



BHANJA CHEUNG & CO.

for

Excel Engineering & Technology
(International) Limited

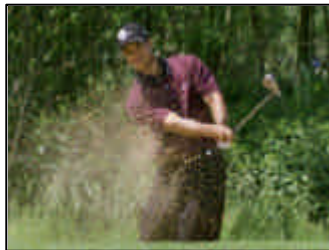
in association with

Urbis Limited

Philip So & Associates Limited

Prudent Design Limited

Development of SkyCity Golf Course



Soil Sampling Plan

Soil Sampling and Monitoring Plan
31 December 2005

**Airport
Management
Services
Limited**

1. INTRODUCTION

1.1.1 Environmental Permit (EP) No. 229/2005 dated 17 October 2005 was granted for the SkyCity Golf Course. EP Condition 2.11 reads :

The Permit Holder shall conduct a regular soil sampling and testing before operation, during operation and before expiry of operation of the Project to confirm and verify that there is no land contamination caused as a result of the operation of the golf course. The Permit Holder shall deposit the following submissions to the Director:

- (i) *A soil sampling and monitoring plan no later than two weeks before commencement of construction of the Project to include details of sampling plan, parameters to be analysed, necessary remedial measures and reporting requirements;*
- (ii) *A baseline monitoring report no later than two weeks before operation of the Project to confirm the baseline condition of the soil;*
- (iii) *A soil contamination assessment report no later than four weeks after expiry of operation of the Project to include all soil monitoring and testing results and interpretations and if any remedial measures are required.*

1.1.2 The project will be managed by Airport Management Services Limited (AMS) who will employ a Works Contractor to carry out the construction and also an Operator to oversee operation of the facility. An Environmental Team (ET), who are part of AMS, will be responsible for implementing the EM&A programme.

1.1.3 According to the current programme prepared by AMS, commencement of construction (as defined in the EP) will not commence until mid-January 2006, and commencement of operation is not scheduled until October 2006.

1.1.4 This soil sampling and monitoring plan is submitted, pursuant to EP Condition 2.11 (i), two weeks before commencement of construction. The conclusions and recommendations of this plan have been incorporated into the EM&A Manual for SkyCity Golf Course, which itself has also been submitted at this time, pursuant to EP Condition No. 2.6. With reference to EP Condition 2.11(ii), soil sampling need not be carried out until October 2006 (i.e. prior to the operation of the Golf Course).

2. SOIL CONTAMINATION ISSUES

2.1.1 Based upon an examination of EPD's guidance on land contamination ("*Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops*" and ProPECC PN3/94 "*Contaminated Land Assessment and Remediation*"), the landuses that could give rise to contamination include :

- Oil Installations
- Gasworks
- Power Plants
- Shipyards/Boatyards
- Chemical Manufacturing/Processing Plants
- Steel Mills/Metal Workshops
- Car Repair/Dismantling Workshops

2.1.2 SkyCity Golf Course is located on land that was reclaimed using clean fill during the formation of the Airport Platform in the early 1990s. Subsequently, it was used as a site for accommodating workers during airport construction. None of the activities listed above have ever occurred on this site and so there is no reason to suspect that the site has been contaminated by previous uses.

2.1.3 In accordance with EP Condition 2.11, the purpose of soil sampling relates to the potential for chemicals used in the operation of the Golf Course to cause soil contamination.

- 2.1.4 The only chemicals that will be used during the operation of the Golf Course are those contained in organic nutrients, predominantly nitrates, phosphates and potassium. Although these nutrients will be applied on fairways, greens and tees, the sub-soil drainage system will ensure that all runoff drains into the artificial lake.
- 2.1.5 There are currently no enforceable standards in Hong Kong for land contamination. In *ProPECC PN3/94*, the Dutch Ministry of Public Housing, Land-Use and Environment Guidelines (the Dutch Guidelines) are used as reference criteria by the EPD. In the Netherlands, these guidelines were developed for the specific case where the drinking water supply is sourced entirely from groundwater. Hence, the Dutch Standards are very strict in regard to some specific contaminants and are not necessarily appropriate for all situations in Hong Kong.
- 2.1.6 Nevertheless, it is considered prudent to review the parameters listed in EPD's guidance on land contamination to confirm the applicability, or otherwise, of each parameter for this soil sampling programme. Tables 2.1 and 2.2 summarise this review :

Table 2.1 : Applicability of Soil Testing Parameters Listed in Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/ Dismantling Workshops

Materials	Possible Source	Applicable ?
1. Fuels	Petroleum storage, LPG storage	Yes – only at on-site plant / equipment maintenance facility
2. Lubricating oils, hydraulic fluids	Spillage, maintenance and dismantling of equipment, scrapped tanks and pipeworks, vehicle maintenance	Yes – only at on-site plant / equipment maintenance facility
3. Cleaning solvents	Engine room and equipment maintenance	No
4. Used chemical solutions	Engine coolant, battery fluid	No
5. Acids	Treating steel plate to remove millscale	No
6. Asbestos	Application and removal of engine room insulation	No
7. Transformer oil (PCB)	Scrapped electrical equipment	No
8. Anti-corrosive paints, thinners	Application of anti-corrosive coatings	No
9. Coal, ash, oily tank and bilge sludge	Boiler room/engine room maintenance, tank cleaning	No
10. Finely divided metal wastes	Grinding and milling operations, especially welding joints	No
11. Electrical wiring	Electrical installation, maintenance, scrapped electrical equipment	No
12. Low -level radioactive waste	Scrapped instruments	No
13. Wood preservatives	Timber treatment	No
14. Polyurethane foam	Hull manufacture/ maintenance	No

Source : “Annex B : Checklist Of Possible Contaminants”, Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/ Dismantling Workshops, EPD

Table 2.2 : Applicability of Soil Testing Parameters Listed in ProPECC PN3/94

Component	Soil (mg/kg dry soil)			Applicability		
	A	B	C			
1. Metals						
Cr	100	250	800	It is not anticipated that any activities that could result in contamination by metals will occur during Golf Course operation		
Co	20	50	300			
Ni	50	100	500			
Cu	50	100	500			
Zn	200	500	3000			
As	20	30	50			
Mo	10	40	200			
Cd	1	5	20			
Sn	20	50	300			
Ba	200	400	2000			
Hg	0.5	2	10			
Pb	50	150	600			
2. Inorganics						
NH ₄ (as N)	—	—	—	It is not anticipated that any activities that could result in contamination by inorganics will occur during Golf Course operation (no inorganic fertilisers will be used, only organic nutrients)		
F (total)	200	400	2000			
CN	(tot.free) (tot.comb.)	1 5	10 50			
S (total)	2	20	200			
Br (total)	20	50	300			
PO ₄ (as P)	—	—	—			
3. Aromatics Compounds						
Benzene	0.01	0.5	5	It is not anticipated that any activities that could result in contamination by aromatic compounds, polycyclic hydrocarbons or chlorinated hydrocarbons will occur during Golf Course operation		
Ethylbenzene	0.05	5	50			
Toluene	0.05	3	30			
Xylenes	0.05	5	50			
Phenols	0.02	1	10			
Total	0.1	7	70			
4. Polycyclic Hydrocarbons						
Naphthalene	0.1	5	50		It is not anticipated that any activities that could result in contamination by aromatic compounds, polycyclic hydrocarbons or chlorinated hydrocarbons will occur during Golf Course operation	
Anthracene	0.1	10	100			
Fenanthrene	0.1	10	100			
Flouranthene	0.1	10	100			
Pyrene	0.1	10	100			
1,2-benzopyrene	0.05	1	10			
Total	1	20	200			
5. Chlorinated Hydrocarbons						
Aliphatics	(Individual)	0.1	5	50	Although artificial chemical pesticides will not be used, confirmatory testing for "total pesticides" may be worthwhile	
	(Total)	0.1	7	70		
Chlorobenzenes	(Individual)	0.05	1	10		
	(Total)	0.05	2	20		
Chlorophenols	(Individual)	0.01	0.5	5		
	(Total)	0.01	1	10		
Chlor. PAHs (Tot.)	0.05	1	10			
PCB's (Tot.)	0.05	1	10			
EOCL (Tot.)	0.1	8	80			
6. Pesticides						
Chlorinated organics	(Individual)	0.1	0.5	5		Although artificial chemical pesticides will not be used, confirmatory testing for "total pesticides" may be worthwhile
	(Total)	0.1	1	10		
Pesticides	(Total)	0.1	2	20		
7. Other Pollutants						
Tetrahydrofuran	0.1	4	40	As there will be an on-site maintenance facility for plant/equipment and a car park, confirmatory testing for "total petroleum hydrocarbons" may be worthwhile		
Pyridine	0.1	2	20			
Tetrahydrothiophene	0.1	5	50			
Cyclohexanes	0.1	6	60			
Styrene	0.1	5	50			
Gasoline	20	100	800			
Mineral oil	100	1000	5000			

Source : Appendix IV : Soil and Groundwater Criteria used in the Netherlands for Contaminated Land (the "Dutch List"), ProPECC PN3/94 "Contaminated Land Assessment and Remediation" EPD

3. SAMPLING PARAMETERS AND FREQUENCY

3.1.1 Based on the review of applicability of parameters for soil sampling in Tables 2.1 and 2.2, the following are parameters are recommended for sampling :

- Total Pesticides
- Total Petroleum Hydrocarbons

3.1.2 It should be noted that nitrate, phosphorous and potassium will be applied to the Golf Course (in their organic forms) as these are components of the organic nutrients that will be used. However, as nitrate, phosphorous and potassium are not specified on the "Dutch List", these are not considered to be contaminants and therefore will not be sampled as part of the soil sampling plan.

3.1.3 All samples shall be analysed in a HOKLAS accredited laboratory using an approved determination method, with full QA/QC support.

3.1.4 Permit Conditions require regular soil sampling and testing before operation, during operation and before expiry of operation to confirm and verify that there is no land contamination caused as a result of the operation of the golf course.

3.1.5 To meet these requirements, the following sampling frequencies are proposed :

- Before beginning of operation (and before lakes are lined/filled)
- The mid-point of operation (sometime in 2009)
- After the end of operation (after lakes are emptied and liners removed)

4. SAMPLING LOCATIONS

4.1.1 *ProPECC PN3/94* recommends that soil samples should be taken on a regular grid pattern in line with most international practices and that additional samples should be taken in areas which are identified as potential "hot spots". However, since there are no potential "hot spots" within the site, regular grid sampling is appropriate.

4.1.2 For grid sampling, the intention is to locate an area of soil contamination which occupies 10% of a site with a 95% confidence limit – this is in accordance with Appendix II of *ProPECC PN3/94*. Table 4.1, below, shows the example grid sizes provided in paragraph (I)(a) of Appendix II of *ProPECC PN3/94* and extrapolates these for large site areas :

Table 4.1 : Grid Sizes for Site Areas

Size of Site (ha)	Grid Size (m)
1*	18
3*	31
9*	56
12**	73
16**	92
20**	111

Notes : * From paragraph (I)(a) of Appendix II, *ProPECC PN3/94 "Contaminated Land Assessment and Remediation"* EPD

** Rounded figures extrapolated from paragraph (I)(a) of Appendix II, *ProPECC PN3/94*

4.1.3 Based on Table 4.1, the closest size of site to the 11.56ha Golf Course is 12ha, with a corresponding grid size of 73m. It is therefore proposed, in accordance with the examples given in Appendix II of *ProPECC PN3/94*, that a grid size of 73m is adopted for soil sampling. Figure 4.1 and Table 4.2 provide details of the proposed sampling locations :

Figure 4.1 : Location of Soil Sampling Points

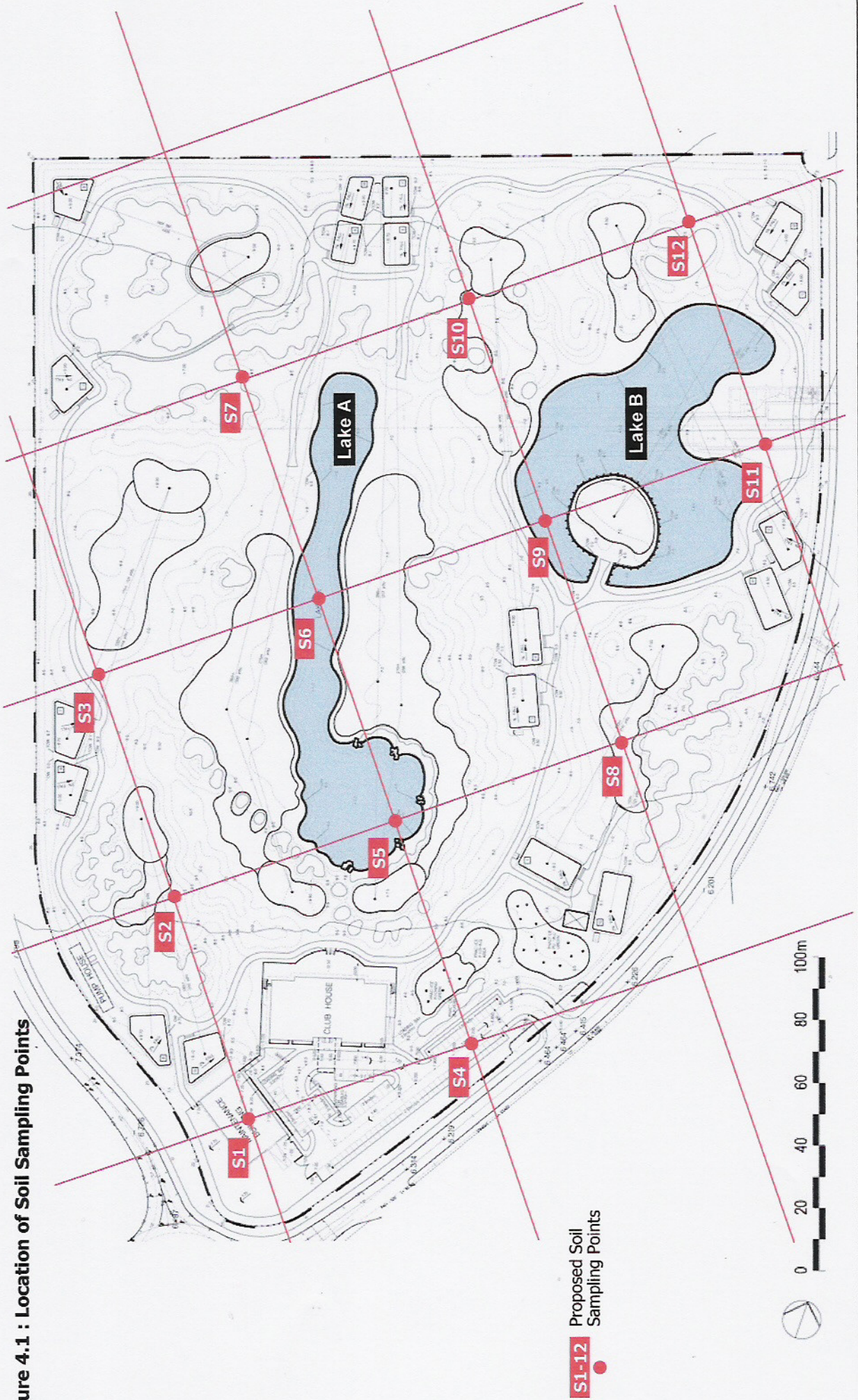


Table 4.2 : Description of Sampling Points

Sampling Point	Location	Parameter		Frequency		
		Total Pesticides	Total Petroleum Hydrocarbons	Before Beginning of Operation	Mid-point of Operation	After End of Operation
S1	Maintenance Facility		✓	✓		✓
S2	Fairway	✓		✓	✓	✓
S3	Fairway	((((
S4	Car Park		(((
S5	Lake A	(((
S6	Lake A	(((
S7	Rough	((((
S8	Green	((((
S9	Lake B	(((
S10	Green	((((
S11	Rough	((((
S12	Rough	((((

Sampling for Total Pesticides

- 4.1.4 Pesticide contamination will be tested for only in those areas that form the Golf Course itself (i.e. greens, fairways and rough). There will be no possibility of pesticide application in the maintenance facility or car park during the operation of the Golf Course.
- 4.1.5 Within the golf course, any pesticides will be carried in the irrigation water, which by design will not penetrate below the sub-soil surface drainage layer. As such, there will be no presence of these contaminants below the sub-surface drain. All water will flow into the two artificial lakes, which will be provided with an impermeable liner to retain water. Any potentially contaminated sediments would gravitate towards the lowest part of the lakes.
- 4.1.6 It is proposed to sample for pesticide contamination at only at one depth. To avoid damage to the compacted sub-base of the sub-soil drainage layer, it is proposed that samples within the Golf Course area itself should be taken from within the 200-300mm deep sand layer that lies above the sub-base but below the turfgrass. To maintain consistency, it is proposed to sample at 200-300mm below hard surfacing and also at 200-300mm below the lake bed level.
- 4.1.7 In terms of frequency, as shown in Table 4.2, sampling for pesticide contamination will be carried out before the beginning of operations, at the mid-point and after the end of operations (except for those locations below the lakes for which mid-point sampling is not

possible for obvious reasons).

Sampling for Total Hydrocarbons

- 4.1.8 Hydrocarbon contamination will be tested for only in the maintenance and car park areas. There will be no possibility of pesticide application in those areas that form the Golf Course itself (i.e. greens, fairways and rough).
- 4.1.9 Petroleum hydrocarbons, if present, will only occur at the maintenance facility and car parking area. As these areas will be covered by hard surfacing (likely asphalt or bitumen) throughout the duration of the operation, there will be no opportunity for any hydrocarbon contamination to enter the soil beneath, which is effectively capped by the hard surfacing.
- 4.1.10 In accordance with the examples given in paragraph (I)(a) of Appendix II of *ProPECC PN3/94*, it is proposed to sample for hydrocarbon contamination at three depths so that the penetration profile of any contamination can be delineated. Depths of 0.5m, 1m and 1.5m are proposed.
- 4.1.11 In terms of frequency, as shown in Table 4.2, sampling for hydrocarbon contamination will be carried out before the beginning of operations and after the end of operations. It is not proposed to carry out mid-point sampling beneath maintenance and car park areas as this will require removal of the hard surfacing that is protecting the soil beneath from hydrocarbon contamination. The hydrocarbon content of any asphalt or bituminous hard surfacing material may also taint any samples that are taken, thereby rendering the test results meaningless. Furthermore, the need to sample at three depths (requiring boreholes/trial pits) would be too disruptive to the operation of the maintenance and car park areas.

5. REPORTING

- 5.1.1 All reporting shall be prepared by the ET and submitted to : EPD (EIAO Register Office and Local Control Office), Project Proponent (AMS), Works Contractor (during Construction Period only) and the Operator (during Operation Period only). Submissions (including the number of copies) may be made as a hardcopy and/or softcopy subject to the preference of, and as agreed beforehand with, each recipient. Distribution of softcopies as .pdf files by email is strongly recommended.

Pre-Operation Monitoring Report

- 5.1.2 A Pre-Operation Monitoring Report on soil contamination shall be prepared. The report shall be prepared and submitted within ten working days of completing the laying of the impermeable liner for the artificial lakes and shall include :
- Drawings showing locations of the pre-operation monitoring locations.
 - Monitoring results together with the following information :
 - monitoring methodology
 - equipment used and calibration details (from the testing laboratory)
 - parameters monitored
 - monitoring locations
 - monitoring date, time, frequency and duration
 - Details on influencing factors, including :
 - major activities, if any, being carried out on the site during the period
 - weather conditions during the period
 - other factors which might affect the results
 - Determination of existing ambient soil concentrations for each measured parameter at

each sampling location, with commentary as appropriate. No Action/Limit Levels, as such, are required for soil samples.

- 5.1.3 The Pre-Operation Monitoring Report shall form part of the Baseline Monitoring Report required under the EM&A programme.

Mid-Operation Monitoring Report

- 5.1.4 An Operational Monitoring Report on soil contamination shall be prepared at the mid-point of the operational period. The report shall include :

- Drawings showing locations of the mid-operation monitoring locations.
- Monitoring results together with the following information :
 - monitoring methodology
 - equipment used and calibration details (from the testing laboratory)
 - parameters monitored
 - monitoring locations (and depth)
 - monitoring date, time, frequency, and duration
- Determination of ambient soil concentrations for each measured parameter at each sampling location, with a discussion of any changes since the baseline sampling.
- Review of nutrient application rates to-date where mid-operation concentrations are greater than pre-operation concentrations.

- 5.1.5 The Mid-Operation Monitoring Report shall form part of one of the regular Compliance Monitoring Reports required under the EM&A programme.

Post-Operation Monitoring Report

- 5.1.6 A Post-operation Monitoring Report on soil contamination shall be prepared. The report shall be prepared and submitted after the removal of the impermeable liner for the artificial lakes and no later than two weeks prior to the handover of the project site to the subsequent user. The report shall include :

- Drawings showing locations of the monitoring locations.
- Monitoring results together with the following information :
 - monitoring methodology
 - equipment used and calibration details (from the testing laboratory)
 - parameters monitored
 - monitoring locations
 - monitoring date, time, frequency and duration
- Details on influencing factors, including :
 - major activities, if any, being carried out on the site during the period
 - weather conditions during the period
 - other factors which might affect the results
- A comparison of pre-operation, mid-operation and post-operation monitoring results and a review of the reasons for and the implications of any significant differences, including review of pollution sources and operating procedures.
- Comments, recommendations and conclusions.

- 5.1.7 The Post-Operation Monitoring Report shall form part of the Final Monitoring Report required under the EM&A programme.

6. REMEDIAL MEASURES

- 6.1.1 Should it be necessary to carry out remedial measures to reduce land contamination to an acceptable level, a separate Contamination Assessment Report (CAR) and Remediation Action Plan (RAP) shall be prepared in accordance with standard EPD guidance, and shall be agreed beforehand with EPD.
- 6.1.2 According to *ProPECC PN3/94*, a wide range of land remediation measures are adopted world-wide for the restoration of contaminated sites. These include :
- Recovery Trenches or Wells – often used for the removal of leaked oil
 - Soil Venting – commonly used for removal of volatile or semi-volatile organics
 - Biotreatment – a number of methods are available that degrade a wide range of organics
 - Immobilisation – mainly applicable to heavy metals
 - Excavation and Landfilling – convenient but should only be considered as a “last resort” and only when there is localised contamination and where the extent of contamination is small
- 6.1.3 According to *ProPECC PN3/94*, the selection of an appropriate remedial measure will depend on a number of factors, including :
- Nature of the contamination
 - Degree of the contamination
 - Who/which is the potential receiver
 - Time allowable
 - Treatment cost
 - Availability of local expertise for undertaking the treatment
- 6.1.4 The majority of these factors are unknown at this time and can only be determined when the results from the post-operation monitoring are available. Therefore, the appropriate remedial measure(s) will be recommended in the CAR and RAP in due course and will be agreed beforehand with EPD.