4 WATER QUALITY

4.1 INTRODUCTION

This section presents an environmental assessment of potential water quality impacts associated with the construction and operation of the proposed 73CD Works (or Eastern MDC). Impacts are identified, and appropriate mitigation measures are recommended to reduce impact to acceptable level.

4.2 ENVIRONMENTAL LEGISLATION AND NONSTATUTORY GUIDELINES

The *Water Pollution Control Ordinance, Waste Disposal (Chemical Waste) (General) Regulations* and the *Waste Disposal (Livestock Waste) Regulations* are the relevant pollution control legislations which regulate impact on inland water quality.

Under the *Water Pollution Control Ordinance* (WPCO), Hong Kong waters are subdivided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The streams and rivers from San Tin area drain into Shenzhen River and eventually into Deep Bay. Under the Ordinance, Deep Bay falls under the Deep Bay WCZ, any discharge into the WCZ will require licensing.

The *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM), issued under *Section 21* of the WPCO, defines acceptable discharge limits to different types of receiving waters. Under the TM, effluents discharged into the inland waters are subject to standards for particular volumes of discharge (as stated in *Tables 3, 4, 5* and *6* of the TM). The discharge standard will vary with the use of downstream water. Group B waters are mainly those draining through agricultural lands. Group C waters refers to those which run across large numbers of fish ponds. These are defined by the Environmental Protection Department (EPD) and specified in licence conditions for any new discharge within a WCZ.

In addition to the TM, the EPD requires that all new development within Deep Bay catchments should not result in any net additional pollution loads to Deep Bay if a connection to a public sewer system is not feasible. Although this is not directly relevant to this drainage improvement/flood protection scheme project, sewage produced from construction workers requires treatment prior to disposal.

Waste Disposal Ordinance 1980 (WDO) provides an overall management framework for the collection and disposal of Hong Kong's waste. The Ordinance was amended in 1991 to provide specific control over chemical waste. 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 the EPD and all chemical waste generated will have to be disposed of at a licensed facility such as the Chemical Waste Treatment Centre (CWTC) at Tsing Yi.

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. However, the livestock waste remains a major source of pollution for inland wastes due to problems with implementation and enforcement. The WDO and the relevant regulations were amended recently and a new implementation programme has been introduced. Since 1 July 1997, the discharge standard from livestock farms at San Tin is restricted to 250 mg l^{-1} of biochemical oxygen demand (BOD_5) and 250 mg l^{-1} of suspended solids (SS). This standard was tightened to 100 mg l^{-1} of BOD_5 and 100 mg l^{-1} of SS from 1 July 1998 and then to the ultimate discharge standard of 50 mg l^{-1} of BOD_5 and 50 mg l^{-1} of SS by 1 July 1999.

4.3 *BASELINE CONDITIONS AND SENSITIVE RECEIVERS*

4.3.1 *Baseline Conditions*

Existing Conditions

The locations of the proposed Eastern MDC is shown in *Figure 4.3a*. The 73CD Works, or Eastern MDC, will extend from the existing open nullah below Castle Peak Road (near San Sham Road) and run parallel to San Sham Road before it drains into Shenzhen River. The proposed alignment will run across fish ponds and small streams at the east of Sham Po Shue.

For the Eastern MDC, the existing stream channel (at the Castle Peak end of Eastern MDC) water appears to be greyish during dry weather. Stream channel flow is sluggish under dry weather and the water quality is affected by the upstream discharge, and contaminated run-off and seepage along both sides of the stream channel. Sediment is deposited near the slopes of the stream channel and rubbish and debris were observed at the dried river bed downstream. However, the stream channel is generally free from heavy livestock based pollution. No river quality monitoring data were available for this stream channel.

Along the western side of the Eastern MDC are mainly fishponds, which are expected to have relatively good water quality. A number of fishponds at the south of the Eastern MDC have been filled in for temporary container vehicle park and container storage up to November 2000 (as shown in *Figure 4.3a*).

Baseline water quality monitoring was undertaken for Shenzhen River EIA[1]. Water quality was monitored on the Shenzhen River from January to October 1994, and the data collected in the catchment area of the San Tin MDCs (W2, W3 and W4) is shown in *Table 4.3a*. The relevant monitoring locations are illustrated in *Figure 4.3a*. The water is characterised by low DO with high BOD_5 and SS. According to Shenzhen River EIA, Shenzhen River is heavily polluted due to discharge of untreated effluent from industry, agriculture, poultry and livestock farming, and human sewage. Most pollutants from Hong Kong arise from livestock waste.

[1] Environmental Impact Assessment Study for Shenzhen River Regulation Project, Final EIA Study Report (I), Peking University, 1995.

Table 4.3a *Water Quality of the Shenzhen River (at high and low water levels) in Dry Season of 1994*

Station No.	W2		W3		W4	
Water Levels	**High**	**Low**	**High**	**Low**	**High**	**Low**
Dissolved Oxygen (DO) (mg l^{-1})	1.0	0.8	0.7	0.6	0.8	0.7
SS (mg l^{-1})	250	241	120	87	135	125
BOD_5 (mg l^{-1})	74	75	63	62	25	46

Future Conditions

For the operation of Eastern MDC, storm water from upstream of the existing open nullah will be diverted away from the existing fish ponds by the extended Eastern MDC towards Shenzhen River. Water collected in 35CD Phase 1 will be partially diverted to Eastern MDC and eventually to Shenzhen River. According to Drainage Services Department (DSD), the design flow of the Eastern MDC is 155 $m^3 s^{-1}$ (to accommodate a 200 year return flood) and the estimated maximum dry weather flow rate will be 1 $m^3 s^{-1}$. The construction of Eastern MDC will commence in June 2001 and ends in December 2004.

4.3.2 *Sensitive Receivers*

Around the Eastern MDC, there are fish ponds towards the east and the stream channel towards south, although stream water does not directly drain though the fishponds. Streams which drain the San Tin area discharge into Shenzhen River and eventually into Inner Deep Bay approximately 2 km downstream.

As shown in *Figure 4.3a*, Water Quality Sensitive Receivers (WSRs) during construction include the surrounding water bodies along the Eastern MDC, either in direct contact (existing stream channel and Shenzhen River) or indirect contact (adjacent fishponds). During the operation phase, the WSR will be the discharge water body which is the Shenzhen River.

4.4 *CONSTRUCTION PHASE*

4.4.1 *Introduction*

It is anticipated that the drainage works at Eastern MDC will inevitably cause some disturbance to the water bodies due to excavation activities. The main construction activities will include excavation and filling, followed by grasscreting of channel linings and the access road construction. The plant used for the construction of the channels includes dump trucks, excavators, loaders, etc. The major plant used will be earth moving plant for the construction of the earth embankment.

4.4.2 *Potential Sources of Impact*

The construction of Eastern MDC will commence in June 2001 for a period of 30 months and the estimated volume of excavation will be 115 000 m^3.

Marine access is not available because of the presence of the Border Fence. The invert levels of the proposed Eastern MDC (from 0.15 mPD to 1.5 mPD) all lie within the tidal range which is not deep enough for marine plant. Construction will therefore be carried out by land plant. For land based excavation at existing steam, long-reach excavators are expected be employed. The fishponds to be excavated are expected to be dried up beforehand. It should be noted that excavated sediment will be generated from stream and pond sediment excavation which has a relatively high water content.

Although the quality of sediment will only be studied in detail via site-specific investigation held before the construction of the Eastern MDC, the sediment quality data from the Territorial Land Drainage and Flood Control Strategy Study-Phase III Sedimentation Study (TELA-3)[1] shows that sediment quality around Eastern MDC is partly seriously and moderately contaminated (both in Class B and Class C) (details are discussed in *Section 5.4.3*). The findings indicated that the sediment at Eastern MDC are generally contaminated with heavy metals, commonly with Copper, Lead and Zinc (see *Table 5.4a*). The depths of contaminated sediment are generally limited to the top 500 mm (i.e. the estimated volume of seriously and moderately contaminated Class B/C sediment is 29 000 m^3 and the estimated volume of uncontaminated sediment is 86 000 m^3). The organic content of the sediments are generally low (see *Table 5.4b*).

Sources of potential impacts resulted from the proposed Eastern MDC works include:

- disturbance to natural processes and temporary flow obstruction via excavation works;
- resuspension of sediment;
- release of organic / inorganic pollutants from the sediment and accumulation of the pollutants within the water column;
- construction run-off and drainage;
- general construction activities;
- pollutant impacts associated with disposal of contaminated excavated sediment; and
- domestic sewage effluents from the on-site work force.

The potential impacts to water quality from excavating the existing stream and disposal of contaminated material will vary according to the quantities and level of contamination, as well as the sensitive receivers at the excavated and disposal sites. The likely impacts include:

[1] Task 5 Report: Dredging Operations and Sediment Disposal, Territorial Land Drainage & Flood Control Strategy Study-Phase III Sedimentation Study, Hyder Consulting Limited, May 1997.

- release of previously bound heavy metals contaminants and nutrients into the water column, either via suspension or by disturbance from turbulent flow or sediment waves as a result of excavating activities at existing stream, disposal of sediment, or depositing fill materials;

- release of the heavy metal contaminants due to leakages and spillages as a result of poor handling and overflow from off-site barges during its journey to appropriate disposal site; and

- suspension of solids in the water column during excavating activities at existing stream and marine sediment dumping activities, with the likely consequence of reducing DO levels and increasing nutrient levels.

All of the above can result in deterioration in the receiving water quality and is likely to have adverse effects on inland and coastal sensitive receivers.

Potential water quality impacts can be minimised on-site by restricting the construction activities within the enclosed area. Containment measures including bunds should be adopted to minimise potential impacts upon the downstream water quality.

4.4.3 *Evaluation of Impacts*

Disturbance to Natural Processes and Temporary Flow Obstruction

The construction of the Eastern MDC is expected to involve excavation, formation of embankments, infilling of fish ponds, and permanent and temporary diversion of water courses, each of which probably lead to temporary or permanent obstruction of flows. In addition, construction activities which are carried out along the streams is likely to lead to scouring and deposition of sediment which, if not contained, will result in an increase in suspended solids (SS) levels and turbidity, and depletion of dissolved oxygen (DO) of the water bodies locally and downstream of the works, thereby altering the existing natural processes such as siltation, flows, and flow velocity. Potential increase in SS and increased siltation is likely to affect the water sensitive uses downstream of the works, the receiving water body of Inner Deep Bay, and associated ecological sensitive receivers.

Resuspension of Sediment

Construction of Eastern MDC will involve excavation works mainly in fishponds and relatively small sections of existing stream channels. Since the construction will only be conducted within dried up fishponds, sediment should only be released from these excavation activities as surface runoff.

Excavation along existing streams may disturb and resuspend deposited bottom sediment. The extent of SS impact will depend on the scale of works along the stream, but is predicted to be minimal if excavation activities are undertaken with mitigation measures or within dried-up stream channels.

Release of Pollutants from the Sediment

The excavation at stream will lead to resuspension of sediment. Of particular concern is the potential for toxic metal released from the sediments to the water column. 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.

Based on the sediment quality data of TELA-3 provided by DSD, it is considered that some of the sediments in the water courses and drainage channels at San Tin that run into Deep Bay are contaminated by heavy metals, partially copper, lead and zinc (see *Table 5.4a*). Disturbance of the sediments, to some extent, release the contaminants that will potentially be absorbed by downstream river and marine organisms and subsequently accumulated in their body tissue. This can also be a threat to human health when people consume the seafood.

The release of SS and pollutants from the disturbed sediments will depend on a number of factors including:

- physical and chemical nature of any excavated sediment;
- rate and type of construction activities, that is, the quantity of sediment to be excavated per day, and methods applied;
- phasing of construction activities; and
- dispersion, flushing characteristics of the receiving water body.

Given the existing poor water quality (see *Table 4.3a*) of the rivers, further deterioration in water quality would be particularly undesirable. Potential water quality impacts can be minimised by the channel diversion.

During the construction of Eastern MDC, flow from upstream will have to be diverted though the construction of temporary channels. Before completion of the Eastern MDC the stream flow may need to be pumped over the Eastern MDC in order to avoid flooding of the works area.

It is anticipated that high levels of zinc and copper within bottom sediment are likely to arise in areas upstream of livestock farms [2]. Additionally, industrial discharges are also likely to lead to local contamination of river bed sediments.

To estimate the potential water quality impact due to release of pollutants from the sediment, elutriate test results from other studies is used, as the exact quality and quantity of sediment to be excavated is not certain. In the Shenzhen River EIA, elutriate tests were undertaken to determine the potential release of pollutants, namely, total Kjeldahl nitrogen (TN), total phosphorus (TP), chemical oxygen demand (COD), copper (Cu) and lead (Pb) from the resuspended sediments. The heavy metal concentrations and the resulting elutriate concentrations are illustrated in *Table 4.4a* and *4.4b*, respectively.

[2] Main Drainage Channels for Ngau Tam Mei, Yuen Long and Kam Tin: Environmental Impact Assessment. ERM-Hong Kong Ltd, 23 May 1996.

Elutriate test was also performed for the Main Drainage Channels for Ngau tam Mei, Yuen Long and Kam Tin EIA (Kam Tin MDC EIA). The heavy metal concentrations in sediment and the results of elutriate test are respectively shown in *Table 4.4c* and *4.4d*.

Since the sediment contamination level measured in the TELA-3 roughly lies between sediment contamination level found in Shenzhen River EIA and Kam Tin MDC EIA, the potential water quality impact due to release of pollutant from sediment excavated for Eastern MDC is also expected to lie between the elutriate test results of the two studies.

Table 4.4a ***Shenzhen River Regulation Project Sediment Analysis (mg kg^{-1})***

Location		Cr	Cu	Hg	Ni	Pb	Zn	Cd
River	Zhanmatou	106.0	207.0	0.30	-	102.0	523.0	0.43
	Hekou	65.0	99.0	0.13	-	82.0	308.0	0.24

Table 4.4b ***Shenzhen River EIA Elutriate Test Results (mg l^{-1})***

		TN	TP	COD	Cu	Pb
River Water	No sediment	26.97	2.82	19.39	0.018	0.048
	1:100	24.50 *	0.55 *	20.13 (+3.8%)	0.014 *	0.048
	1:1000	28.48 (+5.6%)	1.87 *	21.06 (+8.6%)	0.014 *	0.048

Note: * Decrease due probably to adsorption or degradation

Table 4.4c ***Kam Tin River Sediment Heavy Metal Analysis Results (mg kg^{-1} dry weight)***

Station	Cd	Cr	Cu	Hg	Ni	Pb	Zn
A	92**	<0.1	92**	<0.1	21	52	253**
11	32**	<0.1	32	<0.1	4	44	116

Note: ** Class C material according to EPD TC 1-1-92

Table 4.4d ***Kam Tin River Elutriate Analysis Results (mg l^{-1})***

Stn.	Water	Cu		Pb		Zn		N	
		1@	2	1	2	1	2	1	2
A	River water	0.01	0.005	<0.001	<0.001	0.009	0.009	21	21
	Elutriate	<0.001*	<0.001*	0.001	0.001	0.003*	0.10	20*	23(+9.5%)

Note: @ There were 2 sample runs, namely 1 and 2
* Decrease due probably to adsorption or degradation

The increase in pollutant concentrations in river water is generally minimal with a maximum of 9.5% of N (*Table 4.4d*) and 8.6% of COD (*Table 4.4b*). The Shenzhen River EIA report indicated that although linear extrapolation is expected not be strictly valid, it can be used as an indicative level of pollutant release at low SS levels. It was deduced from the Shenzhen River EIA report that no more than 5% increase in pollutant levels will result from an SS increase of 40 mg l^{-1}.

From TELA-3, the pollutants of highest concentrations detected in sediment were copper, lead and zinc (see *Section 5*). Whereas the principle pollutant of sediment gathered (for elutriate test) in Shenzhen River EIA were lead, and from Kam Tin MDC EIA were cadmium, copper and zinc. Heavy metal concentration found in the corresponding river water and elutriate did not indicate a significant increase of heavy metal due to suspension of sediment. However, from the elutriate test result of Shenzhen River EIA, the potential release of COD and TN were higher (percentage indicated above).

It is revealed that the heavy metal concentrations leached from the sediments were minimal, and this slight fluctuation in the pollutant levels is expected to be in the natural variation range of pollutant levels in the existing river water. However, the organic matter / nutrient concentration leaching potential is higher, as compare to heavy metals.

It is therefore considered important to emphasis that containment measures, including close grab excavation and construction of temporary diversion, should be adopted to minimise potential impacts on the water quality. Recommended mitigation measures are described in the following section.

Construction Run-off and Drainage

Run-off from construction sites is expected to contain increased loads of SS and contaminants. Potential sources of water pollution from site runoff include:

- run-off and erosion from site surfaces, stream channels, dried up fishpond, earth working area and stockpiles;
- contaminated ground water from any dewatering activities as a result of excavation and disturbance of contaminated sediments;
- release of any bentonite slurries and other grouting materials with construction run-off, storm water or ground water dewatering process;
- wash water from dust suppression sprays and wheel washing facilities; and
- fuel, oil and lubricants from maintenance of construction vehicles and equipment.

Without mitigation, construction runoff and drainage is likely to cause physical, chemical and biological effects. The physical effects arise from any increase in SS from the site which cause blockage of drainage channels and associated local flooding when heavy rainfall occurs, as well as local impacts on downstream water quality in Deep Bay. High SS concentrations in marine waters could lead to associated reduction in dissolved oxygen levels.

It is important that mitigation measures, as described in *Section 4.4.4*, to 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 SS transfer downstream. Also of concern are wetland areas and the prevention of the flow of high level of sediment into fish ponds.

With the implementation of appropriate measures to control runoff and drainage from the construction site, including the installation of silt traps and use of embankments or bunds, it is considered that disturbance to water bodies will be localised and deterioration in water quality will be minimal. Thus unacceptable impacts on the water quality are not expected provided that recommended measures are effectively implemented.

Possible chemical and biological effects would arise as a result of construction runoff, depending upon the chemical and nutrient content (see previous subsection). Primary chemical effects would result from liquid containing significant quantities of concrete and cement derived materials. These may include localised increases in turbidity and discolouration, localised elevations in pH, and accretion of pH solids. Bentonite slurry and other grouting material within runoff could also contribute to these chemical effects within the water column. A number of secondary effects is also likely result in toxic effects to river and marine biota due to elevated pH values, reduced decay rates of faecal microorganisms due to decreased light penetration, and a localised increase in the proportion of unionised ammonia. However, as the design of the channel is mostly grasscrete lined, the impact from concrete and cement derived material is expected to be much smaller than a full concreted lined channel.

General Construction Activities

General construction activities is expected to generate debris and rubbish, such as packaging and used construction materials, that enter water column as site run-off and result in floating refuse in the vicinity of the site that reduces the aesthetic quality of any receiving water body. Spillage of liquids stored on site, such as oil, diesel and solvents is also expected to result in water quality impacts if they enter surrounding water bodies and soils.

However, the effects on water quality from construction activities are likely to be minimal, provided that site boundaries are well maintained and good construction practices are observed to ensure that litter, fuels and solvents are managed, stored and handled properly.

Marine Disposal of Excavated Sediment

Excavation along the proposed Eastern MDC is likely to result in the requirement for marine disposal depending on the quantity of spoil. The extent of potential water quality impacts associated with marine spoil disposal will vary according to the quantity, rate of disposal and the extent of spoil contamination, and the location and sensitivity of the disposal site. Details of the management and disposal of excavated sediment is discussed in *Section 5*.

Domestic Sewage Effluents

Domestic sewage will arise from sanitary facilities provided for the on-site construction work force. Sewage is characterised by high levels of BOD, ammonia and *E. coli* counts.

There will be no public sewers available for domestic sewage discharge. Owing to the lack of established guidelines of sewage generation rate for construction sites, the recommended design rate for offices, specified in the *Guidelines for the Design of Small Sewage Treatment Plants, EPD Solid Waste Control Group, March 1990* has been used to estimate the sewage generation. The expected maximum number of workers on site daily will be 90. Therefore a volume of approximately

5.0 m^3 per day is likely to be generated at the site. Significant water quality will happen only if the domestic sewage is allowed to discharge directly into the drainage channels or fish ponds without any treatment. The adequate and proper sewage collection and disposal facilities using portable toilets with regular emptying services by licensed contractors should be installed to ensure that the discharge standards stipulated in the TM are met and there is not net increase in pollutant loading to Deep Bay.

Cumulative Impact from Lok Ma Chau Kiosk Expansion, Shenzhen River Regulation Project and Western Railway Lok Ma Chau Station

There is a proposal to expand the Kiosks and Facilities at Lok Ma Chau Border Crossing (LMC Kiosks Expansion). The construction of the LMC Kiosks Expansion is expected to commence in 1999 [3]. Phase I involving site formation would be completed by end 1999. Phase II and III comprise building construction, X-ray facilities and testing to be completed by mid 2002. It is anticipated that cumulative impact would likely in Phase II and III during June 2001 to end 2002. Potential impacts will be similar to that discussed above but of a larger magnitude. However, the cumulative impact is likely to be minimal as site formation of the kiosk project will be completed before the commencement of the Eastern MDC work, and is expected to be mitigatable to an acceptable level.

According to the current information the Shenzhen River Regulation Project (SRRP) Stage III works, at Lo Wu over 4.5 km upstream, will be constructed from April 2001 to September 2004, and therefore would overlap the Eastern MDC construction period. Potential impacts from the SRRP works will be of a significantly larger magnitude, but it is expected that proper mitigation measures from the SRRP project will be implemented to ensure no significant residual impact.

The main construction period for the proposed KCRC Eastern Railway Sheung Shui to Lok Ma Chau Spur Line (Lok Ma Chau Spur Line) is 2001 to 2004. Cumulative impact will be expected during 2001 to early 2004. Construction site runoff form Lok Ma Chau Spur Line have the potential to impact water quality in the Eastern MDC or adjacent water bodies which lead to Shenzhen River and ultimately Deep Bay. It is expected that potential cumulative impact assessment will be addressed in the EIA Study for the Lok Ma Chau Spur Line (application for EIA Study Brief is being proceeded with by the proponent).

In order to minimise the impacts, mitigation measures which have been/will be specified for each project should be implemented. Potential cumulative impacts can be reduced by implementing the recommended measures for the present project as completed as possible during the works.

4.4.4 *Mitigation Measures*

4.4.4.1 To safeguard the water quality of the sensitive receivers within and downstream of San Tin villages during construction, the Contractor should implement appropriate mitigation measures. EPD Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94) provide advice on how to handle and reduce construction site discharge.

[3] Agreement No. CAA F1, PWP Item No. 6GB, Expansion of Kiosks and Other Facilities at Lok Ma Chau Boundary Crossing, Final Environmental Study, March 1999.

Excavation of Stream Channel

4.4.4.2 Excavation of the existing stream is confined at the southern end of the Eastern MDC near Castle Peak Road. Excavation within the stream channel, disposal and fill activities is likely to result in reduced water quality through turbidity and increased concentration of contaminants. The Contractor will be required to minimise adverse impacts on water quality resulting from excavation and marine disposal activities.

4.4.4.3 The Contractor should implement the following for excavation on wet stream:

- minimise disturbance to the river bed while excavating;
- minimise leakage of excavating material during lifting;
- prevent loss of material during transport of excavated material;
- prevent discharge of excavated material except at approved locations;

4.4.4.4 To minimise the leakage and loss of sediments during excavation, tightly sealed closed grab excavators should be employed in river sections where material to be handled is wet. Where material is dry and in non-river sections, conventional excavators can be used.

Works Timing

4.4.4.5 It is considered that excavation at existing stream should be undertaken during periods of low flow (dry season) as these temporal restrictions in the works would minimise downstream impacts on sensitive water bodies.

Construction Runoff and Drainage

4.4.4.6 Exposed soil areas should be minimised to reduce the potential for increased siltation, contamination of run-off and erosion. In addition, no site run-off should enter fishponds. Construction run-off impacts associated with above ground construction activities can be readily controlled through the use of appropriate mitigation measures which include:

- temporary ditches should be provided to facilitate run-off discharge into appropriate watercourses, via a silt retention pond;
- boundaries of earthworks should be marked and surrounded by dykes or embankments for flood protection, as necessary;
- open material storage stockpiles should be covered with tarpaulin or similar fabric to prevent material washing away;
- exposed soil areas should be minimised 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 preformed;

- use of sediment traps; and

- maintenance of drainage systems to prevent flooding and overflow.

4.4.4.7 All temporary drainage pipes and culverts provided to facilitate runoff discharge should be adequately designed to facilitate rapid discharge of storm flows. All sediment traps should be regularly cleaned and maintained. The temporarily diverted drainage should be reinstated to its original condition, when the construction work is completed or the temporary diversion is no longer required.

4.4.4.8 Sand and silt in wash water from wheel washing facilities should be settled out and removed before discharge into temporary drainage pipes or culverts. A section of the haul road between the wheel washing bay and the public road should be paved with backfall to prevent wash water or other site run-off from entering public road drains.

4.4.4.9 Oil interceptors should be provided in the drainage system downstream of any significant oil and grease sources. They should be regularly maintained to prevent the release of oils and grease into the storm water drainage system after accidental spillage. The interceptor should have a bypass to prevent flushing during periods of heavy rain, as specified in ProPECC PN 1/94.

General Construction Activities

4.4.4.10 Debris and rubbish on site should be collected, handled and disposed of properly to avoid water quality impacts. Requirements for solid waste management are detailed in *Section 5* of this report.

4.4.4.11 All fuel tanks and storage areas should be provided with locks and placed on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching the downstream WSRs.

Marine Disposal of Excavated Sediment

4.4.4.12 The following measures have been identified to minimise potential impacts on water quality arising during marine transportation of the excavated material (including sediment excavated from stream beds and fishponds) for marine disposal:

- The decks of all marine dumping disposal barges and floating pontoons will be kept tidy and free of oil or other substances or articles which might be accidentally or otherwise washed overboard.

- All off-site vessels and barges should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash.

- The works should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water at the loading berth or dumping grounds.

- Use of water tight trucks during transportation of marine disposal of excavated material.

4.4.4.13 Additional provisions will be required upon confirmation that marine sediments are contaminated. The locations and depths of any areas of contaminated marine sediments should be indicated in the construction contract. The Contractor would ensure that contaminated sediments are excavated, transported and placed in approved special dumping grounds in accordance with the EPD Technical Circular No. 1-1-92, Works Branch Technical Circular (WBTC) No. 22/92 and WBTC No. 6/92.

4.4.4.14 Mitigation measures to minimise the loss of contaminated material to the water column are listed below:

- Transport of contaminated marine sediment to the marine disposal grounds should be by split barge (off-site) of not less than 750 m^3 capacity, well maintained and capable of rapid opening and discharge at the disposal site.
- The material should be placed in the pit by bottom dumping, at a location within the pit specified by the Fill Management Committee (FMC).
- Discharge should be undertaken rapidly and the hoppers should then immediately be closed, material adhering to the sides of the hopper should not be washed out of the hopper and the hopper should remain closed until the barge next returns to the disposal site.
- The dumping vessel should be stationary throughout the dumping operation.
- The contractor must be able to position the dumping vessel to an accuracy of +/- 10 m.
- Barge loading should be monitored to ensure that loss of material does not take place during transportation.
- Transport barges or vessels will be equipped with automatic self monitoring devices as specified by the EPD.
- The contractor should follow procedures as outlined in the Guidance Note for Dumping and Additional Conditions on Disposal of Contaminated Marine Mud at East Sha Chau Contaminated Mud Disposal Pits.

Sewage Effluents

4.4.4.15 Construction work force sewage is expected to be handled by portable chemical toilets along the alignment if connection to a public sanitary sewer system is not feasible. Appropriate and adequate portable toilets should be provided by licensed contractors who will be responsible for appropriate disposal and maintenance of these facilities.

4.4.5 *Residual Impact*

General construction activities associated with the construction of Eastern MDC is expected to lead to site runoff containing elevated concentrations of SS and associated contaminant, if uncontrolled, and would impact the WSRs. However, it is anticipated that water quality impacts will generally be temporary and localised during construction. Therefore, no unacceptable residual water quality impacts are anticipated from the Eastern MDC's construction phase, provided that:

- All of the recommended mitigation measures, including appropriate drainage and silty runoff collection facilities, as recommended in subsection *Construction Runoff and Drainage* of *Section 4.4.4*, are adopted.
- Any diversions of drainage pipes or channels are constructed to allow flow to the discharge point without overflow or washout, as recommended in subsection *Excavation of Stream Channel* of *Section 4.4.4*.
- All construction site discharges comply with the TM standards of the WPCO. Any practical options for the diversion and realignment of drainage should be engineering feasible and comply with environmental requirements, as stated in subsection *Excavation of Stream Channel* in *Section 4.4.4*.

4.5 *OPERATION PHASE*

4.5.1 *Introduction*

This section provides the assessment of water quality impacts associated with the operation of the Eastern MDC. Mitigation measures are recommended, where appropriate, to minimise those identified potential operational water quality impacts.

The operational stage of Eastern MDC will have different physical and catchment characteristics from the existing drainage system. The proposed alignments will have wider river sections than the existing drainage system. The channel bed will be grasscrete. Eastern MDC will be equipped with an inflatable dam near the confluence of Shenzhen River and a pumping station near the dam. The MDC is designed to cope with the large volume of storm flow during the wet season and prevent any severe flooding in the area.

4.5.2 *Potential Sources of Impact*

During operation, the flood protection works will not produce extra pollutant loading to the flow. On the other hand, the water quality of the existing stream can be improved if the upstream pollution sources (such as rubbish accumulation along the channel) are strictly controlled.

The Eastern MDC will change the hydrological characteristics of the catchment, including velocity of the channel flow, rate of sedimentation, and surface drainage of the fish ponds and farmlands adjacent to the new alignments. These changes are considered to have both beneficial and negative effects on water quality. The sources of positive impact is illustrated below:

- channel straightening;
- barrier for tidal intrusion;
- accumulation of potential solid pollutants; and
- reduction in natural sediment erosion.

Negative impacts may arise from the grasscrete river bed and the regular maintenance dredging. Potential sources of water quality impacts are the following:

- minor restriction to water seepage;
- maintenance dredging; and
- change in flow rate, siltation, erosion rates and sedimentation patterns.

4.5.3 *Evaluation of Impacts*

Positive Impacts

Channel Straightening: The new alignments of MDC will provide widened sections to alleviate flooding at San Tin during heavy rainfalls. The new grasscrete channels will allow greater flow and flushing during the flood periods. The greater flushing will enable organic, nutrients, heavy metals, and other dissolved pollutants to be dispersed downstream, whereas previously pollutants were confined upstream by backing-up due to low flows and the quality of 'retained' waters remained poor. In addition, river straightening will also increase natural aeration of the widened channel waters that will alleviate the anoxic conditions which occur generally in the water courses in the Study Area.

Barrier for Tidal Intrusion: An inflatable dam will be built near the confluence of each alignment and Shenzhen River. Water will be pumped downstream via the adjacent pumping station at each alignment. These inflatable dams will act as a barrier to prevent downstream tidal intrusion and allow pollutants to be carried further downstream rather than being retained and backwashed upstream as a result of the tidal intrusion effect.

Accumulation of Potential Solids Pollutants: The inflatable dams will tend to hold back the river flow and thus allow suspended solids within the water column to settle and accumulate directly upstream of the dams. This will significantly reduce downstream sediment pollution associated with any domestic and livestock waste. Deposited accumulated material behind the inflatable dam can thereafter be cleared through regular maintenance dredging and disposed of at public dumps, marine dumps, or landfill (after dewatering) subject to licensed conditions of disposal.

Reduction in Natural Sediment Erosion: As the Eastern MDC will be grasscreted lined, sediment erosion will be substantially reduced. The reduction will reduce the maintenance dredging frequency downstream of Shenzhen River and minimize the potential water quality impacts which may arise from maintenance dredging activities.

Negative Impacts

Restrictions to Water Seepage: As the Eastern MDC is grasscrete lined, water seepage from the surrounding area will be possible through the grasscrete of the channel.

Maintenance Dredging: Ad hoc maintenance dredging is likely to cause potential short term negative local impacts on water quality. Dredging will lead to resuspension within the water column of organic and pollutants associated with the disturbed sediments.

As an inflatable dam will be installed at Eastern MDC upstream of the confluences of Shenzhen River, the influence of tidal siltation will be reduced. In addition, the sediment load will be further reduced under the enforcement of the Livestock Waste Control Scheme (LWCS) and WPCO.

Changes in Erosion Rates and Sedimentation Patterns: The water levels in the Eastern MDC are predicted to be lower than existing conditions due to channel widening. The lowering of water levels and the low flow during dry season will enhance sedimentation. This will be countered by the pumping station near the inflatable dam to divert water downstream.

Changes in Other Pollutants Downstream

Besides the potential operational water quality impacts of Eastern MDC discussed above, other pollutant loads entering the Eastern MDC and the receiving water body of Deep Bay are outside the direct control of this Study. Future water quality within the Eastern MDC and the receiving water body of Deep Bay will essentially depend on the effectiveness of enforcement associated with the WPCO and the LWCS at San Tin, and the future population growth and distribution at San Tin.

4.5.4 *Mitigation Measures*

4.5.4.1 With regard to mitigation, ad hoc maintenance dredging during dry season will be adopted to maintain flood capacity. It will be imperative that appropriate disposal of dredged materials are handled and managed in accordance with current EPD guidelines at the time of dredging.

Site Specific Mitigation Measures

4.5.4.2 For works involving maintenance dredging (the removal of silt and other materials) from the Eastern MDC, a system of containment or isolation must be specified to prevent water, heavily contaminated with the removed material from being carried downstream into Deep Bay.

4.5.5 *Residual Impact*

With the adoption and incorporation of the above mitigation measures, minimal residual operational water quality impacts are predicted.

4.6 CONCLUSION

The key issue in terms of water quality will be related to the excavation along the proposed alignment of the Eastern MDC during the construction phase. This activity, if uncontrolled, is likely to lead to the release of SS and pollutants from the disturbed existing stream sediments and reduction of DO within the local water bodies, affecting potential water sensitive receivers downstream.

A range of mitigation measures and working method controls has been recommended to ensure that potential to water quality impact is minimised to acceptable levels.

The proposed Eastern MDC works will introduce drainage improvements at San Tin, and will improve water quality through enhanced transportation of pollutants and increased flow rate of the water column. The installation of inflatable dams at the proposed Eastern MDC will also eliminate the impact of tidal intrusion that inhibits the flushing of upstream pollutants, and facilitate sedimentation of SS directly upstream of the dams and reduce downstream sediment pollution. Potential impact from ad hoc maintenance dredging is expected to be limited and will be controlled by appropriate measures.

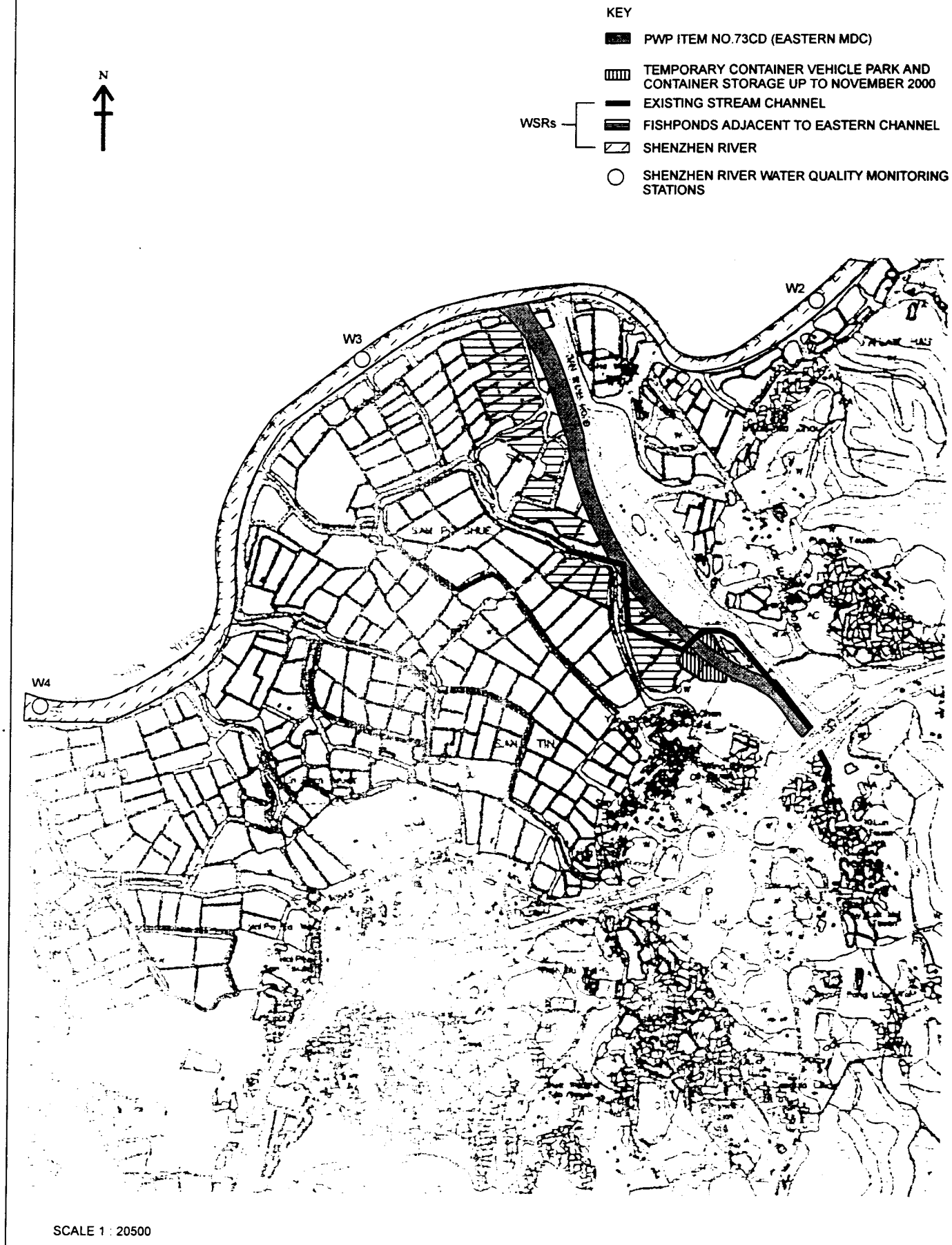

FIGURE 4.3a WATER QUALITY SENSITIVE RECEIVERS AND LOCATIONS OF SHAM CHUN RIVER WATER QUALITY MONITORING STATIONS

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