6.0 WATER QUALITY

6.1 Background

6.1.1 The proposed sewer network will serve to collect the sewage from the villages and by a series of pumping stations transfer the sewage to the trunk sewer which passes along the existing Castle Peak Road. This will achieve the effect of eliminating the untreated sewage discharges to surface water courses along this part of the coast and so improve stream water quality and reduce the bacterial counts at the bathing beaches in the area which frequently fail to meet the Bathing Beach Quality Standards.

6.2 Existing Environment

6.2.1 So Kwun Wat Tsuen and So Kwun Wat San Tsuen are situated in a low lying area to the south of Tai Lam Country Park. The area is drained by a stream which flows westwards and discharges to Castle Peak Bay through a partially enclosed marine shelter and mooring area at the Gold Coast. In its upper reaches at So Kwun Wat San Tsuen, the stream is relatively natural and clean and supports a variety flora and fauna, but becomes channelised in So Kwun Wat Tsuen and polluted by sewerage discharges which reduces both the water quality and ecological importance.

6.2.2 The other part of the project area lies either side of the Tai Lam Chung valley nullah which connects directly into the Urmston Road to the north west of Brothers Point.

6.2.3 There is no routine water quality monitoring data for these two streams although there is a significant amount of data regarding the marine water quality in Tuen Mun Bay and the Urmston Road from the EPD marine water quality monitoring programme (Stations NM1 and NM2). The marine water quality standards for the North Western Water Control Zone are broadly complied with, although occasionally the bathing areas at Cafeteria Beach fail to meet the Bathing Beach standards.

6.3 Assessment Methodology

6.3.1 The water quality impact assessment has qualitatively considered the two phases of construction and operation of the project as distinctly separate, since there is little in terms of the impact process that is common to both phases.

6.3.2 The two phases are:

- installation of the sewerage network and construction of the pumping stations. Impacts will be associated with the trenching works for the sewers and excavation for the pumping stations. This phase is of limited duration; and
- the operation of the scheme, which will be an on-going phase.

6.3.3 The identification and assessment of water pollution impacts has taken into account the following factors:

- water quality of the water bodies with the potential to be affected;
- the hydrology of the aquatic systems;
- bottom sediments; and
- the supported aquatic ecology.

6.3.4 The aim of the assessment has been to maintain the balance and integrity of the water causes as far as possible through prevention and minimisation of impacts at source in order to:

- maintain the natural properties of the water body;
- maintain the hydrological factors;
- control any discharges to within the relevant Water Quality Objectives;
- maintain the physical environment as far as practicable; and
- protect aquatic ecology.

6.4 Construction Phase Impacts

Background

6.4.1 The most significant potential impact on water quality will be due to suspended solids runoff from excavation sites and spoil heaps and from dewatering of trenches and foundations, when water containing high concentration of suspended solids may be discharged to water courses. The magnitude of any impacts will depend on the following:

- the extent of excavation;
- the nature of the excavated ground;
- topography; and
- weather conditions.

Tai Lam Valley

6.4.2 In the Tai Lam Valley, Drawing 1.1a, the works will be carried out along the banks of the spillway and there will be a possibility of run off from stockpiles of excavated material washing into the nullah which is estuarine in character and supports at least two commercial species of fish.

6.4.3 The upper pumping station will be constructed in the grounds of the Tai Lam Correctional Institution and the first length of sewer pipeline, linking it to the second pumping station at Tai Lam Chung Tsuen runs, along the right (east) bank of the water course tailrace. It is anticipated that for most of its length the sewer will be laid in the road or pavement and consequently there is unlikely to be any significant disturbance of open ground which might give rise to run off of suspended solids. Stockpiles of excavated material should be kept to a minimum and covered during times heavy rainfall.

6.4.4 The use of mechanical plant for the construction of the main sewer alignment and the pumping stations in this area will inevitably require refuelling together with fuel and oil storage and maintenance areas. As a consequence, there is the risk of spillage and leakage into the stormwater drains or directly into the nullah. However, proper site management measures will

be able to minimise any impacts to a negligible level. Excavation works in the villages themselves will be undertaken by largely by hand due to space constraints and, therefore, the issues associated with mechanical equipment will not be as pertinent.

6.4.5 At Tai Lam Chung Tsuen, the proposed location for the pumping station is located adjacent to the Tai Lam Chung Road in an area currently used as a garden. Excavation and construction works will be undertaken on the verge above the nullah and, thus, control of run-off will be a key issue. However, it is considered that with proper control, impacts can be reduced to acceptable levels.

6.4.6 The sewerage network serving Tai Lam Chung Tsuen will be constructed through the relatively narrow village streets and consequently it is unlikely that significant stockpiles of excavated material will be accumulated. However, excavation heaps and stockpiles of bedding should be covered during heavy rain to prevent run off carrying material into the surface water drains and causing partial blockages with the consequent risk of overflow onto surrounding streets and passageways.

6.4.7 In the village of Luen On San Tsuen, the sewer will generally follow either existing access routes or be constructed under a new access road as part of the proposed housing development in Tai Lam Chung and so the general precautions for minimising run-off from stock piles of excavated material will need to be followed. Control of stockpiled material and site run-off will be required during construction works and interface with the housing development will be required to avoid cumulative impacts.

6.4.8 The sewer will cross the route of a small tributary in Luen On San Tsuen which connects to the sea. Particular care will need to be exercised during construction of the crossing which will be installed below the stream bed. It is anticipated that this will be achieved by an open trench method and that this work will need to be carried out during the dry season. The ecology study has shown that the nullah contains fish. Thus, while the works are not anticipated to give rise to significant impacts, the appropriate measures for the control of water quality impacts as described in the EPD Practice Note for Professional Persons ProPECC PN 1/94 Construction Site Drainage are recommended to be followed.

6.4.9 Immediately after leaving the Tai Lam Chung Tsuen pumping station the sewer will need to cross the main estuary. The crossing will be achieved by means of a pipebridge located adjacent to an existing pedestrian bridge. The key issue in this respect will be during the construction of the two piers which will require dredging and foundation works. Three species of fish have been recorded for this location *Acanthopagrus latus* (Black Bream), *Mugil cephalus* (Grey Mullet) and *Monotaxis grandoculis* (Bigeye Basenose), all of which are commercial species. Impacts from suspended solids generations may impair fish respiration. However, the fish are large enough to avoid the impact and move to cleaner waters. Notwithstanding, while the works are not expected to give rise to any significant impacts, the dredging will be undertaken in the dry season and within the confines of a cofferdam which will minimse the dispersion of any suspended material.

6.4.10 The sewer section between the Tai Lam Chung Tsuen pumping station and that adjacent to the Castle Peak Road passes along the west bank of the lower section of the nullah. The route is

anticipated to follow a strip of land already cleared of vegetation. As with all open works adjacent to water courses precautions are required to prevent excavated materials washing into the water course. This is best achieved by covering exposed stock piles of excavated material and if any trench dewatering is required to pass the discharge through a suitable capacity portable silt trap.

6.4.11 Below the Tai Lam Valley pumping station, the main will be constructed within the existing pavement since the road is bounded by steep rock slopes. This will reduce the quantity of material with small particle size which is excavated and consequently run off from piles of this material will be more easily controlled.

6.4.12 Castle Peak Villa is situated close to the shoreline and during installation of the rising main and gravity sewers and the construction of the pumping station, it will be necessary to observe the recommendations in the EPD Practice Note for Professional Persons ProPECC PN 1/94 Construction Site Drainage in order to prevent run off from the site into the bay below the site.

So Kwun Wat Tsuen

6.4.13 This part of the project involves the construction of only one pumping station, as shown in Drawing 1.1c, to serve the sewage generated from the villages of So Kwun Wat Tsuen and So Kwun Wat San Tsuen. Most of the works will be carried out adjacent to the So Kwun Wat Road to the point at which the pumping station will be constructed. From this point the network will be predominantly within the village apart from the single main heading east to the small group of dwellings less than one kilometre away, at So Kwun Wat San Tsuen.

6.4.14 Within the whole area there are a large number of small watercourses which eventually drain into the stream which enters Castle Peak Bay at the Hong Kong Gold Coast. Most of the water courses within the village areas are canalised and relatively unnatural. They currently suffer from septic tank overflow discharges which greatly lowers the water quality. The upper reach of the So Kwun Wat Valley stream at So Kwun Wat Tsuen is natural in character with good water quality. Below the village, however, stream naturalness is limited through canalisation, shotcrete banks and sewage pollution. Most of the works will be carried out in ground adjacent to existing roads and paths and so will generate stockpiles of excavated material which could, if unprotected, be washed into the water courses during period of heavy rain. Based upon the ecological importance of the streams above the So Kwun Wat village, minimisation of exposure of the stockpiles to rain by carrying out reinstatement as soon as practicable, limiting the lengths of trench exposed and covering of stockpiles will be required to control any impacts.

6.4.15 Construction of the So Kwun Wat Valley stream crossing at the eastern edge of the proposed sewer alignment will generate suspended solids for a short period but will have no lasting effects on the water quality. In order to reduce impacts on the stream fish and invertebrates, the work should be carried out during periods of low water flow and disturbance to the stream bed minimised within the site limits.

6.5 Construction Phase Mitigation Measures

6.5.1 The EPD Practice Note for Professional Persons ProPECC PN 1/94 Construction Site Drainage provides detailed information on the measures which should be adopted during the construction process to prevent or minimise the impact of projects on adjacent water quality. Procedures which are appropriate to this project are discussed below.

Surface Run Off

6.5.2 The following specifications relating to surface run-off are relevant:

- excavation works should be carried out in the main estuary and small tributary during the dry season;
- excavation works in streams will be carried out during periods of low flow;
- dredging in the main estuary will be carried out within a cofferdam to minimise suspended solids dispersion;
- when works are carried out during the rainy season exposed slopes, stockpiles should be covered with tarpaulin and temporary access roads protected with a layer of gravel or crushed stone;
- surface run off should be discharged to storm drains via sand/silt removal traps;
- channels, bunds or sand bags should be used to direct any storm water to the traps and perimeter channels should be constructed before the main works begin to prevent external run off from crossing the site;
- silt removal structures, channels and manholes should be maintained to remove accumulated material, specifically at the onset and end of rainy periods;
- trenches for the sewer main should be dug and backfilled in short sections to minimise the quantities of rain water which will need to be pumped from them and up-slope bunding provided to prevent surface water from flowing into the trenches;
- rainwater pumped from the trenches should be discharged to storm drains via sand/silt removal traps; and
- discharges to natural water courses should only take place when the effluent can be shown to comply with the standards specified in the Technical Memorandum, Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters;

Mechanical Equipment

6.5.3 The following measures should be implemented during the construction phase to reduce the

potential for impacts from mechanical equipment:

- all plant should be in proper working order and maintained such that there is no leakage of fuel or oil. Any waste oils should be collected in designated tanks prior to disposal off site; and

- all mechanical plant maintenance and refuelling areas shall be sited on paved areas. All storm water run-off from these areas should be discharged via oil separators/petrol separators and sand/silt removal traps.

Groundwater

6.5.4 Groundwater pumped out of excavations for the construction of pump sumps should only be discharged following removal of silt by sand/silt removal traps.

Boring and Drilling Water

6.5.5 Water from drilling of rock should only be discharged following removal of silt by sand/silt removal traps.

Wheel-wash Water

6.5.6 The wheels of all vehicles leaving the construction site should be washed before leaving the site to minimise the carry over of mud onto public roads. Wheel wash water should be recycled and only discharged following removal of silt by sand/silt removal traps.

Wastewater from Site Facilities

6.5.7 The following specifications relating to waste water from site facilities are relevant:

- run off from the roofs of site buildings should be conveyed in closed drains to the nearest surface water course to prevent the generation of excessive quantities of surface water run off carrying suspended solids;

- all spillages should be cleaned up immediately to prevent their downward migration into the groundwater; and

- sewage arising from any toilets and kitchens in the construction site should be treated via a septic tank and soakaway system. If this is not practicable, chemical toilets should be provided and the effluent and waste arising from these facilities, together with any other 'grey water' generated from the site, should be removed on a daily basis for disposal at an appropriate receiving point.

6.6 Operational Phase Impacts

6.6.1 Once in operation, the system will collect the sewage from this area that has previously been chronically discharged, untreated or only partially treated, into the surface water drainage

system, with subsequent effects on the water quality of the surrounding water courses. Thus, the scheme offers a significant environmental benefit to the area in terms of improvements in the quality of inland streams and coastal water.

6.6.2 However, two types of pumping station operational failures could result in an overflow of sewage, namely possible pump failure or interruption of the electrical power supply. An emergency overflow bypass has been provided to each of the pumping stations to channel any overflow directly, or via the storm water drainage system, into the local receiving waters. This system is an effective mitigation measure to prevent any sewage discharging into the surrounding area, including village streets, in an emergency situation and will not be used during the regular maintenance procedures. While this facility has been provided, DSD records show that in the Tuen Mun area, no emergency sewage overflows have occurred as a result of pump or power failure, nor during any maintenance operation, since the first station became operational over 20 years ago. However, notwithstanding the lack of a previous incident, in order to reduce the possibility of such an event occurring as far as possible, a series of design integrated mitigation measures have been adopted for all pumping stations, as discussed below.

Individual Pump Failure

6.6.3 Failure of an individual pump can be mitigated by the inclusion of a standby pump in each pump house which will be initiated on the failure of the primary pump. This will prevent the build up of sewage at any single pump house and the use of the emergency overflow. In all cases, one standby pump has been provided which will allow the system to carry on as designed

Interruption of Power Supply

6.6.4 The interruption of power supply will result in the failure of the complete system. The risk of such a power failure is very small, with China Light and Power reporting a power supply reliability of 99.95%. However, in order to further protect against such an event, all the proposed pumping stations will be equipped with a dual power supply in the form of a ring main which will automatically take over in the event of the main power failure. The ring main system is the most reliable back-up system available. In case of the failure of the dual power supply, China Light and Power can restore the power supply within a relatively short period of time. However, in the extreme event of a prolonged failure of the dual power supply, a portable generator will be mobilised to ensure that the pumping stations remain operational until normal services are resumed.

6.6.5 In addition to the above measures, a telemetry system will be installed at all the pumping stations to ensure that prompt action can be taken in an emergency situation. The telemetry system is connected to the Pillar Point Sewage Treatment Works which is continuously manned. Other possible mitigation measures to protect against overflow discharges include the installation of storage tanks to contain the sewage flow until normal service can be resumed. The inclusion of storage tanks would significantly increase the landtake required for each of the facilities, having impacts on the landuse within the villages. Based upon the potential for landuse and environmental effects and the precautionary measures already included in the design of the pumping station and the fact that no failures have been recorded by DSD for the existing pumping stations in the Tuen Mun region in the past 20 years, it is considered that the risk of

an emergency overflow occurring is negligible and therefore, overflow storage tanks are not warranted.

6.6.6 In the extremely unlikely event that both the operational and standby pumps fail and/or prolonged failure of the dual power supply, the sewage will pass through the emergency overflow system into the local drainage system or stream course. Due to the telemetry system, any failure would be repaired promptly and the discharge would be short-term. In the case of the Tai Lam Valley system, the discharge should be to the water body with the greatest dilution capacity, in this case the large nullah or the open coastal water. As recommended, for the four pumping stations in this area, including the alternative locations, the emergency overflows have been designed to ultimately drain into the large or small nullahs, as shown in Drawing 1.1a, and, thus, any impact would be short-term and localised to the point of discharge only.

6.6.7 The emergency overflow at the Castle Peak Villas pumping station is designed to flow into a small existing drainage culvert, as shown on Drawing 1.1b, which flows to the centre of the non-gazetted beach and will ultimately drain into the sea at high tide. The position of the pumping station was recommended in the Sewerage Master Plan as being the technically optimum location, being the lowest point in Lok Chui Street. Utilising the lowest ground is necessary if gravity sewers are to be employed. If the station was moved to higher ground, then some individual properties would require pumps in order to transfer their household sewage to the pumping station.

6.6.8 The location of the pumping station places a constraint on the position of the emergency overflow. It has been determined that connecting the emergency bypass to the existing storm water drain to the centre of the beach represents the best technical solution. Alternative means to divert the overflow to other locations, thus avoiding the centre of the beach, have been investigated before this conclusion was reached. Connecting the bypass to the storm water drainage system would ultimately produce the same flow as the storm water flows into the existing culvert proposed to be used and thus, would not divert the overflow to an alternative location. The overflow cannot be located in an adjacent manhole as the level of the pumping station is lower than the manhole and this would result in any overflow spilling out into the street. Locating the overflow in any other position than at this lowest point would also require the sewage to be pumped uphill, which in an emergency situation would not be possible.

6.6.9 The land on the western edge of the beach is private and, thus an alternative outfall could not be located on that side. Positioning the outfall at the eastern side of the beach is constrained by the topography, visual impacts of locating a pipeline or channel across the beach and the need to remove the headland rock and vegetation in that area to allow for the channel which would cause additional construction phase impacts and a long term change to the landscape character of the area. The adjacent beach to the east may also be affected.

6.6.10 The alternatives and the constraints surrounding the selection of the emergency outfall are summarised in the following Table 6.1.

Table 6.1 Summary of Key Issues for Castle Peak Villas Pumping Station Emergency Outfall

Alternative	Constraints/Effects
Connect bypass to storm water drainage system	Ultimately drain to same location.
Locate overflow in an adjacent manhole	Height difference between level of the pumping station and manhole resulting in any overflow spilling out into the street.
Locate the outfall on the western edge of the beach.	Private land.
Locate the outfall at the eastern side of the beach.	Topography would require sewage to be pumped. Visual impacts of locating a pipeline or channel across the beach. Removal of the headland rock and vegetation area. Potential effects on the adjacent beach.
Locating the overflow in any other position than at this lowest point.	Requires sewage to be pumped uphill, which in an emergency situation would not be possible.

6.6.11 Thus, based upon the topographical constraints and technical requirements, the location of the pumping station and utilisation of the existing outfall represents the best option. It should be noted that the sewage will be screened on entry to the pumping station and therefore, large material will be removed. In addition, the wet well will provide some short-term storage, approximately 18 minutes, and thus, an overflow would not occur immediately should an emergency situation arise. A deeper wet well would result in additional pump power, hence using significantly more electricity over the whole operation life and the benefits of any supplementary storage achieved is not considered sufficient to offset the impacts, based upon the remote chance of such an emergency incident.

6.6.12 Risk of an emergency overflow occurring is negligible based upon the inclusion of the mitigation measures and contingencies discussed above. The key aspects are summarised below:

- regular maintenance to prevent failures in the first place;
- standby pump in case of pump failure;
- main power supply with 99.95% reliability;
- dual power supply in remote case of main power failure;
- telemetry system to ensure rapid response in an emergency situation;
- wet well to provide storage in emergency;
- screening basket to remove larger material; and
- portable generator in extreme case of both main and backup power failure.

6.6.13 In addition, it should be reiterated that the overflow bypass has been included to prevent any

overflow of sewage onto the streets in the remote chance that an emergency situation occurs.

6.6.14 In the unlikely event of an overflow occurring, the overflow would discharge into an embayed area which has, over most of its area, water depths of the order of 0mCD inshore to -4mCD where the bay joins the main coastal waters offshore. Tidal variations in water level will vary from less than 1m on small amplitude neap tides to over 2.5m on the largest amplitude spring tides. Considering the relatively shallow water depths, this variation in tidal level will result in a significant exchange between the open coastal waters and the bay. Assuming any discharged effluent is uniformly mixed over the water depth, the residence time of the bay, that is the length of time taken to flush any pollutants from the bay, can be predicted to be of the order of 1-2 days. In reality, especially in the dry season, the effluent will have a salinity of around 10kg/m^3 or less and will be significantly less dense than the seawater (34kg/m^3 in the dry season). Because of this density difference, any overflow from the pumping station will tend to form a thin surface layer which will spread horizontally and flow seawards out of the bay. The residence time of the bay, therefore, can be expected to be significantly shorter than 1-2 days due to tidal flushing alone.

6.6.15 The total volume of effluent which might be discharged into the bay in exceptional circumstances is estimated to be no more than 130m^3 (0.109m^3/s for 15-20 minutes). The embayed area is approximately 750m wide at the seaward entrance and up to 200m from the entrance to the shore with a total water volume (at low water) of around 200,000m^3. As a result, if the effluent discharge did become well mixed over the bay, dilution factors of over 1,500 could be expected. If the effluent forms a thin surface layer up to 0.5m thick say, an area of up to 260m^2 could be affected initially, before the effluent is flushed from the bay. The plan area of the bay is estimated to be 75,000m^2 and so only 0.3% of the embayed area would be temporarily affected.

6.6.16 Bearing in mind that any emergency overflow would be of limited duration and would generate a relatively small patch of contaminated water, the relatively short time any discharge is expected to remain in the bay and the relatively large dilution rates which could be achieved, the impact on water quality in the bay is expected to be minimal. In these circumstances, any reduction in dissolved oxygen levels due to the oxygen demand of the effluent or increase in nutrient levels would be difficult to observe and would have insufficient time to exert any significant influence on the ambient water quality. The only effluent parameter which might be of concern would be the bacteria in the discharge. The overflow will discharge at the shore and, especially on a rising tide, bacterial contamination of the beach and nearshore waters might occur over a limited length of the shoreline. The beach, however, is not a gazetted beach and the viability of the bacteria in shallow water in bright sunlight is likely to be no more than a few hours up to say 24 hours.

6.6.17 Once the effluent patch has reached the open coastal waters, the strong tidal flows in the Urmston Road would ensure rapid dilution and dispersion of the effluent and any impact on the open coastal waters would be negligible.

6.6.18 In the case of So Kwun Wat Tsuen, the options are limited to the stream. Due to the quality of the water courses in this area, any emergency overflow could affect the fauna in the area of

the discharge. A discharge of raw sewage would probably affect the less mobile vertebrate and invertebrates but the effect would be very localised. Location of the emergency overflow below So Kwun Wat Tsuen, however, would avoid damage to the more natural upper stream in So Kwun Wat San Tsuen. As detailed in Drawing 1.1c, the overflow has been designed to discharge at the recommended location. Recovery of the streams fauna would be expected to occur relatively quickly as species re-colonise from the more diverse and natural upstream areas.

Waste Disposal

6.6.19 In order to avoid secondary impacts to water quality resulting from the inappropriate disposal of screenings, these should be disposed of at a suitably licenced landfill.

6.7 Residual Impacts

6.7.1 No residual impacts are predicted during the construction phase with all predicted impacts being able to be reduced to acceptable levels by the implementation of the recommended mitigation measures. Residual impacts during the operational phase will only occur during an emergency overflow situation. However, extensive mitigation measures have been implemented to ensure that the risk of this happening are negligible and the effects minimised in the unlikely event that an overflow does occur. In addition, as the overflow bypasses have been included into the pumping station designs to prevent sewage discharging onto the surrounding streets close to residential properties should an emergency occur, it is considered that any residual impacts would be acceptable within the overall benefits of the scheme.

6.8 Environmental Monitoring and Audit

6.8.1 The assessment has concluded that water quality impacts can be mitigated to acceptable levels and no residual impacts will occur. However, it is recommended that construction phase environmental monitoring and audit is undertaken to ensure that the recommended mitigation measures are being implemented and are effective. This will take the form of site supervision during the regular EM&A site inspections. Operational water quality EM&A is not required. Further details of the specific EM&A requirements are detailed in Section 11 of this report and in the EM&A Manual.