OPERATIONAL PHASE KEY ISSUES
ASSESSMENT OF
CRPC SOUTH EAST TSING YI
PETROLEUM TERMINAL
TSING YI ISLAND
HONG KONG

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FINAL REPORT

Prepared for : China Resources Petroleum & Chemicals Company

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1.0 PROJECT DESCRIPTION

1.1 Introduction

(1) The potential environmental issues arising from the development of the CRPC Southeast Tsing Yi Petroleum Terminal have been identified in the Initial Assessment Report for the Development (DNV Technica Report K5220-IAR) [1]. The report highlighted the key environmental issues of concern anticipated to arise during the various phases of the Development.

(2) The objective of this report is to address the key issues of concern arising during the operational phase of the Development which are considered to be as follows:

- Air Quality Impacts
- Water Quality Issues
- Operational and Traffic Noise
- Chemical Waste Arisings
- Marine Impacts

1.2 Site Description

(1) The existing CRPC Oil Terminal to be redeveloped is situated on the south eastern tip of the island of Tsing Yi and covers an area of 3.2 hectares. The island covers an area of 950 hectares and its topography is rugged with steep ridges up to 332m high. Flat areas are confined to the coastal margins and the northeastern portion of the island. The 1993 population of Tsing Yi is about 173,000.

(2) The CRPC Oil Terminal is over 1 km from the nearest populated or residential area to the north which include a Technical Institute, Cheung Ching Estate and Mayfair Gardens. The site is bordered to the west by the Esso Oil Depot; to the north lie Tsing Yi Road and to the south lies the Rambler Channel. To the northeast lies the newly commissioned Chemical Waste Treatment Facility (CWTF) for Hong Kong. To the east lies an area earmarked for industrial development and the proposed Container Terminal No. 9 (CT9) land reclamation development. The proposed CT9 reclamation area will merge with the CRPC Terminal at the eastern site boundary.

1.3 Project Description

(1) The concept for the proposed Oil Terminal extension envisages a phased demolition of the existing facility and combining the joint facilities of the existing south-east Tsing Yi Terminal and the relocated north-east Tsing Yi Terminal at Nga Ying Chau. The expansion will add another 8.4 hectares of land area most of which will be provided by reclamation. The total area of the proposed facility will be 11.6 hectares.

(2) The project will be developed in three phases as follows:

Phase 1

The first phase will involve site formation works, construction of the temporary berth, tanker pier and fairway realignment. Target date for completion of Phase 1 will be the end of 1994.

Phase 2

The second phase will include construction of the tanks, piping, buildings, roads and other infrastructure for oil storage facility. Pre-commissioning of the developed facility is expected to begin towards the end of 1995. No storage of chemical products is planned during this phase.

Phase 3

The third phase will involve the construction of the LPG facility, chemical and lube oil blending facilities. The completed development is expected to be fully operational in early 1998.

1.3.1 Layout

(1) The layout of the redeveloped Terminal is shown in Figure 1.3.1. The main elements are:

- Main jetty and marine berths on the waterfront
- Tank farm
- LPG tank storage
- Lube oil blending and filling shed
- LPG cylinder filling station
- Chemical filling shed
- Commercial petrol filling station
- Lorry loading area
- Office building

1.3.2 Materials Handled

(1) The Terminal will handle a wide range of oil and chemical products, including:

- Leaded Petrol grades 1 and 2 (LP1 and LP2)
- Unleaded Petrol (ULP)
- Liquefied petroleum gas (LPG)
- Kerosene (Kero)
- Aviation Fuel (Jet A-1)
- Light Diesel Oil (LDO) including Automobile Light Diesel Oil (ADO) and Fisher Light Diesel Oil (FLDO).
- Industrial Diesel Oil (IDO)
- Special Light Diesel Oil (SPE-LDO)

- Marine Diesel Oil (MDO)
- Boiler Diesel Oil (BDO)
- High Sulphur Fuel Oil (HSFO)
- Low Sulphur Fuel Oil (LSFO)
- Lube Oil
- Toluene-A/Toluene-B
- Acetone
- Iso-Propyl Alcohol (IPA)
- Flux-A/Flux-B
- Styrene Monomer (SM)

The Terminal will import products in bulk by ship, and deliver them in smaller quantities to customers by road and marine vessels. The Terminal is expected to have an annual throughput of approximately 3,900,000 tonnes as shown in Table 1.3.2.1.

TABLE 1.3.2.1 : CRPC REDEVELOPED TERMINAL THROUGHPUT

Material	Throughput (tonnes per year)
LPG	35,000
Gasoline	20,000
Jet A1	600,000
Kerosene	60,000
Diesel	1,031,000
Fuel oil	1,056,000
Acetone	10,000
Toluene	20,000
Iso propyl alcohol	8,000
Flux-A/Flux-B	15,000
Lube Oil	30,000
Styrene Monomer	250,000
TOTAL	3,869,000

1.3.3 Storage Facilities

(1) The Terminal will have approximately 36 atmospheric storage tanks for flammable liquids from Class 1 to 3, with capacities ranging from 600 to 35,000 m^3, located within concrete bunds. LPG will be stored in three cylindrical pressure vessels, each with a capacity of 1333 m^3, located in a shallow pit and mounded with sand.

1.3.4 Marine facilities

(1) A temporary jetty approximately 200 m in length will be constructed prior to demolition of the existing jetty. This temporary jetty will allow operations of the Terminal

to continue at a reduced capacity while the new Terminal construction works are being carried out. The temporary jetty will allow for tankers up to 5,000 DWT to berth.

(2) The terminal will have a main T-shaped jetty, with a main berthing location at the head capable of handling tankers up to 80,000 DWT, allocated mainly for product receipt. The main jetty also has 4 subsidiary berths on the landward side. There are also 6 berths against the sea wall spaced around the Terminal, allocated mainly for barge deliveries.

(3) The Terminal is expected to handle approximately 6000 marine vessels per year. LPG traffic will amount to 35,000 tonnes unloadings and 15,000 tonnes loadings per year. The LPG berth has a 6" articulated loading arm with 4" vapour return connection, and a hydraulic emergency remote-operating shut-down valve.

1.3.5 Process Operations

(1) The Terminal will blend fuel oil and light diesel oil to form many grades of fuel oil (ie. HSFO) and boiler diesel oil (ie. BDO).

(2) The LPG cylinder filling station from the existing Terminal will be retained in the redeveloped Terminal. It will bottle about 15,000 tonnes per year of LPG, i.e. about 43% of LPG throughput. It has one carousel with filling nozzles for 18 cylinders. Most cylinders are of 10.5 or 16 kg capacity.

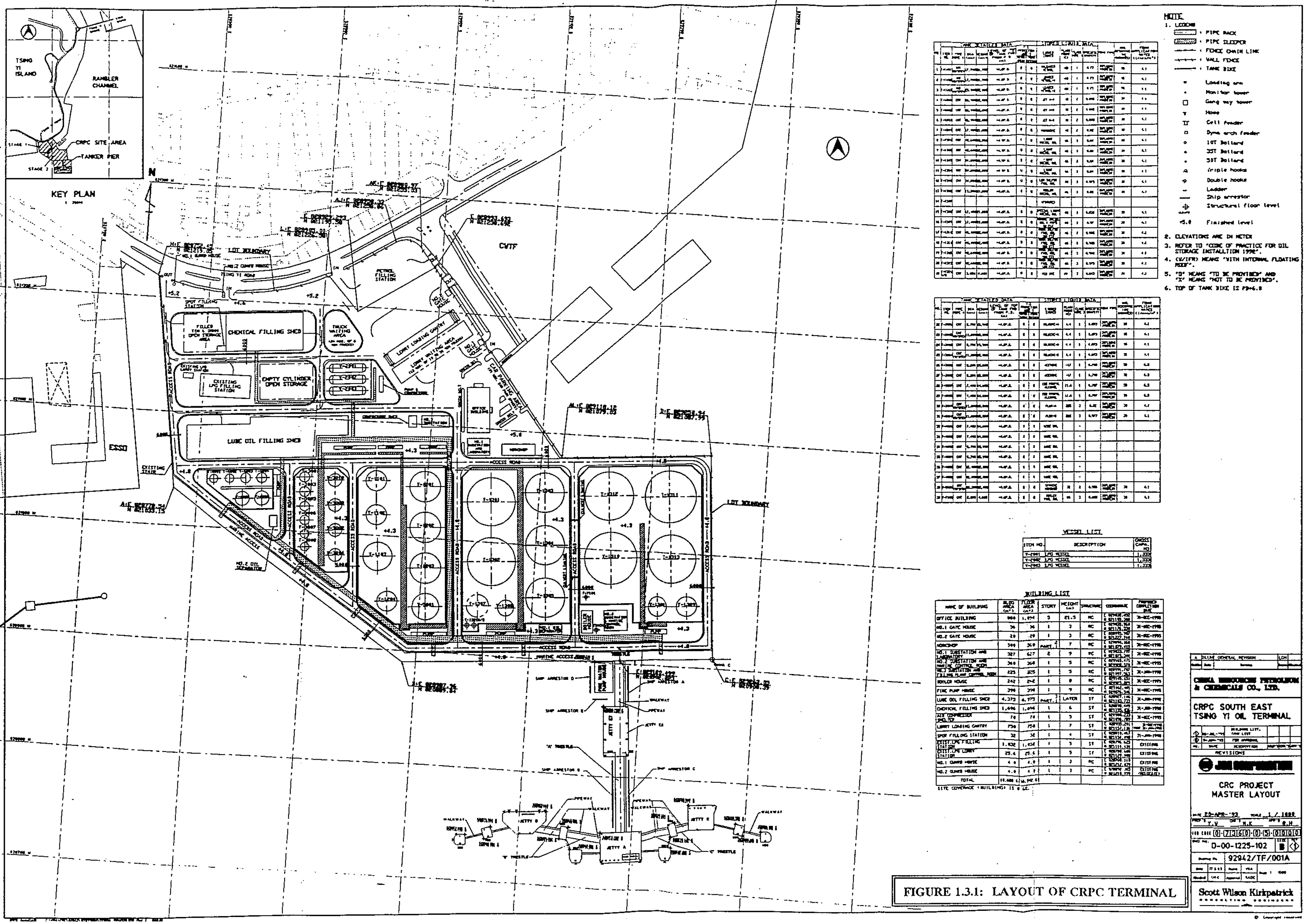


FIGURE 1.3.1: LAYOUT OF CRPC TERMINAL

(3) Approximately 20% of the chemicals and 83% of the lube oil handled by the Terminal is packed into drums for deliveries.

1.3.6 Road Deliveries

(1) Approximately 457,000 tonnes per year of liquid products (mainly diesel oil) will be delivered by road tanker. The Terminal will load approximately 230 tankers per day. The average tanker load is approximately 6 tonnes.

(2) A total of 5000 tonnes per year of LPG will be delivered by road tanker. The road tankers carry an average of 8 tonnes each in cylindrical pressure vessels.

(3) All the LPG cylinders and chemical and lube oil drums will be delivered from the Terminal by road.

2.0 AIR QUALITY IMPACTS

2.1 General

(1) The principal emissions to atmosphere during the operation of the CRPC Terminal will be hydrocarbons and volatile organic compounds (VOCs) from petroleum and organic liquid products handling and storage. Emissions of products of combustion will arise from vehicular traffic and steam generation associated with the Terminal operations.

2.2 Legislation, Codes of Practice and Control Criteria

(1) Under the Air Pollution Control Ordinance (APCO), processes which have a significant potential for air pollution are classified as "Specified Processes". Operators of specified processes are subject to approval and licensing requirements and are also required to use best practicable means (BPM). Under the Air Pollution Control (Amendment) Order No. 13, 1993, the CRPC Terminal is categorised as an organic chemical works and as such is classified as a specified process. BPM requirements for organic chemical works have not been finalised; BPM requirements are currently in draft form (3rd draft) and will be subject to further revision. Despite the fact that the BPM is in draft form, CRPC will proceed with the detailed design of the Terminal facilities based on the existing regulations and also the draft BPM requirements. CRPC will allow adequate flexibility for moderate further changes to meet with the BPM requirements to render itself subject to the same level of control as that of other oil companies in the area. CRPC is given to understand that sufficient deliberation and reasonable flexibility will be considered by the approving authorities in implementing the future BPM requirements when issuing the Licences to CRPC's new Oil Terminal and the other oil companies' existing oil depots.

(3) As a general guideline the loading/unloading, storage and handling of fuel, products, wastes and by-products should be carried out in a manner that is acceptable to EPD so as to prevent the release of visible dust emissions; and/or emissions of organic vapours; and/or other noxious or offensive emissions.

(4) The draft BPM requirements (3rd draft provided to DNV Technica June 1994) specify ambient pollutant concentrations which must not be exceeded at or beyond the plant boundary; these are intended as a means of controlling fugitive emissions. The ambient standards are shown in Table 2.2.2.

TABLE 2.2.2: AMBIENT AIR QUALITY LIMITS FOR ORGANIC CHEMICAL WORKS [2]

Parameter	Limit Value
Benzene	185 $\mu g/m^3$ (1-hour average)
Odour	2 odour units

(5) The Air Pollution Control (Fuel Restriction) Regulations 1990 were enacted to restrict the sulphur content of liquid and solid fuels used by industry throughout Hong Kong. Under these Regulations, the maximum permissible sulphur content in liquid fuels is 0.5% w/w.

(6) The Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations were enacted under the APCO. The principal objective of these Regulations is to prevent air pollution caused by the installation of unsuitably designed furnaces, ovens and chimneys. Under these Regulations, the occupier of the premises is required to obtain approval from EPD prior to installing a furnace (e.g boiler), oven or chimney. The application for approval should include information on the type, grade and quantity of fuel to be used; the operational hours of the equipment; details of the control system; boiler rating; structural details of the chimney (flue) and type of burner.

(7) Emissions of dark smoke from stationary combustion sources are controlled under the Air Pollution Control (Smoke) Amendment Regulations, 1990.

(8) Liquid fuel-fired commercial and industrial appliances should also be operated in accordance with the Code of Good Practice for the Operation of Liquid Fuel-Fired Commercial, Industrial and Domestic Appliances.

(9) Pollutant emissions from motor vehicles are controlled under the Road Traffic Control Ordinance, 1985. Under this legislation motor vehicles must be designed to meet emission standards and must be constructed and maintained to ensure that there are no emissions of excessive smoke.

2.3 Ambient Air Quality

(1) Southeast Tsing Yi is topographically confined with resultant poor dispersion of pollutants; the CRPC site is located on the margins of the Tsuen Wan/Kwai Chung airshed and to the southwest of the primary urban areas on the mainland; as such the prevailing winds from the northeast will to a large extent carry pollutants away from potentially sensitive receptors located to the north-northeast of the CRPC Terminal site.

(2) Background pollutant monitoring at sensitive receptors in the South East Tsing Yi area has been conducted in 1990 for CO, NO_2, and TSP [3]. A summary of the results for monitoring carried out at Ching Pak House and Cheung Ching Estate in 1990 is presented in Table 2.3.1.

TABLE 2.3.1: SUMMARY OF AIR QUALITY MONITORING DATA FOR 17 SEPTEMBER - 11 OCTOBER 1990 [3]

Parameter	1 hour ($\mu g/m^3$) Averages		24 hour ($\mu g/m^3$) Averages	
	Range	Mean	Range	Mean
CO	93.3 - 1318.3	425.1	46.7 - 1318.3	265.7
NO_2	38.3 - 134.2	77.4	9.3 - 39.7	24.3
TSP	-	-	49 - 108	72.5

2.4 Assessment Methodology

2.4.1 Fugitive Emissions

(1) Evaporative losses of hydrocarbons and VOCs will arise as a result of the storage and handling of petroleum and organic chemical products at the new CRPC Terminal. For the purpose of this assessment, since the requirements for detail design of the new facilities have not been fully defined, it has been assumed that a vapour recovery will only be provided for road tanker filling with DG Class 1 products. The principal potential sources of fugitive emissions are considered to be:

- Product storage

- Product loading/dispatch (vessel loading/unloading, valves, pumps flanges etc, road tanker and drum loading)

- Other sources will include evaporative losses from waste water treatment and evaporation of spills from hardstanding surfaces.

Product Storage

(2) Three types of tank will be utilised for storage at the CRPC Terminal; cone roof tanks and cone or dome roof tanks with an internal floating roof. The physical parameters of the proposed storage tanks and inventory of the products types to be stored is summarised in Appendix I.

(3) Storage tanks emit vapour through four primary processes: displacement, withdrawal, breathing and standing storage vapour emissions. API publications 2518 [4] and 2519 [5] provide emission factor equations for the estimation of emissions from fixed roof and internal floating roof tanks respectively.

Internal Floating Roof Tanks (IFRT)

(4) The principal emissions from IFR tanks are standing storage emissions and withdrawal emissions [6]. Standing storage emissions are caused mainly by evaporation of the liquid product via imperfections in the flexible peripheral seal between the tank annulus and the floating roof deck. Evaporative emissions may also occur through the deck structure and fittings (e.g. manholes, hatches, roof support columns etc).

(5) Withdrawal emissions occur due to evaporation of the film of product which adheres to the tank wall/roof support columns following roof lowering as product is withdrawn from the tank.

Fixed Roof Tanks (FRT)

(6) FRTs are subject to withdrawal, breathing and displacement emissions. Displacement emissions occur due to the displacement of the air and product vapour by incoming product. Breathing emissions are caused by temperature variations in the tank contents as a result of the diurnal cycle and atmospheric pressure variations. These fluctuations in ambient conditions result in expansion/contraction of the tank liquid/vapour contents.

(7) Withdrawal emissions occur following withdrawal of product from the tank which results in an intake of air via the pressure-vacuum (P-V) relief valve. Dilution of the hydrocarbon vapour/air mixture previously contained within the vapour space leads to further product evaporation as the equilibrium is restored. This results in an increase in pressure in the vapour space which will result in emission when the pressure setting on the P-V valve is exceeded [6].

Product Despatch Emissions

(8) Transport filling emissions arise when volatile products are loaded into a bulk transport compartment. CONCAWE, Report No. 85/54 [6] provides emission factor equations for emissions from transport operations.

(9) The emitted vapour is normally a mixture of preloading vapour and evolution vapour. Preloading vapour (PLV) is residual vapour originating from the previous contents, which is displaced by the product loaded. Evolution vapour (EV) is vapour which evaporates from the batch of product due to splashing and turbulence, and is displaced by the continuing addition of product.

(10) Fugitive emissions will also occur from valves, pump seals, flanges, pressure relief seals during loading/unloading and product transfer. To attain improved accuracy in fugitive emission predictions, the US EPA have identified methods of determining estimates of emissions to air of volatile compounds from equipment component leaks. These were presented in the EPA Protocol "Protocols for Generating Unit-Specific Emission Estimates for Equipment Leaks of VOC and VHAP". The SOCMI (Synthetic Organic Chemical Manufacturing Industry) average emission factor method does not require site specific emission monitoring; this method is therefore suitable for use in this study.

(11) The lorry loading facilities will be designed to handle three different types of product; black oils (BDO), white oil (petrol, diesel etc) and chemicals (toluene, acetone etc); a vapour recovery system will be provided for DG Class 1 product loading operations. The maximum rate of product loading into road tankers will occur during a three hour morning peak period. The peak product handling volumes during this period are presented in Table 2.4.1.1.

TABLE 2.4.1.1: MORNING PEAK ROAD TANKER LOADING RATES [7]

Product	Peak Hourly Handling Volume (m^3/hr)
Light diesel oils	111.8
Boiler diesel oils	349.0
Petrol	8.9
Kerosene	6.3
Toluene	10.2
Acetone	5.8
Isopropyl alcohol	4.6
Flux-A	4.7
Flux-B	3.5

(12) The chemical filling plant will be designed to fill products into 200 litre drums and 18 litre tins at an annual rate of 155700 and 1426700 pieces per year (350 days) respectively [8]. The anticipated total product volumes that will be handled on a daily basis in the chemical filling plant are presented in Table 2.4.1.2.

TABLE 2.4.1.2: CHEMICAL FILLING PLANT PRODUCT HANDLING

Product	Volume Packed (m^3/hr)
Kerosene	13.77
Light diesel oil	21.22
Toluene	8.00
Acetone	4.44
Isopropyl alcohol	3.55
Flux-A	3.55
Flux-B	2.66

(13) The number of pumps that will be provided for lorry loading and chemical plant filling operations are summarised in Table 2.4.1.3.

TABLE 2.4.1.3: PUMPS PROVIDED FOR PRODUCT LOADING BY ROAD TANKER AND CHEMICAL FILLING PLANT

Product	No Pumps (lorry loading)	No. Pumps (chemical filling)	Total
Petrol (LP & ULP)	2	-	2
Kerosene	1	2	3
Diesel oils	6	2	8
LPG	1	-	1
Toluene	2	2	4
Isopropyl alcohol	1	1	2
Acetone	1	1	2
Flux-A	1	1	2
Flux-B	1	1	2

2.4.1.1 Determination of Fugitive Emissions

(1) Fugitive emissions from the CRPC Terminal have been estimated utilising emission factors presented by API, US-EPA and CONCAWE. Detailed design information for the new CRPC Terminal is not currently available (eg piping and instrumentation diagrams etc) and suitable emission factors relating to all the product handling operations carried out at the CRPC site are not available in the literature; therefore, product evaporative losses have only been estimated for the following potential sources at the site:

- storage tanks
- lorry loading gantry
- pumping system (lorry loading and chemical filling)

(2) Evaporative losses from fixed storage tanks have been estimated on an annual basis utilising the product handling volumes presented in the Initial Assessment Report [1] and emission factor methodologies presented in API Publication 2518 (fixed roof tanks) and API Publication 2519 (internal floating roof tanks) and the approach summarised in Reference 9. Fugitive emissions from road tanker loading operations (during the 3-hour morning peak period) have been estimated using emission factors presented in CONCAWE Report 85/54; for the purpose of this assessment it is assumed that the vapour recovery system to be provided for Class 1 product loading will adequately contain all Class 1 product PLV and EV emissions. Fugitive emissions from pumps and associated components have been estimated using average SOCMI emission factors. Emission factor equations are presented in Appendix I.

(3) The physical properties used for the estimation of fugitive emissions of the products handled at the new CRPC Terminal have been derived from information provided by CRPC and from relevant literature [5],[6],[9],[11]; physical properties are summarised in Appendix I.

(4) Ambient environmental conditions influence fugitive emissions from storage tanks; for the purpose of this assessment, annual average environmental parameters have been utilised. Table 2.4.1.1.1 presents a summary of the meteorological data obtained from the Hong Kong Observatory which has been used to represent typical ambient conditions at

the CRPC site.

TABLE 2.4.1.1.1: MEAN AMBIENT ENVIRONMENTAL CONDITIONS AT THE CRPC SITE.

Parameter	Annual Mean Value
Atmospheric Pressure (Pa)	1.0129×10^5
Air Temperature (°C)	23.0
Mean Daily Temperature Range (°C)	4.8
Solar Radiation (MJ/m²)	14.46

(5) The estimated hourly evaporative losses for tank storage, lorry loading activities and pump operation are presented in Table 2.4.1.1.2.

TABLE 2.4.1.1.2: HOURLY EVAPORATIVE LOSSES

Product	Evaporative Loss (kg/hr)		
	Tank Storage	Road Tanker Loading	Pumps
Leaded/unleaded Petrol	0.230	-	0.102
Jet A-1	0.630	-	-
Kerosene	0.069	0.006	0.069
Diesel Oils	0.851	0.080	0.184
Fuel Oils	0.076	-	-
Toluene	0.028	-	0.204
Acetone	0.041	-	0.102
Iso Propyl Alcohol	0.008	-	0.102
Styrene	0.006	-	-
Lube Oil	0.0002	-	-
Flux-A	0.001	-	0.102
Flux-B	0.0006	-	0.102

2.4.1.2 Fugitive Emissions Modelling

(1) Dispersion modelling has been conducted in order to estimate VOC concentrations and odour levels at the CRPC site boundary and at sensitive receptors in the area. Dispersion modelling has been used to estimate concentrations at these receptors for 1-hour 'worst-case' conditions. The results of the modelling can then be compared against the BPM ambient air quality limit values in order to indicate within the accuracy of the modelling method, the potential adverse impacts that may arise as a result of fugitive emissions to atmosphere.

(2) Odour is an important consideration with regard to possible nuisance effects. Odour threshold values have been reported [10],[12],[24] for a range of the products which will be handled at the new CRPC Terminal. Due to the subjective nature of odour determination, reported odour threshold values for a given compound often vary

considerably. It is generally accepted that odour nuisance effects are reported when ambient levels are 5-times the odour threshold of a given compound [10]. A summary of typical odour threshold values for certain products handled by CRPC are presented in Table 2.4.1.2.1; concentrations at which these materials may give rise to odour nuisance are also presented in the Table.

TABLE 2.4.1.2.1: ODOUR PROPERTIES OF SELECTED PRODUCTS [10][12],[24]

Product	Odour Threshold Value (mg/m^3)	2 Odour Unit Equivalent(1) (mg/m^3)	Possible Odour Nuisance Value(2) (mg/m^3)
Unleaded petrol	0.7	1.4	3.5
Kerosene	5.4	10.7	27.0
Jet A1	5.4	10.7	27.0
Styrene	0.2	0.4	1.0
Acetone	240	480	1200
Toluene	8.1	16.2	40.5
Iso Propyl	240	480	1200
Alcohol	3.7	7.4	18.5
Diesel			

Note (1): Draft BPM Odour Limit Value = Threshold Value x 2 (An odour unit is the measuring unit of odour level and is analogous to pollutant concentration. In this context, the odour level is defined as the ratio of the volume which the sample would occupy when diluted with air to the odour threshold, to the volume of the sample. In other words, one odour unit is the concentration of the odorant which just induces an odour sensation).

Note (2): Odour Nuisance Value = Threshold Value x 5 for a 5-second average time period.

(3) The odour nuisance criteria with which the CRPC Terminal must comply are therefore as follows:

- Odour level not exceeding 5-times the odour threshold for a 5-second average time period.

- Draft BPM 2-Odour units, to be established by an odour panel, for monitoring purposes.

(4) A number of the products that will be stored/handled at the new Terminal may contain un-eliminated benzene; a summary of the typical benzene content of these products based on information provided by CRPC and chemical product suppliers is shown in Table 2.4.1.2.2.

TABLE 2.4.1.2.2: TYPICAL BENZENE CONTENT FOR CRPC PRODUCTS

Product	Benzene Content (%)
Gasoline (LP/ULP)	< 3.0
Diesel	< 0.1
Fuel Oil	< 2.0
Kerosene	< 0.1
Jet A-1	< 0.1
Styrene Monomer	< 0.1
Toluene	< 0.0005
IPA	< 0.0005
Acetone	< 0.0005

Industrial Source Complex Short Term Model (ISCST2)

(4) Computer modelling of fugitive emissions from the CRPC site has been carried out using the US EPA approved Industrial Source Complex Short-Term Model (ISCST2).

Meteorological Data

(5) For the prediction of 1-hour concentrations the following Pasquill Stability and windspeed combinations have been used to represent stable, neutral and unstable atmospheric conditions:

- Pasquill Stability F, Windspeed $1.0ms^{-1}$
- Pasquill Stability D, Windspeed $5.0ms^{-1}$
- Pasquill Stability B, Windspeed $3.0ms^{-1}$

Receptor Information

(6) The nearest sensitive receptors are considered to be the residential area of Mayfair Gardens and the Technical Institute which are located to the north-northeast of the site boundary.

(7) Receptors have been chosen to allow assessment of potential impacts of fugitive emissions in a general arc from east through to west of the CRPC Terminal site, thereby including the CRPC site boundary and the sensitive receptors. A list of chosen receptors is shown in Table 2.4.1.2.3; the locations of the CRPC site boundary receptors are presented in Figure 2.4.1.1.

TABLE 2.4.1.2.3: RECEPTOR LOCATIONS

Receptor	Location
1	CRPC Site Boundary (west)
2	CRPC Site Boundary (west)
3	CRPC Site Boundary (northwest)
4	CRPC Site Boundary (north)
5	CRPC Site Boundary (north)
6	CRPC Site Boundary (northeast corner)
7	CRPC Site Boundary (northeast)
8	CRPC Site Boundary (north)
9	CRPC Site Boundary (east)
10	Mayfair Gardens
11	Technical Institute
12	Ching Yeung House

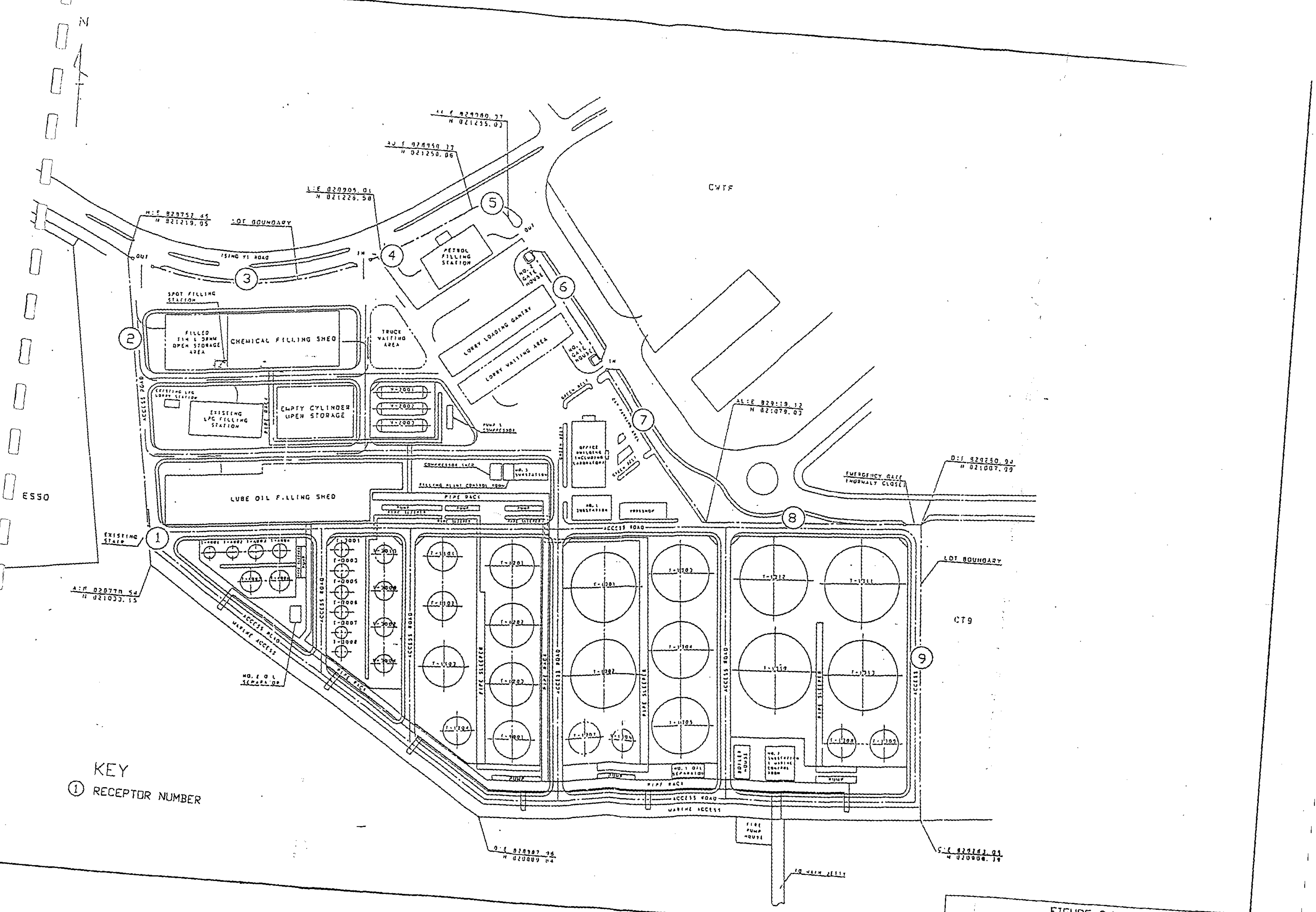
Dispersion Modelling Results

(8) The maximum predicted 1-hour concentrations were found to occur under pasquill stability F, windspeed 1.0ms^{-1}. The maximum predicted 1-hour concentrations at each receptor location for this worst-case meteorological condition are presented in Table 2.4.1.2.4. The predicted concentrations also represent future odour levels for each product considered since odour levels are analogous to pollutant concentration.

TABLE 2.4.1.2.4: PREDICTED 1-HOUR CONCENTRATIONS/ODOUR LEVELS - PASQUILL STABILITY F, WINDSPEED $1MS^{-1}$

Receptor	ULP/LP (μg/m³)	Styrene (μg/m³)	Toluene (μg/m³)	Acetone (μg/m³)	IPA (μg/m³)	Flux-A (μg/m³)	Diesels (μg/m³)	Jet A1 Kerosene (μg/m³)	Fuel Oil (μg/m³)	Lube Oil (μg/m³)	Benzene (Note 1) (μg/m³)	Flux-B (μg/m³)
1	27.2	0.41	23.0	22.5	9.7	10.9	37.8	35.2	0.50	0.04	0.92	9.8
2	28.2	0.33	17.4	15.1	8.6	8.7	37.9	41.4	0.49	0.02	0.95	8.6
3	35.5	0.36	21.5	13.3	10.6	10.6	45.8	37.0	0.56	0.01	1.18	10.6
4	42.3	0.37	25.1	16.6	12.2	12.5	63.4	51.4	0.47	0.02	1.42	12.2
5	35.5	0.27	21.7	16.1	10.5	10.7	93.6	47.2	0.61	0.02	1.24	10.4
6	45.5	0.41	28.3	20.5	13.5	13.7	192.7	38.4	0.70	0.01	1.64	13.2
7	45.0	0.57	41.5	25.7	20.1	19.8	57.2	38.6	0.88	0.02	1.51	19.2
8	28.0	0.51	19.8	15.7	9.5	9.6	38.9	37.8	0.79	0.01	0.95	9.5
9	22.3	0.46	9.8	9.2	4.8	4.4	35.9	33.1	0.72	0.01	0.76	3.8
Ching Yeung House	1.7	0.01	1.0	0.8	0.5	0.5	3.1	2.1	0.10	<0.001	0.06	0.4
Mayfair Gardens	2.9	0.04	1.5	1.0	0.7	0.7	7.0	4.7	0.08	<0.001	0.10	0.6
Technical Institute	3.7	0.05	1.8	1.2	0.7	0.9	7.8	5.8	0.07	<0.001	0.13	0.8

Note 1: Benzene concentrations have been estimated based on the typical benzene content of individual products



KEY

① RECEPTOR NUMBER

FIGURE 2.4.1.1
LOCATION OF CRPC SITE BOUNDARY RECEPTORS

2.4.2 Road Traffic Emissions

(1) The development of the new CRPC Terminal will result in an increase in road traffic on the Tsing Yi road network; although when compared to the additional traffic which will arise in this area as a result of the CT9 development the significance of the increased number of vehicle movements associated with the CRPC development is small.

(2) The SETY study produced traffic forecasts for 1996 and 2001; a recent study to assess the traffic implications associated with the CRPC Terminal development [13] has revised the traffic forecasts for SETY to account of a predicted reduction in container lorry parking trips due to a reduction in available parking space (the CRPC site includes part of the area originally designated for lorry parking). The forecast increase in road traffic at the new CRPC site will therefore be partly offset by a decrease in the number of lorry parking trips.

(3) Motor vehicle exhausts contain a wide range of compounds, principally nitrogen, water vapour and carbon dioxide which are not usually considered to be pollutants (although CO_2 is a greenhouse gas). Other constituents which cause more concern are:

- nitrogen oxides (NO_x)
- carbon monoxide (CO)
- hydrocarbons (HC)
- particulates.

(4) The potential air quality impact in the vicinity of the sensitive receptors (Technical College, Mayfair Gardens etc) due to vehicular emissions arising as a result of the significant development projects and associated infrastructure planned for southeast Tsing Yi has been previously assessed by the environmental impact assessment for the CT9 project [3]. This study therefore assesses traffic emissions in a qualitative manner based on the findings of the CT9 assessment.

2.4.3 Packaged Boilers

(1) The new Terminal utility facilities will include two packaged boilers for generating steam; steam is primarily required for heating purposes to compensate for the heat loss from tanks and lines and to heat up HSFO-380 during loading operations using the suction heaters [14]. Since steam consumption will demonstrate a considerable seasonal fluctuation, it is proposed to provide two packaged boilers. The two boilers will be operated in parallel during winter to meet the peak winter load. As a provision for the statutory maintenance requirement, each boiler will be of sufficient capacity to meet the summer peak load (one boiler can then be taken out of service during the summer for routine maintenance).

(2) The boilers will be fired on boiler diesel oil (BDO) and will exhaust products of combustion to atmosphere. Emissions will principally comprise oxides of carbon (CO_2 and CO) and nitrogen (NO_X); other emissions will include unburnt hydrocarbons (UHCs), particulate material and sulphur oxides (SO_X); emissions of SO_X will be dependent on the sulphur content of the fuel which is restricted by Hong Kong legislation (0.5% sulphur w/w). Potential gaseous emissions from the boilers during winter operations have been

provided by the design contractor; the estimated emission rates for NO_X, SO_2 and particulates are presented in Table 2.4.3.1.

TABLE 2.4.3.1: EMISSIONS FROM THE PACKAGED BOILERS

Parameter	Emission (g/s)
Particulates	0.39
Sulphur dioxide (SO_2)*	5.25
Nitrogen oxides (NO_X)	3.14

Note * Assuming all sulphur oxides emissions as sulphur dioxide.

Dispersion Modelling

(3) Dispersion modelling has been carried out using the SCREEN dispersion model (see Appendix I) to estimate future maximum 1-hour ground level and elevated receptor (Mayfair Gardens) pollutant concentrations arising as a result of emissions from the packaged boilers for comparison with the Hong Kong AQOs.

(4) The emission conditions for the combustion products from the boiler stack, based on data provided by the design contractor are presented in Table 2.4.3.2.

TABLE 2.4.3.2: PACKAGED BOILERS EMISSION CONDITIONS

Parameter	Value
Stack internal diameter (m)	1.1
Stack height (m)	25.0
Flue gas exit velocity (m/s)	14.7
Flue gas exit temperature (k)	553.0

Meteorological Data

(5) The SCREEN model has been run using the "full meteorology" option to identify the 'worst-case' meteorological conditions resulting in maximum pollutant concentrations. Downwind pollutant concentrations have been predicted in the direction of the sensitive receptors (Mayfair Gardens) to the north of the boiler stack location.

Dispersion Modelling Results

(6) The maximum predicted ground level concentrations and the maximum predicted concentrations for elevated receptors at Mayfair Gardens are shown in Table 2.4.3.3.

TABLE 2.4.3.3: MAXIMUM PREDICTED 1-HOUR POLLUTANT CONCENTRATIONS, PASQUILL STABILITY E, WINDSPEED 1.0 MS^{-1}

Pollutant	Elevated Receptor Concentration ($\mu g/m^3$)(1)	Ground Level Concentration ($\mu g/m^3$)
NO_X	41.0	44.7
SO_2	68.5	74.8
Particulates	5.1	5.6

2.4.4 Air Quality Impact

2.4.4.1 VOCs

(1) Maximum ground level VOC concentrations are predicted to occur under Pasquill Stability category F, windspeed $1ms^{-1}$ at the northeastern site boundary adjacent to the road tanker loading gantry. Estimated benzene concentrations have been derived in order to allow a comparison with the BPM ambient benzene limit value of $185\mu g/m^3$ (see Table 2.4.1.2.4).

(2) The results of the fugitive VOC assessment indicate that future ambient benzene concentrations as a result of emissions from the sources that have been considered are unlikely to exceed the BPM required limit value $185\mu g/m^3$. However, these results consider VOC emissions from only three sources (pump operation, road tanker filling and storage tank evaporative losses) and do not include potential emission from operation of the chemical filling facility, lube oil blending, LPG handling and marine loading/unloading operations). On this basis, subject to finalisation of the BPM requirements, regular monitoring at the site boundary should be undertaken to demonstrate that benzene levels at and beyond the boundary of the CRPC Terminal are within acceptable limits. Exceedance of the BPM ambient benzene limit value during operation of the CRPC Terminal is not anticipated.

(3) Although no specific monitoring data on background VOC concentrations in this area is available, it should be noted that other existing VOC sources in the area include the Esso Oil Depot and CWTF in combination with UHC emissions from motor vehicles on the surrounding roads.

(4) Significant variations in VOC concentrations with height above ground level at the sensitive receptors are not anticipated primarily due to the relatively wide distribution of sources at the Terminal; as a result of the wide distribution of the sources it is likely that the distribution of downwind VOC concentrations within the central region of the plume will be relatively uniform. The ISCST2 dispersion modelling results indicate that maximum VOC concentrations at Mayfair Gardens and Ching Yeung House will occur at ground level; predicted maximum 1-hour concentrations at a height of 20m above ground level for these locations are estimated to be approximately 4% lower than those predicted at ground level.

Odour Nuisance

(5) In order to compare predicted odour levels with odour nuisance criteria, maximum predicted 1-hour concentrations for each product (see Table 2.4.1.2.4) have been multiplied by a factor of 16 to allow for an approximate conversion to 5-second average odour levels [10],[43]. Table 2.4.4.1.2 presents a comparison between the maximum predicted boundary odour level (5-second average) and the odour nuisance value (see Table 2.4.1.2.1) for each of the products for which suitable odour threshold data is available.

TABLE 2.4.4.1.2: MAXIMUM SITE BOUNDARY ODOUR LEVELS

Compound	Maximum Predicted Odour Levels (5-Second Average) (mg/m^3)	Odour Nuisance Value (mg/m^3)
LP/ULP	0.73	3.5
Kerosene/Jet A1	0.82	27.0
Styrene	0.01	1.0
Acetone	0.41	1200
Toluene	0.66	40.5
IPA	0.32	1200
Diesel	3.08	18.5

(6) On the basis of the modelling methodology and assumptions that have been made, these results indicate that fugitive emissions from product storage and handling activities at the new CRPC Terminal under worst case meteorological conditions are unlikely to result in an exceedance of the odour nuisance criteria.

(7) The predicted odour levels at the sensitive receptors are considered insignificant; the maximum predicted values at the Technical College (nearest sensitive receptor) for each product (for which suitable odour threshold data was available) are considerably below the reported odour threshold values and odour nuisance values for these compounds.

(8) Significant land use implications as a result of the residual impacts on air quality (increases in ambient pollutant/odour levels) in the vicinity of the new CRPC Terminal are not expected. This region of Tsing Yi Island has been designated for industrial developments and as such both the existing and possible future industrial developments in the surrounding area are considered to be compatible with the proposed CRPC Terminal development.

2.4.4.2 Road Traffic

(1) Vehicular emissions modelling conducted for the environmental impact assessment for the CT9 project [3] found that maximum predicted 1-hour pollutant concentrations were within the AQOs. A summary of the maximum predicted 1-hour pollutant concentrations for 1996 SETY traffic flows is provided in Table 2.4.4.2.1.

TABLE 2.4.4.2.1: MAXIMUM PREDICTED 1-HOUR NO_2, CO AND TSP CONCENTRATIONS FOR 1996 TRAFFIC FLOWS [3]

Location	$\mu g/m^3$		
	NO_2	CO	TSP
Mayfair Gardens (south)	84	441	35.2
Mayfair Gardens (north)	96	501	39.0
Ching Yueng House	128	643	49.8
Building (adjacent to Ching Yeung House)	142	745	56.7
Ching Tao House	190	946	71.6
Ching Pak House	80	258	34.1
School (Cheung Ching Estate)	92	290	32.9

(2) The anticipated increase in total traffic flow in the vicinity of the sensitive receptors due to the CRPC Terminal development is less than 10% of the total traffic flow during the AM peak due solely to CRPC traffic. Significant additional deterioration in ambient air quality at sensitive receptors above that predicted for the CT9 development as a whole is therefore not anticipated. Significant impact on local air quality as a direct result of the CRPC Terminal development is considered to be unlikely.

2.4.4.3 Packaged Boiler

(1) The modelling results indicate that during dual boiler operations (two boilers operating in parallel during winter period) maximum 1-hour ground level pollutant concentrations in the direction of the sensitive receptors will occur under Pasquill Stability E, windspeed $1.0ms^{-1}$ at a distance of 1000 metres from the stack The maximum predicted ground level NO_X concentration of $44.7\mu g/m^3$ represents 15% of the AQO one hour value for NO_2 of $300\mu g/m^3$, assuming all NO_x emitted from the boiler is in the form of NO_2; in practice, only about 20% of emitted NO_X will be in the form of NO_2, representing an even lower additional contribution (less than 3% of the one hour guideline).

(2) Addition of the maximum predicted ground level pollutant concentration to the existing background pollutant concentrations in an area enables a prediction of future pollutant levels to be made. NO_2 background concentrations in the southeast Tsing Yi area are assumed to be $77.4\mu g/m^3$ (see Section 2.3), therefore following the commissioning of the new facilities the maximum predicted ground level NO_2 concentration under worst-case meterological conditions would be approximately $86\mu g/m^3$ (assuming 20% of NO_x emitted as NO_2). This future increase in ground level nitrogen dioxide concentrations is considered relatively insignificant.

(3) The maximum predicted ground level SO_2 concentrations of $75.3\mu g/m^3$ represents less than 10% of the AQO one hour value for SO_2 of $800\mu g/m^3$.

(4) The maximum predicted ground level particulate concentration of $5.6\mu g/m^3$ does not represent a significant increase in future ambient particulate levels.

(5) Elevated receptors at Mayfair Gardens and Ching Yeung House are not anticipated to experience pollutant levels exceeding ambient AQO limits.

(6) Overall, potential increases in future pollutant concentrations as a result of boiler operations at the new CRPC Terminal are unlikely to result in significant impacts on Tsing Yi local air quality.

2.5 Mitigation and Monitoring

2.5.1 Fugitive Emissions Control

(1) Fugitive emissions control during volatile organic liquid (VOL) storage and handling can be achieved by both operational procedures and hardware techniques.

(2) There are two types of emission control programmes which may be used for equipment leaks. These are inspection and maintenance (I&M) programmes and equipment modification and/or substitution. Typically a combination of these two types of control programme will achieve the most cost-effective control.

(3) The following sections provide a broad overview of some of the procedures for minimising fugitive emissions.

<u>Inspection and Maintenance Programmes</u>

(4) Inspection and maintenance (I&M) programmes, as recommended by the US EPA, involve the detection of leaking sources using a screening survey. A portable hydrocarbon analyzer may be used to measure concentrations around components to determine which are leaking.

(5) The key parameters to be specified when designing an I&M programme are:

- source types subject to I&M
- screening value level which triggers a repair attempt
- frequency of inspection
- level of record-keeping.

(6) The source types which are most suited to I&M programmes are valves, flanges and other connections. Valves are the source type most frequently handled in this manner, since they tend to leak frequently, contribute a substantial proportion of the fugitive emissions and can generally be easily repaired on line by adjustment of packing gland tightness. Flanges and connections are also suited to simple on line maintenance but have a much lower leak frequency.

(7) Screening is a quick semi-quantitative measurement of ambient concentration near the point of suspected leakage on suspected sources. Portable hydrocarbon analyzers are used to measure the concentration at the leak interface, such as around the perimeter of the valve stem. The screening value level at which a repair is initiated is known as the 'leak definition'. Any source registering at or above this level must be repaired if practical. Many such programmes use a level of 10,000 ppm of hydrocarbon as the leak definition, which results in maintenance on a relatively small number of sources and a potential decrease in the estimated emission factor of between 60% and 80%.

(8) The type of repair, the allowed time interval and the policy on sources which may not be repaired on line define the repair programme. Simple tightening is usually the first attempt at repair for valves, flanges and connections and is done when the leak is first detected. This will be effective for many sources. However care must be taken not to over-tighten the fitting which could lead to deformation of the packing/gasket and actually increase leakage. If tightening is unsuccessful, the packing or gasket may need to be replaced.

(9) An I&M programme which maintains a semi-permanent record for each source, including the precise screening value in ppm and repair history, is recommended. The screening value data will enable more accurate estimates of the total emission rates to be made. The repair history data will allow the identification of problem services and components and so enable cost-effective replacement by intrinsically non-leaking or low-leaking equipment.

Equipment Modification or Substitution

(10) Some source types can be more effectively dealt with by equipment modifications or by substitution of an intrinsically non-leaking or low-leaking design. The source categories which are more amenable to this type of control include open-ended lines, compressor seals, pressure relief valves and some pump seals.

(11) The leakage from open-ended lines may be virtually eliminated by equipping them with caps or plugs. These caps and plugs should be in place at all times except when being used as a drain or vent.

(12) Compressor seals virtually always leak. The best approach to controlling the resulting emissions is to enclose the area between the compressor body and the discharge piece and vent to a control device.

(13) There may be more sophisticated options for the control of pump emissions (e.g. use of canned pumps, magnetic drive pumps) but these options are limited in terms of capacity, temperature and pressure and cost significantly more than conventional pumps. The primary options for the control of pump emissions are the substitution with an intrinsically non-leaking type of pump.

Combustion Plant

(14) Emissions of smoke from the operation of combustion plant such as the packaged boilers for steam generation can be controlled by adhering to correct operating procedures and conducting regular routine maintenance; this should ensure efficient fuel atomization/ combustion and limit the build-up of carbon in the combustion chamber which can lead to the formation of dark smoke.

2.5.2 Recommended Control Measures

2.5.2.1 Fugitive Emissions

(1) The requirement for mitigation measures to be incorporated in to the design of the CRPC Terminal to minimise/prevent fugitive emissions from the new Terminal will depend on the finalised requirements for handling/storage of organic chemicals in accordance with BPM.

(2) The proposed schedule for the implementation of BPM is as follows:

- February 1993 - Legislation Enacted
- August 1994 - Target Date for New Installations
- August 1996 - Target Date for Existing Installations to Comply with BPM Requirements

(3) At the time of writing, BPM requirements are in draft form (3rd draft) and may be subject to further revision; a copy of the draft BPM requirements is provided in Appendix VI. Specific requirements will be incorporated into the design for the new Terminal following issue of the finalised BPM.

(4) The meaning of organic chemicals or organic liquids referred to herewith is as defined under the draft BPM:

- Any organic liquid, including liquid fuel, having a flash point below 23°C;

- Any other liquid which is artificially heated above its flash point for transfer, handling and storage.

(5) The following sections therefore outline the draft BPM requirements (Appendix VI) for the transfer, storage and handling of organic chemicals/liquids, some of which have already been incorporated into the Terminal design and others which may in the future also be incorporated.

Transfer and Handling

i) During road tanker filling with organic liquids from storage tanks, the vented organic vapour should be vented to vapour control system before discharge to the atmosphere. To satisfy this requirement, the use of the technology of "Bottom Loading" is recommended (these requirements have already been incorporated into the CRPC Terminal design).

ii) Adequate means such as high level detector, liquid shut-off device and other appropriate devices should be provided to avoid spills during filling road tanker with organic liquids.

iii) At the locations where fugitive emission of organic vapour may occur (such as filling the drums with organic liquids), adequate local exhaust should be provided to extract and vent the emissions to a suitable vapour control system.

iv) Suitable seals should be provided in transfer pumps, valves and couplers to avoid leakages during transferring and handling organic liquids.

Storage

v) Storage tanks should be installed according to the requirements under the Building (Oil Storage Installations) Regulations wherever the Regulations apply (these requirements have already been incorporated into the CRPC Terminal design).

vi) Any storage tank greater than 1,000 m^3 capacity should be equipped with floating roof (as per Code of Practice for Oil Storage Installations 1992), unless the storage tank is not required under the Building (Oil Storage Installations) Regulations to install the floating roof.

vii) Any storage tank with capacity greater than 100 m^3 but less than or equal to 1,000 m^3 should be equipped with either:

- Floating roof (as per Code of Practice for Oil Storage Installations 1992)), or
- Vapour control system

to minimize vapour loss.

Vapour Control System

viii) Vapour control systems should be capable of processing the organic vapour vented to the vapour control system so as to prevent the vapour emission to the atmosphere at an efficiency of at least 95% by weight.

ix) For the vapour control system provided for drum filling areas etc (see iii above) where the emissions may be diluted with extraction air, the vapour control system should be designed to aim at removing the organic vapour of the gas vented to the vapour control system by at least 95% efficiency when the concentration of the organic vapour of the vented gas is more than 1000 ppm (v/v).

x) Wherever practicable, the vapour control systems mentioned above should be designed to recover the removed vapours and transfer them back to the plant system for subsequent use [This requirement may be deleted from the next draft BPM].

Prevention of Leakage

xi) Good engineering design must be ensured and all practicable steps should be taken to prevent the leakage of organic liquid or vapour from the process/system. If leakage occurs, suitable mitigation measures as well as operation procedures should be enforced to minimize any resultant air pollutant emission as for as practicable. Without prejudice to the generality of the above requirements, the following measures should be implemented as minimum requirements:

- The plant should be designed, constructed and operated in a manner that there will be no leakage of organic liquid or vapour during normal plant operation.

- The plant operator should implement a suitable monitoring programme and procedure for detection and prevention of leakage. If any leakage is detected, repair should be done as soon as possible.

- Pressure relief valve (excluding P/V vents) which may release organic vapour into the atmosphere should be vigorously checked for any residual leakage after each pressure release.

Sampling and Maintenance

xii) Good plant design and operation procedure should be used to minimize the purge or release of any organic liquid or vapour from the process/system during:

- Sampling of the organic liquid, and
- Maintenance/repair/inspection of the plant.

2.5.2.2 Packaged Boiler

i) Conduct regular and routine maintenance.

ii) Follow manufacturers' recommended start-up and shut-down procedures. If during start-up, ignition failure occurs at the second attempt and the control system initiates lock-out, the system should be inspected prior to attempting re-start.

iii) Shut-down operations for maintenance should be performed in accordance with the boiler operation manual. The operation manual will specify the correct shut-down procedures to be used in order to prevent the build-up of carbon on the burner (carbon build-up reduces fuel atomization efficiency).

iv) During maintenance, furnace tubes and walls should be checked for carbon build-up. If carbon build-up persists in one area, burner alignment should be checked; any accumulations of soot and dust should be removed.

2.5.2.3 Environmental Management

(1) A focal point for environmental affairs should be established within the CRPC management structure. This individual should be responsible for ensuring that all inspection/monitoring programmes are conducted in accordance with BPM requirements and compiling monthly monitoring summary reports for submission to EPD. Any malfunction in air pollution control equipment/systems likely to give rise to breaches of the BPM air pollution control requirements should be reported to EPD within 3 working days.

2.5.3 VOC Emissions Monitoring

(1) Emissions monitoring programmes will be required during the operation of the CRPC Terminal. Compliance monitoring will be required in order to demonstrate compliance with environmental quality (BPM) limit values; it should be noted that the benzene limit value of $185\mu g/m^3$ (1-hour average) and odour limit value (2 odour units) specified under the draft BPM requirements may be subject to change when the BPM requirements are finalised.

(2) Inspection and maintenance monitoring will be required to demonstrate compliance with BPM inspection requirements in order to identify fugitive emission sources. An outline specification for an I&M monitoring programme is provided in the following sections.

2.5.3.1 Inspection & Maintenance (I&M) Monitoring Programme

(1) I&M monitoring should be carried out by visual inspection and the use of a portable hydrocarbon detector.

(2) **Pumps** should be visually inspected on a daily basis to identify any liquid releases from the pump seal and monitored weekly by portable hydrocarbon detection instrument. A leak is detected if liquid is dripping from the pump seal or the instrument reading indicates 10,000 ppm or more total hydrocarbon (in accordance with Method 21 USEPA Pt 60, App. A).

(3) **Pressure Relief Devices (PRV)**: During normal operation emissions from PRVs should be less than 500 ppm total hydrocarbon. These devices should be monitored with a portable instrument to ensure emissions do not exceed 500 ppm.

(4) **Valves** should be monitored on a monthly basis; a leak is detected if an instrument reading indicates 10,000 ppm or more total hydrocarbon (in accordance with Method 21 USEPA Pt 60, App. A). If no leak is detected for two consecutive monthly inspections then the monitoring frequency for this valve should be reduced to once every three months. If a leak is detected then the valve should be monitored monthly until no leak is detected for two consecutive months.

(5) **Closed Vent Systems** should be monitored on a weekly basis to ensure that emissions do not exceed 500 ppm total hydrocarbon above background.

2.5.3.2 Compliance Monitoring

(1) **Ambient Monitoring:** The new CRPC Terminal operations will need to comply with the BPM requirements for the storage of organic chemicals once they are finalised. Although subject to finalisation, it is likely that monitoring of ambient concentrations will be required in order to demonstrate that CRPC Terminal operations are in accord with BPM. The ambient concentrations of the following should be measured on a regular basis at the plant boundary or any other location as agreed with EPD:

- Benzene
- Any other organic vapours which may be emitted from the process in a significant amount

(2) **Inventory and Operational Parameters.** Records should be maintained for monthly plant throughput of different organic liquids and essential operating parameters which may affect emissions of air pollutants (eg vapour control system operating conditions). Such information will provide a means of quantifying product losses (product losses during storage and transfer will reflect approximately the emission that has occurred to atmosphere).

Monitoring Procedure

(3) Prior to any monitoring programme being undertaken all monitoring equipment should be serviced, calibrated and certified by an accredited laboratory. Equipment should be operated in accordance with the manufacturers instructions and all test/checks recommended by the manufacturer should be carried out. During monitoring activities, wind direction, windspeed and ambient temperature should be measured and recorded.

Boundary Monitoring Locations

(4) The number and location of monitoring stations at the site boundary should be agreed with EPD. Monitoring locations should be chosen so as to provide valid and representative results. To achieve this objective consideration should be given to the proximity of other off-site VOC sources; the Esso Oil Depot to the west of the site, TCVT to the north/northwest and the CWTF to the east/northeast; VOC emissions from these sources may contribute to measured levels at the CRPC boundary. Motor vehicles emit VOCs in exhaust emissions; traffic on Tsing Yi Road will also contribute to measured VOC levels. Tentative monitoring locations are shown in Figure 2.5.3.1.

Monitoring Frequency

(5) The sampling frequency for the boundary monitoring programme will be determined by EPD. However as a general guideline, it is recommended that monitoring at the site boundary is conducted on a monthly basis.

Commissioning

(6) Commissioning trials (to be witnessed by EPD where appropriate) should be conducted to demonstrate the performance/capability of air pollution control measures. A report of commissioning trials should be submitted to EPD after completion of the trials.

2.6 Conclusions

(1) This assessment has identified the principal sources of emissions to atmosphere during operation of the new CRPC Terminal. Operation of the CRPC Terminal will result in increases in ambient pollutant/odour levels in the southeast Tsing Yi Island area although significant deteriorations in local air quality are not anticipated.

(2) Emissions of combustion products from the packaged boiler are unlikely to result in significant impact on air quality and exceedance of AQOs.

(3) Emissions of VOCs from product storage and handling are unlikely to result in an exceedance of the draft BPM ambient benzene limit or odour nuisance criteria at or beyond the site boundary under worst case meteorological conditions.

(4) Significant land use implications as a result of the residual impacts on air quality (increases in ambient pollutant/odour levels) in the vicinity of the new CRPC Terminal are not expected. This region of Tsing Yi Island has been designated for industrial developments and as such both the existing and possible future industrial developments in the surrounding area are considered to be compatible with the proposed CRPC Terminal development.

(5) Both hardware and operational management and monitoring techniques are available for mitigating fugitive VOC emissions and it is recommended that these are incorporated into the design and operational procedure for the new Terminal subject to the finalisation of BPM requirements for organic chemical works; this will to a large extent define the required level of fugitive loss minimisation that is required. From an environmental perspective all emissions of VOC to atmosphere should be minimised/prevented wherever possible.

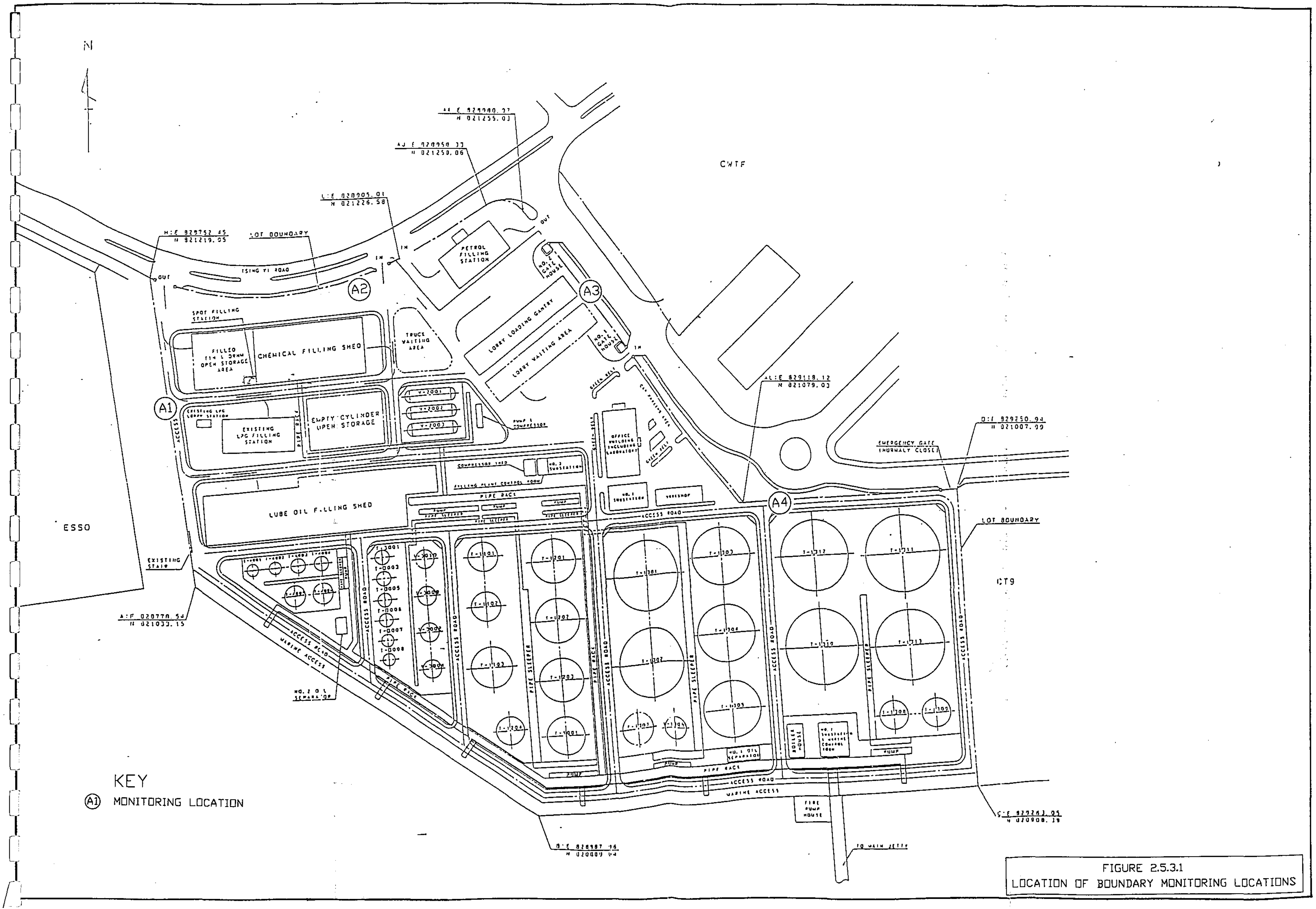


FIGURE 2.5.3.1
LOCATION OF BOUNDARY MONITORING LOCATIONS

3.0 WATER QUALITY IMPACTS

General

(1) Potential adverse impacts on marine water quality during Terminal operations may arise as a result of effluent discharges; leaks and spillages from the storage/loading facilities and during marine transfer operations. The impacts of the CRPC Terminal development on water quality will be discussed based on the assumption that the neighbouring Container Terminal 9 will be developed.

3.1 Legislation/Criteria

(1) The Water Pollution Control Ordinance (Chap. 358, 1980) [15] empowers the government to set up water control zones in which regulations control effluent discharges. Water Quality Objectives (WQOs) are declared for each Water Control Zone on the basis of beneficial uses of the water bodies. The WQOs form the basis for defining the licence conditions under which effluent discharges are permitted. Sections 45 and 46 of the Shipping and Port Control Ordinance (Cap 313) stipulates that ships are prohibited from discharging oil or a mixture containing oil into the waters of Hong Kong. The CRPC Terminal site is located within the Western Buffer Water Control Zone whose Water Quality Objectives were gazetted in June 1993 (Table 3.1.1).

TABLE 3.1.1: WATER QUALITY OBJECTIVES FOR WESTERN BUFFER WATER CONTROL ZONE BASED ON GENERAL USE

Parameter	Limit value
Dissolved Oxygen (mg/l)	> 4(1)
pH	6-5 to 8.5
Temperature (°C)	daily change < ± 2
Salinity (ppt)	± 10% ambient
Suspended Solids (mg/l)	30% above ambient
Ammonia-N (unionized)(mg/l)	< 0.021
Inorganic-N (mg/l)	0.4
Toxic Substances	No significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or other aquatic organisms

(1): For 90% of the sampling occasions during the whole year: values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above the seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg/l within 2m of the seabed for 90% of the sampling occasions during the whole year.

(2) The Water Pollution Control (Amendment), 1990 incorporated a Technical Memorandum on 'Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters' [16] which acts as a guide to the setting of the standards required for inclusion in licences with which the discharge must comply. The Standards are set based on the effluent flow rate as shown in Appendix II. A licence under the Water Pollution Control Ordinance (WPCO) (Cap. 358) will be required for the effluent from this proposed oil storage installation.

(3) The design, construction and operation of the proposed CRPC Terminal must comply with the Code of Practice for Oil Storage Installations, 1992 [17] established under the Building (Oil Storage Installations) Regulations. Apart from specific structural requirements for the tanks and bunds themselves, structural design and construction is subject to the Building (Construction) Regulations. In view of the latest requirements of the regulatory authorities in Hong Kong, 'Best Practicable Means' should also be utilised for the operation of this proposed Terminal.

3.2 Baseline Conditions

(1) EPD conducts regular water quality monitoring programmes at selected stations in the Western Buffer Zone; details of baseline water quality monitoring conducted by EPD are given in Reference 18. A summary of water quality in the Western Buffer Water Control Zone is presented in Table 3.2.1

TABLE 3.2.1: WATER QUALITY MONITORING DATA FOR STATION WM3 FOR 1992 and 1993 (Source: EPD)

Parameter	Value
Faecal Coliform (No/100ml)	213-440
E. Coli (No/100ml)	163-373
BOD^5 (mg/l)	0.2-0.6
Conductivity (umhos/cm)	428.6-441.9
Dissolved Oxygen (mg/l)	6.6-9.2
Dissolved Oxygen % Saturation	74.5-121.4
pH	8.0-8.2
Salinity (ppt)	32.3-33.3
Temperature (°C)	17.2-19.5
Turbidity (ntu)	5.2-24.0
Ammoniacal Nitrogen (mg/l)	0.049-0.467
Nitrite Nitrogen (mg/l)	0.013-0.078
Nitrate Nitrogen (mg/l)	0.045-0.234
Ortho-phosphate (mg/l)	0.013-0.058
Chlorophyll-a (mg/m^3)	0.2-1.1

3.3 Assessment Methodology

3.3.1 Sewer and Drainage Systems

(1) The principal effluent streams that will arise from operation of the new CRPC Terminal are as follows:

- Sewage and waste water
- Rainfall run-off
- Firewater run-off
- Tank/drum cleaning
- Tank draining

(2) The proposed sewer and drainage system for the CRPC Terminal (Figures 3.3.1.1 - 2) has been designed to segregate contaminated and non-contaminated effluents; independent drainage systems will be provided for the following effluent categories:

- Non-contaminated effluent system
- Oil contaminated effluent system
- Chemically contaminated effluent system
- Sewage/domestic wastewater system

3.3.1.1 Non-Contaminated Effluent

(1) Rainfall surface run-off from general site areas of the Terminal; open yard, office area and road ways which are unlikely to be contaminated by hydrocarbons/chemicals will be collected and discharged to the sea without treatment.

3.3.1.2 Oil Contaminated Effluent

(1) Areas of the site which may potentially be contaminated with petroleum products (diesel oils, fuel oils etc) will be isolated by means of bunds or concrete containment walls. Effluents from these areas of the Terminal will be discharged to corrugated plate interceptor (CPI) units prior to discharge to sea. The discharge points for the treated effluent from the CPI units are shown in Figure 3.3.1.2.1. Potentially oil contaminated effluent will arise from the following areas [19]:

Isolated areas with roof: White and black oil lorry loading gantry, lube oil warehouse, lube oil blending and filling area, utility area, LPG compressor shed and workshop.

Isolated areas without roof: Tank farms for black and white oils (T-4001 to T-4006, T1101 to T-1103, T-1201 to T-1204, T-1301 to T-1306, T-1308 to T-1313); pump stations (black and white oils); jetty heads (black and white oils); drum storage area.

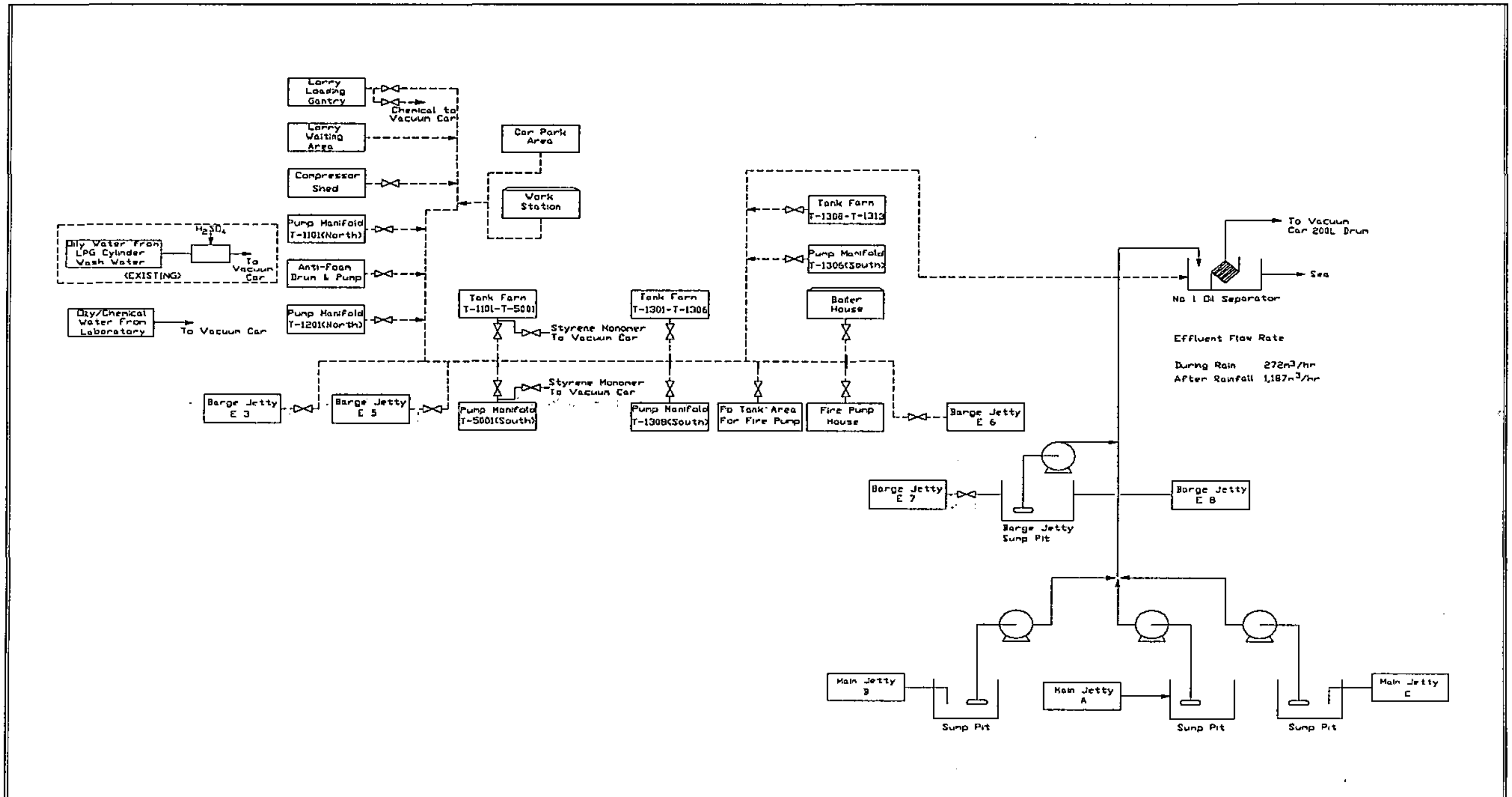


FIGURE 3.3.1.1 PROCESS FLOW DIAGRAM FOR CPI NO.1

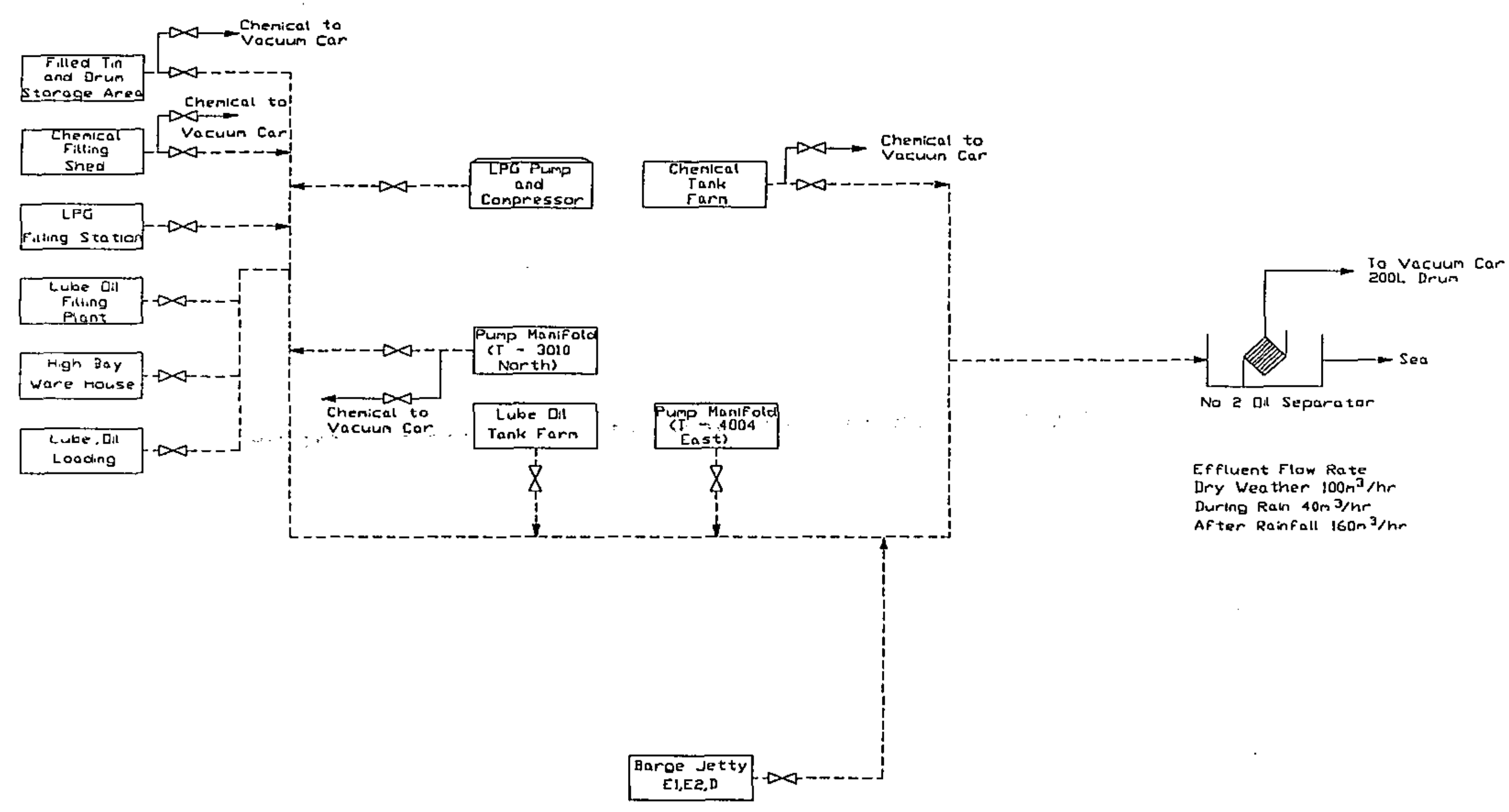


FIGURE 3.3.1.2 PROCESS FLOW DIAGRAM FOR CPI NO.2

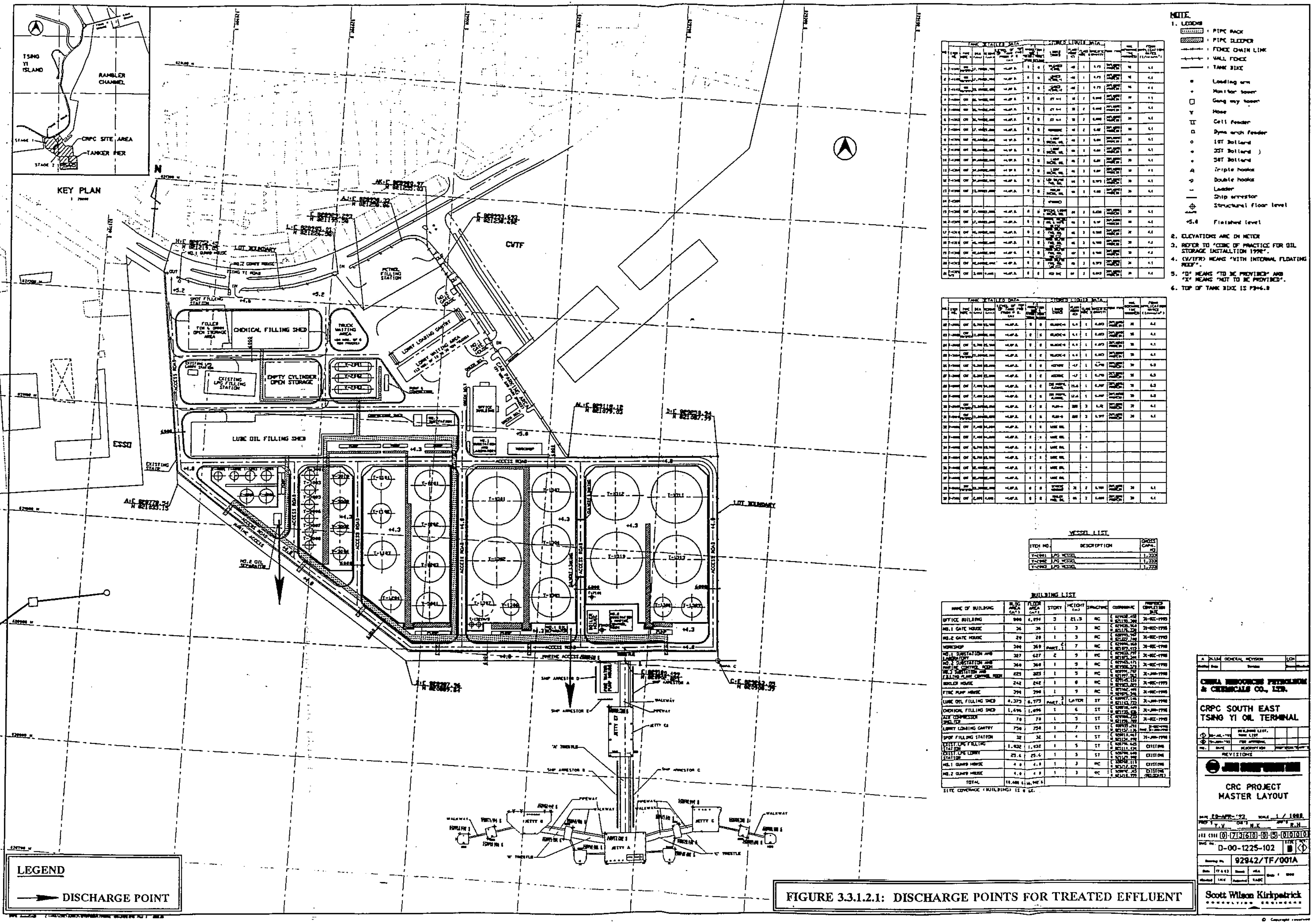


FIGURE 3.3.1.2.1: DISCHARGE POINTS FOR TREATED EFFLUENT

Isolated Areas with Roof

(2) Effluent from the lorry loading gantries (white and black oils), lube oil warehouse, lube oil blending and filling area, utility area, LPG compressor shed and workshop will be contained and discharged to a corrugated plate interceptor.

Isolated Areas without Roof

(3) Effluent from the tank farm (white and black oils), pump stations, outside drum storage yard, jetty heads will be isolated and contained using either bunds or spill walls.

(4) The tank storage areas for petroleum products (diesel oils, low and high sulphur fuel oils, lube oil etc) will be enclosed by a bunds with sufficient capacity to contain the inventory of the largest tank. The floors within the bunded areas will be constructed from reinforced concrete to prevent the permeation of any contaminants into the ground. Bundwall drain valves will be nominally maintained in a closed position to prevent an uncontrolled release in the event of a tank leakage or rupture. Rainfall run-off from the bunded areas of the tank farm will be stored for a period of approximately 24 hours inside the bunded area. Accumulated rainwater will then be discharged at a controlled rate to the CPIs over the following 12 hour period.

(5) Oil contaminated effluent arising from the main and barge jetties will be discharged to an oily water collection sump from where accumulated effluent will be pumped to a CPI unit.

(6) During normal operations the drainage valves in areas enclosed by isolating spill walls (pump stations, drum storage area) will be nominally in a closed position. During rainfall the valves will be opened to allow the discharge of run-off to the CPIs.

3.3.1.3 Chemically Contaminated Effluent

(1) Certain products that will be stored/handled at the new CRPC Terminal are miscible with water (acetone and isopropyl alcohol) and will therefore not be effectively separated from water by a CPI.

(2) In view of the above, the drainage system for areas that may potentially be contaminated by petrochemical products will be designed such that effluents from these areas will not be discharged to sea but will be contained within the Terminal. The design of the areas which may be contaminated with miscible chemicals is based on the principle of localization and isolation from the other Terminal drainage systems; this will be achieved by bunds and spill walls. Chemically contaminated water will be contained in the bunded or spill wall areas and then discharged to the CPI separators or the dedicated Waste Water Treatment System (referred to hereafter as WWT) in accordance to the degree of contamination. In the event of a miscible chemical spillage, an attempt will be made to fully recover and reuse the chemical. However, if the spillage cannot be reused, it will then be pumped into drums or tankers and transferred to the dedicated Waste Water Treatment (WWT) Plant for treatment. Effluents potentially contaminated by petrochemicals will arise from the following areas [19]:

Isolated areas with roof: Chemical filling shed, lorry loading gantry (petrochemicals).

Isolated areas without roof: Tank farm for chemicals (T3001 to T-3010); pump stations (petrochemicals); jetty heads and chemical drum/tin storage area.

Isolated Areas with Roof

(3) Effluent from the chemical filling shed and the lorry loading gantry may be contaminated by miscible petrochemicals. Effluent contaminated with petrochemicals from these areas will only be discharged to the WWT. If the effluent from these areas is heavily contaminated with chemicals, then it will be loaded onto lorries by means of a portable pump for further treatment by the WWT.

Isolated Areas without Roof

(4) Effluent streams potentially contaminated with miscible petrochemicals will arise from rainwater run-off from the petrochemical tank storage areas, pump station, main jetty heads and outside chemical drum/tin storage yards. Surface run-off from these areas will be isolated and contained by means of bunds and spill walls.

(5) The tank storage areas for miscible petrochemical products (acetone, isopropyl alcohol) will be enclosed by a bund with sufficient capacity to contain the inventory of the maximum spillage from the largest tank. The floors within the bunded areas will be constructed of reinforced concrete to prevent the permeation of any contaminants into the ground. Bundwall drain valves will be nominally maintained in a closed position to prevent the an uncontrolled release in the event of a tank leakage or rupture. Rainfall run-off from the bunded areas of the tank farm will be stored for a period of approximately 24 hours inside the bunded area. During this period samples of the accumulated rainwater will be taken and analyzed for contamination; if contamination levels are within discharge limits, accumulated rainwater will then be discharged at a controlled rate to the CPIs over the following 12 hour period. If laboratory tests indicate that accumulated rainfall is chemically contaminated, contaminated water will be pumped into lorries to be sent to the in-house WWT for treatment.

(6) Effluent potentially contaminated with miscible petrochemicals arising from the main and barge jetties will be kept in bunded area segregated from the potentially oil contaminated areas. Samples will then be taken for laboratory analysis to determine levels of contamination before any accumulated effluent is sent to the CPI. If laboratory analysis indicates significant contamination, accumulated effluent will be pumped into drums and transferred to the WWT.

(7) During normal operations the drainage valves in areas enclosed by isolating spill walls (pump stations, drum/tin storage area) will be nominally in a closed position. During rainfall, the valves will be opened to allow the discharge of run-off to the CPIs after inspection to ascertain that no leakage or spillage has occurred.

Effluent Summary

(8) A summary of effluent streams from the operation of the new CRPC Terminal are presented in Tables 3.3.1.3.1-2 [20].

TABLE 3.3.1.3.1: EFFLUENT SUMMARY OF POTENTIAL DISCHARGE TO CPI NO.1

Terminal Area	Isolated Area (m^2)	Volume Rainfall Retained in Bunded Area (m^3/24hr)	Dry Weather (Process Discharge) (m^3/hr)	Rainfall Run-off Discharge Rate (m^3/hr)	Post Rainfall Controlled Rate of Discharge of Accumulated Effluent (m^3/hr)	Fire Water Run-off Rate (m^3/hr)
Tank farm (T1308-T1313)	14500	5400	-	retained	450	(940)
Pump manifold T-1308 (tank south)	80	-	-	8	-	(324)
Boiler house	roof	-	5(1)	5(1)	5(1)	(324)
Fire pump house	roof	-	-	-	-	(324)
Tank farm (T1301-T1306)	13500	5020	-	retained	420	(905)
Pump manifold T-1306 (tank south)	75	-	-	8	-	(324)
Tank area for fire pump	60	22	-	-	2	-
Tank farm (T1101-T5001)	10000	3720	-	retained	310	(675)
Pump manifold T-5001 (tank south)	90	-	-	9	-	(324)
Anti-foam Drum & Pump	25	-	-	3	-	(324)
Pump manifold T-1101 (tank north)	60	-	-	6	-	(324)
Pump manifold T-1201 (tank north)	70	-	-	7	-	(324)
Lorry waiting area	1000	-	-	100	-	(324)
Compressor shed	roof	-	-	-	-	(324)
Lorry loading gantry	roof	-	-	-	-	(605)
Car park	400	-	-	40	-	(324)
Workshop	roof	-	-	-	-	(504)
Barge jetty (E-6)	135	-	-	14	-	*
Barge jetty (E-7,E-8)	95	-	-	10	-	*
Barge jetty (E-3)	80	-	-	9	-	*
Barge jetty (E-5)	120	-	-	13	-	*
Main jetty (A)	830	-	-	20	-	*
Main jetty (B)	250	-	-	10	-	*
Main jetty (C)	230	-	-	10	-	*
TOTAL			5	272	1187	1280

Note: Quantities in brackets not included in total as they are not considered to occur simultaneously
*: Discharge direct to sea
(1): Boiler blowdown

TABLE 3.3.1.3.2: EFFLUENT SUMMARY OF POTENTIAL DISCHARGE TO CPI NO.2

Terminal Area	Isolated Area (m^2)	Volume Rainfall Retained in Bunded Area (m^3/24hr)	Dry Weather (Process Discharge) (m^3/hr)	Rainfall Run-off Discharge Rate (m^3/hr)	Post Rainfall Controlled Rate of Discharge of Accumulated Effluent (m^3/hr)	Fire Water Run-off Rate (m^3/hr)
Chemical Tank farm	3830	1400		retained	110	(310)
Pump manifold (T-3010 north)	230	-		24	-	(324)
Lube Oil Tank farm	1400	520	-	retained	50	(230)
Pump manifold (T-4006 east)	60	-		10	-	(324)
LPG Filling station	roof	-		-	-	(960)
LPG pump/comp area	roof	-		-	-	(350)
Lube oil filling station	roof	-		-	-	(1260)
Lube oil ware house	roof	-		-	-	(740)
Lube oil loading area	roof	-		-	-	(1150)
Filled drum storage	roof	-		-	-	(1150)
Chemical filling plant	roof	-		-	-	(545)
Barge jetty (E-1,E-2,D)	-	-		10	-	*
TOTAL		-	-	44	160	1260

Note: Quantities in brackets not included in total as they are not considered to occur simultaneously
* : Discharge direct to sea

3.3.2 Effluent Treatment Systems

Waste Water Treatment Facility

A dedicated Waste Water Treatment Facility will be installed at this new depot. The design consideration for this Facility is described in Appendix V - Technical Specification for Waste Water Treatment System.

Corrugated Plate Interceptor

(1) Two corrugated plate interceptors (CPI No.1 and CPI No.2) will be provided to separate free contaminants (oil and solids) from effluents streams arising from the operations of the new CRPC Terminal. CPI No. 1 will be located to the south of tank T-1305, CPI Separator No.2 will be located within the lube oil storage tank area adjacent to tank T-4006.

(2) The corrugated plate interceptor utilises the principle that particle removal efficiency is a direct function of the projected horizontal surface area of the flow path. An extended projected horizontal surface area is achieved by providing a large number of separating surfaces or plates stacked in the flow stream. Maintaining a stable laminar flow between the plates will achieve efficient separation. The CPI plates are corrugated and the oil separated from the feed stream migrates to the top of the corrugation where it coalesces into larger droplets. Settleable solids fall through the corrugations and are typically

contained within primary and secondary grit chambers. CPI unit designs are typical based on standard sizing criteria.

(3) Other studies that have been carried out [22] have shown that current CPI technology provides effective removal of hydrocarbon droplets larger than 20-30 microns. Droplets smaller than 60 microns are expected to be less than one percent by weight of the oil and is not likely to impact on the CPI discharge quality.

(4) The capacity of the two CPIs has been determined based on the size of the catchment area, rainfall intensity and required discharging procedures. The basis of design is summarised as follows [19]:

(i) The design rainfall intensity is based on a maximum rainfall event with a 10 year return period. For the run-off from non-bunded areas, the rainfall intensity used is 104 mm/hr; for bunded areas such as the tank farm, the design value is 372 mm/24hr.

(ii) Rain water in the tank farm is totally retained within the bunded area and then discharged to the CPIs over a subsequent period of 12 hours.

(5) The CPIs have been sized to handle rainfall run-off; in the event of a fire scenario the capacity of the CPIs will not be sufficient to remove free oil from firewater run-off; the CPI units are designed to allow overflow of firewater run-off to the sea to prevent flooding of the site.

(6) The design contractor for the CPIs has guaranteed the following effluent quality (except during fire-fighting) [23]:

- Oil content: 20ppm max
- Suspended solids content: 30ppm max

(7) The basic arrangement of the CPIs will be as follows:

- Two plate packs per bay
- 45° plate inclination
- Internal plate separation 20mm

(8) The anticipated quality of effluents discharged to the two CPIs is summarised in Tables 3.3.2.1-2 [23].

TABLE 3.3.2.1: OPERATING CONDITIONS FOR CPI NO.1 [23]

Parameter	During Rainfall	After Rainfall	Firewater
Flow rate (m^3/hr)	272	1187	1280
Effluent type	Rainwater	Rainwater	Seawater
Free oil (ppm)	500(1)	500(1)	Trace
Suspended solid (ppm)	300	300	Trace
Temperature (°C)	20	20	20
pH	6-10	6-10	6-10

(1): Estimated Value

TABLE 3.3.2.2: OPERATING CONDITIONS FOR CPI NO.2 [23]

Parameter	During Rainfall	After Rainfall	Firewater
Flow rate (m^3/hr)	40	160	1260
Effluent type	Rainwater	Rainwater	Seawater
Free oil (ppm)	500(1)	500(1)	Trace
Suspended solid (ppm)	300	300	Trace
Temperature (°C)	20	20	20
pH	6-10	6-10	6-10

(1): Estimated Value

(9) Free hydrocarbon material separated by the interceptor plates in the CPIs will be discharged to the CPI slop oil sumps. Accumulated "slop-oil" will be pumped into 200 litre drums and transferred to approved facilities for subsequent treatment and disposal.

3.3.3 Sewage/Wastewater System

(1) Sewage and domestic wastewater arising from approximately 100 employees on site will be collected in septic tanks and then discharged to the bio-treatment section of the WWT.

3.3.4 Tank Bottom Discharges

(1) Tank bottom discharges from oil storage tanks will contain high levels of BOD/COD. The discharges will be collected in containers (150litre volume) and sent to the WWT by means of a portable pump.

3.3.5 LPG Bottle Washings

(1) Rinsing water of the LPG bottles will contain solvents. The water will therefore be sent to the WWT in drums for further treatment.

3.3.6 Tidal Flow

Tidal flow simulations to assess the effect of the SETY reclamations were carried out previously for the environmental impact assessment of Container Terminals 8 and 9 [3]. This assessment will therefore present relevant finding of this previous study.

3.4 Water Quality Impact

3.4.1 Non-contaminated Effluent

(1) Rainfall run-off from non-contaminated areas of the site will be discharged direct to the marine environment. Levels of entrained sediments are unlikely to exceed effluent discharge standards and adverse impacts on the marine environment are not anticipated.

3.4.2 Impact of Contaminated Effluent Discharges

(1) The products handled by the new CRPC Terminal have the potential to cause significant deleterious effects on the marine environment [24],[25]; it is therefore essential that discharges are minimised and accidental spillages contained within the Terminal.

(2) All effluents discharged from the CRPC Terminal will be required to comply with the effluent discharge limits specified for inshore waters of the Western Buffer Water Control Zone; as stated under the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM). In addition EPD has set additional standards for parameters in accordance with a part of the TM in order to facilitate planning of the treatment facilities and control of discharges for this development. The applicable limits for specific parameters are shown in Table 3.4.2.1.

TABLE 3.4.2.1: EFFLUENT DISCHARGE LIMITS FOR SPECIFIC PARAMETERS

Parameter	Standards (flow rate >$10m^3$/day)
pH Temperature (°C) Colour (Lovibond units) Suspended solids (mg/l) BOD (mg/l) COD (mg/l) Oil & grease (mg/l) (including petroleum oil, waste liable to cause scum, deposit or discolouration) E.Coli (count/100ml)	6-9 40 1 30 20 80 20 1000
Isopropyl alcohol Acetone	No specific standard, to be controlled by COD limits
Toluene Styrene monomer Benzene Xylene Naphthalene Phenols Other aromatic solvents	Total concentration not to exceed standard for Phenols in Table 10a of TM

(3) The design of the drainage systems should be sufficient to ensure that effluents with different levels/types of contamination are segregated and that in the event of an accidental spillage within the Terminal, that the spillage will be contained by the containment facilities that are to be provided.

(4) Actual levels of contamination for rainfall run-off should be relatively low; during normal operations the only source of contamination should be fugitive releases from equipment components and drips from loading hose connections at the jetties. Significant contamination of rainfall run-off will only occur in the event of a product spillage. The proposed CPIs should be sufficient to separate free hydrocarbon and solids such that discharged effluent is within acceptable limits.

(5) Effluents with a higher level of contamination will arise as a result of process discharges e.g draining of water accumulated in storage tanks. These process effluent streams will have a significantly higher level of contamination (2000ppm free oil, 300ppm suspended solids [see Tables 3.3.2.1-2]). Such effluents which will also contain high levels of BOD/COD will be discharged to the WWT.

(6) Significant volumes of contaminated effluents from roofed areas of the Terminal such as the lorry loading gantry, chemical filling shed and lube oil facility are not anticipated during normal operations. Contaminated effluents from these areas will only arise as a result of fugitive equipment leakages and product spillages. It is recommended that effluents from within these areas are discharged to collection sumps and collected for treatment by the WWT.

(7) All effluents which may potentially be contaminated by miscible petrochemicals must be contained within the Terminal for tests and analysis prior to discharge to the CPI units since water contaminated by miscible petrochemical products will not be effectively treated by a CPI. If tests on chemical parameters indicate that they are within regulatory limits, these effluents will then be discharged via the CPI units to the sea. If levels of contamination exceed agreed limit values, effluents will be collected in drums or tankers and transferred to the WWT. Areas where effluent may be contaminated by low levels of miscible petrochemicals will include accumulated rainwater in the acetone/IPA tank farm and the chemical collection sump at the jetties.

(8) Effluent discharge from the CPIs to the marine environment will result in localised increases in suspended solids concentrations in the vicinity of the discharge locations. Providing levels of contamination in discharged effluent are within acceptable limits (effluent discharge standards) significant adverse effects on the marine environment are not anticipated; the assimilative and dispersive capability of the receiving waters in the southern Rambler Channel should ensure that the Water Quality Objectives are not exceeded.

(9) Residual hydrocarbons in discharged effluents from the CPIs will contribute to hydrocarbon levels in the marine waters and sediments off the southern part of Tsing Yi. Although these discharges will be principally intermittent in nature, all discharges of hydrocarbons to the marine environment are undesirable and as such should be minimised wherever possible.

(10) EPD monitoring results indicate the sediments off Tsing Yi are heavily contaminated with heavy metals. Discharges from the new Terminal facilities are not expected to contain significant amounts of heavy metals and are therefore unlikely to result in significant increases in heavy metals concentrations in the sediments in this area.

(11) Although corrugated plate interceptors can provide effective removal of free hydrocarbons and suspended solids, the use of a CPI as the only means of effluent treatment will not guarantee compliance with effluent limit values for other parameters such as BOD and COD. The provision of a Waste Water Treatment Facility of adequate capacity will ensure proper treatment of the BOD/COD rich effluent.

3.4.3 Sewage Discharges

(1) No significant impacts from discharge of sewage are expected as the workforce is small and effluents from septic tanks will be passed to the bio-treatment section of the WWT and the final effluent should comply with discharge limits.

3.4.4 Tidal Flow

(1) Previous studies [3] have predicted the effects of the realigned fairway on tidal flows in the Rambler Channel and Western Buffer Zone. The results of these studies predicted that re-alignment of the fairway could result in a redistribution of flows locally and a general marginal increase in tidal flow velocities over a wide area from the Kellet Bank to the south of Tsing Yi Island and east of Stonecutters Island.

(2) The results of the WAHMO modelling studies carried out in conjunction with the SETY development [3] indicated that, overall, the effects on tidal flow and water quality would be beneficial, although a slight deterioration in selected water quality parameters ie. BOD, NH_4-N and E.Coli would occur at certain locations. Overall it was found that the SETY reclamation would not result in a worsening of the percentage compliance with the Water Quality Objectives and would improve the compliance rates for dissolved oxygen.

(3) Since the reclamation for the CRPC project was included in the above assessment, significant adverse effects on tidal flows within this area as a result of the CRPC expansion and fairway realignment are not anticipated.

3.5 Mitigation and Monitoring Recommendations

3.5.1 Mitigation Measures

Effluent Treatment

(1) CPI units have limits for throughput and oil loading that can reduce performance efficiencies. The design of the CPI units must satisfy the effluent discharge limits under the worst case condition of maximum flowrate and oil loading to the CPI.

(2) CPI units will not be effective for removal of other non-oil related parameters such as miscible petrochemicals, COD and BOD. The dedicated Waste Water Treatment System (WWT) to be installed within the Terminal in addition to the CPI units will ensure that the effluents comply with effluent discharge standards as stated in the Technical Memorandum.

Product Storage

i) All tanks should be provided with high level alarms and level indicators to prevent product spillage as a result of overfilling.

ii) The emergency shut-down system (ESD) should be designed to allow closing of valves on liquid flow lines either in-situ or from a remote location.

iii) Mechanical seals should be provided for all liquid transfer pumps.

iv) Loading hose connections for bottom loading to lorries should be provided with positive grip couplings.

vi) Under adverse meterological conditions, marine loading/unloading operations should be halted.

vii) The disposal of all chemically contaminated effluent, slop-oil and sludges from the CPIs and tanks should be in accordance with the "Code of Practice on the Packaging, Labelling and storage of Chemical wastes and the Waste Disposal (Chemical Wastes) (General) Regulations.

viii) An attempt should be made to repair any process component which has an identified leak within 24 hours of detecting the leak.

Environmental Management

ix) A focal point for environmental affairs should be established within the CRPC management structure. This individual should be responsible for ensuring that all liquid line inspections and effluent quality monitoring is conducted and for compiling monthly monitoring summary reports for submission to EPD.

Drainage

x) The seals between poured concrete slabs in the tank farms should be regularly inspected to ensure no deterioration/cracking has occurred. Sealant materials to be used between adjacent slabs should be selected based on the types of products to be stored. Bitumen should not be used in areas where Class I products will be stored due to their solvent properties.

xi) The status (open/closed) of the bundwall drain valves should be clearly identifiable. A signboard should be provided for each drain valve providing information on when the valve should be closed/opened.

xii) Bundwall drain valves should only be opened when discharge of accumulated rain water is required. At the end of each working day, all bundwall drain valves must be closed.

xiii) During tank filling operations, it is essential that all bundwall drain valves in the tankfarm in which the tanks are receiving product are closed.

xiv) The correct water level in the CPI units should be maintained to ensure that hydrocarbons cannot pass directly to the outlet (CPI unit water levels should therefore be inspected on a daily basis).

xv) Separated 'slop-oil' and sludges should be recovered on a regular basis. These materials are classified as chemical wastes and must therefore be handled and disposed of in accordance with the Waste Disposal (Chemical Waste) (General) Regulations.

3.5.2 Monitoring

(1) Monitoring will be required during operation of the CRPC Terminal as a means of demonstrating compliance with effluent discharge limits and to identify potential leaks.

Leak detection

(2) An inspection of all the equipment in liquid service should be carried out on a daily basis. An inspection record should be maintained to record the leak history for each component.

Compliance Monitoring

(3) The quality of discharged effluent from the CPIs and the WWT should be monitored monthly and after periods of heavy rainfall for pH, colour, suspended solids, oil & grease, BOD and COD content to ensure compliance with Effluent Discharge Standards. Other parameters should be monitored at a frequency of at least once a month or as stipulated in the discharge licence conditions issued by EPD. The parameters recommended for monitoring are shown in Table 3.5.2.1.

TABLE 3.5.2.1: EFFLUENT MONITORING PROGRAMME

Parameter	Sampling Frequency
pH, SS, BOD, COD, Oil & Grease, colour	monthly and after heavy rain
Toluene, Acetone, Iso Propyl Alcohol, Styrene Monomer, Volatile Organic Compounds	monthly or when requested by EPD

3.6 Conclusions

(1) During normal operation of the new CRPC Terminal, effluent streams will be principally intermittent in nature with varying levels of contamination. The proposed drainage systems are considered to be adequate to segregate non-contaminated and contaminated effluent streams and to prevent their accidental discharge to the marine environment.

(2) Significant impacts on the marine environment as a result of effluent discharges from the new CRPC Terminal are not anticipated. The CPI units alone may not be sufficient to ensure that COD, BOD and chemical levels in the discharges are within acceptable limits and a Waste Water Treatment System will therefore be necessary so as to ensure compliance with the effluent discharge limits. The provision of a Waste Water Treatment System (WWT) will ensure that effluents discharged from the Terminal meet the required discharge standard (see Appendix V).

4.0 OPERATIONAL NOISE ISSUES

4.1 Criteria

(1) Environmental noise control is enacted under the Noise Control Ordinance (NCO) which defines statutory limits which will apply to noise from the operation of the proposed CRPC Oil Terminal extension. In addition, all planning must take into account the Hong Kong Planning Standards and Guidelines (HKPSG) [31].

(2) The NCO invokes three relevant technical memoranda, (TM), which define the technical means for the assessment of noise. Together, the NCO and the TM provide a mechanism for assessing noise levels and the statutory power to control noise retrospectively. The HKPSG suggests planning standards (noise assessment criteria) with reference to the NCO limits, with safety margins, and to other criteria where considered applicable. Noise criteria are applied at Noise Sensitive Receivers (NSRs); in this case 'Mayfair Gardens' and the Technical Institute are considered to be the primary NSRs.

Operation

(3) The TM for the 'Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites', details the method for determining statutory noise limits. These are referred to as Acceptable Noise Levels (ANLs) at each of the affected NSRs.

(4) For the CRPC Terminal the HKPSG criteria for 'fixed' developments applies; i.e. 5dB below the ANL or not exceeding the existing background noise level, whichever is the lower. The stipulation of noise criteria below the statutory ANLs reflects the 'safety margin' required in planning assessments.

(5) Appropriate noise criteria for the operational phase of the Terminal are given in Table 4.1.1. (The derivation of these criteria was discussed in more detail in the Initial Assessment Report) [1].

TABLE 4.1.1: SITE OPERATION NOISE CRITERIA

Noise Sensitive Receiver	Facade Noise Level Limit (L_{Aeq} 30 mins)	
	Day 0700 - 2300	Night 2300 - 0700
Mayfair Gardens	61	55
Technical Institute	61	55

Road Traffic

(6) The HKPSG define maximum desirable traffic noise levels for new developments next to existing roads. Identical criteria and their application have been assumed as in the earlier SETY study. These levels are given in Table 4.1.2.

TABLE 4.1.2: ROAD TRAFFIC NOISE CRITERIA

Noise Sensitive Receiver	Noise Level Limit (L_{A10} 1 hour)
Dwelling	70
Technical Institute/School	65

4.2 Operational Noise

4.2.1 Assessment Methodology

(1) At this stage of the design, full details of equipment to be utilised (and hence specific noise data) are not available (e.g manufacturer, type ref. etc)

(2) Environmental noise levels have therefore been predicted based upon the site layouts, project specifications, estimates of Terminal equipment and typical equipment noise data in DNV Technica's database.

(3) A general arrangement of the Terminal is shown in Figure 2.4.1.1. Equipment contributing significantly to on-plant and community noise levels is listed in Table 4.2.1.1; equipment not listed is not expected to be a significant noise source.

TABLE 4.2.1.1: EQUIPMENT DESCRIPTION

Item No.	Service	kW
P-1101	ULP Lorry Loading Pump	22
P-1102	LP-1 Lorry Loading Pump	22
P-1103	LP-1/ULP/Kerosene Lorry Loading Pump	22
P-1104	LP-2 Marine Loading Pump	110
P-1201 A/B/C	Jet A-1 Marine(Pipeline) Loading Pump	280
P-1202 A/B	Kerosene Marine Loading Pump	112
P-1203	Kerosene Lorry Loading Pump	30
P-1211 A/B	Stadis Injection Pump	0.55
P-1301 A/B/C/D/E	LDO/IDO Marine Loading Pump	110
P-1302 A/B/C	IDO/ADO Lorry Loading Pump	90
P-1303 A/B	LDO Blending Pump	75
P-1305	LSPO Blending Pump	30
P-1306 A/B/C	BDO Lorry Loading Pump	75
P-1307	SPE-LDO Marine Loading Pump	45
P-1308	MDO Marine Loading Pump	75
P-1309	HSFO(380 cst) Marine Loading Pump	220
P-1310	HSFO (180cst) Marine Loading Pump	220
P-1311	HSFO(120cst) Marine Loading Pump	220
P-1312	HSFO(120/180/cst) Marine Loading Pump	220
P-1321 A/B	Red Dye Injection Pump	7.5
P-1322 A/B	Antifoamer Injection Pump	0.55
P-1391	MDO/SPE-LDO Lorry Loading Pump	-
P-2001 A/B	LPG Marine Loading Pump	37
P-2002	LPG Lorry Loading/Cylinder Filling Pump	37
P-2004	Odorant Injection Pump	0.55
P-3001	Toluene-A Marine/Lorry Loading Pump	30
P-3002	Toluene-A Drum Filling Pump	11
P-3003	Toluene-B Marine/Lorry Loading Pump	30
P-3004	Toluene-B Drum Filling Pump	11
P-3005	Acetone Marine/Lorry Loading Pump	30
P-3006	Acetone Drum Filling Pump	7.5
P-3007	IPA Marine/Lorry Loading Pump	30
P-3008	IPA Drum Filling Pump	7.5
P-3009	Flux-A Marine/Lorry Loading Pump	30
P-3010	Flux-A Drum Filling Pump	7.5
P-3011	Flux-B Marine/Lorry Loading Pump	37
P-3012	Flux-B Drum Filling Pump	11
P-5001	Styrene Monomer Pipeline Loading Pump	45
P-5091	Styrene Monomer Pipeline Loading Pump (Ware House)	-
P-7101 A/B	Boiler Fuel Oil Pump	3.7
P-7102	BFW (Boiler Feed Water) Pump	45
P-7103	Condensate Pump	3.7
P-8001 A/B/C/D	Fire Pump (diesel)	710
P-8002 A/B	Jockey Pump	7.5
P-8514	Barge Jetty Sump Pump	5.5
P-8515	Main Jetty-A Sump Pump	5.5
P-8516	Main Jetty-B Sump Pump	5.5
P-8517	Main Jetty-C Sump Pump	5.5
P-8591	Sump Pump (Ware House)	5.5
C-2001	LPG Compressor	15
C-7201 A/B	Instrument/Plant Air Compressor	132
F-7101 A/B	Fire Tube Boiler Package	22.5
P-1111 A/B	Green Dye Injection Pump	0.55

TABLE 4.2.1.1 Continued

Item No.	Service	kW
P-1112	Green Dye Hand Pump (Air Driven)	-
P-1205	Jet A-1 Drain Pump (Air Driven)	-
P-1212	Stadis Hand Pump (Air Driven)	-
P-1323	Antifoam Injection Pump	0.5
P-1324	Antifoam Hand Pump (Air Driven)	5
P-3091	Flux-B Marine/Lorry Loading Pump (Ware House)	-
P-3092	Flux-B Drum Filling Pump (Ware House)	-
		-

(4) There will be numerous smaller pumps/motor on the Terminal, however these are not expected to contribute significantly to overall noise levels. A full list is presented in Appendix III.

4.2.2 Prediction of Noise Levels

(1) Calculation of environmental noise levels has been carried out using computer-based prediction programmes developed by DNV Technica. Calculations are performed in accordance with EEMUA Specification 140 and CONCAWE 4/81, ("The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities") [29],[30]. These describe in detail methods for calculation of sound power level, sound propagation with distance under free field conditions, summation of noise sources, etc. Calculations are performed in octave bands from 31.5Hz to 8kHz, and include the effects of source dimensions, distance, atmospheric and ground attenuation.

(2) Individual or groups of noise sources on the plant are 'modelled' in terms of individual coordinates and octave band sound power levels; discrete barriers are also incorporated in the model. The modelling in this case is actually considered to be pessimistic as it has assumed no off-site screening by natural barriers/buildings and only limited on-plant screening.

(3) Calculations are also based on the 'worst case' operating conditions as given in Study Report on Pump Quality and Capacity [28]. For the marine pumps, these represent the peak 9 hour demand; for lorry loading pumps, these represent the peak 3 hours demand.

(4) On this basis the total calculated sound power level for the Terminal is as given in Table 4.2.2.1.

TABLE 4.2.2.1: TOTAL ESTIMATED PLANT SOUND POWER LEVEL

Octave Band Centre Frequency (Hz)									dBA
31	63	125	250	500	1K	2K	4K	8K	
101	102	105	109	109	111	104	98	91	114

(5) Further details of calculation procedures are given in Appendix IV.

4.2.3 Predicted Noise Levels

(1) Predicted free field noise levels are presented in Figure 4.2.3.1 in the form of noise contours around the site, extending out to NSRs1-2 (Mayfair Gardens and the Technical Institute.)

(2) A + 3dB correction should be applied to the contours in order to obtain noise levels at the facades of the NSRs.

(3) Noise levels are not actually expected to exceed 55dBA much beyond the site boundary, and to be well below the required limits at the NSRs. Noise levels at the nearest NSRs due to the new facilities (27-29 dBA-facade) will be well below the existing background noise levels.

(4) Any requirement to limit noise levels may therefore be driven by the need to comply with occupational noise legislation.

FIGURE 4.2.3.1 CRPC TERMINAL PREDICTED NOISE LEVELS

4.2.4 Mitigation and Monitoring Recommendations

4.2.4.1 Mitigation Measures

(1) It is clearly important to limit the noise emission of all major noise sources on the new plant. This should be achieved by ensuring that appropriate noise limits and guarantees are placed on all major plant. On the basis of the above, the following measures are recommended:

i) Noise limits should be specified to ensure compliance with both environmental noise limits and also the requirements of the Factory Inspectorate.

ii) It may be appropriate to prepare a suitable noise specification detailing the information required from vendors with their tenders, details of suitable noise test procedures and stipulating any particular noise control measures to be provided to accompany the mechanical specification documents.

iii) Typical mitigation measures which would be expected to be required include:

- Selection of inherently quiet cooling tower fan and electric motors/pumps.
- Use of air compressors housed in proprietary acoustic enclosures.

iv) It is recommended that a detailed noise study forms part of the ongoing design work on the new facilities to ensure that both environmental and occupational requirements are achieved and to determine specific requirements for noise mitigation.

<u>Environmental Management</u>

v) A focal point for environmental affairs should be established within the CRPC management structure. This individual should be responsible for ensuring that any noise monitoring programmes are conducted and compiling monitoring summary reports for submission to EPD.

4.2.4.2 Monitoring

(1) Environmental noise levels should be monitored on completion of commissioning of the Terminal, at periods of peak demand.

(2) In practice, it is expected to be difficult to monitor operational noise levels at the NSRs above noise due to general traffic and other sources at these locations. In these circumstances it may be appropriate to monitor noise levels at a point closer to the site. The TM states that, in these circumstances, assessment will be carried out in a manner considered appropriate, having regard to standard acoustical principles and practices.

(3) L_{eq} (30 min) should be used as the monitoring parameter for the all measurements.

Monitoring Locations

(4) Monitoring should be carried out at the two nearest NSRs (see Figure 4.2.4.2.1) as required. In addition, it is recommended that monitoring is carried out at an additional location on the boundary of the CRPC site to provide additional information on noise from normal operation at the site.

Monitoring Procedure

(5) Prior to any monitoring programme being undertaken all monitoring equipment should be serviced, calibrated and certified by an accredited laboratory. Equipment should be operated in accordance with the manufacturers instructions and all test/checks recommended by the manufacturer should be carried out. During monitoring activities, wind direction, windspeed and ambient humidity/temperature should be measured and recorded.

Monitoring Audit Reporting

(6) Monitoring results from the designated monitoring stations can be compared with the noise limits given in section 4.1. If monitoring results indicate exceedance of the limits, the individual nominated for environmental responsibility within the CRPC management structure, will be responsible for further monitoring, checking operational procedures, equipment and mitigation measures and instigating any additional remedial action.

(7) In practice, exceedance of the limits is considered extremely unlikely during normal operation.

4.3 Traffic Noise Assessment

4.3.1 Traffic Flows

(1) Peak predicted traffic flows for 2001 with and without the CRPC relocation have been taken from a Traffic Impact Assessment study conducted for CRPC in July 1992 [13].

(2) Forecast trips for the new CRPC Terminal, compared with 1992 levels are reproduced in Table 4.3.1.1.

TABLE 4.3.1.1: TRAFFIC FLOWS - 2001

Trip Generation	Hourly PCUs			
	AM		PM	
	In	Out	In	Out
Forecast (2001) - Terminal	225	195	130	130
Forecast (2001) - Petrol Filling Station	50	50	60	60
Forecast (2001) - Total	275	245	245	190
Existing (1992)	110	110	100	70
Difference (2001 Minus 1992)	+165	+145	+120	+120

(3) However some of the increase in traffic is offset against a reduction in CT9 traffic.

(4) Resultant traffic flows, as distributed over the overall local road network are shown in Figures 4.3.1.1. and 4.3.1.2.

(5) The WSA report concluded that there should be no negative traffic impacts arising from the relocation.

(6) While the increase in CRPC traffic noise levels close to the site calculated using the UK Department of Transport 'Calculation of Road Traffic Noise,' prediction methodology (CRTN), would increase by up to 3dBA, the CRPC traffic will be only a small proportion of the total traffic on the roads around CT9. The increase in total traffic flow due to the relocation is less than 10% of the total traffic flow at the AM peak. The increase in noise levels at the NSRs (for example, Mayfair Gardens) due solely to the increase in CRPC traffic will therefore be negligible (less than 0.5 dB).

(7) Predicted noise levels due to the increase in traffic due to CT9 and appropriate mitigation measures have been considered in detail in the SETY study and the Duplicate Tsing Yi Bridge Study.

4.3.2 Mitigation and Monitoring

(1) Traffic noise levels will be dominated by noise associated with the CT 9 development. Traffic noise impacts due to CRPC will be insignificant. No additional mitigation measures are considered to be necessary due to the CRPC relocation.

(2) Traffic noise due to the proposed CRPC relocation is not expected to be significantly higher than existing levels. It will be impracticable to monitor and distinguish the noise from the CRPC operations with other traffic noise generated from nearby developments at the NSRs.

(3) Any requirements for monitoring and additional mitigation will be 'driven' by consideration of impacts from CT9.

4.4 Conclusions

(1) The only significant noise sources on the Terminal are motors/pumps, air compressors, the boilers.

(2) Environmental noise levels are expected to be well below the recommended noise limits.

(3) However, a noise study should be carried out in association with the detail design to ensure that environmental and occupational requirements are achieved.

(4) A comprehensive boundary and community noise survey should be conducted on completion of commissioning of the new facilities. Further surveys should be carried out following any significant changes in plant operation or the implementation of any remedial noise control programme.

(5) The CRPC nominated individual should be responsible for monitoring general on-site operational noise levels with the objective of ensuring that all noise control equipment is functioning and used correctly, that noise control and mitigation programmes are enforced and for instigating alternative operational practices and deployment of remedial measures when monitoring results indicate an exceedance of acceptable conditions.

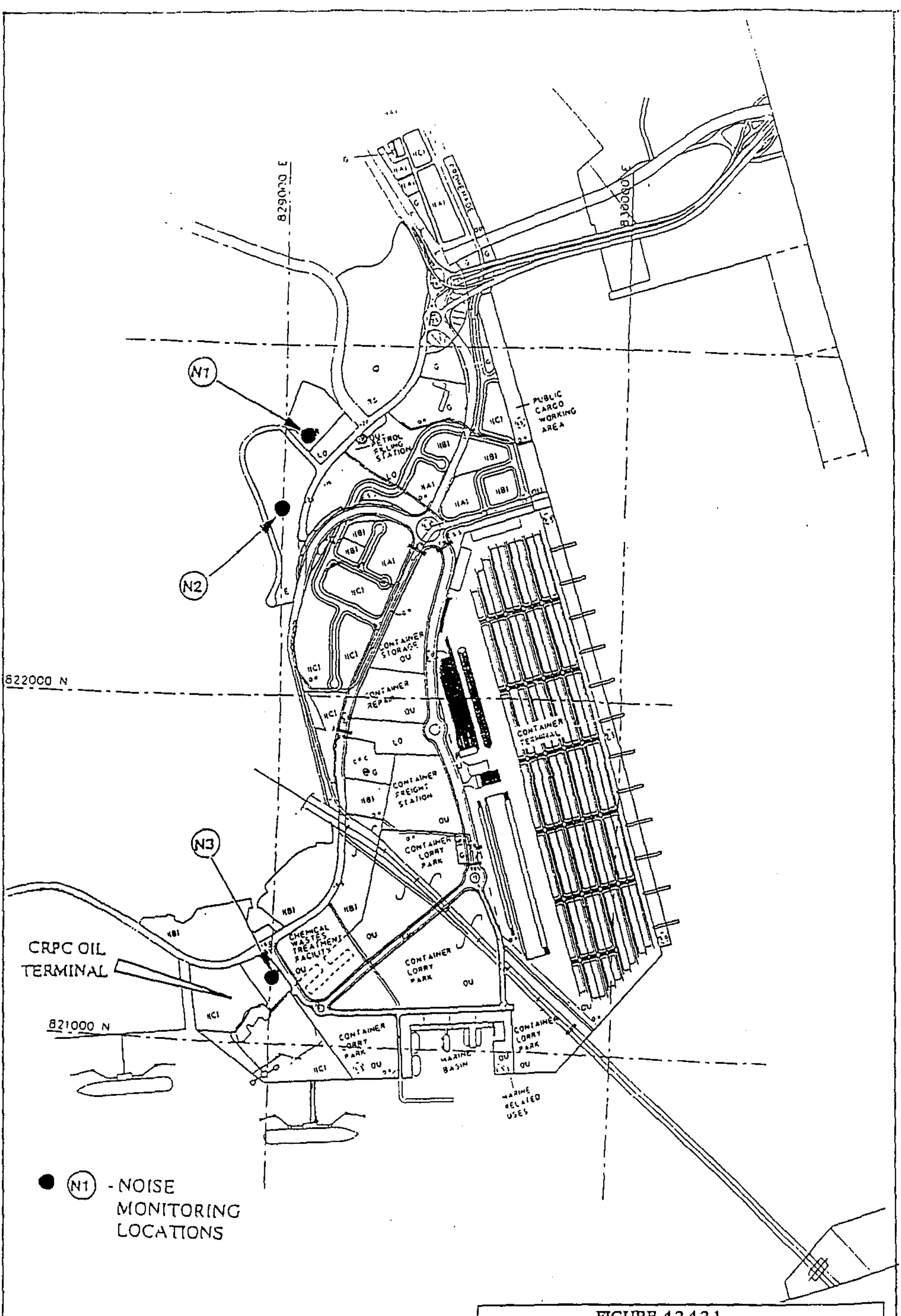
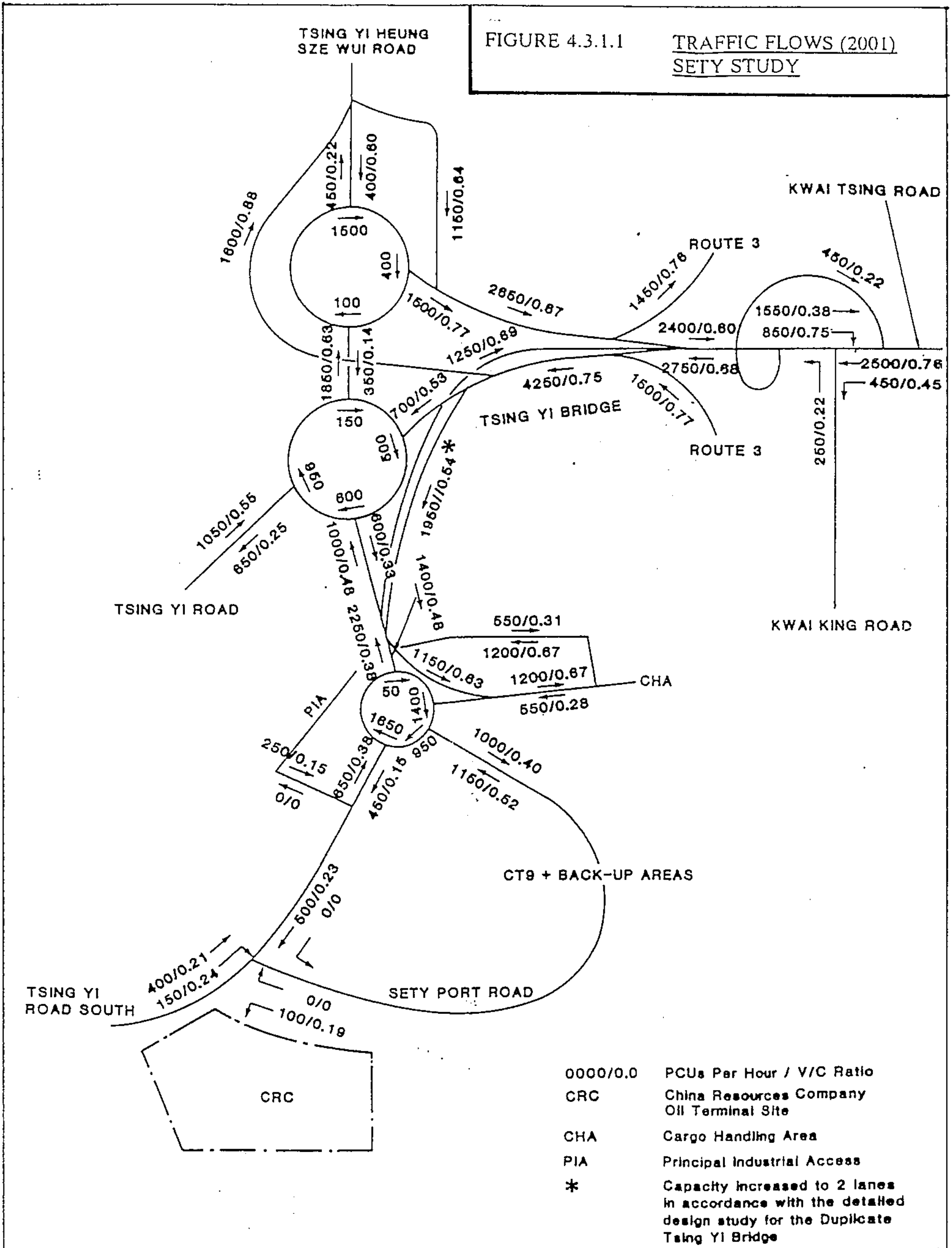


FIGURE 4.2.4.2.1

RECOMMENDED NOISE MONITORING

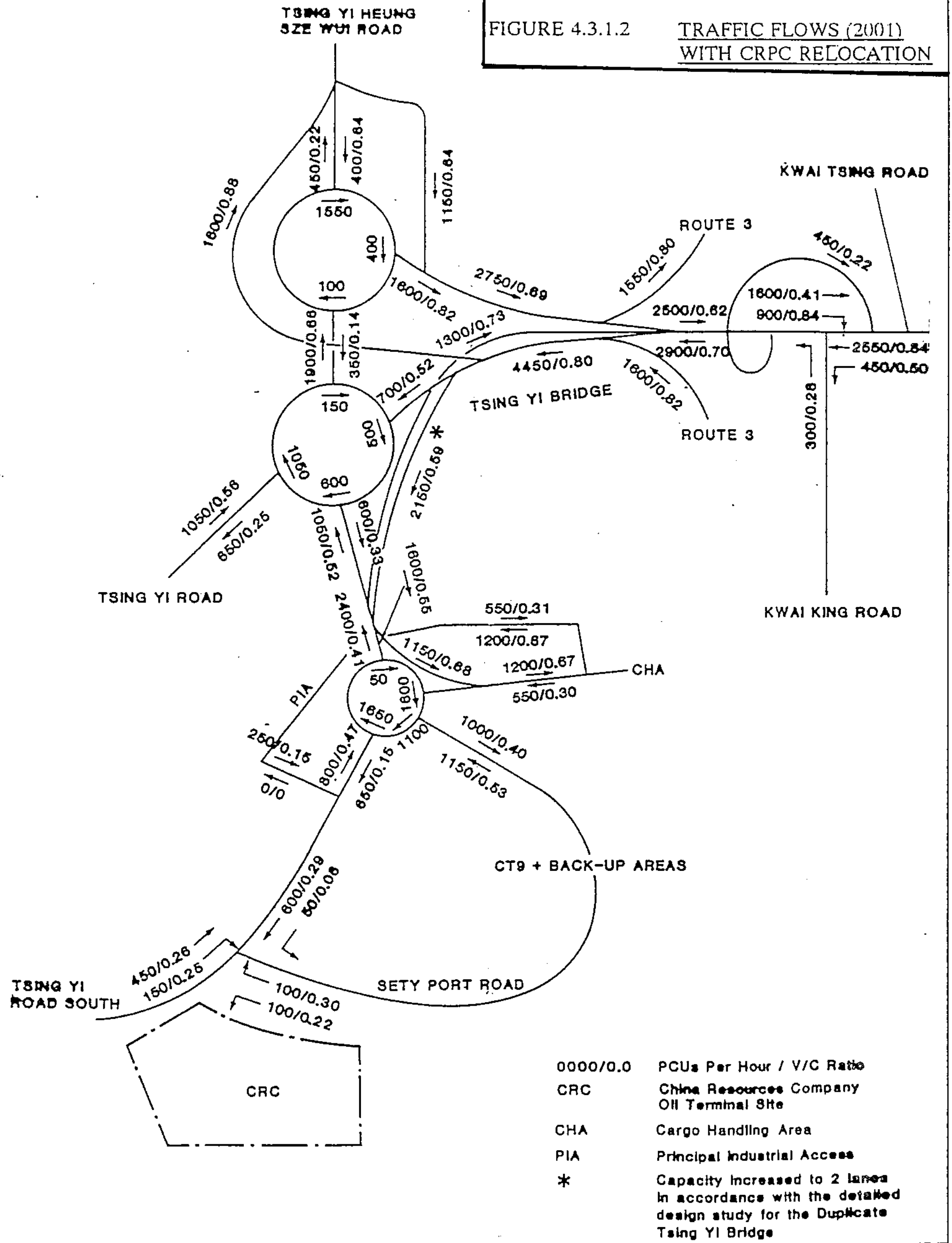
3

FIGURE 4.3.1.1 TRAFFIC FLOWS (2001) SETY STUDY



CRC Oil Terminal Relocation At Tsing Yi Island South
Traffic Impact Assessment
REFERENCE AM PEAK 2001 TRAFFIC VOLUMES FROM SETY STUDY

FIGURE 4.3.1.2 TRAFFIC FLOWS (2001) WITH CRPC RELOCATION



CRC Oil Terminal Relocation At Tsing Yi Island South

Traffic Impact Assessment

FORECAST AM PEAK 2001 TRAFFIC VOLUMES WITH CRC RELOCATION SITE

5.0 MARINE IMPACTS

5.1 General

(1) Potentially significant adverse environmental effects may arise as a result of a hydrocarbon/chemical spillage during product transfer operations at the jetty or as a result of a vessel rupture caused by ship collisions or impact on the jetty/seawall. Detailed studies have already been carried out to assess the implications of the realigned fairway and SETY developments on marine traffic in terms of potential increases in vessel encounters and delays, and the affects on the availability for mooring/anchoring at Kellet Bank [35]. This assessment therefore assesses the potential interaction between tanker activities at the CRPC jetty and nearby marine activities in a qualitative manner, emphasising events with the potential to damage the environment.

(2) The principal legislation for the control of oil pollution in Hong Kong waters is the Shipping and Port Control Ordinance (Chap 313) which prohibits the discharge of oil or oily wastes from vessels [44]. Under these regulations any incidents resulting in pollution such as an oil spill must be reported.

5.2 Marine Jetty Facilities

(1) The new CRPC Terminal will have 11 jetties as shown in Figure 5.2.1; Table 5.2.1 presents the type of berth, and the maximum and minimum tanker sizes that will be handled

TABLE 5.2.1: JETTY TANKER HANDLING CAPACITIES

Jetty	Location	Tanker Handling (DWT)	
		Minimum	Maximum
Main jetty A	Pier	5000	80000
Main jetty B	Pier	1000	8000
Main jetty C	Pier	100	1500
Barge jetty E-1	Wharf	100	1500
Barge jetty E-2	Wharf	100	1000
Main jetty D	Wharf	100	5000
Barge jetty E-3	Wharf	100	1500
Barge jetty E-5	Wharf	100	1500
Barge jetty E-6	Wharf	100	1000
Barge jetty E-7	Finger	100	500
Barge jetty E-8	Finger	100	500

(2) The Jetties are classified into three main groups: Main Jetties provided off-shore (referred to as Main Jetty A/B/C) which will be allocated mainly to product receipt, Barge Jetties along Wharf (referred to as Wharf Jetties D, E-1/2/3/4/5/6) which will be mainly for delivery, and Finger Jetties extended from the main Jetty's trestle (referred to as Finger Jetty E-7/8). Three berthing points will be located on the pier, one at Jetty Head (Main Jetty A) for tankers up to 80,000 DWT and another two are at its mooring dolphins (Main Jetty B and C). Jetty B will be able to accommodate tankers up to 8,000 DWT while Jetty C will only be able to accommodate up to 1,500 DWT, to avoid any interferences with the adjacent CT 9 development. The jetties are designed to allow for simultaneous berthing of the tankers without interferences and their target occupancy rates are not more than 60%.

(3) In addition to the above Jetties, some additional berthing points will be provided on the wharf facing the neighbouring Esso Oil Depot to accommodate tug boats, water pollution abatement boats, and barges carrying LPG bottles.

Ship Arrestor

(4) Several ship arrestors are provided for the protection of the main trestles of the jetty from being struck accidentally by marine vessels during the berthing and manoeuvring at the landward berths B, C, E7, E8, E5 and E6. These ship arrestors are provided at the advice of the Marine Department and the Pilot Association.

Tanker-Jetty Connection and Equipment

(5) More than 70 loading and unloading points will be provided on the 11 jetties, using either one of the following tanker-jetty connecting devices:

- Hydraulically-operated articulated metal loading arms
- Manually-operated articulated metal loading arms
- Hoses, operated by the hose handling rack
- Hoses operated by tankers' derrick cranes during loading/unloading operations.

(6) Each loading/unloading pipeline will be equipped with an isolating valve to separate Terminal side piping from tanker pier piping in case of marine emergency. Each loading point will also be provided with a flow meter and a flow control valve; the control valve also operate as an emergency shut-down (ESD) valve. Jetty heads and barge jetties will be equipped with large size change-over valves, sump facilities, loading arm hydraulic power units, small rest rooms and gangway tower (Jetty A only), fire fighting equipment and access ways.

Fire Fighting System

(7) The proposed fire fighting systems that will be provided for the jetty will consist of the following:

- Two motor operated foam monitors with a discharge rate of 4,500 l/min. each to cover the berth area of the main jetty.

- Jetties B & C will be provided with two motor operated foam monitor with a rate of 2,000 l/min respectively.

- Jetties E7 & E8 will be provided with a total of two motor operated foam monitor with a discharge rate of 2,000 l/min.

- Two foam proportioning tanks with fluoroprotein foam concentrate and has a minimum capacity of 4,500 litres each will be provided to supply all foam monitors. The quantity of foam concentrates shall be sufficient for 30 min. operation of monitors installed at jetty A. The water supply for the system will be fed from the fire water main.

- Fire Hydrants will be provided for each jetty. Each hydrant shall have four outlet valves, each capable of delivering 900 l/min. of water.

- A motor operated water curtain system will be provided to separate the berth and the oil tanker. The water will be discharged from the ground level of the berth to a level 2 m above the tanker deck.

- A motor operated water curtain system will be provided for the trestle to protect the escaping personnel. The water will be discharged 2m above the level of the trestle.

- A separate fire water main will be provided to supply water for foam and water fire fighting systems.

The above proposed fire fighting systems for the jetties are not exhaustive. Detailed Fire Services requirements will be formulated by the Fire Services Department during the formal submission of application to the Department.

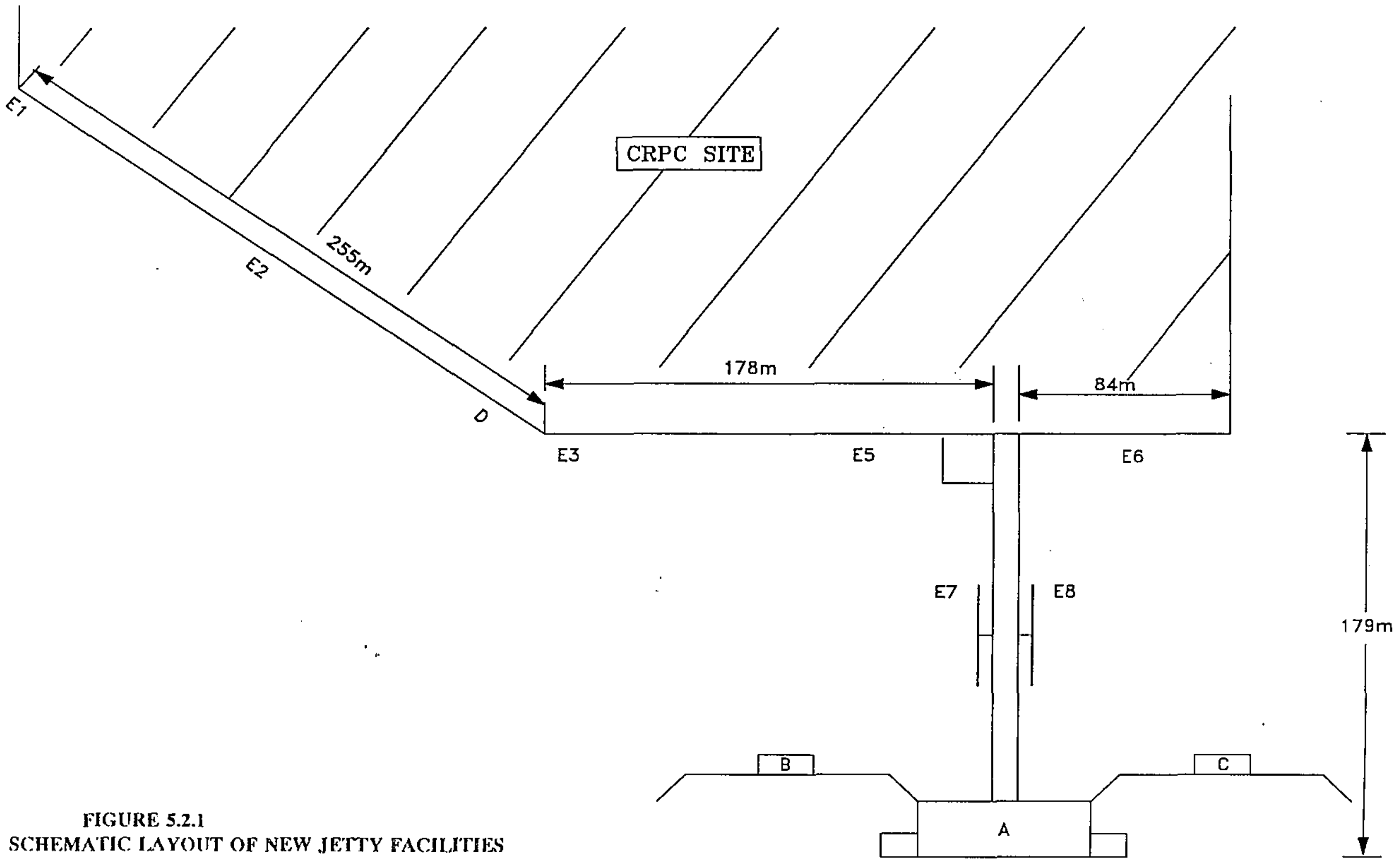


FIGURE 5.2.1
SCHEMATIC LAYOUT OF NEW JETTY FACILITIES

5.3 Assessment Methodology

5.3.1 Spillages Resulting From Impact/Striking and Jetty Operations

(1) The projected total number of vessels to be handled by the new CRPC Terminal will increase to 6000 per year [33]. The majority of the ship movements will be to and from the west; other routes are expected to include the Rambler Channel, Northern Fairway and the E. Lamma Channel.

(2) The potential interaction between tanker and operational activities at the CRPC jetty and nearby marine activities with the potential to damage the environment are considered to be as follows.

- Impacts from tankers visiting the CRPC jetty on nearby marine activities, which may involve disruption, damage to moorings and possible oil spill if they are handling oil/liquid products.

- Impacts from vessels in the fairway passing the CRPC jetty on tankers moored there, possibly leading to spillages. Vessels arriving at the CRPC jetty may have similar impacts on tankers already moored there.

- Impacts due to pumping equipment failure, human error, hose rupture and leakages during loading/unloading operations.

5.3.1.1 Vessel Interactions

(1) When one vessel passes near to another vessel which is moored at a jetty or dockside, hazards can arise from hydrodynamic interactions or wake effects.

<u>Wake Effects</u>

(2) The passing vessel's wake, in the form of a train of waves, may cause the moored vessel to "range", i.e. move against its moorings. Since ships are designed to minimise their wake (for reasons of propulsive efficiency), these wakes are usually relatively small, unless the passing vessel is large and fast and the water shallow. The wakes are relatively high frequency (compared to wind-blown waves), and have relatively small effects, except on small vessels, which tend to drift in the direction the waves are radiating (for a vessel passing parallel to the shore, this will be at an oblique angle to the shore), as well as moving up and down. Since this effect occurs every time a vessel passes, the moorings and loading arms are designed to cope with such movements. In extreme cases, where moorings or loading arm connections were deficient, the wake could lead to a spill, but no examples of such incidents are known. More likely would be disruption to barge unloading and possible dangerous swinging loads from barge-mounted cranes.

[3] Speed limits in Hong Kong are set by the Shipping and Port Control Ordinance (Cap. 313). In the area adjacent to the CRPC Terminal, the speed limit is 8 knots for vessels over 60 m in length, and 10 knots for vessels of 15 - 60 m in length. This is considered to be adequate to minimize hazards from wake effects. However if vessels are manoevring at speeds in excess of the speed limit, it could potentially cause damage to moorings, disruption of loading and unloading operations and in the extreme case may lead to product spillages.

Hydrodynamic Interactions

(4) Hydrodynamic interaction between vessels may cause more severe ranging and possible "striking", i.e. collision of the passing vessel into the moored vessel. This interaction results from the pressure field around a moving ship. As a vessel passes another vessel, the pressure field first causes the bow to turn away and later to turn back towards the other vessel. These forces are greatest for large ships passing close to each other, especially in shallow water. If the passing ship fails to compensate correctly, a striking may result. This has mainly safety impacts, but could cause a failure of the loading arm or even a rupture of the tanks, and thus has potential for a large spillage. One major event of this type has occurred between two vessels under way (collision between Tien Chee and Royston Grange, River Plate, 1972), and it could occur with a moored vessel, although no such incidents are known.

(5) The fairway for vessels approaching the container Terminals was relocated as part of the SETY study (Figure 5.3.2.1), and one of the requirements of the choice of location was to minimise this type of interaction. At that time, another berth was planned (for Dow Chemicals) which was closer to the fairway than the CRPC berth. The SETY study expressed concern about the interaction forces on this berth. The CRPC berth is 150 m further away from the fairway, and such concerns did not apply to it.

(6) Vessels moored at the CRPC jetty will be at least 250 m from the edge of the fairway (based on Figure 5.3.2.1). Since the fairway is 600 m wide, most vessels will pass further away than this. The largest passing vessels are likely to be fourth generation 60,000 DWT container vessels of 300 m length. Their maximum permitted speed would be 8 knots, but a more realistic speed would be 5 knots (based on the SETY study). Without detailed calculations it is impossible to be certain, but subjectively it is considered unlikely that moored vessels would experience any hazardous interaction forces in such a scenario.

5.3.1.2 Other Causes of Impacts

Steering Failure

(1) Steering failure on the passing vessel may also lead to strikings. This may involve a mechanical failure of the passing vessel's steering gear of power supply, which results in a loss of directional control. Similar effects may result from human error in navigation, often associated with proceeding too fast or failing to allow for the effects of wind and current. If the vessel is approaching the CRPC jetty or passing it, and the uncontrolled trajectory happens to be towards to shore, and a ship is moored at that point, a striking will occur, with possible effects as above. If no ship is present, an impact with the jetty may occur, with similar, pollution potential. Several such incidents have occurred world-wide. This mechanism probably accounts for the largest proportion of the striking risks.

Severe Weather

(2) Severe weather may cause vessels to drift into jetties or vessels moored there. Drifting barges in tropical storms are a particular problem in Hong Kong. These pose a striking hazard with pollution potential similar to those above. This risk may be reduced by tankers leaving the jetties when storms are forecast.

Impact Frequencies

(3) The frequencies of occurrence of vessel strikings, impact with jetty, and fires/explosions while at berth will be analyzed fully in the Hazard Assessment Study for the new CRPC Terminal.

(4) The likelihood of the CRPC berth being struck by a passing vessel is likely to be low; frequencies for this type of event are typically in the order of 10^{-8} to 10^{-5} per year [34]. The consequences of a vessel striking the jetty or a moored tanker could be severe in view of flammable and environmentally hazardous nature of the products handled.

(5) The maximum probable release is estimated based on a worst-case scenario in which one quarter of the largest vessel's (80,000 DWT) contents are spilled. In the unlikely event of such an occurrence, the consequence of such a failure may result in a spillage of 20,000 tonnes of oil into the marine environment. The failure frequencies associated with a large hole (150 mm) release from a ship at Jetty A is estimated at $2x10^{-03}$ per year [34].

(6) It has been suggested that the majority of small spillages occur while the tanker is actually transferring cargo or bunker fuel [32]. No one operation appears particularly likely to lead to accidents, with loading and bunkering taken together being as hazardous as unloading. The consensus is that the majority of such accidents are due to human factors.

(7) Spillages can occur from failure of equipment; for example, the flange connections between the ship and loading hoses may leak or the hose may rupture. Losses can also arise because of poorly designed transfer manifold systems.

5.3.2 Vessel Manoeuvring and Approaches

(1) The positioning of the new CRPC Terminal will place vessels moored at the jetty facilities in close proximity to the principal marine traffic flows in this area; the main flow of container vessel traffic through the SETY fairway and the passage of smaller vessels across the south of Tsing Yi Island and vessels berthing at the adjacent Esso Oil Depot and CWTF [35]. The potential vessel conflicts arising as a result of the new CRPC Terminal were assessed as part of the feasibility study for the CT 9 development which included recommendations for a dedicated approach for vessels berthing at CRPC Terminal.

(2) For the approach to the CRPC Terminal it was recommended that vessels should be on a track continuing north of the Kellet Buoy and turning east to approach the berths outside the boundary of the SETY fairway [35]; this approach course is shown in Figure 5.3.2.1.

5.3.3 Impacts of the Jetties on Water Circulation

(1) The length of the pier is 179 m with, two jetties (E7 & E8) midway along the main trestle, and three jetties with two side trestles at the head (Main Jetty A/B/C). Figure 5.5 shows the layout of the tanker pier.

(2) The 10m wide main trestle will be supported on two piles of 900mm diameter per beam, spaced every 13.5m along its length. Jetties E7 and E8 rests on 42 piles; Jetty A sits on 46 piles; Jetty B sits on 28 piles; and Jetty C sits on 28 piles. All the jetty piles are of 1016mm diameter each. In addition there will be 6 mooring dolphins along the Jetty head each of which is resting on 8 to 12 piles of 1016mm diameter.

(3) Looking perpendicular to the main trestle, the piles appear to block approximately 7 percent of the flow profile under the main trestle and approximately 23 to 40 percent of the flow under the Jetties. The piles effectively will act as obstacles to the currents and will block between 7 to 40 percent of the flow profile. Since the piles are circular, they will be relatively smooth obstacles in the moving water and their influence on the currents will be localized, extending to a few diameters beyond the piles.

(4) Vessels moored parallel with the current do not represent great obstacles to the flow. Current flows perpendicular to the moored vessels could be drastically impeded; depending on their sizes and keel clearance from the bottom. The influence of moored vessels on the currents will typically extend to about two to three times the length of the vessel around the jetty head.

5.3.4 Risk Reduction and Contingency Plan

(1) Based on historical oil spill data, the majority of releases during loading/unloading operations tend to be small spillages and are difficult to quantify. However, the adoption of the BPM Requirements will reduce the risks from such events. CRPC is aware of the need for a proper Contingency Plan and the provision of adequate oil spill combat capabilities. Such a plan will need to be prepared and submitted to the Building Authority prior to commencement of operations. In addition it is equally important to have sound operational instructions and procedures in place to minimize the risk of pollution arising from the daily operation of the terminal.

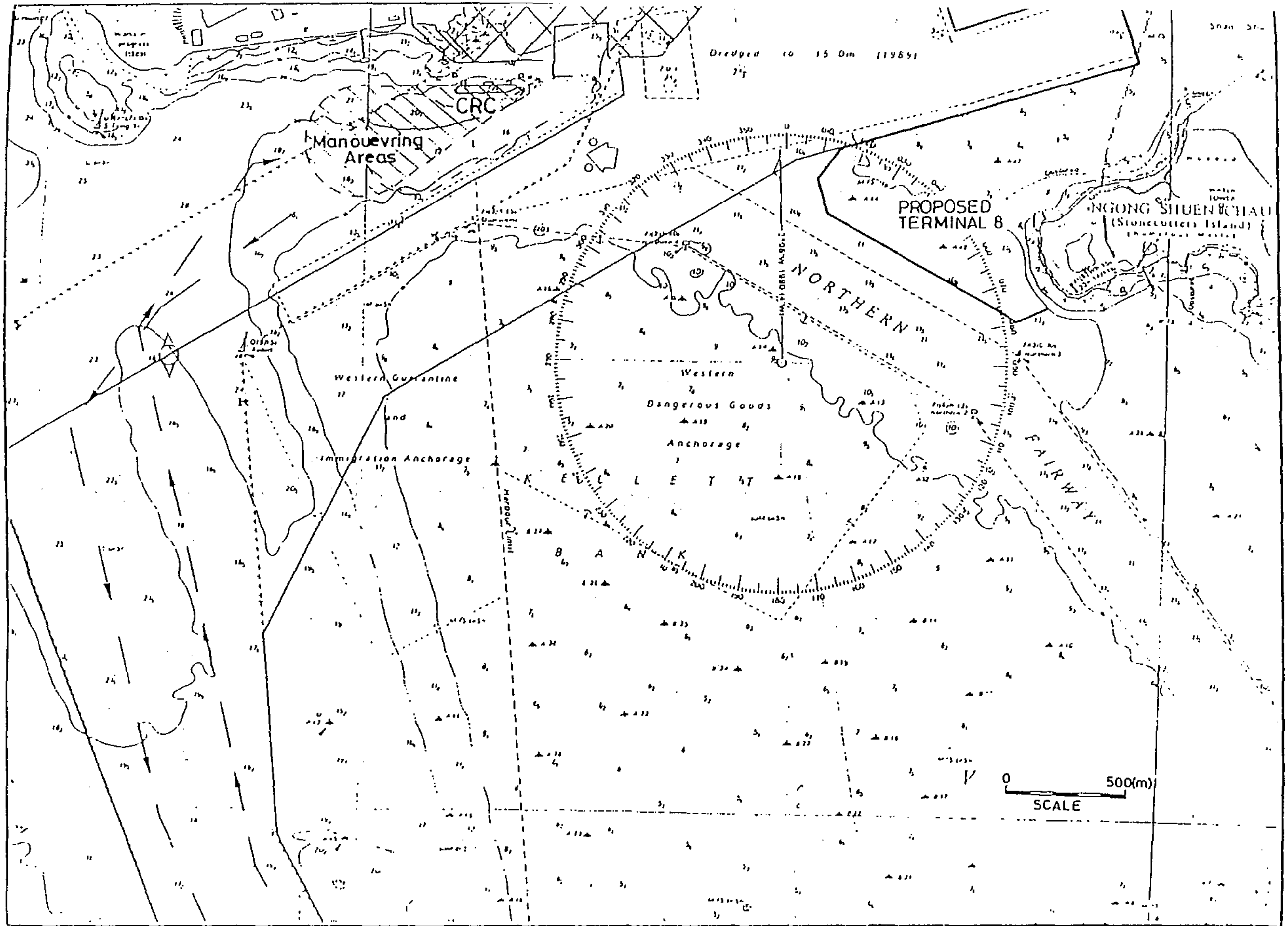


FIGURE 5.3.2.1: APPROACH TO CRPC BERTHS

5.4 Marine Impacts

5.4.1 Accidental Spillage

(1) A spillage of petroleum or petrochemical products could result in significant adverse impacts on the marine environment. On this basis, spill contingency equipment and emergency response plan will be required.

(2) The impact of a significant spillage of the products that will be handled at the new CRPC Terminal will generally depend on the following factors:

- Type of product
- Quantity released
- Physical properties (viscosity, specific gravity etc)
- Chemical properties (toxicity, bioaccumulative potential)

(3) The principal physical properties that influence the behaviour of a spillage are specific gravity, distillation characteristics (volatility), viscosity and pour point. These factors in association with the environmental conditions occurring at the time of the release (windspeed and direction, wave climate and current velocity) will determine the rate of spreading/dispersion/evaporation of the spillage.

(4) In predicting the fate of a spillage there is a difference between persistent and non-persistent products. Non-persistent products include gasoline, kerosene, toluene, styrene, IPA, acetone, and light diesel oils whereas heavy refined products have varying degrees of persistence. As a general rule, the lower the specific gravity of the product, the less persistent it will be. Non-persistent products tend to disappear rapidly from the sea surface while persistent heavy oils will dissipate more slowly.

(5) The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are long term processes which determine the ultimate fate of oil [36].

5.4.1.1 Products Environmental Hazard Potential

(1) The petroleum and petrochemical products which will be stored/handled at the new CRPC Terminal have potential environmental hazards [24][25]. The hazards include aquatic toxicity, biological oxygen demand, bioaccumulative potential and their potential to effect the amenity value of the receiving environment.

(2) The impacts as a result of a spillage at the new CRPC Terminal are summarised in the following sections.

(3) With the exception of acetone and isopropyl alcohol, all other products that will be handled at the CRPC Terminal will most likely form a surface slick following release to the marine environment; acetone and IPA which are miscible with water will become dispersed through the water column. Some heavy fuel oils and water-in-oil emulsions have specific gravities near 1.0, and may adhere to particles of sediment or organic matter causing it to sink in seawater. Shallow coastal waters are often laden with suspended solids providing favourable conditions for sedimentation.

(4) Localised toxic effects on marine organisms could result, in particular from spillages of acetone and toluene. For spillages which result in the formation of a surface slick, any toxic effects would be localised to surface waters in close proximity to the slick. With the exception of styrene monomer, all other products handled have zero bioaccumulative potential; styrene monomer has been shown to be accumulated by fish and can result in fish tainting effects [37].

(5) Spillages of heavy oils in particular will result in contamination of jetty structures, mooring lines and ships hulls. A large spillage will also result in interference with activities at the neighbouring industrial sites.

(6) A spillage of flammable products such as gasoline, acetone, styrene, toluene, IPA will pose a significant fire hazard.

(7) The seawater intakes at the Peninsula Electric Power Co. Ltd. and the Chemical Waste Treatment Facilities (CWTF) which are adjacent to the CRPC site could be adversely affected by a spillage. The power station, in particular, requires substantial quantities of water for cooling purposes; substantial quantities of oils drawn through its intakes could result in contamination of the condenser tubes. Contamination of the condenser tubes would result in a reduction in output or a total shutdown of the plant while cleaning is carried out. The intake of water significantly contaminated by toluene, styrene, IPA, acetone and lighter hydrocarbons could result in rupture or explosion of boilers or industrial process equipment.

(8) Given the potentially significant environmental impact that could result from a product spillage it is essential that proper contingency plans be drawn up and the necessary equipment to combat spills be provided.

5.4.2 Vessel Manoeuvring and Approaches

(1) The vessel approach recommended by the SETY study was proposed as a means of reducing the risk of vessels encounters between tankers/barges berthing at the new CRPC Terminal and the flow of container ships within the SETY Fairway. The assessment identified that this approach would place CRPC traffic within the traffic flows of the smaller craft across the south of Tsing Yi and tankers berthing the Esso Oil Depot jetty.

(2) Encounters with smaller craft outside the SETY Fairway were considered preferable to encounters with the large container vessels within the fairway.

5.4.3 Impacts of Jetties on Water Circulation

(1) The jetty piles will influence local water movement patterns and will obstruct between 7 to 40 percent of the flow profile, however the piles will be relatively smooth obstacles and their influence on the currents will be localized, extending to a few diameters beyond the piles.

(2) The influence of vessels moored at the CRPC Terminal on local currents will typically extend to about two to three times the length of the vessel around the jetty head.

(3) In general the influence of the new CRPC marine loading facilities on currents is considered to be insignificant. The intake and release of cooling water at the nearby Peninsula Electric Power Co. situated about to the west of the site is unlikely to be significantly impacted.

(4) The effect of the pier structure on the wave climate will be negligible due to its short length; vertical seawalls will lead to increases wave heights locally due to reflection.

5.5 Recommended Mitigation Measures

5.5.1 Jetty Oil Spill Mitigation Facilities

(1) The following sections recommend the requirements for marine pollution control equipment and spillage contingency plan that should be provided for the new CRPC Terminal in accordance with the Code of Practice for Oil Storage Installations (1992).

Containment Boom

i) A containment boom should be provided with a total length not less than 625m (i.e. approximately 2.5 times the maximum anticipated length of vessel 250m, which will berth at the CRPC Terminal).

ii) The boom should be of an internationally recognised type and incorporate the following features:

- Freeboard to prevent splashover
- Subsurface skirt
- Air/buoyant material floatation
- Longitudinal tensioners (eg chain, wire etc)

iii) Curtain booms with air floatation chamber will only take up a small storage area when deflated, will generally have good wave-following capabilities, moderate escape velocities and are reasonably easy to clean.

iv) All boom connectors should be of a type compatible with government booms which have a 'unicorn' connection.

Dispersants

v) 5500 litre stock of Type III dispersant should be maintained at the CRPC Terminal (based upon the deadweight tonnage of the maximum size of vessels (80000 DWT) that will berth). The quantities specified above are based upon concentrate type (Type III) dispersants. Concentrate dispersants have alcohol or glycol solvents and usually contain a higher concentration of surfactant components. Typical recommended dose rates are between 1:5 and 1:30 (neat dispersant:oil). For the case of Type II dispersant for which dilution is required before application, the specified quantities should be calculated by multiplying the dilution factor. The chemical dispersant held in stock must be of a type approved by the Hong Kong Government; should not contain toxic aromatic solvents and the supplier of the dispersant must posses a valid supplier's licence issued by the Director of Environmental Protection. In addition, CRPC must possess a valid user's licence issued by the Director of Environmental Protection.

Oil Skimmer

vi) At least one self-propelled oil skimmer of the suction type should be provided. The oil skimmer should be able to work in open sea condition and capable of skimming up at least 10 m^3 of medium fuel oil per hour from the sea. The main types suction devices currently being used in oil spill clean-up includes weir skimmers, vortex skimmers and air suction skimmers.

Ancillary Equipment

vii) CRPC should also maintain in stock ancillary equipment such as pumps, hoses, vacuum trucks and floatation or support vessel to handle the oil recovered from the sea by the oil skimmer. The ancillary equipment should be capable of receiving 18 m^3 of skimmed oil. Adequate storage facilities should be provided for the large volumes of water and oil collected. Settling tanks are also necessary to separate the oil from the water before the oil is transported for final disposal.

Oil Sorbent Material

viii) At least 1 000 sheets of sorbent pads or 500 m of oil sorbent material is required in stock. The sorbent pad should be not less than 450 mm wide and 4 mm thick. The kinds of sorbents available include :

- natural organic material such as bark, peat moss, straw, hay, feathers, coconut husks, sugar cane waste;
- mineral-based materials such as vermiculite, perlite and volcanic ash;
- synthetic organic sorbents such as polyurethane foam and polypropylene fibres.

ix) In general, the use of sorbents is recommended for use only during the final stages of the clean-up or to help in the removal of thin films of oil from inaccessible locations. Application is normally done manually or by means of a blower in the case of a large scale use of loose material. Recovery of oil soaked material by manual means is often the only viable alternative since many skimmer types become clogged with sorbent materials.

Maintenance

x) The marine pollution equipment should be regularly inspected and maintained in accordance with the manufacturer's maintenance specification and schedule. In the absence of such a specification and schedule then the equipment should be inspected and maintained at least once every six months.

Storage Facilities

xi) The large volumes of material requiring disposal following clean-up will necessitate the provision of storage facilities on site to provide a buffer between collection and final disposal. The resultant slurry should be considered as chemical waste and transferred to suitable containers for disposal. As far as possible, bulk oil should be stored separately from oily debris so that different methods of treatment and disposal can be followed. Highly viscous oils are best stored in open containers such as barges, skips or drums to facilitate treatment and transfer operations. Storage facilities (e.g lined storage pits and containers)should be made available.

5.5.2 Contingency Plan

(1) The operating instructions should also include a contingency plan including a Fire Order for dealing with fire, spillage and other environmental pollution incidents. The Contingency Plan should:

- Assess the nature and size of a possible spillage.

- Identify nearby sensitive areas and sea-water intakes and measures to be adopted if a spillage affects these areas. Nearby sensitive areas include the inshore capture fisheries within Victoria Harbour and the Ma Wan Fish Culture Zone. The seawater intake for the Peninsula Electric Power Co. Ltd. is located about 1km to the west of the proposed jetty, whilst that of the CWTF is only 200m away to the northeast. In case of an oil spill, booms should be deployed at these two intakes. It is noted that Esso Oil Depot also operates an intake about 200m to the west for industrial use and fire fighting purposes. The operations of the Esso Depot may be jeopardized by the closure of its intake and shipping activities will have to cease and its jetty be closed for the duration of the clean-up operations.

- Establish a viable operational organization and define the role of the different personnel.

- Determine the alerting and communication procedures.

- Formulate actions to deal with a spillage i.e. stop source of spillage, containment, recovery and final cleanup.

- Establish means of disposing of collected petroleum products.

- List available equipment and sources of outside resources.

- Establish training and exercise needs.

(2) The management and operational staff should be trained in implementation of the plan, including the proper and expeditious deployment of equipment, and an instruction to inform all relevant Government Departments immediately. The relevant Government Departments should include:-

- Fire Services Communication Centre and Tsing Yi Fire Station of Fire Services Department
- Tsing Yi Police Department
- Vessel Traffic Centre
- Pollution Control Unit of Marine Department
- Nearest Hospital
- Fire Fighting Information (CHUBB) Centre
- Kwai Tsing District Officer

(3) Full-scale contingency plan practice drills involving the management and operational staff should be held at intervals not exceeding twelve months. Familiarization drills, not requiring full-scale deployment of equipment, involving operational staff should be held at the intervening six-month period between annual drills.

Styrene Monomer Spill Emergency Procedure

(4) Dow Chemicals have prepared a Styrene Monomer Spill Contingency Plan for unloading operations at their plant and the Mobil Jetty located nearby. As far as possible, whenever a spill occurs CRPC will follow the procedures laid down by Dow Chemicals which are as follows:

- Locate the source of the spill immediately.

- Inform the Duty officer on deck to stop pumping and to close manifold valves.

- Close all necessary valves on shore and drain the remaining product in the pipeline on shore to a safe place.

- Remove all sources of ignition to reduce fire hazard

- Prevent spread of spilled styrene by blocking drains and close outlet valves of CPI separators.

- Deploy boom (recommended type).

- If spill cannot be readily contained, spray a water-dispersant mixture over the spill until it is dispersed.
- While the clean-up operation is in progress, report the incident to the plant Supervisor and furnish the following information:

  a) Source of spill and quantity remaining on ship.

  b) Quantity spilled and whether it is still spilling.

  c) Location of spill.

  d) Extent of spill.

  e) Status of spill containment efforts.

  f) Length of time elapsed since commencement of spill.

  g) Condition of the ship.

- Inform the relevant organizational personnel and authorities.

5.5.3 Operational Procedures

(1) Regular inspection and maintenance procedures and well written operating guidelines form the basis of all operational procedures to prevent leakages, spillages and accidents. Spillages can be prevented by competent design, careful construction, rigorous inspection and efficient operation. In case of an emergency, contingency plans and training of operators aimed at quick spillage control and at minimizing the impact on the environment. Supervision and training of operators also contribute to the prevention of spillage and leakage especially during loading and unloading operations at the jetty.

(2) When severe weather is forecast (typhoon warning signal No3), tankers should leave the jetties. During thunderstorms marine loading/unloading operations should be suspended.

5.5.4 Hydrodynamic Forces

(1) Hydrodynamic forces between vessels at the CRPC Terminal and passing traffic are expected to be minimised by the existing harbour speed limits and the relocated fairway. Harbour traffic should be monitored to ensure that it complies with these regulations. any problems with tanker ranging at the CRPC berths should be logged and monitored to confirm that the safety measures are adequate.

(2) During ship loading or unloading operations if the vessel drifts markedly from its fixed position loading/unloading operations should be halted until the ship has been returned to the correct position.

5.6 Conclusions

(1) The products that will be loaded/unloaded at the new CRPC Terminal have the potential to result in significant adverse impacts on the marine environment and neighbouring industrial facilities. It is therefore essential that suitable spill containment and clean-up equipment is maintained at the site and a contingency plan is produced for incorporation into the operations manual for the Terminal.

Significant impact as a result of the physical presence of the jetties and approaching/passing vessels on marine activities is not anticipated.

6.0 WASTE ISSUES

6.1 Waste Arisings

Chemical Wastes

(1) Chemical wastes as defined under Schedule 1 of the Waste Disposal (Chemical Waste) (General) Regulations [39] made under the Waste Disposal ordinance (Cap. 354) will arise during the operational phase of the Terminal. These regulations require CRPC as a producer of chemical wastes to be Registered with the Director of Environmental Protection. These wastes are toxic or hazardous and are mostly in a liquid or semi-solid form. Chemical waste arisings from the new facilities will include the following:

- Oily sludges from storage tanks residues and CPIs
- Maintenance and Storage tank cleaning
- Off-specification laboratory chemicals, solvents and product container washings.

(2) These wastes will have to be sent to the nearby CWTF scheduled waste treatment facility for further treatment and disposal. Facilities are available at CWTF for recovery of oily wastes.

MARPOL Wastes

(3) Under the International Convention for the Prevention of Pollution from Ships, 1973, oil or oily mixtures from ships are not allowed to be discharged into Hong Kong waters. MARPOL wastes will not be received at the CRPC Terminal. A MARPOL Jetty and treatment facilities are available at the CWTF located next to the CRPC site.

Commercial Wastes

(4) Commercial and domestic type wastes will arise from the operations of the Oil Terminal Office and normal operational activities. These types of wastes will include garbage, waste paper, packaging, plastic, and leftover food. Commercial waste will most likely be collected from the site by private waste disposal contractors. Such wastes do not require any specialised handling although suitable containment facilities must be provided for onsite storage prior to collection. Ultimately, the wastes will be disposed off by means of landfill, pulverisation or incineration.

Industrial Wastes

(5) Industrial wastes as defined under the factories and Industrial Undertakings Ordinance (Cap 59), include solid and semi-solid waste from industrial sites but exclude chemical wastes and construction wastes. Collection of these wastes from the CRPC Terminal will be either by private contractors or by CRPC themselves. All industrial wastes are suitable for landfill disposal.

6.2 Waste Disposal

(1) The disposal of chemical waste must comply with the Waste Disposal Ordinance (WDO) and its relevant subsidiary regulations. For those wastes listed under part A in Schedule 1 of the Regulation, waste producers are required to give notification of the disposal of such waste to EPD and the disposal has to follow EPD's directions. CRPC as a producer of chemical waste should arrange proper packaging, labelling and storage of chemical waste before transportation to disposal facilities. The requirements are stipulated in the Code of Practice on the Packaging, labelling and Storage of Chemical Wastes [40]. The general requirements of the Code of Practice are summarized as follows:

- Chemical waste should be packed and held in containers of suitable design and construction so as to prevent leakage, spillage or escape of the contents under normal conditions of handling, storage and transport.
- Mixing of different types of chemical wastes in a container is prohibited.
- The approval of EPD will have to be sought when large containers whose capacities are greater than 450 litres are to be used.
- The design and dimensions of labels for the containers and the particulars to be included on the labels must be according to the specifications and should be in English and Chinese. The appropriate waste type and its code should also be entered as set out in the booklet on A Guide to the Registration of Chemical Waste Producers [41].
- The storage area for the containers must satisfy certain minimum requirements with regards to the design and location of storage areas. For instance, the storage area should have an impermeable floor or surface made of suitable materials to prevent infiltration of liquid into the ground in case of leakage or spillage. There should be no connection to any surface water drains or foul sewers. For the area where liquid chemical wastes are stored, the area should be designed to contain the content of the largest container intended to be stored or 20% of the total quantity of chemical wastes stored, whichever is the greater. The height of such retention structure should not exceed 200mm to allow convenient manual or mechanical lifting and handling of containers.
- Each storage area must have a warning panel or notice.
- Stacking of containers of chemical waste is allowed provided that the enclosure walls are impermeable, the stacks are made secure, and in the normal upright position. The maximum height of a stack should not be greater than 2.5 metres.

(2) CRPC or its appointed waste disposal contractor should apply for a Waste Collection Licence from EPD for collection and transport of chemical waste. Certain types of chemical waste (eg. Flammable organic solvents) are classifiable as Dangerous Goods under the Dangerous Goods Ordinance (Cap 295). The Dangerous Goods (General) Regulations stipulate requirements on the use, packaging, labelling, and storage of dangerous goods.

(3) The permissible methods of treatment and disposal of different types of wastes arisings from this facility are as indicated in Table 6.2.1.

TABLE 6.2.1 METHODS OF TREATMENT AND DISPOSAL OF DIFFERENT TYPES OF WASTES

Waste Category	Type	Disposal Method
Commercial	Office and canteen wastes	landfill /incineration /recycling
Industrial	Metal, plastic, wood, ferrous & non-ferrous materials, used equipment parts	landfill/ recycling
Chemical waste	oily sludges, spent lubricating oils & hydraulic fluid, solvents, tank residues, off-spec chemicals	specialised processes (CWTF)/ codisposal at landfills
MARPOL waste	oil and oily mixtures from ships	specialised processes (CWTF)

6.3 Recommended Mitigation and Monitoring

6.3.1 Waste Management

(1) It is recommended that a waste management plan be drawn up and put into practice during the operational phase of the new CRPC Oil Terminal. The waste management plan should aim at minimizing the amounts of waste generated, and the recovery and recycling of wastes should be actively pursued. There are five commonly referred to levels of priority in a waste management programme (in decreasing order of priority).

- Elimination
- Source reduction
- Recycling
- Treatment
- Disposal

(2) Good waste management programmes concentrate efforts towards the high priority levels, since conceptually it makes sense to avoid producing a waste rather than to develop extensive treatment schemes. Waste minimisation can provide long-term benefits in two ways. Firstly, it can assist in the attainment of and improvement on regulatory requirements. Secondly, it can improve profitability by reducing storage, treatment and disposal costs; improving the health and safety of employees; reducing liabilities and increasing operating efficiency.

6.3.2 Monitoring

(1) A trip-ticket system for tracking the consignment of chemical waste will have to be implemented for monitoring of chemical waste streams collected from the Terminal. It is recommended that waste quantities arising from each aspect of the operations are inventorised. Currently within the existing CRPC facility, there is a lack of quantified information on waste arisings from existing operations. It is anticipated that a sizeable amount of chemical and dangerous waste will be generated during the operational phase and at infrequent intervals. Reports on waste arisings should be compiled on a monthly basis and summarised on a quarterly basis or as directed by EPD. The report should include details related to waste production and consignment records.

7.0 ROAD TRAFFIC

7.1 General

(1) The existing CRPC Terminal serves both marine and land-side traffic and generates several lorry and tanker trips per day. Consolidation of operations from the Nga Ying Chau site at the new south Tsing Yi site will allow for improved site access and facilities layout and an increase in the range of products handled. The number of vehicles entering and leaving the site will be a combination of traffic from workforce, servicing, visitors and materials delivery in combination with ongoing product dispatches.

(2) The products transported by road include LPG, fuel oils, petrol, kerosene and diesel and petrochemical stocks such as acetone, toluene and isopropyl alcohol. In the event of a road traffic accident, a loss of product containment could occur resulting in the uncontrolled release of petroleum or petrochemicals into the environment.

7.2 Assessment Methodology

7.2.1 Traffic Flows

(1) An assessment of the traffic impacts arising from the proposed relocation of the Nga Ying Chau Terminal facilities to the South Tsing Yi site was carried out on behalf of CRPC [13]; this section therefore summarises the principal finding of this study.

(2) Traffic surveys were conducted during March 1992 to provide baseline information for the determination of future trip generation from the new Terminal operations. A standard equivalent passenger car unit (PCU) was applied to the results of traffic surveys. Table 7.2.1.1 presents the existing traffic flow on Tsing Yi Road at the South East Tsing Yi CRPC site.

TABLE 7.2.1.1: EXISTING TRAFFIC FLOWS ON TSING YI ROAD [13]

Time Period	Hourly PCUs
Morning	
Westbound	420
Eastbound	220
Evening	
Westbound	250
Eastbound	330

(3) The Tsing Yi Road is a dual 2-lane road which runs from the Tsing Yi Bridge to south Tsing Yi at which point it narrows to a single 2-lane road. Currently for the majority of the dual 2-lane road section from the roundabout junction with Ching Hong Road to the existing CRPC site, parked container lorries and other vehicles on both sides of the road reduce the capacity to one lane in each direction. The presence of slow moving vehicles turning into site accesses along this section of road in combination with the reduction in road capacity due to vehicle parking leads to occasional interruptions to traffic flow.

(4) Tsing Yi is linked to the mainland by two bridges; Tsing Tsuen (north) and Tsing Yi bridges (south). Tsing Yi bridge is a single 2-lane carriageway and currently experiences extreme congestion at the western (Tsing Yi Island) end.

(5) Several planned road improvement schemes should have been completed prior to completion of the new CRPC Oil Terminal in 1997. These improvements which include the duplicate Tsing Yi Bridge, Tsing Yi Road, Route 3 and Hing Fong Road improvements are anticipated to significantly improve traffic conditions to and from south Tsing Yi [13].

(6) The SETY study [3] produced traffic forecasts for the years 1996 and 2001 using the SATURN (Simulation and Assignment of Traffic in Urban Road Networks) traffic model; this same model was used to predict the effect of the increased traffic flows associated with the CRPC Terminal development.

7.3 Road Traffic Impact

7.3.1 Effect on traffic Flows

(1) The traffic impact assessment concluded that acceptable operating conditions will occur following the CRPC and SETY development projects with traffic volumes unlikely to exceed road capacity; on this basis there should be no negative traffic impacts resulting from the proposed CRPC Terminal development.

7.3.2 Accidental Spillage

(1) The petrochemical and petroleum products transported by road from the new CRPC site have the potential to cause significant environmental contamination in the event of an uncontrolled release.

(2) Products will be transported from the site either in bulk tankers with a capacity of 10,000 litres (petroleum products) and 6000 litres (petrochemical stocks) or contained in drums/tins with capacities of 200 litres and 18 litres respectively [7],[6].

(3) From an environmental perspective the worst case scenario would be an accident involving a bulk transport tanker which resulted in a catastrophic tank rupture. An unignited uncontrolled release of 10000 litres of motor gasoline or 6000 litres of petrochemicals into the environment could result in significant contamination. Released gasoline, acetone, IPA or toluene will pose a significant fire hazard and will enter the roadway drainage system and will therefore be ultimately discharged either to a sewerage works or direct to the marine environment.

(4) The risk and safety issues associated with the road transport of hazardous materials on Tsing Yi Island have been previously addressed by another study [42] and are therefore not considered further.

7.4 Mitigation

(1) Mitigating against the environmental effects of a spillage arising as a result of a road traffic accident is more difficult than for a fixed installation as conventional engineering remedial measures are often not practical on a vehicle due to size and weight constraints.

Possible means of reducing the risk of spills from road tankers can be categorised as:

- Improved tanker design (hardware measures)
- Improved operational practices
- Improved safety management
- Improved emergency planning

These are reviewed in turn.

(2) **Improved tanker design** may involve (depending on the existing design standards):

- Compliance with existing codes of practice or regulations. This may involve improving the tanker design or labelling to reflect international practices or enforcing compliance with regulations using spot-checks to identify deficiencies. Such deficiencies are believed to be much less common with tankers operated by oil companies than with independently operated vehicles.

- Anti-lock brakes and other techniques to reduce the likelihood of the tanker being involved in an accident.

- Thicker tank walls or protective barriers, to reduce the likelihood of a puncture in an accident. These are not generally used, except for liquefied gases.

- Low centres of gravity and other techniques to reduce the likelihood of roll-over or corners or in accidents. Since many spills result from roll-overs, this is likely to be beneficial, but it is best suited to long-term tanker fleet development, due to the expense of buying new vehicles. There is a danger that better road-holding ability will lead to faster driving, so this needs to be coupled with driver safety training.

- Shielded valves and other techniques to reduce the likelihood of shearing in a roll-over. This has already been widely adopted.

- Devices to prevent over-filling during loading. Loading meters with pre-set stop functions are widely used.

- Devices to isolate the loading arm in the event of a spill, such as excess-flow valves and emergency stop facilities. These are already widely used.

- Portable telephones in drivers' cabs, to alert emergency services in the event of an accident. These are being widely adopted. They should be accompanied by procedures limiting their use during normal driving.

In general, once a good basic standard of tanker design has been achieved, further hardware improvements are not cost-effective. The main exception is a portable telephone, which is recommended.

(3) **Improved operational practices** may involve:

- Routing of vehicles to avoid areas of population or particularly hazardous roads. On Tsing Yi, there is very little scope for this.

- Scheduling of vehicles to avoid times of high traffic density. This is probably not practicable within the operating constraints of an oil Terminal. Movement at night reduces the level of traffic on the road, but the frequency of accidents per km is higher in general, and the traffic speeds are also higher, so no major benefit is expected.

- Use of smaller loads for narrow, congested routes. The load size of a tanker is largely determined by access constraints at the delivery point, and loads in Hong Kong are already relatively small. In principle, larger and less frequent loads may be advantageous in certain circumstances, but this is probably not appropriate for Hong Kong.

- Use of moderate speeds and careful driving. This is part of defensive driving, considered below, but should also be supported by scheduling which avoids unnecessary time-pressures.

- Avoiding unnecessary stops while the tanker is loaded. Such stops are believed to be rare in Hong Kong already due to time-pressures.

In general, there is little scope for risk reduction by improved operational practices.

(4) **Improved safety management** may involve:

- Use of good general safety management practices. This may require the tanker drivers to be brought within the oil company's safety management system, or programme of safety management improvement and audit to be applied to the tanker operators.

- Selection of drivers with suitable experience, temperament and health for the job. General accident rate data suggests that drivers should not be aged less than 25.

- Medical examinations for drivers, especially those aged 50 or over, to identify possible health problems.

- Counselling and possible testing of drivers to prevent problems with drink or drugs.

- Training of drivers in defensive driving to avoid accidents.

- Provision of information to the driver about the substances carried.

- Provision of safety handbooks and operating procedures for drivers.

- Reporting of incidents during transport and analysis to identify incipient problems or trends.

In general, improved safety management measures are highly cost-effective, and hence the above measures are all recommended.

(5) **Improved emergency planning** may involve:

- Preparation of a formal emergency plan for transport accidents.
- Exercising the plan with Fire Services, the oil company, and as many drivers as possible.
- Provision of appropriate equipment to the drivers for sealing or impounding a small spill, or warning drivers and pedestrians in the event of a large spill.
- Provision of information to the public on how to recognise and avoid hazardous situations. This may be by leaflet distribution or through community organisations for residents. For other drivers, media campaigns could be used, as in the UK, or key safety information could be included in the Highway Code and examined as part of the normal driving test, as in Norway.

In general, improved emergency planning is highly cost-effective, and hence the above measures are all recommended.

7.5 Conclusions

(1) Significant negative impact on traffic flows on Tsing Yi as a result of the CRPC Terminal development are not anticipated.

(2) The nature of the products that will be handled by road is such that, an accident resulting in a product spillage will result in a significant fire hazard and potentially lead to environmental contamination.

8.0 SOIL AND GROUNDWATER CONTAMINATION

8.1 General

(1) The bulk storage and handling of petroleum and petrochemical products has the potential to cause soil and groundwater contamination in the event of an uncontained spillage or undetected leakage.

8.1.1 Assessment Criteria

(1) Hazards posed by soil and groundwater contamination will depend on the chemical, physical and toxicological characteristics of the contaminants, the quantities and concentrations of these compounds, interactions between the soil/groundwater system and these compounds, and the pathways by which contaminants might reach sensitive targets (humans, biological resources and their habitats).

(2) EPD currently have not defined specific process/land use assessment criteria for defining levels of contamination (it is understood that general criteria specific to the nature of land use are due to be developed).

8.2 Impact on Soil and Groundwater

(1) The potential for the operations/nature of products handled at the CRPC Terminal to cause contamination of soil and ground water resources has been taken into account during the design of the new facilities. Design measures which have been incorporated include the provision of hardstanding surfaces in areas where accidental spillages may occur; provision of segregated drainage/containment systems to prevent contaminants entering the environment. The storage facilities (tanks) have been designed in accordance with the Code of Practice for Oil Storage Installations, 1992; provisions incorporated into the design of the CRPC Terminal under this Code of Practice with the objective of preventing contamination of the soil or groundwater include:

- a 50mm thick bitumen/sand mix impermeable layer to protect the tank bottom and to provide a barrier to any leaking products.
- tanks will be enclosed within a bunded area with a reinforced concrete floor, capable of containing an accidental release/leakage.

(2) Although the design of the new CRPC Terminal has considered the potential to cause contamination of the soil and groundwater and has incorporated suitable mitigation measures, in principal contamination of underlying resources could occur and may be difficult to detect; leakage through tank bottoms or permeation of surface contaminants via cracks in concrete flooring or faulty expansion seals may accumulate and be undetected for a considerable period of time. Accumulated contaminants would ultimately permeate into the water table. Due to the liquid nature of the potential contaminants that could arise from the CRPC Terminal, and the difficulty of detecting the leaks potentially giving rise to contamination, a groundwater monitoring programme is recommended.

8.3 Soil and Groundwater Monitoring

(1) Appropriate sampling procedures are of paramount importance in order to obtain valid samples; issues to be considered for collection of ground water samples include:

- Precautions to be taken to ensure that a representative sample is collected
- Preservation of the sample to ensure that no deterioration/chemical changes occur prior to analysis
- Extraction techniques appropriate to the nature of parameters to be tested for.

(2) It is recommended that for appropriate sampling and analytical procedures reference is made to ASTM D510-68: Sampling Industrial Water, ASTM D1496-67: Sampling Homogenous Industrial Waste Water and API Publication No. 4449: Manual of Sampling and Analytical Methods for Petroleum Hydrocarbons in Groundwater and Soil.

<u>Groundwater Sampling</u>

(3) Four boreholes (subject to EPD approval) should be provided for the new Terminal at the following locations (see Figure 8.3.1):

- Adjacent to the chemical filling shed
- Adjacent to the lorry loading gantry
- Adjacent to the petrochemical tank farm
- Adjacent to the HSFO/LDO tank farms

(4) The bore holes should be located such that there is no possibility for an accidental spillage to enter ground water directly via a bore-hole.

(5) Water samples from boreholes can be taken with a bailer, in-situ depth controlled water sampler or pump.

(6) Prior to sampling all equipment should be washed with deionized water and the well/borehole should be adequately purged/bailed prior to actual sampling. Monitoring for pH, conductivity and temperature should be carried out. Ideally three samples should be taken from each borehole and combined to provide a sample volume of 1 litre.

(7) Sample containers (preferably with Teflon liners and cap) should be clearly labelled and during the transfer of samples from the site to the analytical laboratory a strict custody transfer procedure should be employed.

<u>Monitoring Parameters</u>

(8) Soil and groundwater samples should be analyzed for total hydrocarbons, volatile organic compounds and petrochemicals (e.g. acetone, toluene, isopropyl alcohol and styrene monomer)

Monitoring Frequency

(9) Ground water monitoring should be carried out every three months or as agreed with EPD. In the event of a product spillage/suspected leakage event, ground water samples should be taken at regular intervals following the incident to determine if ground contamination has occurred.

8.4 Conclusions

(1) The design of the proposed facilities is considered to be adequate to contain and prevent the permeation of petroleum/petrochemical products during normal Terminal operations or as a result of a spillage. Potential contamination could still occur as a result of an undetected leakage or via cracks in containment devices resulting in contamination of groundwater.

9.0 ENVIRONMENTAL MONITORING AND AUDIT

9.1 Requirement For EM&A

(1) A programme of environmental monitoring and auditing is a requirement of the CRPC Terminal Development. This section therefore provides an outline approach for EM&A to be adopted by CRPC; specific requirements for EM&A will be refined post-detail design for approval by EPD (These specific EM&A proposals will reflect the finalised BPM requirements).

Environmental Monitoring

(2) Environmental monitoring during the operational phase of the CRPC Terminal is required in order to demonstrate compliance with legislative and guideline limit values (compliance monitoring), and as a means of quantifying any impacts arising from the development (impact monitoring).

Audit

(3) An audit programme is required in order to provide a framework for implementing and interpreting, reviewing/reporting monitoring results and activities; assess compliance with regulatory requirements: to assess the effectiveness of environmental management; to identify action plans and ameliorative and control measures required to redress unacceptable or unanticipated environmental impacts.

9.1.1 Operation Phase Environmental Monitoring and Audit

EM&A Requirements (Operation)

(1) The requirements for monitoring during the operation of the CRPC Terminal which have been defined in Sections 2.0-8.0 of this report are summarised in Table 9.1.1.1.

(2) If any exceedance of acceptable conditions are identified by the monitoring programme, EPD must be informed of the results and the proposed remedial actions to be undertaken.

(3) Environmental monitoring requires specialist skills; it is therefore recommended that CRPC train specific personnel to carry out all environmental monitoring and auditing tasks, reviews of the results and preparation of audit reports.

(4) The EM&A programme for operation of the new CRPC Terminal should include the following:

i) Verification and validation of all the monitoring results for noise, boundary air quality, groundwater (every 3 months) and effluent discharges.

ii) Collation and clear presentation of all monitoring data.

iii) An analysis and interpretation of the monitoring results in order to establish the environmental profile of the project at the time of the audit.

iv) Verification of whether the results of the environmental monitoring comply with or exceed the defined environmental quality limits and/or other regulatory requirements. Any exceedances of environmental quality limits and BPM requirements must be recorded.

v) On-site inspections and investigations to identify sources and causes of non-compliance with environmental quality limits and any unacceptable impacts.

vi) Verification of CRPCs statutory requirements and licensing conditions relating to the protection of the environment.

vii) Verify that all environmental mitigation measures are properly and effectively implemented. A review the adequacy of the implemented measures should also be carried out.

viii) Assessments of the effectiveness of the environmental management systems, practices and procedures for the CRPC Terminal.

ix) Identifying additional remedial measures in the case of non-compliance with environmental quality limits and improvements that could be made in management, environmental controls and site operations if the environmental objectives are not achieved.

x) Investigate any complaints from local residents and neighbouring industrial installations and the actions taken when complaints are received.

xi) Review the overall monitoring philosophy in terms of procedures, location of monitoring stations, frequency, parameters measured and test methods to ensure that environmental objectives are achieved.

Monthly EM&A Progress Report

(5) In order to ensure that the EM&A programme is correctly implemented an EM&A Progress Reports should be compiled once per month. The EM&A progress report for the CRPC Terminal operations should include the following:

i) An executive summary (1-2 pages)

ii) A brief summary of the CRPC operation and management structure.

iii) A summary of the EM&A requirements including:

- noise, air quality, groundwater and effluent discharge monitoring parameters.
- monitoring schedule
- environmental quality limits (e.g. BPM requirements, effluent discharge standards etc).
- recommended mitigation measures
- environmental requirements specified in licensing conditions.

iv) Plans identifying the location of sensitive receivers and noise, air, groundwater and effluent discharge monitoring locations.

v) Monitoring results (in both hard and computer diskette copy) together with the following information:

- description of the monitoring methodology.
- inventory of equipment used and calibration details (calibration certificates should be provided).
- parameters monitored.
- monitoring date, time, frequency, duration and period.
- weather conditions at the time of sampling/measurement (e.g. where relevant: wind speed & direction, temperature, precipitation, relative humidity etc)
- details of any factors which may have affected monitoring results (up-set operational conditions etc)

vi) A summary of non-compliance with environmental performance limits.

vii) A review of the reasons for non-compliance including a review of the sources of pollution and working procedures.

viii) A description of the remedial actions that were taken in the event of non-compliance and details of any follow-up procedures related to earlier non-compliance.

ix) A summary of the inspection reports compiled by the individual responsible for environmental management.

x) A record of all complaints (written or verbal) received, including the location and nature of the complaint; consultations and liaisons undertaken, and actions and follow-up procedures taken.

xi) Comments and conclusions for the month

9.1.2 Post-Project Environmental Monitoring and Audit

EM&A Requirements (Operation)

(1) A post-project audit of the CRPC Terminal should be carried out approximately eighteen months after the commencement of full Terminal operations. The principal objectives of the post-project audit are as follows:

- to determine compliance with statutory limits and achievement of environmental objectives
- to establish the environmental profile of the Terminal operations.
- on-site inspections and investigations to identify sources and causes of non-compliance with environmental quality limits and any unacceptable impacts.

- to verify whether CRPC are fulfilling statutory requirements and licensing conditions relating to the protection of the environment.

- to verify that pollution abatement measures are properly and effectively implemented. A review of the adequacy of the implemented measures should also be carried out.

- to assess the effectiveness of the environmental management systems, practices and procedures for the CRPC Terminal development.

- to identify improvements to Terminal operations in the case of non-compliance with environmental quality limits.

(2) It is recommended that an independent environmental consultancy is commissioned by CRPC to carry out the post-project audit.

TABLE 9.1.1.1 OPERATIONAL PHASE ENVIRONMENTAL MONITORING SCHEDULE

Parameter	Location	Objectives	Standard	Frequency	Audit
Air Quality Benzene	Boundary monitoring locations (subject to EPD approval)	Compliance monitoring	BPM required limit of 185$\mu g/m^3$ [subject to BPM finalisation]	Monthly (subject to EPD approval)	Prepare EM&A report and submit to EPD
Effluent Water Quality pH, colour, TSS, BOD, COD, oil & grease	CPI (or future effluent treatment plant) discharge locations	Compliance monitoring	Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters	Monthly or when requested by EPD	Prepare EM&A report and submit to EPD
Noise L_{eq} (30 min)	Two nearest sensitive receptors (Technical College & Mayfair Gardens) and on site boundary	Compliance/impact monitoring	Technical Memorandum	Post commissioning survey	Prepare EM&A report and submit to EPD
Groundwater Total hydrocarbon, volatile organics (toluene, acetone, IPA, styrene)	Site boreholes (subject to EPD approval)	Impact monitoring (identify occurrence of groundwater contamination)	To be defined by EPD	Every three months	Prepare EM&A report and submit to EPD

10.0 REFERENCES

1. "Initial Environmental Assessment Of CRPC South East Tsing Yi Petroleum Terminal, Tsing Yi Island Hong Kong" DNV Technica Draft Report DNV-T/K5220.IAR, June 1993.

2. Notes on the Best Practicable Means Requirements For Organic Chemical Works (Bulk Storage of Organic Liquid), Third Draft, HK EPD, 1994.

3. " Environmental Impact Assessment for South-East Tsing Yi Port Development - Working Paper No. 9 ", Maunsell-Scott Wilson, April 1991.

4. "Evaporative Loss From Fixed Roof Tanks". American Petroleum Institute Publication 2518, Second Edition, 1991.

5. "Evaporative Loss From Internal Floating Roof Tanks". American Petroleum Institute Publication 2519, Third Edition, 1989.

6. "Hydrocarbon Emissions for Gasoline Storage and Distribution Systems" CONCAWE Report No. 85/54, 1986.

7. "Study report on Lorry Loading Facilities". JGC Corporation DOC No. T-00-1212-003 Rev.1, February 1993.

8. "Study report on Chemical Filling Plant". JGC Corporation DOC No. T-00-1212-008 Rev.0, April 1993.

9. "Evaporative Loss from Storage Tanks". R.J Laverman, Institute of Petroleum Fourth Oil Loss Conference, Real and Apparent Losses in Refining and Storage. October 1991.

10. Warren Spring Laboratory (WSL) (1980): "Odour Control - A Concise Guide" WSL, Stevenage.

11. "Compilation of Air Pollutant Emission Factors - Volume 1: Stationary, Point and Area Sources" AP-42 Fourth Edition, US Environmental Protection Agency, Office of Air Quality Planning and Standards. September 1985.

12. "Compilation of Odour Threshold Values in Air and Water." Central Institute for Water Supply and Central Institute for Nutrition and Food, Netherlands, June 1977.

13. "Traffic Impact Assessment - Oil Terminal Relocation, Tsing Yi South." Wilbur Smith Associates, July 1992.

14. "Utility Generator Quantity and Capacity" JGC Corporation Doc No. S-70-1223-001 Rev.02, March 1993.

15. "Water Pollution Control Ordinance (Cap. 358, 1980)"

16. "Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters"

17. "Code of Practice for Oil Storage Installations". Building Authority, Hong Kong, 1992.

18. "Construction Phase Key Issues Assessment of CRPC South East Tsing Yi Petroleum Terminal, Tsing Yi Island Hong Kong" DNV Technica Draft Report DNV-T/K5220.KIC, June 1993.

19. "Consideration on Sewer and Drainage System" JGC Corporation Doc No. S-85-1223-001 Rev.A, March 1993.

20. "Effluent Summary" JGC Corporation Doc No: S-85-1223-002 Rev.01, March 1993.

21. "Corrugated Plate Interceptors", Mansfield G.E. American Institute of Chemical Engineers National Meeting Publication, New York, USA, 1987.

22. "Characteristics and possibilities of Some Techniques for De-oiling produced Water", W.M.G.T van den Broek et al, 1991.

23. "Process Requirements for CPI Separator" JGC Corporation Doc No. S-85-1223-003 Rev.0, April 1993.

24. "Chemical Hazard Response Information (CHRIS) - Hazardous Chemical Data", 1984 U.S. Dept. of Transportation

25. "The Evaluation of the Hazards of Harmful Substances Carried by Ships." Revision of GESAMP Reports and Studies No.17. International Maritime Organisation, 1989.

26. "Impact of Oil on the Marine Environment" GESAMP Reports and Studies No.6. Food and Agriculture Organisation of the United Nations, Rome, 1977.

27. "Long-term Environmental Effects of Offshore Oil and Gas Development." Donald F. Boesch and Nancy N. Rabalais. Louisiana Universities Marine Consortium Chauvin, USA, July 1987.

28. "Pump Quality and Capacity for New CRC Tsing Yi Terminal Project". JGC Corporation T-00-1212-005 dated March 1993.

29. 'Noise Procedure Specification', EEMUA Specification 140.

30. 'The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities;, CONCAWE Report 4/81, 1981.

31. "Hong Kong Planning & Standards Guidelines", 1991.

32. "Accidental Oil Pollution of the Sea", Pollution Paper No. 8, 1976, Department of the Environment, U.K.

33. "Study Report on Product jetty Facilities for New CRC Tsing Yi Terminal Project", JGC Corporation Doc No. T-00-1212-002 Rev. 3, 5 March 1993.

34. "Draft Report on Hazard Assessment of the Redeveloped Site, Tsing Yi Terminal", DNV Technica, Aug. 1993.

35. "South East Tsing Yi Port Development Planning and Engineering Feasibility Study For Container Terminal No.9" Maunsell-Scott Wilson, Final Report, August 1991.

36. "Response To Marine Spills", The International Tanker Owners Pollution Federation, 1991.

37. "Environmental and Technical Information for Problem Spills, Styrene" Canadian Environmental Service, Canadian Government Publishing Centre, Ottawa, Canada, 1984.

38. "Environmental and Technical Information for Problem Spills, Toluene" Canadian Environmental Service, Canadian Government Publishing Centre, Ottawa, Canada, 1984.

39. "Waste Disposal (Chemical Waste)(General) Regulation (Cap. 354)"

40. "Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes", EPD

41. "A Guide to the Registration of Chemical Waste Producers", EPD, 1992.

42. "Tsing Yi Island - Risk Reassessment Report" Final Report, Technica Ltd, April 1989.

43. "Workbook of Atmospheric Dispersion Estimates" D. B Turner, Environmental Protection Agency, Research Triangle Park, USA, 1970.

44. "The Shipping and Port Control Ordinance, 1978 (Cap.313)"

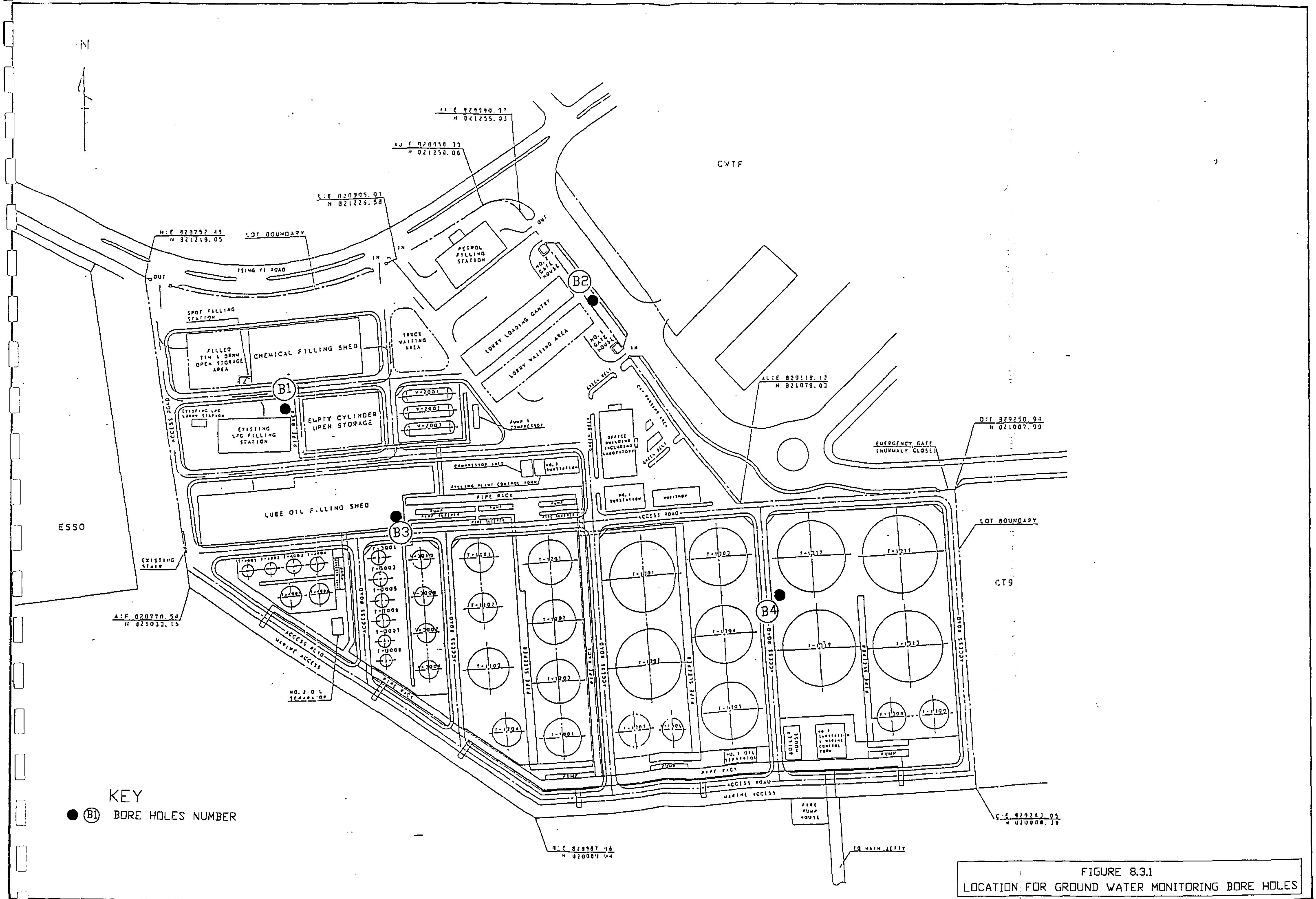


FIGURE 8.3.1
LOCATION FOR GROUND WATER MONITORING BORE HOLES

APPENDIX I
FUGITIVE VOC EMISSION FACTORS

I.1.1 Storage Tanks

Three types of tank will be utilised for storage at the CRPC Terminal; cone roof tanks (with and without internal floating roof) and dome roof tanks with an internal floating roof. The physical parameters of the proposed storage tanks and an inventory of the products types to be stored is summarised in Table I.1.1

TABLE I.1.1: PRODUCT STORAGE AND TANK PHYSICAL PARAMETERS

Tank	Product	Class	Type	Diameter (m)	Height (m)	Capacity m^3
T-1101	ULP	1	DRT (IFR)	17.7	21.9	5,000
T-1102	LP-1	1	DRT (IFR)	17.7	21.9	5,000
T-1103	LP-2	1	DRT (IFR)	25	22	10,000
T-1201	Jet A-1	2	CRT	26.9	22	12,000
T-1202	Jet A-1	2	CRT	26.9	22	12,000
T-1203	Jet A-1	2	CRT	26.9	22	12,000
T-1204	Kerosene	2	CRT	17.4	21.8	5,000
T-1205	Jet A-1/Water	2	CRT	2.41	2.5	10
T-1301	LDO	3	CRT	42.6	22	30,000
T-1302	LDO	3	CRT	42.6	22	30,000
T-1303	LDO	3	CRT	34.8	22	20,000
T-1304	LDO	3	CRT	34.8	22	20,000
T-1305	LSFO	3	CRT	34.8	22	20,000
T-1306	BDO	3	CRT	13.5	21.8	3,000
T-1308	SPE-LDO	3	CRT	17.4	21.8	5,000
T-1309	MDO/HSFO-80	3	CRT	17.4	21.8	5,000
T-1310	HSFO-380	3	CRT	46	22	35,000
T-1311	HSFO-180	3	CRT	46	22	35,000
T-1312	HSFO-180	3	CRT	42.6	22	30,000
T-1313	HSFO-120	3	CRT	42.6	22	30,000
T-1321 A/B	Red Dye	-	CRT	3.85	4.6	50
T-3001	Toluene-A	1	CRT (IFR)	8.7	15.9	900
T-3002	Toluene-A	1	CRT (IFR)	11.8	18	1,800
T-3003	Toluene-B	1	CRT (IFR)	8.7	15.9	900
T-3004	Toluene-B	1	CRT (IFR)	11.8	18	1,800

TABLE I.1.1: (continued)

Tank	Product	Class	Type	Diameter (m)	Height (m)	Net Capacity m³
T-3005	Acetone	1	CRT (IFR)	8.2	15.8	800
T-3006	Acetone	1	CRT (IFR)	8.2	15.8	800
T-3007	IPA	1	CRT (IFR)	7.4	14.6	600
T-3008	IPA	1	CRT (IFR)	7.4	14.6	600
T-3009	Flux-A	1	CRT (IFR)	11.8	18	1,800
T-3010	Flux-B	1	CRT (IFR)	11.8	18	1,800
T-5001	SM	2	DRT (IFR)	23.3	22	8,900
T-4001	Lube Oil	3	CRT	7.4	14.6	600
T-4002	Lube Oil	3	CRT	7.4	14.6	600
T-4003	Lube Oil	3	CRT	8.7	15.9	900
T-4004	Lube Oil	3	CRT	8.7	15.9	900
T-4005	Lube Oil	3	CRT	12.4	22	2,500
T-4006	Lube Oil	3	CRT	12.4	22	2,500
T-7101	BFO	3	CRT	2.89	4.6	26

Legend for Table I.1.1

Tank Type

CRT	Cone Roof Tank
CRT (IFR)	Cone Roof Tank with Internal Floating Roof
DRT (IFR)	Dome Roof Tank with Internal Floating Roof

Product

ULP	Unleaded Petrol
LP	Leaded Petrol
LDO	Light Diesel Oil
LSFO	Low Sulphur Fuel Oil
BDO	Boiler Diesel Oil
MDO	Marine Diesel Oil
HSFO	High Sulphur Fuel Oil
IPA	Iso Propyl Alcohol
SM	Styrene Monomer

I.1.1.1 Product Physical Properties

The physical properties used for the estimation of fugitive emissions of the products handled at the new CRPC Terminal have been derived from information provided by CRPC and from relevant literature [4],[5],[9],[11],[24]; physical properties are summarised in Table I.1.1.1. Where suitable physical properties were not available in the literature, representative values were selected from similar products.

TABLE I.1.1.1: PHYSICAL PROPERTIES OF PRODUCTS HANDLED

Product	Molecular Wt of Vapour (g/mol)	True Vapour Pressure at 60°F (psia)	Product Specific Gravity
Leaded/Unleaded	66.0	3.707	0.732
Petrol	130	0.008	0.8
Kerosene	130	0.030	0.8
Aviation Oil	92.13	0.309	0.867
Toluene	58.08	2.862	0.791
Acetone	60.09	0.483	0.785
Iso Propyl Alcohol	130	0.006	0.83
Light Diesel Oil	130	4.3×10^{-5}	0.95
High Sulphur Fuel Oil	130	4.3×10^{-5}	0.95
Low Sulphur Fuel Oil	130	0.006	0.879
Boiler/Marine Diesel	130	4.3×10^{-5}	0.902
Oil	104.15	0.082	0.906
Lube Oil			
Styrene Monomer			

I.1.2 Evaporative Loss From Internal Floating Roof Tanks (IFRT)

This section presents the American Petroleum Institute (API) methodology (API Publication 2519) for the evaporative loss calculation procedures for IFRTs

Total Loss

The total Loss, L_T, is the sum of the withdrawal loss (L_W) and the standing storage loss (L_S). Equation 1:

$$L_T = L_W + L_S \tag{1}$$

Withdrawal Loss

The withdrawal loss (L_W). Equation 2:

$$L_W = (0.943) \left(\frac{Q\ C\ W_L}{D} \right) \left[1 + \left(\frac{N_C\ F_C}{D} \right) \right] \tag{2}$$

Standing Storage Loss

The standing storage loss (L_S). Equation 3:

$$L_S = (F_R\, D + F_F + F_D)\,(P^*\, M_V\, K_C) \tag{3}$$

The vapour pressure function (P*). Equation 4:

$$P^* = \left(\frac{P}{P_A}\right)\left[1 + \left(1 - \frac{P}{P_A}\right)^{0.5}\right]^{-2} \tag{4}$$

Stock vapour pressure (P) is determined at the stock liquid bulk storage temperature (T_B).

Rim Seal Loss Factor

The rim seal loss factor (F_R) for IFRTs depends on the tank construction parameters; rim seal system type and seal fit. IFRT rim seal loss factors for different rim seal systems with average-fittings seals are presented in Table A.

Roof Fitting Loss Factor

Roof fitting loss factor (F_F) depends on the roof fitting type and roof fitting construction parameters. IFRT roof fitting loss factor for typical roof fitting construction details are presented in Table B.

Roof Seam Loss Factor

Roof seam loss factor (F_D) accounts for the evaporative loss that occurs from seams on IFRT floating roofs. Equation 5:

$$F_D = K_D\, S_D\, D^2 \tag{5}$$

Product Factor

Product factors (K_C) is taken to be 1.0 for single component petrochemical stocks.

Stock Clingage Factor

Stock clingage factor (C) relates to the quantity of stock that clings to the inside surface of the tank shell and surfaces of roof support columns when stock is withdrawn from the tank. Clingage factor for different stock types and surface conditions are presented in Table C.

I.2.1 Evaporative Loss From Fixed Roof Tanks (FRT)

This section presents the American Petroleum Institute (API) methodology (API Publication 2518) for the evaporative loss calculation procedures for FRTs

Total Loss

Total loss (L_T) is the sum of the working loss (L_W) and the standing storage loss (L_S). Equation 6:

$$L_T = L_W + L_S \tag{6}$$

Working Loss

Working loss (L_W). Equation 7:

$$L_W = 0.0010\ M_V\ P_{VA}\ Q\ K_N\ K_P \tag{7}$$

Standing Storage Loss

Standing storage loss (L_S). Equation 8:

$$L_S = 365\ (V_V\ K_E)\ (W_V\ K_S) \tag{8}$$

Tank vapour space volume (V_V). Equation 9:

$$V_V = \frac{\pi}{4}\ D^2\ H_{VO} \tag{9}$$

Stock vapour density (W_V). Equation 10:

$$W_V = \frac{M_V \, P_{VA}}{R \, T_{LA}} \tag{10}$$

<u>Vapour Space Expansion Factor</u>

Vented vapour expansion factor (K_E). Equation 11:

$$K_E = \left(\frac{\Delta T_V}{T_{LA}}\right) + \left(\frac{\Delta P_V}{P_A - P_{VA}}\right) - \left(\frac{\Delta P_B}{P_A - P_{VA}}\right) \tag{11}$$

Daily average stock liquid surface temperature (T_{LA}). Equation 12:

$$T_{LA} = 0.44\ T_{AA} + 0.56\ T_B + 0.0079\ \alpha\ I \tag{12}$$

Daily vapour temperature range (ΔT_V). Equation 13:

$$\Delta T_V = 0.72\ \Delta T_A + 0.028\ \alpha\ I \tag{13}$$

Daily maximum liquid surface temperature (T_{LX}). Equation 14:

$$T_{LX} = T_{LA} + 0.25\ \Delta T_V \tag{14}$$

Daily minimum liquid surface temperature (T_{LN}). Equation 15:

$$T_{LN} = T_{LA} - 0.25\ \Delta T_V \tag{15}$$

Liquid bulk temperature (T_B) can be taken from tank operating records or estimated from Equation 16:

$$T_B = T_{AA} + 6\ \alpha\ -1 \tag{16}$$

To calculate the temperatures in Equations 12, 13 and 16, the following meteorological information for the tank site is required:

Daily average ambient temperature (T_{AA}).
Daily ambient temperature range (ΔT_A).
Daily total solar insolation (I).

Stock vapour pressure at daily maximum stock liquid surface temperature (P_{VX}). Equation 17:

$$P_{VX} = \exp\left[A - (B/T_{LX})\right] \tag{17}$$

Stock vapour pressure at daily average stock liquid surface temperature (P_{VA}). Equation 18:

$$P_{VA} = \exp\left[A - (B/T_{LA})\right] \tag{18}$$

Stock vapour pressure at daily minimum stock liquid surface temperature (P_{VN}). Equation 19:

$$P_{VN} = \exp\left[A - (B/T_{LN})\right] \tag{19}$$

Stock daily vapour pressure range (ΔP_V). Equation 20:

$$\Delta P_V = P_{VX} - P_{VN} \tag{20}$$

Constants A and B depend on stock type

Vented Vapour Saturation Factor

Vented vapour saturation factor (K_S). Equation 21:

$$K_S = \frac{1}{1 + 0.053\ P_{VA}\ H_{VO}} \tag{21}$$

Working Loss Turnover Factor

Working loss turnover factor (K_N). Equations 22 and 23:

$$K_N = \frac{180 + N}{6N} \quad (for\ N > 36) \tag{22}$$

$$K_N = 1 \quad (for\ N \leq 36) \tag{23}$$

Working Loss Product Factor

Working loss product factor (K_P) is taken as 1.0 for refined petroleum stocks and single-component petrochemical stocks

TABLE A: IFRT ROOF FITTING LOSS FACTORS

	Roof Fitting Type and Construction Details	F_F (lb-mole/yr)
1.	VACUUM BREAKER Weighted Actuation, Gasketed	0.7
2.	STUB DRAIN	1.2
3.	ACCESS HATCH Bolted Cover, Gasketed	1.6
4.	ROOF LEG Adjustable	7.9
5.	GAUGE-FLOAT WELL Unbolted Cover, Ungasketed	28.0
6.	COLUMN WELL Pipe Column, Sliding Cover, Ungasketed	32.0
7.	UNSLOTTED GUIDE-POLE WELL Sliding Cover, Ungasketed	32.0
8.	SLOTTED GUIDE-POLE/SAMPLE WELL Sliding Cover, Ungasketed	57.0
9.	LADDER WELL Sliding Cover, Ungasketed	76.0

TABLE B: CLINGAGE FACTOR, C (BBL/1000 FT^2)

Product	Shell Condition		
	Light Rust	Dense Rust	Gunite Lined
Gasoline	0.0015	0.0075	0.15
Single - Component Stocks	0.0015	0.0075	0.15
Crude Oil	0.0060	0.030	0.60

TABLE C: SOLAR ABSORPTANCE

Colour	Shade/Type	Paint Condition	
		Good	Poor
Aluminium	Specular	0.39	0.49
Aluminium	Diffuse	0.60	0.68
Grey	Light	0.54	0.63
Grey	Medium	0.68	0.74
Red	Primer	0.89	0.91
White	------	0.17	0.34

I.1.4 Road Tanker Filling Emissions

Transport filling emissions arise when a volatile product is loaded into a bulk transport compartment. CONCAWE, Report No. 85/54 provides emission factor equations for emission from transport operations.

The emitted vapour is normally a mixture of:

a) Preloading Vapour (PLV)

This is residual vapour originating from the previous contents, which is displaced by the product loaded. It is defined as a fraction or percentage of full saturation (C_p)

b) Evolution Vapour (EV)

This is vapour which evaporates from the batch of product due to splashing and turbulence, and is displaced by the continuing addition of liquid gasoline.

Factors Affecting Filling Emissions

a) True vapour pressure of the product loaded.

b) The type of operation conducted with the previous tank contents, which influences the magnitude of PLV.

c) The degree of splashing and turbulence which occurs during loading, which influences the magnitude of EV.

Note that factors (b) and (c) have an interaction. A high preloading vapour content of a compartment will tend to suppress the quantity of vapour evolved during loading.

Preloading Vapour (PLV)

The preloading vapour concentration in gasoline transport compartments may vary widely from near zero to completely saturated. Typical concentrations, expressed as a fraction or as a percentage of saturation (C_p) are:

a) Previous contents non-volatile product such as kerosene: less than 1%

b) Road tanker compartment after complete discharge at one point: 10-20%

c) Road tanker compartment after discharge at more than one point: 30-50%

d) Road tanker compartment after discharge at service station tank with vapour return: 90-100%

Evolution Vapour (EV)

The quantity of vapour emitted as EV will be influenced by the design and mode of operation of the filling device, and the preloading vapour. EV will be minimum for bottom filling, provided the inlet has a suitable deflector plate, or other device, to ensure there is no splashing of liquid as the compartment fills. EV will be a maximum for splash filling.

Between these extremes there may be a number of intermediate values. For example, if a top-loading submerged filling arm is placed with the outlet at the bottom of a compartment, EV would be near to that for bottom filling. In practice, due to design or working deficiencies, it is sometimes found that the filling arm is not placed at the bottom of a compartment, and partial splash loading ensues until the outlet is covered. In such cases evolution vapours may be significantly higher than for bottom or fully submerged top fill.

Parameter, V_b, represents the amount of splashing which may be used to estimate evolution vapours. V_b is equal to the fraction of the original tank atmosphere which is assumed to be completely saturated during loading. Typical values are presented in Table I.1.4.1:

TABLE I.1.4.1: TYPICAL VALUES OF PARAMETER V_B

		V_b Range	V_b Average
Road Top Loading (90 - 180 m³/h)			
a)	Arm outlet height 0 - 0.2m from bottom compartment	0.08 - 0.22	0.15
b)	Arm outlet height 0 - 0.2m from bottom compartment with slow-start valve		0.13
c)	Arm outlet height 0.38 - 1.4 m from bottom of compartment	0.26 - 0.54	0.40
Road Bottom Loading (90 - 120 m³/hr)		0.09 - 0.16	0.13

Calculation of Filling Emissions for Road Tankers

The following equation may be used to calculate the filling emissions likely to occur when loading road tankers.

$$E_f = 0.45 \times C_s \left(C_p + V_b \frac{1 - C_p}{1 - C_s} \right)$$

where:

E_f = Filling emission (liquid equivalent) expressed as a percentage of the volume of liquid loaded.

C_s = Vapour concentration at full saturation as a volume fraction, which can be taken as equal to the TVP in bars, i.e. kPa x 10^{-2}.

C_p = Average preloading vapour concentration expressed as a fraction of full saturation.

V_b = The parameter representing the fraction of the tank volume containing saturated vapour as a result of splashing during filling.

The values in Table I.1.4.2 can be taken for E_f where input data for the equation are not available.

TABLE I.1.4.2: E_F ESTIMATION TABLE

	Top Road Loading		Bottom Road Loading
	Submerged	Partial Splashing	
Evolution vapour (E_f) % volume of liquid loaded	0.055	0.106	0.050

I.1.5 Average SOCMI Emission Factors

Emission factors for estimating fugitive losses from process equipment are based on the component population counts. Table I.1.4 shows the Average Emission Factors for SOCMI population components.

TABLE I.1.5.1: AVERAGE SOCMI EMISSION FACTORS FOR FUGITIVE EMISSIONS

Equipment	Service	Emission Factor (kg/hr/source)
Valves	Gas Light Liquid Heavy Liquid	0.0056 0.0071 0.00023
Pump Seals	Light Liquid Heavy Liquid	0.0494 0.0214
Compressor Seals	Gas/Vapour	0.228
Pressure Relief Seals	Gas/Vapour	0.104
Flanges	All	0.00083
Open-Ended Lines	All	0.0017
Sampling Connections	All	0.0150

I.1.6 Nomenclature Used In Appendix I

Symbol	Description	Units
A	constant in the vapour pressure equation	dimensionless
B	constant in the vapour pressure equation	$^{\circ}R$
C	clingage factor	bbl/1000 ft^2
D	tank diameter	ft
F_C	effective column diameter	ft
F_D	roof seam loss factor	lb-mole/yr
F_F	total roof fitting loss factor	lb-mole/yr
F_R	rim seal loss factor	lb-mole-ft yr
H_{VO}	vapour space outage (or equivalent height)	ft
I	daily total solar insolation on a horizontal surface	Btu/ft^2 day
K_C	product factor	dimensionless
K_D	roof seam loss factor	lb-mole/ft yr
K_E	vapour space expansion factor	dimensionless
K_P	working loss product factor	dimensionless
K_S	vented vapour saturation factor	dimensionless
K_N	working loss turnover factor	dimensionless
L_S	standing storage loss	lb/yr
L_T	total loss	lb/yr
L_W	working loss or withdrawal loss	lb/yr
M_V	stock vapour molecular weight	lb/lb-mole
N	stock turnover rate	turnovers/yr
N_C	number of columns	dimensionless
P	stock vapour pressure	psia
P^*	vapour pressure function	dimensionless
P_A	atmospheric pressure	psia
ΔP_B	breather vent pressure setting range	psi
P_{VA}	stock vapour pressure daily average liquid surface temp)	psia
P_{VN}	stock vapour pressure at daily minimum liquid surface temperature	psia
P_{VX}	stock vapour pressure at the daily maximum liquid surface temperature	psia
ΔP_V	stock daily vapour pressure range	psi
Q	stock annual net throughput	bbl/yr
R	ideal gas constant	
S_D	roof seam length factor	ft/ft^2
T_{AA}	daily average ambient temperature	°R
Δ_{TA}	daily ambient temperature range	°R
T_B	liquid bulk temperature	°R
T_{LA}	daily average liquid surface temperature	°R
T_{LN}	daily minimum liquid surface temperature	°R
T_{LX}	daily maximum liquid surface temperature	
ΔT_V	daily vapour temperature range	°R
V_V	tank vapour space volume	ft^3
W_L	stock liquid density	lb/gal
W_V	stock vapour density	lb/ft^3
α	tank paint solar absorptance	dimensionless

I.1.7 SCREEN Model

Uses

The SCREEN model has been developed by the US EPA as a simple dispersion coding for prediction of short-term concentrations of gaseous pollutants. Based on previous US EPA regulatory models, and incorporating Pasquill-Gifford dispersion coefficients and Briggs plume rise formulae, the model uses the basic Gaussian dispersion equations to predict airborne concentration from point, area and flare sources.

Source Data

For this study the stack was modelled as a single point source emission, with the definition of stack height (m), the internal stack diameter (m), the pollutant emission rate (g/s), the exit velocity of stack gas (m/s), and the temperature of the exiting gas (K).

SCREEN models pollutant concentrations in a simplified downwind direction away from the source. Four terrain options are available to represent local terrain elevations away from the source in a particular direction:

- Flat terrain; for ground at or below the base of the stack;
- Simple terrain; for ground between the stack base elevation and the stack height;
- Complex terrain; for ground elevations above the top of the stack;
- Simple and complex terrain; a combination of simple and complex options.

In addition to local topographical phenomenon, the influence of structures near the stack on plume dispersion can be included, with the calculation of 'wake' effects on increased ground level concentrations near the release point. For the study, downwash effects were not included due to the elevated stack heights relative to local structures.

Meteorological Data

SCREEN has three meteorology options which are:

- full meteorology
- single stability
- stability and wind speed.

The 'full meteorology' allows the model to assess the worst possible weather combination at every distance point from the source. Output files give the worst weather conditions resulting in maximum predicted concentrations in terms of atmospheric stability (A to F) and wind speed.

'Stability and wind speed' requires the input of atmospheric stability and an associated wind speed for the analysis of specific conditions.

For this study, the full meteorology option was utilised in order to predict 1-hour concentrations in a downwind distance towards Mayfair Gardens.

Dispersion Calculations

SCREEN uses the simple source information in order to calculate pollutant concentrations at ground level or at user specified elevated receptor heights above ground level. For receptor elevations above the height of the stack, the model predicts pollutant concentrations over a 24-hour period. An estimated 1-hour maximum concentration can be derived from this 24-hour value by using a conversion factor of 2.5 [US EPA Users Guide For Screening Procedures For Estimating The Air Quality Impact Of Stationary Sources, August 1988].

APPENDIX II
EFFLUENT DISCHARGE STANDARDS

TABLE II.1.1: STANDARDS FOR EFFLUENTS DISCHARGED INTO THE INSHORE WATERS OF SOUTHERN, MIRS BAY, JUNK BAY, NORTH WESTERN, EASTERN BUFFER AND WESTERN BUFFER WATER CONTROL ZONES. (All units in mg/l unless otherwise stated)

Flow rate (m^3/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (°C)	40	40	40	40	40	40	40	40	40	40	40	40
Colour (Lovibond Units 25mm cell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	50	30	30	30	30	30	30	30	30	30	30	30
BOD	50	20	20	20	20	20	20	20	20	20	20	20
COD	100	80	80	80	80	80	80	80	80	80	80	80
Oil & Grease	30	20	20	20	20	20	20	20	20	20	20	10
Iron	15	10	10	7	5	4	3	2	1	1	0.8	0.6
Boron	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.7	0.5	0.4	0.3	0.2	0.15	0.1	0.1	0.1
Total toxic metals	2	2	1.6	1.4	1	0.8	0.6	0.4	0.3	0.2	0.1	0.1
Cyanide	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03	0.02	0.02	0.01

TABLE II.1.1: (CONTINUED)

Flow rate (m^3/day)	**≤10**	**>10 and ≤200**	**>200 and ≤400**	**>400 and ≤600**	**>600 and ≤800**	**>800 and ≤1000**	**>1000 and ≤1500**	**>1500 and ≤2000**	**>2000 and ≤3000**	**>3000 and ≤4000**	**>4000 and ≤5000**	**>5000 and ≤6000**
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total Nitrogen	100	100	80	80	80	80	50	50	50	50	50	30
Total Phosphorus	10	10	8	8	8	8	5	5	5	5	5	5
Surfactants (total)	20	15	15	15	15	15	10	10	10	10	10	10
E. Coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

APPENDIX III
EQUIPMENT LIST

EQUIPMENT LIST (PUMPS)

ITEM NO	SERVICE	EST HP (KW)
P-1101	ULP Lorry Loading Pump	22
P-1102	LP-1 Lorry Loading Pump	22
P-1103	LP-1/ULP/Kerosene Lorry Loading Pump	22
P-1104	LP-2 Marine Loading Pump	110
P-1111 A/B	Green Dye Injection Pump	0.55
P-1201 A/B/C	Jet A-1 Marine(Pipeline) Loading Pump	280
P-1202 A/B	Kerosene Marine Loading Pump	112
P-1203	Kerosene Lorry Loading Pump	30
P-1211 A/B	Stadis Injection Pump	0.55
P-1301 A/B/C/D/E	LDO\IDO Marine Loading Pump	150
P-1302 A/B/C	IDO/ADO Lorry Loading Pump	90
P-1303 A/B	LDO Blending Pump	75
P-1305	LSPO Blending Pump	30
P-1306 A/B/C	BDO Lorry Loading Pump	75
P-1307	SPE-LDO Marine Loading Pump	45
P-1308	MDO Marine Loading Pump	75
P-1309	HSFO(380 cst) Marine Loading Pump	220
P-1310	HSFO (180cst) Marine Loading Pump	220
P-1311	HSFO(120cst) Marine Loading Pump	220
P-1312	HSFO(120/180/cst) Marine Loading Pump	220
P-1321 A/B	Red Dye Injection Pump	7.5
P-1322 A/B	Antifoamer Injection Pump	0.55
P-1391	MDO/SPE-LDO Lorry Loading Pump (Ware House)	-
P-2001 A/B	LPG Marine Loading Pump	37
P-2002	LPG Lorry Loading/Cylinder Filling Pump	37
P-2004	Odorant Injection Pump	0.55
P-3001	Toluene-A Marine/Lorry Loading Pump	30

ITEM NO	SERVICE	EST HP (KW)
P-3002	Toluene-A Drum Filling Pump	11
P-3003	Toluene-B Marine/Lorry Loading Pump	30
P-3004	Toluene-B Drum Filling Pump	11
P-3005	Acetone Marine/Lorry Loading Pump	30
P-3006	Acetone Drum Filling Pump	7.5
P-3007	IPA Marine/Lorry Loading Pump	30
P-3008	IPA Drum Filling Pump	7.5
P-3009	Flux-A Marine/Lorry Loading Pump	30
P-3010	Flux-A Drum Filling Pump	7.5
P-3011	Flux-B Marine/Lorry Loading Pump	37
P-3012	Flux-B Drum Filling Pump	11
P-3091	Flux-B Marine/Lorry Loading Pump (Ware House)	-
P-3092	Flux-B Drum Filling Pump (Ware House)	-
P-5001	Styrene Monomer Pipeline Loading Pump	45
P-5091	Styrene Monomer Pipeline Loading Pump (Ware House)	-
P-7101 A/B	Boiler Fuel Oil Pump	3.7
P-7102	BFW (Boiler Feed Water) Pump	45
P-7103	Condensate Pump	3.7
P-8001 A/B/C/D	Fire Pump	710 (Engine)
P-8002 A/B	Jockey Pump	7.5
P-8514	Barge Jetty Sump Pump	5.5
P-8515	Main Jetty-A Sump Pump	5.5
P-8516	Main Jetty-B Sump Pump	5.5
P-8517	Main Jetty-C Sump Pump	5.5
P-8591	Sump Pump (Ware House)	-
C-2001	LPG Compressor	15
C-7201 A/B	Instrument/Plant Air Compressor	132

ITEM NO	SERVICE	EST HP (KW)
F-7101 A/B	Fire Tube Boiler Package	22.5
P-1112	Green Dye Hand Pump (Air Driven)	-
P-1205	Jet A-1 drain Pump (Air Driven)	-
P-1212	Stadis Hand Pump (Air Driven)	-
P-1323	Antiform Injection Pump	0.55
P-1324	Antiform Hand Pump (Air Driven)	-

APPENDIX IV
NOISE CALCULATION PROCEDURES

A 1.1 NOTATION AND DEFINITIONS

The following notation is used:

a	Sound Absorption Coefficient	
d	Measuring Distance	(m)
D	Directivity Index	(dB)
D_0	Typical source dimension	(m)
E_1	Geometric Near Field Correction	(dB)
E_2	Environmental Correction	(dB)
E_3	Conformal Surface Correction	(dB)
f	Frequency	(Hz)
F	Correction for Area of Conformal Surface	
K	Attenuation Factor	(dB)
L_{eq}	Equivalent Continuous Sound Level	(dB)
L_p	Sound Pressure Level	(dB)
L_{pm}	Mean Sound Pressure Level	(dB)
$L_{p\text{-}}$	Directional Sound Pressure Level	(dB)
L_w	Sound Power Level	(dB)
l_n	Dimension of reference surface	(m)
p	Sound Pressure	(N/m^2)
p_o	Reference of Sound Pressure	(N/m^2)
Q	Ratio of Measuring Surface to Reference Surface	
r	Radius	(m)
R	Room Constant	(m^2)
t	Time Period	(s)
s	Surface Area	(m^2)
W	Sound Power	(W)
W_o	Reference Sound Power	(W)

A 1.2 The following definitions are applicable:

Acoustic Near Field

The region near a noise source where particle velocity and pressure are not in phase.

Conformal Surface

Is a form of measuring surface which is at a distance, d, from all points on the reference surface.

Directional Sound Pressure Level

Is the sound pressure level in free field at any distance from the equipment in the specified direction.

Directivity Index

Of a small source in a particular direction is the difference between the directional sound pressure level L_{p*} and the mean sound pressure level L_{pm} at the same distance:

$$D = L_{p*} - L_{pm}$$

For a large source it is the difference between the sound power level in a particular direction and the total sound power level of the source.

Equivalent Continuous Sound Level (L_{eq})

Is the level of a steady sound that has, over a given period, the same energy as the fluctuating sound in question.

Free Field

That part of the sound field where the effects of its boundaries are negligible. (Note: where the effects of the boundaries are constant, such as above a continuous reflecting plane, the sound levels may be treated as in a free field and corrections made as necessary.)

Geometric Near Field

The region near a noise source where the measuring distance from the reference surface is less than the maximum linear dimensions of the source or reference surface element.

Octave Bands

Refer to the preferred octave frequency bands of BS 3593 or ISO 266.

Reference Surface

Is the smallest possible imaginary parallelepiped enclosing the source and terminating on the ground (excluding re-entrant sections and minor protuberances which are not significant emitters of noise).

Sound Level

Is the A-weighted overall sound level.

Sound Power Level

Is defined as 10 log (W/W_0) in dB where W is the sound power in watts, and W_0 is the reference sound power of 10^{-12} watt.

Sound Pressure Level

Is defined as 20 log (p/p_o) in dB where p is the measured sound pressure in N/m^2 and p_o is the reference sound pressure of 2×10^{-5} N/m^2.

A 2.1 Calculation Methods and Procedures

General Calculations

2.1.1 Calculations are performed separately in octave bands 63-8k Hz.

2.1.2 Directivity index is taken into account.

2.1.3 Sound Pressure/Sound Power Levels are added/subtracted as follows:

$$L = 10\,Log\,(\,10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \ldots + 10^{\frac{L_i}{10}} + \ldots + 10^{\frac{L_n}{10}}\,)$$

$$L = 10\,Log\,(\,10^{\frac{L_1}{10}} - 10^{\frac{L_2}{10}}\,)$$

2.1.4 The mean sound pressure level is calculated by means of the equation:

$$L_{pm} = 10\,Log\left[\frac{1}{n}\,(\,10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + \ldots + 10^{\frac{L_{pi}}{10}} + \ldots + 10^{\frac{L_{pn}}{10}}\,)\right]$$

Where

L_{pi} = sound pressure level at position i (dB)
n = number of test positions considered.

2.1.5 The values in the table below are used to convert linear octave bands levels to A-weighted levels.

Octave Band Centre Frequency (Hz)								
31	63	125	250	500	1k	2k	4k	8k
-39	-26	-16	-9	-3	0	+1	+1	-1

2.2 Calculation of Sound Power Levels

Sound power levels are calculated by one of the following methods depending on dimensions of source.

2.2.1 For small sources, the sound power level is calculated from the mean level by means of the equation:

$$L_w = L_{pm} + 10 \log 2\pi r^2 - E_2$$

$$\textit{where } r = 2D_O = 2\sqrt{(\,(l_1/2)^2 + (l_2/2)^2 + l_3^2}$$

and l_1 = length, l_2 = width, l_3 = height of source

2.2.2 For the majority of sources, the sound power level L_w is calculated using the following equations:

$$L_w = (L_{pm} - E_1) + 10 \log S - E_2$$

Where,

L_w is the sound power level

L_{pm} is the mean sound pressure level over the measuring surface

S is the area of the measuring surface (conformal surface)

E_1 is the near field correction

E_2 is the environmental correction

For typical sources, the conformal surface has rounded corners and edges and its area can be obtained from the area of the cuboid, S_c, by using the correction factor, F. The area, S, in the equation above is then given by:

$$S = S_c F$$

where

$$S_c = (l_1 l_2 + 2l_2 l_3 + 2l_1 l_3) + 4d\,(l_1 + l_2 + 2l_3) + 12d^2$$

$$F = (l_1 + l_2 + 2l_3 + 6d)/(l_1 + l_2 + 2l_3 + 10d)$$

and l_1, l_2, l_3 are the length, width and height of the reference surface and d is the measuring distance. The first term in brackets is the area of the reference surface.

(Note: The surface S is equivalent to the conformal surface in ISO 3744).

2.2.3 Large sources are divided into zones. The sound power level L_{wi} for each zone i is calculated, using the following equation:

$$L_{wi} = (L_{pmi} - E_{li}) + 10 \log S_i$$

where

L_{pmi} is the mean sound pressure level over the zone, i.

S_i is the area of the measuring surface zone

E_{li} is the near field correction for the zone

The total sound power level for the source L_w is obtained by summing the values of L_{wi} for each zone.

2.2.4 The sound power level radiated from linear sources (eg: pipework) is calculated using the following equation:

$$L_w = L_{pm} - E_1 + 10 \log S + 10 \log l - E_2$$

where

L_{pm} is the mean sound pressure level measured at a radius r from the axis of the source.

S is the area of a measuring surface of unit length given by $2\pi r$ for a cylinder and πr for a half cylinder.

l is the length of the source.

2.3 Calculation of Sound Pressure Levels from Sound Power Levels (Source/receiver Distances <100m & Enclosed Area)

2.3.1 Hemispherical Radiation

As sound propagates from the source its intensity decreases in inverse proportion to the surface area over which the energy is distributed. On the basis of the 'geometrical attenuation', the sound pressure level L_p at a distance r from a source on a reflecting surface (such as the ground) with sound power level L_w is calculated as follows:

$$L_p = L_w - 10 \log(2\pi r^2) = L_w - 20 \log r - 8$$

2.3.2 Spherical Radiation

For elevated sources where the sound waves are not influenced by reflections (such as reflected waves from the ground, for example) the following equation is used to calculate the sound pressure level at a distance, r.

$$L_r = L_w - 10 \log (4\pi r^2) = L_w - 20 \log r - 11$$

2.3.3 Reverberation Effects

When a source is mounted in an enclosed or semi-enclosed space, sound will reflect from the walls. At any point in the room, a distance r from a noise source, the sound pressure level is a function of the direct radiation and the reflected or reverberant noise and is calculated from:

$$L_p = L_w + 10 \, Log \left(\frac{1}{2\pi r^2} + \frac{4}{R} \right)$$

L_p is the sound pressure level at the distance, r

L_w is the sound power level of the source (assumed to be on the ground).

r is the distance from the source

R is the room constant defined by R = Sa/(1-a)

S is the total area of the room surface

a is the average absorption coefficient.

The average absorption coefficient of the room is calculated from the absorption coefficients of the various surfaces. For partly enclosed spaces, openings are counted as surface areas with an absorption coefficient of unity. When there are several noise sources in the room, their contributions to the sound pressure level at any point are added.

2.3.4 Image Method Calculations

This is an alternative calculation method to the "classical" reverberant noise calculation above, and is particularly relevant for partially-enclosed areas.

The method is a ray tracing technique where the received sound pressure level is modelled as the sum of the direct contributions and discrete reflections from the surfaces of the containing space. For more information, see UEG Publication UR25 "Noise and Vibration Control Offshore".

There are, in fact, an infinite number of images, but in practice it has been shown that only the first reflection off each of the surfaces is generally significant.

2.4 Calculation of Sound Pressure Levels from Sound Power Levels (Source/Receiver Distances >100m)

A number of design procedures have been developed in order to enable predictions to be carried out over distances greater than 100m (i.e. considering the effects of ground attenuation, meteorological conditions etc.). Of these, EEMUA Specification 140 and CONCAWE Report 4/81 have found widespread acceptance and are therefore used as the basis for predictions within Technica Indecon. A summary of the procedures is given below.

2.4.1 EEMUA "Noise Procedure Specification"

The sound pressure level at a distance is calculated from the equation

$$L_p = L_w + D - k$$

where
$k = k_1 + k_2$
k_1 is the combined effect of geometrical attenuation and air absorption
k_2 is the ground effects attenuation.

2.4.1.1 Geometrical Spreading/Air Absorption (k_1)

This factor is given by reference to a graph of attenuation against distance. The value of air absorption is the figure is $5rf10^{-6}$dB where r is the distance, f is the frequency. Hemispherical radiation is assumed.

2.4.1.2 Ground Effects/Screening (k_2)

This is given as a factor of attenuation against distance for either "minimal screening" or "significant screening". The factor k_2 is subject to a correction factor dependent on the value of h/r (source height/receiver distance). The "significant screening" curves include the in-plant screening of a typical process area, but not the attenuation due to significant discrete barriers.

2.4.1.3 Comments

The EEMUA curves are based on the time-averaged effects of weather; no recommendations are made for correction of the results to allow specifically for upwind/downwind propagation, or temperature inversion. The curves are based on empirical data, collected over a number of years.

2.4.2 CONCAWE 4/81 "The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities

The sound pressure level at a remote point is, again, calculated according to:

$$L_p = L_w + D - \Sigma k$$

D is the directivity index, and is generally taken to be 0. Σk is the sum of the individual attenuations due to seven mechanisms.

i)	geometrical spreading	(k_1)
ii)	atmospheric absorption	(k_2)
iii)	ground effects	(k_3)
iv)	meteorological effects	(k_4)
v)	source height effects	(k_5)
vi)	barriers	(k_6)
vii)	in-plant screening	(k_7)

2.4.2.1 Geometrical Spreading (k_1)

This assumes spherical radiation from a source, and is given by:

$$k_1 = 10 \log 4\pi r^2 \text{ dB}$$

The reflection due to the ground surface is allowed for in the value of k_3.

2.4.2.2 Atmospheric Absorption (k_2)

Values of atmospheric absorption are calculated in accordance with ANSI SI.26 "Method of Calculation of Absorption of Sound by the Atmosphere", 1978.

2.4.2.3 Ground Attenuation (k_3)

For acoustically hard surfaces, such as concrete

$$k_3 = -3 \text{ dB}$$

(Effectively correcting k_1 to represent hemispherical radiation)

For other surfaces, k_3 is obtained from a graph of attenuation against distance for different frequencies.

For propagation over "hard" and "soft" ground, only the distance over "soft" ground is considered, and k_3 obtained from the figure.

2.4.2.4 Meteorological Correction (k_4)

Six meteorological categories are defined, based on a combination of Pasquill Stability Factor (representing the temperature gradient) and vector wind speeds (v ms^{-1}). Tables give the Pasquill Stability Factor (G) based on wind speed, time and nature of the day, and cloud cover and the resulting meterological category.

The meteorological correction factor k_4 is given graphically. For meteorological category 4 the correction is zero in all cases.

2.4.2.5 Source and/or Receiver Height Correction (k_5)

The <u>decrease</u> in excess attenuation due to increases in source height is obtained using the following relationship

For $k_3 + k_4 > -3$ dB; $k_5 = (k_3 + k_4 + 3)(\gamma - 1)$ dB

γ is a function of the grazing angle ψ. These terms are given by:

$$\Psi = \arctan\left[\frac{h_s + h_r}{d}\right]$$

where h_s and h_r are the source and receiver heights.

$h_s \leq 2\ m$: $\gamma = 1$

$h_s > 2\ m$: $\gamma = 1 - 0.478\Psi + 0.068\psi^2 - 0.0029\Psi^3$

2.4.2.6 Barrier Attenuation (k_6)

Barrier attenuation is calculated using Maekawa's prediction method, based on calculation of the Fresnel number. CONCAWE recommend that, if a discrete barrier is introduced, the ground effect be re-calculated to take into account the effective increase in source height.

2.4.2.7 In-Plant Screening (k_7)

No recommendations are given for the prediction of a correction due to in-plant screening.

2.4.2.8 Comments

The propagation model has been developed from an extensive experimental exercise, following a literature search.

2.5 Computer-Based Prediction Method

Calculation procedures are as described in the previous sections. Source details, i.e. source sound pressure or sound power levels in octave bands 31 - 8k Hz, dimensions, co-ordinates (relative to a specified datum) are entered for all major sources within an area. For enclosed areas, module details are entered, i.e. dimensions, absorption coefficients.

The overall noise level can be calculated at 1m from each item of plant (to enable maximum noise levels in an area to be quantified), on a grid basis over the whole area of interest or at specific locations. In practice, a combination of these three alternatives is used to provide a realistic assessment of noise levels at all critical locations. The noise levels at a point due to each specific item of equipment can be established, to enable the effects of corrective action on any given source to be assessed.

Total sound pressure level within an enclosed module is calculated on the basis of these levels. Both direct and reverberant contributions are evaluated.

Calculation of noise levels due to HVAC systems are carried out according to procedures and using data given in the Atkins guide, "The Control of Noise in Ventilation Systems" . The prediction calculation follows the chosen HVAC system from the fan, along the duct work, to the room supplied. System parameters: fan sound power level, duct lengths and dimensions, fitting types, characteristic dimensions, etc are entered. The room acoustic characteristics, i.e.: dimensions and absorptive properties, are then used in the calculation of the total sound pressure level anywhere in the room, due to the HVAC system. This includes both direct and reverberant terms.

APPENDIX V
TECHNICAL SPECIFICATION
FOR
WASTE WATER TREATMENT SYSTEM

TECHNICAL SPECIFICATION FOR WASTE WATER TREATMENT SYSTEM

1.0 INTRODUCTION

This specification specifies the technical requirements for the "Waste Water Treatment System" of TSING YI NEW OIL TERMINAL.

2.0 PROCESS FLOW SCHEME

To conceptually show the overall system flow for the waste water treatment system (hereinafter called the unit) and demonstrate the scope of design/supply between purchaser and Vendor, attached in Process Flow Diagram for "Waste Water Treatment System". (See ATTACHMENT 1)

3.0 INFLUENT CONDITIONS

The analysis of waste water streams to be treated in the unit is specified as follows:

3.1 Name of waste water streams

For the waste water streams as an influent to the unit, the following short names are given.

a. LDO
This waste water is intermittently drained from the bottom of diesel oil storage tanks.

b. ULP
This waste water is intermittently drained from the bottom of unleaded petroleum storage tanks.

c. Mogas
This waste water is intermittently drained from the bottom of mobil gasoline storage tanks.

d. Jet A-1
This waste water is intermittently drainage from the bottom of jet fuel oil tanks.

e. F.O
This waste water is intermittently drained from the bottom of fuel oil tanks.

f. LPG
This waste water is wash water of LPG cylinder and collected from the pit.

g. Sewage (Sanitary Waste Water)
This water is pretreated in a septic tank and directed to an aeration tank.

h. MCCW (Miscible Chemical Contaminated Water)
This water will be collected at sump pit or kerbed area where chemical is occasionally or accidentally leaked out. The kind of chemicals are Toluene, Acetone, Isopropyl-alcohol and Styrene monomer.

Note: Bottom drain water which is shown in the ATTACHMENT 1 corresponds to the above (a) to (f) & (h), and characteristics of these waste water refers to item 3.2.

3.2 Characteristics of waste water

Design figure of quantities and qualities of each waste water is as follows:

a. Bottom drain water

Stream	Quantities (m^3/ year)	Qualities (ppm) BOD	COD	Oil & Grease	Monthly Frequency
LDO	2125	230	1900	1100	4
ULP	70	2200	18000	1100	0.16 (twice/year)
Mogas	120	3500	20800	350	0.16 (twice/year)
Jet A-1 (Kero)	570	330	4400	11000	5
F.O	210	220	1800	160	2
LPG	550	1700	6900	610	26
MCCW	2125	230	1900	1100	-

Note 1 : The bottom drain water is discharged intermittently as shown in the above table. ULP & Mogas will not be drained to the buffer tank at the same time.
2 : The bottom drain water is mainly sea water.
3 : Disposal capacity of this unit shall be designed at 5,770 m^3/year. Treatment load of MCCW is less than the quantity and quality as listed above.

b. Sewage (Sanitary Waste Water)
Quantity: 20 m^3/day
Qualities (after pretreated in a septic tank):
BOD : 100 ppm
COD : 200 ppm
Oil & Grease : 30 ppm

Note : The bottom drain water will be mixed with sewage water at the aeration tank.

4.0 EFFLUENT REQUIREMENTS

The unit shall be designed and fabricated to meet the following requirements at the tie-in point with purchaser.

4.1 Effluent Qualities

The treated effluent quality shall be in accordance with the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, 1991.

4.2 Dewatered Cake

Water content of the dewatered cake shall be less than 70% for landfill disposal.

5.0 SYSTEM DESIGN CONDITIONS

5.1 Process Design

The waste water treating system operates in continuous or intermittent mode to meet effluent demand of this plant. Vendor shall design the overall integrated system within the unit and constitutional sub-units in order to ensure the effluent requirements. Process design shall be performed by the Vendor based on his own technical experiences and know how irrespective of attached process flow scheme.

5.2 Sub-units Description

As the guideline to the vendor, the process concept is given as follows:
Following major sub-units shall constitute the unit.

a. Buffer tank
A 100 m^3 buffer tank/pit is provided to absorb fluctuation of influent flow and of influent composition. The stored water is pumped to oil separator.

b. Oil separator
Oil in bottom drain water is removed by API oil separator and then pumped to the sedimentation tank. Skimmed oil is pumped to drum which is furnished by others.

c. Chemical sedimentation section
This section is constituted of a sedimentation tank & chemical dosing unit. Alum and caustic are injected automatically and mixed with mixer to flocculate the suspended solids in the sedimentation tank. Flocculated suspended solid in the tank is sent to the sludge tank automatically.

d. Bio-treatment section
This section is constituted of aeration tank, settling tank & nutrient dosing unit. In the aeration tank, nutrients are added and an aerobic environment is

provided by a aeration system. This biological treatment decomposes and removes organic matter (BOD and COD).

After biological treatment, the waste water together with sludge is sent to the settling tank. The sludge is settled and returned to the aeration tank as return sludge. Some is wasted and sent to the sludge tank. The separated surface water from the settling tank enters into the effluent chamber.

e. Tertiary treating section
This section is constituted of sand filter, 2 sets activated carbon filters & treated water tank. Effluented water in the effluent chamber is pumped to the sand filter. Suspended solid is removed at sand filter, and organic compound (COD) is removed at activated carbon filter. Treated water is collected in the treated water tank and discharged to the outside of the plant.

f. Dehydrate section
The sludge in the sludge tank is sent to the dehydrator regularly to make the dewatered cake and then picked up by others for dumping.
The sludge pit is sized to have a holding capacity of 7 day normal operation.

6.0 DESIGN AND ENGINEERING REQUIREMENTS

6.1 Mechanical

Major sub-unit (as listed on item 5.2) shall be designed according to Vendor's standard design criteria.
Sparing for the pumps shall be considered as follows:

For continuous operation	:	100% x 2
For intermittent operation	:	Vendor to recommend

6.2 Shelter

Shelter shall be considered according to Vendor's standard design criteria.

6.3 Piping

All pipe connection among the equipments shall be tied-in with flanged connection, and piping design shall be applied as follows:
- Piping : ANSI B31.3 (Chemical Plant & Petroleum Refinery Piping)
- Flange : ANSI B16.5 (Steel Pipe & Flange Fittings)
- Material : ASTM

6.4 Instrumentation

1. Instrument shall be in accordance with project specification S-00-1370-001 "General Specification for Instrumentation".
2. Operation of this unit will be done from local control panel which is installed near this unit, and trouble alarms shall be sent to the central control room. So,

vendor shall provide suitable local panel for the above subjects.

3. Start up of this unit will be operated manually, but after steady operating condition is created this unit will be operated automatically.

6.5 Electrical

Electrical shall be in accordance with project specification S-00-1380-801 "Electrical Specification for Packaged Equipment" and S-00-1380-901 "Project Specification for Induction Motors".

6.6 Painting

Painting and coating shall be in accordance with the project specification S-00-139A-001 "Specification for Painting".

6.7 Noise

The equipment noise limit shall be 85 dB(A) at a distance of one meter from equipment surface.

7.0 VENDOR'S SCOPE

7.1 Battery Limits

Vendor shall provide (unless stated otherwise) all equipment indicated within the battery limits as shown on FLOW DIAGRAM ATTACHMENT 1.
Terminal flange connections at the battery limits shall be established and defined by the vendor.

7.2 Scope of Supply

For the details, please refer to JGC Requisition, for waste water treatment system.

8.0 UTILITY SUPPLY CONDITIONS

1. Steam
   - Pressure : max 8.0/min 5.0 barg
   - Temperature : max 175/min 159°C
   - For mechanical design : 9.8 barg @ 185°C

2. Plant Air
   - Pressure : 7.5 barg
   - Temperature : ambient
   - For mechanical design : 9.8 barg @ 80°C

3. Instrument Air

- Pressure : 6.7 barg
- Temperature : ambient
- Dew point : -10°C @ 7.8 barg
- For mechanical design : 9.8 barg @ 80°C

4. Electricity

- For motors
  - Less than 0.25 kw : 220/380V, 50 Hz, 1/3 phases
  - 0.25 kw and over : 380V, 50 Hz, 3 phases
- For instruments : 220V, single phase

9.0 SITE CONDITIONS

9.1 Site Conditions

The units shall be installed outdoor in a tropical climate near the sea shore with humid and saliferous atmosphere.
Area classification for the unit is non hazardous.

1. Ground elevation : PD + 4.8 meters
   Ground Water Table : PD + 1.05 to PD + 2.55 meters

2. Climatic temperature
   - Design Maximum : 36.5°C
   - Design Minimum : 0°C
   - Humidity : 100%

3. Wind load
   - Height variations : 3.44 m/s

4. Rainfall rate
   - Per day : 372 mm
   - Per hour : 104 mm

5. Earthquake : not to be considered

10.0 INFORMATION TO BE SUBMITTED WITH THE PROPOSAL

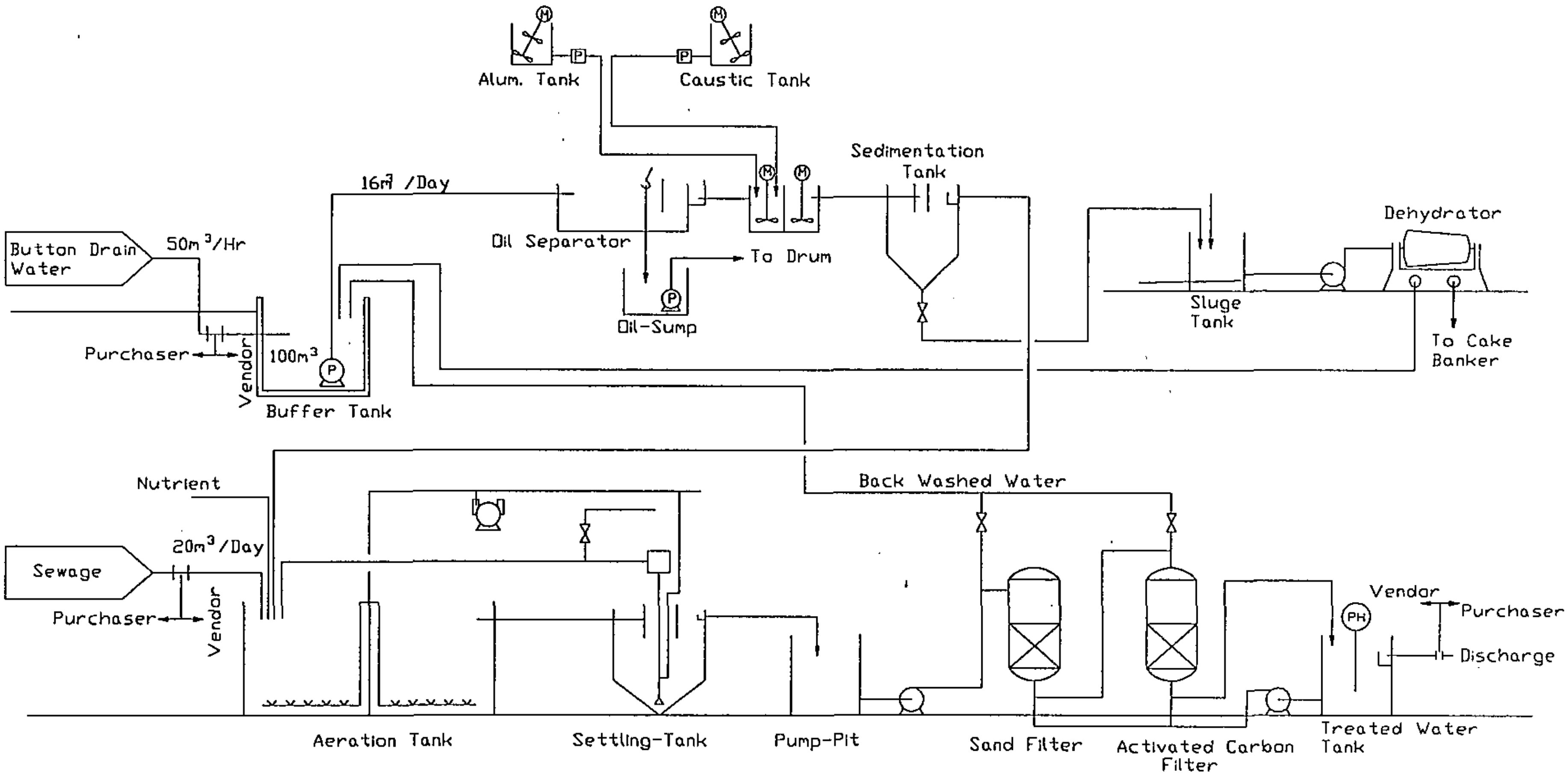
10.1 Explanation of system configuration and basis of all sub-units

10.2 Influent and effluent qualities, including calculation sheets, for each sub-units

10.3 Overall plot plan and equipment layout drawings

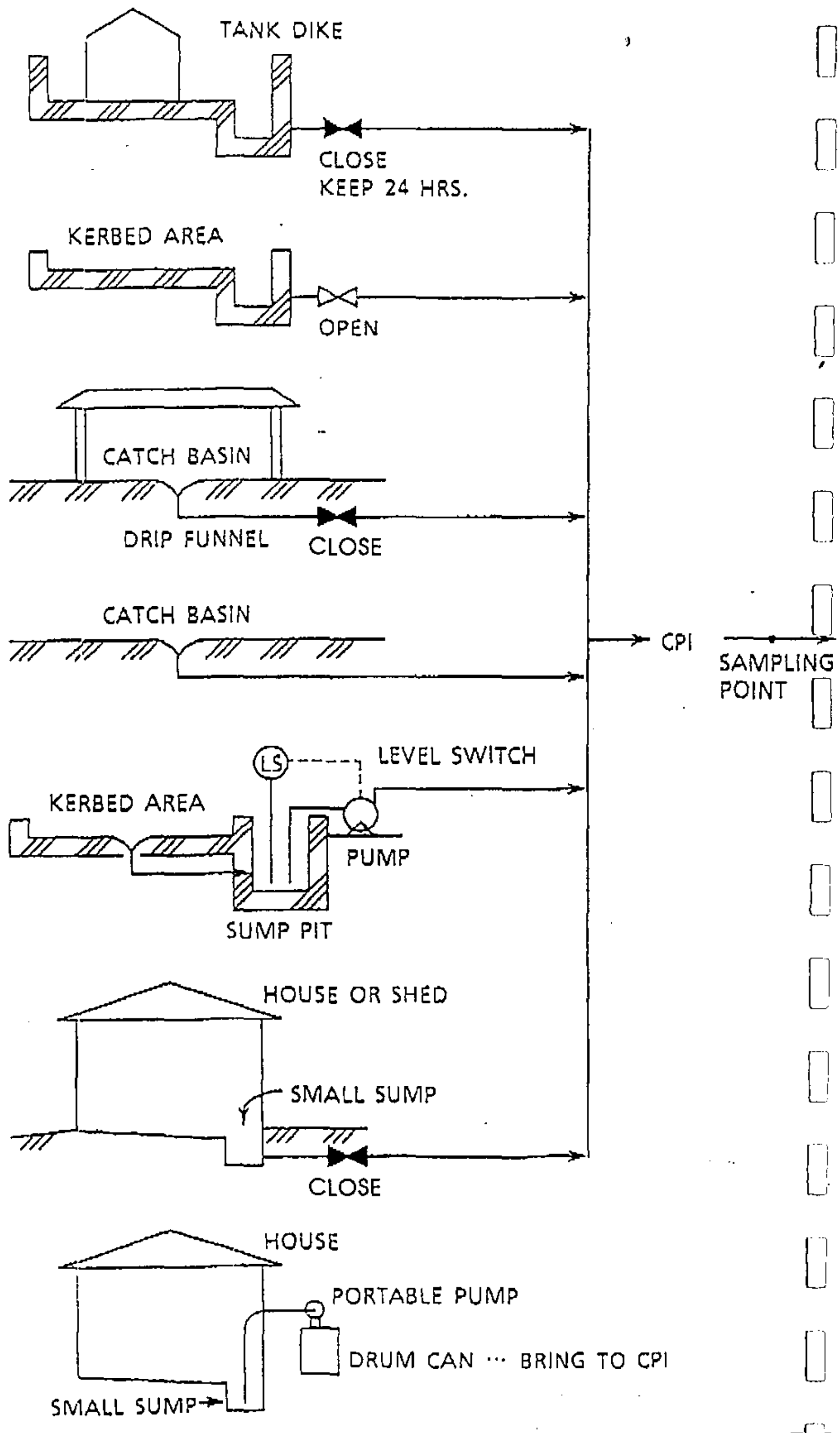
10.4 Other information requested in the "REQUISITION" and "GENERAL

ATTACHMENT 1

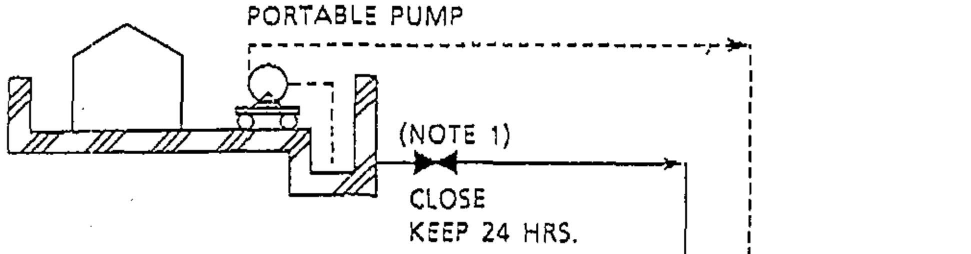
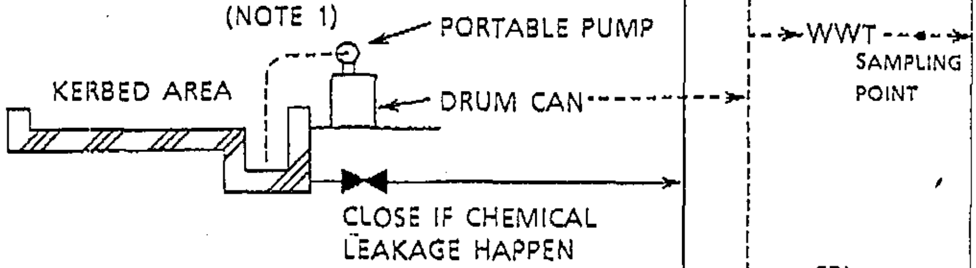
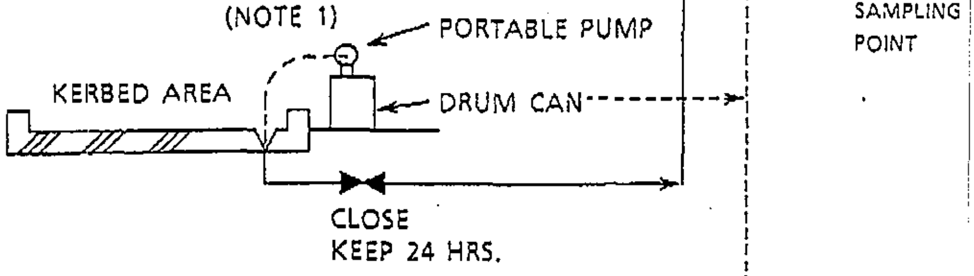
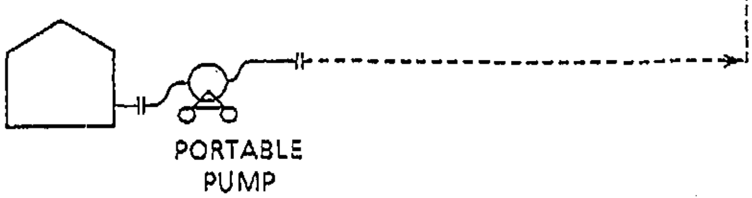


FLOW DIAGRAM FOR
WASTE WATER
TREATMENT SYSTEM

POSSIBLE OIL CONTAMINATED WATER AREA

<table>
<tr><th>AREA</th><th>WATER COLLECTION SCHEME</th></tr>
<tr><td>TANK FARM</td><td rowspan="7">
</td></tr>
<tr><td>PUMP MANIFOLD
WHARF JETTY
F.O. TANK FOR FIRE PUMP</td></tr>
<tr><td>LORRY LOADING GANTRY</td></tr>
<tr><td>LORRY WAITING
CAR PARK</td></tr>
<tr><td>TANKER PIER JETTY</td></tr>
<tr><td>BOILER HOUSE
WORK SHOP
COMPRESSOR SHED</td></tr>
<tr><td>FIRE PUMP HOUSE</td></tr>
</table>

POSSIBLE OIL OR CHEMICAL CONTAMINATED WATER AREA

AREA	WATER COLLECTION SCHEME
TANK FARM	
PUMP MANIFOLD	
TANKER PIER JETTY	
LPG CYLINDER WASHING DRUM	DRUM CAN TO WWT
TANK DRAIN WATER	 NOTE 1 : IF COMTAMINATION IS SUSPECTED, SAMPLE WATER SHALL BE CHECKED WHETHER IT IS ACCEPTABLE TO DISCHARGE OR NOT. IF ACCEPTABLE, RELEASE TO CPI IF NOT ACCEPTABLE, TRANSFER TO WWT.

APPENDIX VI
DRAFT BEST PRACTICABLE MEANS

NOTES ON THE BEST PRACTICABLE MEANS REQUIREMENTS FOR ORGANIC CHEMICAL WORKS (BULK STORAGE OF ORGANIC LIQUID) THIRD DRAFT

1.0 INTRODUCTION

These notes list the minimum requirements for meeting the best practicable means for Organic Chemical Works in which :-

(i) not being a chemical process described in any other specified process, and

(ii) any organic liquids, including liquid fuel, are stored in tanks having an installed capacity (individual) exceeding 100 cubic metres.

It should be noted that in granting licence under the Air Pollution Control Ordinance, the Authority, i.e., the Director of Environmental Protection, will also consider all other relevant aspects and may impose more stringent and/or additional control requirements.

2.0 FUEL RESTRICTION

For combustion process, gaseous fuel is the recommended fuel to be used, but the Authority may also accept the use of conventional liquid fuel with the following specifications:-

Sulphur content	:	Not greater than 0.5% (by weight)
Viscosity	:	Not greater than 6 centistokes (at 40°C)

3.0 CONTROL ON AIR POLLUTANT EMISSIONS

3.1 General Requirements

Appropriate air pollution control measures shall be used and good housekeeping shall be followed in order to minimize the air pollutant emission into the atmosphere.

3.2 Ambient Air Quality

An acceptable ambient air quality shall be maintained at or beyond the plant boundary. In particular, the following ambient limits measured at ambient conditions shall not be exceeded at or beyond the plant boundary:-

Benzene	:	185 $\mu g/m^3$ (one-hour average)
Odour	:	2 odour units

(An odour unit is the measuring unit of odour level and is analogous to pollutant concentration. In this context, the odour level is defined as the ratio of the volume which the sample would occupy when diluted with air to the odour threshold, to the volume of the sample. In other words, one odour unit is the concentration of the odourant which just induces an odour sensation).

3.3 Transfer, Handling and Storage of the Volatile Organic Liquid

The requirements listed in this section 3.3 apply to the transfer, handling and storage of the following organic liquids:-

(i) any organic liquid, including liquid fuel, having a flash point below 23° C.

(ii) any organic liquid which is artificially heated above its flash point for transfer, handling or storage.

For transferring, handling and storing the aforesaid organic liquids, the following control measures shall be implemented:-

Transfer and Handling

(a) During filling the road tanker with the aforesaid organic liquids from storage tank, the vented organic vapour shall be vented to vapour control system before discharge to the atmosphere. To satisfy this requirement, the use of the technology of "Bottom Loading" is recommended.

(b) Adequate means such as high level detector, liquid shutoff device and other appropriate device shall be provided to avoid spills during filling road tanker with the aforesaid organic liquids.

(c) At the locations where fugitive emission of organic vapour may take place (such as filling the drums with the aforesaid organic liquids), adequate local exhaust shall be provided to extract and vent the emissions to suitable vapour control system.

(d) Suitable seals shall be provided in transfer pumps, values and couplers to avoid leakages for transferring and handling the aforesaid organic liquids.

Storage

(e) The storage tanks shall be installed according to the requirements under the Building (Oil Storage Installations) Regulations wherever the Regulations apply.

(f) Any storage tank greater than 1,000 m^3 capacity shall be equipped with floating roof (see *), unless the storage tank is installed before 1993 and not required under the Building (Oil Storage Installations) Regulations to install the floating roof.

(g) For those storage tanks greater than 1,000 m^3 capacity but not required to equip floating roof (see *) as provided in clause 3.3 (f) above, vapour control system shall be provided to serve the tanks so as to minimize vapour loss from the tanks.

(h) Any storage tank with capacity greater than 100 m^3 but less than or equal to 1,000 m^3 shall be equipped with either:-

- floating roof (see *), or
- vapour control system

to minimize vapour loss.

(*: Floating roof shall conform to the requirement of floating roof tank as set out in the Code of Practice for Oil Storage Installations (1992) issued by the Building Ordinance Office).

Vapour Control Systems

(i) The vapour control system mentioned in the clauses 3.3 (a), (g) and (h) above shall be capable of processing the organic vapour vented to the vapour control system so as to prevent the vapour emission to the atmosphere at an efficiency of at least 95% by weight.

(j) For the vapour control system mentioned in the clause 3.3 (c) above where the emissions may be diluted with extraction air, the vapour control system shall be designed to aim at removing the organic vapour of the gas vented to the vapour control system by at least 95% efficiency when the concentration of the organic vapour of the vented gas is more than 1000 ppm (v/v).

(k) Wherever practicable, the vapour control system mentioned above should be designed to recover the removed vapours and transfer them back to the plant system for subsequent use.

3.4 Prevention of Leakage

Good engineering design must be ensured and all practicable steps shall be taken to prevent the leakage of organic liquid or vapour from the process/system. If leakage occurs, suitable mitigation measures as well as operation procedures shall be enforced to minimize any resultant air pollutant emission as far as practicable.

Without prejudice to the generality of the above requirements, the following measures shall be implemented as minimum requirements:-

a. The plant shall be designed, constructed and operated in a manner that there will be no leakage of organic liquid or vapour during normal plant operation.

b. The plant operator shall implement a suitable monitoring programme and procedure for detection and prevention of leakage. If any leakage is detected, repair shall be done as soon as possible.

c. Pressure relief valve (excluding P/V vents) which may release organic vapour into the atmosphere shall be vigorously checked for any residual leakage after each pressure release.

3.5 Sampling and Maintenance

Good plant design and operation procedure shall be used to minimize the purge or release of any organic liquid or vapour from the process/system during:-

a. sampling of the organic liquid; and

b. maintenance/repair/inspection of the plant.

4.0 MONITORING REQUIREMENTS

Parameters and sampling frequency will be determined by the Authority. However, the following parameters shall be monitored continuously as a minimum requirement and the monitoring results shall be submitted to the Authority on a regular basis:-

4.1 Process Monitoring

i. monthly plant throughout of different organic liquids;

ii. other essential operating parameter(s) which may significantly affect the emission of air pollutants, such as the operating conditions of vapour control system.

4.2 Ambient Monitoring

The ambient concentration of the following chemicals shall be monitored on a regular basis at plant boundary or any other locations agreed with the Authority:-

i. Benzene; and

ii. any other organic vapours which may be emitted for the process/system in a significant amount.

5.0 COMMISSIONING

Commissioning trials (to be witnessed by the Authority whenever appropriate) shall be conducted to demonstrate the performance and capability of the air pollution control measures and a report of commissioning trial shall be submitted to the Authority within 1 month after completion of the trial.

6.0 OPERATION AND MAINTENANCE

Requirements include not only the provision of the appliances, but the proper operation and maintenance of equipment, its supervision when in use, and the training and supervision of properly qualified staff.

In general, equipment shall be repaired as soon as practicable. Specific operation and maintenance requirements may be specified for individual equipment.

Malfunctioning and breakdown of the process or air pollution control equipment which would cause exceedance of the emission limits or breaches of other air pollution control requirements shall be reported to the Authority within 3 working days.

APPENDIX VII
RESPONSE TO COMMENTS FROM EPD ON
DRAFT OPERATIONAL PHASE KEY ISSUES REPORT

RESPONSE TO COMMENTS FROM EPD ON OPERATIONAL PHASE KEY ISSUE REPORT

	EPD's Comments	DNV Technica's Reply
1.0	**Mr C W Hui**	
1.1	According to the Air Pollution Control Ordinance (APCO), the operation of an oil depot would be classified as one of the Specified Processes and will be subject to Environmental Protection Department (EPD)'s licensing requirements. A copy of the draft Best Practicable Means (BPM) requirements for the oil depot is attached for the Consultants' reference. The Consultants should ensure that CRPC meets with the BPM requirements. As the BPM requirements for oil depots are still under review, the Consultants are advised to approach our Mr K P CHING (tel: 594 6221) direct for the finalized version of the BPM requirements.	DNV and CRPC has had many discussions with the Air Pollution Group of EPD and Mr K P Ching on the BPM requirements. At this moment the BPM is not yet finalised. CRPC confirms that the new oil depot would adhere to the requirements of the BPM once they are agreed to by the oil companies. A copy of the most recent draft of BPM dated March 1994 is included in Attachment (1).
1.2	The Consultants should also include the odour threshold values for petrol, diesel and kerosene for comparison purpose as they are the major petrochemical products stored at CRPC.	We have done a literature search but were unable to find any useful information. Can EPD provide any information.
1.3	For modelling fugitive emissions and emission from packaged boilers, the Consultants have shown the 1-hr ground level concentrations for a number of receptors. Since Mayfair Gardens and Ching Yeung House are high rise buildings, the Consultants are required to confirm that elevated receptors at these locations will not experience pollution levels exceeding the ambient limits for the pollutants either by providing concentrations at elevated receptors or by demonstrating the concentration reaches its maximum at ground level.	We have carried out additional air modelling to get the required results at elevated receptors which are shown in Attachment (2).
1.4	In order to model odour level, the Consultants should convert the hourly concentration into 5-second average concentration before it is compared with the ambient limit for odour. The Consultants are thus required to review the methodology used in modelling odour level and the modelling results if necessary.	The results of the odour level prediction and the revised text are shown in Attachment (3).
2.0	**Mr Peter Tang**	
2.1	<u>General</u>	
2.1.1	The type and volume of fuels and chemicals stored in the depot should be limited to that mentioned in this report and the previous "Initial Environmental Impact Assessment of CRPC South East Tsing Yi Petroleum Terminal". Any change should be subject to further assessment by EPD.	The type & volume of fuels and chemicals stored in the depot will be as stated in the operational phase report
2.1.2	Contingency plan and personnel involved should be well established prior to operation for smooth implementation should an accident occur.	A contingency plan including personnel involved will be provided as part of the Emergency Response Plan and will be ready prior to commencement of operations.

	EPD's Comments	DNV Technica's Reply
2.2	Specific	
2.2.1	Section 3.3.1.3 (5), Section 3.4.2 (7) and Section 5.4.1.1 - Miscible toxic chemicals	
	Provision of more intermediate storage of the effluent contaminated by miscible chemicals may be required as it may take more than 24 hours to assess the levels of contaminations in the effluent. Miscible toxic chemicals when spilled into the marine water will disperse and dissolve in the water. Presumably, adequate safety precautionary measures would have been taken into consideration.	A dedicated waste water treatment (WWT) system will be installed within the terminal to treat the effluents such as to comply with the Water Pollution Control Ordinances and subsidiary regulations. The design basis of the effluent handling and treatment system is being reviewed and a new design will be submitted by CRPC as a stand-alone document for EPD approval. Subject to agreement with EPD references to the effluent treatment system discussed in the draft will then be removed from the EIA report. The design concept for handling, treatment and disposal of potential chemically contaminated water will be as follows. Spilled Chemicals Spilled chemicals will be collected and reused. Contaminated Water Chemically contaminated water will be kept in a pit or bunded area and will not be discharged directly to the sewer system. A sample of the contaminated water will be taken and analyzed in the laboratory with a gas-chromatograph once a day, which takes 30 minutes. The pit and bunded area are therefore designed to hold the water for 24 hours. If the chemical content is found to be within acceptable limits, the water will be discharged to the oily water system. If the chemical content is found to be unacceptable, then it will be sent to the proposed WWT system which will be installed within the Terminal. The WWT system will be designed to treat contaminants such as BOD/COD and oil to an acceptable level based on the effluent discharge standards.

	EPD's Comments	DNV Technica's Reply
		In principle, chemically contaminated water will be treated in the WWT within the terminal.
2.2.2	Section 5.5.2 (2) The consultants should clarify whether "Pollution Control Group" means "Pollution Control Unit of the Marine Department". It should be noted that it is not necessary to include EPD in the list as Marine Department will inform EPD should they consider it necessary.	We mean " Pollution Control Unit of the Marine Dept."
2.2.3	Section 5.5.2(4) It is noted that the Styrene Monomer Spill Emergency Procedure is provided in the report, can similar spill emergency procedure be drawn for other group of fuels or groups of chemicals?	The detailed Emergency Response Procedure will be drawn up prior to project operations by CRPC.
2.2.4	Material data sheets (composition and safety related etc.) to be provided for the fuels and chemicals stored on site. These can also be attached to the spill contingency plan.	Material data sheets will be provided for the fuel and chemicals stored on site by CRPC
2.2.5	There is a lot of useful information relating to the oil spill contingency plan in the "Response to Marine Spills" published by 'The International Tanker Owners Pollution Federation reprinted 1993' which could be incorporated in the CRPC Contingency Plan Page V.17 of the report is attached for the Consultants' easy reference.	We have a copy of this report and agree that it contains useful information for incorporation into the Contingency Plan. CRPC will incorporate useful information from this report into their Contingency Plan.
3.0	**Dr Cherie Lee**	
3.1	Section 8.2 p.79 It is considered that the precautionary measures taken, including impermeable covers, bunded area design, segregated drainage & interceptor systems, are acceptable in terms of contamination prevention.	Noted
3.2	Section 8.3 p.81, para 9 For the groundwater monitoring proposed, the monitoring frequency of once every three months should be sufficient. However, it should be noted that ad-hoc monitoring or assessment should also be conducted in cases when leakage or spillage occurs or is suspected. Of course, other alternative leak detection systems will also be acceptable if they can serve the same purpose.	We have added a statement in the Report, "In the event of a product spillage/suspected leakage event, ground water samples should be taken at regular intervals following the incident to determine if ground contamination has occurred".
3.3	Section 8.3 p.80, para 3 Locations of the boreholes should be so designed that it can detect any leaks and migration into the groundwater in the first instance when such has taken place. The boreholes should be located in the downstream of a potential contamination causing working area. It would also be best if the sampling can be designed taking the following grid sampling pattern as a rough guideline.	It would be ideal but impractical to base the groundwater boreholes on the proposed sampling grid. Putting bore holes within bunded areas could cause problems unless the bore hole top is elevated above the level of the bund.

	EPD's Comments	DNV Technica's Reply
	Size of the site, ha / Grid Size metres 1 — 13–18 3 — 23–31 4 — 39–55	
3.4	Land Contamination of the existing site In this connection, I would also like to reiterate our concern on the land contamination for the existing site. The company, as agreed, should also conduct contamination assessment and necessary remediation for the existing old site.	CRPC will carry out the necessary contaminated land assessment based on Statutory requirements and Industry practices.
4.0	**Miss Amy Chau**	
4.1	Section 3.3.1.2 (4) Impermeable lining or surface treatment is recommended for the concrete bunded areas to prevent leakage of spilled oil or chemical through cracks in the concrete.	The design of the concrete bunded areas is in accordance with the Code of Practice for Oil Storage Installations, 1992. The floor is entirely covered with reinforced concrete, capable of containing an accidental release and leakage. All joints are completely sealed with oil resistant and resilient material that can effectively block ingress of petroleum products and prevent formation of cracks. The walls are heavily reinforced against the maximum possible loads thus precluding cracks due to stresses. The tank foundation is provided with an impermeable membrane to prevent accidentally spilled oil from spreading to bunded area, together with a leak detection pipe. The design philosophy is based on API 650. Based on the above, leakage is very unlikely to occur through the concrete floor or the concrete wall and an impermeable lining or surface treatment is not considered necessary for bunded area (Item 3.1 of EPD's comments also state that the precautionary measures taken are considered acceptable).
4.2	Section 3.3.1.3 (2) Is it feasible to pass large quantity of rainwater contaminated with miscible chemicals to CWTF for treatment? Will CWTF accept such diluted effluent (contains low concentration of chemicals) for treatment?	According to the revised design basis, contaminated rainwater will be treated by the WWT within the terminal. See reply 2.2.1 above.

	EPD's Comments	DNV Technica's Reply
4.3	Section 3.3.1.3 (5) Is it feasible to perform lab tests on the bunded rainwater in 24 hours?	The analysis in the laboratory will be carried out by a gas chromatograph which will take 30 mins. See reply 2.2.1 above.
4.4	The run-off management plan mentioned in 3.3.1.2 (4) and 3.3.1.3 (5) appears acceptable on paper. But will there be problems in practice? For example, will there be staff on site during storm events to manually open the valves to pass water into the CPIs before flooding occurs in the bunded areas? Will lorries, tanks and drums always be provided on-site to hold the chemically contaminated effluent if lab tests show that the discharge standards are exceeded? Will CWTF accept the effluent with low chemical concentrations for treatment?	See reply 2.2.1 above. The pit and bunded area are designed to be able to contain the run-off for 24 hours. This will allow operational staff enough time to open the discharge valves to prevent flooding. If lab tests show that the discharge standards are exceeded, the effluent will be sent to the WWT for treatment.
4.5	Tables 3.3.2.1 and 3.3.2.2 The CPIs should be designed for the maximum flow rate, ie. the sum of the dry weather process flow rate, the flow rate during rainfall and the flow rate of release of bunded rainwater.	Dry weather process flow is expected to contain high levels of BOD/COD, essentially from tank bottom discharges. These discharges will be sent to the in-house waste water treatment system and will not be introduced to the CPIs. During rainfall, the tank bunded area's drainage valves are closed and flow rates to the CPI is expected to be minimal as the bunded area is the major source of water. After rainfall, the water retained in the tank bunded area will be discharged to CPI if found acceptable, and this is the maximum flow rate used for the design of the CPI.
4.6	Section 3.3.3 Discharge of sewage into septic tanks and soakaway is undesirable. The site may not even suitable for soakaway. Attempts must be made to connect the sewage and domestic wastewater to public sewers.	Sewage will be collected in the septic tanks and then discharged to the Bio-treatment section of the in-house Waste Water Treatment System and no soakaway will be provided.
4.7	Table 3.4.2.1 Should not the dry and wet weather flows be the total flow through CPI No. 1 and CPI No. 2?	See reply 4.5 above.
4.8	Section 3.3.1.3 (3) and (5) Both of these sections state that effluent discharge standards will be complied with before the effluent or bunded rainfall runoff is allowed to be discharged. Please refer to the following comments 5.0.	See reply 2.2.1 above. Bunded areas are designed to be able to contain the maximum rainfall event.

	EPD's Comments	DNV Technica's Reply
5.0	**Miss Cathie Kueh**	
5.1	Petrochemicals are prohibited substances which are not to be deposited in the sewer, drain or waters of Hong Kong. A list of prohibited substances are found in Sections 6.2, 8.4 and 9.1 of the Technical Memorandum (TM).	Noted. The revised design of the WWT and drainage system will take into consideration the list of prohibited substances. See reply 2.2.1 above.
5.2	There is no "allowable concentration" for the disposal of these substances into the sewer. Spent chemicals or prohibited substances should be segregated from the waste stream of the discharge and should be treated and disposed of separately.	Noted. See reply 2.2.1 above
6.0	**Mr Dan Fung**	
6.1	Sec. 6.2 (1) The first sentence should be written as "The disposal of chemical waste must comply with the Waste Disposal Ordinance (WDO) and its relevant subsidiary regulations. For those wastes listed under Part A in Schedule 1 of the Regulation, waste producers are required to give notification..."	Text revised as suggested. See Attachment (4).
6.2	Sec. 6.2 (2) The first sentence should read "...apply for a Waste Collection Licence from EPD..."	Text revised as suggested. See Attachment (4).
6.3	Sec. 6.3.2 (1) The first sentence should read "...waste streams collected from the Terminal".	Text revised as suggested. See Attachment (5).
6.4	Sec. 7.5 (2) The Consultants should recommend feasible mitigating measures against accidental spillage which is identified to potentially cause significant environmental contamination. The drivers should be made aware and be able to follow a set of emergency procedures in order to reduce the effect to the minimum.	Feasible mitigating measures will be incorporated into the revised report as shown in Attachment (6).
7.0	**Mr David Tsoi**	
7.1	Section 3.3.1.3(3), (5) & (6) (p.31) Attention should be paid to the time lag for laboratory tests during which the effluent characteristics may have changed.	The time lag is reduced to only 30 mins by using a gas chromatograph to test the effluent characteristics.
7.2	Section 3.3.1.2(4) & 3.3.1.3 (5) (p.30 & 31) The 24-hr storage period inside the bunded area may be shortened; consequently the containment volume can be reduced accordingly.	The 24-hr storage period can definitely be shortened; the 24 hrs is a design contingency and under normal operations, the rainwater will be released before 24 hours.

	EPD's Comments	DNV Technica's Reply
7.3	Section 3.3.1.3 (7) (p.32) The valves should not be opened during rainfall and procedures similar to Section 3.3.1.3 (5) have to be taken, ie. rainfall runoff from the enclosed areas will be stored for a certain period during which samples will be analyzed for determining the subsequent way of disposal.	CRPC will amend and review their working practices in conjunction with the redesign of the effluent treatment and handling system. All rainfall runoff in the bunded areas will be analysed to determine the mode of disposal.
7.4	Table 3.3.1.3.1 9p.32) Can effluent from boiler blowdown and workshop meet the TM standards for parameters other than oil and grease?	See reply 2.2.1 above.
7.5	Table 3.3.2 (4) (i) (p.34) It is advisable if the Consultants can elaborate how the value 372mm/24hr is come up with.	This rainfall intensity was used by JGC in a previous design of an oil terminal project in Hong Kong, and was approved by the Government authorities.
7.6	Section 3.3.1 (5) (p.34) The CPIs should also be designed to cater for firewater run-off instead of allowing overflow to the sea.	The CPIs are designed to accommodate the overflow of the maximum fire water flow rate without flooding.
7.7	Section 3.3.2 (6) (p.34) I have reservation in the CPIs oil removal capacity from 500 or 2000 ppm to 20 ppm	The design contractors for the CPIs has guaranteed oil removal capacity from 500 or 2000 ppm to 20 ppm.
7.8	Section 3.3.3 (p.35) I reserve my comment on the feasibility of soakaway pits.	See reply 4.6 above.
7.9	Section 3.4.2 (7) (p.37) The Consultants' attention should be drawn to the list of prohibited substances for coastal waters on P.12 of the TM and also be reminded that an oil-water separator is used to separate free oil only.	Noted. See reply 2.2.1 above.
8.0	**Mr Alan Yim**	
8.1	There is no mention in the report on the quality and treatment/disposal methods for two effluent streams, namely tank/drum cleaning and tank drains identified in section 3.3.1 item (1).	Tank/drum cleaning and tank drains will contain BOD/COD and these effluents will be sent to the in-house waste water treatment system. See also reply 4.5.
8.2	There is no mention in the report whether washing, reconditioning and testing of LPG cylinder is being carried out in the plant. If so, the effluent streams from these operation should be identified and their treatment/disposal means should be included.	Washing, reconditioning and testing of LPG cylinders will be carried out as part of the depot operations. See reply 8.1 above.

	EPD's Comments	DNV Technica's Reply
8.3	It is reported in Sect. 3.3.1.2 item (2) and Sect. 3.3.1.3 item (3) that effluent will be contained and discharged to a CPI. However, how and where the effluent is contained is not mentioned.	For isolated areas with roof, collection will be by means of catch basin or drip funnel. For isolated areas without roof collection will be through a sump pit with valve.
8.4	It is mentioned in a number of places in Sect. 3.3.1.3 that contaminated rain water run off will be passed to CWTF for disposal. The Consultants should be advised that CWTF only accepts chemical wastes and it is unlikely for contaminated rainwater to be classified as chemical wastes. In this regard in-house effluent treatment facilities should be provided.	Agreed. See reply 2.2.1 above.
8.5	The Consultants should provide further information on how the maximum daily flow in table 3.4.2.1 is calculated. Furthermore, under the Technical Memorandum for effluent discharge (TM), there is no categorization for dry weather flow and wet weather flow. The highest daily flows should be applied in deciding the discharge standards.	<u>Dry Weather Effluent Discharge (5 m^3/day)</u> Continuous boiler blowdown water of <u>5 m^3/day</u> is the expected dry weather process discharge. Tank bottom drain which contains high BOD/COD will be treated by the in-house WWT. <u>Wet Weather Effluent Discharge (1409 m^3/day)</u> The total area of pump manifold, lorry waiting area, car park area, large jetty E3/E5/E6, main jetty A, B, C worked out to be 3790 m^2. Using a design rainfall intensity of 372 mm/day multiplied by 3790 m^2 gave a discharge of 1,409 m^3/day.
8.6	In sect. 3.4.2 item (5), there is no mention of how the highly contaminated effluent from process discharge are treated and disposed.	See reply 4.5 above.
8.7	In sect. 3.4.2 item (7), again it is unlikely that effluent that cannot meet the effluent discharge standard in the TM can be classified as chemical waste and be accepted by CWTF. In-house treatment/disposal facilities should be provided.	See reply 2.2.1 above.
9.0	**Mr K Y Wong** It should be noted that a separate Hazard Assessment (HA) study is currently being undertaken by the same Consultants under the direction of another Steering Group chaired by EMSD (GSO). Without reviewing the report on the HA study, it is premature for us to give comment on the related hazard issue at this stage.	 The Hazard Assessment Study Report has been submitted to GSO and awaiting comments. The HA study will be handled separately from the EIA by another steering committee chaired by GSO.

	EPD's Comments	DNV Technica's Reply
10.0	**District Officer (Kwai Tsing) Ref: (78) in KCL/4/101** **Mr Lawrence Show**	
	As I am responsible for coordinating the work of all Government departments during emergencies and natural diasters, it would be useful for the management and operation staff of the China Resources Petroleum and Chemicals Co. Ltd. to immediately inform me of any fire, spillage and other environmental pollution incidents related to the operation of the above Oil Terminal Para 5.5.2 on contingency plan on P. 68 of the report refers.	Noted. The relevant paragraph of the text has been changed. See Attachment (7).
11.0	**Director of Agriculture and Fisheries Ref: (25) in AF DVL 10/3 pt. 15** **Mr P J Gaiger**	
11.1	We assume that the basic precautionary procedures have included enclosing the storage areas within a bund to prevent accidental spillage reaching the marine environment.	Yes. The design of the containment facilities is in accordance with the Code of Practice for Oil Storage Installations, 1992.
11.2	Under the contingency plan for Marine Impacts (Sect. 5.5.2), it should be noted that nearby sensitive receivers include the following: • inshore capture fisheries within Victoria Harbour • the Ma Wan Fish Culture Zone	Noted. The text has been amended to include the two sensitive receivers. See Attachment (8).
12.0	**Director of Marine Ref: (5) in PA/S 909/109/9/1(2)** **Mr. A.L.P. Rodrigues**	
12.1	Para 5.1 (2) Replace "The Merchant Shipping (Prevention and Control of Pollution) Ordinance, 1990 (Chapter 413)" by the "Shipping and Port Control Ordinance (Chapter 313)."	Noted. The relevant text has been revised.
12.2	Section 5.3 The impacts due to pumping equipment failure, human error, hose rupture and leakages during loading/unloading operations mentioned in para 5.3.1 (2) have not been assessed.	Based on historical oil spill data, the majority of releases during loading/unloading operations are small spillages and are difficult to quantify. The adoption of the draft BPM requirements will reduce the risks from such events.
12.3	A contingency plan and suitable spill containment and clean-up equipment is required.	CRPC is aware of the need for a proper contingency plan and oil spill equipment capabilities.
12.4	Significant marine impact from passing vessels on CRC marine activities should be anticipated.	Noted. Relevant text has been added to emphasize on the marine impact from passing vessels.