FINAL REPORT

San Miguel Brewery Hong Kong Limited

Environmental Impact Assessment of Proposed Brewery at Yuen Long

November 1995

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CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES MANAGEMENT

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November 1995

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For and on behalf of ERM Hong Kong

Approved by: _____

Position: Technical Director

Date: 22 November 1995

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1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

San Miguel Brewery Hong Kong Limited (SMHK) propose to relocate and expand its existing facilities at Sham Tseng to a new site at the Yuen Long Industrial Estate. ERM Hong Kong were commissioned by SMHK in August 1994 to undertake an Environmental Impact Assessment (EIA) for the proposed relocation.

1.2 PURPOSE OF THE STUDY

The purpose of the EIA is to assist in minimising environmental impacts from the construction and operation of the new brewery by providing information on the nature and extent of the potential environmental impacts recommending mitigation measures where appropriate.

The broad scope of the EIA Study is outlined in the Environmental Protection Department (EPD) Study Brief (*Annex A*). The objectives of the assessment are as follows:

- to minimise pollution, and nuisance arising from the development and its operation and environmental disturbance during construction, operation and decommissioning of the project.

- to identify and evaluate the net impacts expected to arise during construction and operational phases for the issues outlined in the EPD Study Brief.

This assessment will focus on the proposed site design with a view to determining if there are any insurmountable residual environmental impacts associated with the development in construction or operational phases.

The development is proceeding on an exceptionally fast track with the new Brewery expected to be operational in 1996. As such this EIA has been conducted in parallel with the detailed design process enabling environmental considerations to be incorporated into the design at an early stage.

1.3 ORGANIZATION OF THE REPORT

Following this introductory section, the rest of this report is organized as below:

Section 2	describes the proposed development;
Section 3	presents the findings of the Water Quality assessment;
Section 4	presents the findings of the Air Quality assessment;

Section 5	presents the findings of the Noise assessment;
Section 6	presents the findings of the Waste Management assessment;
Section 7	presents the findings of the Health and Safety assessment;
Section 8	presents the findings of the Transport and Traffic; and Visual, Ecology and Fung Shui assessments; and
Section 9	presents the conclusions and recommendations of the study.

The environmental monitoring and audit (EM&A) requirements are also presented in a separate EM&A manual.

2 PROPOSED DEVELOPMENT

2.1 SURROUNDING ENVIRONMENT

The new San Miguel Brewery (SMB) is to be sited in Section L of Yuen Long Town Lot No 313, inside the Yuen Long Industrial Estate. The site location and its surrounding environment are shown in *Figure 2.1a*. As is expected in an industrial estate, the vicinity of the SMB site is occupied by other industrial users. The Hong Kong Petrochemical Company Limited is located to the east of the SMB site. The facility next to the Hong Kong Petrochemical Company Limited is under construction and will be occupied by the Dairy Farm. Three companies are sited to the north of the SMB site: the Fortune Corrugated Limited which produce corrugated paper boards; the Yau Sang Galvanizers (Hot Dip) Company Limited which carry out hot dip galvanizing of mild steel materials and products; and the Kyowa Industrial Company Limited which manufactures plastic parts for photocopiers. To the west, there are the Acme Magnetic Tapes Limited whose main products are video pancake tapes and video cassette tapes; the TDK Hongkong Company Limited which produce ferrite products; and the Toppan Printing Centre. To the south of the site are a bus terminus, a vacated site and an open area currently used for the parking of container trucks.

2.2 DESCRIPTION OF THE DEVELOPMENT

The site is just under four hectares in area, and will house the entire SMHK brewing operation. San Miguel has a multi brand strategy and their product lines include:

- San Miguel Pilsen;
- San Miguel Super Dry;
- Lowenbrau;
- Kirin; and
- Sun Lik.

The new brewery will be designed for an annual target production capacity of 1 million hectolitres (M hl) (Phase 1), and is capable of being expanded to 1.5 M hl in the future if so required (Phase 2). The expansion would involve the installation of additional equipment, mainly for storage, blending and filtration purposes. Note that no extra boilers are necessary for the possible Phase 2 expansion. The extra production capacity for Phase 2 would be achieved by extending the actual brewing time per week. Note this EIA is completed on a conservative basis for the ultimate capacity in Phase 2.

Main raw materials used for the brewing operations are water, malt, rice and hops. A brief description of the brewing process is presented in *Section 2.3* below.

Figure 2.2a shows the layout of the new brewery. The site is divided into four main areas:

- *The Process Building*

  The process building houses all the equipment for beer production. The brewing process includes the malt storage facilities and processing plant, the main brew house, wort cooling, and spent grain handling. After brewing, products pass to the fermenting and storage facilities which include the filtration system, yeast propagation system and beer recovery system. The equipment includes a large number of stainless steel tanks with associated pipework and fittings.

  The process building also houses various utilities including systems for steam generation, compressed air, carbon dioxide (CO_2) recovery, glycol cooling, and refrigeration.

  Four boilers will be installed to raise steam for use in the various brewing operations. Three of these boilers run on light diesel oil (LDO). The other is a dual fuel boiler running on both LDO and biogas, utilizing beneficially a by-product from the on-site biological wastewater treatment plant.

  Stack emissions from these boilers have the most potential to impact local air quality of the various emissions from the Brewery.

- *The Packaging Building*

  The packaging building includes facilities for bottling, canning and kegging, together with the equipment for palletising, washing, pasteurizing and packing. These operations are expected to be the main sources of potential noise impacts from the Brewery.

- *The Administration Building*

  The offices and reception area will be based in the administration building where there is also a half basement for carparking.

- *The Ancillary Buildings*

  These include substations, the waste water treatment plant, dangerous goods stores, the guard house and fire control room, together with hardstandings and roadways.

  The wastewater treatment plant has been specifically designed and built to treat all kinds of wastewater generated at the Brewery. Influent collected in the equalization tank and sludge generated from the treatment process could have generated bad smells if left exposed and posed as potential sources of odour impacts from the Brewery. However, the potential odour impacts have been designed out by covering the equalisation tank and enclosing the desludging process.

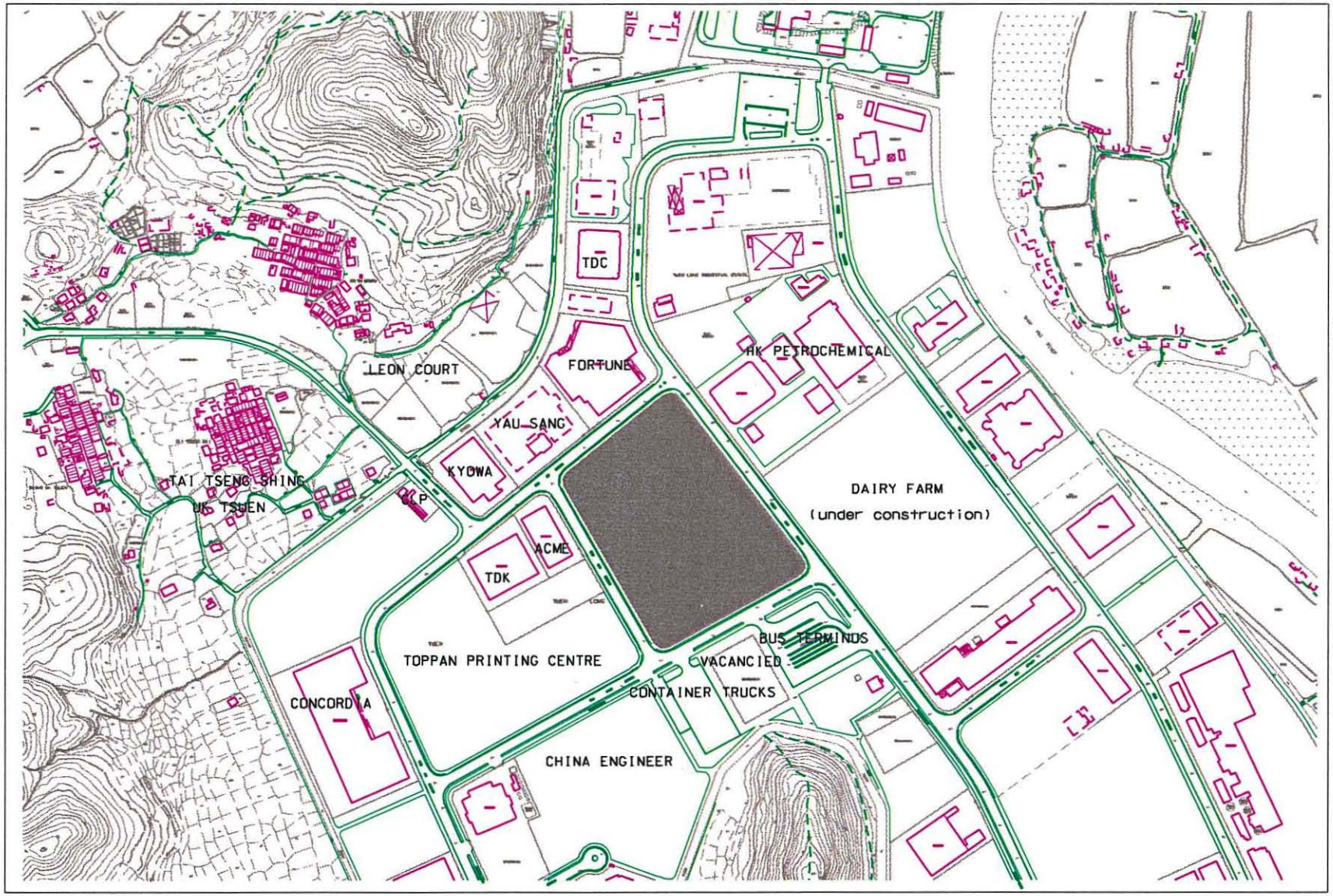

Figure 2.1a Site Location and Surrounding Environment

Date : 4 November 1994	Drawing no.: ERMHK/GIS/C1214/001
Prepared by : GIS & Mapping, ERM	Base map : 1:1 000 topo. LANDS DEPT.

KEY

SMB WORK SITE

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Hecny Tower
9 Chatham Road
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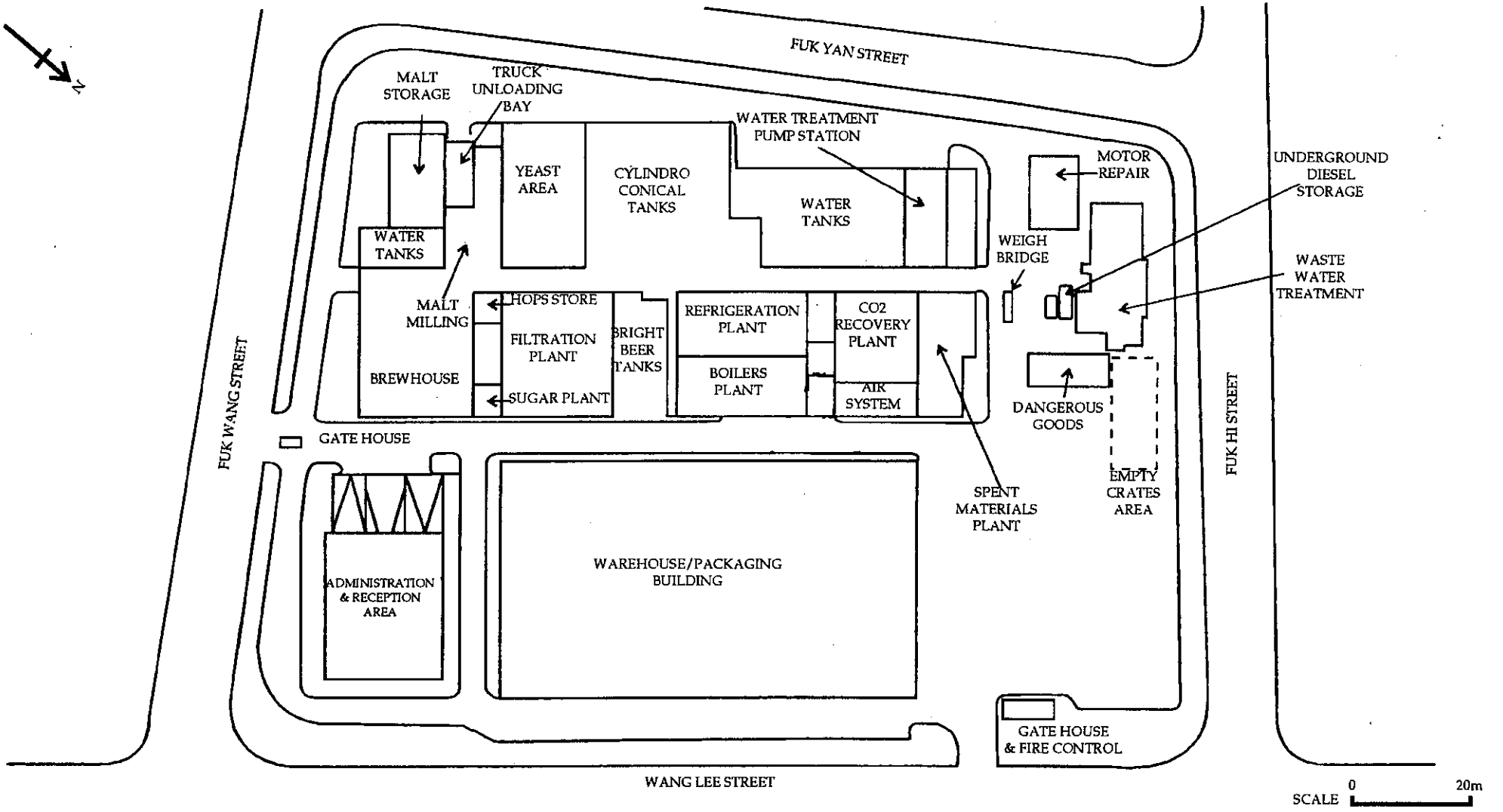

FIGURE 2.2a - LAYOUT OF BREWERY

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2.3 PROCESS DESCRIPTION

Brewing and *Packaging* are the two main stages involved in the production of beer.

2.3.1 *Brewing*

Wort Production and Treatment

This process involves the extraction of the desirable components from malt, cereal adjuncts and hops using conditioned water, producing an extract solution called *wort* which is the starting material for fermentation by yeast. The major operations involved are listed in *Table 2.3a* and are presented in a flow diagram in *Figure 2.3a*.

Spent grains are produced as a major by-product from the wort separation and sparging operations. These will be transported off-site for sale as animal feed but are also a potential source of odour nuisance.

Table 2.3a ***Major wort production and treatment operations***

Operations	Location
Malt milling	Malt mill
Cooking of Unmalted Cereal Adjunct	Cereal Cooker
Mashing	Mash vessel
Wort separation and sparging	Mash filter
Wort boiling	Brew kettle
Hot sludge separation	Hot wort tank/ Whirlpool tank
Wort cooling	Wort cooler
Cold wort aeration	Wort aerator

Fermentation

Fermentation is the process by which treated *wort* is converted into *beer* by yeast, producing the desired alcohol content and flavour in the final product. The major operations involved are listed in *Table 2.3b*.

Table 2.3b ***Major operations in Fermentation***

Operations	Location
Pitching of wort with yeast	Yeast room
Fermentation of wort by yeast	Fermenting tank area
Yeast recovery and storage	Yeast room

CO_2 gas and spent yeast are generated as by-products during the fermentation process. The gaseous CO_2 produced is purified, condensed and liquefied. It is reused throughout the production process and injected into the beer during the beer storage and conditioning processes. Any surplus is to be sold in tankers or cylinders.

Beer Storage and Conditioning

The properties of the fermented beer are adjusted to the required level by:

- removal of excess flavour compounds produced during fermentation; and
- optimal removal of residual substances that result in haze formation.

This is then followed by *Clarification* and *Carbonation* of beer to give the product a brilliant appearance and palatability. The major operations involved are listed in *Table 2.3c* and are presented in a flow diagram in *Figure 2.3b*.

Table 2.3c ***Major beer storage and conditioning operations***

Operations	Location
Beer cooling and storage	Beer storage tank area
Beer cooling and final filtration	Beer filtration room
Beer carbonation and Cooling	Bright beer cellar

As shown in *Figure 2.3b*, spent yeast is produced as a by-product during the fermentation and beer storage operations. The spent yeast will be dried and packed in paper sacks for sale to food industry. It is also a potential source of odour nuisance.

In addition, during the beer final filtration process, waste filter cake will be produced which will need to be disposed of off-site.

2.3.2 *Packaging*

Bright beer produced is either bottled, canned or kegged. These are further divided into the following categories:

- Returnable bottles 640 ml and 330 ml
- Non-returnable bottles 330 ml
- Cans 500 ml and 330 ml
- Kegs 30 litre and 50 litre

The major beer bottling and canning operations are listed below:

Beer Bottling

- Depalletizing of bottles in cases
- Uncasing of bottles

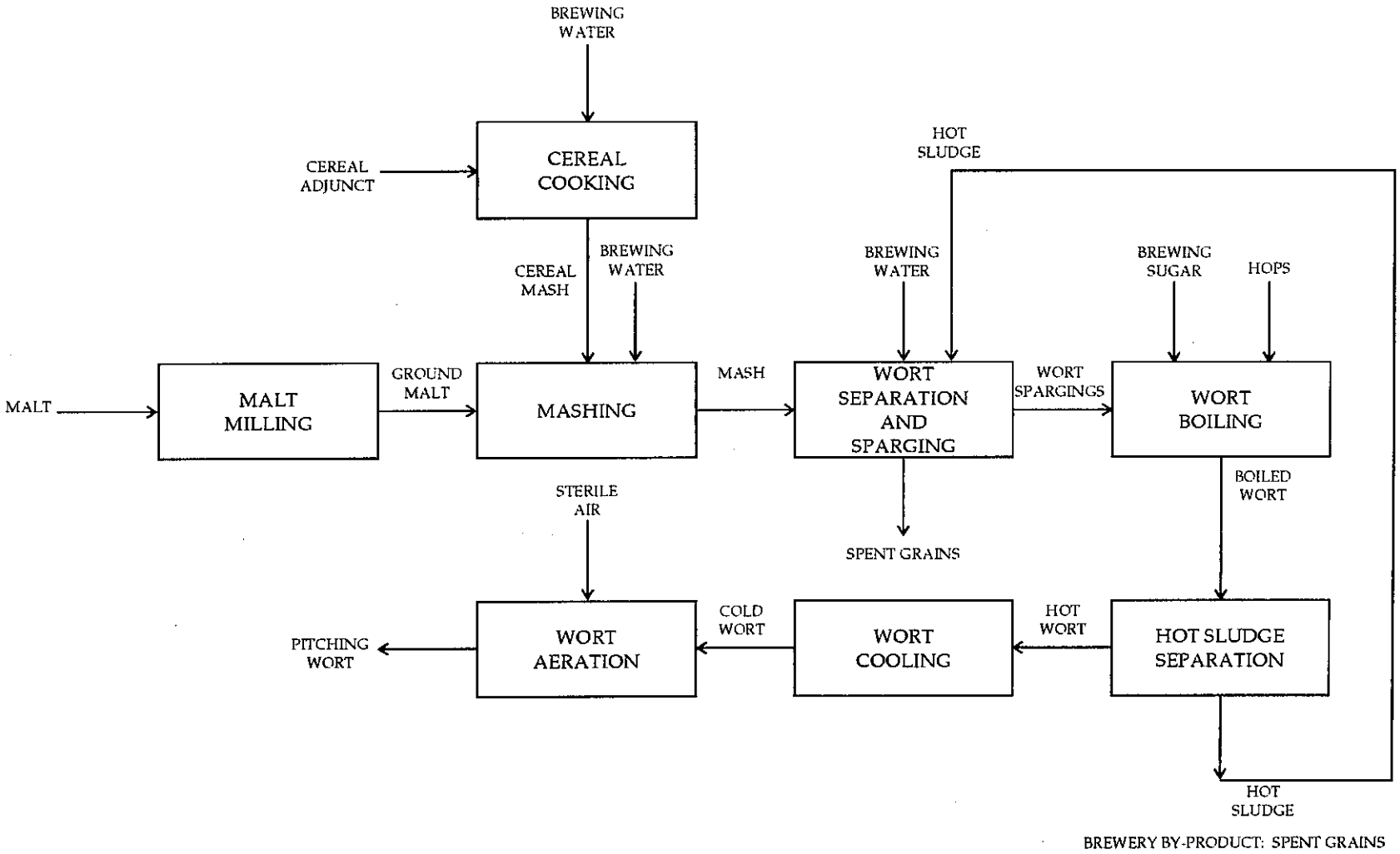

FIGURE 2.3a - WORT PRODUCTION AND TREATMENT

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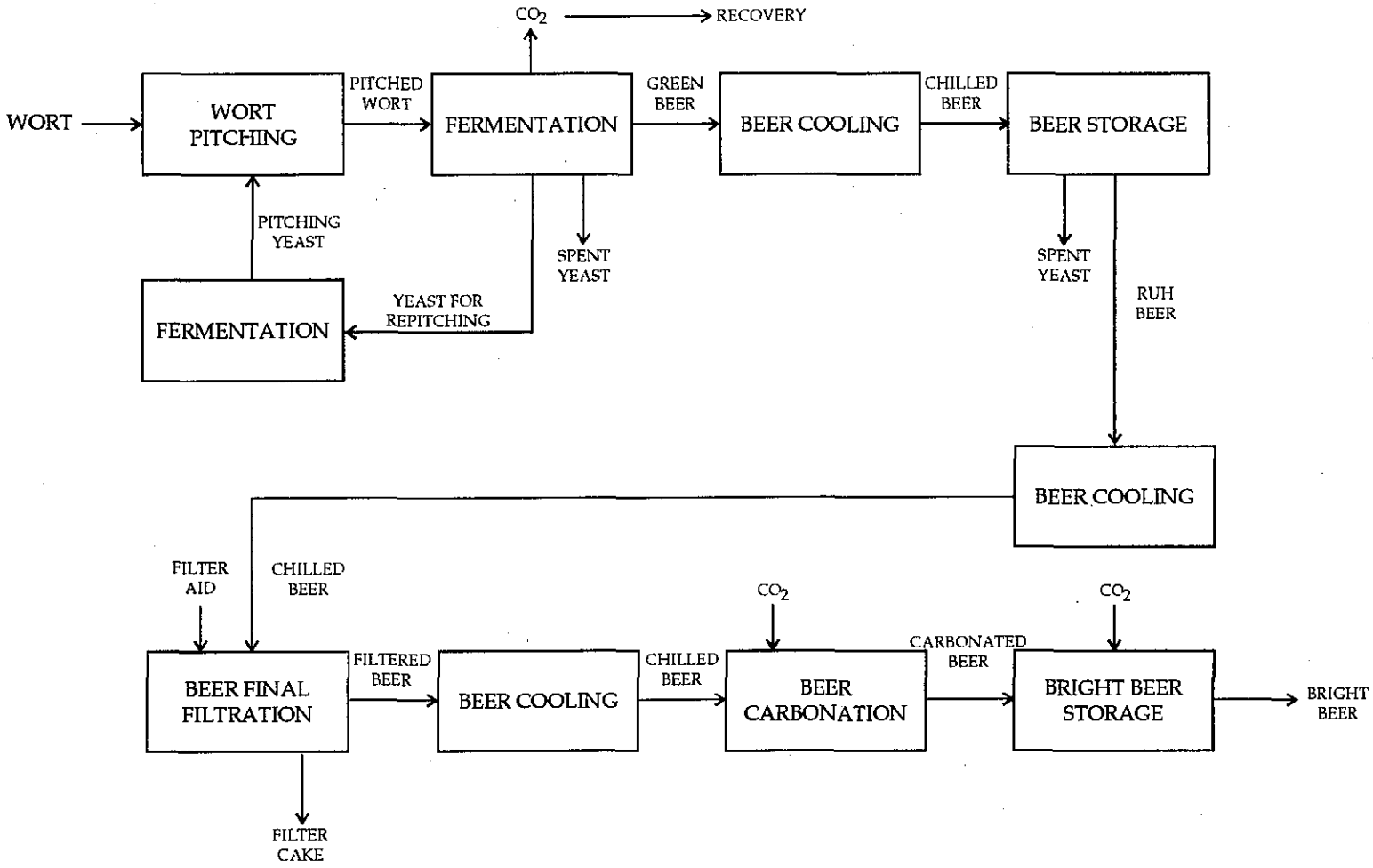

BREWERY BY-PRODUCT: CO_2 AND SPENT YEAST FILTER CAKE

FIGURE 2.3b - BEER STORAGE AND CONDITIONING

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- Bottle pre-inspection
- Bottle washing and inspection
- Bottle filling
- Removal of headspace air
- Bottle crowning
- Pasteurization
- Final product inspection
- Bottle Labelling
- Packing of bottled beer in cases or crates
- Bottled beer palletizing
- Other operations such as case washing, carton forming and sealing

Beer Canning

- Can depalletizing
- Can rinsing
- Can filling
- Removal of headspace air
- Can seaming
- Pasteurization
- Final product inspection
- Packing
- Palletizing
- Other operations such as carton forming and sealing

2.4 *DEVELOPMENT PROGRAMME*

The design of the new San Miguel Brewery commenced in May 1994. Site formation works are scheduled to start in December 1994, and the expected plant commissioning date is 1 July 1996. A copy of the latest project master programme is shown in *Figure 2.4a*.

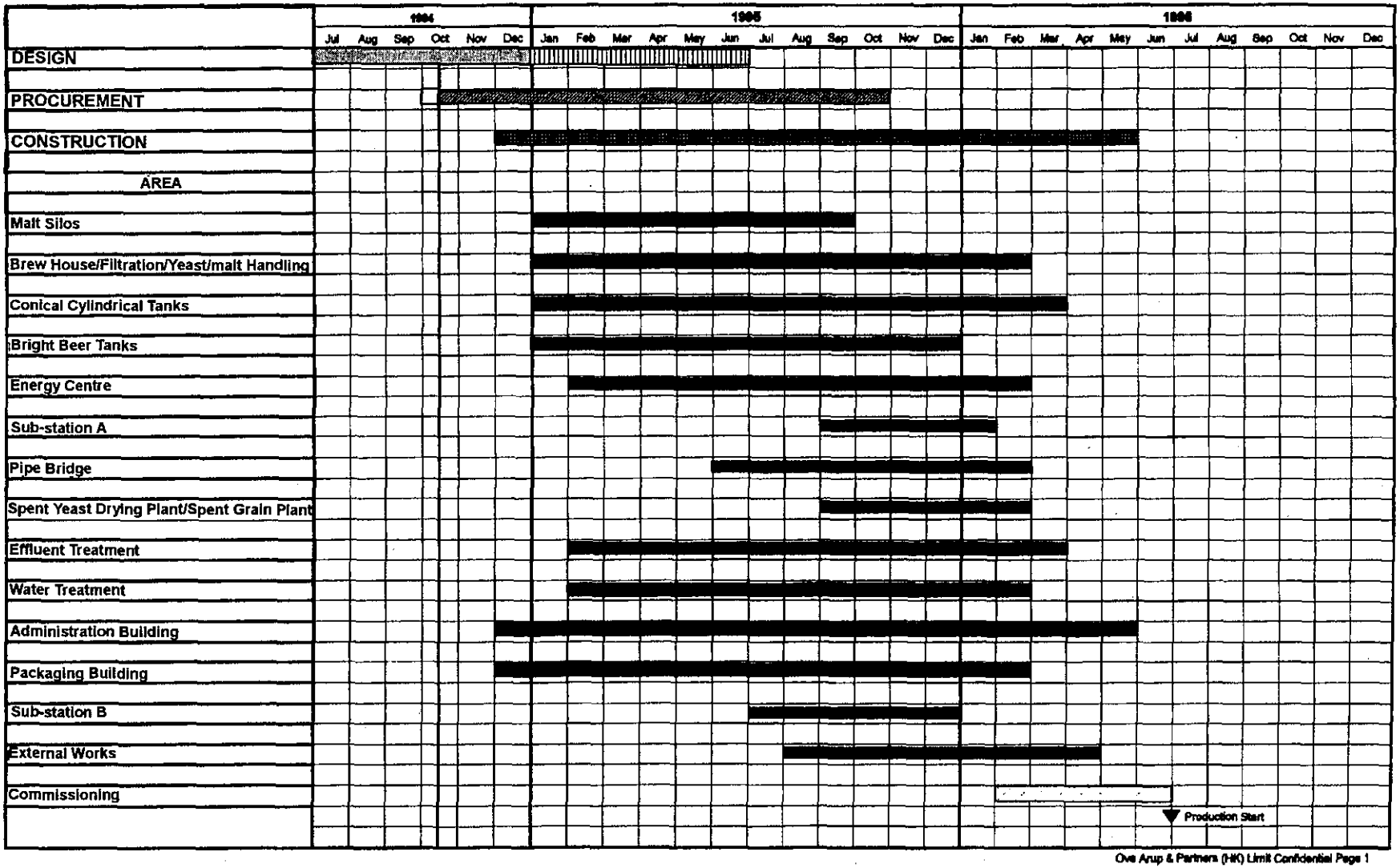

FIGURE 2.4a - DEVELOPMENT PROGRAMME

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3 WATER QUALITY

This section presents the construction and operational impacts to water quality associated with the proposed San Miguel Brewery at Yuen Long Industrial Estate. Mitigation measures to minimise potential water quality impacts are recommended. Operational considerations of the wastewater treatment plant and water conservation measures are discussed.

3.1 BASELINE CONDITIONS

The proposed San Miguel plant is situated in the Yuen Long Industrial Estate adjacent to which the Yuen Long Creek meanders on the eastern boundary of the Estate. The Yuen Long Creek is classified as one of 12 "Priority Rivers" which the Government are applying efforts to improve water quality with the implementation of the *Livestock Waste Control Scheme* (LWCS), the *Water Pollution Control Ordinance* (WPCO) and the *Waste Disposal Ordinance* (WDO) for chemical waste.

Sewage from the Yuen Long catchment area is conveyed to the Yuen Long Sewage Treatment Works, located to the North East of the Yuen Long Industrial Estate, where sewage will undergo primary and later secondary treatment. Stormwater system drains in the area discharge into nearby rivers which drain into the Deep Bay area.

3.1.1 *Existing Conditions*

The Yuen Long Creek is badly polluted by the discharge of livestock and industrial waste and also by the intrusion of tidal currents from Deep Bay. The river was classified as "very bad" with a high Biological Oxygen Demand (BOD), level equivalent to the strength of raw sewage, and low dissolved oxygen. The results of water quality monitoring in the Yuen Long Creek undertaken by the EPD in 1992 is presented in *Table 3.1a.*

Further downstream, the Yuen Long Creek drains into Inner Deep Bay. The Inner Deep Bay area has the lowest compliance of gazetted water control zones (WCZs) with *Water Quality Objectives* (WQOs) as a result of indiscriminate discharges of livestock waste, sewage and industrial effluent from the Shenzhen River on the China side; and the rivers Indus, Beas and Ganges and Kam Tin on the Hong Kong side. The water quality in the Inner Deep Bay area exhibits low pH, high bacteria, and high inorganic nitrogen levels.

3.1.2 *Future Conditions*

The river water quality is expected to improve in the future with planned river training works to improve the flow to alleviate the recurrent flooding in the Yuen Long lowlands; the implementation of the WPCO, WDO for chemical waste, the LWCS and the *Yuen Long and Kam Tin Sewage Master*

Plan (SMP). However, the future water quality will greatly depend on the effectiveness of the enforcement of these regulations.

Tale 3.1a *Summary of Water Quality Monitoring Results for Yuen Long Creek (1992)*

Parameter	Yuen Long Creek	
	YL3	YL4
Dissolved Oxygen (mg/L)	1.9 (0.9 - 3.5)	1.7 (0.4 - 4.6)
Biochemical Oxygen Demand (mg/L)	200 (90 - 680)	220 (130 - 400)
Suspended Solids (mg/L)	115 (45 - 300)	108 (34 - 620)
Ammoniacal-N (mg/L)	21.55 (9.00 - 43.90)	12.50 (7.36 - 22.70)
pH	7.2 (6.4 - 7.3)	6.9 (6.0 - 8.9)
Aluminium (μg/L)	285 (60 - 720)	305 (60 - 4100)
Cadmium (μg/L)	0.15 (0.01 - 0.06)	0.30 (0.10 - 1.80)
Chromium (μg/L)	1.0 (1.0 - 6.0)	2.5 (1.0 - 94.0)
Copper (μg/L)	28.0 (6.0 - 170.0)	11.5 (2.0 - 42.0)
Lead (μg/L)	10.0 (1.0 - 20.0)	7.5 (2.0 - 180.0)
Zinc (μg/L)	110 (30 - 360)	80 (30 -990)
E.coli (no./100 mL)	NM	NM
Flow (L/s)	426 (130 - 722)	170 (13 - 425)

3.1.3 *Water Sensitive Receivers*

Reference to the *Hong Kong Planning Standards and Guidelines* (HKPSG) indicates the presence of a water sensitive receiver, fish ponds, near the proposed San Miguel Brewery located downstream of Yuen Long Creek.

Further downstream the river eventually runs into Inner Deep Bay. Deep Bay is of great environmental conservation value in that it is an internationally recognised conservation site for waterfowl and other birds. Within Deep Bay, there are two nature reserves (at Mai Po and at Fu Tien) and five *Sites of Special Scientific Interests* (SSSIs), namely Inner Deep Bay SSSI, Mai Po Egretry SSSI, Mai Po Marshes SSSI, Tsim Bei Tsui SSSI, and Pak Nei SSSI. There are two principal fishery resources in Deep Bay; the oyster shellfishery and the inland freshwater fishponds.

3.2 CONSTRUCTION PHASE

3.2.1 *Potential Sources of Impacts*

The major sources of water quality impacts that can potentially arise from the construction of the new brewery plant will be similar to those of normal construction activities. These will include:

- construction runoff;
- general construction activities; and
- sewage from construction work force.

Construction Runoff

Runoff and drainage from construction sites may contain suspended solids and contaminants. Potential sources of pollution from site drainage include:

- runoff and erosion from site surfaces, drainage channels, earthworking and stockpiles;
- drainage from dust suppression sprays; and
- fuel and lubricants from construction vehicles.

General Construction Activities

Site construction activities will have the potential to cause water pollution from the following:

- debris and rubbish such as packaging, used construction materials and floating refuse; and
- spillages of liquids such as oil, diesel and solvents are likely to affect water quality if they enter surrounding water bodies.

Sewage from Construction Workforce

Sewage effluents will arise from sanitary facilities and works canteen provided for the construction workforce. Based on the scale of the construction work, it is estimated that around 100 - 200 workers will be employed. However, this will greatly depend on the construction activities on-site and will vary throughout the construction period.

3.2.2 *Evaluation Criteria*

There are a number of pollution control regulations which apply to inland water quality. Of relevance to the construction phase of the new brewery plant will be the WPCO and *Waste Disposal (Chemical Waste) (General) Regulations.*

The *Technical Memorandum (TM) on Effluents Standards* under the WPCO defines the limits for discharges into Drainage and Sewerage Systems, Inland and Coastal Waters. Discharges to the stormwater system from the plant will be drained to the nearby river. In general, standards for discharges to river bodies can be grouped under their beneficial uses. Downstream of the Yuen Long Creek is an extensive area of fishponds, water that drains through these areas is classified as Group C inland waters. Discharges to these water bodies will therefore have to comply with the limits stipulated in the TM. *Table 3.2a* shows limits which apply to discharges which enter into government foul sewers. These limits are defined by EPD and specified in licence conditions for any new discharge within a *Water Control Zone.*

The *Waste Disposal (Chemical Waste) (General) Regulation 1992* controls chemical waste and specifies the requirements for the packaging, labelling, storage, collection and disposal of chemical waste. Under the regulations, all chemical waste generators will have to register with EPD and all chemical waste generated will have to be disposed of at a licensed facility such as the Chemical Waste Treatment Centre on Tsing Yi. Discharge of chemical waste into foul sewer or stormwater system is not permitted.

Table 3.2a *Standards for effluents discharged into foul sewers leading into Government sewage treatment plants*

Determinands / Flow rate (m^3/day)	≤10	>10 and ≤100	>100 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 (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	43	43	43	43	43	43	43	43	43	43	43	43	43
Suspended solids	1200	1000	900	800	800	800	800	800	800	800	800	800	800
Settleable solids	100	100	100	100	100	100	100	100	100	100	100	100	100
BOD	1200	1000	900	800	800	800	800	800	800	800	800	800	800
COD	3000	2500	2200	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Oil & Grease	100	100	50	50	50	40	30	20	20	20	20	20	20
Iron	30	25	25	25	15	12.5	10	7.5	5	3.5	2.5	2	1.5
Boron	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Barium	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Mercury	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	4	4	4	3	1.5	1.5	1	1	1	1	1	1	1
Nickel	4	3	3	2	1.5	1	1	0.8	0.7	0.7	0.6	0.6	0.6
Chromium	2	2	2	2	1	0.7	0.6	0.4	0.3	0.2	0.1	0.1	0.1
Zinc	5	5	4	3	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Silver	4	3	3	2	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Other toxic metals individually	2.5	2.2	2	1.5	1	0.7	0.6	0.4	0.3	0.2	0.15	0.12	0.1
Total toxic metals	10	10	8	7	3	2	2	1.6	1.4	1.2	1.2	1.2	1
Cyanide	2	2	2	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.08	0.06
Phenols	1	1	1	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.1	0.1
Sulphide	10	10	10	10	5	5	4	2	2	2	1	1	1
Sulphate	1000	1000	1000	0	1000	1000	1000	900	800	600	600	600	600
Total nitrogen	200	200	200	200	200	200	200	100	100	100	100	100	100
Total phosphorus	50	50	50	50	50	50	50	25	25	25	25	25	25
Surfactants (total)	200	150	50	40	30	25	25	25	25	25	25	25	25
Copper	1.5	1	1	1	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.05

Remark: All units in mg/L unless otherwise stated, all figures are upper limits unless otherwise indicated

3.2.3 *Evaluation of Impacts*

Construction Run-off

The physical effects of construction runoff will be of concern as increased suspended solids (SS) concentrations may have potential impacts on the water quality of the nearby Yuen Long Creek which in turn may affect downstream fishponds. However, given the substantial distance of the Yuen Long Creek from the site, and the temporary and localised nature of the disturbances, any water quality impacts will be minimal.

General Construction Activities

The effects on water quality from other construction activities other than runoff are likely to be minimal. Good construction practice should be implemented to ensure that litter, fuels and solvents do not gain access to the nearby water bodies.

Sewage from Construction Force

Sewage effluents arising from on-site construction workforce have the potential to cause water pollution. In general, sewage effluents may be discharged to the existing sewer system which leads to the nearby Yuen Long Sewage Treatment Plant. However, if existing facilities are not available, interim sewage treatment facilities such as chemical toilets will be used.

3.2.4 *Mitigation Measures*

Although the construction activities are not expected to result in adverse water quality impact, proper site management is essential to minimise wash-off during rainy seasons and "good housekeeping" practices should be implemented to ensure that debris and rubbish cannot gain access to nearby stormwater system. Construction site discharges into the nearby river bodies or foul sewer are controlled under the WPCO and thus valid WPCO licences are required. Mitigation measures should also be in accordance with those listed in the *Practice Note for Professional Persons - Construction Site Drainage (ProPECC PN1/94).*

The following provides a guideline on the standard measures which should be enforced.

Site runoff

All site construction runoff should be controlled and treated to prevent runoff with high level of SS. The following measures should be considered:

- the boundaries of earthworks should be marked and surrounded by dykes or embankments for flood protection as necessary;

- temporary ditches such as channels, earth bunds or sand bag barrier should be provided to facilitate runoff discharge into the stormwater drain, via a silt retention pond;

- permanent drainage channels should also incorporate sediment basins or traps and baffles to enhance deposition;

- sediment traps and channels must be regularly cleaned and maintained by the contractor. Daily inspections of such facilities should be required of the Contractor;

- perimeter channels should be provided at the site boundary to intercept storm runoff from offsite. These channels should be constructed in advance of site formation works and earthworks;

- all traps (temporary or permanent) should also incorporate oil and grease removal facilities;

- manholes should be adequately covered or temporarily sealed;

- all drainage facilities must be adequate for the controlled release of storm flows;

- open stockpiles should be covered with tarpaulin or similar fabric to prevent washing away;

- minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff;

- earthwork final surfaces should be well compacted and subsequent permanent work should be immediately performed; and

- construction programme should be scheduled between September and April whenever possible to minimize soil erosion during the rainy season.

Wastewater from Construction Activities

- Water used for water testing, boring, drilling works and precast concrete casting should be recirculated/reused as far as practicable;

- Online standby sump pumps should be provided to prevent wastewater overflow from water recycling system; and

- Washwater from wheel washing facility should have sand or silt removed before discharging into stormwater drains; the area between site exit and public road should be paved with backfill to prevent site runoff from flowing on to the public road.

Debris and Litter

The contractors should ensure that site management is optimised and that any solid materials, litter or wastes are prevented from entering surface and marine waters.

Oils and Solvents

All fuel tanks and storage areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank. Oil leakage or spillage should be contained and cleaned up immediately.

Vehicle and plant servicing areas, vehicle wash bays and lubrication bays should be located within roofed areas where possible. Drainage should be connected to local sewer via oil interceptor.

Sewage

Sewage from toilets should be discharged into foul sewer which leads to the Yuen Long Sewage Treatment Works. Grease traps should be installed for discharges from drainage from basins, sinks and floor drains. Chemical toilets can be used if local sewer is not available.

3.2.5 *Monitoring and Auditing Requirements*

In light of the minimum impacts expected on the water quality of the surrounding environment, no monitoring or auditing requirement are recommended during the construction phase provided that the appropriate mitigation measures described previously are observed.

3.3 *OPERATIONAL PHASE*

3.3.1 *Potential Sources of Impact*

The new brewery will be capable of producing 1 million hl of beer per year (Phase 1), expandable to 1.5 million hl in the future (Phase 2). For Phase 1, the daily water consumption for this production capacity is estimated to be around 1400 m^3/day for October to May (low season) and 1700 m^3/day for June to September (high season). (The corresponding figures for Phase 2 are 2100 and 2500 m^3/day.)

With a typical water consumption to beer ratio of less than 5 : 1, around 1120 to 2000 m^3/day of wastewater will be generated daily depending on the beer production capacity (Phase 1 or 2). Note the proposed water to beer ratio is exceptionally low and amongst the lowest achievable. However, the wastewater generation can be reduced with the implementation of water conservation measures as discussed in *Section* 3.3.4.

The principal sources of wastewater arising from the operation of the brewery are :

- production process wastewater from the brewing operation and associated cleaning requirement;
- rinsing/washing water from bottling, canning and kegging lines;
- waste detergents from cleaning of process units;
- backwash from water treatment plant;
- boiler blowdown;
- sanitary sewage; and
- site runoff.

Figure 3.3a shows the effluent streams from the brewery processes.

3.3.2 *Evaluation Criteria*

The evaluation criteria applied to the construction phase as discussed in *Section 3.2.2* is generally applicable to the operational phase. The effluent from the plant will be discharged into local sewer which drains to the Yuen Long Sewage Treatment Plant. The discharge limits will be evaluated against the TM standards for discharges into government sewer.

3.3.3 *Evaluation of Impacts*

The operation of the Brewery will generate large volume of effluent discharge in the region of 1120 to 1360 m^3 per day (1680 to 2000 m^3 per day for Phase 2). Consultation with the Drainage Services Department (DSD) and the Hong Kong Industrial Estate Corporation confirmed that there is adequate sewerage infrastructure to accept the effluent load from both Phase 1 and 2 of the new Brewery.

The exact quality of individual effluent streams are not available. However, based on existing brewery operations, the wastewater will have a high Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and suspended solids level. Wastewater from the brewery will have to meet the discharge limits as stipulated in *Table 3.2a*.

Biological treatment systems are commonly employed by the brewery industries to reduce COD and BOD_5 and suspended solids loads from the waste water. A number of biological wastewater treatment plants are designed to reduce the BOD, COD and suspended solids levels. A brief description of these treatment processes are given in *Annex B*. The merits and demerits of these wastewater treatment system are given in *Table 3.3a*. The consultants were advised that anaerobic digestion, that is the Upflow

Anaerobic Sludge Blanket (UASB) process will be employed at the new brewery. The process is discussed in greater detail below:

Background

Anaerobic technology has been applied for the stabilization of animal manures and municipal sludge for many years. The two major municipal wastewater treatment facilities in Hong Kong (Shatin and Tai Po Wastewater Treatment Works) also employ this technology for the digestion of surplus activated sludge. Recently, the application of this technology has also expanded to treatment of industrial wastewaters. The pioneer digester designs were of continuous stirred tank type in which effective contact between waste and active biomass was achieved by lengthy retention time within the digester. Since the introduction of anaerobic technology for wastewater treatment by *Young and McCarty* (1969), anaerobic wastewater treatment has become more and more popular because of the development of high-rate reactors which successfully achieve the separation between the hydraulic retention time (HRT) and the solids retention time (SRT). Such separation allows the slowly growing microorganisms to remain within the reactor independent of the wastewater flow, thereby allowing application of significantly higher volumetric loading rates.

During the past 30 years, many different design concepts have been developed to achieve separation of HRT and SRT. Among all these designs the UASB process has become the most popular not only in Europe but also in East Asia for the treatment of wastewater from industries, such as brewery, distillery, dairy, sugar processing, potato, etc. (*Hulshoff Pol and Lettinga 1986* [1]*; Lettinga and Hulshoff Pol 1991* [2]*; Fang et al. 1986* [3]). According to a report by the *Netherlands Agency for Energy and the Environment* in 1990, there are more than two hundred full-scale UASB reactors installed worldwide. Over 30 of them are employed for the brewery industry.

[1] Hulshoff Pol, L. W., Lettinga, G., (1986). New technologies for anaerobic wastewater treatment. Wat. Sci. Tech., 18(12), 41-53.

[2] Lettinga, G., Hulshoff Pol, L. W., (1991). UASB-process design for various types of wastewaters. Wat. Sci. Tech., 24(8), 87-107.

[3] Fang, H. H. P., Liu, G., Zhu, J., Cai, B., Gu, G., (1990). Treatment of brewery effluent by UASB process. J. Environ. Engrg., 116(3), 454-460.

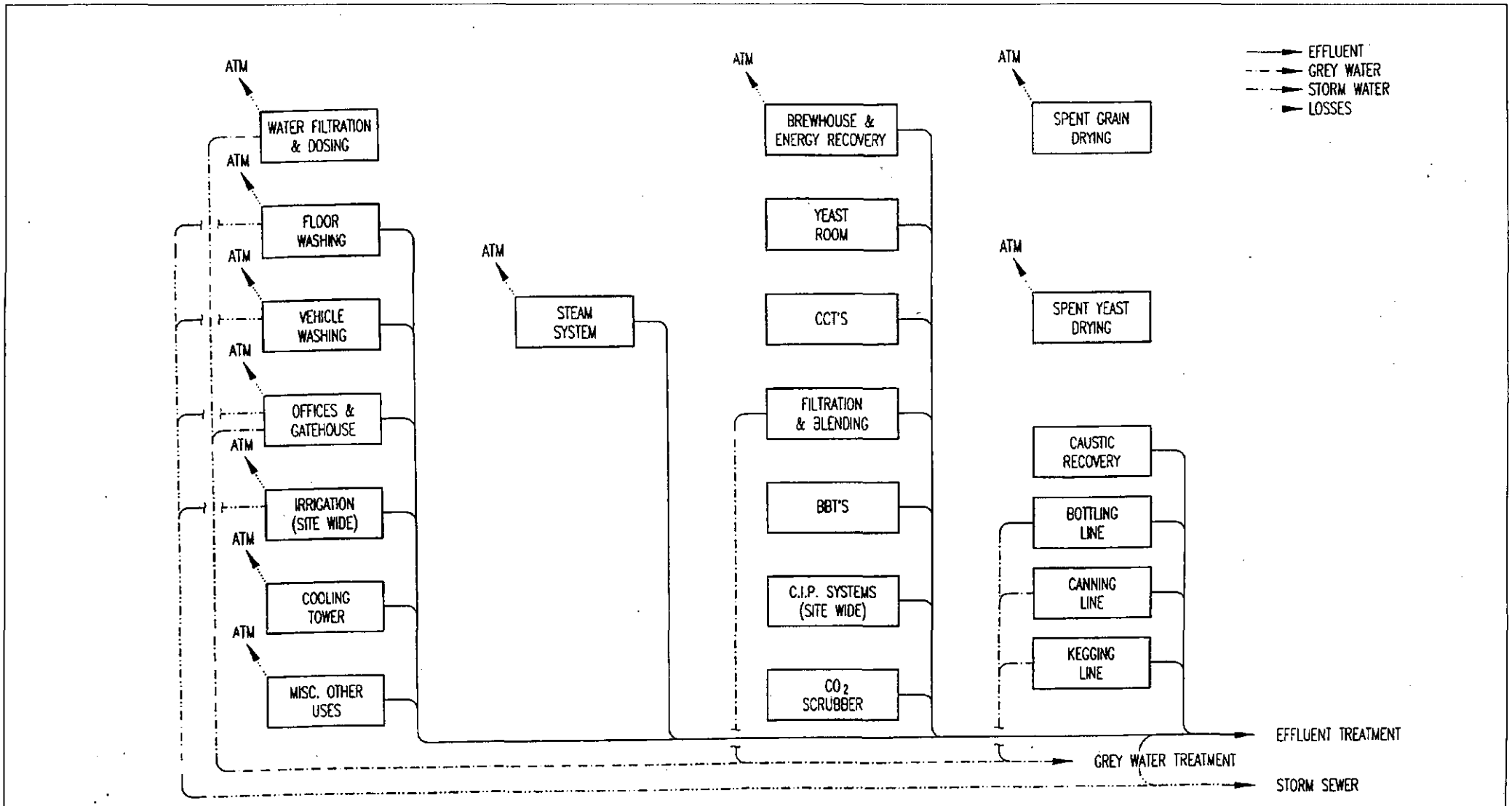

FIGURE 3.3a - EFFLUENT STREAMS FROM THE BREWERY

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10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

Table 3.3a ***Comparison of operational parameters in different reactor designs***

	Anaerobic Digestion	Activated Sludge - Aerobic	Activated Sludge with Oxygen	Biofilters
Advantages	• Reduced sludge volume generation • Generation of bio-gas for use within boilers • Reduced nutrient requirement than compared to aerobic systems	• Less sensitive to pH variation • Operates at ambient temperatures	• Less sensitive to pH variation • Operates at ambient	• Operates at ambient temperatures
Disadvantages	• Less suitable for dilute wastes with COD<400mg/L • Sensitive to pH variation, most efficient operation between pH 6 to 8 - pH adjustment required • Requirement to provide heating to digestion unit, but given temperature of waste water (40°C) this requirement likely to be minimal	• High strength brewery wastes require substantial oxygen transfer capacity - pump sizing - operational costs • Higher operating costs than aerobic systems • Increased flow balancing requirements	• Sensitive to generation of acidic conditions from CO_2 • High costs of providing oxygen (HK$4560/day) • Increased flow balancing requirements	• Greater volume and volatility of sludge generated • Potential difficulties in achieving aeration capacity due to strength of waste • Possible problems with odour generation • Increased flow balancing requirements
Primary Land Take Requirements	$400m^{2*}$ * Assumes 12 hour hydraulic retention	$800m^{2*}$ * Assumes 3.0 day hydraulic retention	$500m^{2*}$ * Assumes 1.5 day hydraulic retention	$500m^{2*}$ * Requires two stage treatment process
Relative Capital Cost	high	medium	high	low
Operating cost	low	medium	highest	low
Power Requirements	20kW	110kW	40kW	Minimal
Sludge yield ($g\text{-}VSS/g\text{-}COD_{removed}$)	0.08 - 0.23	0.4 - 0.6	0.4 - 0.6	0.4 - 0.6

Process Description

A typical UASB design consists of a biological reaction zone and a sedimentation zone. In the reaction zone, the biodegradable organic matter in the influent are converted to methane and carbon dioxide gases as the flow passes upward through a bed of highly active sludge, usually called a sludge blanket. The gases produced and the sludge carried up by entrapped or attached gas bubbles are separated from the liquid effluent via a Gas-Liquid-Solid (G-L-S) separator installed at the top of the reactor. The upflow current created by the influent and the rising biogas, not only provides complete mixing of reactor content, and thereby increasing contact between waste and biomass, but also produces a selection pressure which allows the retention of biomass having high settleability and high methanogenic activity. The anaerobic sludge retained inside the reactor is often granular in nature. High concentration of granular sludge of 5-10% can be retained in UASB systems, which allows the process to achieve high removal efficiencies at high volumetric COD loading rates. A COD loading rate as high as 160 $kg/m^3/day$ has been reported in a laboratory scale UASB treating sugar wastewater. In the brewery industry, COD loading rate of 3-32 $kg/m^3/day$ with more than 90% COD removal can be achieved (*Hickey et al. 1991* [1]).

The proposed UASB system will consist of the following pretreatment system:

- a rotary screen
- a buffer tank
- pH adjustment system

The wastewater will then be pumped into UASB reactor through an influent distributor system at the bottom of the reactor. Effluent from the UASB will be discharged to the foul sewer. *Figure 3.3b* shows the typical flow diagram for an UASB system.

Design Criteria

Table 3.3b shows the technical specifications upon which the design of the UASB process will be based on.

Table 3.3c presents the discharge criteria which the plant will be designed to meet. It should be noted that the design discharge limit is well below the TM requirements. SMHK have expressed their intention to achieve lower discharge limits based on the "Best-Practical Means" concept to benefit the environment.

[1] Hickey, R. F., Wu, W. M., Viega, M. C., and Jones, R., (1991). Start-up, operation, monitoring and control of high-rate anaerobic treatment systems. Wat. Sci. Tech., 24(8), 207-255.

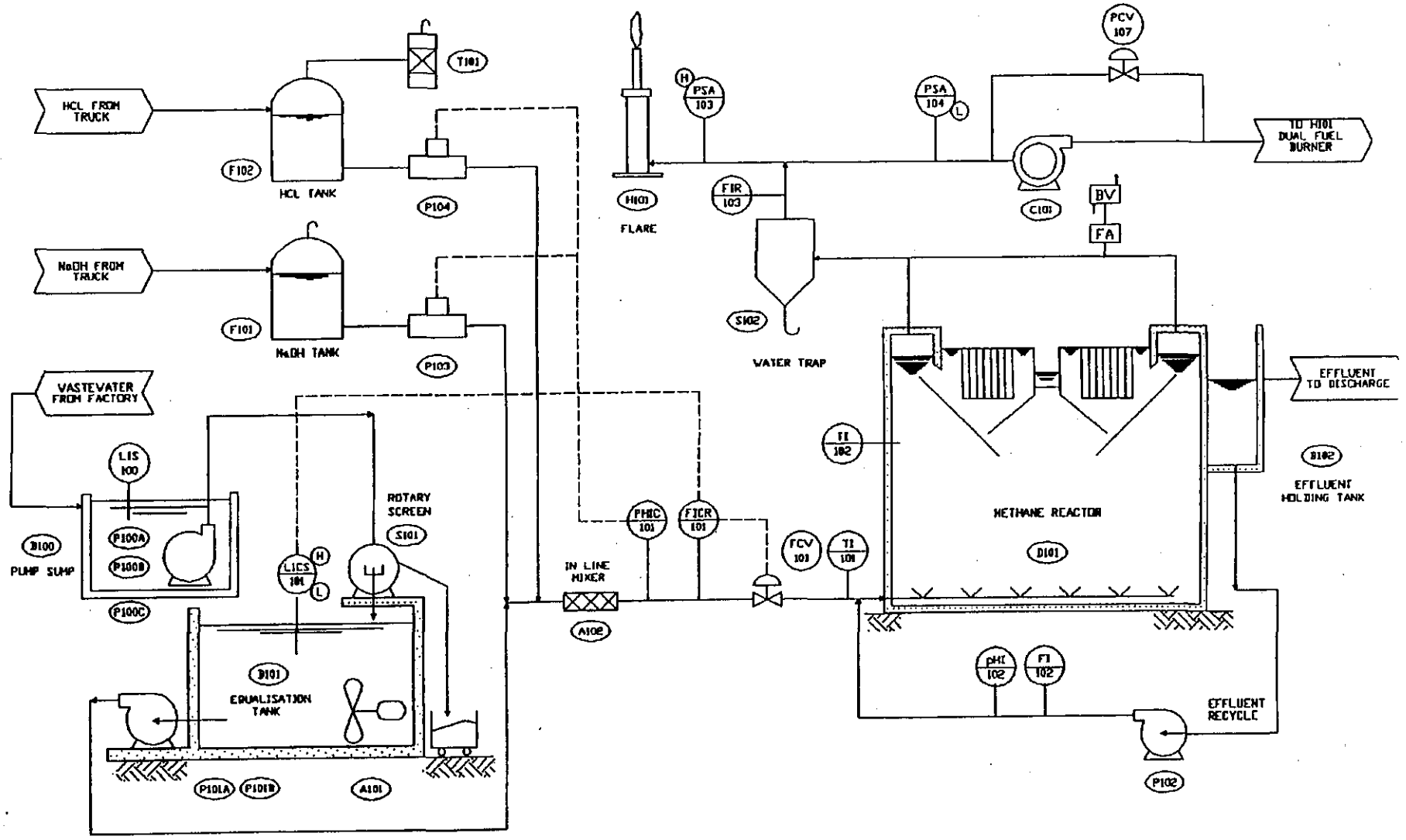

FIGURE 3.3b - TYPICAL FLOW DIAGRAM FOR A UASB SYSTEM

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Hecny Tower
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Tsimshatsui, Kowloon
Hong Kong

ERM

Table 3.3b ***Basic Design Data***

Design Criteria			
Design capacity		1M hl/year	
Flow Rate	Maximum	175 m^3/hr	
	Average	129 m^3/hr	
Operating hours per day		16 hrs	
Brewing days		250 days	
COD loading	Maximum (10 kg/m^3/day)	12,400 kg/day	
	Average (7 kg/m^3/day)	7800 kg/day	
Design Parameters		Ave	Max
	BOD_5 mg/L	1500	2000
	COD mg/L	3000	4000
	Total Suspended Solids (TSS) mg/L	400	980
	pH	variable 6.5 - 11	
	Temperature °C	28 - 38	

Reference: Basic Design Data from Supplier

Table 3.3c ***Effluent Standards***

Discharge Criteria	Limits* (mg/L)	TM limits (mg/L) for flow between 1500 and 2000 m^3/day
COD	<500	2000
BOD_5	<250	800
TSS	<250	800
pH	6.5 - 10	6 - 10

Note : * Proposal for the Wastewater Treatment of San Miguel Brewery Hong Kong Limited dated 15 September 1994.

3.3.4 *Mitigation Measures*

The operation of the brewery as envisaged generates large volumes of effluent. Although adequate sewerage infrastructure is available, DSD recommended the use of buffer tanks to regulate peak flow conditions so as to prevent overloading of the sewerage system. SMHK's on-site biological wastewater treatment plant will be equipped with a buffer tank that will be used for this purpose.

Mitigation in the form of effluent treatment in a proposed purpose designed water treatment plant is considered adequate. However, considerations should be given to the following points to ensure that the plant operates in a satisfactory and effective manner:

Operational Considerations

Although UASB process is a well proven technology with high loading capacity and less sludge production than other wastewater treatment systems for treating brewery waste, some operational conditions should be closely controlled in order to achieve a performance efficiency and to ensure smooth and uninterrupted service. Some of the important conditions should be considered:

- *Commissioning*

Granular sludges recovered from existing UASB reactors in Europe are generally used for seeding new reactors. However, experience on the use of other non-granular material such as sludge from local digester or cow manure are well documented. Cultivation of granular sludge often requires 2 to 6 months. During this period, the loading conditions should be strictly controlled. Sufficient time allowance should be given to meet the operation schedule of the plant. The failure of the plant to meet the discharge limit can have significant impact on the overall operation of the brewery.

It is recommended that experienced staff be employed during commissioning and knowledgeable resident staff be available for troubleshooting in the early stage of plant operation. In addition, the payment schedule to the vendor should be carefully considered so that certain amount of the payment can be retained over and beyond the initial commissioning.

- *Granular Sludge Floating*

Granule floating can occur when a reactor receives a shock load or are re-fed after a prolonged starvation period. Empty cores caused by death of cells within the granules will be formed as a consequence of the lack of substrate. A practical method to alleviate this problem is to disrupt the granules by breaking them into small particles via pumping. The particles will eventually reform as granules of high settling properties.

It is observed that there are only 250 brewing days per year. Sludge floating problems could thus occur. The integration of an internal recycling pumping

device is recommended [1]. On the other hand, if the supply of influent is interrupted for a short period of time, for example five brewing days per week, this may allow the reactor to digest the accumulated organic matters in the reactor and thus resulting in a more stable performance.

- *Disposal of Excess Sludge*

The main concern with anaerobic treatment is to retain a high concentration of active biomass inside the reactor. This differs from aerobic treatment where the main problem is the disposal of excess sludge. Discharge of sludge may not be required in the first year of operation of the UASB during start-up period. However, suitable disposal methods should be established beforehand. Excess sludges are to be withdrawn from the reactor at one-half the height of the reactor where there are more flocculent sludges than granular sludges. Granular sludge of high methanogenic activity is very useful in the start-up of new reactors, potential purchasers are widely available in Europe and Asia to accept these sludges (see also *Section 6.3.3*).

- *High Suspended Solids*

Although applications of UASB has been successful in treating many industrial wastewaters, the process has been perceived to be vulnerable to high levels of suspended solids (SS). The presence of high concentration decomposable SS in the wastewater may inhibit sludge granulation and impair the methanogenic activity of the sludge, or, in some extreme cases, may cause a sudden acidification of the reactor content or even a sudden washout of the sludge bed. Recent research results indicated that UASB processes are able to process wastewater containing mainly SS as the sole substrate when granular sludge are acclimated and operation conditions are strictly controlled. As the SS content of the existing brewery wastewater is, on average, 400 mg/L, and these are readily biodegradable, adverse effects caused by high SS may not occur.

- *Nutrients*

Nutrients such as nitrogen and phosphorous, requirements for anaerobic digestion are generally lower than for aerobic digestion. In another words, the nutrient removal efficiency of anaerobic digestion is not as high. The effluent after anaerobic digestion have a COD:N ratio of 200:5. The effluent could contain reduced products and fermentation products such as NH_4^+, S^{2-}, and volatile fatty acids which may generate bad odours.

- *Methane*

The biogas produced from the reactor will comprise between 25-40% of carbon dioxide, 60-75% of methane, and trace amounts of hydrogen sulphide. Methane will be utilised as fuel gas for the boilers. The health and safety aspects of methane gas are addressed in *Section 7*.

[1] The Consultants have subsequently been advised that recycling is included in the system.

- *Dedicated Environmental Team*

The UASB will require well trained and experienced operators to ensure smooth and uninterrupted service. A full time dedicated staff fully conversant in the operation of the treatment plant is recommended to run the plant in an effective manner.

- *Technical Laboratory*

San Miguel are to set up its own technical laboratory equipped with the appropriate facilities to carry out analytical work on site to avoid delays in sampling and reporting. Results will be readily available to on-site staff so that appropriate action can be taken promptly.

Water Conservation Measures

The new brewery will have a fixed water supply allocation. The current water allocation will be 1400 m^3/day for October to May and 1700 m^3/day for June to September. A water management study [1] was undertaken to examine the possible water conservation measures. A summary of water conservation measures to minimise the water consumptions at the plant is presented below. These are currently being further considered to determine their respective practicality.

- *Use of Air Blast Coolers*

Water is conventionally used to cool the refrigeration systems through evaporative condensers. This can be replaced by dry air blast coolers which passes air over a coil to effect the required heat transfer from the refrigerant.

- *Grey Water System*

A substantial volume of water used within the plant can be reused without excessive treatment. Potential sources of water supply include:

- floor washings from selected areas;
- brewing water filter plant backwashes;
- activated carbon filter backwashes;
- crate washings
- rinse water from clean/non-returnable bottles; and
- boiler feed water exchange plant.

The wastewater from these sources can undergo simple treatment to remove the solids and small amount of organic matter and dissolved minerals. The grey water can be screened and dosed with chemicals. The treated grey water can then be suitable for re-use for non-critical applications such as cleaning of external keg, flushing of sanitary toilets, irrigation, vehicle and floor washings and external crate washing.

[1] San Miguel Brewery Hong Kong Limited - Yuen Long Brewery Water Management Study by Ove Arup & Partners, September 1994

- *Rainwater Collection*

A rainwater collection scheme is proposed to collect rainwater from the roofs of the administration building, the packaging hall, and the production block. While rainfall varies from year to year, based on past statistics on the rainfall in Hong Kong, it is estimated that 20,700 m^3 of rainwater can be collected from the roof areas. Rainwater can be stored at the grey water storage tank.

- *Reject Full Goods Recycling*

The possibility of recycling filler bleeds and reject full goods should be considered to reduce the effluent load and overall water consumption.

- *Reuse of Spent Grain Press Liquor*

Brew extract which is lost with the spent grains can be reclaimed in a press, autolysed and returned to the wort kettle. The estimated reduction in water consumption is reported to be around 10%.

- *Design Considerations*

The philosophy of water conservation is being considered by SMHK as an integral part of the design process. Practical measures will be implemented to ensure that consideration is given to water conservation throughout the design stage. These include:

- setting of target water consumptions;
- nominated personnel with specific responsibility and authority to consider water conservation measures throughout the design stage;
- incorporation of water recycling option into the equipment specification;
- water consumption guarantees; and
- careful equipment selection.

The overall water : beer ratio is estimated to be less than 5 : 1 if no water conservation measures are implemented. With the above mentioned water conservation programme, a ratio of 3.9 : 1 is possible. This will enable greater production flexibility and higher peak production of up to 33% increase in production which in turn results in reduction in the wastewater generated.

The consultant strongly supports San Miguel's approach to water conservation. Water conservation is desirable from an environmental viewpoint in that it not only enables greater production flexibility but also results in lesser wastewater generation which in turn reduces the load to the sewage treatment plant. As a good practice, it is recommended that the opportunity of water conservation measures be explored on a regular basis throughout the operational phase of the plant.

3.3.5 *Monitoring Requirements*

Water quality monitoring will be necessary as a check on the performance of the wastewater treatment system and on the compliance of the effluent within the discharge standards for the foul sewer as stipulated by EPD.

Sample analysis of COD, BOD and total suspended solids should be carried out on a daily basis during initial operations and monitoring frequency should be reviewed, after a period of time to be agreed with EPD, and revised as necessary in the light of the performance of the plant. Sampling locations should be located before the point of discharge and at a location agreed with EPD. *Table 3.3d* presents the recommended monitoring requirements for the plant, which should be reviewed on a regular basis. Ongoing monitoring results can serve as a basis for determining the monitoring requirements.

Monitoring data should be recorded and stored for ease of reference. A regular report should be submitted to EPD at a frequency to be agreed. The reports should include monitoring data, audit/review of the environmental monitoring data to ensure compliance with regulatory requirements, policies and standards and any remedial works taken/required in the event of an exceedance in the discharge limits.

3.4 CONCLUSIONS AND RECOMMENDATIONS

3.4.1 *Construction Phase*

The construction of the new brewery is not envisaged to have any water quality impacts provided that proper site management and good housekeeping practices are implemented.

3.4.2 *Operational Phase*

The operation of the Brewery will generate a large volume of effluent, in the region of 1120 to 1360 m^3 per day (1680 to 2000 m^3 per day for Phase 2). Consultation with the Drainage Services Department (DSD) and the Hong Kong Industrial Estate Corporation confirmed that there is adequate sewerage infrastructure to accept the effluent load from both Phase 1 and 2 of the new Brewery. However, DSD recommended that buffer tanks should be used to regulate peak flow conditions so as to prevent overloading of the sewerage system. SMHK's on-site biological wastewater treatment plant will be equipped with a buffer tank that will be used for this purpose.

The proposed brewery has been designed to function at a very low water consumption to beer ratio. A water conservation and recycling programme will further reduce overall water consumption.

Effluent from the brewery plant will be treated to well below the required TM discharge limit at an on-site biological wastewater treatment plant where high levels of suspended solids, BOD and COD are reduced. Special

considerations concerning the running of the treatment plant during the operational phase are recommended.

A water quality monitoring programme will be required as a check on the performance of the treatment plant and to ensure compliance with the discharge standards.

Table 3.3d ***Proposed Water Quality Monitoring Programme for Operational Phase***

Measurement Details	Description
Measurement Method	Analytical methods as listed in the Technical Memorandum
Locations	Before point of discharge, to be agreed with EPD.
Limits	TM limits
Continuous Monitoring	*Frequency*
	Hourly
	Measuring Parameters
	Flowrate pH Temperature
Performance Monitoring	*Frequency*
	Daily
	Measuring Parameters
	BOD COD Suspended Solids Levels
Compliance Monitoring	*Frequency*
	Monthly
	Measuring Parameters
	pH Temperature Suspended solids Settleable solids BOD COD Oil and grease Iron, Boron, Barium, Mercury, Cadmium, Copper, Nickel, Chromium, Zinc, Silver, Cyanide, Phenols, Sulphide Total Nitrogen, Total Phosphorus Surfactants

4 AIR QUALITY

4.1 INTRODUCTION

This section discusses the air quality impacts associated with the construction and operation of the new San Miguel Brewery in Yuen Long Industrial Estate. The impacts were evaluated against the *Hong Kong Air Quality Objectives* (HKAQOs). Relevant EPD guidelines and criteria were also adopted. With regard to the operational air impacts, background aerial emissions in the Yuen Long Industrial Estate are also considered.

4.2 BASELINE CONDITIONS

4.2.1 Existing Conditions

The air quality profile in the study area is dominated by aerial emissions from the operation of nearby industries. Pollutants in aerial emissions include sulphur dioxide (SO_2), nitrogen oxides (NO_x), fine particulates and hydrocarbons. Several new developments are being constructed next to the proposed plant. Dust levels in the study area could be elevated by fugitive dust from these construction sites.

The nearest EPD air monitoring station is at Tai Po. Due to similar development regimes, the air quality at the station may be indicative of the general air quality in the study area. The air quality at Tai Po in 1992 and 1993 is shown in *Table 4.2a*. Gaseous pollutants, NO_2, SO_2 and O_3 were all of low concentrations and within AQO. However, Total Suspended Particulates (TSP) levels have exceeded the AQO and Respirable Suspended Particulates (RSP) concentrations were approaching the maximum allowable concentrations.

Table 4.2a Air Quality at Tai Po[1]

Pollutants	92		93	
	24-hour Maximum	Annual Average	24-hour Maximum	Annual Average
TSP	(290)	(90) [2]	230	(90)
RSP	180	50	150	50
SO_2	120	10	–	–
NO_2	100	40	100	40
O_3	–	5	–	–

[1] Data abstracted from *Hong Kong Environment 93* and *94*
[2] Pollutant concentrations in brackets have exceeded AQO

4.2.2 *Future Conditions*

Yuen Long Industrial Estate has not yet been fully occupied, several new plants are expected to be constructed in the near future and there is also room to accommodate additional industrial units. Therefore, levels of aerial emissions can be expected to also increase in the future. Increases in traffic on the nearby roads due to future developments in the area will also produce more emissions to the atmosphere.

4.2.3 *Meteorological Conditions*

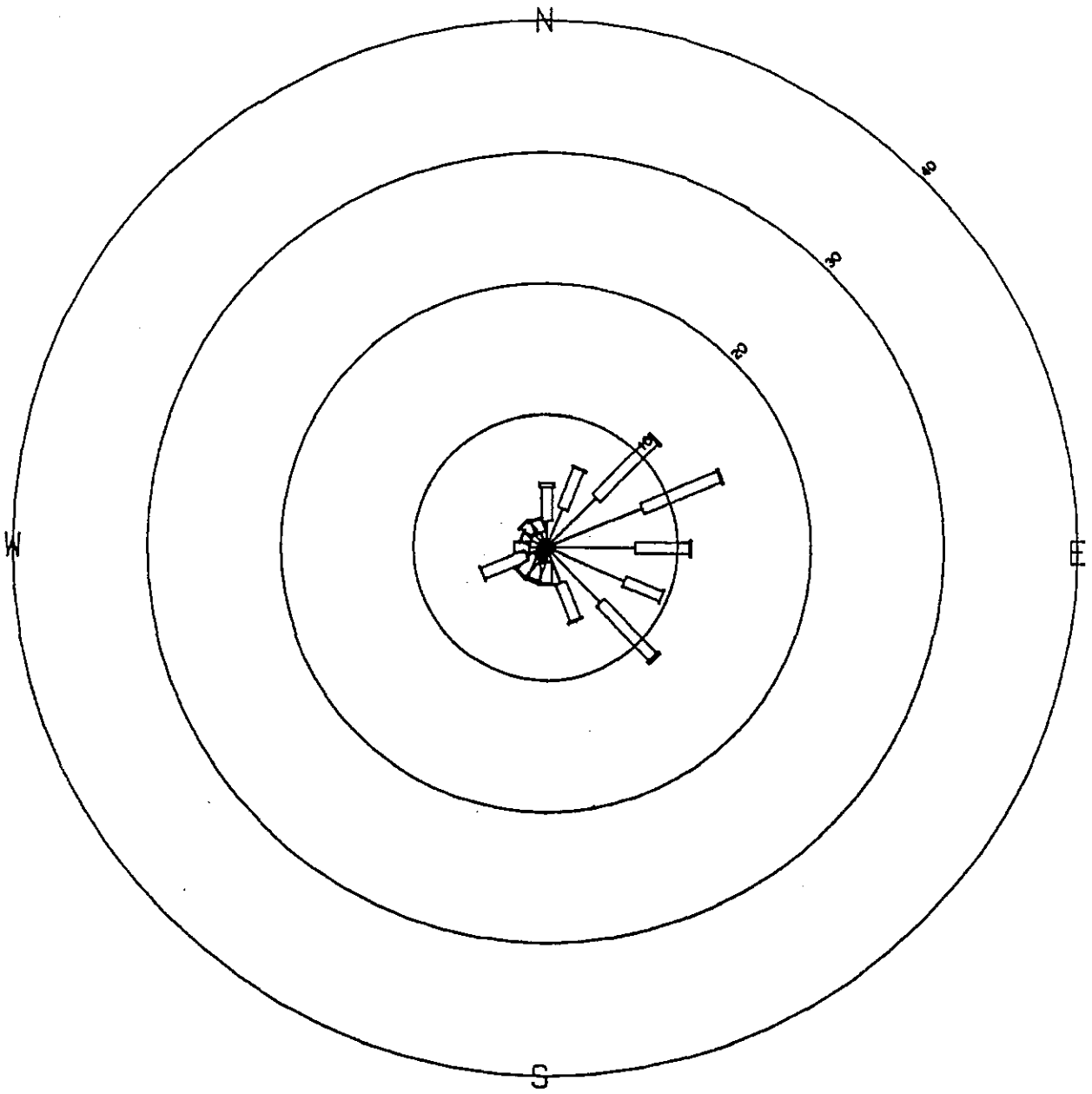
The study area is situated in the Deep Bay Airshed which has a limited dispersive capacity. *Figure 4.2a*, a wind rose at Royal Observatory's Lau Fau Shan Automatic Weather Station (AWS), indicates that the predominant winds in the Deep Bay Airshed are northeasterly to southeasterly and wind speeds fall within the category of 0–3 m s^{-1}. These predominant categories of wind directions and speeds account for more than 70% and 50% of all wind occurrences independently.

4.2.4 *Sensitive Receivers*

In accordance with *Hong Kong Planning Standards and Guidelines* (HKPSG), sensitive receivers include residential uses, schools and academic institutions, and actively used open spaces. The identified air sensitive receivers (ASR) in the vicinity of San Miguel Brewery are summarized in *Table 4.2b* below and their locations are shown in *Figure 4.2b*. Most of the identified ASRs are residential premises but a school was identified at Long Ping Estate.

Table 4.2b *Identified Air Sensitive Receivers (ASR) in the Study Area*

ASRs	Land Uses	Elevations	Distance from San Miguel Brewery Boiler stack (m)
Long Ping Estate (LPE)	residential, school	high rise	1100
Fuk Hing Tsuen (FHT)	residential	ground level	880
Tai Tseng Wai (TTW)	residential	ground level	460
Shing Uk Tsuen (SUT)	residential	ground level	660
Sai Tau Wai (STW)	residential	ground level	1000
Chung Sam Wai (CSW)	residential	ground level	970
Tung Tau Wai San Tsuen (TTWST)	residential	ground level	950
Ng Uk Tsuen (NUT)	residential	ground level	400
Leon Court (LC)	residential	ground level	300
Tai Tseng Shing Uk Tsuen (TTSUT)	residential	ground level	360



NO. OF OBSERVATIONS = 25276

NO. OF VARIABLE = 298 (1.2 %)

NO. OF CALM = 35 (.1 %)

PERCENTAGE FREQUENCY

0 10 20 30 40

BEAUFORT FORCE

1 - 2	3 - 4	5 - 6	> 6
0.1 - 3.3	3.4 - 7.9	8.0 - 13.8	> 13.8 m/s
1 - 11	12 - 28	29 - 49	> 49 kn/

SPEED

FIGURE 4.2a - WIND ROSE AT LAU FAU SHAN AWS
(OCTOBER 1986 - SEPTEMBER 1989)

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10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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Figure 4.2b Locations of Air Sensitive Receivers

4.3 STATUTORY REQUIREMENTS

The whole of the Hong Kong Territory is covered by the *Hong Kong Air Quality Objectives (HKAQO)* under the *Air Pollution Control Ordinance (APCO)*, which stipulate the statutory limits of some typical air pollutants and the maximum allowable numbers of exceedance over specific periods. The HKAQO are depicted in *Table 4.3a* below.

Table 4.3a Hong Kong Air Quality Objectives[(i)] ($\mu g\ m^{-3}$)

Pollutant	Concentration in micrograms per cubic metre [(i)]				
	Averaging Time				
	1 Hour[(ii)]	8 Hours[(iii)]	24 Hours[(iii)]	3 Months[(iv)]	1 Year[(iv)]
Sulphur Dioxide (SO_2)	800		350		80
Total Suspended Particulates (TSP)	500 [(vii)]		260		80
Respirable Suspended Particulates [(v)] (RSP)			180		55
Nitrogen Dioxide (NO_2)	300		150		80
Carbon Monoxide (CO)	30,000	10,000			
Photochemical Oxidants (as Ozone) [(vi)] (O_3)	240				
Lead (Pb)				1.5	

Note:
(i) Measured at 298 K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in the air with nominal aerodynamic diameter of 10 micrometres and smaller.
(vi) Photochemical oxidants are determined by measurement of ozone only.
(vii) In addition to the above established statutory limits, it is generally accepted that an hourly average TSP concentration of 500 $\mu g/m^3$ should not be exceeded. Such a control limit has no statutory basis but is particularly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contract clauses.

4.4 CONSTRUCTION PHASE

4.4.1 *Introduction*

The principal source of potential air quality impacts during the construction of the San Miguel Brewery will be dust. The access roads to the proposed site are all paved; therefore dust will mainly arise within the construction site itself. The principle activities relating to this air quality assessment are construction of roadways and buildings including brewhouse, packaging

hall, administration and ancillary buildings; and ground excavation for the proposed underground car park.

4.4.2 *Potential Sources of Impacts*

Due to the limited works area on the site, a batching plant will be operated off-site and, hence, will not contribute to any dust sources in the study area. Construction vehicles used on site will include up to twelve concrete trucks and dump trucks per day. Limited emissions of SO_2 and NO_x will be produced from this equipment and vehicles, but these are not anticipated to reach significant levels.

The main dust source will be from the handling of excavated materials. Soil excavation will take place for three weeks, and the excavated materials are planned to be stored within the site for general use. Fugitive dust will therefore be generated at the stockpile area, which will be situated near the area designated for the waste water treatment plant. The size of stockpiles will fluctuate with construction activities.

4.4.3 *Significance of Dust Impacts*

The construction site is surrounded by industrial buildings approximately 20 m high. The ASRs identified in *Section 4.2.4* are either screened by these buildings or are at a significant distance from the site behind Chu Wong Ling. The dust impacts at the these ASRs would be very low due to the effects of path obstruction and dilution when travelling towards distant ASRs. In addition, there are only a limited number of activities on the site which might cause dust nuisance. Demolition works are not required and the site is ready for construction. The stockpile area allocated is about 1000 m^2. Extensive excavation is only required for the car park underneath the administration building, which is approximately 2000 m^2, indicating the adequacy of the stockpile provision. In the light of the above, there should not be any unacceptable TSP impacts at the ASRs with the small scale of construction works envisaged. However standard dust suppression measures should be adopted as below.

4.4.4 *Mitigation Measures*

To minimize any dust nuisance, the following dust control measures are recommended:

- stockpiles of excavated materials should be enclosed on three sides with walls extending above the pile;
- water spray facilities should be provided and used for damping the stockpile materials;
- on-site unpaved roads that are frequently used should be regularly compacted and the road surface should be kept clear of loose material. Water spraying should also be used to control dust; and

- wheel-wash troughs and hoses should be provided at traffic exits from the site to minimise the quantity of material deposited on public roads.

4.4.5 *Monitoring Requirements*

The identified ASRs will not be directly affected by the construction activities since they are either screened behind the buildings in the industrial estate or the surrounding hills and the construction activities are not extensive. Hence, monitoring is not required given the above mitigation measures are applied to control dust generation at the site.

4.5 *OPERATIONAL PHASE*

4.5.1 *Introduction*

The principle activities at the plant are brewing and packaging. Trace amount of volatile organic compounds (VOCs) will be emitted during the different stages of brewing. The common constituents of the VOCs are ethanol, alkanes, alcohol and acetate. Emissions of VOCs to the atmosphere is limited as the brewing environment is enclosed and condensers are installed in the boiling kettle.

Associated facilities and treatment are required in line with beer production. Four boilers will be installed for energy supply. Spent yeast and grain drying plants are required for treatment of used materials, and a wastewater treatment plant is designed for treatment of all types of wastewater from the brewery. Air quality impacts will be induced from the operation of all these facilities. The main potential air quality impacts could arise from the gaseous emissions and associated odours.

4.5.2 *Potential Sources of Impacts*

The principle air pollutant emissions associated with the operation of the San Miguel Brewery are aerial emissions from their boiler facilities. Three new boilers at the proposed San Miguel Brewery are being designed to run on light diesel oil (LDO) and the fourth boiler on LDO/biogas. The major potential pollutants from the boilers are SO_2, NO_2 and particulates. Quite a large amount of vapour emissions will also be emitted to the atmosphere during normal operation.

An anaerobic wastewater treatment plant will be employed in the new brewery. Products of anaerobic digestion are dominated by biogas where methane gas concentration can be up to 75%. Biogas will be collected and utilised in the dual fired boiler.

In addition to the gaseous emissions, odour nuisance is also a potential air quality impact. Intermittent by-products of beer production include spent yeast and spent grain. In the new plant, all spent yeast will be dried before removal from the site, and dried spent yeast is less odorous than fresh wet spent yeast. However, there is a possibility that spent grain will be

disposed without drying. Disposal of the spent grain and drying of spent yeast are anticipated to be the major potential sources of odour nuisance. Brewery effluents are treated in the anaerobic treatment plant where sludges with offensive smells will be produced periodically. However as the equalisation tank, which is the main source of odour impact, will be fully covered and that the removal of sludge from the wastewater treatment plant will be an enclosed operation, no significant odour emission is expected.

4.5.3 *Assessment Methodology*

Dispersion Modelling

The *Industrial Source Complex Version* 2 (ISC2) model was used to evaluate the aerial emission and odour impacts. This model was chosen because of its enhanced capacities of processing extensive meteorological data, and its capability to model different source types (point, area and volume) over a wide range of averaging time periods (including 1-hour, 24-hour and annual averages).

Meterological Conditions

The sequential hourly meteorological data at Lau Fau Shan in 1993 were used as the model meteorological input in assessing emissions from plant that could operate continuously, such as the boilers. Meterological parameters recorded at the Automatic Weather Station include wind speed, direction, temperature, and stability class. These represent a total of 8760 hourly variations on meteorological conditions. Daily maximum mixing height over Hong Kong for the corresponding dates in 1993 were also employed for modelling.

Disposal of spent grain will be carried out during daytime and the drying plant will be operated during normal working hours. However, as the drying plant has the potential capacity of 24-hour operation, sequential hourly meterological data were employed in determining the worst case odour impact from the drying plant.

Assessment Criteria

The predicted gaseous emission impacts were evaluated against the AQOs for SO_2 and NO_2 over the different averaging periods, namely, 1-hour, 24-hour and annual. These AQOs are shown in *Table 4.3a* above. There is no statutory criteria for maximum levels of odour in Hong Kong. Therefore EPD criterium of 5 odour units over an averaging time of 5 seconds at ASRs and at the site boundary are taken as the guideline for the evaluation of odour impacts.

Emissions from Nearby Facilities

An emission inventory was derived, primarily based on a fuel consumption inventories prepared by EPD and updated to November 1990. The effect of the latest developments at Concordia Paper Limited on the background air

quality was also considered. SO_2 and NO_x emission rates were estimated in accordance with USEPA's *"Compilation of Emission Factors", AP42.* This formulated emission inventory was used to predict the background air quality to allow the aerial emission impacts from San Miguel Brewery to be evaluated in an appropriate context, for the meteorological conditions and time averaging periods of concern.

Gaseous Emissions from San Miguel Brewery Boilers

Four boilers, three diesel boilers with capacity of 16,000 kg hr^{-1} and one diesel/biogas boiler with capacity of 16,000 kg hr^{-1}, will be installed in the new brewery. Highest aerial emissions are expected from diesel combustion with its associated higher sulphur content. Therefore air quality impacts will be assessed for four diesel boilers. The fuel consumption is estimated for 24-hour operation of the four new boilers to ensure worst case impacts are evaluated. *Table 4.5a* shows the fuel consumption and the characteristics of emissions from the boiler stack which is consisted of four flues.

Table 4.5a *Characteristics of emissions from San Miguel Brewery boilers*

Parameters	LDO
LDO Sulphur (% w/w)	0.5
Max. LDO feed rate (kg hr^{-1}) [i]	3370
Max. SO_2 rate (g s^{-1})	2.3x4=9.2[ii]
Max. NO_x (as NO_2) (g s^{-1})	0.6x4=2.4[ii]
Minimum Stack height (m)	30
Exit Velocity (m s^{-1})	12
Efflux temperature (K)	433

Note i) 24-hour continuous operation per day.
ii) Total Emission from four flues

Odour Emission

Emission factors for odour sources are estimated from measurements made at the existing San Miguel Brewery at Sham Tseng. Air samples were collected from spent yeast and grain disposal areas and the effluent treatment works, during operation of the Sham Tseng plant and disposal periods of the waste materials. Collected samples were then analysed for the odour levels in the laboratory by an odour panel.

Odour levels are defined as the ratio of the volume which the sample would occupy when diluted to the odour threshold, and the volume of the actual sample. The result is expressed in odour units (O.U.). The odour threshold is the level at which 50% of the panel can just detect an odour. The odour levels for the identified odorous sources at the existing plant is shown in *Table 4.5b.*

Table 4.5b *Measured Odour Levels at Various Odour Sources*

Location	Odour Level (O.U.)
Spent yeast disposal	280
Spent grain disposal	110
Wastewater treatment plant (effluent)	10
Sludge treatment and disposal	220

The odour emissions from spent grain disposal and spent yeast drying plant were considered as point sources and volume sources respectively in the modelling. The odour levels of the sources were converted to odour emission rates by multiplying the volume flow rate over the source. For example, odour level at source is 110 O.U. and flow rate is 10 m^3 s^{-1}, the emission rate would be 1100.

The production rate of spent grain is up to 28.5 m^3 per day and therefore a maximum of 200 m^3 of spent grain will be discharged each week. Displacement of ambient air by the discharged spent grain is considered as the volume flow rate. Two types of dump trucks are employed for collecting the spent grain with gross weights of 5 tonnes and of 13 tonnes respectively. It takes 5 minutes to 10 minutes to fill up the 13-tonne truck of 15 m^3 capacity. The flow rate is estimated as 0.05 m^3 per second at most.

At the spent yeast/grain drying plant, there will be two stacks with diameters of 500 mm. The stack height is 16 m which is 2 m above the roof top. The volumetric flow rate of odorous air from spent yeast drying plant stack will be 1.2 m^3 s^{-1}. There is no drying process at the existing plant so the odour level of untreated spent yeast was measured. This is used as a reference for modelling. The emission factor for each source is listed in *Table 4.5c*.

Table 4.5c *Emission Factors of Odorous Sources*

Sources	Emission Factors
Spent Grain Disposal	110 x 0.05 = 5.5
Spent Yeast Disposal	280 x 1.2 = 336

Predicted 1-hour averaged odour levels from ISCST2 model were converted to 5 second average so as to compare with the criteria. The conversion factors for 1-hour average to 3-minute average are 4.5, 3 and 2 for Class A-B, Class C and Class D-F respectively. [1] The conversion factor for 3-minute average to 5-second average is 10.

[1] Duff, R., O'Brien, M. & Ostijic, N., "*Odor Modelling - Why and How*" in *Recent Developments and Current Practices in Odor Regulations, Control and Technology* edited by Derenzo, D. and Gnyp, A, Air & Waste Management Association and "*Odour Control - A Concise Guide*" edit by Valentin, F. & North, A. (1980), Warren Spring Laboratory.

4.5.4 *Evaluation of Impacts*

Aerial Emission

Predicted SO_2 and NO_2 concentrations arising from San Miguel Brewery boilers and the cumulative impacts at the identified ASRs are shown in *Table 4.5d* and *Table 4.5e*. The results show that the predicted pollutant concentrations (including background levels) are within the AQO at all the ASRs. A maximum 1-hour SO_2 concentration of 627 $\mu g\ m^{-3}$ is predicted at a height of 90 m at Long Ping Estate. The daily and yearly SO_2 impacts are also lower than the respective AQOs. The maximum daily and yearly SO_2 impacts are only 98 $\mu g\ m^{-3}$ and 26 $\mu g\ m^{-3}$ respectively at Long Ping Estate. They are less than 50% of the AQO criteria.

The predicted NO_2 concentrations at all ASRs are also below the AQOs. The maximum 1-hour NO_2 concentration is predicted to be 87% of the hourly criteria of 300 $\mu g\ m^{-3}$. The predicted daily and annual levels are also much lower than AQO at a maximum of 33% and 16% of the AQO. More distant ASRs at low elevations are less affected by the stack emissions.

The modelling results show that the SO_2 and NO_2 emissions from the San Miguel Brewery boilers are only a minor source of ambient pollutants. The predicted cumulative SO_2 and NO_2 concentrations are much higher than the maximum that could be emitted from the boilers. The annual impacts from boilers vary from a few percent to 20 percent of the cumulative impacts. As discussed the dominant winds are from the north-east or south-east, and all ASRs except 'LC', 'TTSUT' and 'NUT' are located due south or west of the stack, and will therefore not usually be directly affected by SMB emissions. The identified ASRs are thus more affected by background emissions rather than those from the San Miguel Brewery boilers.

Table 4.5a *Predicted SO_2 at ASRs*

ASR	Elevation (m)	Highest SO_2 Concentration in $\mu g\ m^{-3}$ (Without background)			Highest SO_2 Concentration in $\mu g\ m^{-3}$ (Including background)		
		1-hour	24-hour	Annual	1-hour	24-hour	Annual
LPE	30	199 (48)	19 (28)	1.8 (9)	414	67	19.9
	40	214 (50)	20 (27)	1.8 (9)	428	74	21.7
	50	227 (52)	21 (26)	1.9 (8)	441	80	23.5
	60	239 (53)	21 (24)	1.9 (7)	451	87	25.1
	70	245 (46)	21 (23)	1.9 (7)	533	93	26.2
	80	245 (41)	21 (22)	1.8 (7)	595	97	26.5
	90	238 (38)	21 (21)	1.8 (7)	627	98	26.0
	100	225 (36)	20 (21)	1.7 (7)	625	97	24.7
	110	207 (35)	19 (21)	1.6 (7)	590	93	22.7
FHT	0	153 (43)	13 (30)	1.5 (10)	353	43	14.3
TTW	0	158 (34)	41 (45)	6.5 (19)	465	90	33.5
SUT	0	159 (39)	33 (32)	6.3 (20)	403	103	32.1
STW	0	195 (49)	18 (37)	1.7 (10)	395	50	16.2
CSW	0	193 (55)	16 (25)	1.5 (11)	351	64	14.0
TTWST	0	142 (47)	14 (28)	1.1 (11)	304	49	10.4
NUT	0	180 (39)	56 (60)	6.5 (19)	463	93	33.8
TTSUT	0	148 (46)	56 (56)	7.4 (22)	326	100	34.3
LC	0	177 (51)	71 (72)	6.3 (18)	349	98	34.8

Remark: Values in ( ) are SO_2 concentrations from San Miguel Brewery in percentage.

Table 4.5b *Predicted NO_2 at ASRs*

ASR	Elevation (m)	Highest NO_2 Concentration in $\mu g\ m^{-3}$ (Without background)			Highest NO_2 Concentration in $\mu g\ m^{-3}$ (Including background)		
		1–hour	24–hour	Annual	1–hour	24–hour	Annual
LPE	30	52 (33)	5 (25)	0.5 (8)	159	20	6.1
	40	56 (34)	5 (24)	0.5 (7)	163	21	6.6
	50	59 (36)	5 (23)	0.5 (7)	167	23	7.2
	60	62 (37)	5 (22)	0.5 (6)	168	25	7.6
	70	64 (38)	6 (21)	0.5 (6)	167	27	7.9
	80	64 (38)	6 (20)	0.5 (6)	168	28	7.9
	90	62 (35)	5 (19)	0.5 (6)	177	28	7.8
	100	59 (33)	5 (19)	0.4 (6)	177	28	7.4
	110	54 (32)	5 (19)	0.4 (6)	167	27	6.8
FHT	0	40 (31)	3 (25)	0.4 (8)	129	14	4.6
TTW	0	41 (16)	11 (30)	1.7 (14)	261	36	12.0
SUT	0	42 (18)	9 (19)	1.6 (15)	226	44	11.3
STW	0	51 (36)	5 (27)	0.4 (9)	141	18	5.1
CSW	0	50 (44)	4 (23)	0.4 (9)	115	18	4.5
TTWST	0	37 (33)	4 (21)	0.3 (9)	113	16	3.3
NUT	0	47 (17)	15 (38)	1.7 (14)	277	38	12.4
TTSUT	0	39 (23)	15 (30)	1.9 (16)	168	49	12.1
LC	0	46 (23)	18 (38)	1.6 (13)	199	48	12.7

Remark: Values in ( ) are NO_2 concentrations from San Miguel Brewery in percentage.

Flare at Wastewater Treatment Plant

Expected biogas production varies from about 1900 to 4650 m^3 day^{-1} over the expected plant life. The biogas contains up to 75% methane (CH_4), 25% carbon dioxide (CO_2) and some trace constituents (less than 0.1%) of hydrogen sulphide. Under normal operating conditions, the biogas produced from the wastewater treatment plant will be utilised as a supplementary fuel for the boiler. If, however, the biogas produced cannot be fed to the boiler, it will be burned off at a flare located above the equalisation tank of the wastewater treatment plant. H_2S contained in the flare gas will be converted into SO_2 after flaring. For a worst case scenario, assuming all the trace constituents is H_2S, ie 0.1%, the emission rate of SO_2 would be 0.06 to 0.15 g s^{-1}. The emission rate of SO_2 from the wastewater treatment plant is therefore very minor compared with the emission from the boilers which is 2.3 g s^{-1}.

The height of the flare is 6 m above the equalisation tank which in turn is 6 m above ground, ie the total height of flare above ground is 12 m. The equalisation tank is separated from other buildings by some local roads and roadways within the site and to the east of the flare, there is an open space. There should be sufficient dispersion of the limited amount of pollutants from the flare and pose no air quality impacts.

Odour

- *Spent Yeast and Spent Grain Disposal / Treatment*

  The offensiveness of odours depend on their strength and nature. Odour from spent grain has a characterised sweet smell when it is fresh. Spent grain is discharged from an elevated tank to a truck prior to transportation off–site for sale or disposal. The worst cases were predicted at Class D and F at the ASRs and boundary. The odour levels resulting from spent grain disposal are predicted to be less than 1 O.U. at the ASRs (see *Table 4.5e*). Spent yeast has a markedly less pleasant and different smell from spent grain, and the resulting odour level is higher. The highest odour level is predicted at Leon Court, being 2.5 O.U. However, it is well within the criteria of 5 O.U over 5 seconds averaging time.

  The odour levels have also been predicted at all four boundaries of the site; northern, eastern, southern and western. The assessment points were identified on a conservative basis as those with the shortest distance to the drying plant. The odour levels are predicted to be the highest for the spent yeast drying process. The odour levels at ASRs and site boundary are below the criterium and odour impacts from spent material treatment and disposal should be acceptable.

Table 4.5e *Predicted Odour Levels at ASRs using 1993 Lau Fau Shan Meterological Data*

ASR	Elevation (m)	Predicted Odour Levels (O.U.)	
		Spent Grain Disposal	Spent Yeast Disposal
LPE	30	0.008	0.5
	40	0.007	0.4
	50	0.006	0.4
	60	0.005	0.3
	70	0.004	0.3
	80–110	0.003	0.2
FHT	0	0.011	0.6
TTW	0	0.059	2.0
SUT	0	0.024	1.1
STW	0	0.012	0.7
CSW	0	0.014	0.8
TTWST	0	0.012	0.6
NUT	0	0.073	2.0
TTSUT	0	0.096	2.2
LC	0	0.127	2.5
Boundary			
· Northern Boundary	0	1.3	4.7
· Eastern Boundary	0	0.6	4.8
· Southern Boundary	0	0.2	4.0
· Western Boundary	0	1.0	4.8

· *Effluent Treatment Plant*

The influent and the equalisation tanks are potential odour sources. However, as the equalisation tank will, on the Consultants' advice, be covered odour emissions are not expected to be a significant issue.

· *Sludge Disposal from Methane Reactor of Upflow Anaerobic Sludge Blanket Type (UASB)*

Excess sludge in UASB will be removed from time to time. During the time of desludging, sludge is discharged from the reactor into an enclosed tanker through sealed pipes. The discharged sludge is removed from the site without requiring on-site treatment.

Desludging is not envisaged in the first year of operation and is only required in every 5–6 months thereafter. In foreseeing the required

frequency of desludging process, the odour impacts would be even lesser.

4.5.5 *Mitigation Measures*

The following mitigation measures are recommended to reduce the air quality impacts caused by the operation of the San Miguel Brewery:

- washing and cleaning of the disposal area after discharge of spent grain to remove accidental spills of disposed and regular collection to prevent aging of spent grain;
- minimize the exposed area of disposal materials to air, ie if practical use a direct link from storage tank to truck;
- transportation of spent materials in enclosed containers; and
- installation of condenser in spent material drying plant to condense VOCs and odorous compounds.

4.5.6 *Monitoring Requirements*

In light of the acceptable impacts from emissions of San Miguel Brewery, no continuous in-stack or ambient monitoring is warranted. Recording of fuel consumptions, analysis of fuel composition on a regular basis, and annual stack sampling should be sufficient to provide information regarding the emissions from the plant.

Odour nuisance is very subjective and odour levels vary temporarily and geographically depending on the dispersion conditions. Hence whilst this assessment indicates the technology to be applied at the new brewery will not give rise to significant odour impacts offsite, regular checking is required. Plant managers should be assigned for regular odour patrols, monitoring on the operation practices and checking on the efficiency of mitigation measures. Special attention and detail investigation would be required in the event complaints are received to rectify the adverse odour impacts.

4.6 *Conclusions and Recommendations*

4.6.1 *Construction Phase*

The impacts arising from the construction activities are not expected to be extensive. The level of activities and size of works area are small in scale. In addition the air sensitive receivers (ASRs) are screened by topographic features (eg Chu Wong Ling) and structures. The predicted dust levels at these ASRs are much reduced by dilution and screening by structures and terrain. Dust impacts during construction in the surrounding area have been shown to be within acceptable levels.

4.6.2 *Operational Phase*

The impact from various operation activities differ in extent. The major source of aerial emission is from the boiler chimney. The predicted cumulative NO_2 and SO_2 concentrations at ASRs are within the respective *Air Quality Objectives* when the San Miguel Brewery development is included. San Miguel have received approval to build a stack to a regulation height of 48.5m, since it has been shown that there are minimal impacts to ASRs using a 30m stack, the higher stack built will have even less of an impact to the surrounding ASRs. Biogas produced as a by-product from the on-site biological wastewater treatment plant will be utilised beneficially as a supplementary fuel for the boiler. This will reduce the light diesel oil consumption and the pollutant emissions from the boilers. Minor emissions from the flaring of biogas at the wastewater treatment plant may occur occasionally.

Odour nuisance has been an environmental concern at the Sham Tseng Brewery and has been extensively investigated at the new plant. Odour impact from wastewater treatment is minimized by the selection of an anaerobic treatment method. The impact is further reduced since the equalisation tank, which is the major odour source, will be covered and that the removal of sludge from the wastewater treatment plant will be an enclosed operation.

The expected residual odour sources mainly arise from the spent materials. The predicted odour levels for spent yeast and spent grain disposal are within the EPD criteria of 5 odour units at ASRs. Odour impacts are, therefore, not expected to be a significant issue based on this assessment. Residual impacts can be minimised by the proposed good housekeeping practices.

5 NOISE

5.1 BASELINE CONDITIONS

5.1.1 Existing Conditions

The proposed brewery is to be constructed in the Yuen Long Industrial Estate, north of Yuen Long City. The immediate environment is industrial; however, the regional environment is rural, supporting farms and village settlements. In the immediate vicinity, there are other noise sources which include:

- construction of a Dairy Farm facility to the east of the site;
- Yau Sang Galvanizers and Fortune Corrugated to the north of the site;
- Toppan Printing Centre to the west of the site; and,
- container storage and container truck access to the south of the site.

As a result, the local environment is dominated by noise from industrial sources and truck movements while the regional environment has a noise climate typical of an agricultural community.

5.1.2 Future Conditions

The future noise environment will include new noise sources from proposed transport and infrastructure projects as well as from local development within the Yuen Long Industrial Estate. These projects will include the Route 3 Expressway, the KCRC Port Passenger Line (PPL) and the Yuen Long–Kam Tin Sewer System. As a result of these projects it is likely that future ambient noise levels will show an overall increase over time and the noise environment will be increasingly influenced by road and rail noise.

5.1.3 Noise Sensitive Receivers

Noise Sensitive Receivers (NSRs), as defined by the *Hong Kong Planning Standards and Guidelines* (HKPSG) and the *Noise Control Ordinance* (NCO), have been identified with reference to previous environmental studies undertaken in the region of the Yuen Long Industrial Estate, and have been updated by site surveys and by referring to survey sheets and development plans.

The local NSRs and their respective distances to the notional centre of the site are given in *Table 5.1a* below. The locations of the NSRs are shown in *Figure 5.1a.*

Table 5.1a *Distances (m) to Noise Sensitive Receivers (NSRs)*

NSR	*Description*	*Distance*
Leon Court	3-storey houses	200
Tai Tseng Shing Uk Tsuen	Village settlement	250
Ng Uk Tsuen	Village settlement	300
Tai Tseng Wai	Village settlement	350
Fuk Hing Tsuen	Village settlement	650
Tung Tau Wai San Tsuen	Village settlement	700
Chung Sam Wai	Village settlement	750
Long Ping Estate	High rise residential	975

Due to the low-rise construction of most of the developments (except for Long Ping Estate) in the region, the nature of the topography and the locations of buildings within the Industrial Estate, all NSRs with the exception of Long Ping Estate, will be partially screened from construction and operational noise sources. As geometrical and topographical screening will just obstruct sight lines from the worksite to NSRs, the level of this screening has been generally set at 5 dB(A).

5.2 CONSTRUCTION

5.2.1 *Introduction*

A methodology for assessing noise from the construction of the proposed San Miguel Brewery has been developed based on the *Technical Memorandum on Noise From Construction Work Other Than Percussive Piling* (TM1) and the *Technical Memorandum on Noise from Percussive Piling* (TM2). In general, the methodology is as follows:

- locate NSRs that may be affected by the worksite;
- calculate distance attenuation and barrier corrections to NSRs from worksite notional noise source point;
- predict construction noise levels at NSRs in the absence of any mitigation measures; and,
- calculate maximum total site sound power level (SWL) for construction activities such that $L_{Aeq,30min}$ noise levels at NSRs comply with appropriate noise criteria.

The practicability of achieving the aforementioned maximum total site sound power level is then considered since this might offer a preferred form

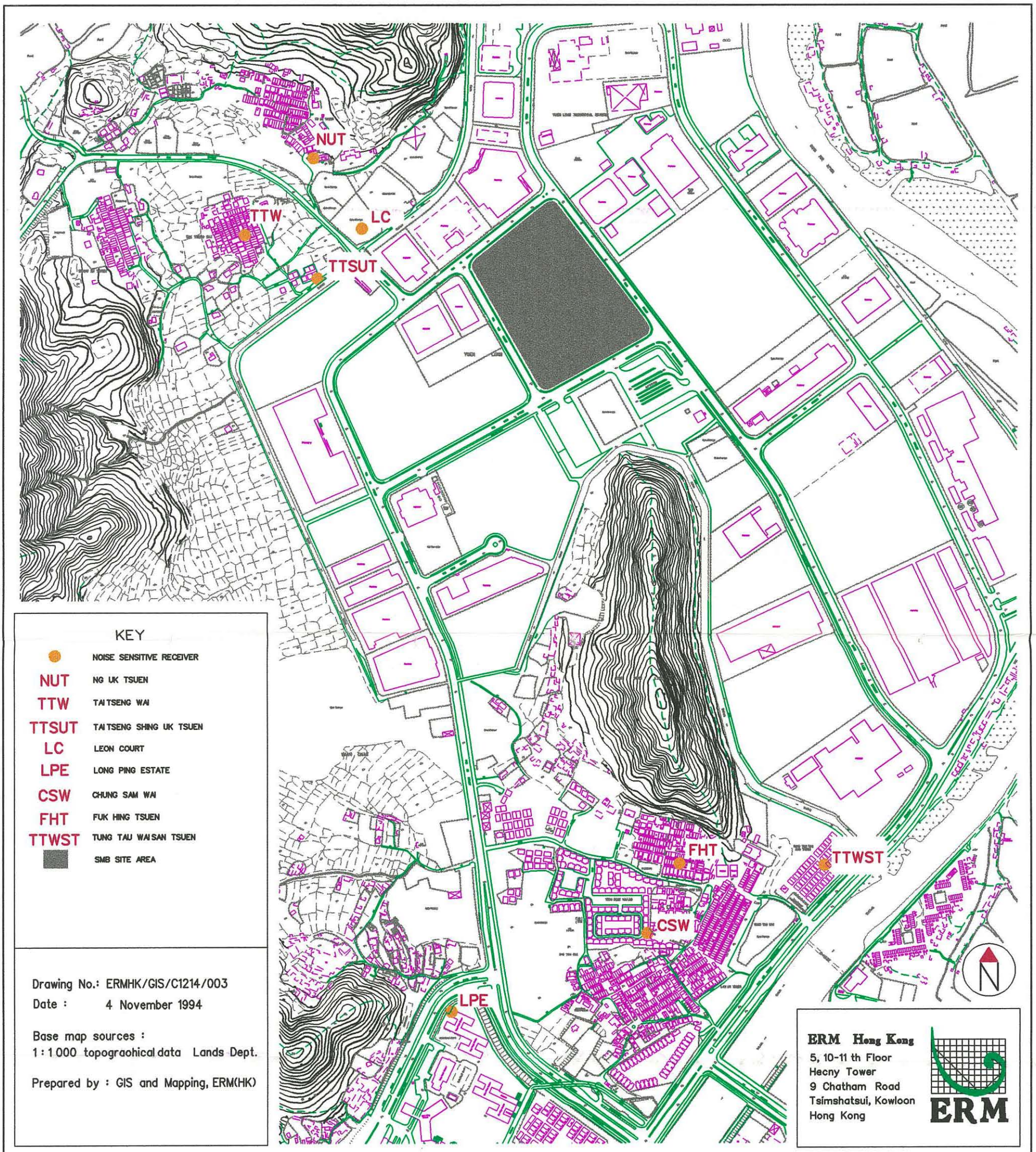

Figure 5.1a Locations of Noise Sensitive Receivers

of mitigation. Other mitigation measures are then considered and recommended as appropriate.

5.2.2 *Environmental Legislation and Guidelines*

In Hong Kong the control of construction noise outside of daytime, weekday working hours (0700–1900, Monday through Saturday) is governed by the NCO and the subsidiary technical memoranda, TM1 and TM2. These TMs establish the permitted noise levels for construction work depending upon working hours and the existing noise climate.

The NCO criteria for the control of noise from powered mechanical equipment (PME) are dependant upon the type of area containing the NSR rather than the measured background noise level. As the NSRs surrounding the proposed brewery fall into mainly rural and urban fringe areas, the *Area Sensitivity Rating* (ASR) for these NSRs, according to TM1, is specified as 'A' and 'B', respectively. The NCO requires that noise levels from construction at affected NSRs be less than a specified *Acceptable Noise Level* (ANL) which depends on the *Area Sensitivity Rating.*

It is intended that the construction activities of the proposed works should be planned and controlled in accordance with the NCO. Works requiring the use of PME during restricted hours (ie outside of 0700–1900 Monday through Saturday, and during public holidays) and particularly at night, will require a *Construction Noise Permit* (CNP) and will need to achieve the applicable ANL. The ANL is derived from the *Basic Noise Levels* (BNL) by applying corrections for the duration of the works and the effect of any other nearby sites operating under a CNP. For this assessment these corrections are negligible and so have been set to zero. As a result, the ANLs are equal to the BNLs. These are shown in *Table 5.2a* below. It should be noted that all NSRs have been assigned, in accordance with the TM, an ASR of 'B', as they are each indirectly affected by the Yuen Long Industrial Estate.

Table 5.2a ***Acceptable Noise Levels (ANL, $L_{Aeq,5min}$ dB(A))***

Time Period	ASR – B
All days during the evening (1900–2300) and general holidays (including Sundays) during the day and evening (0700–2300)	65
All days during the night-time (2300–0700)	50

Although the NCO does not provide for the control of construction activities during normal working hours, a limit of $L_{Aeq,\ 30\ min}$ 75 dB is proposed in the *Practice Note For Professional Persons, PN2/93*" issued by the *Professional Persons Environmental Consultative Committee* (ProPECC) in June 1993. This limit has been applied on major construction projects in recent months, and is now generally accepted in Hong Kong, and will therefore be adopted in this study in order to protect NSRs to an appropriate extent.

According to TM2 a CNP will be required from EPD for carrying out any percussive piling works. In determining whether the permit should be issued, EPD will compare the calculated *Corrected Noise Level* (CNL) with the ANL. In the event that the CNL exceeds the ANL, EPD will impose restrictions on the permitted hours of piling operation. As percussive piling will be needed for the foundations of the brewery, this assessment will consider the likely restrictions to the hours of working, if necessary, for unmitigated piling activities.

5.2.3 *Potential Sources of Impact*

For the construction of the brewery facility there will be four major activities which will be capable of creating noise impacts at nearby NSRs. These are:

- site clearance;
- excavation;
- piling of foundations; and
- building superstructure construction.

All other activities will be of small scale or suitably screened such that they will not contribute more noise than the activities which have been chosen for assessment. In particular, construction traffic should not exceed 12 vehicles per hour; as the distances involved preclude the possibility of significant noise impacts from such a small fleet of vehicles, construction traffic has not been assessed in further detail.

The plant inventories for each of these construction activities are given in the tables below. Communication with the Engineer prior to the completion of this report has ensured that the plant teams assumed for each construction activity should be reliable not only in terms of plant items used but also in terms of the number being employed simultaneously.

Site Clearance

Initial work on the site will constitute removing the layer of topsoil as well as any small hills or obstructions which may pose a difficulty to the remainder of the construction process. The plant inventory for this operation is given in *Table 5.2b* below.

Table 5.2b ***Plant Inventory for Site Clearance Activities***

Plant	Number	TM Reference Number	Sound Power Level (dB(A))
Excavator	2	CNP 081	112+3
Bulldozer	1	CNP 030	115
Truck	2	CNP 141	112+3

The total sound power level calculated for all plant operating at one notional point is 120 dB(A).

Excavation

Sizeable excavation activities will be carried out in localised areas for the carpark and malt receiving areas. In addition, smaller excavation works will be carried out to prepare the ground for foundations piling. As foundations activities will be carried out simultaneously with the excavation works, the localised excavation and piling excavation works will be assessed together.

Mini-excavators, rather than full excavators, will be used for the foundations excavation work. As these excavators are approximately half as powerful as typical Hong Kong excavators (22 kWh vs 49 kWh), the sound power level has been approximated by proposing that two mini-excavators working together would produce the same sound power level as one full excavator. This translates to a mini-excavator having a sound power level of 109 dB(A). The plant inventory for this operation is given in *Table 5.2c* below.

Table 5.2c *Excavation Plant Inventory*

Plant	Number	TM Reference Number	Sound Power Level (dB(A))
Excavator	5	CNP 081	112+7
Mini-excavator	8	N/A	109+9
Truck	5	CNP 141	112+7

The total site sound power level calculated for all plant operating at one notional point is 123 dB(A).

Piling of Foundations

The foundation piling work will be carried out solely with percussive piling rigs. Communication with the Engineer has indicated that 6 diesel hammer rigs driving steel piles (each rig @ 132 dB(A)) would be used simultaneously for the piling works. The total site sound power level for all rigs working simultaneously would be 140 dB(A).

Building Superstructure Construction

The buildings for the brewery facility will be built without basements and will be constructed of steel and concrete formwork. This construction activity will have the longest duration of those assessed and so will serve as the primary measure of the impact of the construction operations on the surroundings. The plant inventory for this activity is shown in *Table 5.2d.*

Table 5.2d *Building Superstructure Plant Inventory*

Plant	Number	TM Reference Number	Sound Power Level (dB(A))
Mobile Crane	4	CNP 048	112+6
Tower Crane	3	CNP 049	95+5
Concrete Truck	2	CNP 044	112+3
Concrete Pump	2	CNP 047	112+3
Poker Vibrator	6	CNP 170	113+8
Truck	2	CNP 141	112+3
Hand tools	Various	N/A	105

The total site sound power level calculated for all plant operating at one notional point is 125 dB(A).

5.2.4 *Evaluation of Impacts*

Predictions of noise levels from construction activities have been carried out according to the methodology outlined above in *Section 5.2.1*. The worst-case facade noise levels at the nearby NSRs from each of the construction activities are given in *Table 5.2e* below.

Table 5.2e *Facade Noise Levels ($L_{Aeq,period}$ dB) at NSRs from Construction Activities*

NSR	Site Clearance	Excavation	Percussive Piling	Superstructure
Leon Court	64	67	80	69
Tai Tseng Shing Uk Tsuen	62	65	77	67
Ng Uk Tsuen	61	64	75	66
Tai Tseng Wai	59	62	74	64
Fuk Hing Tsuen	54	57	67	59
Tung Tau Wai San Tsuen	53	56	67	58
Chung Sam Wai	53	56	66	58
Long Ping Estate	55	58	68	60

This table has taken account of a 5 dB(A) screening correction, due to terrain and building geometry, for all NSRs (except for Long Ping Estate, high rise).

These predictions indicate that no exceedances of the daytime (0700–1900) noise criterion are anticipated at any of the NSRs from activities associated with the construction of the San Miguel Brewery facility. It should be noted, however, that if works are carried into restricted hours (outside of

daytime hours, Monday through Saturday) then mitigation measures will be necessary to ensure that nearby NSRs are not subjected to excessive noise impacts. In addition, though no exceedances of the ANL for percussive piling have been predicted, under the NCO the Contractor must still apply for a CNP for any piling works.

5.2.5 *Mitigation Measures*

As no exceedances of the normal daytime (0700–1900, Monday through Saturday) noise criteria (percussive and non–percussive) have been predicted, no mitigation measures are recommended for daytime construction activities. If it becomes necessary for SMHK to continue construction activities into evening hours (1900–2300) or during the daytime or evening on Public Holidays (including Sundays), it should be noted that exceedances of the evening noise criterion have been predicted at Leon Court. In addition, if construction activities are proposed for night time hours (2300–0700), predictions have indicated exceedances of the applicable criterion at all nearby NSRs and so mitigation measures would be necessary in order for the Contractor to be eligible for a CNP.

The section below details some methods of mitigation which could be of aid to a Contractor in choosing appropriate mitigation measures for restricted hours working. The general approach to mitigation has been to recommend three key measures in addition to general good site practice; these are: noise barriers, quiet plant or reduced plant teams and on–site noise management.

As a general rule, good site practice can reduce the impact of a construction site's activities on nearby NSRs. To provide significant noise reduction on site, the following measures should be followed during each phase of construction:

- only well–maintained plant should be operated on–site and plant should be serviced regularly during the construction programme;
- machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- plant known to emit noise strongly in one direction, should, where possible, be orientated so that the noise is directed away from nearby NSRs;
- silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction programme;
- mobile plant should be sited as far away from NSRs as possible; and
- material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on–site construction activities.

In addition to these measures, specific mitigation measures for each of the construction activities assessed above are recommended below. It should be understood that these mitigation measures are only for works during evening hours or during public holidays (0700–2300, including Sundays); night–time working (200–0700) is not recommended for any activity due to the prohibitive amount of noise mitigation which would be necessary to comply with the NCO.

Site Clearance

The most significant predicted noise impacts for this operation are at the NSRs to the north and west of the site; at these locations worst–case predited impacts will be within 3 dB(A) of the applicable noise criterion. It should be noted, however, that no exceedances of the evening noise criterion have been predicted for any of the nearby NSRs. As a result, no noise mitigation is specifically required; however, it is recommended that due care be taken as predictions indicate the potential for exceedance.

At Leon Court, noise levels have been predicted to exceed the night time noise criterion by approximately 14 dB(A) for unmitigated activities; as a result, no night time site clearance activities are recommended.

Excavation

As above, the most significant predicted noise impacts for this operation are at the northern NSRs (Leon Court), where exceedances of the evening criterion would be approximately 2 dB(A) for unmitigated activities. To achieve a reduction of 2 dB(A), it is recommended that operations be limited to the use of three full excavators (or six mini excavators) and three trucks (total site sound power level of 120 dB(A)), which would reduce the total site sound power level by 3 dB(A).

As night–time impacts at Leon Court have been predicted to exceed the appliable criterion by 17 dB(A), no night time excavation works are recommended.

Piling

Percussive piling activities are not allowed, by law, to operate outside of normal daytime working hours (0700–1900, Monday through Saturday). As a result, no restricted hours percussive piling will be admissible.

Building Superstructure Construction

The most significant predicted noise impacts for this operation are at Leon Court, where exceedances of the evening criterion would be approximately 4 dB(A) for unmitigated activities. To reduce impacts, it is recommended that operations be constrained to the use of four mobile cranes, hand tools and up to two trucks (no concreting activities). This restriction would reduce the total site sound power level to 120 dB(A) (reduction of 5 dB(A)). Such a level of reduction in the total site sound power level would be

enough to ensure compliance with the appropriate noise criterion at all nearby NSRs.

As superstructure works could be carried out solely with the use of hand tools during the advanced construction stage, it is noted that night time works could be carried out if only hand tools were employed (sound power level of 105 dB(A)). Use of only hand tools would generate a worst-case noise level at Leon Court of approximately 49 dB(A).

Noise Monitoring

In addition to the above mitigation measures, if work is carried into restricted hours, it is recommended that a noise monitoring programme be undertaken at the nearby NSRs to ensure that the appropriate criteria are met.

5.3 OPERATION

5.3.1 *Introduction*

The operational noise from the San Miguel Brewery facility has been assessed using the methodology based on the *Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites* (TM). In general, the methodology is as follows:

- locate NSRs and determine the *Area Sensitivity Rating* (ASR) of the area;
- determine the ANL for each NSR;
- determine the noise levels from noisy operations at the Brewery;
- determine corrections to the noise levels due to tonality, intermittency and impulsiveness of the source;
- calculate distance attenuation to NSRs from the noise source(s);
- predict noise levels at NSRs in the absence of any mitigation measures; and
- calculate the maximum sound power level for each source such that $L_{Aeq,period}$ noise levels at NSRs comply with appropriate noise criteria.

Mitigation measures are then considered and recommended, if necessary, to reduce the noise impact at the NSRs.

5.3.2 *Environmental Legislation and Guidelines*

Noise from Industrial Sources in Hong Kong is controlled by the *Noise Control Ordinance 1988*, and its associated *Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places and*

Construction Sites. New developments in Hong Kong are also controlled by the *Hong Kong Planning Standards and Guidelines* (HKPSG). The HKPSG recommends that for new developments the noise levels at the nearest NSRs should be 5 dB(A) below the appropriate ANL referenced under the NCO, or equal to the prevailing background noise levels, whichever is lower.

Background noise surveys carried out in the nearby area in August 1995 indicated that night time (00:00–01:00) $L_{Aeq,30min}$ noise levels were approximately 50–55 dB. As these background noise levels are higher than the appropriate noise criteria stipulated under the HKPSG (Noise Control Ordinance [NCO] Acceptable Noise Level [ANL] – 5 dB(A)), stated above, the HKPSG noise criteria are the applicable, most stringent atmospheric planning noise standards for this area.

According to the TM, NSRs which are located within a rural environment which is between 100 and 250m from an Industrial Estate (Yuen Long Industrial Estate) are given an ASR of 'B'. The ANL for ASR 'B' is shown in *Table 5.3a* below.

Table 5.3a *Acceptable Noise Levels ($L_{Aeq,\ 30min}$) for Industrial Noise Sources*

Time Period	NCO Standard for ASR 'B',dB(A)	HKPSG Criteria (ANL–5 dB(A))
Daytime (0700–1900)	65	60
Evening (1900–2300)	65	60
Night time (2300–0700)	55	50

The theoretical measured noise level (MNL), calculated by standard acoustical techniques, is not compared directly with these criteria; instead, a corrected noise level (CNL) is first calculated according to the following formula:

$$CNL = MNL + C_{tone} + C_{imp} + C_{int} \ dB(A);$$

where:

C_{tone} is a correction for tonality (not in excess of 6 dB(A));
C_{imp} is a correction for impulsiveness (not in excess of 3 dB(A)); and
C_{int} is a correction for intermittency (not in excess of 6 dB(A)).

Then the CNL is compared with the criteria and if exceedances are anticipated then mitigation is recommended.

Current Hong Kong statutory requirements (*Factories and Industrial Undertakings [Noise at Work] Regulation*) stipulate that the plant within occupied areas of the facility should be designed to achieve the following noise levels:

- maximum limit of $L_{A, EP,d}$ 85 dB at any location with all facility equipment in full operation; and

- a maximum daily noise peak of 140 dB(A).

An assessment of internal noise levels has been made possible by the receipt of plant design information from the engineers and by making noise measurements at existing facilities.

5.3.3 *Potential Sources of Impact*

There are two primary sources of noise which have the potential to create significant impacts at nearby NSRs during the operational phase of the brewery. These are noisy equipment and operations, and road traffic generated or attracted by the Brewery. In addition, noisy equipment and operations have the potential to generate health and safety hazards to workers within the facility unless the equipment is properly insulated.

Plant and Equipment

Noisy equipment is located primarily in the Packaging Building and the Process building, the noisiest areas being:

- the bottling/canning facility in the Packaging Building;
- compressors and boilers in the Process Building; and
- equipment in the roof utility area on the Process Building.

In order to determine the noisiest pieces of equipment and the noisiest activities in the brewing process, noise measurements were taken at the existing San Miguel Brewery facilities at Sham Tseng (measurements taken on 17 August and 7 September 1994). The results of these noise measurement surveys are shown in *Table 5.3b* below.

Table 5.3b ***Noise Measurements (dB(A) @ 1m) Taken at the Sham Tseng Brewery***

Source	$L_{eq,period}$	L_{max}	L_{min}
Bottle Washer	95	99	90
Bottling Machine	94	95	93
Canning Machine	98	99	96
Can Conveyor Belt	95	N/A	N/A
Keg Washing Room	88	107	79
Bottle Cap Maker	95	N/A	N/A
Compressor for NH_3	95	100	87
Compressor for CO_2	86	87	85

It should be noted that each of the $L_{Aeq,period}$ measurements in the table above indicates levels above the statutory daily (*Noise at Work*) maximum of $L_{A, EP,d}$ 85 dB should a worker be stationed by each piece of equipment for an average workday (8 hours). In addition, the areas with the highest exceedances of the regulation are in the canning and the bottling room.

As the machinery in the Sham Tseng brewery is quite old, additional noise measurements were carried out in the noisiest area, the packaging room, in a newer San Miguel facility, to determine more appropriate plant noise levels for this assessment. The Mandaue brewery in the Phillipines was chosen for measurement as this facility is very similar in design to the proposed brewery and uses bottling equipment which is only a few years old. The measured noise levels from this exercise are shown below in *Table 5.3c*. Also noted in this table, for comparison purposes, is the plant 'design,' average sound pressure level at 1 metre from the equipment, as supplied by KHS, the equipment supplier for the Yuen Long Brewery Packaging Room.

Table 5.3c *Measured Noise Levels at the Mandaue Brewery Packaging Room*

Equipment Type	Mandaue Plant LAeq,period	Comment	KHS Design Level
Decrater	93	Between two pieces of equipment	79–81
Bottle Washer			
–discharge	95–96		82–83
–intake	91		80–82
Crate Magazine	90		75–76
Bottle Filler	93		81–82
Clean In Place (CIP)	93		
Pasteurizer	95/85	Cycles on/off: (75%/25% by time)	78–80
Depalletizer	87	G/F	77–79
Case Washer	90	G/F	80–82
Single Pump near Bottle Filler	89	No workers nearby	
Palletizer	89		79–81
Bottle conveyor	91–94		

Measured noise levels at worker locations near to major equipment were generally in the range $L_{Aeq, period}$ 90 to 95 dB. These results are consistent with measurements taken by San Miguel in March this year, and allow direct comparison with the *Noise At Work* regulations. Direct comparison of measured levels with the KHS design level should be made with caution as KHS levels do include room effects.

The results of typical reverberant octave band noise levels at the second floor level of the Mandaue facility are given below in *Table 5.3d.*

Table 5.3d *Typical Octave Band Noise Levels (LAeq,period dB)*

	Octave Band Centre Frequency (Hz)								
	31	63	125	250	500	1000	2000	4000	8000
dB	78	74	75	76	81	82	85	81	75
dB(A)		48	59	67	78	82	86	82	74

These results indicate that the A-weighted reverberant noise level in the Packaging Building is dominated by the 1 kHz, 2 kHz, and 4 kHz octave bands. This relatively high frequency component of the noise spectrum indicates that the ambient noise is produced primarily by the impact of bottles with each other and with the guiderails.

Road Traffic

Road traffic daily flow for the year 2011 has been estimated at 235 trucks per day (by SMHK) with a peak traffic flow of 70 trucks per hour. Traffic has been predicted to peak twice per day, once at 0800 and again at 1700 hours. It should be noted that the daytime (0700-2300) (ASR 'B') HKPSG recommended noise limit for the region is $L_{Aeq,30min}$ 60 dB.

5.3.4 *Evaluation of Impacts*

Impacts from noisy brewery equipment, both internal and external to the brewery, and from road traffic on the roads that surround the brewery have been evaluated in this assessment. To improve clarity, the brewery equipment noise has been further subdivided into sections relating to the Packaging Building and sections relating to the Process Building. The evaluation of impacts is found in the subsections which follow.

Equipment and Machinery--External Noise

Packaging Building

The assessment of noise external to the Packaging Building was based on three primary assumptions:

- the reverberant noise level within the Packaging Building has been assumed to meet the statutory 85 dB(A) reverberant value specified in the *Noise at Work* regulation (refer to the Internal Noise Section for justification of this value);
- the double-skinned steel cladding to be used for the walls and the roof has a nominal Sound Reduction Index (SRI) of 25 dB(A);
- the windows to the packaging room will be closed; and
- the plant may need to operate at night.

The details of the assessment were as follows:

- the area of the north facade (the facade facing the nearest NSRs) directly affected by the packaging plant is 315 m^2;
- windows and louvres make up 65 m^2 of this portion of the north facade while wall cladding makes up 250 m^2; and
- the sound pressure level outside of the wall cladding would be 54 dB(A) while that outside of the closed windows would be 65 dB(A) and that outside of the louvres would be 79 dB(A).

The problem of calculating the sound pressure level can be approached in different ways. In this calculation, the approach was to divide the external

envelope of the packaging room into three distinct components (the windows, the louvre section and the wall section), calculate the sound pressure level from each component at Leon Court, and then logarithmacally add the resulting levels together to obtain the total sound pressure level.

The total sound pressure level at Leon Court can then be calculated as the logarithmic addition of the result: 42 dB(A) (louvres), 31 dB(A) (windows) and 26 dB(A) (the walls), which is equivalent to 42 dB(A). In addition, it should be noted that the noise will most probably have a tonal quality (as it will most probably be dominated by clinking noises from moving/knocking bottles), the resultant sound pressure level needs to have an additional correction of 3 dB(A). In addition, as only the northern facade has been considered in the assessment above, and the western facade may also contribute to the noise level at Leon Court, there are valid reasons for adding up to an additional 1– 2 dB(A) to the value calculated above. As a result, the total combined corrected sound pressure level at Leon Court would be approximately 45–47 dB(A).

As the HKPSG noise criterion for Leon Court, during night-time hours (2300–0700) is $L_{Aeq,30min}$ 50 dB, it can be seen that the existing design for the Packaging Building should be adequate to ensure compliance with the relevant environmental noise criterion. As a result, no noise mitigation measures are necessary.

Process Building

In the Process Building there are four sources which have the potential to cause noise exceedances with respect to the HKPSG. These areas, located on the Ground Floor and the roof, are:

Ground Floor

- the refrigeration plant room (to contain 5 NH_3 compressors each with a sound power level of 103 dB(A); internal reverberant level of approximately 90 dB(A)); and

- the CO_2 recovery and air system plant room (to contain 2 booster compressors w/SPL of 93 dB(A), two CO_2 compressors w/SPL of 98 dB(A) and 3 air compressors w/SPL of 84 dB(A); internal reverberant level of approximately 85 dB(A)).

Roof Utility Area

- evaporative condensors (4 units each w/SPL of 96 dB(A)); and
- cooling towers (2 units each w/SPL of 96 dB(A)).

Analysis has indicated that the combined $L_{Aeq,30min}$ night time noise level at Leon Court, from both the ground floor and roof utility areas, without mitigation, would be approximately 44 dB(A) (34 dB(A) from the ground floor and 43 dB(A) from the roof utility area), which is below the night time noise criterion. As a result, it is not recommended that mitigation measures be employed to reduce the noise levels at Leon Court.

Equipment and Machinery--Internal Noise

Packaging Building

Information on the equipment to be purchased, from the supplier *Klöckner-Holstein-Seitz* (KHS), has indicated that all the machinery meets the German standard DIN 45635 for sound levels in the workplace and so will be significantly quieter than the equipment currently operating in the existing San Miguel Brewery. No single piece of equipment is specified to generate more than 85 dB(A) @ 1 m (this level achieved by the filling and sealing machine for bottling), however, no machine was rated at less than 80 dB(A) @ 1 m; while most were rated to generate 82 to 83 dB(A) @ 1 m.

However, in the Mandaue Brewery, the noise levels measured at worker locations close to major items of bottling equipment, were generally 5 to 10 dB above the $L_{Aeq,period}$ 85 dB first Action Level of the Noise At Work Regulations, and up to 5 dB above the second 90 dB Action Level. In addition, the reverberant noise levels averaged over 10 locations at the Mandaue brewery were about 4 dB above the $L_{Aeq,period}$ 85 dB first Action Level. It should also be noted that the noisiest areas were near the conveyors, which are quite extensive, where noise is generated by bottles knocking into each other as well as against the railings.

As a result, it may be necessary to employ some form of noise mitigation to reduce reverberant noise levels to within prescribed *Noise at Work* limits.

Process Building

Information on equipment to be supplied by *Huppman Handel* for the Process Building, primarily air compressors, refrigeration and boiler plant equipment, has indicated most of the equipment will generate 85 dB(A) @ 1 m or less. Two exceptions to this generalisation are for the NH_3 compressors (rated at 95 dB(A) @ 1 m) and the CO_2 compressors (rated at 90 dB(A) @ 1 m).

As the Hong Kong standard of $L_{A,EP,d}$ 85 dB @ 1 m from a single source, must hold for any occupied location in the facility with all machinery in full operation, there is the potential for single and/or multiple pieces of *Huppman Handel* equipment plus reverberant noise to exceed the *Noise at Work Regulation* for worker exposure for unmitigated machinery. Information from SMHK, however, has indicated that none of the noisy rooms (refrigeration room, boiler room and CO_2 recovery room) within the Process Building will be occupied by workers on a regular daily basis. Workers will only enter and work in these rooms to provide maintenance for the machinery. As a result exceedance of the $L_{A,EP,d}$ 85 dB noise limit need not be a concern provided hearing protection is employed for maintenance workers.

Road Traffic

For this analysis, a worst case routing for truck traffic has been assumed. This routing assumes that all trucks entering and leaving the San Miguel site travel onto and off Fuk Hai Street (on the northern side of the site continuing to the western side of the Industrial Estate). This analysis is considered worst-case as it brings trucks into the closest proximity to NSRs and offers unscreened views of truck traffic. The site has been assumed, in

compliance with Industrial Estate Regulations, to be bounded by a 2.4 m wall, and 70 trucks (140 truck movements) have been assumed for the peak hour in the year 2011.

Predictions of impacts have been calculated by following the methodology recommended in *Section A.3.4.2 in BS5228:Part 1:1984*. For this analysis each truck has been assumed to have a sound power level of 117 dB(A) and a speed of 30 kph. The centre of the street has been approximated as 125 m from both Leon Court and Tai Tseng Shing Uk Tsuen. Calculations indicate that noise levels at these two NSRs will be $L_{Aeq,30min}$ 69 dB (no screening assumed). This level is 9 dB(A) above the NCO daytime/evening criterion and so mitigation measures will be necessary to ensure that nearby NSRs are protected from excessive noise levels. As a result, mitigation measures are recommended to reduce noise levels from construction road traffic near the San Miguel Brewery construction site.

5.3.5 *Mitigation Measures*

Equipment and Machinery--External Noise

Packaging Building

The foregoing analysis, based on reverberant noise levels within the Packaging Building, has indicated that noise levels at the nearest NSR, from packaging room operations, will fall into the range of 45–47 dB(A). As the most stringent noise criterion for the NSRs near the proposed brewery, the night-time noise criterion, is $L_{Aeq,30min}$ 50 dB, no exceedances of the appropriate HKPSG noise criteria have been predicted for any time period during a day. As a result, no mitigation measures are recommended to limit reverberant noise emitted from the Packaging Building, assuming that internal reverberant noise levels meet the 85 dB(A) *Noise at Work* criterion.

It should be noted, however, that mitigation measures will most likely be necessary to screen the direct noise path from noisy equipment or conveyor belts which are located within about 5 metres from the louvred wall sections. These partitions should have a specification such that transmitted noise levels are at least 10 dB(A) below the incident noise levels.

Use of these measures should ensure that external noise levels at Leon Court will be in compliance with the HKPSG (limiting $L_{Aeq,30min}$ 50 dB criterion) and workers within the packaging room will not be subject to noise levels in exceedance of the Hong Kong *Noise at Work* regulations.

Process Building

Calculations have indicated that the combined total sound power level from both the ground floor and roof utility areas would be approximately 44 dB(A). This level being below the night time noise criterion indicates that no exceedances of the HKPSG would be likely. As a result, it is not recommended that mitigation measures be employed in the Process Building to reduce the noise levels at the nearby NSRs.

Equipment and Machinery--Internal Noise

Packaging Building

For the Packaging Building it is recommended that the packaging room design incorporate an allowance for a suspended acoustic ceiling or hanging acoustic baffles. The acoustic ceiling or hanging baffles should be specified to reduce reverberant noise levels by at least 4 dB(A). It should be noted that a ceiling of this type or hanging acoustic baffles should be capable of reducing reverberant noise levels by up to 7 dB(A). Such a reduction in noise levels would ensure that reverberant noise levels in the packaging room would be in compliance with the statutory *Noise at Work* limiting noise level.

Whilst the need for such acoustic treatment for internal noise levels is not certain at this stage due to uncertainty in the likely reverberant noise level within the packaging room, such treatment is recommended as good design practice since it would guarantee noise levels below the 85 dB(A) statutory limit. However, the need for, and design of, the acoustic treatment could be left to the commissioning stage (at that time the reverberant noise level could be measured and the need for acoustic treatment decided) if the cost and design implications are considered prohibitive at this stage of the project (it is recommended, however, that allowance is made for such treatment at this stage).

For workers stationed near to the major noisy equipment (bottle washers, decraters, bottle fillers, pasteurisers, case washers, CIPs, crate magazines, palletizers, etc.), it is recommended that the worker be separated from the equipment by a distance of at least 1 metre, and if necessary a clear, acoustic cubicle or partition be placed between the worker and the piece of equipment. The acoustic partition should be capable of reducing noise levels directly behind it by up to 10 dB(A). For locations where these mitigation measures may not be practical, such as near the bottle conveyors, it is recommended that the workers be provided with ear plugs or suitable ear defenders.

Process Building

Reference to the supplier's specification for equipment in the Process Building indicates that only two pieces of equipment should exceed the *Noise at Work* 85 dB(A) regulation. These are the NH_3 compressors (rated at 95 dB(A) @ 1 m) and the CO_2 compressors (rated at 90 dB(A) @ 1 m), both to be supplied by *Huppman Handel.*

As no workers, however, will be permanently stationed near this equipment there will be no need to acoustically treat the rooms containing this equipment or to silence these compressors. As workers will enter these rooms to maintain the equipment, from time to time, it is noted that maintenance workers should be provided with ear protection. Specifically, in accord with the guidelines promulgated in the Hong Kong *Noise at Work* standard, it is recommended that maintenance workers working in the refrigeration, boiler and/or CO_2 recovery rooms be provided with ear plugs or suitable ear defenders.

Road Traffic

As a worst case analysis has indicated that use of Fuk Hai Street for truck traffic would lead to unacceptable impacts at nearby NSRs, mitigation measures have been recommended. To reduce noise levels at nearby NSRs it is recommended that truck traffic be routed so that it makes use of Wang Lee Street (the street to the east of the site) rather than Fuk Hai Street. If this same truck traffic uses Wang Lee Street rather than Fuk Hai Street (entrances to the site are on the south and east side of the site), then impacts will be reduced substantially as a result of three factors:

- screening (10 dB(A)) of truck traffic by the 2.4 m site boundary wall;
- screening (5 dB(A)) of truck traffic by 1 – 2 storey buildings both on the site and on adjoining sites; and
- increased distance (350 m vs 125 m) from truck traffic to NSRs.

If this route is employed the predicted noise level at the nearest NSRs would be about $L_{Aeq,30min}$ 50 dB, which is within the applicable NCO noise criterion.

5.4 CONCLUSIONS AND RECOMMENDATIONS

5.4.1 *Construction*

The assessment above has indicated that it is unlikely that daytime construction (0700–1900) activities will be capable of generating significant impacts at nearby NSRs. As a result, no mitigation measures have been recommended for daytime construction activities.

If construction activities continue into restricted hours, however, exceedances have been predicted and mitigation measures will be necessary for the Contractor to be eligible for a CNP.

Recommended mitigation measures, including reduction in plant teams, use of noise barriers and use of on–site noise management have been shown to reduce impacts at nearby NSRs. In addition, if construction activities are proposed for restricted hours, noise monitoring should be carried out at nearby NSRs.

5.4.2 *Operation*

The foregoing analysis has indicated that noise sources in the Packaging Building and the Process Building as well as road traffic on the roads surrounding the facility will have the potential to cause exceedances of Hong Kong statutory and planning noise criteria. The sections below summarise recommended mitigation measures for these areas.

Equipment and Machinery––External Noise

Packaging Building

Noise predictions have indicated that external noise levels from reverberant noise within the Packaging Building would be in compliance with all of the

applicable HKPSG noise criteria (24-hour compliance), assuming a maximum internal level of 85 dB(A). As a result, no mitigation measures are recommended to reduce external noise levels generated by reverberant noise within the Packaging Building. It is recommended, however, that mitigation measures be applied to screen the direct noise path from noisy equipment or conveyor belts which are located near to the louvred wall sections. In particular, acoustic partitions should be installed to screen noisy equipment or conveyor belts which are located within 5 metres of the louvred wall sections. These partitions should have a specification such that transmitted noise levels are at least 10 dB(A) below the incident noise levels. Such a screening of direct atmospheric noise paths would mean that even if all louvred sections of the packaging room were designed with standard louvres, noise levels at the nearest NSR (Leon Court) would not exceed the appliacable HKPSG night time noise limit ($L_{Aeq,30min}$ 50 dB).

Process Building

Two areas associated with the Process Building were established as having the potential to produce unacceptable night time noise levels. Analysis, however, has indicated that the combined total sound power level from both the ground floor and roof utility areas would be approximately 44 dB(A), which is below the night time noise criterion ($L_{Aeq,30min}$ 50 dB). As a result, noise mitigation measures would not be necessary for the Process Building for the purpose of reducing noise at sensitive receivers external to the building.

Cumulative External Noise From All Buildings

There is the potential for impacts from both the Process Building and the Packaging Building to result in cumulative impacts at Leon Court in excess of the HKPSG night time noise criterion; daytime and evening operation would not be problematical. Assuming a noise level impact of 47 dB(A) at Leon Court from the Packaging Building (see preceding section) and a 44 dB(A) impact at Leon Court from the Process Building, the overall impact could be theoretically 49 dB(A). As this value is below the limiting night time noise criterion, it is not recommended that any additional mitigation measures be incorporated into the design of the facility solely for the purpose of reducing the potential for cumulative impacts.

Equipment and Machinery--Internal Noise

Packaging Building

For the Packaging Building it is recommended that the packaging room design incorporate an allowance for a suspended acoustic ceiling or hanging acoustic baffles. The acoustic ceiling or hanging baffles should be specified to reduce reverberant noise levels by at least 4 dB(A). It should be noted that a ceiling of this type or hanging acoustic baffles should be capable of reducing reverberant noise levels by up to 7 dB(A). Such a reduction in noise levels would ensure that reverberant noise levels in the packaging room would be in compliance with the statutory Noise at Work limiting noise level.

Whilst the need for such acoustic treatment for internal noise levels is not certain at this stage due to uncertainty in the likely reverberant noise level within the packaging room, such treatment is recommended as good design

practice since it would guarantee noise levels below the 85 dB(A) statutory limit. However, the need for, and design of, the acoustic treatment could be left to the commissioning stage (at that time the reverberant noise level could be measured and the need for acoustic treatment decided) if the cost and design implications are considered prohibitive at this stage of the project (it is recommended, however, that allowance is made for such treatment at this stage).

For workers stationed near to the major noisy equipment (bottle washers, decraters, bottle fillers, pasteurisers, case washers, CIPs, crate magazines, palletizers, etc.), it is recommended that the worker be separated from the equipment by a distance of at least 1 metre, and if necessary a clear, acoustic cubicle or partition be placed between the worker and the piece of equipment. The acoustic partition should be capable of reducing noise levels directly behind it by up to 10 dB(A). For locations where these mitigation measures may not be practical, such as near the bottle conveyors, it is recommended that the workers be provided with ear plugs or suitable ear defenders.

Process Building

For the Process Building, the noise level in three rooms were evaluated with respect to the Noise at Work regulations. These areas, all located on the Ground Floor, were:

- the boiler plant room;
- the refrigeration plant room; and
- the CO_2 recovery and air system plant room.

Analysis has indicated that the reverberant noise levels in the boiler and refrigeration rooms would most probably be out of compliance with the statutory *Noise at Work* noise limit (85 dB(A)). However, it is understood that these rooms will not normally be occupied, except for occasional maintenance work, and so no noise mitigation is required except for suitable ear defenders, in accordance with the *Noise At Work* Regulations.

Road Traffic

Road traffic will be capable of generating significant impacts at nearby NSRs if allowed to travel on Fuk Hai Street. As a result, it has been recommended that road traffic use Wang Lee Street rather than Fuk Hai Street.

Monitoring

It is recommended that all rooms within the facility be monitored at commissioning and every 6 months thereafter to determine if machinery is in need of maintenance or additional silencing, and to determine the hearing protection requirement.

Provided Wang Lee Street rather than Fuk Hai Street is used for peak hour truck transport, no operational noise monitoring is recommended. However, if Fuk Hai Street is to be employed rather than Wang Lee Street, even for a restricted number of truck movements, then monitoring at the nearby NSRs is recommended.

6 WASTE MANAGEMENT

6.1 INTRODUCTION

The issues of solid wastes require slightly different treatment from other subjects studied in an EIA. Construction and operation of any facility has direct and immediate implications on water, air, and noise quality which can only be dealt with on site. Solid wastes, on the other hand, can be contained and transported, and thus do not represent a direct environmental issue to the facility which generates them.

The following sections focus on ensuring that wastes produced are contained and transported for disposal in an environmentally acceptable manner. However, a brief note will also be made of any particular opportunities for waste minimisation or recycling, due to their associated potential cost savings and environmental benefits.

6.2 CONSTRUCTION PHASE

6.2.1 *Government Regulation and Requirements*

The *Waste Disposal Ordinance (1987)* requires that all waste be disposed of at approved sites. In order to comply with this, all commercial and industrial waste generators must deliver or arrange for a private waste contractor to deliver their waste to these sites.

Requirements for wastes going to landfill are changing as Hong Kong's older landfills give way to a new generation of strategic landfills. During the construction phase of the Brewery, disposal options with the following requirements will be available:

- new strategic landfills – WENT (near Black Point) and SENT (near Tseung Kwan O) strategic landfills. These landfills will officially accept waste only if a requirement of at least 20% dry solids is met. In addition, EPD may implement a higher requirement for 30% dry solids in the future, at their discretion, for certain types of waste. These landfills may also turn away any trucks carrying construction waste which exceeds 20% inert material (rubble, sand, rock, etc) by volume. However, this last requirement is currently in flux and not being enforced.

- Pillar Point Valley Landfill – is scheduled to close in 1997. This older landfill is run by the Civil Engineering Department, and currently takes waste which has been rejected by other landfills because of high water content. The requirement for moisture content is less precise than for the strategic landfills. However, in practice, determining water content of all vehicles is problematic, so wastes will generally be accepted unless water is slopping within or spilling over the sides of the incoming truck.

- Public Dumps – which should be operating during the construction phase of the new San Miguel Brewery include those at Tseung Kwan O, Pat Sek Kok (north of Sha Tin) and Tuen Mun. Public dumps are the preferred disposal sites for inert construction wastes such as concrete,

brick, soil, tile, rock, gravel, and similar materials. Since they are being used for reclamation purposes, wastes brought to these sites must not contain a "significant amount" of timber or other non-inert (biodegradable) materials.

Flytipping (either on or off site), which has been a problem in the past, is controlled under the *Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws (Cap. 132)*. Following recent (April 1994) amendments, penalties for flytipping have increase considerably.

In early 1995, government is planning to implement charging scheme for all construction, commercial, and industrial waste brought to landfill. The charge is planned to be initially set at $175 per truckload of under 5 tonnes and $350 per truckload of over 5 tonnes. It is planned that the charge will eventually be double this level, in order to achieve full cost recovery of landfills. While waste collectors themselves will absorb some of the cost, the majority will be passed along to waste generators including San Miguel.

6.2.2 *Production of Waste Materials and Potential Effects*

The construction of the new brewery will inevitably gives rise to construction debris and waste, including:

- sand, rock, earth, and mud from excavation;
- concrete, mortar, and bricks from foundation and building activities;
- wood from hoardings, falsework, and (possibly) formwork; and
- organics and garbage.

While many of these materials are inert, and so largely non-biodegradable, their improper management can result in negative visual impact. Because they are generated in large quantities, building operations may also be hindered. When these wastes are improperly handled, workers would be exposed to unnecessary risk.

Non-inert organic materials, on the other hand, require somewhat different treatment. As they degrade, fluid and chemicals can be leached into the surrounding environment. Without frequent collection, food-type organics can also rot quickly in Hong Kong's hot and humid climate, potentially creating health problems and drawing insects and rodents.

However, as noted below, proper storage and transportation of wastes is simple and sharply reduces any on-site environmental impact.

6.2.3 *Management of Waste Materials*

On site storage and transport

A primary responsibility of San Miguel is to ensure that no wastes from the site escape or are deposited into the surrounding area. A second aim should be to ensure that all wastes are properly disposed of once they leave the site. A number of steps can be taken to help ensure these requirements:

- A reputable waste contractor with proven standards for environmental hygiene should be chosen to manage the site's waste. Such a contractor will be to some extent self-regulating, and will ensure that waste materials are properly managed on site and disposed of off site.

- Waste should only be handled once. For example, a skip which is filled on site and cranked directly onto the back of a truck would be preferable to having waste transferred from site skip (or ground) into a truck via crane. This helps prevent waste from being blown or dispersed into the surrounding area.

- Ensure that skips provided are properly sized and regularly serviced, and are strategically located on the site. Covered skips would be an advantage.

- Locate smaller covered bins for any organic and food waste at points throughout the site. These have the advantage of being convenient for the use of construction employees, as well as preventing water from seeping in and leachate from seeping out which could contaminate surrounding areas. Organic food wastes should also be collected frequently (separately if necessary) at least 3 times per week.

Surveys of San Miguel's existing operations a Sham Tseng indicate these criteria are currently fulfilled in general.

In addition, on-site measures may be implemented which promote the proper disposal of wastes once off site. For example having separate skips for inert (rubble, sand, stone, etc) and non-inert (wood, organics, etc) wastes would help ensure that the former are taken to public dumps, while the latter are properly disposed of at controlled landfills. Since waste brought to public dumps will not be charged as are those brought to landfill, separating waste can also help to reduce waste management costs.

Waste reduction

While proper disposal is a requirement in Hong Kong, there is some opportunity for San Miguel to go beyond compliance through waste minimisation. As well as reducing indirect environmental impacts and saving resources, waste minimisation and recycling are potential money saving techniques. Possible measures during construction are limited but include:

- Utilise any excavated materials on site such that borrow and fills can balance each other.

- Require that the construction contractor uses durable steel instead of disposable wood for formwork, as far as is practical. However, the one-off nature of any formwork applications for the brewery construction may complicate this.

- Simple good housekeeping.

6.3 OPERATION PHASE

6.3.1 *Government Requirements*

The requirements for operational commercial and industrial waste with regards to disposal points, moisture content, flytipping, and charging are similar to those for construction waste. However, it is anticipated that the older Pillar Point Valley Landfill may be closed by the time the new

brewery is operational. In addition, public dumps do not accept commercial/ industrial waste, limiting the disposal options to the three strategic landfills, WENT, SENT, and NENT.

As stated in *Section 6.2.1*, the major requirements for these sites are:

- waste received must have a minimum of 20% dry solid material;
- flytipping on or off site of wastes is illegal; and
- waste will be charged upon arrival to landfill.

6.3.2 *Production of Waste Materials*

Information provided by San Miguel indicates that the following waste materials will be produced through daily operation:

- 19 cubic metres of spent grains, at 70% water content;
- 1.5 tonnes of dried yeast, at 10% water content;
- 1.1 tonnes of filter aid at 20% water content;
- 0.2–0.3 tonnes of total suspended solids (TSS) from the waste water treatment plant assuming sludge yield of 0.05 TSS/kg COD removed.

This sludge has usually 5–10% dried solids content which will amount to approximately 6 tonnes of wet sludge per day;

- 2 skips (of approximately 9 cubic metres each) of miscellaneous waste consisting of canteen waste, broken glass, cans, office paper, etc;
- waste oil such as lubrication oil, diesel oil and paraffin oil, etc; and
- waste oil drums.

After the phase two expansion, it is expected that these wastes will be increased by approximately 50%.

As long as these wastes are properly managed, no serious environmental issues should arise. However, improper management (such as infrequent collection, inappropriate containers, etc) could give rise to problems with odour, insects and rodents, and contaminated water run-off.

In addition, San Miguel have indicated that no asbestos containing material will be used in the construction of the new brewery in Yuen Long, and so asbestos waste will not be an issue in the new plant.

6.3.3 *Management of Operational Wastes*

On site management of wastes

As with construction wastes, San Miguel is responsible for ensuring that operational wastes are dealt with in an acceptable manner. Operational wastes can be managed properly through many of the same techniques as construction waste.

Choosing a waste contractor with proven high environmental health standards will help ensure that wastes are properly managed during the operational phase. However, inspection and audits should from time to time be conducted by San Miguel staff to ensure that wastes are being properly managed and disposed of on and off site.

It is also noted that San Miguel propose that lidded or enclosed waste skips of the type that can be hauled directly onto a collection vehicle being used of odorous wastes. Using roll-on roll-off compacting containers would also help reduce the space required for mixed waste storage, and ensure that waste is handled only once.

Spent yeast is to be dried on site prior to either sale or disposal.

Waste oil produced from equipment cleaning and lubrication are not recommended to be disposed in landfill site. These waste may be able to be processed in other treatment facilities such as the Chemical Waste Treatment Centre (CWTC). However, the appropriate licences must be obtained before discharge and transportation should be carried out by a licensed contractor. Any chemical wastes produced will be handled according to the *Code of Practice on the packaging, labelling and storage of Chemical Wastes.*

In addition, any empty containers which had previously contained chemical waste will be collected by licensed contractors and sent to landfill for co-disposal.

Any wet sludge requiring disposal would have to be dried prior to transport to landfill.

Potential for waste reduction

While it is prudent to ensure that all wastes meet the requirement for disposal to landfill (should the need arise), it is of course more desirable to avoid their disposal all together. Minimising waste for disposal has numerous benefits, including:

- reducing the collection fee paid to waste contractors who (implicitly or explicitly) charge on a per tonne basis;
- avoiding the future cost of the planned landfill charge, which may eventually cost San Miguel and additional $40 to 80 per tonne of waste; and
- improving public relations, and serving as a solid example of San Miguel's environmental policy.

The large scale nature of San Miguel's activities produce several homogenous waste streams which may have potential for recycling.

San Miguel has stated its intention to sell as much waste material for reuse or recycling, thus reducing the amount that is sent to landfill. Plans include:

- Selling as much general waste (paper, metals, etc) to recyclers. Given that a thriving market for recovered materials does exist in Hong Kong. There may be significant scope for reducing the amount of office paper,

glass, aluminum, and other metals sent for disposal. Sale of reject aluminum cans and sheets from the capping plant may be especially lucrative given the current high market price for non ferrous metals, though it is doubtful if any price would be paid for glass cullet. High quality office paper can also be sold though, as with all other materials, buyers demand clean and uncontaminated materials. Source separation would be an advantage.

- Selling the spent grains as animal feed (assuming a market could be found) though this material would also be a suitable input for a composting operation.

- Selling dried yeast to the food industry.

- Selling/reusing the sludge from the proposed anaerobic effluent treatment system. After stabilisation for removal of residual volatile fatty acids, the sludge can be composted and used for landscaping or agricultural soil conditioner. In addition, the granular sludge produced by upflow reactors have good settling ability and high methanogenic activity. These sludge can be used to start up other anaerobic reactors. *Euro Mark Technologies Ltd*, the effluent treatment plant designers, has offered to take back the sludge for this purpose. In Europe, there is a market of this sludge, while *Biotim, Biothane* and similar companies are other possible purchasers.

- Selling of waste oils to oil recycling industries.

6.4 CONCLUSIONS & RECOMMENDATIONS

Solid wastes will be generated during the construction and operation phases of the facility. Biodegradable and inert fraction of the construction waste should be collected and disposed separately. The main types of waste generated during daily operation of the facility are waste oil, yeast, spent grain, glass/cans, filter aid and wet sludge from wastewater treatment process etc. Initially these wastes are to be reused and recycled as much as possible, and potential for further improvement will be reviewed on a regular basis. When disposal is unavoidable, transportation, handling and storage procedures should meet strict performance requirements to ensure that all waste is eventually disposed of in an environmentally acceptable manner.

No significant environmental impact is envisaged during both the construction and operation phases providing that proper waste management and good housekeeping practices, as recommended in the report, are implemented.

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7 HEALTH AND SAFETY

7.1 INTRODUCTION

San Miguel Hong Kong are planning the development of a new brewery at Yuen Long. Required for the operations at the new site are a number of Dangerous Goods as defined by the *Dangerous Good (application and exemptions) Ordinance*. These dangerous goods are to be kept in the designated dangerous goods store.

Of these goods, only liquefied petroleum gas (LPG) is proposed to be stored in quantities that would constitute a notifiable gas installation. Even though the proposed quantities of the other dangerous goods do not make them notifiable, they still constitute a hazard and must be handled accordingly.

This section of the report outlines the population potentially at risk from the site operations and details the potential hazard from all the Dangerous Goods to be kept as well as procedures for their safe handling and the required responses if an accidental event involving these goods were to occur. All quantities of dangerous goods quoted in this section are best available estimates of actual quantities that will be required, as the project is still in the design stage.

7.2 POTENTIAL POPULATION AT RISK

The populations potentially at risk from accidental events involving dangerous goods on the San Miguel Site are both residential and industrial. The residential populations are those of Tai Tseng Wai and Ng Uk Villages to the northwest of the site. These villages consists of a series of 2–3 storeys high village houses and were originally located over 100 m from the boundary of the Yuen Long Industrial Estate. However due to recent development of Tai Tseng Wai village the number of houses has increased. It is estimated that 400 people may live in close proximity of the Industrial estate upon full development of Tai Tseng Wai Village. Ng Uk village is further to the north and is not so populous. It is estimated that 150 people live there.

Without a survey it is difficult to know the population on the industrial estate, however it is estimated by the Hong Kong Industrial Estates Corporation that the present worker population in the Yuen Long Industrial Estate is about 4,500, increasing to 6,000 in two years time.

7.3 ACETYLENE

Acetylene or Ethyne (C_2H_2) is a Category 2, Class 3 Dangerous Good as defined by the *Dangerous Goods Regulations*. It is a colourless, compressed gas with a mild garlic odour and is slightly lighter than air, dispersing

slowly unless confined. Commercial grade acetylene is supplied dissolved in acetone under pressure in cylinders. Three 50 kg cylinders of Acetylene are to be stored at the San Miguel site.

Table 7.3a *Physical and Chemical Properties of Acetylene*

Property	
Physical State at 15°C and 1 atm	Gas
Molecular Weight	26.04
Boiling Point (1 atm)	−119°F = 84.0°C = 189.2K
Specific Gravity	0.613 at −80°C (liquid)
Vapour (Gas) Specific Gravity	0.9

7.3.1 Precautionary Actions

Upon release of Acetylene, shut off ignition sources, issue a warning that a highly flammable gas has been released and call responding services (ie *Fire Services Department* (FSD), *Gas Standards Office* (GasSO) and EPD). Stop the discharge if possible. Keep people away and stay upwind of the release point. Use water spray to 'knock down' vapour if possible.

7.3.2 Fire Hazard

Acetylene is a flammable gas with an ignition temperature of 581°F and its containers may explode if exposed to fire. Upon ignition flashback along the gas trail may occur. Acetylene may explode if ignited in an enclosed area. The flammability limits in Acetylene in air are 2.5%−100%.

If an acetylene release is ignited, stop the flow of gas, and allow released gas to burn off. Fire extinguishing agents such as carbon dioxide, dry chemical and water spray are not generally recommended because the discharged gas or volatile liquid may create a more serious explosion hazard due to increased turbulence caused by the application of the extinguishing agent.

Due to the relatively small quantities of Acetylene to be kept on site any risks to life posed to off−site personnel are not expected.

7.3.3 Health Hazard

Personnel entering areas of high concentration should use air supply respirators. Symptoms following exposure may include headache, dizziness and loss of consciousness. Death from "smothering" may occur if oxygen content of the air is severely reduced by dilution with acetylene.

No specific antidote is known for treatment following inhalation. Exposed persons should be removed to fresh air, kept warm and calm, and attended

by medical personnel; recovery is usually rapid. If patient is unconscious, administer oxygen; if breathing has stopped, give artificial respiration.

7.3.4 *Toxic Exposure Hazard*

If personnel are exposed to an Acetylene release call for medical aid. The gas is not irritating to eyes, nose or throat but if inhaled will cause headache, difficult breathing, or loss of consciousness. See *Health Hazard* above.

7.3.5 *Water Pollution Hazard*

Acetylene is not harmful to aquatic life.

7.4 *AMMONIA*

Ammonia (NH_3) is a Category 2 Class 2 Dangerous Good. It is a colourless, liquefied compressed gas with an extremely pungent "Ammonia" odour. Ammonia floats and boils on water, is poisonous, and forms a visible vapour cloud in air.

It is proposed to store ten 50 kg cylinders of ammonia on site. In addition to this ammonia is used in various applications in the process (*See Appendix 1 of Ref [1]*). Commercial, industrial, refrigeration, electronic, and metallurgical grades all have purity greater than 99.5%. Storage temperature for ammonia should be ambient for pressurized ammonia and low temperature for ammonia at atmospheric pressure.

Table 7.4a ***Physical and Chemical Properties of Ammonia***

Property	
Physical State at 15°C and 1 atm	Gas
Molecular Weight	17.03
Boiling Point (1 atm)	-28.1°F = -33.4°C = 239.8K
Freezing Point	-108°F = -77.7°C = 265.5K
Specific Gravity	0.682 at -33.4°C (liquid)
Vapour (Gas) Specific Gravity	0.6
Reid Vapour Pressure	211.9 psia

7.4.1 *Precautionary Actions*

Upon release of ammonia, avoid contact with liquid and vapour. Keep people away. Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves). Stop discharge if possible. Stay upwind and use water spray to "knock down" vapour. Call responding services. Isolate and remove discharged material.

7.4.2 *Fire Hazard*

Ammonia is combustible. Goggles, self-contained breathing apparatus, and rubber overclothing (including gloves) must be worn by personnel attending a release. Stop flow of gas or liquid if possible, cool exposed containers and protect men effecting shutoff with water. If ammonia ignited let the fire burn while protecting adjacent containers and building with water spray.

7.4.3 *Toxic Exposure Hazard*

If personnel are exposed to ammonia vapour call for medical aid. The vapour is poisonous if inhaled and is irritating to eyes, nose and throat. Exposed personnel should be exposed to fresh air. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.

Exposure to ammonia liquid will burn skin and eyes, and is harmful if swallowed. Contact with the liquid will cause frostbite. Remove contaminated clothing and shoes and flush affected areas with plenty of water. Do not rub affected areas. If in eyes, hold eyelids open and flush with plenty of water; if swallowed and victim is conscious, have victim drink water or milk.

Due to the relatively small quantity of ammonia on site (100 tonnes are required for the installation to be termed a Potentially Hazardous Installation (PHI) and the separation of this into ten cylinders, it is not expected that there will be any significant off-site risks from ammonia.

7.4.4 *Water Pollution Hazard*

Ammonia is harmful to aquatic life in very low concentrations. May be dangerous if it enters water intakes. Notify EPD and operators of nearby water intakes.

7.4.5 *Health Hazards*

Contact with vapours cause severe eye or throat irritation and may cause eye or lung injury; vapours cannot be tolerated even at low concentrations.

Contact with liquid causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.

Gas-tight chemical goggles, self-contained breathing apparatus, rubber boots, rubber gloves, emergency shower and eye bath should be made available if ammonia is to be stored. Exposure to 700 ppm causes eye irritation, and permanent injury may result if prompt remedial measures are not taken; 5000 ppm can cause immediate death from spasm, inflammation, or edema of the larynx. Contact of the liquid with skin freezes the tissue and then produces a caustic burn.

Upon inhalation of ammonia move victim to fresh air and give artificial respiration if necessary. Oxygen may be useful. Observe for laryngeal spasm and perform tracheostomy if indicated. Upon contact with skin or eyes, flood affected area immediately with running water for 15 minutes. Treat subsequently as thermal burn.

7.4.6 *Fire Hazards*

Ammonia is not flammable under conditions likely to be encountered due to the high ignition temperature (1204°F) required. The flammability limits of ammonia in air are 15.5%-27.0%. Upon ignition, stop flow of gas or liquid and let fire burn. Liquid ammonia will burn at a rate of 1 mm/min.

7.5 *SODIUM HYDROXIDE*

Sodium Hydroxide (NaOH) (or Caustic Soda) is a Category 3 Dangerous Good. It is a solid in the form of white flakes or pellets. It is odourless and sinks and mixes with water.

Table 7.5a Physical and chemical Properties of Sodium Hydroxide

Property	
Physical State at 15°C and 1 atm	Solid
Molecular Weight	40.00
Boiling Point (1 atm)	Very high
Freezing Point	604°F = 318°C = 591K
Specific Gravity	2.13 at 20°C (solid)

7.5.1 *Precautionary Actions*

Avoid contact with solid and dust and keep people away from loss of containment. Attendant personnel should wear rubber overclothing (including gloves). Stop discharge if possible. Isolate and remove discharged material.

7.5.2 *Fire Hazard*

Sodium Hydroxide is not flammable but it may cause fire on contact with combustible materials. A flammable gas may be produced on contact with metals. Wear rubber overclothing (including gloves). Flood discharge area with water. Cool containers exposed to fire with water.

7.5.3 *Toxic Exposure Hazard*

Sodium Hydroxide dust is irritating to eyes, nose and throat. Move exposed persons to fresh air. If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen. If in eyes, hold eyelids open and flush with plenty of water.

Sodium Hydroxide solid will burn skin and eyes and is harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. If in eyes, hold eyelids open and flush with plenty of water.
If swallowed and victim is conscious, have victim drink water or milk. Do not induce vomiting.

7.5.4 *Water Pollution Hazard*

Sodium Hydroxide is dangerous to aquatic life in high concentrations and may be dangerous if it enters water intakes. Notify operators of nearby water intakes of potential hazards.

7.5.5 *Health Hazards*

Chemical safety goggles, face shield, filter or dust-type respirator, rubber boots, rubber gloves should be worn by personnel attending to Sodium Hydroxide loss of containment incidents.

Sodium Hydroxide has a strong corrosive action on contacted tissues and if inhaled the dust may cause damage to upper respiratory tract and lung itself, producing from mild nose irritation to pneumonitis. If ingested, severe damage to mucous membranes and severe scar formation or perforation may occur. Contact with eyes produces severe damage.

Persons who have inhaled NaOH should be removed from exposure and if needed their respiration should be supported. If ingested water or milk followed by dilute vinegar or fruit juice should be administered; do not induce vomiting. Sodium Hydroxide is a severe skin irritant that causes second and third-degree burns on short contact and is very injurious to the eyes. Areas of skin that come into contact with Sodium Hydroxide should be washed immediately with large quantities of water under emergency safety shower while removing clothing; continue washing until medical help arrives. If eyes come into contact with NaOH they should be irrigated

7.6 *DIESEL*

Diesel is a category 5 class 2 (division 1) dangerous good. It is an oily yellow-brown liquid with a lube or fuel oil odour. It is proposed to use diesel at the brewery as a source of primary fuel to fire the boilers and the diesel will be stored in two underground tanks, of 22m^3 and one of 44m^3 capacities.

Table 7.6a *Physical and Chemical Properties of Diesel*

Property	
Physical State at 15°C and 1 atm	Liquid
Boiling Point (1 atm)	550–640°F = 288–338°C = 561–612K
Freezing Point	0 to –30°F = –18 to –34°C = 255 to 239K
Specific Gravity	0.841 at 16°C (liquid)
Reid Vapour Pressure	Varies

7.6.1 Precautionary Actions

Upon release of diesel, stop discharge if possible. Call respondent services. Personnel should avoid contact with liquid. Isolate and remove discharged material.

7.6.2 Fire Hazard

Diesel is combustible and if ignited should be extinguished with dry chemical, foam, or carbon dioxide extinguishers. Water may be ineffective on diesel fires because diesel is immiscible and floats on water. Containers exposed to fire should be cooled with water. The flammable limits of diesel in air are 1.3–6.0% with an ignition temperature of 350 to 625°F. Diesel burns at a rate of 4 mm/min.

The quantities of diesel kept on site will not pose significant risks to offsite personnel.

7.6.3 Toxic Exposure Hazard

Diesel is irritating to skin and eyes and harmful if swallowed. Contaminated clothing and shoes should be removed and affected areas should be flushed with plenty of water. If in eyes, hold eyelids open and flush with plenty of water. If diesel is swallowed and victim is conscious, have victim drink water or milk. Do not induce vomiting.

7.6.4 Water Pollution Hazard

Diesel is dangerous to aquatic life in high concentrations and causes fouling to shoreline. It may also be dangerous if it enters water intakes and operators of nearby water intakes should be notified of any releases that may impact them.

7.6.5 *Health Hazards*

If diesel is spilled on clothing and allowed to remain, it may cause smarting and reddening of the skin. Goggles or face shield should be worn when dealing with diesel releases. If diesel is ingested do not induce vomiting. If skin comes into contact with diesel, wipe off and wash with soap and water. Wash contacted eyes with copious amounts of water.

Diesel vapours cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.

7.7 *FREON (CHLORODIFLUOROMETHANE)*

Freon ($CHClF_2$), commonly known as Eskimon–22, Genetron–22, Isotron–22, Monochlorodifluoromethane and Uconn–22, is a Category 2, Class 2 Dangerous Good. It is a colourless liquefied compressed gas with a faint odour. Liquid Freon sinks and boils in water and forms a visible vapour cloud. It is proposed to keep three 50 kg cylinders of Freon on site.

Table 7.7a Physical and Chemical Properties of Freon

Property	
Physical State at 15°C and 1 atm	Gas
Molecular Weight	86.48
Boiling Point (1 atm)	−40.9°F = −40.5°C = 232.7K
Critical Temperature	204.8°F = 96.0°C = 369.2K
Critical Pressure	716 psia = 48.7 atm = 4.93 MN/m^2
Specific Gravity	1.41 at −40°C (liquid)
Liquid Surface Tension (est.)	15 dynes/cm = 0.015 N/m at −41°C
Liquid Water Interfacial Tension	Data not available
Vapour (Gas) Specific Gravity	3.0
Reid Vapour Pressure	212.6 psia

7.7.1 *Precautionary Actions*

Upon release of Freon, stop discharge if possible. Avoid contact with liquid. Isolate and remove discharged material. Notify respondent services.

7.7.2 *Fire Hazard*

Freon is not flammable but poisonous gases are produced when heated. Goggles and self–contained breathing apparatus must be worn when dealing with Freon releases. Containers exposed to fire should be cooled with water.

7.7.3 *Toxic Exposure Hazard*

Freon vapour is not irritating to eyes, nose or throat. If inhaled it will cause dizziness or loss of consciousness. Affected people should be moved to fresh air. If breathing has stopped, give artificial respiration and if breathing is difficult, give oxygen.

Freon liquid will cause frostbite if in contact with skin. Flush affected areas with plenty of water. Do not rub affected areas.

7.7.4 *Water Pollution hazard*

Freon is not harmful to aquatic life.

7.7.5 *Health Hazards*

Rubber gloves; goggles should be worn when handling Freon. Inhalation at greater than 10% concentration in air may cause narcosis. Contact with liquid may cause frostbite. Personnel in contact with Freon should be removed to non-contaminated areas and artificial respiration should be applied if breathing has stopped.

7.8 *HYDROCHLORIC ACID*

Hydrochloric acid (HCl) is a Category 3 dangerous good. It is a watery colourless liquid with sharp, irritating odour. HCl sinks and mixes with water producing an irritating vapour. It is proposed to store four five-gallon drums of HCl on site.

Table 7.8a Physical and Chemical Properties of Hydrochloric Acid

Property	
Physical State at 15°C and 1 atm	Liquid (Physical properties apply to 37% solution.)
Molecular Weight	36.46
Boiling Point (1 atm)	123°F = 50.5°C = 323.8K
Specific Gravity	1.19 at 20°C (liquid)
Reid Vapour Pressure	8.0 psia

7.8.1 *Precautionary Actions*

Avoid contact with liquid and vapour. Keep people away from releases. Attendant personnel should wear chemical protective suits with self-contained breathing apparatus. Discharge should be stopped if possible and people should stay upwind of vapour cloud, using a water spray to "knock down" vapour. Discharged material should be isolated and removed and respondent services should be notified.

7.8.2 *Fire Hazard*

Hydrochloric acid is not flammable but a flammable gas may be produced on contact with metals. Chemical protective suits with self-contained breathing apparatus should be worn when dealing with HCl releases.

HCl is corrosive to most metals with evolution of hydrogen gas, which may form explosive mixtures with air.

7.8.3 *Toxic Exposure Hazard*

HCl vapour is moderately irritating to eyes, nose and throat such that personnel will not usually tolerate moderate or high vapour concentrations. If inhaled, will cause coughing or difficult breathing. Affected personnel should be moved to fresh air. If breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen.

HCl liquid is a fairly severe skin irritant and may cause pain and second-degree burns after a few minutes' contact with skin and eyes and is harmful if swallowed. Remove contaminated clothing and shoes and flush affected areas with plenty of water. If in eyes, hold eyelids open and flush with plenty of water. If swallowed and victim is conscious, have victim drink water or milk. Do not induce vomiting.

7.8.4 *Water Pollution Hazard*

HCl is dangerous to aquatic life in high concentrations and may be dangerous if it enters water intakes. Operators of nearby water intakes should be notified of potential hazards.

7.8.5 *Health Hazards*

Self-contained breathing equipment, air-line mask, or industrial canister-type gas mask; rubber or rubber-coated gloves, apron, coat, overalls, shoes should be worn when handling HCl. Inhalation of fumes results in coughing and choking sensation, and irritation of nose and lungs. Liquid causes burns. If inhaled remove person to fresh air and get medical attention immediately; start artificial respiration if breathing stops.

If ingested, have person drink water or milk; do not induce vomiting. If in contact with eyes, immediately flush with plenty of water and get medical attention. If in contact with skin immediately flush skin while removing contaminated clothing; get medical attention promptly; use soap and wash area.

7.9 KEROSENE

Kerosene (Very approximately $C_vH_{(2v+2)}$ where "v" varies among components in the complex mixture (which is also likely to contain components with different structures)) is a Category 3 Dangerous Good. It is a colourless watery liquid with a fuel-oil odour and floats on water. It is proposed to keep four 5 gallon drums of Kerosene at the site.

Table 7.9a Physical and Chemical Properties of Kerosene

Property	
Physical State at 15°C and 1 atm	Liquid
Boiling Point (1 atm)	392-500°F = 200-260°C = 473-533K
Freezing Point	-50°F = -45.6°C = 227.6K
Specific Gravity	0.80 at 15°C (liquid)
Reid Vapour Pressure	0.1 psia

7.9.1 *Precautionary Actions*

Stop discharge if possible. Call fire department. Avoid contact with liquid. Isolate and remove discharged material. Notify local respondent services.

7.9.2 *Fire Hazard*

Kerosene is combustible and should be extinguished with dry chemical, foam, or carbon dioxide extinguishers. Water may be ineffective on fire as Kerosene floats on water. The flammability limits of Kerosene in air are 0.7% to 5% and it has an ignition temperature of 444°F and burns at a rate of 4 mm/min. Kerosene containers exposed to fire should be cooled with water.

7.9.3 *Toxic Exposure Hazard*

Kerosene is irritating to skin and eyes and is harmful if swallowed. Contaminated clothing and shoes should be removed and affected areas flushed with plenty of water. If in eyes hold eyelids open and flush with plenty of water. If swallowed and victim is conscious, have victim drink water or milk. Do not induce vomiting.

7.9.4 *Water Pollution Hazards*

Kerosene is dangerous to aquatic life in high concentrations and causes fouling to shoreline. Kerosene may be dangerous if it enters water intakes, therefore notify operators of nearby water intakes of potential hazards.

7.9.5 *Health Hazards*

Protective gloves; goggles or face shield must be worn when handling Kerosene. Vapour causes slight irritation of eyes and nose if present in high concentrations, however, the effect is temporary. Liquid irritates stomach and if taken into lungs, causes coughing, distress, and rapidly developing pulmonary edema. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

If ingested do not induce vomiting; call a doctor. If in eyes, wash with plenty of water. If on skin, wipe off and wash with soap and water.

7.10 *LIQUEFIED PETROLEUM GAS (LPG)*

LPG (Primarily mixture of C_3H_6 + C_3H_8 + C_4H_{10}) is regulated under the *Gas Safety Ordinance, Cap 51*. It is a colourless gas with a weak odour which often has an odorant added to make it more distinctive. LPG floats and boils on water and produces a flammable vapour cloud. It was initially proposed to use LPG as the primary or secondary fuel for the boilers but it is now only to be considered as a fuel source for use in the kitchens of the site canteen. It is proposed that four 50 kg cylinders be kept on site for this purpose.

An LPG store where containers are kept with an aggregated nominal water capacity of more than 130 litres is classified as a *Notifiable Gas Installation* (NGI) under the *Gas Safety Ordinance Cap.51* and application for construction approval to the *Gas Authority* is required. For the quantities of LPG planned it would need to be accepted by the Gas Authority that the site complies with the CCPHI risk guidelines. Due to the relatively small quantities to be stored, it is expected that the site will comply in full with the regulations and that this can be demonstrated quite easily.

Table 7.10a Physical and Chemical Properties of LPG

Property	
Physical State at 15°C and 1 atm	Gas (Physical properties apply to propane; no standard LPG exists.)
Molecular Weight	>44
Boiling Point (1 atm)	> –40°F = > –40°C = > 233K
Specific Gravity	0.51–0.58 at –50°C (liquid)
Reid Vapour Pressure	High

7.10.1 *Precautionary Actions*

In the event of an LPG release stop discharge if possible, keep people away, shut off ignition sources and call respondent services. Personnel should stay upwind and use water spray to "knock down" vapour. The local area

should be evacuated in the event of large releases. Avoid contact with liquid.

7.10.2 *Fire Hazard*

LPG is flammable with flashback to be expected along the vapour dispersion trail. LPG containers may explode in fire and the vapour may explode if ignited in an enclosed area. The flammability limits of LPG in air are between 2.2% and 9.5%. The ignition temperature of LPG is between 761°F (butane) and 871°F (propane) depending on the mixture and a liquid LPG pool would burn at 8.2 mm/minute. In the event of an LPG fire, stop discharge if possible, cool exposed containers and protect men effecting shutoff with water. Allow the released fuel to burn while cooling adjacent equipment with water spray. Extinguish small fires with dry chemicals. Water is not to be used to extinguish fire.

LPG vapour is heavier than air and may travel a long distance to a source of ignition and flash back.

7.10.3 *Toxic Exposure Hazard*

LPG vapour is not irritating to eyes, nose and throat, however, if inhaled, will cause dizziness, difficult breathing, or loss of consciousness. LPG liquid will cause frostbite if in contact with skin. Move affected persons to fresh air and if breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen. Flush affected skin areas with plenty of water.

7.10.4 *Water Pollution Hazard*

LPG is not harmful to aquatic life.

7.10.5 *Health Hazards*

Self-contained breathing apparatus must be used when dealing with high concentrations of gas. Concentrations in air greater than 10%; cause dizziness in a few minutes, 1% concentrations give the same symptom in 10 minutes. High concentrations cause asphyxiation. Following exposure remove victim to open air. If victim is overcome by gas, apply artificial resuscitation.

7.11 *NITRIC ACID*

Nitric acid (HNO_3–H_2O) is a Category 3 Dangerous Good. It is a colourless watery liquid with an acrid sweet odour. It sinks and mixes with water producing a harmful vapour.

Table 7.11a Physical and Chemical Properties of Nitric Acid

Property	
Physical State at 15°C and 1 atm	Liquid
Boiling Point (1 atm)	192.0°F = 88.9°C = 362.1K
Freezing Point	−50°F = −45.6°C = 227.6K
Reid Vapour Pressure	1.9 psia

7.11.1 Precautionary Actions

Avoid contact with Nitric Acid liquid and vapour. Keep personnel away from releases and use chemical protective suit with self-contained breathing apparatus to attend to nitric acid releases. Stop discharge if possible. Isolate and remove discharged material. Notify local respondent services.

7.11.2 Fire Hazard Summary

Nitric acid is not flammable but may cause fire on contact with combustibles and flammable gas may be formed on contact with metals. Poisonous oxides of nitrogen and acid fumes can be produced when heated. Chemical protective suit with self-contained breathing apparatus should be worn when handling Nitric acid releases. Nitric acid containers exposed to fire should be cooled with water.

7.11.3 Toxic Exposure Hazards

Nitric acid vapour will burn eyes, nose and throat and if inhaled, will cause difficult breathing or loss of consciousness. Affected personnel should be moved to fresh air and if breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen.

Liquid nitric acid will burn skin and eyes and is harmful if swallowed. Contaminated clothing and shoes should be removed and affected areas flushed with plenty of water. If in eyes, hold eyelids open and flush with plenty of water. If swallowed and victim is conscious, have victim drink water or milk. Do not induce vomiting.

7.11.4 Water Pollution Hazard

Nitric acid is harmful to aquatic life in very low concentrations and may be dangerous if it enters water intakes. Operators of nearby water intakes should be notified of potential hazards.

7.11.5 Health Hazards

Air mask, rubber acid suit, hood, boots and gloves, chemical goggles, safety shower and eye bath should be present when attending Nitric acid releases. 58–68% vapour is moderately irritating such that personnel will not usually tolerate moderate or high vapour concentrations. 95% vapour cause severe

irritation of eye and throat and can cause eye and lung injury. Liquid may cause severe burns to eyes and skin, causes second and third-degree burns on short contact and is very injurious to the eyes.

If inhaled affected persons should be removed to fresh air and artificial respiration administered if required. If ingested large volumes of water should be drunk; do not induce vomiting. If skin or eyes are in contact with nitric acid, they should be flushed with water for at least 15 minutes.

7.12 *OXYGEN*

Compressed oxygen (O_2) is a category 2, Class 1 Dangerous Good. It is a light blue odourless gas that sinks and boils in water. It is proposed to keep three 50 kg cylinders in the dangerous goods store at the San Miguel site.

Table 7.12a ***Physical and Chemical Properties of Oxygen***

Property	
Physical State at 15°C and 1 atm	Gas
Molecular Weight	32.0
Boiling Point (1 atm)	−297.3°F = −182.9°C = 90.3K
Freezing Point	−361°F = −218°C = 55K
Specific Gravity	1.14 at −183°C (liquid)
Vapour (Gas) Specific Gravity	1.1
Reid Vapour Pressure	Very high

7.12.1 *Precautionary Actions*

Avoid contact with liquid and keep people away. Wear rubber overclothing (including gloves). Stop discharge if possible.

7.12.2 *Fire Hazard*

Oxygen is not flammable but is a strong supporter of combustion, increasing the intensity of any fire. Mixtures of liquid oxygen and any fuel are highly explosive. Containers may explode in fire and therefore must be kept cool with water when exposed to fire.

7.12.3 *Toxic Exposure Hazards*

High concentrations of oxygen vapour, if inhaled, will cause dizziness, or difficult breathing. Liquid oxygen will cause frostbite. Affected areas should be flushed with plenty of water. Do not rub affected areas.

7.12.4 *Water Pollution Hazard*

Oxygen is not harmful to aquatic life.

7.12.5 *Health Hazards*

Safety goggles or face shield; insulated gloves; long sleeves; trousers worn outside boots or over high-top shoes (to shed spilled liquid) should be worn when dealing with oxygen releases.

Inhalation of 100% oxygen can cause nausea, dizziness, irritation of lungs, pulmonary edema, pneumonia, and collapse. Liquid may cause frostbite of eyes and skin.

If inhaled, in all but the most severe cases (pneumonia), recovery is rapid after reduction of oxygen pressure. If in eyes or on skin, treat frostbite burns and soak skin in lukewarm water.

7.13 *SULPHURIC ACID*

Sulphuric acid (H_2SO_4) is a Category 3 dangerous good. It is a colourless, odourless, oily liquid that sinks and mixes violently with water, producing an irritating mist. It is proposed to store 25 five-gallon plastic containers of sulphuric acid in the dangerous goods store at the on-site dangerous goods store.

Table 7.13a Physical and Chemical Properties of Sulphuric Acid

Property	
Physical State at 15°C and 1 atm	Liquid [Physical properties apply to concentrated (98%) acid unless otherwise stated. More dilute acid is more water-like.]
Molecular Weight	98.08
Boiling Point (1 atm)	644°F = 340°C = 613K
Specific Gravity	1.84 at 20°C (liquid)
Reid Vapour Pressure	Low

7.13.1 *Precautionary Actions*

Avoid contact with liquid and keep people away. Goggles, self-contained breathing apparatus, and rubber overclothing should be worn when dealing with sulphuric acid releases. Stop discharge if possible and isolate and remove discharged material. Notify local respondent services.

7.13.2 *Fire Hazard*

Sulphuric acid is not flammable but may cause fire on contact with combustibles. Flammable gas may be produced on contact with metals and poisonous gas may be produced in a fire. Water must not be used on fires adjacent to sulphuric acid stores. Extinguish with dry chemical or carbon dioxide.

7.13.3 *Toxic Exposure Hazard*

Sulphuric Acid mists are irritating to eyes, nose and throat. If inhaled, it will cause coughing, difficult breathing, or loss of consciousness. Affected persons should be moved to fresh air. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration, if breathing is difficult, give oxygen.

Sulphuric acid liquid will burn skin and eyes and is harmful if swallowed. If swallowed and victim is conscious, have victim drink water or milk. Remove contaminated clothing and shoes, flush affected areas with plenty of water.
Do not induce vomiting.

7.13.4 *Water Pollution Hazards*

Sulphuric acid is harmful to aquatic life in very low concentrations and may be dangerous if it enters water intakes. Operators of nearby water intakes should be notified of potential hazards.

7.13.5 *Health Hazards*

Safety shower; eyewash fountain; safety goggles, face shield, approved respirator (self–contained or air–line), rubber safety shoes and rubber aprons should be used when dealing with sulphuric acid releases.

Inhalation of vapour from hot, concentrated acid may injure lungs. Vapours from hot acid (77–98%) cause moderate irritation of eyes and respiratory system, but the effect is temporary. Swallowing may cause severe injury or death. Contact with skin or eyes causes severe burns.

If ingested, have victim drink water if possible; do not induce vomiting. If on eyes and skin, wash with large amounts of water for at least 15 minutes, do not use oils or ointments in eyes, treat skin burns. 77–98% acid causes severe second and third–degree burns of skin on short contact and is very injurious to the eyes.

7.14 METHANE

Methane (CH_4) or Natural gas is regulated under the *Gas Safety Ordinance Cap 51*. It is a colourless gas with a weak, sweet odour.

Methane will be produced as a by product of the effluent treatment process at the San Miguel Brewery and will be flared off or used to supplement the boiler fuel.

7.14.1 *Precautionary Actions*

Upon release of methane shut off all ignition sources and call responding services. Stop discharge if possible, keep people away and stay upwind of the release point. Use water spray to "knock down" vapour if possible. In case of large releases, evacuate area. Avoid contact with liquid or vapour.

7.14.2 *Fire Hazard Summary*

Methane is a flammable gas with an ignition temperature of 1004^0F and may explode if ignited in an enclosed area. The flammability limits of methane in air are 5% to 15%. Dispersed clouds may flashback along vapour trail. Exposed containers should be cooled and attendant personnel protected with water spray. Let the fire burn.

Methane is not stored on the site, it is however produced during processing. The methane gas will not be pressurised.

7.14.3 *Health Hazards*

Personnel entering areas of high concentration must wear personal protective equipment including self-contained breathing apparatus. Symptoms following exposure may include asphyxiation if exposed to high concentrations. Methane is an asphyxiant, the limiting factor is the availability of oxygen.

7.14.4 *Toxic Exposure Hazard Summary*

If personnel are exposed to methane gas, call for medical aid. The gas is not irritating to eyes, nose or throat but if inhaled will cause dizziness, difficult breathing, and loss of consciousness. Move affected personnel to fresh air; if breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen.

7.14.5 *Water Pollution Hazard*

Methane is not harmful to aquatic life.

Table 7.14a Physical and Chemical Properties of Methane

Property	
Physical State at 15°C and 1 atm	: Gas
Molecular Weight	16.04
Boiling Point (1 atm)	−258.7°F = −161.5°C = 111.7K
Freezing Point	−296.5°F = −182.5°C = 90.7K
Critical Temperature	−116.5°F = −82.5°C = 190.7K
Critical Pressure	668 psia = 45.44 atm = 4.60 MN/m^2
Specific Gravity	0.422 at −160°C (liquid)
Liquid Surface Tension	14 dynes/cm = 0.014 N/m at −161°C
Liquid Water Interfacial Tension	(est.) 50 dynes/cm = 0.050 N/m at −161°C
Vapour (Gas) Specific Gravity	0.55
Ratio of Specific Heats of Vapour (Gas)	1.306
Latent Heat of Vaporization	219.4 Btu/lb = 121.9 cal/g = 5.10 X 10^5 J/kg
Heat of Combustion	−21,517 Btu/lb = −11,954 cal/g = −500.2 X 10^5 J/kg
Heat of Fusion	13.96 cal/g
Reid Vapour Pressure	Very high

7.15 REFERENCES

[1] Draft Report on Proposal for Storage of Dangerous Goods, San Miguel Brewery Yuen Long, November 1995, Ove Arup.

8 OTHER ISSUES

This section presents the assessments of the following categories of environmental impacts anticipated during the construction and operation of the new San Miguel Brewery at the Yuen Long Industrial Estate:

- Transport and Traffic; and
- Visual, Fung Shui and Ecological Aspect.

Socioeconomic benefits of the development centre on the employment provided at the plant and are not addressed further.

8.1 TRANSPORT AND TRAFFIC

8.1.1 Introduction

The construction and operation of the Sam Miguel Brewery will result in the generation and attraction of increased traffic flows on the roads within the Yuen Long Industrial Estate. The main roads in the industrial estate to be affected by this increase in traffic have been assumed to be Wang Lee and Fuk Hai Streets, as these are the most logical roads to use to gain access to the proposed San Miguel Brewery site.

Currently, the area in the immediate vicinity of the proposed brewery site in the Yuen Long Industrial Estate is used by approximately 10 firms, each of which has a site area which is generally smaller than that for the proposed San Miguel Brewery. As the roads within the Yuen Long Industrial Estate are used primarily by the member firms, it has been assumed that normal daily traffic will consist primarily of truck traffic (supplies/haulage) and employee vehicles. A short traffic survey taken during off-peak hours (approximately 15:00) has indicated that off-peak traffic flows are generally negligible, less than 1 vehicle per minute.

8.1.2 Assessment of Impact

Construction

During the construction phase there is the potential for traffic impacts from two main traffic sources; these are:

- normal construction office; and
- oversize loads carrying materials to the brewery.

Normal construction traffic, if not properly regulated, can lead to the creation of gridlock by jamming junctions and access points on or near the site. Peak hour construction traffic flows have been projected to range between 12 and 18 vehicles. As this number is quite small and the roads of adequate design and capacity (dual-lane, dual-direction), it is noted that

even if all vehicles entered and left the site at the same time, there would be little concern for the creation of gridlock or problematic traffic conditions. As a result, normal construction traffic associated with the proposed San Miguel Brewery is not anticipated to create significant impact upon the traffic patterns in the Yuen Long Industrial Estate.

The transport of over-sized equipment onto the Yuen Long Industrial Estate will force road closures and therefore have the potential to serious disrupt traffic flow if not well orchestrated. As a result, it is recommended that the *Royal Hong Kong Police Force* (RHKPF) be notified of the need for road closure and the routing of the over-sized load so that the transport process can be expedited with minimum of disruption to the Yuen Long Industrial Estate traffic flow. In addition, the over-sized loads should be moved preferably during evening (1900-2300) or night-time (2300-0700) hours so as to minimise disruption on local roads in and around the Yuen Long Industrial Estate.

Operation

During the operational phase of the Brewery there is the potential for traffic impacts from two main traffic sources; these are:

- normal employee traffic for the facility; and
- daily truck (supplies/haulage) traffic.

The peak hour for normal employee traffic will be 0800 and 1700 hours, opening and closing times respectively. Considering the parking accommodations (approximately 40 spaces in the carpark) and truck movements, it has been estimated that 50 vehicles, in the worst-case, would be generated by the facility during the peak hour. As the average flow during the peak hour is less than 1 vehicle per minute, it is unlikely that traffic congestion problems would arise by the addition of this traffic to the existing flows. This conclusion is supported by the observation that most of the other firms in the estate have less parking available than the San Miguel Brewery and so would not contribute as many vehicles. On average, considering 20 additional firms in the immediate vicinity of the San Miguel Brewery in the year 2011 (in the industrial estate), it could be concluded that the peak hour flow would contribute 20 vehicles per minute to the local roads.

The projected daily truck traffic flows are also small. As shown in *Table 8.1a*, below, the daily flows for 1997 (opening year) and 2011, excluding employee traffic, are 103 vehicles and 201 vehicles, respectively. It should be noted that in extrapolating 2011 flows from those for 1997, and that in extrapolating 1997 flows from 1994, a 5% annual traffic flow increase has been assumed. This traffic flow increase has in turn been based on a 7% annual increase in beer production.

Table 8.1a *Daily Estimated Vehicle Flow for San Miguel Brewery*

Type of Vehicle	1994	1997	2011
Finished Goods			
Route Truck	15	18	34
Haulage Truck	25	28	57
Wholesaler	13	15	30
Container for Export	4	5	9
Raw Materials			
Containers for Malt/Hops	10	12	23
Can Supplier	13	15	30
Miscellaneous	4	5	9
Other			
Spent Grain	4	5	9
Visitor/Staff	30	35	35
Total	**118**	**138**	**236**
Total (w/out staff)	**88**	**103**	**201**

These flows indicate, assuming a 12 hour day, that even in the worst-case instance (the year 2011), the proposed San Miguel Brewery would add an additional 20 trucks per hour (average 1 vehicle every 3 minutes) to the local roads. As a result, even if these flows are combined with normal employee traffic flow (average 1 vehicle every 45 seconds), it is unlikely that traffic congestion problems would arise.

8.1.3 Conclusions and Recommendations

The assessment above has indicated that the expected traffic flows from the construction and operation of the proposed San Miguel Brewery should not lead to significant impacts to the flow of traffic on the roads within the Yuen Long Industrial Estate. The sole exception to this conclusion is for the transport of over-sized loads during the construction stage for which road closures will be necessary; however, if special consideration is given to this operation (RHKPF being notified and operation carried out during evening or night-time hours), the projected impact to the road system should be insignificant.

8.2 *VISUAL/FUNG SHUI AND ECOLOGICAL ASPECT*

The proposed site for the new brewery within the Yuen Long Industrial Estate is currently vacant, overgrown with grass species widely found in waste/abandoned land in Hong Kong. Such disturbed grass land habitat does not have high ecological value and therefore minimal ecological impacts are expected from its removal during the development.

The site is situated roughly in the centre of the northern part of the industrial estate surrounded by existing installations such as petrochemical plant, paper manufacturing plant and other manufacturing buildings. Three densely vegetated mounts are located to the south, west and north of this part of the estate.

The new brewery will comprise the following main components:

- a process building;
- a warehouse/packaging building;
- an administration and reception centre; and
- waste water treatment/dangerous goods/empty crane areas.

The heights of the above structures will be in the same order as the existing structures in the industrial estate.

Due to the flat topography of the adjacent area, the existing buildings/structures and mounts surrounding the site will effectively screen the brewery from nearby low-rise villages, such as Ng Uk Tsuen, Tai Tseng Wai and Funk Hing Tsuen, therefore avoiding any visual/Fung Shui intrusion.

Although some residents of the northern most high-rise buildings in Long Ping Estate to the south will have a distant view of the brewery, it is considered that the brewery will blend in with the surrounding established industrial character and will not cause extra visual/Fung Shui intrusion.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 INTRODUCTION

In general the EIA has shown that environmental impacts of the proposed Brewery, as currently planned or at ultimate capacity, will not be significant and the new technology and design philosophy employed will represent a considerable improvement over current operations at Sham Tseng. This section summarises the impacts and recommended mitigation measures.

9.2 WATER QUALITY

9.2.1 *Construction Phase*

The construction of the new brewery is not envisaged to have any water quality impacts provided that proper site management and good housekeeping practices are implemented.

9.2.2 *Operational Phase*

The operation of the Brewery will generate a large volume of effluent, in the region of 1120 to 1360 m^3 per day (1680 to 2000 m^3 per day for Phase 2). Consultation with the Drainage Services Department (DSD) and the Hong Kong Industrial Estate Corporation confirmed that there is adequate sewerage infrastructure to accept the effluent load from both Phase 1 and 2 of the new Brewery. However, DSD recommended that buffer tanks should be used to regulate peak flow conditions so as to prevent overloading of the sewerage system. SMHK's on-site biological wastewater treatment plant will be equipped with a buffer tank that will be used for this purpose.

The proposed brewery has been designed to function at a very low water consumption to beer ratio. A water conservation and recycling programme will further reduce overall water consumption.

Effluent from the brewery plant will be treated to well below the required discharge limit, as stipulated in the *Technical Memorandum on Effluents Standards* (TM), at an on-site biological wastewater treatment plant where high levels of suspended solids, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are to be treated. Special operational considerations during the operational phase have been recommended including the implementation of a water conservation programme to reduce water consumption and wastewater generation.

A water quality monitoring programme will be required as a check on the performance of the plant, particularly in the early months of operation, and to ensure compliance with the discharge standards.

9.3 AIR QUALITY

9.3.1 Construction Phase

The impacts arising from the construction activities are not expected to be extensive. The level of activities and size of works area are small in scale. In addition the air sensitive receivers (ASRs) are screened by topographic features (eg Chu Wong Ling) and structures. The predicted dust levels at these ASRs are much reduced by dilution and screening by structures and terrain. Dust impacts during construction in the surrounding area have been shown to be within acceptable levels.

9.3.2 Operational Phase

The impact from various operation activities differ in extent. The major source of aerial emission is from the boiler chimney. The predicted cumulative NO_2 and SO_2 concentrations at ASRs are within the respective *Air Quality Objectives* when the San Miguel Brewery development is included. Biogas produced as a by-product from the on-site biological wastewater treatment plant will be utilised beneficially as a supplementary fuel for the boiler. This will reduce the light diesel oil consumption and the pollutant emissions from the boilers. Minor emissions from the flaring of biogas at the wastewater treatment plant may occur occasionally.

Odour nuisance has been an environmental concern at the Sham Tseng Brewery and has been extensively investigated at the new plant. Odour impact from wastewater treatment is minimized by the selection of an anaerobic treatment method. The impact is further reduced since the equalisation tank, which is the major odour source, will be covered and that the removal of sludge from the wastewater treatment plant will be an enclosed operation.

The expected residual odour sources mainly arise from the spent materials. The predicted odour levels for spent yeast and spent grain disposal are within the EPD's criteria of 5 odour units at ASRs. Odour impacts are not expected to be significant based on this assessment. Residual impacts can be minimised by the proposed good housekeeping practices.

9.4 NOISE

9.4.1 Construction Phase

The noise assessment has indicated that it is unlikely that daytime construction (0700-1900) activities will be capable of generating significant impacts at nearby noise sensitive receivers (NSRs). As a result, no mitigation measures have been recommended for daytime construction activities. If it becomes necessary for SMHK to apply for construction activities to continue into restricted hours, however, exceedances have been predicted and mitigation measures would be necessary for the Contractor to be eligible for a *Construction Noise Permit.*

Recommended mitigation measures, including reduction in plant teams, use of noise barriers and use of on-site noise management have been shown to reduce these impacts at nearby NSRs. In addition, if construction activities are proposed for restricted hours, noise monitoring should be carried out at nearby NSRs .

9.4.2 *Operation Phase*

The noise assessment has indicated that unmitigated equipment operating within the brewing facility is unlikely to be capable of generating significant impacts at nearby NSRs. However, external plant (chillers, fans, etc) will be capable of generating significant impacts at NSRs when operated during night-time hours, unless sound power levels are below certain limits, which are based on the number of external plant in simultaneous operation and the frequency characteristics of these sources. If the rating of external plant is above this value, then appropriate silencing measures should be employed to reduce the sound power level to below this limit.

Road traffic will be capable of generating significant impacts at nearby NSRs if allowed to travel exclusively on Fuk Hai Street. As a result, it has been recommended that road traffic use Wang Lee Street rather than Fuk Hai Street. In addition, it is probable that equipment operating within the facility will breach the *Noise at Work* standards if left untreated. Hence it is recommended that equipment within the facility be analysed during the later design stages to specify appropriate mitigation. Areas of concern within the facility have been specified as follows:

- the bottling room;
- the canning room;
- the keg washing area;
- the compressor for ammonia; and
- the compressor for CO_2.

Monitoring

It is recommended that all rooms within the facility be monitored at commissioning and every 6 months thereafter to determine if machinery is in need of maintenance or additional silencing.

If Wang Lee Street rather than Fuk Hai Street is used for peak hour truck transport, no operational noise monitoring is recommended. However, if Fuk Hai Street is to be employed rather than Wang Lee Street, even for a restricted number of truck movements, then monitoring at the nearby NSRs is recommended.

9.5 *WASTE MANAGEMENT*

Solid wastes will be generated during the construction and operation phases of the facility. Biodegradable and inert fraction of the construction waste should be collected and disposed separately. The main types of waste generated during daily operation of the facility are waste oil, yeast, spent grain, glass/cans, filter aid and wet sludge from wastewater treatment process etc. Initially these wastes are to be reused and recycled as much as possible, and potential for further improvement will be reviewed on a regular basis. When disposal is unavoidable, transportation, handling and storage procedures should meet strict performance requirements to ensure that all waste is eventually disposed of in an environmentally acceptable manner.

No significant environmental impact is envisaged during both the construction and operation phases providing that proper waste management and good housekeeping practices, as recommended in the report, are implemented.

9.6 *HEALTH AND SAFETY*

The assessment has examined all the dangerous chemicals proposed to be stored and used on-site, and have recommended health and safety precautionary measures to be observed when working with the chemicals.

Only liquefied petroleum gas (LPG) is proposed to be stored in quantities that would constitute a notifiable gas installation. An application for construction approval from the *Gas Authority* is required. For the quantities of LPG planned the *Gas Authority* needs to accept that the site complies with the *Coordinating Committee on land use planning and control in the vicinity of Potentially Hazardous Installations' (CCPHI) Risk Guidelines.* In the unlikely event that demonstration of this is required, due to the relatively small quantities to be stored, it is expected that the site will comply in full with the regulations and that this could be demonstrated quite easily.

Due to the relatively small quantities of the other chemicals proposed to be stored on-site, any risks to life posed to off-site personnel are expected to be acceptable.

9.7 *TRANSPORT AND TRAFFIC*

The transport and traffic assessment has indicated that the expected traffic flows from the construction and operation of the proposed San Miguel Brewery should not lead to significant impacts to the flow of traffic on the roads within the Yuen Long Industrial Estate. The sole exception to this conclusion is for the transport of over-sized loads during the construction stage for which road closures will be necessary; however, if special consideration is given to this operation (the police being notified and

operation carried out during evening or night-time hours), the projected impact to the road system should be insignificant.

9.8 *VISUAL, FUNG SHUI AND ECOLOGY*

The new brewery development on the currently vacant site overgrown with common grass species is expected to have minimal ecological impact. There will be no visual/Fung Shui intrusion to the nearby low-rise villages as the existing buildings/structures in the industrial estate and the hill mounts surrounding the site provide effective visual screening. The view of the brewery from distant high-rise residential blocks will blend in with the existing industrial character surrounding the site and additional visual intrusion is not expected.

9.9 *OVERALL CONCLUSIONS*

It is concluded that with implementation of the proposed mitigation measures, environmental impacts from the construction and operation of the proposed new San Miguel Brewery in Yuen Long will not be significant. Considerable effort has been made by the environmental and design teams to further minimize residual environmental impacts and reduce overall water and energy requirements during the detailed design process. In environmental terms the new Brewery will provide significant benefits.

Annex A

Study Brief

Yuen Long Industrial Estate

Environmental Impact Assessment (EIA) for San Migual Brewery

Study Brief

1 Introduction

The purpose of this Environmental Impact Assessment (EIA) Study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the proposed project and all related activities taking place concurrently. This information will contribute to decisions on :

i) the overall acceptability of any adverse environmental consequences that are likely to arise as a result of the proposed project;

ii) the conditions and requirements for the detailed design, construction and operation, of the proposed project;

iii) the acceptability of residual impacts after the proposed mitigation measures are implemented

2. Objectives of the Environmental Impact Assessment Study

The objectives of the assessment are as follows :

i) to describe the proposed project and associated works together with the requirements for carrying out the proposed project;

ii) to identify and describe the elements of the community and environment likely to affect/be affected by the proposed project;

iii) to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

iv) to propose the provision of infrastructure or mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of the project;

v) to identify, predict and evaluate the residual (i.e. after practicable mitigation) environmental impacts and cumulative effects expected to arise during the construction and operation phases of the project in relation to the sensitive receivers and potential affected uses;

vi) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the project which are necessary to mitigate these impacts and reduce them to acceptable levels;

vii) to design and specify the environmental monitoring and audit requirements necessary to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted;

viii) to investigate the extent of side-effects of proposed mitigation measures that may lead to other forms of impacts;

ix) to identify constraints associated with the mitigation measures recommended in the study; and

x) to identify any additional studies necessary to fulfil the objectives to the requirements of this Environmental Impact Assessment Study.

3. Requirements of the Environmental Impact Assessment Study

The proponent shall meet the objectives listed in section 2 above by:

i) carrying out the necessary background studies to identify, collect and analyze existing information relevant to the EIA study;

ii) carrying out any necessary environmental survey, site investigations and baseline monitoring work to achieve the objectives;

iii) quantifying, by use of models or other predictive methods, the residual and cumulative environmental impacts (specifying whether these are transient, long term and/or irreversible) arising from the construction and operation of the project;

iv) proposing practicable, effective and enforceable methods, measures and standards to effectively mitigate any significant environmental impacts in the short and long term; and

v) outlining a programme by which the environmental impacts of the project can be assessed, monitored and audited.

4. Technical Requirements of the Environmental Assessment Study

The Proponent shall consider all aspects of the activities arising from the proposed project in any stage/phase of implementation, and, observe the following guidelines in addition to the Hong Kong Planning Standards and Guidelines as well as other statutory requirements during the EIA Study.

4.1 Air quality Impact

The air quality impact assessment shall address the following:

i) provision of an emission inventory of the air pollution sources;

ii) analysis of all aerial emissions its related air quality impact and characterization;

iv) proposals of effective mitigation measures to reduce the cumulative air pollution impacts to acceptable levels.

In case of odour impact, any odour prediction at a receptor exceeding five odour units based on a prediction averaging time of five seconds shall be considered as an indication of odour nuisance to the receptor. For odour monitoring, two odour units at the site boundary shall be the criteria for odour nuisance.

4.2 Water Quality Impact

The water quality impact assessment shall address the following :-

i) analysis of activities related to the use of water;

ii) provision of an emission inventory of the water pollution sources;

iii) analysis of the generation of wastewater;

iv) assessment of the adequacy of sewerage infrastructure;

v) evaluation of impacts and proposals for water pollution control measures (including detailed information on treatment facilities and process).

4.3 **Sludge Generation**

The water content of the sludge by weight should be identified. It should meet with the acceptance criteria at strategic landfills. Alternative options to reduce or recycle the wet waste should be considered.

4.4 **Solid Waste Pollution**

If sufficient information on Chemical Wastes and Asbestos Wastes are not provided as requested in our letter dated 12.7.94, then a solid waste assessment might be required. The solid waste assessment, if required, shall focus on :-

i) identification of the sources of solid waste with details of the waste generation, waste characterization and waste separation;

ii) investigation on any secondary impacts such as, odour, gas emission, noxious leachate;

iii) evaluation of the proposed waste management strategy, and, waste handling, treatment and disposal methods; and

iv) incorporation of waste reduction/reuse/recycling by any practical means.

If chemical wastes are present, the project proponent is required to follow the "Code of Practice on the Packaging and storage of Chemical Wastes" for direction and guidelines.

4.5 **Environmental Monitoring and Audit (EM&A) Requirements**

i) Environmental Monitoring

The Consultants shall identify and recommend environmental monitoring requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to the identification of sensitive receivers, monitoring locations, monitoring parameters and frequencies, monitoring equipment to be used, and any other necessary programmes for baseline monitoring, impact and compliance monitoring, and data management of monitoring results.

ii) Environmental Audit

The Consultants shall identify and recommend environmental audit requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to:

a. organisation and management structure, and procedures for auditing of the implementation of respective environmental mitigation measures recommended for the detailed design, contract document preparation, construction, post-project operation stages of the development;

b. environmental quality performance limits for compliance auditing for each of the recommended monitoring parameters to ensure compliance with relevant environmental quality objectives, statutory or planning standards, or acceptance criteria recommended by the EIA. These limits shall give indication of a deteriorating environmental quality and shall allow proactive responses to be taken. (The commonly used approach is a set of trigger, action and target levels);

c. organisation and management structure, and procedures for reviewing the monitoring results and auditing the compliance of the monitoring data with the environmental quality performance limits (point (b) above), project contractual and regulatory requirements, and environmental policies and standards;

d. Event/Action plans for impact and compliance monitoring;

e. complaints handling, liaison and consultation procedures; and

f. reporting procedures, report formats and reporting frequency including periodical reports and annual reviews to cover all construction and post-project/operational phases of the development.

iii) The Consultants shall prepare an Environmental Schedule (Manual) which covers the requirements and recommendations in (1) and (2) above. The Manual shall also contain a summary list of recommended environmental mitigation measures. This Manual shall be used as a guideline for environmental monitoring and audit during the construction and post-project operational phases. This Manual shall be a stand-alone document and form part of the EIA report.

5. Compliance with Environmental Law

5.1 An EIA Study is a tool to identify potential environmental impacts arising from the proposed project and to provide a basis for decisions for the implementation of the project, but it does not automatically exempt the proposal from licensing requirements and the approvals from relevant authorities.

5.2 The Proponent shall comply with and observe all Ordinances, bye-laws, regulations and rules for the time being in force in Hong Kong governing the control of any form of pollution for environmental protection.

6. Liaison and Administration

6.1 The Proponent shall liaise with relevant Government departments and agencies, and all other parties involved in this and any other projects or developments likely to be affected by this development. Any correspondence, notes or minutes arising from this liaison shall be copied to the Director of Environmental Protection.

6.2 A Study Management Group (SMG) comprises representatives of EPD and relevant Government Departments together with the project proponent and his consultants, may be established by EPD to oversee the EIA study.

6.3 The proponent is strongly encouraged to allow public access to the EIA conducted. Subject to the agreement of the proponent, the project would be included in the long list to be submitted to Advisory Council on the Environment (ACE) EIA Sub-committee to see whether a presentation to the Council is required.

7. Report Requirements

7.1 The assessment shall consist of at least the following :-

i) a **Final Assessment Report** which

a) fully satisfies the requirements of this brief in respect to the prediction and assessment of impacts, the identification of environmental impact mitigation measures and the associated residual impacts;

b) describes the agreed schedules and programmes for monitoring and audit requirements;

c) prescribes the specification for detailed design, construction and operation requirements of the proposed project (in any case, the projected decommissioning scenario(s) should be addressed and outline the action(s) to restore and/or rehabilitate the site to an acceptable level prior to handing over to Government or any legal successor(s)); and

d) provides with the impacts summary, the study findings, conclusions, recommendations and a mechanism for implementation;

ii) an **Executive Summary** in both English and Chinese of the study, highlighting the issues of concern to the community, the acceptability of residual environmental impacts and cumulative effects, requirements for implementation of the project, and the basis for and implications of those requirements. It is intended that the information contained therein would assist the ACE, DB and other public consultation(s) (please see para 6.3);

iii) any revisions or supplements to the above as might be required by the Director of Environmental Protection.

7.2 The Proponent shall produce the following reports to the Director of Environmental Protection:

i) a draft Final Assessment Report
ii) a Final Assessment Report
iii) a draft Executive Summary Report
iv) an Executive Summary Report*
v) an Environmental Monitoring & Audit Manual

* in both Chinese and English versions.

The number of copies for each report will be advised in due course, depending on whether presentation to ACE is required, pelase see para 6.3.

7.3 The Proponent shall also supply the government with appropriate copies of such reports, technical notes, working papers, briefs, supporting documents and other relevant inputs as may be required during the EIA Study or any public consultation exercise.

7.4 The following environmental - friendly measures in preparing the documents as required in para 7.2 should be adopted :-

a) All Tender Documents, Tender Submission, Reports, Technical Notes and Working Papers are to be printed on both sides.

b) Final Reports and the Executive Summary have to be printed on recycled paper. The use of recycled paper with not less than 50% recycled materials and not exceeding 80 gsm should be used as a general rule. The logo of recycled paper should be printed in prominent area of the report.

c) Documents other than Final Reports and Executive Summary should not be excessively bleached.

d) Excessive use of plastic laminates, glossy covers or double covers should be avoided as far as possible. Use of recyclable non-glossy art board paper as document covers should be encouraged.

e) Final Reports and Executive Summary should be of single line spacing on the both sides of the paper.

f) Excessive white space around the borders and in between the paragraphs of all documents prepared by the consultants should be avoided.

g) Excessive use of blank papers should be avoided as far as possible.

h) Page numbers can be reduced by reducing the size of typeface (font). For example, "Time Roman" or "C.G. Times" font size not exceeding 10 characters per inch (cpi) or equivalent to point 12 should be used in balancing legibility and clarity against our waste reduction objective

7.5 The final Environmental Impact Assessment (EIA) reports and the Executive Summary should normally be made available to the public and should be prepared with this in mind. It is Government's policy to release Government-owned EIA reports to the public and proponents of private projects are strongly encouraged to follow the same approach. For details, refer to Appendix D of the EPD Advice Note 2/92.

Regional Assessment Group
Environmental Protection Department
July 1994

I.D. NO. SANMIGUE

Annex B

Biological Wastewater Treatment Process

A number of biological wastewater treatment plants are designed to reduce BOD, COD and suspended solids levels. A brief description of these processes are given below:

- Anaerobic Digestion - anaerobic digestion involves the decomposition of organic and inorganic matter in the absence of molecular oxygen. In an anaerobic digestion process, the organic material in mixtures of primary settled and biological sludges under anaerobic conditions is biologically converted to methane and carbon dioxide. The process is carried out in an airtight reactor. Sludges are introduced continuously or intermittently and retained in the reactor for varying period of time. An example of an anaerobic digestion is an Upflow Anaerobic Sludge Blanket (UASB).

- Activated Sludge - Organic waste is introduced in a reactor where an aerobic bacteria culture is maintained in suspension. In the reactor the bacterial culture breakdown the organic matters into carbon dioxide. The aerobic environment in the reactor is achieved by the use of diffused or mechanical aeration which also serves to maintain the mixed liquor in a completely mixed regime.

  Activated sludge is the most widely used biological waste treatment. There are many reference plants including several municipal wastewater treatment works in Hong Kong where operating characteristics are well documented and readily available. This process is very versatile and can be adopted to almost any type of organic wastewater treatment problem. However, several operating conditions should be closely monitored when adopting activated sludge process in treating high organic loading wastewater including maintaining dissolved oxygen levels in the aeration tanks; regulating the amount of return activated sludge; and controlling and disposing large amount of return activated sludge produced. Some of the operational problems currently encountered in activated process also need to be taken into considerations such as sludge rising, bulking, and foaming.

- Activated Sludge with Oxygen - The use of pure oxygen as a substitute for air in the activated sludge process has grown in popularity. For this application, the aeration tanks are covered and the oxygen that is in the aeration tank is recirculated. The amount of oxygen will be four times the amount of oxygen that could normally be put in with air. This technology allows the achievement of higher loading rates and smaller reactor volume. Sludge settleability can also be improved. However, operation cost will certainly be higher as pure oxygen is required for aeration. The use of pure oxygen is particularly applicable where there is only limited space available for a treatment plant; wide fluctuations in the organic loading; and strong municipal or industrial wastewaters are to be treated.

- Biofilters - biofilters consist of a bed of highly permeable media, usually of rocks or plastics media to which microorganisms are attached and through which wastewater is percolated. The organic material present in the wastewater is degraded by a population of microorganisms attached to the filter media. Organic material from the liquid is adsorbed onto the biological film or slime layer. In the outer portions of the biological slime layer, the organic material is degraded by aerobic microorganisms.

The process has been widely used for treating brewery wastewater and is a stable and easily operated process. Since odour may be generated, reactor should before be covered and odour washing technology are usually required.