3 APPROACH AND METHODOLOGY

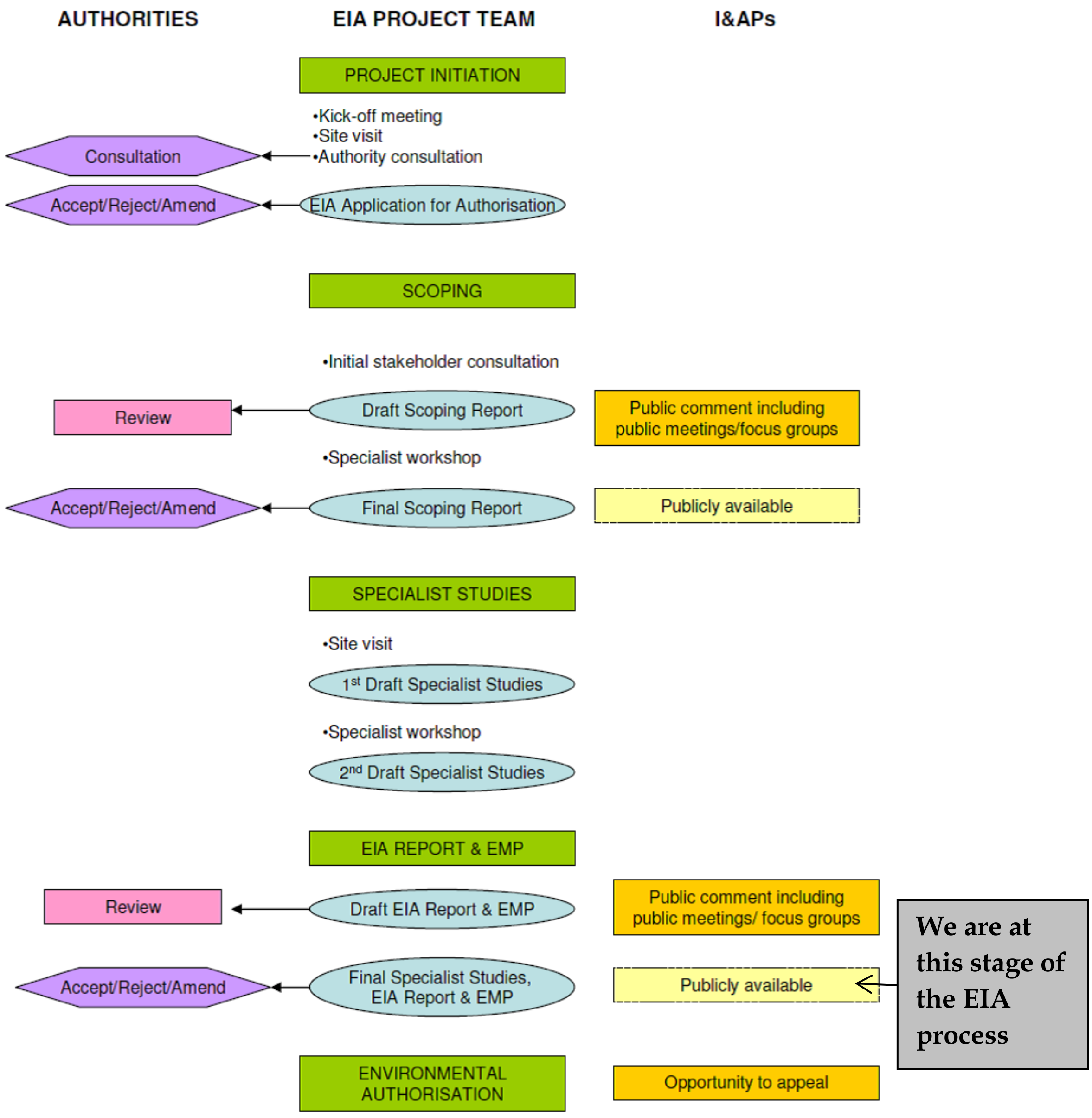
3.1 THE EIA PROCESS

EIA is a systematic process that identifies and evaluates the potential impacts (positive and negative) that a proposed project may have on the biophysical and socioeconomic environment, and identifies mitigation measures that need to be implemented in order to avoid, minimise or reduce the negative impacts and also identifies measures to enhance positive impacts. The overall EIA process required for developments in South Africa is shown schematically in *Figure 3.1.* The EIA is not fully a linear process, but one where several stages are carried out in parallel and where the assumptions and conclusions are revisited and modified as the project progresses.

The following sections provide additional detail regarding the key stages in the EIA process. These stages are:

- project initiation;
- scoping study phase; and
- integration and assessment phase.

Figure 3.1 *EIA Process Flow Diagram*



3.2 *PROJECT INITIATION PHASE*

The project initiation phase began with a project inception meeting followed by a review of available and relevant project related background information. Key activities during this phase of the project included the submission of an EIA Application for Authorisation form to DEA&DP on 05 September 2011. DEA&DP's Acknowledgement of Receipt and approval to proceed with the Scoping Study was received on 16 September 2011, under the DEA&DP reference E12/2/4/2-A2/75-3030/11, and is attached as *Annex E*.

3.3 SCOPING PHASE

Environmental scoping has several important functions aimed at facilitating decision-making. These include the following:

- providing a description of the proposed project and associated activities;
- reviewing existing information to gain an understanding of the baseline environmental conditions;
- identifying any gaps in information and uncertainties;
- investigating and screening of alternatives;
- obtaining input from I&APs about their issues and concerns;
- identification and initial assessment of potential environmental and social impacts associated with the Project; and
- identifying potential mitigation and management measures.

3.3.1 Site visit

Junaid Moosajee and Aabida Davis of ERM carried out a site visit on 28 September 2011. The purpose of the site visit was to familiarise the Project team with the Project proposal and study area and to identify potential impacts that may arise as a result of the Project.

Additionally, the site visit was also used to place the site notices and take photos of the site and surrounding land use.

3.3.2 Public Participation

The following tasks relating to public participation have been undertaken as part of this Scoping Study:

- A preliminary database has been compiled of neighbouring landowners, authorities (local and provincial), Non-Governmental Organisations and other key stakeholders (see *Annex C)*. This database of registered I&APs will be expanded during the on-going EIA process;

- The Project was advertised in the *Cape Times* and the *Cape Towner* on the 29 September 2011 and in *Die Burger* on 30 September 2011 (see *Annex C).* The advertisements informed the public of the Project and requested them to register as I&APs, if they would like to participate in the EIA process. I&APs that responded to the advertisements were included on the Project database.

- A Background Information Document (BID) (see *Annex C*) was distributed to the potential I&APs on the database for a 30-day notification period (ending 28 October 2011). The purpose of the BID was to convey information about this project to I&APs and allow them the opportunity to comment on the Project and Scoping Study process. The BID also invited I&APs to register their interest in the Project. Proof of the BID delivery is attached as *Annex C.*

- On-site notices were displayed at the site as well around the harbour. The notices were displayed from 28 September – 28 October 2011 (although they have not been removed by ERM). Photos showing the site notices are attached in *Annex C.*

- Throughout the EIA process to date, issues and concerns raised by I&APs and authorities, and communicated to ERM were recorded and have been included in *Annex D* of this report. All issues raised have been compiled into a Comments and Response Report (*Annex D*).

- The Draft Scoping Report was released for a 40 day comment period ending on the 10 February 2012 (excluding the festive season). A Comments and Responses Report has been compiled and is included in *Annex D*. An advert was placed in Die Burger, the Cape Times and the Cape Towner to advertise the availability of the Draft Scoping Report. Proof of the adverts can be found in *Annex C*.

- All I&APs were notified of the release of the Final Scoping Report for a 21 day comment period ending on the 23 May 2012. A Comments and Responses Report has been compiled and is included in *Annex D*.

3.3.3 Authority Consultation

Authority consultation and involvement up until the release of the Final Scoping Report included:

- The distribution of the BID to various authorities for a 30-day review period (Refer to the I&AP Database attached as *Annex C* to view the list of authorities);
- Submission of the Draft Scoping Report to relevant authorities. Acknowledgement of Receipt can be found in *Annex E* and a list of the authorities can be found in *Annex C.*
- Submission of the Final Scoping Report to relevant authorities. Acknowledgement of Receipt can be found in *Annex E* and a list of the authorities can be found in *Annex C*.
- An Acknowledgment of Receipt was received for the Final Scoping Report on the 4 May 2012, and an Acceptance of the Final Scoping Report was received on the 20 July 2012 (see *Annex E*).
- An acknowledgement for an extension to the EIA process was received from DEA&DP on 4 July 2013 following delays in the Project (see *Annex E*).
- A Project re-initiation letter was submitted to the DEA&DP on the 15 November 2013 (see *Annex E*).
- A Project update letter was submitted to the DEA&DP on the 16 January 2014 (see *Annex E*).
- An acknowledgement for an extension to the EIA process was received from DEA&DP on 30 January 2014 (see *Annex E*).

3.4 *INTEGRATION AND ASSESSMENT PHASE*

The final phase of the EIA is the Integration and Assessment Phase. The assessment of impacts proceeds through an iterative process considering three key elements:

a) **Prediction of the significance** of impacts that are the consequence of the Project on the natural and social environment.
b) **Development of mitigation measures** to avoid, reduce or manage the impacts.
c) **Assessment of residual significant impacts** after the application of mitigation measures.

A synthesis of the specialist studies, which addresses the key issues identified during the Scoping Phase, is documented in this EIR. Relevant technical and specialist studies are included as appendices to this EIR.

3.4.1 *Public Participation*

The initial Draft EIR was made available to I&APs and commenting authorities for a public comment period. Registered and identified I&APs were notified of the release of the Draft EIR and where the report could be reviewed.

Due to project description changes comments containing new information not previously raised by and I&AP, a Draft EIR Revision 2 was made available to I&APs and commenting authorities for an additional public comment period. Registered and identified I&APs were notified of the Draft EIR Revision 2 and where the report may be viewed.

Comments received on the initial Draft EIR and the Draft EIR Revision 2 have been assimilated and responded to in this Final EIR. A Comments and Responses Report is appended to this Final EIR, which will be submitted to DEA&DP for decision-making.

This Final EIR has been made available for a further 21-day commenting period, with any further comments being incorporated into the Comments and Responses Report which will be submitted to the DEA&DP for decision making.

All registered I&APs will be notified if an Environmental Authorisation has been issued by DEA&DP. If it is issued, a 40-day appeal period will follow the issuing of the Environmental Authorisation.

3.4.2 *Specialist Studies*

During the Specialist Study phase, the appointed specialists gathered data relevant to identifying and assessing environmental impacts that may occur as a result of the Project. They assisted the Project team in assessing potential impacts according to a predefined assessment methodology included in the Scoping Report. Specialists have also suggested ways in which negative impacts could be mitigated and benefits enhanced.

The independent specialists responsible for the specialist studies are listed in *Table 3.1*.

Table 3.1 Independent Specialist Studies and Appointed Specialists

Specialist Study	**Name and Organisation**	**Qualifications**
Traffic Impact Assessment	Bernard Phillips Kantey and Templer	Masters in Transportation Planning & Engineering Bachelor of Architectural Studies Diploma in Civil Engineering Certificate in Business Communication
Economic Assessment	Hugo van Zyl Independent Economic Researchers	BSc., BCom. Honours (Economics), Mcom. (Economics), PhD. (Economics)
Industry Assessment	Paul Buley Independent	BSc (Chem Eng) PMD UCT School of Business Management
Air Quality Impact Assessment	Demos Dracoulides DDA Environmental Engineers	Diploma in Mechanical Engineering, M.Sc. in Engineering and Energy Studies
Qualitative Risk Assessment	Tim Price ERM	BEng Honours (Chemical), MEng (Chemical)
Contaminated Site Assessment	Ken King ERM	BSc Honours (Geology), MSc (Geology)

The specialist reports and declarations of each specialist are included in *Annex F – J*.

3.4.3 Environmental Impact Report (EIR)

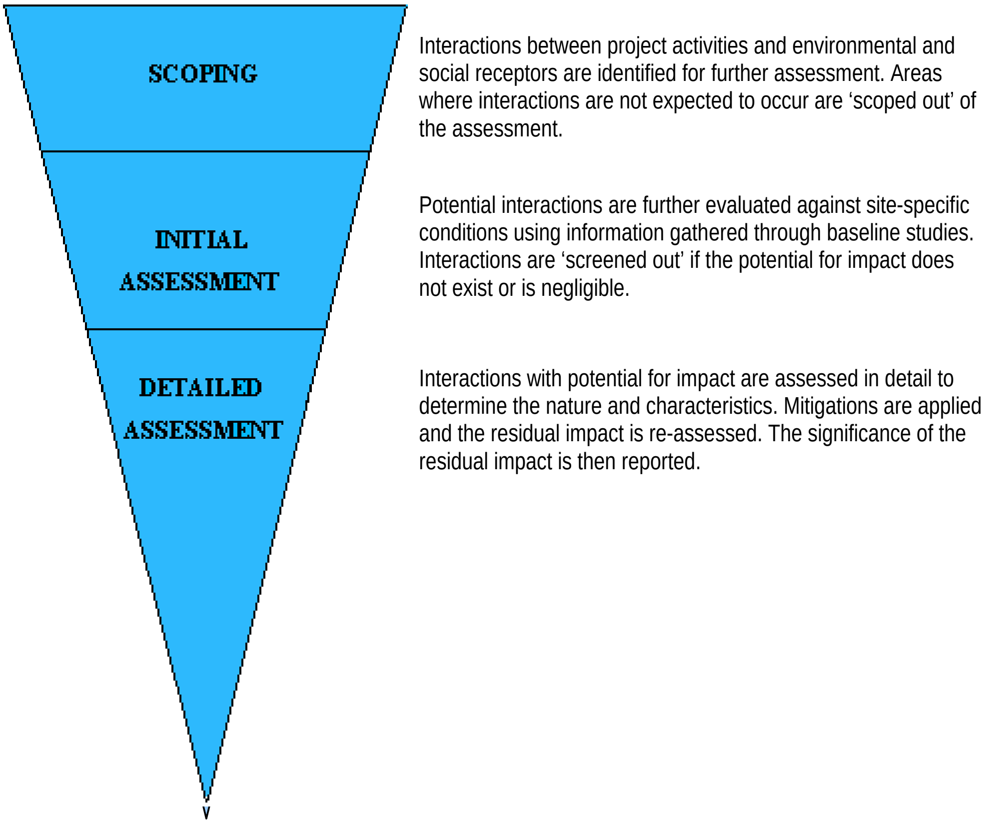
This EIR provides a description of the Project, a synthesis of relevant baseline information and identifies and evaluates the key issues and opportunities associated with the Project. Recommendations on the mitigation of adverse impacts and the enhancement of positive impacts associated with the Project are also included. These mitigation measures / enhancements are translated into specific actions in the Draft Environmental Management Programme (EMPr) (see *Annex K*).

3.5 IMPACT ASSESSMENT METHODOLOGY

3.5.1 *Impact Assessment Process*

The following diagram (*Figure 3.2*) describes the impact identification and assessment process through scoping, screening and detailed impact assessment. The methodology for detailed impact assessment is outlined in *Section 3.5.2* below.

Figure 3.2 Impact Assessment Process



3.5.2 *Impact Assessment Methodology*

The purpose of impact assessment and mitigation is to identify and evaluate the significance of potential impacts on identified receptors and resources according to defined assessment criteria and to develop and describe measures that will be taken to avoid or minimise any potential adverse effects and to enhance potential benefits.

Definition of Key Terminology

- **Project** - The features and activities that are a necessary part of the Project Proponent's development, including all associated facilities without which the Project cannot proceed. The Project is also the collection of features and activities for which authorization is being sought.

- **Project Site** - The (future) primary operational area for the Project activities. Private transport corridors (ie, those dedicated for use solely by Project operational activities) are included as part of the Project Site.

- **Project Footprint** - The area that may reasonably be expected to be physically touched by Project activities, across all phases. The Project Footprint includes land used on a temporary basis such as construction lay down areas or construction haul roads, as well as disturbed areas in transport corridors, both public and private.

Impact Types and Definitions

An impact is any change to a resource or receptor brought about by the presence of a Project component or by the execution of a Project related activity. The evaluation of baseline data provides crucial information for the process of evaluating and describing how the Project could affect the biophysical and socioeconomic environment.

Impacts are described according to their nature or type, as summarised in *Table 3.1*.

Table 3.1 Impact Nature and Type

Nature or Type	Definition
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. in-migration for employment placing a demand on resources).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

Assessing Significance

Impacts are described in terms of 'significance'. Significance is a function of the **magnitude** of the impact and the **likelihood** of the impact occurring. Impact magnitude (sometimes termed severity) is a function of the **extent, duration and intensity** of the impact. The criteria used to determine significance are summarised in *Table 3.2*. Once an assessment is made of the magnitude and likelihood, the impact significance is rated through a matrix process as shown in *Table 3.3* and *Table 3.4*.

Significance of an impact is qualified through a statement of the **degree of confidence**. Confidence in the prediction is a function of uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence is expressed as low, medium or high.

Table 3.2 Significance Criteria

Impact Magnitude	
Extent	**On-site** – impacts that are limited to the boundaries of the development site. **Local** – impacts that affect an area in a radius of 20km around the development site. **Regional** – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystem. **National** – impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.
Duration	**Temporary** – impacts are predicted to be of short duration and intermittent/occasional. **Short-term** – impacts that are predicted to last only for the duration of the construction period. **Long-term** – impacts that will continue for the life of the Project, but ceases when the project stops operating. **Permanent** – impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the project lifetime.
Intensity	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms of the sensitivity of the biodiversity receptor (i.e. habitats, species or communities).* **Negligible** – the impact on the environment is not detectable. **Low** – the impact affects the environment in such a way

	that natural functions and processes are not affected. **Medium** – where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High** – where natural functions or processes are altered to the extent that they will temporarily or permanently cease. ***Where appropriate, national and/or international standards are to be used as a measure of the impact.*** *Specialist studies should attempt to quantify the magnitude of impacts and outline the rationale used.* SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of people/communities affected by the Project to adapt to changes brought about by the Project.* **Negligible** – there is no perceptible change to people's livelihood. **Low** - people/communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium** – people/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support. **High** - affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.
Likelihood - the likelihood that an impact will occur	
Unlikely	The impact is unlikely to occur.
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

Once a rating is determined for magnitude and likelihood, the following matrix can be used to determine the impact significance.

Table 3.3 Significance Rating Matrix

SIGNIFICANCE				
		LIKELIHOOD		
MAGNITUDE		**Unlikely**	**Likely**	**Definite**
	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Table 3.4 Significance Colour Scale

Negative ratings	Positive ratings
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

Table 3.5 Significance Definitions

Significance definitions	
Negligible significance	An impact of negligible significance (or an insignificant impact) is where a resource or receptor (including people) will not be affected in any way by a particular activity, or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations.
Minor significance	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that 'moderate' impacts have to be reduced to 'minor' impacts, but that moderate impacts are being managed effectively and efficiently.
Major significance	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual

	impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors such as employment, in coming to a decision on the Project.

Once the significance of the impact has been determined, it is important to qualify the **degree of confidence** in the assessment. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence can be expressed as low, medium or high.

Mitigation Measures and Residual Impacts

For activities with significant impacts, the EIA process is required to identify suitable and practical mitigation measures that can be implemented. The implementation of the mitigations is ensured through compliance with the Environmental Management Programme (EMPr). After first assigning significance in the absence of mitigation, each impact is re-evaluated assuming the appropriate mitigation measure(s) is/are effectively applied, and this results in a significance rating for the residual impact.

3.6 IDENTIFICATION OF MITIGATION MEASURES

For the identified significant impacts, the project team, with the input of the client, has identified suitable and practical mitigation measures that are implementable. Mitigation that can be incorporated into the project design, in order to avoid or reduce the negative impacts or enhance the positive impacts, have been defined and require final agreement with the client as these are likely to form the basis for any conditions of approval by DEA&DP.

3.7 SPECIALIST STUDY METHODOLOGY

3.7.1 Traffic Impact Statement

A Traffic Impact Assessment was undertaken by Kantey and Templer.

This assessment was prepared in accordance with standards set by the South African Department of Transport. The study undertook the following:

- Described the extent of the proposed development.
- The study assessed the existing traffic operations on the road network in the vicinity of the site through traffic counts during peak traffic periods. The key intersection in the study area was analysed in order to assess

the existing traffic operations during the typical weekday peak commuter periods.

- Undertook a quantitative calculation of the potential additional traffic generated by the new development and estimate the distribution of that new traffic.
- The assessment of the effect that this generated traffic is likely to have on the existing road network was undertaken.
- Recommendations were then made for improvements to the existing road network and intersections affected by the generated traffic.

3.7.2 *Economic Assessment*

The Economic Assessment has been undertaken through a two phase approach.

Phase one of the study focused on need and desirability in order to establish and assess at a strategic level the economic rationale for the Project. This included interrogation of the assumptions that underlie the Project and a high level review of potential impacts on other key parties (including Chevron, PetroSA, Portnet and Burgan Oil). Degree of fit with relevant fuel industry policy and planning as well as port planning was addressed along with concerns regarding over-supply and financial viability.

Phase two of the study assessed the impacts of the Project focusing on the local, regional and national scales where relevant. Adverse, positive, direct and indirect impacts were identified for the establishment and operational phases of the Project. Impacts were assessed in accordance with the provincial guidelines for economic specialist inputs into EIAs (van Zyl, et al., 2005) that use a cost benefit analysis framework. The following impacts were assessed using a cost-benefit analysis framework:

- Impacts on overall economic development potential in the area including impacts on commercial enterprises nearby the site.

- Impacts associated with Project expenditure on direct and indirect employment and household incomes. These impacts were investigated through an examination of how the Project and the spending injection associated with it may impact on the local, regional and national economy. Impacts associated with upstream and downstream economic linkages and spin-offs were also assessed taking import content and other relevant factors into consideration. Experience from other similar Projects and any suitable economic models for the area were used to assess impacts. Indirect impacts were discussed qualitatively to the extent possible.

- Impacts associated with environmental impacts that cannot be mitigated and have economic implications. This focused on potential negative impacts and risks where relevant and to the extent possible based on the availability of other specialist studies focusing on assessing these risks.

- Potential cumulative economic impacts that may be associated with the Project.

In order to further address Chevron's concerns raised about the potential socio-economic impact specifically on its refinery because the Project may be a competitor in aspects of the Chevron's business, an additional Fuel Sector Specialist study has been undertaken and informed amendments to the Economic Specialist Study, to which it is appended.

3.7.3 *Air Quality Impact Assessment*

The Air Quality Impact Assessment undertook the following approach:

- Collection of meteorological data and determination of the meteorological conditions of the area which affected the dispersion of emissions.

- Established a detailed emissions inventory that includes fugitive emissions from the fuel storage tanks, the road tanker filling operations and the Vapour Recovery Unit (VRU).

- Use of dispersion modelling in order to determine the ground-level concentrations of pollutants such as Hexane (-n), Benzene, Isooctane, Toluene, Ethylbenzene, Xylene (-m), Isopropyl Benzene, 1,2,4-Trimethylbenzene and Cyclohexane.

- Assessment of impacts of air pollution with regard to carcinogenic and non-carcinogenic effects via comparisons against South African and international standards and guidelines.

3.7.4 *Contamination Site Assessment*

The Phase I desk top study and Phase II intrusive investigation at the Eastern Mole site will serves the dual purpose of feeding into the Scoping/EIA process as a specialist study (which it did) and providing the baseline contamination status of the site against which the conditions of the site after operation can be measured.

Task 1: Phase 1 Assessment

The Phase 1 Assessment consisted of a desktop study and a site reconnaissance visit. The desktop study focussed on collating available information pertaining to the site in order to compile an initial Site Conceptual Model. The objective of the desktop study was to assist in streamlining the approach taken during the Phase II Intrusive Assessment. The desktop study focused on the following points:

Historical Data Analysis:

Available records pertaining to the history of the site with regards to construction and previous operational history were reviewed as part of the desktop study. The review assisted in identifying previous practices or incidents which may have occurred on the site which could have impacted on the subsurface environment.

GIS/Map Based Study:

Orthophoto maps, geological maps, and topographic maps were reviewed to assess the site and the surrounding environments with regards to land use, soil types and potential receptors. In addition to this, records of above and underground services were reviewed to assess their potential for impacting on the subsurface environment, or conversely for being impacted upon by any potential subsurface contamination.

Site Reconnaissance Visit:

A short site reconnaissance visit was undertaken to provide onsite information which may not have been revealed by the desktop study. Visual observations with regards to soil staining, shot blasting residue, presence of nearby potential contaminant sources and underground services were recorded and used to assist in streamlining and focusing the subsurface soil investigation.

Task 2: Phase II Intrusive Assessment

The Phase II assessment consisted of an intrusive investigation by means of trial pits which were dug with a TLB (Tractor-Loader-Backactor) and the installation of three temporary wells to obtain grab samples from testpits encountering subsurface water.

Health, Safety and Service Clearance:

Service clearance was conducted across the relevant area which was included within the investigation prior to the commencement of intrusive works. This included the obtaining of relevant wayleaves, service diagrams and permits.

Trial Pit Excavation:

Trial pits were dug across the site in a grid-like fashion, to a maximum depth of 1.8m so as to assess any potential contamination which may have impacted the surface zone. The sampling layout was tailored to focus on the site where the fuel storage tanks will be situated and on areas identified during the Phase 1 Assessment as requiring additional investigation. Trial pits were inspected visually and with a Photo Ionisation Detector (PID) in order to assess potential hydrocarbon affected soils.

Sampling:

Soil samples were collected from selected trial pits based upon visual observations and PID measurements. Samples were collected and split into two sub samples, with one sub sample being placed in a sealed laboratory supplied container and the remaining sample being placed in a Ziploc™ bag to be screened with the PID. Soil characteristics such as grain size, colour, consistency, moisture content and competency were recorded along with the PID readings. Samples were couriered under refrigerated conditions to *Analytico Milieu Laboratories* in the Netherlands to be analysed for *Gasoline Range Organics* (***GRO***), *Diesel Range Organics* (***DRO***) and *BTEX* compounds. Selected soil samples were also collected for heavy metals analysis and will be sent to Jones Forensics Services in the United Kingdom.

3.7.5 Quantitative Risk Assessment (QRA)

Risk management has become widely used as a technique to aid decision-making. Five specific elements are involved:

1. **Hazard Identification:** to determine the incident scenarios, hazards and hazardous events, their causes and mechanisms.

2. **Consequence Analysis:** to determine the extent of the consequences of identified hazardous events.

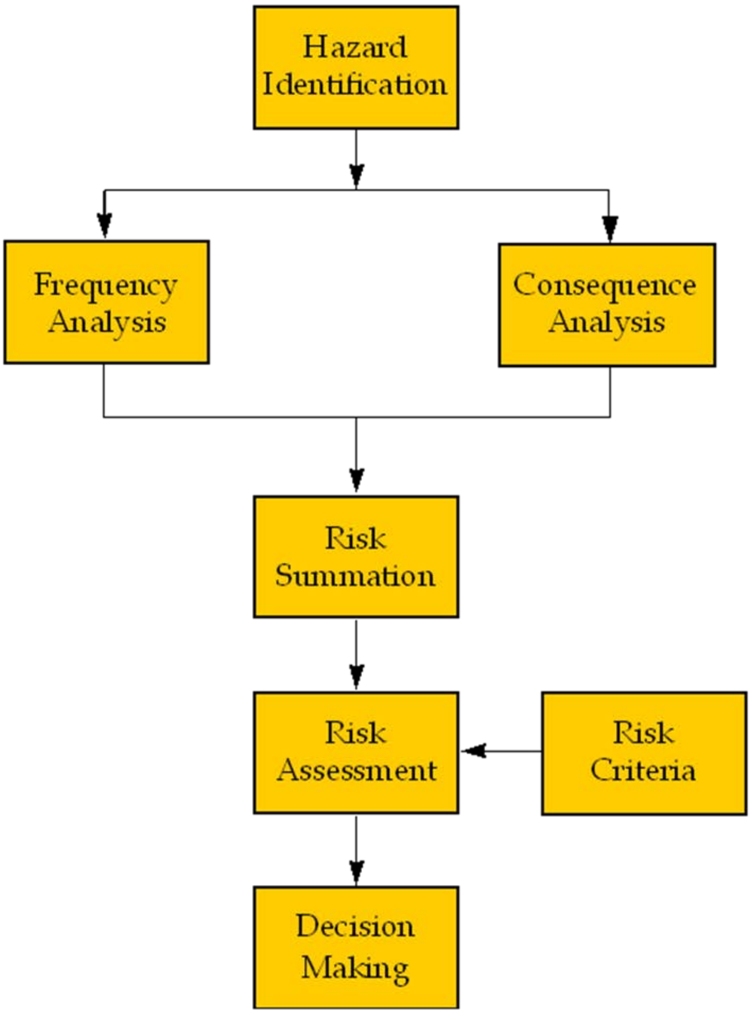
3. **Frequency Estimation:** to determine the frequency of occurrence of identified hazardous events and the various consequences.

4. **Risk Summation:** to determine the risk levels.

5. **Risk Assessment:** to identify if the risk is tolerable/intolerable and to identify risk reduction or mitigation measures and prioritise these using techniques such as risk ranking and cost-benefit analysis.

These elements are shown in the flow diagram in *Figure 3.3*. The elements of the procedure are used both to generate information and as an aid to decision-making in managing the risk. For decision-making, the procedure is only taken as far as is necessary to generate the information required or to make the decision. The extent of application of the various elements and degree of quantification employed therefore varies significantly from one situation to another.

Figure 3.3 Risk Assessment Process



Hazard Identification

The first stage in any Major Hazardous Installation (MHI) risk assessment is to identify the potential incidents that could lead to the release of a hazardous material from its normal containment and result in a major accident. This is achieved by a systematic review of the facilities to determine where a release of a hazardous material could occur from various parts of the installation.

The major hazards are generally one of three types: flammable, reactive and or toxic. In this study, only flammable hazards are relevant involving loss of containment of diesel, petrol, ethanol and bio Fame. Flammable hazards may manifest as high thermal radiation from fires and overpressures following explosions that may cause direct damage, building collapse, etc. Flammable hazards are present throughout the facility and associated pipelines. Fires may occur if flammable materials are released to the atmosphere and ignition takes place.

The possibility of explosions in the instance of over-filling (Buncefield-type incident) has been considered.

This study is only concerned with major incident hazards as defined by the scope of the South African Major Hazard Installation Regulations [(1)]. These regulations are concerned only with incidents which involve dangerous substances that give rise to off-site risk as far as the general public and other industries are concerned.

Consequence Analysis

Harm Criteria for Consequence Analysis:
During the analysis it is necessary to define harm criteria (or 'end points') for use with the consequence models. In the case of this study, these harm criteria are levels of thermal radiation intensity and where relevant, overpressure (in the case of vapour cloud explosions).

<u>Consequence Modelling:</u>

Factors Affecting Consequences:
There are several factors which affect the consequences of materials released into the environment. These include (but are not limited to):

- Release quantity or release rate
- Duration of release
- Initial density of the release
- Source geometry
- Source elevation
- Prevailing atmospheric conditions
- Surrounding terrain
- Physical and chemical properties of the material released.

Such factors will affect the consequence zones for the specific hazardous materials, e.g. the distance at which the level of thermal radiation from a fire or overpressure from an explosion has reduced sufficiently so that it is no longer dangerous.

Factors Affecting Fire Hazards:
When considering large open hydrocarbon fires, the principal hazard is from thermal radiation. The primary concerns are safety of people and potential damage to nearby facilities or equipment.

Determination of thermal radiation hazard zones involves the following three steps:

- Geometric characterisation of the fire, that is, the determination of the burning rate and the physical dimensions of the fire;

(1) Regulation R.692 Occupational Health and Safety Act (85/1993): Major Hazard Installation Regulations.

- Characterisation of the radiative properties of the fire, that is, the determination of the average radiative heat flux from the flame surface; and
- Calculation of radiant intensity at a given location.

These, in turn, depend upon the nature of the flammable material, size and type of fire, prevailing atmospheric conditions and the location and orientation of the target/receptor.

Consequence Models:
The hazards described above can be modelled analytically by standard models used for consequence analysis. Many of these models are performed by computer software and ERM has access to a range of such models

Frequency of Major Accident Hazards

For each hazard identified, the frequency is assessed.

A simple way of defining the frequency of major accident events within a QRA is to use a 'top down' approach. This provides frequencies of the events of interest (fires, explosions, etc.) by reference to historical accident data sources, without considering the causes or development of these events in detail.

Alternatively, if more detail is required, a 'bottom up' approach may be used, where the frequency of individual release scenarios is considered. The different outcomes that may result from these releases and the associated frequencies are then developed using techniques such as event tree analysis.

A release of hazardous material may be considered for a range of hole sizes, which will depend on the various causes considered. For example, a leak from a pipeline due to corrosion will tend to be small, whereas external impact, say, by a mechanical digger, is likely to produce a much larger hole.

ERM has obtained a copy of the *Planning Case Assessment Guide (PCAG)* developed by the *UK Health and Safety Executive (HSE)*. This enables an estimate of the likelihood of potential hazards following the failure of tanks, vessels, process piping, valves, flanges, etc. to be made.

The frequency of the various outcomes (accident scenarios) is then estimated by multiplying the frequency of the release by the probability of the various outcomes. In this study, for flammable releases these outcomes are principally pool fires and flammable vapour clouds of various sizes.

Risk Calculation

The individual risk for a specified level of harm is calculated taking the following variables into consideration:

- The frequency of the hazardous outcome (consequence), e.g. pool fire event
- The probability that the hazardous outcome (consequence) will reach the location specified (This includes variation of wind direction with consequent change to flame tilt; both downwind and crosswind distances need to be taken into account)
- Probability of an individual being at the location
- Probability of escape into shelter by an individual
- The probability that, given exposure to the hazardous outcome, the person suffers a defined level of harm.

The frequency of harm (f_h) being present from each hazardous outcome (consequence) event must be calculated and summed to give the maximum individual risk (IR) from all events at one location.

$$IR_{(max)} = \sum_{\textit{for all consequences}} f_h$$

As individual risk is location specific, the above process needs to be repeated for each location considered. The individual risk from other facilities can be summed to give the overall individual risk level from several major hazards. Calculation can be avoided if it is obvious that the event would not be able to affect a location e.g. the specified location is too far away.

The frequency of harm will be different for differing weather categories and needs to be calculated for each weather category used. The frequency of harm for a given consequence and weather category is expressed as follows:

$$f_h = f_e \times P_w \times P_d \times P_{exp} \times P_{harm}$$

Where:

f_e = frequency of the hazardous outcome (consequence)

P_w = probability of that weather category

P_d = probability of the wind blowing in the required direction for event to affect the individual (P_d = 0 if event cannot reach a particular location)

P_{exp} = probability of exposure

P_{harm} = probability that defined level of harm results given that exposure has occurred

The probability of the wind blowing in the required direction depends on the angle of entrapment, or the circular sector where a particular hazardous outcome encompasses the specified location. This is a function of the distance from the source, the size, and shape of the hazard 'footprint'. The size and shape of the footprint is determined from the results of the consequence analysis, but gives a complex shape and is correspondingly difficult to calculate the angle of entrapment. These complex shapes are often simplified to regular shapes in order to calculate the angle of entrapment.

The frequency of harm for a specific event is the sum of the frequencies of harm for the different weather conditions:

$$f_h = \sum_{\text{all weathers}} f_{h,\text{weather } i}$$

ERM's proprietary *ViewRisk* computer software has been used to calculate iso-risk contours, which show the geographical distribution of individual risk of harm to people.

Risk Assessment

The final and most significant step in the process is the assessment of the meaning and significance of the calculated risk levels. Risk assessment is a process by which the results of a risk evaluation are used to make judgements, either through relative risk ranking of risk reduction strategies or through comparison with established risk targets (criteria).

Where off-site risk criteria relevant to QRA have been issued (in this case based on criteria used in the UK), it is possible to assess the calculated risk levels against these criteria. This determines whether the risks are tolerable, broadly acceptable, or if risk reduction/mitigation measures are required to reduce the risk to levels which can be considered to be as low as reasonably practicable (ALARP). The risk events can then be ranked to determine the relative contribution of each to the overall risk level.

In general the higher risk events should be examined for possible areas of reduction or mitigation as a first step. Measures that prevent the potential incident from occurring should be considered first, followed by measures that reduce the probability (e.g. reduction in flanges), then measures that may limit the amount released (e.g. remotely operated valves, ROVs) and finally measures that may reduce the potential consequences (e.g. water sprays).

The risk assessment will thus enable decisions to be made on whether an investment should be made on particular mitigation measures so that the risk is effectively managed. The residual risk will then be managed by appropriate safety management systems to ensure safe operations, maintenance, good practice, etc.

3.8 *ASSUMPTIONS AND LIMITATIONS*

Environmental Impact Assessment is a process that aims to identify and anticipate possible impacts based on past and present baseline information. As the EIR deals with the future there is, inevitably, always some uncertainty about what will actually happen in reality. Impact predictions have been made based on field surveys and with the best data, methods and scientific knowledge available at this time. However, some uncertainties could not be entirely resolved. Where significant uncertainty remains in the impact assessment, this is acknowledged and the level of uncertainty is provided.

In line with best practice, this EIR has adopted a precautionary approach to the identification and assessment of impacts. Where it has not been possible to make direct predictions of the likely level of impact, limits on the maximum likely impact have been reported and the design and implementation of the Project (including the use of appropriate mitigation measures) will ensure that these are not exceeded. Where the magnitude of impacts cannot be predicted with certainty, the team of specialists have used professional experience and available scientific research from similar facilities worldwide to judge whether a significant impact is likely to occur or not. Throughout the assessment, this conservative approach has been adopted to the allocation of significance.