards for some pollutants were published by the Department of Environmental Affairs (DEA) in Government Notice No. 1210 on 24 March 2009 (GN1210). Of the pollutants discussed in this study, ambient air quality standards for Hg are not available, there are standards for; PM10 particulates (a sub-set of total particulate matter), CO, NO_2 (a sub-set of NOx) are included and the limits are:

PM10

Annual average:	40 µg/m^3, no exceedences
Maximum daily concentration:	75 µg/m^3, 4 exceedences

SO_2

Annual average limit	50 µg/m^3, no exceedences
1-hour maximum	350 µg/m^3, 88 exceedences

NOx (as NO_2)

Annual average limit	40 µg/m^3, no exceedences
1-hour maximum	200 µg/m^3, 88 exceedences

CO

8-hour running average	10 mg/m^3 (10 000 µg/m^3), 11 exceedences
1-hour maximum	30 mg/m^3, (30 000 µg/m^3), 88 exceedences

No ambient air quality standards for H_2S and trimethylamine have been defined.

The number of exceedences mentioned is approximately 1% of the time, i.e. daily exceedences of 4 times per year are marginally more than 1% of the time (3.65). Similarly, 88 exceedences of hourly limits form approximately 1% of the total number of hours per year (1% of 8 760 is 87.6). As a result LAQS modelled 99-percentile concentrations to reflect the maximum level below which concentrations may occur for 99% of the time.

When the results are interpreted it must be borne in mind that LAQS followed a conservative approach by modelling worst-case conditions, given the uncertainties in estimating emission as discussed in Section 10 above.

11.1 PM10 PARTICULATE MATTER

The highest annual average concentration of PM10 is estimated to be 5.8 µg/m^3, which is well below the ambient air quality standard. The maximum 99-percentile daily concentration was shown to be 46.9 µg/m^3, which is also well below the ambient air quality standard.

Both of these estimated maximum concentrations are expected to occur approximately 250 to 300 metres west of the centre of Afro Fishing's planned operations.

The maximum annual average concentration of PM10 at the residential area south-east of Afro Fishing's site is estimated to be approximately 1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 24.5 µg/m^3 which is also well below the air quality standard.

The maximum annual average concentration of PM10 at the residential area west of Afro Fishing's site is estimated to be approximately 1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 28.1 µg/m^3 which is also well below the air quality standard.

11.2 SULPHUR DIOXIDE

The highest annual average concentration of SO_2 is estimated to be 5.2 µg/m^3, which is below the ambient air quality standard. The maximum 99-percentile hourly concentration was shown to be 141.3 µg/m^3, which is also well below the ambient air quality standard.

Both of these estimated maximum concentrations are expected to occur approximately 150 metres north-east of the centre of Afro Fishing's operations.

The maximum annual average concentration of SO_2 at the residential area south-east of Afro Fishing's site is estimated to be 1.6 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 54.2 µg/m^3 which is also well below the air quality standard.

The maximum annual average concentration of SO_2 at the residential area west of Afro Fishing's site is estimated to be 1.7 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 66.5 µg/m^3 which is also well below the air quality standard.

11.3 NITROGEN DIOXIDE

The highest annual average concentration of NO_2 is estimated to be 0.8 µg/m^3, which is well below the ambient air quality standard. The maximum 99-percentile hourly concentration was shown to be 23.0 µg/m^3, which is also well below the ambient air quality standard.

Both of these estimated maximum concentrations are expected to occur approximately 150 metres north-east of the centre of Afro Fishing's operations.

The maximum annual average concentration of NO_2 at the residential area south-east of Afro Fishing's site is estimated to be approximately 0.1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 8.4 µg/m^3 which is also well below the air quality standard.

The maximum annual average concentration of NO_2 at the residential area west of Afro Fishing's site is estimated to be approximately 0.1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 11 µg/m^3 which is also well below the air quality standard.

11.4 CARBON MONOXIDE

The highest 8-hour average concentration of CO is estimated to be 0.8 µg/m^3, which is well below the ambient air quality standard. The maximum 99-percentile hourly concentration was shown to be 11.8 µg/m^3, which is also well below the ambient air quality standard.

Both of these estimated maximum concentrations are expected to occur approximately 150 metres north-east of the centre of Afro Fishing's operations.

The maximum 8-hour average concentration of CO at the residential area south-east of Afro Fishing's site is estimated to be less than 0.1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 3.6 µg/m^3 which is also well below the air quality standard.

The maximum 8-hour average concentration of CO at the residential area west of Afro Fishing's site is estimated to be less than 0.1 µg/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 4.8 µg/m^3 which is also well below the air quality standard.

11.5 HYDROGEN SULPHIDE

Currently there are no ambient air quality standards for H_2S. As is stated in Section 2.2, IRIS defined a reference concentrations (RfC) of 2 µg/m^3 (2 000 ng/m^3) for H_2S.

The highest annual average concentration of H_2S is estimated to be 0.2 ng/m^3 and the maximum 99-percentile hourly concentration was shown to be 6.0 ng/m^3, both of which are well below the assumed odour threshold limit of 700 ng/m^3 and the RfC of 2 mg/m^3.

The maximum annual average concentration of H_2S at both residential areas are estimated to be less than 0.1 ng/m^3, while the 99-percentile concentrations are estimated to be 3.8 ng/m^3 and 3.9 ng/m^3 respectively, all of which are also below the assumed odour threshold limit of 700 ng/m^3 and the RfC of 2 mg/m^3.

11.6 TRIMETHYLAMINE

Currently there are no ambient air quality standards or RfC for TMA.

The highest annual average concentration of TMA is estimated to be 6.5 ng/m^3 and the maximum 99-percentile hourly concentration was shown to be 135.5 ng/m^3, both of which are well below the assumed odour threshold limit of 800 ng/m^3.

The maximum annual average concentration of TMA at the residential area south-east of Afro Fishing's site is estimated to be less than 2.1 ng/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 70.1 ng/m^3. These estimated concentrations are well below the assumed odour threshold of 800 ng/m^3.

The maximum annual average concentration of TMA at the residential area west of Afro Fishing's site is estimated to be less than 2.7 ng/m^3, i.e. well below the air quality standard, and the corresponding 99-percentile daily concentration is estimated to be 99.1 ng/m^3. These estimated concentrations are well below the assumed odour threshold of 800 ng/m^3.

11.7 PLUME VISIBILITY

11.7.1 Boiler stacks

The total particulate emissions from the two boiler stacks were calculated according to the requirements of GN R.533, i.e. using the maximum allowed concentration of 100 mg/Nm^3. This resulted in the estimated annual emissions of 16.3 tons of which it is estimated that 14 tons per annum will consist of PM10 particles.

Using AP-42 emission factors, the TPM emissions can be expected to amount to approximately 4.5 tons per annum, i.e. approximately 27% of the emissions calculated according to GN R.533., implying a concentration of approximately 27 mg/Nm^3. Given the estimated flue has temperature of 180 ºC, this equates to a TPM concentrations of approximately 16.5 mg/m^3 at actual stack conditions.

The general plume visibility "rule-of-thumb" is a TPM concentration of approximately 50 mg/m^3. The low calculated TPM concentration implies, therefore, that boiler emissions will not result in visible plumes during plant operations. However, it is common for all boilers to have visible plumes during start-up conditions, as is currently the case with the existing boiler used in Afro Fishing's canning operations.

11.7.2 RTO Stack

The RTO will use liquid petroleum gas (LPG) to destroy gaseous compounds in an air stream. No visible plume will, therefore exist on the RTO stack.

11.7.3 Cooler Stack

It is expected that a TPM emission limit of 50 mg/Nm^3 will be imposed on the cooler stack and the estimated flue gas temperature is approximately 40 ºC. This equates to a TPM concentration of approximately 43 mg/m^3 at actual stack conditions. This implies that no plume should be visible on the cooler stack.

12 BASIC RISK ASSESSMENT

12.1 OCCUPATIONAL RISK

Occupational health exposure data is given in Section 2.1. The following threshold values are listed:

	TWA		STEL	
	ppm	mg/m^3	ppm	mg/m^3
TMA	5	12 (12 000 $\mu g/m^3$)	15	36 (36 000 $\mu g/m^3$)
H_2S	1	1.4 (1 400 $\mu g/m^3$)	5	7.0 (7 000 $\mu g/m^3$)

Table 6: Occupational Health Exposure Limits

Taking its definition into account, the TWA values are of note as they specify the levels to which workers may be exposed day after day without any adverse effects.

As can be seen from the Table above, these values are orders of magnitude higher than the maximum concentrations derived from the dispersion model's estimations. From an occupational health point of view LAQS is of the opinion that emissions of TMA and H_2S from Afro Fishing's operations will not pose any health risk to workers in areas exposed to these gases in and around the harbour area.

12.2 GENERAL ENVIRONMENT

LAQS used the rating system shown in Figure 29 below to attach a risk to air quality as a result of emissions from Afro Fishing's operations:

Likelihood of occurrence:

Frequency of activity: Daily, i.e. score = 1
Frequency of impact: Almost never, i.e. score = 1
Confidence: High, i.e. score = 2
Total score for likelihood of occurrence: 4

Consequence:

Severity: small, i.e. score = 1
Spatial scope: Impact is specific to fishmeal production activity, i.e. score = 1
Duration: Life of operation, i.e. score = 4
Total score for consequence: 6

The overall score, i.e. likelihood x consequence, is 24 which places the potential risk in the "very low" category.

SPATIAL SCOPE	RATING	DURATION	RATING	SEVERITY	RATING	Confidence	RATING
Activity Specific	1	1 day to 1 month	1	Insignificant	1	Absolute	1
Area Specific	2	1 month to 1 year	2	Small	2	High	2
Whole Site / Plant	3	1 year to 5 years	3	Significant	3	Moderate	3
Neighbouring Area	4	Life of operation	4	High	4	Low	4
Regional Area	5	Permanent	5	Disastrous	5	None	5

FREQUENCY OF ACTIVITY	RATING	FREQUENCY OF IMPACT	RATING
Annually or less	1	Almost never / Almost impossible	1
6 monthly	2	Very seldom / highly unlikely	2
Monthly	3	Infrequent / unlikely / seldom	3
Weekly	4	Often / regularly / likely / possible	4
Daily	5	Daily / highly likely / definitely	5

SIGNIFICANCE RATING OF IMPACT		
Very Low	1 to 25	
Low	31 to 50	
Medium – Low	51 to 75	
Medium – High	76 to 100	
High	101 to 125	
Very High	126 to 150	

TIMING
Pre- Construction / prior to activity
Construction / instillation
Operation / Activity

CONSEQUENCE
(= Severity + special scope + duration)

LIKELY HOOD (= frequency of activity + frequency of impact + confidence)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	57	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Figure 29: Impact Rating System

13 CONCLUSIONS

Based on the overestimated annual operating cycle and the measured emission from two similar plant in Europe, LAQS concludes that it is possible to operate a modern fishmeal production plant in a manner that does not result in odorous emissions to the point where it can be detected in the area surrounding the plant.

In fact, the maximum 99-percentile TMA concentration estimated anywhere in the surrounding area is 135.5 ng/m^3 which is substantially lower than the odour threshold of 800 ng/m^3 (0.8 µg/m^3) used by LAQS in this assessment.

It implies that TMA emissions can increase from the measured TMA concentration of 712 µg/m^3 (0.712 mg/m^3) to approximately 4.2 mg/m^3 before the 99-percentile concentration will be exceeded. This calculated maximum value compares well with the emission limit of 5 mg/m^3 imposed on such plants in France and Switzerland.

If the European TMA odour threshold value of 2 µg/m^3 is used as measure, the TMA emissions can increase to 10.5 mg/m^3 before the European odour threshold limit will be breached.

Apart from the impact of odorous emissions, the dispersion model estimates that none of the other emissions threaten exceedance of the official air quality standards set for PM10 particulates, SO_2, NO_2 and CO.

It must be borne in mind that this air quality impact assessment is based on an expected worst-case scenario and shows annual averaged and 99-percentile concentrations that could potentially occur if Afro Fishing were to operate at full capacity for 24 hours per day and 330 days per year. Actual operating conditions are expected to result in substantially lower annual emissions and, hence, lower impact on air quality.

14 RECOMMENDATIONS

As some of the products of the fishmeal process are destined for human consumption, it is recommended that only freshly harvested fish is processed at the proposed fishmeal plant in order to comply with the current health and hygiene requirements of the canning process.

It is of paramount importance that all process equipment in the fishmeal plant is cleaned and sanitised at regular intervals to minimise the formation of odours between production runs. It is recommended that a cleaning procedure and schedule, similar to that of the canning plant, is defined for this purpose.

It is recommended that a preventative maintenance program is designed and implemented with the assistance of the preferred technology supplier to ensure that the equipment operates at optimum conditions.

It is of paramount importance that the extraction system that gathers fumes from the various process steps are designed properly to ensure that the correct volume of air is extracted from each point. While it can be assembled locally, it is recommended that design of this system is left to the supplier of the RTO so that a well-balanced system is installed.

It is recommended that specific attention is paid to the day-to-day operation of the RTO as its availability is of key importance to remove odorous emissions from the plant. As is the case with the process equipment, it is recommended that a formal maintenance procedure and schedule is developed for the RTO and this schedule meets the requirements of the equipment supplier.

It is recommended that supervisory personnel in charge of the operation of the fishmeal plant receive thorough training in the operation and maintenance of the process, especially the RTO, to ensure that breakdowns and kept to a minimum and that fault diagnosis and correction can be achieved in the shortest period of time.

Even though the main odorous compound emitted from Afro Fishing's operations are expected to consist of amines, there is no easy method for measuring such compounds continuously and costs running to a few million Rand may be incurred if such monitoring of amines is required.

It is rather recommended that the TMA emissions from the RTO stack are verified biannually by an independent contractor.

It is recommended that the emissions from the scrubber stack are verified annually by an independent contractor.

It is recommended further that emissions from the boilers are verified on a biennial basis by an independent contractor.

15 ABBREVIATED CURRICULUM VITA

Surname: Albertyn

First names Christiaan Horn

Date of birth 10 March 1950

University of Pretoria, South Africa: BEng (Chem) 1983.

Engineering Council of South Africa Registration No: 870276

Engineering Council of the UK Registration No: 524825

Institute of Professional Environmental Practice Registration No: 06010019

My experience in the field of environmental investigations, management and control measures extends over a period of more than 40 years and I have conducted air quality investigations for numerous corporate clients and all levels of government departments.

I compiled air quality management plans for the Garden Route District Municipality, the Nelson Mandela Bay Municipality (Port Elizabeth), the Buffalo City Metropolitan Municipality (East London), contributed to the plan for the Limpopo Province and recently revised the air quality management plan for the Garden Route District Municipality. Each of these projects included the compilation of extensive emissions inventories, covering all of the possible sources in each area.

Multi-disciplinary projects undertaken include the following:

-- Coordination of a multi-disciplinary team of specialists to assist a waste disposal company to assess their operations for implementation of operating procedures and installation of equipment to attain regulatory compliance.

-- Assessment of a wood pelletizing plant with the aim of optimising process efficiency, increase product recovery, optimise water usage and minimise atmospheric emissions.

-- Modification and optimising of the effluent treatment activities of a tannery to reduce the potential of odorous emissions.

I have assisted a number of industries in their applications for atmospheric emission licences (AELs) by carrying out specialist air quality impact assessments that were based largely on detailed dispersion modelling studies. In addition to these studies, I carried out various specialist dispersion modelling studies for a number of industries, both locally and abroad. I currently carry out all cumulative dispersion modelling studies for the Coega Development Corporation's industrial development zone in Port Elizabeth.

C H Albertyn, PrEng, CEng, QEP (Emeritus)

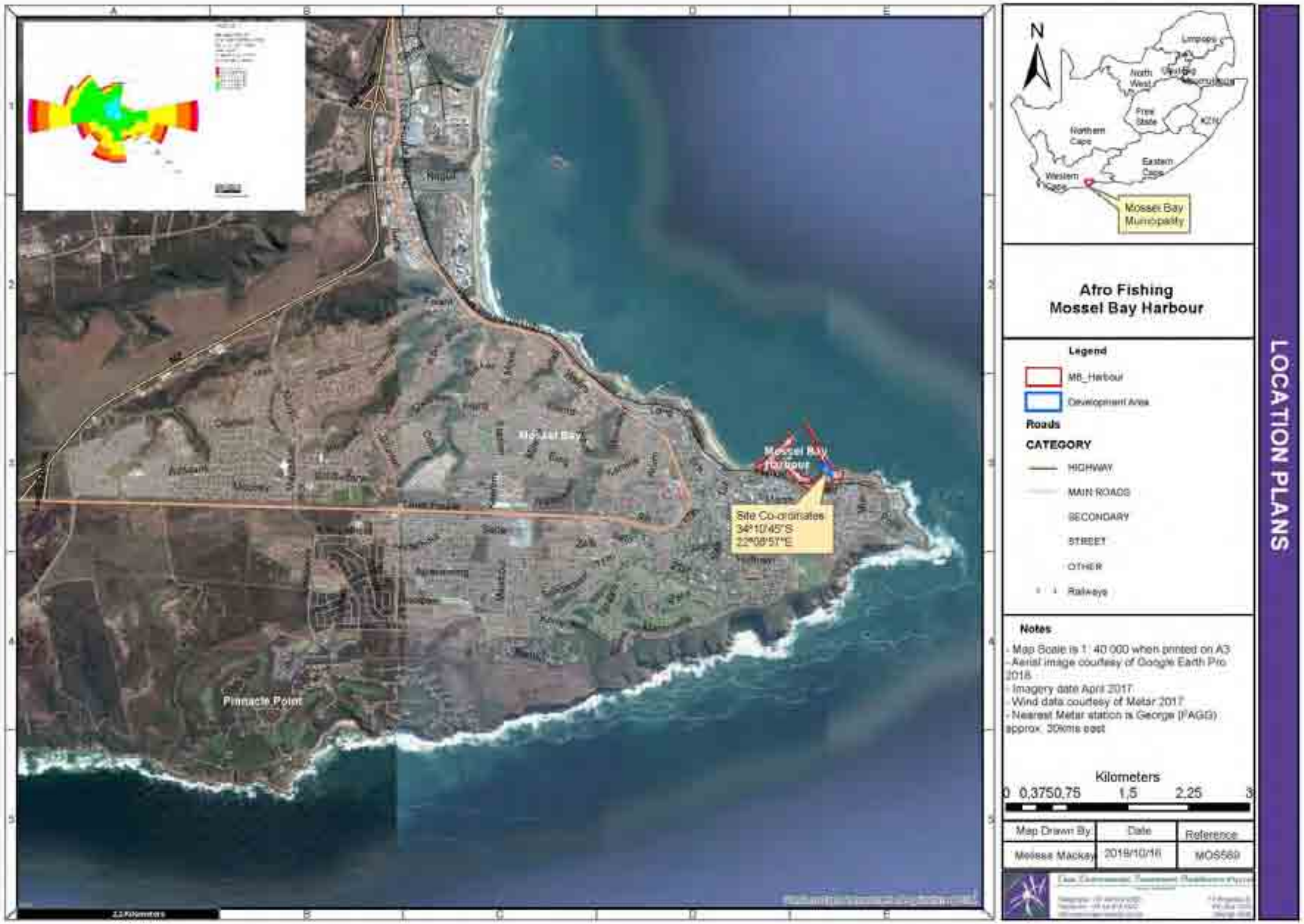
APPENDIX A

AFRO FISHING SITE LAYOUT

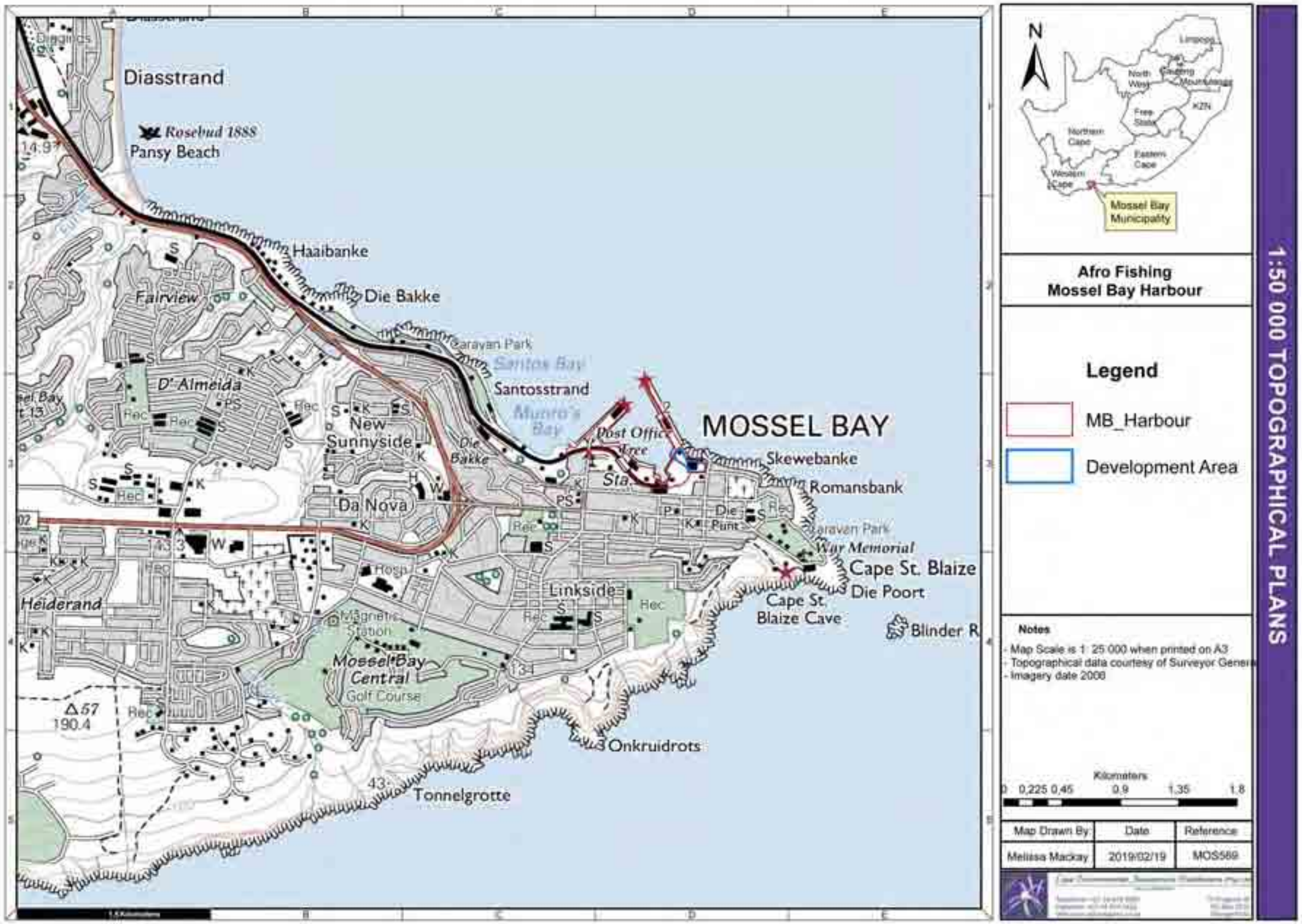
AND

SURROUNDING AREA

(By courtesy of Cape Environmental Assessment Practitioners (Pty) Ltd)



N
Mosse Bay Municipality
Mossel Bay
Mossel Bay Harbour
Site Co-ordinates 34°10'45"S 22°08'57"E
Pinnacle Point
Afro Fishing
Mossel Bay Harbour
Legend
MB_Harbour
Development Area
Roads
CATEGORY
HIGHWAY
MAIN ROADS
SECONDARY
STREET
OTHER
Railways
Notes
- Map Scale is 1: 40 000 when printed on A3
- Aerial image courtesy of Google Earth Pro 2018
- Imagery date April 2017
- Wind data courtesy of Metar 2017
- Nearest Metar station is George (FAGG) approx. 30kms east
Kilometers
0 0,3750,75 1,5 2,25 3
Map Drawn By
Date
Reference
Melissa Mackay
2019/10/16
MOS569
LOCATION PLANS


Diasstrand
Rosebud 1888
Pansy Beach
Haaibanke
Die Bakke
Fairview
D' Almeida
New Sunnyside
Santos Bay
Santosstrand
Munro's Bay
MOSSEL BAY
Skewebanke
Romansbank
Da Nova
Caravan Park
War Memorial
Cape St. Blaize
Die Poort
Cape St. Blaize Cave
Blinder R
Linkside
Heiderand
Magnetic Station
Mossel Bay Central Golf Course
Onkruidrots
Tonnelgrotte
N
Mossel Bay Municipality
Afro Fishing
Mossel Bay Harbour
Legend
MB_Harbour
Development Area
Notes
- Map Scale is 1: 25 000 when printed on A3
- Topographical data courtesy of Surveyor General
- Imagery date 2008
Kilometers
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Map Drawn By: Date Reference
Melissa Mackay 2019/02/19 MOS569
1:50 000 TOPOGRAPHICAL PLANS

Quay 4
Viking Fishing
Quay 5
Yacht Club
Old I&J Facility
New Development Area
Quay 2
SeaHarvest
Quay 1
Afro Fishing
Cannery
Transnet
NSRI
Goods Shed
N
Mossel Bay
Municipality
Afro Fishing
Mossel Bay Harbour
Legend
MB_Harbour
Development Area
Notes
Kilometers
Map Drawn By
Date
Reference
MOS569
SITE LOCATION PLAN

N
Limpopo
North West
Mpumalanga
Free State
KZN
Northern Cape
Eastern Cape
Western Cape
Mossel Bay Municipality
Afro Fishing
Mossel Bay Harbour
Legend
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MB_Harbour
Expansion Site
Afro Fishing Cannery
Notes
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- Aerial image courtesy of Google Earth Pro 2018
- Imagery date 11 August 2016
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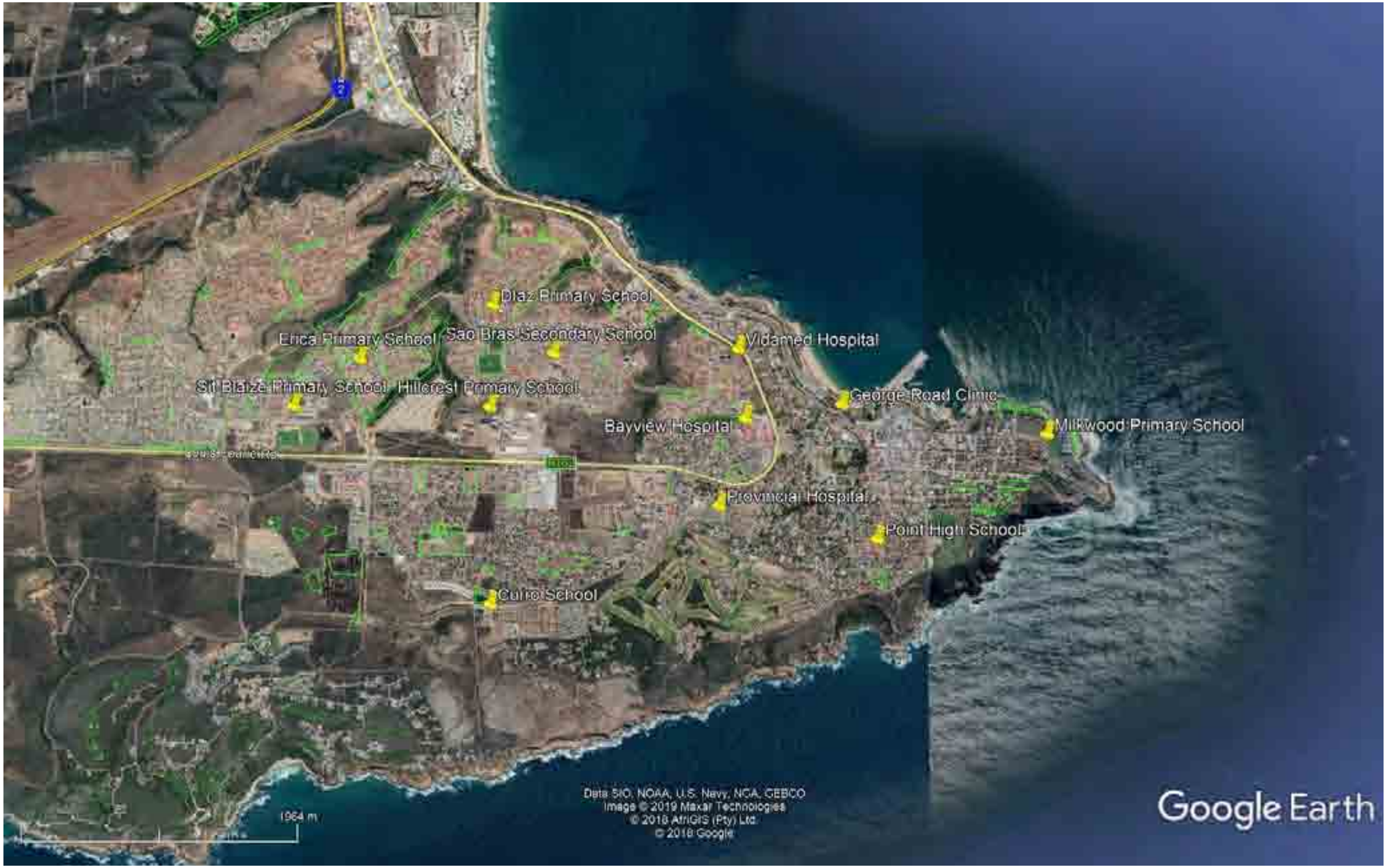
Map Drawn By
Date
Reference
Melissa Mackay
2019/06/07
MOS565
SITE PLAN

APPENDIX B

SENSITIVE RECEPTORS CLOSE TO AFRO FISHING


Diaz Primary School
Erica Primary School
Sao Bras Secondary School
Vidamed Hospital
St Blaize Primary School
Hillcrest Primary School
George Road Clinic
Milkwood Primary School
Bayview Hospital
Provincial Hospital
Point High School
Curro School
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2019 Maxar Technologies
© 2018 AfriGIS (Pty) Ltd.
© 2018 Google
1964 m
Google Earth

APPENDIX C

OTHER SOURCES OF AIR POLLUTANTS
IN AND AROUND MOSSEL BAY

The air pollution sources listed in this Appendix fall within a radius of 50 km from Afro Fishing's site.

This area includes all sources in Mossel Bay and George, but exclude sources in Albertinia and Knysna as they fall outside the radius of 50 km.

The following point sources have been identified in Mossel Bay:

Gourikwa Power Station	PetroSA
PG Bison Woodline	Rheebok Bricks
Southern Cape Fish Meal	South Cape Ostrich Tanners
Techno Asphalt	Afripet
Afrofishing	ATKV Hartenbos
De Bakke Santos	Mossel Bay Hospital
Mossel Bay Panel Beaters	Nestlé
Point Caravan Park	Power Pellet Fuel
The Point Hotel	

The following area sources have been identified in Mossel Bay:

Tank farm	Mossel Bay Harbour
Bulk tanker berth	Pinnacle Point WWTW
Ruitersbos WWTW	Grootbrak WWTW
Friemersheim WWTW	Regional WWTW
Brandwag WWTW	Herbertsdale WWTW
PetroSA landfill site	

Line sources identified are the N2 national load and the R102 regional road (Louis Fourie Road)

The location of these sources is indicated in the figure below.

The following point sources have been identified in George:

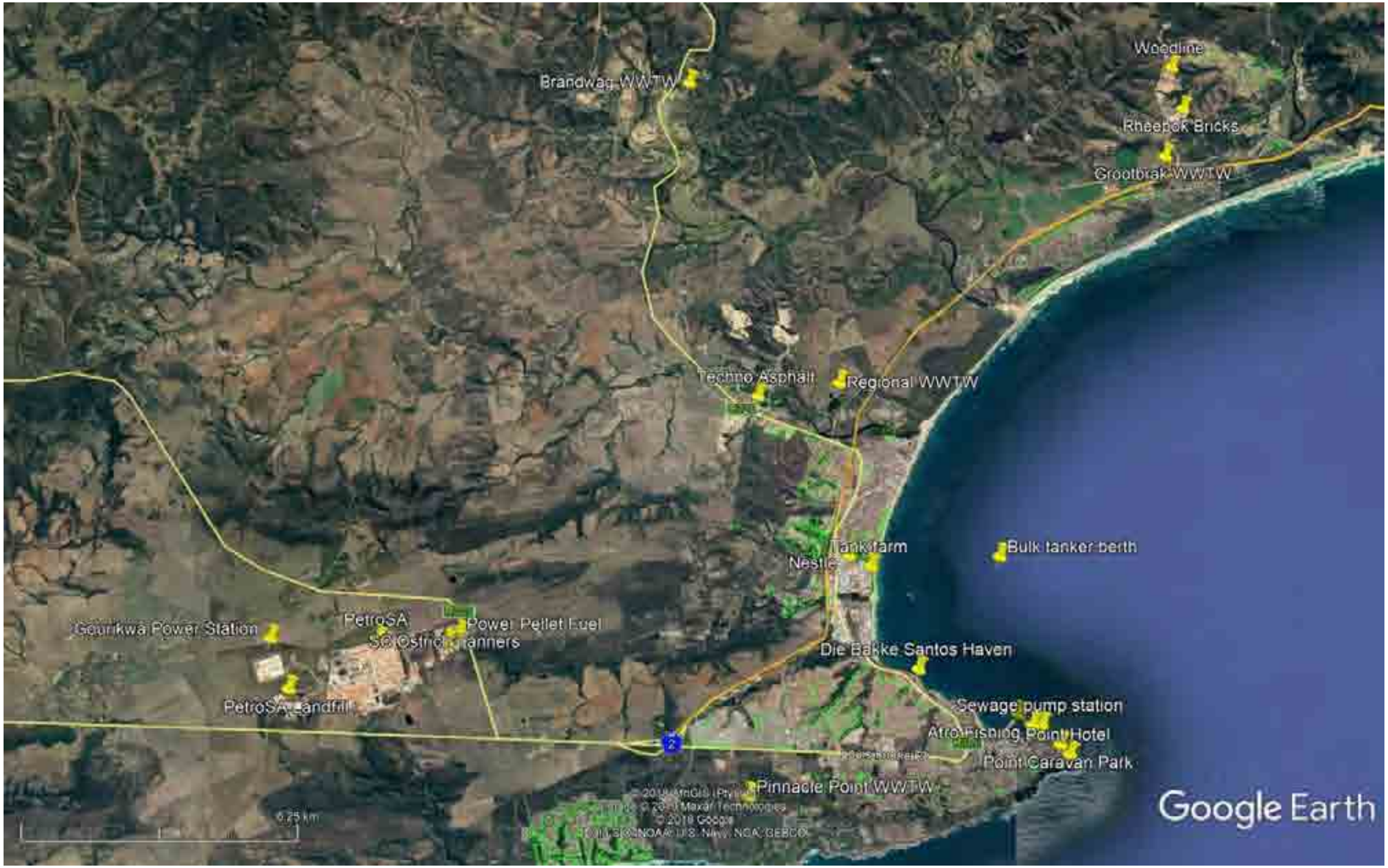
Botha & Barnard	Cape Pine
George Crematorium	Houttek Iuventus
Much Asphalt	Optimum Waste
PG Bison – Thesen	South Cape Galvanising
Express Laundry	George Timber & Palette
Lancewood	Nova Feeds
Outeniqua Bakeries	Pioneer Foods
Ramcom trucks	SAB Hop Farms
Touw Meubels	Woodfirst

The following area sources have been identified in George:

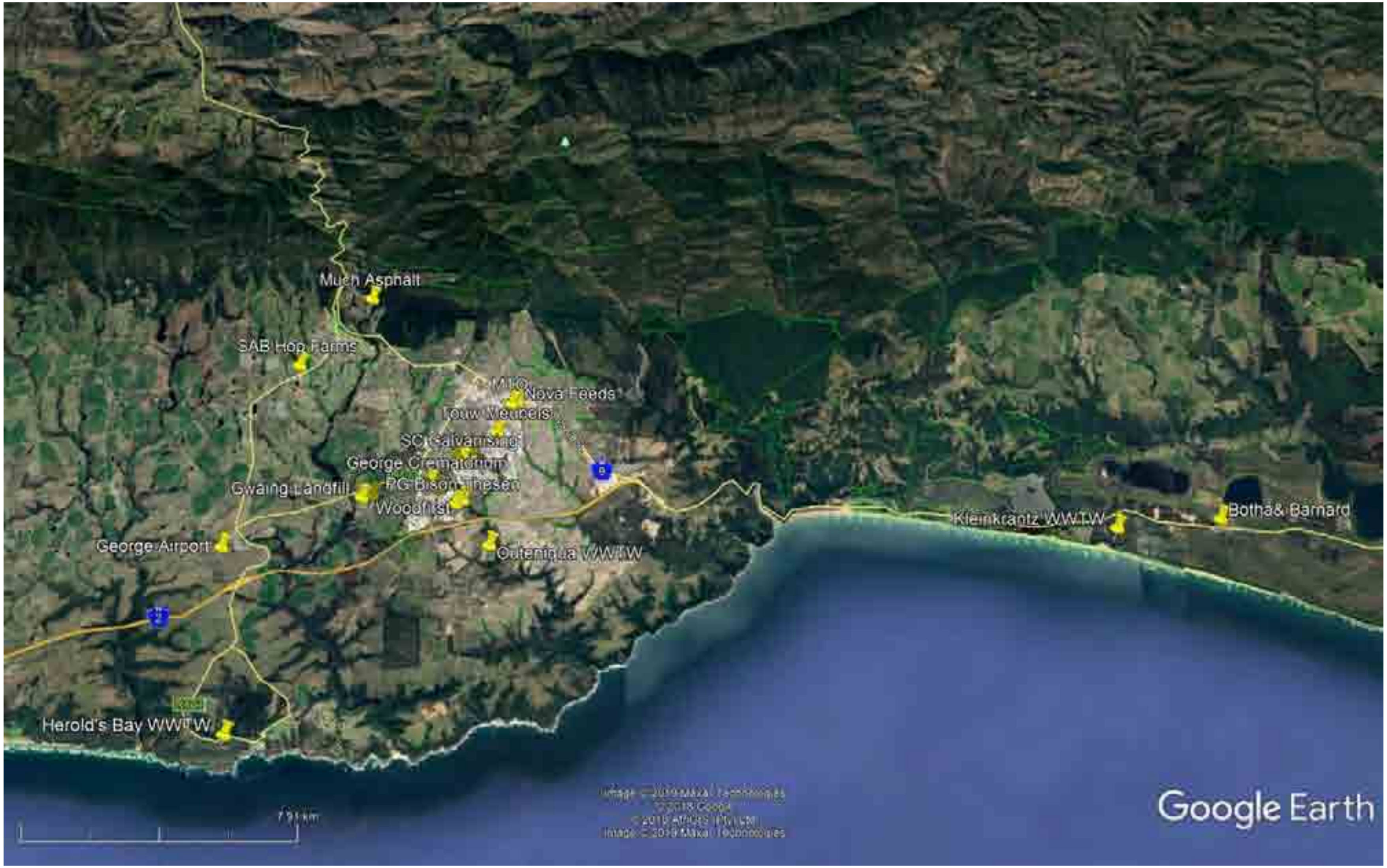
George Airport	Herold’s Bay WWTW
Kleinkrantz WWTW	Outeniqua WWTW
Gwaing WWTW	

Line sources identified for the George area are the N2 and N12 national roads

The location of these sources is indicated in the figure below.



Sources in Mossel Bay



Sources in George