6 WATER QUALITY IMPACT

6.1 Introduction

Potential water quality impacts may arise during the construction of the proposed 132kV overhead pole line and underground cable from Po Lam Substation to Tui Min Hoi Substation as a result of trenching and filling activities for the underground cables and excavation for the overhead pole lines. Parts of the underground cables will be laid across the stream at Ho Chung which runs through the Ho Chung Valley in Sai Kung and discharges into Hebe Haven.

This section presents the detailed assessment of the key water quality impacts likely to arise from the construction of the 132kV overhead pole line and underground cable. The environmental acceptability of these potential water quality impacts is assessed, with a view to identifying appropriate mitigation measures to reduce any identified adverse impacts to acceptable levels, where needed. Thereafter, this section reports on the residual environmental acceptability of the construction impacts.

6.2 Environmental Legislation, Policies, Plans, Standards and Criteria

The major legislation to protect the water quality in Hong Kong is the *Water Pollution Control Ordinance (WPCO) (Cap. 358)* established in 1980. This regulation established water control zones (WCZs) in which objectives were set for the water quality. Ten WCZs covering the whole territory were declared under the Ordinance and its subsidiary legislation. Principal features of the WPCO and its subsidiary legislation are as follows:

- The Ordinance specifies prohibited discharges and deposits.

- This is reinforced by the Technical Memorandum to the WPCO which further provides standards for effluents discharged into drainage and sewerage systems, inland waters and coastal waters.

- The *Water Pollution Control (Amendment) Ordinance 1990* made various changes to the WPCO including the removal of the ‘ right to discharge’ certain pollutants taking place prior to the gazettal of a Water Pollution Control Zone.

- The specific legislation pertinent to water quality in the present case includes:

  Water Pollution Control Ordinance: Cap 358 (1980) – Originally 1980 with enactments up to 1994
  Water Pollution Control (General) Regulations: Cap 358 sub leg D – Originally 1986 with enactments up to 1994
  Water Pollution Control (Port Shelter Water Control Zone) Order 1989
  Water Pollution Control (Port Shelter Water Control Zone) (Appointed Days) Order 1989
  Technical Memorandum Standards for Effluents Discharged into Drainage and

Sewerage Systems, Inland and Coastal Waters: Caps sub leg AK – Originally Special Gazette Supplement No. 5 1990

Corresponding statements of the Water Quality Objectives (WQOs) were stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZ based on their beneficial uses. The proposed project site has the potential to deteriorate the water quality in the Ho Chung Sub-zone of Port Shelter WCZ which ultimately drains into Hebe Haven. Any discharges, run-off, or flows discharging to the marine environment are regulated under the Water Pollution Control (Port Shelter Water Control Zone) and the *Technical Memorandum on Standards for Effluents Discharged into Drains and Sewerage Systems, Inland and Coastal Waters*, issued under Section 21 of the WPCO.

Details of the WQOs statement for this water gathering ground sub-zone of Port Shelter WCZ are listed in Table 6.1.

Table 6.1 Water Quality Objectives for Ho Chung Sub-zone of Port Shelter WCZ

Parameters	Water Quality Objectives (WQOs)
pH	6.5 – 8.5
Suspended solids (SS)	Annual median ≤ 25 mg/L
Dissolved oxygen (DO)	≥ 4 mg/L
Chemical oxygen demand (COD)	≤ 30 mg/L
5-day biochemical oxygen demand (BOD)	≤ 5 mg/L

However, it is considered that a shorter term value should be adopted for SS for evaluating construction impacts instead of the annual median levels.

The mechanism that will regulate discharges from the site including runoff from storm drains and any liquid effluents is the Technical Memorandum (TM) '*Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*'. The Memorandum defines effluent standards that apply to different receiving water bodies. All such effluents covered by this TM are required to be licensed.

The relevant pollution control regulation, *Waste Disposal Ordinance* 1980 (WDO), regulates impact on inland water quality by providing an overall management framework for the collection and disposal of Hong Kong's waste. The control of livestock waste has been encompassed within the WDO since 1988. Under the WDO, keeping of livestock is banned in designated urban areas and a phased programme of progressive controls on livestock keeping in control and restriction areas has been defined.

6.3 Description of Assessment Methodologies

The technical approach set out in Annexes 6 and 14 of the *Technical Memorandum* (TM) *on Environmental Impact Assessment Process* and the Study Brief were closely followed for the assessment of impacts. The following sections serve to elaborate and amplify it.

All relevant reports and information about the Project were reviewed. Existing water quality data for the project site was gathered from Environmental Protection Department (EPD). Environmental standards and regulations relating to water quality were also referenced.

Baseline field study was carried out in early November 1998 to fill identified data gaps. The studies covered river water quality at four different points, W1, W2, W3, and W4 located upstream and downstream of the works sites along two tributaries of the Ho Chung River (see Figure 6.1). Water samples were collected and analyzed for temperature, dissolved oxygen, pH, turbidity, suspended solids and BOD_5.

Information related to the trenching operation was gathered. Such information included the size of the trenches to be dug and the depth where the underground cables will be laid.

Impacts upon the sensitive receivers will be evaluated with reference to the collected information and the applicable assessment criteria of the WQO for river water quality. Mitigation measures will be formulated should the predicted impacts on water quality be found to be significant. Residual impacts after practicable mitigation will also be evaluated.

6.4 Description of the Environment

The proposed works fall within the Ho Chung River. The physical environmental background of the river was evaluated with the baseline data of *River Water Quality in Hong Kong for 1996* as well as annual report from the EPD.

Within the vicinity of the project site, the main water quality sensitive receivers are the lower reach of the Ho Chung River and the lowland pumping station. The proposed project is not expected to cause water quality impacts on any other sensitive receivers during construction and operation.

The 20 km long Ho Chung River runs through the Ho Chung Valley in Sai Kung and discharges into Hebe Haven. The river has a catchment area of 7.2 km^2. The area is mainly formed from coarse tuff which is a type of hard rock comprising fine-grained pyroclastic particles. The two concerned tributaries of the Ho Chung River are covered by cobbles and boulders, approximately 6 metres wide and 0.2 metres deep. The main channel is permanently flooded.

The results of trend analysis conducted by the EPD on long-term data show that the water quality for downstream of the works site at PR2 (see Figure 6.1) was graded as "excellent" in 1996. For another point downstream of the works site near Hiram's Highway at PR1, the water quality was graded as "good" in 1996. The pollution in Ho Chung River is on the decline (Table 6.2). The BOD loads continue to decrease in the past few years but have started to level off recently (Table 6.3).

Table 6.2 River water quality trends in the Ho Chung River based on the results of the Seasonal Kendall Test (Source: EPD, 1996)

Monitoring station		PR1	PR2
Monitoring period (Year)		83-96	83-96
Parameter	Unit	Results of the Seasonal Kendall Test	
Dissolved oxygen	mg/L	↗	–
Suspended solids	mg/L	↘	–
BOD5	mg/L	↘	–
COD	mg/L	↘	–
Oil & grease	mg/L	–	↘
E. coli	cfu/100mL	×	×
Ammoniacal nitrogen	mg/L	↘	–
Nitrate-nitrogen	mg/L	–	↘
Total Kjeldahl nitrogen (SP)	mg/L	↘	–
Ortho-phosphate	mg/L	↘	–
Total phosphorus (SP)	mg/L	↘	–
Sulphide (SP)	mg/L	↘	–
Aluminium	µg/L	↗	↗
Cadmium	µg/L	–	–
Chromium	µg/L	↘	–
Copper	µg/L	↘	↘
Lead	µg/L	↘	–
Zinc	µg/L	↘	–

Notes: 1. (SP): Soluble and particulate fractions (i.e. total) of the water quality parameter.
2. – indicates that no significant trend is detected at $p < 0.05$.
3. ↗ represents an increasing trend significant at $p < 0.05$.
4. ↘ represents a decreasing trend significant at $p < 0.05$.
5. × indicates no measurement was taken.

Table 6.3 Pollution load reductions in the Ho Chung River as at the end of 1996 (Source: EPD, 1996)

Ordinance	Pollution source	No. of discharges[3]	BOD load before control[4] (kg/day)	BOD load after control[3] (kg/day)	BOD load reduction (1989-1996)	
					(kg/day)	(%)
WPCO[1]	Domestic	1,450	185	101	84	45
	Industrial	4	67	1	66	99
	Commercial	0	40	0	40	100
	Institutional	1	2	0	2	100
	Sub-total	*1,455*	*294*	*102*	*192*	*65*
WDO[2]	Chemical	N.A.[5]	N.A.	N.A.	N.A.	N.A.
	Livestock	0	88	0	88	100
	Sub-total	*0*	*88*	*0*	*88*	*100*
Total		***1,455***	***382***	***102***	***280***	***73***

Notes: (1) WPCO: Water Pollution Control Ordinance.
(2) WDO: Waste Disposal Ordinance.
(3) Data shown in these two columns reflect the situation as at the end of 1996.
(4) Pollution discharges in river catchments of the Port Shelter WCZ have been progressively brought under legislative control since the declaration of the Port Shelter WCZ on 1 August 1989.
(5) N.A.: Not applicable or data not available.

The trend mentioned above is substantiated by the baseline information obtained from the 4 sampling stations during the site survey and 1997/1998 monitoring data provided by the EPD. As indicated in Table 6.4 and Table 6.5, the water quality in the river exhibits a low pH, low SS level and low inorganic nitrogen. The river water quality is good and fully complies with the WQOs for pH, suspended solids, dissolved oxygen and 5-day biochemical oxygen demand. By calculating the Water Quality Index, the water quality at all the sampling stations is graded as "excellent". No significant difference is found in the water quality upstream and downstream of the works sites.

The improvement on the previous years' grading is probably a result of waste control measures implemented in the Ho Chung catchment. These measures include legislative control, relocation of livestock farms and large polluting industries out of the catchment, as well as the commissioning of an interception sewer along the lower stretch of Ho Chung Road in 1995. The majority of the remaining pollution load originates from domestic houses scattered in the catchment.

Obviously, the latest available information indicates that the water quality of the two tributaries of Ho Chung River and the main channel is good. However, during the site survey conducted in early November 1998 the main channel downstream was observed to be polluted by increased sediment loading in run-off from the on-going drainage improvement works. During the construction stage of the drainage works, it is expected that the SS levels at PR1 and PR2 will increase substantially.

The future water quality within the Ho Chung area and the receiving water body of Hebe Haven will depend largely on the effectiveness of enforcement associated with the WPCO

and the WDO, in addition to population growth and distribution within the area. However, the review of monitoring data indicates that the general water quality in the area is improving.

Table 6.4 Summary of Water Quality Monitoring Results for the four sampling stations along Ho Chung River during the baseline field survey in November 1998

Parameter	W1	W2	W3	W4
Dissolved Oxygen (mg/L)	8.97	9.57	9.75	9.39
Biochemical Oxygen Demand (mg/L)	< 2	< 2	< 2	< 2
Suspended Solids (mg/L)	< 5	6	< 5	< 5
pH	7.1	7.5	7.5	7.1
Turbidity (NTU)	1.7	1.6	2.4	1.7
Temperature (^{o}C)	24.3	24.4	23.5	23.7

Table 6.5 Summary of water quality monitoring results in the Ho Chung River in 1997 and 1998 (Source: EPD)

Parameter	1997		1998	
	PR1	PR2	PR1	PR2
Dissolved oxygen (mg/L)	7.7 (6.1 – 9.6)	8.3 (7.1 – 9.3)	7.7 (6.2 – 8.2)	8.6 (7.8 – 10.0)
pH	7.1 (6.7 – 7.7)	7.2 (6.8 – 7.8)	7.3 (6.9 – 7.3)	7.5 (7.4 – 7.8)
Turbidity (NTU)	5.0 (2.0 – 19.0)	3.0 (1.0 – 15.0)	6.0 (3.0 – 13.0)	4.0 (3.0 – 10.0)
Suspended solids (mg/L)	8.4 (2.0 – 27.0)	2.8 (1.3 – 14.0)	4.5 (3.2 – 16.0)	2.3 (1.3 – 7.9)
5-day Biochemical oxygen demand (mg/L)	2.2 (0.3 – 6.9)	0.7 (0.2 – 1.6)	1.2 (0.3 – 4.9)	0.4 (0.1 – 0.6)
Chemical oxygen demand (mg/L)	32.5 (2.0 – 100.0)	7.0 (2.0 – 14.0)	9.0 (4.0 – 82.0)	5.0 (2.0 – 18.0)
Ammoniacal nitrogen (mg/L)	0.14 (0.05 – 1.20)	0.05 (0.01 – 0.16)	0.30 (0.10 – 1.40)	0.05 (0.01 – 0.11)

Notes: 1. Data presented for 1997 are annual medians of monthly samples.
2. Data presented for 1998 are medians of monthly samples from January to July. These data are provisional only.
3. Those figures in brackets are the ranges for the sampling period.

6.5 Identification of Environmental Impacts

Physical, chemical and biological disruptions of fresh water system may arise during the construction of the Project as a result of laying of cable ducts across streams at Ho Chung but not during the operation phase. The potential water polluting sources associated with the construction works include:

- Trenching and Mud Disposal
- Construction Site Runoff
- Sewage Treatment and Disposal

During the construction phase, underground cables will be laid about one metre below the river beds of Ho Chung River and its adjoining areas. Trenches have to be dug to facilitate installation of the cables. Excavated mud may cause elevations in SS levels and subsequently reduce the dissolved oxygen content in the water column. Possible impacts would also arise from site runoff, which could contain suspended solids, as well as dust and construction waste. Sewage effluent arising from the on-site construction workforce also have the potential to cause water pollution.

No significant physical, chemical or biological disruptions of the identified water systems are anticipated to be brought about by the operation of the Project as the cables are located below the river bed.

The Ho Chung River itself and its associated wildlife, as well as the lowland pumping station will be the sensitive receivers. Changes in water quality may have an effect on the activities downstream. The Ho Chung River which drains the Ho Chung area eventually discharges into Hebe Haven where the Ma Nam Wat fish culture zone is located. Although Hebe Haven is considered to be active in fishery activities, it is not considered as a marine sensitive receiver as it is too far away (more than 1000m) from the project site. There is unlikely to be any change in the tidal flow and water quality conditions within Hebe Haven.

The excavated mud is unlikely to be contaminated because of decommissioning of livestock farms and large polluting industries in the Ho Chung catchment in recent years. Therefore storage sites for excavated mud along the river channel will not cause pollution of groundwater in the area during the construction phase. Also, there will not be any alteration of groundwater levels and change of catchment types or areas. Thus groundwater is not considered as a water sensitive receiver.

6.6 Prediction and Evaluation of Environmental Impacts

Construction activities associated with the laying of cables and erection of pole lines will inevitably cause some disturbance to the water bodies. It is presently envisaged that hand-dig method and excavation will be employed for trenching the river bed and construction of footings of the overhead pole line.

Sources of potential impacts on water quality resulting from the project works include the following:

- disturbances to natural processes and temporary flow slow down via excavation and filling works;
- resuspension of sediment;
- release of pollutants within the sediment;
- alteration of supply of organic wastes and nutrients downstream;

- construction runoff and drainage;
- general construction activities; and
- those associated with increased nutrients and BOD resulting from sewage effluents from construction workforce.

Disturbances to Natural Processes and Temporary Flow Slow Down

The construction methods may involve trenching and temporary diversion of water courses. Both of which could lead to temporary slow down of flows. Construction activities which are carried out along the rivers may lead to scouring and deposition of sediment which, if not contained, will result in an increase in SS levels and turbidity of the water bodies locally and downstream of the works. Potential increases in SS and increased siltation may therefore pose adverse and direct impacts on the water sensitive uses downstream of the works, such as the lowland pumping station, the receiving water body of the main channel of Ho Chung River and associated ecological sensitive receivers.

Mitigation measures are recommended to be implemented to ensure compliance with water quality objectives. Potential water quality impacts can be minimised by the construction of diversion barriers, whereby any potential water quality impacts will be restricted to within the enclosed area. It is therefore considered important to emphasize that containment measures including barriers should be adopted to minimise potential impacts on the water quality such as sediment loss. With the erection of filter stands and barriers for diverting water flow, construction activities will be confined to within the section of river where cable ducts will be laid. Thus disturbance to the surrounding water bodies will be minimal, and downstream SS increases resulting from trenching will be controlled. As such, interruption and disturbance to the water bodies are likely to be localised and temporary.

Resuspension of Sediment and Associated Release of Pollutants

All forms of trenching will lead to resuspension of sediment. Of particular concern is the potential for heavy metal release from the sediments to the water column which will depend on the sediment contamination level. In addition to heavy metals, the disturbance of sediments will also lead to disturbance of other organic and inorganic contaminants which could be transferred downstream.

However, due to decommissioning of livestock farms and large polluting industries in the catchment, local contamination of river bed sediments is anticipated to be minimal. Release of pollutants and alteration of supply of inorganic/organic matter downstream caused by the construction works will be insignificant. The concentrations of pollutants leaching from the sediments will be minimal. Thus, it is anticipated that the increase in pollutant levels will not result in any unacceptable impact on water quality.

Although the possibility of potential contaminant release within the water column is low, increases in suspended solids resulting from the project works may impact upon dissolved oxygen levels. Dissolved oxygen (DO) monitoring was undertaken for sites upstream and downstream of the works area in November 1998. The water sampling stations, W1, W2,

W3 and W4 are indicated in Figure 6.1, and the results are presented in Table 6.4. In general, DO concentrations were high ranging between 8.97 to 9.75 mg/L at the four monitoring stations, indicating good water quality. It is anticipated that proposed project works will reduce the DO level in the water column as a result of lower flow rate in the river channel. However, with the implementation of practicable measures to control sediment resuspension, it is envisaged that the predicted DO level can comply with the stipulated standard of not less than 4 mg/L.

Construction Runoff and Drainage

Runoff and drainage from the construction sites may contain increased loads of sediments, other SS and contaminants. Potential sources of pollution from site drainage include:

- runoff and erosion from site surface, excavation and stockpiles; and
- fuel and lubricants from construction vehicles.

Construction runoff and drainage may cause both physical and biological effects. This will cause an increase in SS concentrations in receiving waters, which may increase oxygen demand in affected areas. Possible biological effects which may affect aquatic life include eutrophication caused by the nutrient content of the eroded soil, and potential reduction in DO levels caused by high SS concentrations.

It is important that proper site practice and good site management be strictly followed to prevent runoff water and drainage water with high levels of SS from entering the surrounding waters. This should include the provision of silt traps around the works to minimise transfer of SS downstream.

With the implementation of appropriate measures to control runoff and drainage from the construction site, as described in the following section, it is considered that disturbances to the water bodies will be localised and deterioration in water quality will be minimal.

General Construction Activities

On-going site construction activities may also cause water pollution from the following:

- Construction debris, and rubbish such as packaging material and food containers; and

- Spillage of liquids stored on site, such as oil, diesel and solvents etc. from on site plant/equipment, are likely to result in water quality impacts if they enter the river channel.

With appropriate site management practices, including appropriate waste collection, storage and disposal, such detrimental impacts on water quality from general construction activities should be minimal. Site management practices should also include effective control of the site boundary of the work area to ensure that, under no circumstances, should any litter, fuels or solvents enter the nearby river channel.

Impacts Associated with Increased Nutrients and BOD Resulting from Sewage Effluents

Sewage effluents will arise from sanitary facilities provided for the on-site construction workforce. However, in view of the linear nature of the envisaged works associated with the construction works, workers are likely to be spread out and the construction sewage can be handled by appropriate treatment facilities. The concerned water bodies for the proposed works are the two tributaries of the Ho Chung River. The few workers in this particular section are unlikely to cause serious deterioration in the water quality of the Ho Chung River.

Conclusions

In general, disturbances to water bodies will be localised and short term. With the careful scheduling of excavation activities to the dry season where possible and implementation of recommended mitigation measures, the proposed construction works are not expected to cause non-compliance with the Water Quality Objectives. Thus unacceptable impacts on water quality are not anticipated assuming that the effectiveness of the mitigation measures employed is audited through environmental monitoring and auditing (EM&A) procedures.

6.7 Mitigation of Adverse Environmental Impacts

Major disturbance to the stream at Ho Chung will be caused by trenching and mud disposal. Possible impacts may also arise from site runoff and from sewage effluent generated by the on-site construction workforce. It is important that appropriate, practical and cost effective measures be implemented to control runoff and drainage, and thereby prevent high loadings of SS from entering downstream river sections. Proper site management, including defined waste management procedures, will be essential to minimise surface water runoff, and ensure that debris and rubbish cannot enter water bodies. The need for mitigation measures during the construction phase, in fact, would be greatly reduced by carrying out the works at the stream channel in the dry season, during periods of low flow. As such, the temporary construction works would minimise downstream impacts on sensitive water bodies.

The following mitigation measures have been recommended to minimise water quality impacts during construction:

Trenching and Spoil Disposal

The duct laying work in the river sections, lasting for about 3 months, will be carried out in dry season. The cable ducts will be installed section by section after the water flow is diverted. Filter stand will be built temporarily prior to trench excavation in stream bed to prevent sediment flowing down to lower sections of Ho Chung River. Containment of sediments, via diversion of channel with barriers, will be employed to allow works to be carried out within a confined area, thereby minimising potential disturbance to the water bodies.

The excavated soil including that from stream bed will be removed. The surface layer of affected stream bed will be reinstated to its original condition after cable duct construction.

Construction Site Runoff

All runoff from the study area during construction should be routed through oil/grit separators and/or sediment basins/traps before being allowed to discharge into the nearby receiving waters, and the water quality of all discharges must not be allowed to cause exceedances of the WQOs in the receiving Ho Chung River and Hebe Haven. Sediment removal facilities should be maintained and the deposited sediment/grit removed regularly and after heavy rainfall, to ensure that these facilities are functioning properly at all times. All stockpiled areas should be covered (e.g. with tarpaulin) and intercepting drains provided to prevent runoff from washing across exposed soil surfaces or stockpiled areas. Construction is recommended to be scheduled between September and April to minimise soil erosion during rainy season.

Sewage Treatment and Disposal

Any effluent generated by the on-site workforce would require appropriate treatment and disposal. Portable toilets should therefore be provided for the on-site construction workforce.

Water Quality Monitoring and Audit

Water quality monitoring and audit are essential tools to determine the scale of construction stage impacts and to proactively identify and remedy any deterioration in water quality associated with the works. Based on the evaluation of predicted impacts (Section 6.6), trenching activities will be localised and are not expected to impact on downstream sensitive receivers in Hebe Haven. Therefore, water quality monitoring will be confined to the immediate areas upstream and downstream of the work sites where monitoring of the SS and DO levels is recommended to audit potential increase in SS level and potential decrease in DO concentration respectively. The Action / Limit levels for SS and DO shall be set as follows:

Table 6.6 Action / Limit Levels for DO and SS

Parameter	Action	Limit
DO in mg/l (Mid-depth)	1%-ile of baseline data or midway between 5%-ile of baseline data and limit level	4 mg/l
SS in mg/l (depth-averaged)	95%-ile of the baseline data or 120% of upstream control station's SS, whichever the value is lower.	99%-ile of baseline or 130% of upstream control station's SS, whichever the value is lower.

However, if baseline monitoring reveals that the SS level upstream constantly exhibit a higher value than the SS level downstream or the DO level upstream is constantly lower than the DO level downstream, then a compensating factor will have to be taken into account when considering the Action / Limit levels.

The contractor will be under direct supervision by the site engineer and their performance on site will be closely monitored. An EM&A Manual specifying all site specific monitoring requirements, e.g. locations and frequencies, will be prepared to present the monitoring and audit requirements and protocols for assessment of the effectiveness of implemented mitigation measures and the identification of any residual environmental impacts.

No adverse impacts are expected to arise from the foregoing mitigation measures.

6.8 Definition and Evaluation of Residual Environmental Impacts

Provided that the recommended mitigation measures are strictly implemented, it is considered that construction activities for the proposed project will cause only local and temporary disturbance, and no water quality impacts in excess of WQO standard are envisaged.