

	To Kwun Tong PTW	To To Kwa Wan PTW		
Educational Flow (m ³ /day)	354	391	518	944
Employment Flow (m ³ /day)	11,692	4026	5436	14947
Total Average Flow (m³/day)	38,825	23207	27514	57,735
Total Average Flow (m³/s)	0.45	0.27	0.32	0.67

6.4 Assessment of Sewerage and Sewage Treatment Capacities

6.4.1 Introduction

6.4.1.1 The proposed SEKD will discharge sewage flows directly to both the Kwun Tong PTW and the To Kwa Wan PTW. These flows will then enter the existing SSDS Stage I tunnel system conveying flows to the Stonecutters Island Sewage Treatment Works (SCISTW). Therefore, the following assessments will focus on the impacts of the proposed SEKD on:

- SSDS Stage I;
- Existing trunk sewerage system; and
- The internal SEKD sewerage system.

6.4.2 Assessment of Major SSDS Facilities

Stonecutters Island STW and SCIMPS

6.4.2.1 As part of the assessment carried out to evaluate the impacts of the SEKD on the major existing and planned SSDS facilities, a comparison has been made on the projected flows to the Kwun Tong PTW and To Kwa Wan PTW, based on projections for these catchments as developed under the following Studies:

- (1) Agreement No. CE 104/98, Strategic Sewage Disposal Scheme Stage II, Preliminary Project Feasibility Study (flow projections based on TPEDM Scenario II-August 1999 data);
- (2) Agreement No. CE 85/98, Stage II Study On Review of Metroplan and The Related Kowloon Density Study Review (flow projections based on DEVIN model); and
- (3) Agreement No. CE 25/98, Review of Central and East Kowloon Sewerage Master Plans (RC&EKSMF).

6.4.2.2 For all methods, the projected flows from the SEKD for years 2006, 2011 and 2016 have been based on the latest Preliminary Layout Plan as developed under this Study and the corresponding distribution of flows to the two PTWs. **Table 6.5** shows the projected flows to Kwun Tong PTW and To Kwa Wan PTW, for years 2006, 2011 and 2016, based on data from the TPEDM Scenario II – August 1999, DEVIN Model, and the data developed under the RC&EKSMF.

Table 6.5 Projected Flows to Kwun Tong PTW and To Kwa Wan PTW

PTW	Year 2006 ADWF (m ³ /s)			Year 2011 ADWF (m ³ /s)			Year 2016 ADWF (m ³ /s)		
	TPEDM ¹ Sc. II	DEVIN ² Model	RC&EK ³	TPEDM ¹ Sc. II	DEVIN ² Model	RC&EK ³	TPEDM ¹ Sc. II	DEVIN ² Model	RC&EK ³
Kwun Tong	3.79 (0)	3.77 (0)	4.30 (0)	4.26 (0.21)	4.18 (0.21)	4.93 (0.21)	4.58 (0.45)	4.53 (0.45)	5.24 (0.45)
To Kwa Wan	3.29 (0.37)	3.17 (0.37)	3.78 (0.37)	3.36 (0.45)	3.15 (0.45)	3.70 (0.45)	3.62 (0.67)	3.62 (0.67)	3.99 (0.67)

Notes:

1. The SSDS Stage II PPFS flow projections are based on development projections under PlanD's TPEDM Scenario II (August 1999) data.
2. The Metroplan Review projections are based on development projections under the DEVIN Model.
3. Central and East Kowloon projections are based on data obtained from the report titled "Technical Note No. 2 – Population and Land Use (Revised) dated July 2000" under the same study.
4. The flow figures shown in brackets refer to the contribution of flow from the SEKD, as developed under this Study (Table 6.4 refers).
5. Related flow calculations are provided separately in the Appendix to this report
6. Flow figures for 2016 allow for the ultimate development.

6.4.2.3 As can be seen from **Table 6.5**, the flows to Kwun Tong PTW and To Kwa Wan PTW using the TPEDM Scenario II data and the DEVIN Model data are comparable. However, it is evident that the projections developed under the Review of Central and East Kowloon SMP Study exceed those carried out based on the TPEDM Scenario II and DEVIN Model data. The flow projections developed under the SSDS Stage II PPFs “Technical Note No. 1 - Development and Flow Projections” have been endorsed under the SSDS Stage II PPFs Study and are slightly higher than those from the DEVIN Model. It should be noted that TPEDM Scenario II specifically includes a margin of safety over Scenario I, which is the ‘likely’ projection. Therefore, for the purposes of this assessment, average dry weather flows to Kwun Tong and To Kwa Wan PTWs as determined from the TPEDM Scenario II data (updated with the development/flow projections for SEKD) shall be used to assess impacts on the SSDS Stage I System. However the RC&EK projections will also be considered and the measures required to mitigate any constraints from these higher flow projections will be addressed.

Allowance for SEKD in the Design of SSDS Stage I

6.4.2.4 **Table 6.6**, presents a comparison between the population, employment and the resulting flow projections for Central and East Kowloon (including the SEKD) as used in the design of the SSDS Stage I, and those developed under this Study. For the Central (N&S) Kowloon Catchment (discharging to To Kwa Wan PTW), both the total residential and employment population projections for the TPEDM Scenario II are greater than those projected under the SSDS Stage I design for year 2011. In addition, for the East Kowloon Catchment (discharging to Kwun Tong PTW), the residential population projections for the TPEDM Scenario II are greater than those projected under the SSDS Stage I design for year 2011. The SSDS Stage I design employment population projections for East Kowloon, are greater than those projected using the TPEDM Scenario II data. Therefore, the increased flows projected using the Scenario II data, when compared to the Stage I design flows for both these catchments, can be attributed to the increased residential population projections based on the TPEDM Scenario II data.

Table 6.6 Projected Population, Employment and Flows for 2011
Comparison between Stage I Design and TPEDM Scenario II (August 1999) Projections

Catchment		Residential Population		Employment		Flow (m ³ /s)	
		2011 (Stage I)	2011 (TPEDM)	2011 (Stage I)	2011 (TPEDM)	2011 (Stage I)	2011 (TPEDM)
Kwun Tong PTW	Total	781,617	994,939	441,358	407,199	3.66	4.26
	SEKD	88,938	66,279	38,568	16,984	0.41	0.24
	Note 1	692,679	928,660	402,790	390,215	3.25	4.02
To Kwa Wan PTW	Total	628,632	690,637	378,579	390,425	3.07	3.36
	SEKD	136,226	108,205	58,220	22,153	0.61	0.40
	Note 1	492,406	582,432	320,359	368,272	2.46	2.96

Notes:

1. Projections for remainder of the catchment.
2. Projections for SEKD, under the TPEDM projections, have been based on data generated from the SEKD Feasibility Study.

6.4.2.5 The SSDS Stage I was designed to accommodate an ADWF of 1.07m³/s (2021 flow) from the SEKD (as determined from the Stage I design). From **Table 6.5**, the current development proposals for the SEKD project an ADWF of 1.12m³/s. Therefore, the projected flows from the SEKD, as presently envisaged, essentially are the same as those which have been allowed for in the design of SSDS Stage I. The allowance for the SEKD flows in the SSDS Stage I design is presented for background information only, and does not contribute solely to the assessment carried out in this report. Detailed flow calculations for SEKD are provided separately in the **Appendix 6A** to this report.

Projected Flow to Stonecutters Island Sewage Treatment Works (SCISTW) based on the Current SSDS Stage I

6.4.2.6 The projected flows to SCISTW by years 2006, 2011 and 2016 have been derived and are presented in **Table 6.7** and **Figure 6.1**, the total projected flow to SCISTW (excluding the Stage III/IV flows) would be 36.9m³/s, 39.46m³/s and 40.69m³/s respectively. The designed capacity of SCISTW under SSDS Stage I is 39.75m³/s. Therefore, the designed capacity of the SCISTW would not be exceeded by the projected year 2006 and 2011. However, the flow projections suggest that the design capacity of SCISTW might be exceeded before 2016 if no additional facilities are provided by that date.

Table 6.7 Projected Flows to Stonecutters Island STW and SCIMPS in 2006, 2011 and 2016

Area	Peak Flow Into SSDS System (m ³ /sec)		
	2006	2011	2016
SSDS Stage I			
Chai Wan	1.65	1.67	1.58
Shau Kei Wan	1.67	1.58	1.56
Tseung Kwan O	3.50	4.75 ⁽⁵⁾	4.89 ⁽⁵⁾
Kwun Tong	7.58	8.52	9.16
To Kwa Wan	6.58	6.72	7.24
Kwai Chung/Tsuen Wan	5.76	6.10	6.04
Tsing Yi	1.66	1.62	1.72
Total Flow to SCIMPS	28.40	30.96	32.19
NW Kowloon	8.50	8.50	8.50
Total Flow to SCISTW	36.90	39.46	40.69

- 1) Peak factors are for discharge to tunnels, except for NW Kowloon for which the capacity of the NW Kowloon PS at Stonecutters Island is used.
- 2) Flows to Kwun Tong and To Kwan Wan PTWs are based on projections developed using TPEDM Scenario II (August 1999) data, with SEKD flows as projected under the SEKD Study.
- 3) Average flow from Tseung Kwan O (2.376m³/s) taken from the "Feasibility for Intensification and Extension of Tseung Kwan O – Sewerage Impact Assessment (August 1999)"
- 4) Flow from Tseung Kwan O for year 2016 taken to be equal to the design capacity (4.89m³/s) of the tunnel from Tseung Kwan O to Kwun Tong.
- 5) The flow figure for NW Kowloon represent the pump capacity at the NW Kowloon Pump Station.

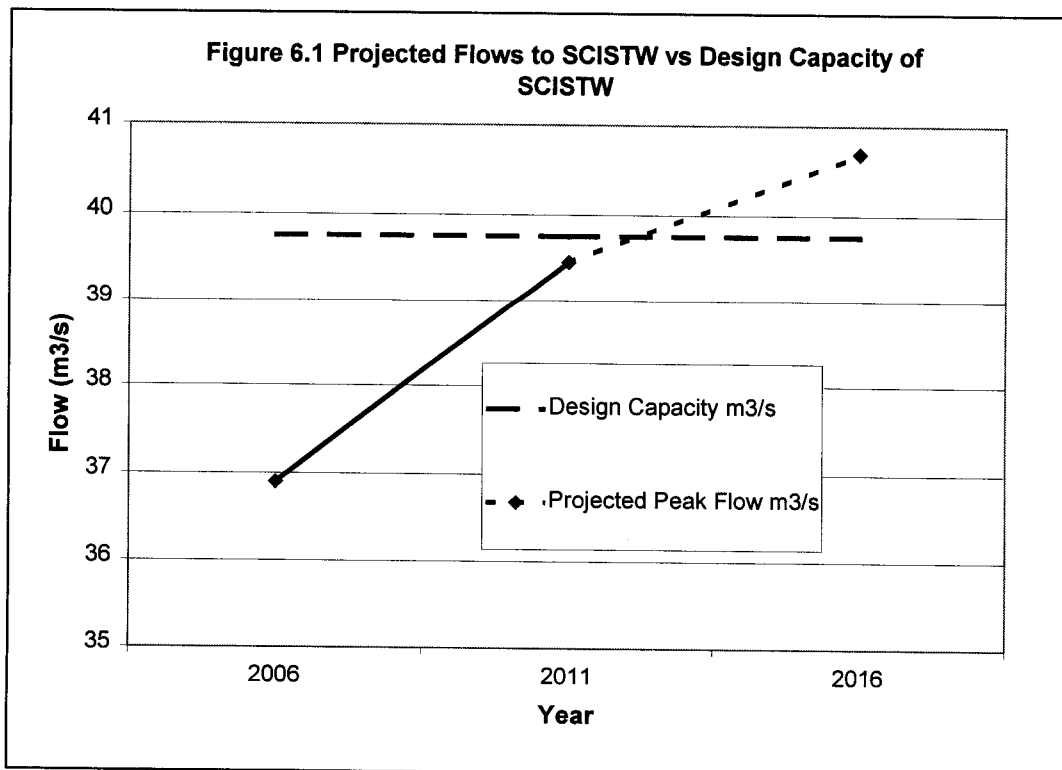


Figure 6.1 SSDS Stage I Tunnel Inlet Flows

6.4.2.7 The Kwun Tong and To Kwa Wan PTWs connect to the ultimate and penultimate nodes of the Eastern Tunnel System. For this assessment, consideration has only been given to the inlet capacity into the SSDS transfer system, and not the SSDS tunnel capacities themselves. EPD are presently undertaking a flow re-assessment for the SSDS Stage I at a strategic level.

6.4.2.8 Comparing the design flows for discharge to the transfer system from the relevant Stage I catchments with the projected flows gives the results shown in **Table 6.8**. The projected flows are based on the TPEDM Scenario II development data, updated to account for SEKD flow projections as determined under this Study.

Table 6.8 Flows to Tunnels from SSDS Stage I Catchments

Catchment	Design Flow to SSDS Tunnels	ADWF (m ³ /sec)			Available peak factor for discharge to tunnels		
		2006	2011	2016	2006	2011	2016
Kwun Tong	7.70	3.79 ¹	4.26 ¹	4.58 ¹	2.03 ¹	1.81 ¹	1.68 ¹
To Kwa Wan	6.99	3.29 ²	3.36 ²	3.62 ²	2.12 ²	2.08 ²	1.93 ²

Notes:

¹ Flows to Kwun Tong include the projected flows from the SEKD based on the population and employment projections developed under this Study

² Flows to To Kwa Wan include the projected flows from the SEKD based on the population and employment projections developed under this Study.

6.4.2.9 The design peak factor (2.0) for tunnel flow would be available at East Kowloon for year 2006 only, whilst the same design peak factor (2.0) would only be available for Central Kowloon for years 2006 and 2011. It should be noted, however, that the tunnel sections from Kwun Tong to To Kwa Wan and To Kwa Wan to SCISTW (Tunnels D and E) represent the most downstream sections of the eastern tunnel system.

Impact of Increased Flow Forecasts on SSDS Stage I (Assuming the delayed implementation of SSDS Stage III/IV or other relief measures)

6.4.2.10 Any impacts associated with increased populations and resulting flows on SSDS Stage I need to be considered in the context of:

- Actual hydraulic performance of the system following commissioning (friction, head losses);
- Actual dry and wet weather flow characteristics of the individual SCAs; and
- Actual flows in the down stream tunnel section as a result of combined contributions of all upstream SCAs.

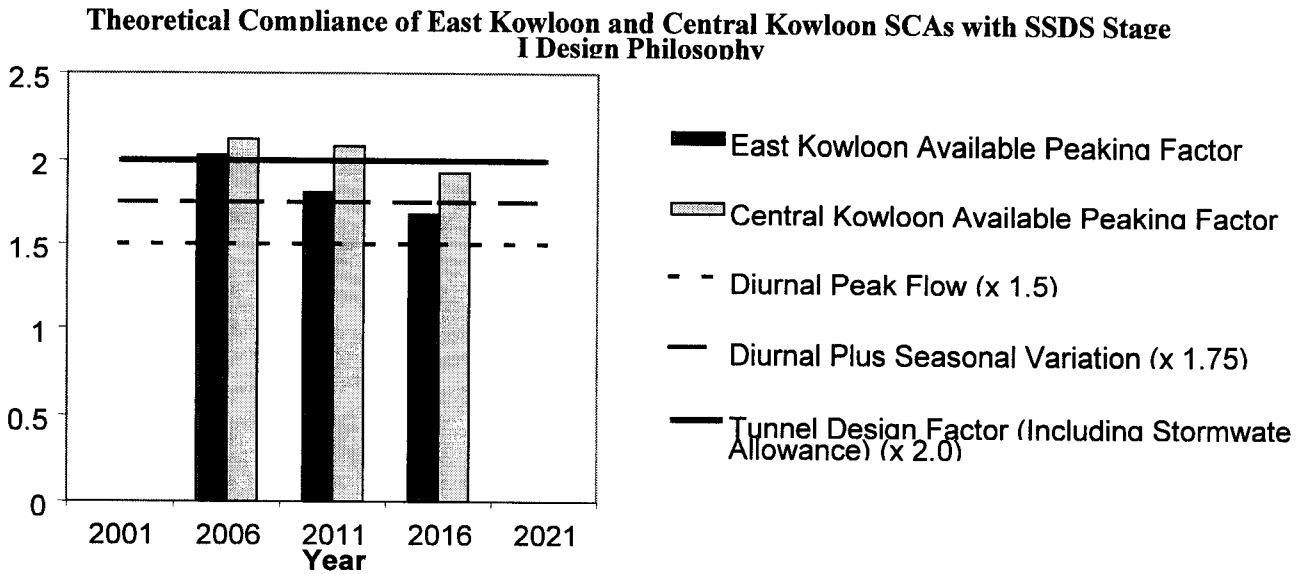
6.4.2.11 The SSDS Stage I design is based on limiting flows to the tunnels, at each PTW, to design values by hydraulic control at the vortex drops or, in the case of Tseung Kwan O, maximum pump capacity.

6.4.2.12 Therefore, in the case of Kwun Tong and To Kwa Wan SCAs it is possible to assess the potential impact of the increased flow by considering the SSDS design philosophy, in terms of flow capture, and comparing it with the revised projections.

6.4.2.13 The SSDS design philosophy is based on capturing all dry weather flows, including provision for seasonal variation, plus some allowance for rainfall. For large catchments (equivalent population exceeding 400,000) such as Kwun Tong and To Kwa Wan, the overall peaking factor for flow to tunnels is determined as follows:

- Diurnal Peak = 1.5 x Annual Average Dry Weather Flow (AADWF)
- Allowance for seasonal variations = (1.17 x 1.5 =) 1.75 x AADWF
- Design flow including rainfall allowance = 2.0 x AADWF

Figure 6.2



- 6.4.2.14 The theoretical compliance of the two catchments, over the period from 2006 to 2016, is shown on **Figure 6.2**. As illustrated, the Central Kowloon catchment is able to accept all diurnal flows including seasonal variations up to at least 2016.
- 6.4.2.15 For the East Kowloon catchment, the current capacity is capable of accepting all diurnal flows including seasonal variations beyond 2011.
- 6.4.2.16 Where the available peaking factor drops below 2, but above 1.75, this indicates a reduction in available capacity for wet weather flow to be accepted into the system. The significance of any reduction is directly related to the wet weather performance of the catchment in terms of inflow and infiltration.
- 6.4.2.17 The substantial rise in population projected for East Kowloon could result in capacity constraints in the SSDS system if development reaches TPEDM Scenario II levels beyond 2011 and peak flows coincide at all contributing catchments.
- 6.4.2.18 Studies are currently being undertaken by EPD to model the peak flows to each node of the SSDS Stage I and their effect on the overall capacity of the system. The work will show whether a real capacity constraint is likely beyond 2011, in advance of further stages of SSDS (or the Harbour Area Treatment Scheme 'HATS'). If measures can be taken to alleviate the constraints through provision of additional facilities at Kwun Tong PTW and To Kwa Wan PTW, on land already allocated for the purpose, specifically the additional facilities would be an expansion of the PTW which may comprise holding tanks. Determination of the volume of holding tanks requires the detailed analysis of SSDS Stage I based on a comprehensive review of long term gauging information. Subject to the above studies and provision of the additional facilities at the PTW sites, if demonstrated to be required by those studies, the proposed South East Kowloon Development is environmentally sustainable with respect to sewerage infrastructure planning.

6.4.3 **Assessment of Preliminary Treatment Works (PTW) Capacities**

- 6.4.3.1 An assessment of the impacts of projected flows on the existing To Kwa Wan PTW and Kwun Tong PTW is given below.

To Kwa Wan PTW

6.4.3.2 As noted previously, the capacity of To Kwa Wan Preliminary Treatment Works is 9.32 m³/sec. As can be seen from the projected flows from the Central Kowloon catchment summarised in **Table 6.9**, this PTW will have sufficient spare capacity. At such flows, full treatment could be provided with standby available.

Table 6.9 Projected Flows to To Kwa Wan PTW

	2006	2011	2016
PTW Capacity, m ³ /sec	9.32	9.32	9.32
Peak Flow (including storm allowance), m ³ /sec (TPEDMII)	7.47	7.61	8.11
Peak Flow (including storm allowance), m ³ /sec (RCEKSMP)	8.47	8.29	8.86
Sufficient Capacity?	✓	✓	X

Note : Peak flow (RCEKSMP) is for whole catchment.

6.4.3.3 Because flow to To Kwa Wan PTW comes from several major pumping stations plus a local catchment gravity flow the peak flow arriving at the PTW is greater than if the total flow was from a single catchment (Based on DSD sewerage design manual peaking factors). The result of this is the flow capacity of the PTW is exceeded by 2016. To obtain a more realistic assessment of peak flows arriving at the PTW, a calibrated dynamic model would need to be carried out. Depending on the outcomes of the HATS study the detailed design of the SEKD sewerage system will need to ensure that the peak flow does not exceed the levels in RCEKSMP or alternatively include the possible extension facilities to the PTW's to cater for excessive peak flows.

6.4.3.4 The potential lack of capacity is a regional planning issue rather than a SEKD problem, nevertheless possible solutions to the issue include:

- An overall telemetry system with real time control to utilise storage in the sewerage systems;
- Variable speed drives for pumping stations to allow pumping rates similar to inflow;
- Balancing tanks at either the PTW or at pumping stations. An area has been allocated for this purpose or possible expansion of the To Kwa Wan PTW of approximately 0.5ha.

Kwun Tong PTW

6.4.3.5 As noted previously, the capacity of Kwun Tong Preliminary Treatment Works is 10.93 m³/sec. As can be seen from the projected flows from the East Kowloon catchment summarised in **Table 6.10**, this PTW will have sufficient capacity based on TPEDM Scenario II.

Table 6.10 Projected Flows to Kwun Tong PTW

	2006	2011	2016
PTW Capacity, m ³ /sec	10.93	10.93	10.93
Peak Flow (including storm allowance), m ³ /sec (TPEDMII)	8.36	9.22	9.83
Peak Flow (including storm allowance), m ³ /sec (RCEKSMP)	9.42	10.55	11.11
Sufficient Capacity?	✓	✓	X

6.4.3.6 Depending on which PWWF projections are adopted, there may be a potential capacity constraint at Kwun Tong PTW by the year 2016. Because flow to Kwun Tong PTW comes from a major pumping station in SEKD plus a local catchment the peak flow arriving at the PTW is greater than if the total flow was from a single catchment (Based on DSD sewerage design manual peaking factors). The result of this is the flow capacity of the PTW is exceeded by 2016. Planning includes for an area of land at the treatment plant to make allowance for an

extension of the PTW which may comprise holding tanks. These extension facilities would be to treat the difference between PTW discharge and SSDS capacity. The extension facilities could be placed upstream of the PTW so that the excess inflow to the works rather than discharge from the works was treated. This has the same impact on flows but also allows the PTW to operate without further upgrade. Determination of the volume of holding tanks requires a detailed analysis of the entire SSDS Stage 1 system based on a comprehensive review of long term gauging information. The approximate area allocated for possible expansion of the Kwun Tong PTW is 3.3ha.

- 6.4.3.7 The PWWF projections the East Kowloon SCA suggests that the KTPTW would exceed its capacity by year 2016, based on the population data obtained from the Review of Central and East Kowloon SMP. It should be noted that for year 2016 the PWWF projection, based on Planning Department's TPEDM Scenario II population data, indicates that no shortfall in capacity will result.
- 6.4.3.8 Land has been reserved for the future expansion of both the KTPTW and the TKWPTW. It is understood that, under the Review of Central and East Kowloon SMP, expansion of the Kwun Tong PTW has been proposed to cater for this projected shortfall in treatment capacity.
- 6.4.3.9 It is recommended that the flows to the KTPTW be monitored to assess the actual build-up of flows in comparison with those projected, to evaluate the accuracy of the projections based on "real" flow data. This assessment of flows, taking into consideration of the timeframe required for the implementation of any expansion facilities should this found to be necessary, could be used to determine whether and when a decision has to be made on whether PTW expansion is required.

6.4.4 *Assessment of Impacts to the Existing Trunk Sewerage System*

- 6.4.4.1 Consideration has been given to an option of providing interim connection of the proposed SEKD sewerage system to the existing trunk sewerage system in central and East Kowloon. The purpose of this is to facilitate discharge of sewage from the early development area within the North Apron Kai Tak Airport (NAKTA) prior to completion of the permanent connecting pipeline between SEKD PS4 and TKWPTW. The proposed option for conveying sewage from the early development areas allows NAKTA flows together with diverted sewage from the existing hinterland to be pumped directly to the To Kwa Wan PTW via a new rising main and therefore will not create an impact on the existing system. It is proposed that the rising main be constructed and commission prior to the first population intake of the SEKD early development areas.
- 6.4.4.2 However, to provide additional flexibility and security for the early development area, it is proposed that a temporary sewerage connection be provided from PS1 into the existing hinterland's sewerage system (via. The DN1650 Prince Edward Road trunk sewer). The full flow capacity of this existing sewer has been assessed to be 2.06 m³/s. The projected hinterland flows (excluding SEKD flows) into this trunk sewer would be approximately 0.38 m³/s by year 2006. The peak flows to be discharged from the early development area within the SEKD, into this existing trunk sewer is approximately 0.82m³/s. Therefore, this trunk sewer would have sufficient spare capacity to accept flows from the early development area, on a temporary basis, in the event that the downstream rising main from Pumping Station No. 4 could not be constructed in time to meet the population intake. In this regard, we have also liaised extensively with the consultant for the Review of Central and East Kowloon SMP (RCEKSMP) on this matter. The RCEKSMP consultant has modelled the existing hinterland's sewerage system has confirmed the assessment made under this Study that the existing DN1650 sewer could accept the early development flows up to year 2006. Additional hinterland flows to be diverted to PS 1 of approximately 1.2m³/s are unlikely to occur before 2011 and therefore will not have any impact on the temporary connection.

6.4.5 Conclusions

6.4.5.1 Since the SSDS Stage I design:

- (1) Flow projection for SEKD has not changed significantly.
- (2) Flow projection for Central and East Kowloon has risen substantially, especially in East Kowloon.

6.4.5.2 The substantial rise in population projected for East Kowloon could result in capacity constraints in the SSDS system if development reaches TPEDM Scenario II levels beyond 2011 and peak flows coincide at all contributing catchments.

6.4.5.3 Studies are currently being undertaken by the EPD to model the peak flows to each node of the SSDS Stage I and their effect on the overall capacity of the system. This work will show whether a real capacity constraint is likely beyond 2011, in advance of further stages of the SSDS (or the Harbour Area Treatment Scheme 'HATS'). If so, the constraint would result primarily from intensified development in the existing urban area of Kowloon, not from the SEKD, and measures could be taken to alleviate the constraints through provision of additional facilities at Kwun Tong and/or To Kwa Wan on land already allocated for the purpose.

6.4.5.4 Possible extension facilities to the To Kwa Wan and Kwun Tong PTWs, as described in sections 6.4.2, 6.4.3 and 6.4.4, will be included in the SEKD projects. Implementation of such facilities is contingent upon the findings of the HATS study to be completed in 2003.

6.5 Part 2 - Sewerage Design Criteria

Preliminary designs for the proposed sewerage system have been prepared in accordance with the requirements specified in the DSD Sewerage Manual and DSD's Standard Drawings. The following additional requirements shall also be adopted in the detail design.

6.5.1 Design Standards

6.5.1.1 Design of the foul sewers, manholes, pumping mains, pumping stations and chambers follow the recommendations of the Drainage Services Department Sewerage Manual, DSD's Standard Drawings and the Tables for the Hydraulic Design of Pipes and Sewers (5th edition) - Hydraulics Research, Wallingford; where appropriate, these designs will comply with the provisions of the following standards:

- BS65 Specification for Vitrified Clay Pipes, Fittings and Joints;
- BS EN598 Ductile iron pipes, fittings, accessories and their joints for sewerage applications, requirements and test methods;
- BS497 Specification for manhole covers, road gully gratings and frames for drainage purposes;
- BS4772 Specification for Ductile Iron Pipes and Fittings;
- BS5911 Part 100 Specification for Unreinforced and Reinforced Pipes and Fittings with Flexible Joints;
- BS5911 Part 120 - specification for unreinforced jacking pipes with flexible joints;
- BS8005 Part 1 : Sewerage - Guide to New Sewerage Construction;
- BS8007 Design of Concrete Structures for Retaining Aqueous Liquid;
- BS8010 Section 2.1 - Code of Practice for Pipeline: Ductile Iron; and
- BS8110 Part 1 : Structural Use of Concrete - Code of Practice for Design and Construction.