立法會
Legislative Council

LC Paper No. CB(2) 579/00-01(01)

Ref : CB2/PL/EA

**Information paper for the
Panel on Environmental Affairs**

Strategic Sewage Disposal Scheme

Purpose

This paper provides background information on the Strategic Sewage Disposal Scheme (SSDS) and the efforts made by the LegCo Panel on Environmental Affairs (EA Panel) to address the environmental and technical problems related to the SSDS.

The problem

2. With the growth of population of Hong Kong over the past years, there has been a significant increase in the sewage discharged into Hong Kong coastal and inshore waters. The raw sewage is heavily contaminated with bacteria and other pollutants which can create severe health risks. The heavily polluted discharges also seriously affect marine fish and other marine life, because sewage pollutants deplete oxygen in the water, which is essential to sustain marine life.

3. In the late 1980s, the Environmental Protection Department (EPD) completed the Sewage Strategy Study which recommended, amongst other things, the implementation of the SSDS to deal with the water pollution problem for the main urban areas surrounding Victoria Harbour.

The Strategic Sewage Disposal Scheme (SSDS)

4. The SSDS [Note 1] is an overall sewage collection, treatment and disposal strategy for areas on both sides of the Victoria Harbour. It comprises a series of deep tunnels to collect and transfer sewage from the central urban areas of Hong Kong and Kowloon to a centralised treatment works at Stonecutters Island, and then to a deep ocean outfall south of Lamma Island after treatment.

[Note 1 : The present form of the SSDS was recommended by the first International Review Panel in 1995.]

5. The SSDS was designed to be built in stages in order to achieve early improvement to the water quality in the Victoria Harbour and to allow time for the Environmental Impact Assessment (EIA) process on the deep ocean outfall to be completed. The SSDS, which combined a degree of land-based sewage treatment with natural dilution of sewage pollutants by ocean waters, was recommended by the consultants as the most cost-effective and environmentally acceptable option.

SSDS Stage I

6. SSDS Stage I consists of seven deep tunnels which have a total length of 25.3 kilometres. The interim outfall tunnel, which is 1.7 kilometres in length and 100 metres below the Victoria Harbour, is already in operation. The other six sewage collection tunnels, which have depths up to 150 metres below ground surface, comprise-

(a) two western tunnels from Kwai Chung to Tsing Yi and from Tsing Yi to Stonecutters Island; and

(b) four eastern tunnels from Tseung Kwan O and Chai Wan to Kwun Tong, from Kwun Tong to To Kwa Wan, and from To Kwa Wan to Stonecutters Island.

7. The SSDS Stage I will treat about 70% of all main urban area sewage on its completion by the end of 2001. In 1994, a capital injection from the Capital Investment Fund was made to fund the implementation of the engineering works of the SSDS Stage I at an estimated cost of $6,693 million (money-of-the-day price). The overall approved project estimates for completing the whole SSDS Stage I was increased to $8,438.7 million on 15 December 2000.

SSDS Stage II, III and IV

8. The current proposal for Stage II is to build an effluent transfer system from the Stonecutters Island Sewage Treatment Works to an oceanic outfall in the East Lamma Channel and sewage disinfection facilities at Lamma Island. SSDS Stages III/IV will collect sewage from the north-shore of Hong Kong Island, Pokfulam and Aberdeen for delivery to Stonecutters Island Sewage Treatment Works for treatment.

Concerns of the Panel on Environmental Affairs

9. Since its launching in the early 1990s, the SSDS has been a subject of serious concern to the environmentalists and the Legislative Council Panel on Environmental Affairs (EA Panel) because of the use of deep tunnels and a

long ocean outfall for discharging treated effluent into deep ocean waters. The Panel is also concerned about the technical problems encountered in the construction of deep tunnels and the costs of the whole project as the budget for Stage I alone is already $8,323.7 million. Panel members have urged the Administration to seriously consider other options and to make use of new technology which were more cost-effective and sustainable.

SSDS Stage II Options Review Study in 1994

10. In view of criticisms about the ocean outfall proposal and in order to consider emerging technologies in sewage treatment and disposal, the Administration commissioned the SSDS Stage II Options Review Study in July 1994 to review the feasibility and implications of providing different treatment options and outfall alternatives under Stage II of the SSDS. The study was conducted by Pypun Engineering Consultants Limited which evaluated some 50 different sewage treatment options. The Administration also appointed a three-member International Review Panel (IRP) to oversee the consultants' work. The IRP was to advise on the level of sewage treatment required and where the treated sewage should be discharged, after considering the information provided by the consultants.

11. On 18 January 1995, the EA Panel held a meeting with the consultants, the three IRP Members and the Administration to discuss the draft review report. The IRP advised that primary treatment alone could not meet Hong Kong's water quality objectives. The IRP gave the preliminary conclusion that the use of CEPT, or a combination of CEPT and biological treatment, would be necessary. It also ruled out the choice of having an outfall into the Victoria Harbour. One IRP member, Professor HARLEMAN, suggested that immediate steps should be taken to upgrade the Stonecutters Treatment Plant by chemical addition and to build a mobile treatment plant of the right size for conducting pilot tests on chemically enhanced settlement at different locations. Another IRP member, Professor QIAN Yi, stressed the need for more cooperation with the Mainland in view of the strong influence of the Pearl River on the water quality of the South China Sea. The minutes of the meeting is in the **Appendix**.

12. The EA Panel held two further meetings with the Administration on 27 April 1995 and 1 May 1995 to discuss the consultants' final report. According to the Administration's paper for the Panel meeting on 27 April 1995, the IRP had endorsed the thrust of the SSDS strategy, which was to collect all wastewater into a collective system and provide centralised treatment at Stonecutters Island . The IRP also recommended that the treatment process at Stonecutters Island should be CEPT and that it was unnecessary to build an outfall as long as originally proposed. It considered that a shorter outfall to the southwest or southeast of Lamma Island would achieve water quality objectives and was less expensive.

13. At the Panel meeting on 27 April 1995, the Administration representatives advised that the consultants and the IRP agreed that a decision on secondary or higher level of treatment for Stage II of SSDS should not be made, pending the results of the water quality analyses after commissioning of Stage I project. On the impact of the proposed outfall on water quality, the Administration assured members that the water quality would be monitored and the results would be taken into account in the EIA and modelling studies for Stage II outfall options. If the results indicated that secondary treatment would be required even for an ocean outfall, the Administration would have to identify a suitable site and make provision for the construction of the plant. The Administration also undertook to conduct EIA studies for the different outfall locations before taking a decision on the outfall location.

14. On the concerns about the risks in the construction of a centralised treatment plant, the Administration responded at the meeting on 1 May 1995 that contingency measures would be put in place to cope with emergency situations. As regards the suggestion of a decentralised treatment system, the Administration advised that it would be much more expensive and difficult to find sufficient land near the outfall locations, even with additional reclamation, for building the required number of treatment plants to meet the demand of the entire population. Moreover, a partially decentralised system would still entail the construction of deep sewage tunnels.

15. An executive summary of the consultants' final report and the IRP comments were released by the Administration in April 1995 for public consultation.

EIA studies of the SSDS

16. The EIA studies of the SSDS were commissioned in May 1996. As the EIA Ordinance only came into operation on 1 April 1998, there was no statutory requirement in 1996 for public consultation of the SSDS EIA before completion of the final report. Nonetheless, in view of the concern of the public and the Panel, the Administration briefed the EA Panel and interested parties at an early stage on the EIA assessment of the various options.

17. Given the wide environmental impact of the SSDS proposal, the detailed arrangement of the EIA study had also been discussed under the Sino-British Joint Liaison Group (JLG) since 1995. Following the return of sovereignty, a new Expert Group on Sewage Disposal was set up in July 1998 to continue the discussion. A Technical Group was also established under the Expert Group to review reports submitted by the consultants. The Administration reported to the Panel on 5 October 1998 that the Technical Group had found the methodology for the EIA study correct and the consultant's findings technically sound.

18. The Administration consulted the academics, green groups and professional organizations on the options in March/April 1997. The consultation results, together with the study progress were reported to the EA Panel on 26 March 1998.

19. The EA Panel had held several meetings since September 1998 to discuss the Phase I EIA report for the SSDS Stage II. Academics and green groups were invited to give views to the EA Panel on 5 and 26 October 1998. The deputations had different views on the proposal of diluting effluent by ocean waters through a long ocean outfall, and the cost-effectiveness and sustainability of a centralised sewage treatment system. Some deputations urged the Administration to conduct more detailed geophysical surveys for the location of the proposed ocean outfall, while other deputations stressed the need for higher level of sewage treatment and closer cooperation with the Guangdong authorities in improving the water quality of the surrounding waters.

20. At the meetings held on 29 September 1998, 5 October 1998 and 26 October 1998, the EA Panel further discussed with the Administration the four options for SSDS Stage II and the merits and demerits of the distributed sewage treatment system as compared to a centralised system. The Administration advised that the four options for Stage II could all meet the water quality objectives. In general, lower levels of treatment and shorter outfalls would require less construction time, and less cost and land. Higher levels of treatment would however provide better effluent quality and incur higher costs. The Administration considered that, compared to a distributed system, a centralised system was more cost effective both in terms of capital and recurrent costs. The Administration also advised that deep tunnels had been used successfully elsewhere such as Boston and Sydney.

<u>Problems encountered in the SSDS Stage I tunnelling works</u>

Suspension of works

21. The original tunnelling contractor for SSDS Stage I was awarded the two contracts for the construction of the six sewage conveyance tunnels in 1995. Under these contracts, the works should be completed in mid 1997. However, the contractor suspended the tunnel boring works progressively from mid June 1996 claiming impossibility to comply with the contract conditions. This finally led to the forfeiture of the two contracts and the Administration took over the sites in December 1996. Completion of the SSDS Stage I tunnels was substantially delayed due to the forfeiture of contracts by the original contractor in December 1996. The contracts were subsequently re-tendered.

22. The problems encountered in the construction of the six tunnels under SSDS Stage I came to the attention of the EA Panel in November 1996 following press reports on the contractor's suspension of works. Several meetings were convened to discuss with the Administration the problems encountered, impact of the delays and extra costs required for completion of the works.

23. The Panel noted that three separate contracts were subsequently awarded in July 1997 and January 1998 for the six tunnels. The new contractor(s) also encountered technical problems because of the difficult ground conditions which gave rise to the need for additional site investigations and ground strengthening and stabilization works. There were also problems with the lifting and mucking systems which had to be replaced eventually. Additional funding was provided for the Stage I projects on 20 August 1998, 25 June 1999 and 15 December 2000. According to the Administration's estimate in November 2000, the target completion date of SSDS Stage I would be the end of 2001.

24. The EA Panel had expressed much concern about the delays in works and the additional expenditure incurred to complete the Stage I project. Some Panel members considered that the consultants and the contractor(s) should be held responsible for the failure to identify the geological problems related to the ground conditions and the operational problems of the lifting and mucking systems. The Administration responded that it was not possible for any site investigation to give 100% accurate information of the rock conditions deep underground. Moreover, it was often a matter of balancing the need for more site investigations with the additional costs. As regards the costs for replacement of systems, the Administration advised that it was seeking arbitration with the original contractor over the suspension of works and would lodge claims to recover the damages and extra costs incurred.

25. In view of the problems with the contractors in Stage I, some Panel members urged the Administration to improve the drafting of its tender/contract documents and to adopt a more effective project management system for subsequent stages of SSDS in order to better safeguard the public interests.

Ground subsidence

26. The EA Panel noted with serious concern that there had been reports of ground subsidence in the new reclamation in the Stage I tunnel areas in Tseung Kwan O. The EA Panel held several meetings with the Administration in November and December 1999. The Administration was asked to explain the cause of the subsidence and give assurance that the construction of deep tunnels under SSDS Stage I would not cause widespread ground settlement at built up areas over the tunnels.

27. The Administration explained that a detailed assessment of the risk of excessive ground settlement at developed areas had been carried out before the tunnelling works commenced. There was also continuous settlement monitoring when the tunnelling works were in progress. The Administration assured members that as tunnels were built deep underground in rock with a minimum rock cover of 30 metres, the risk of surface ground subsidence resulting from tunnel collapse was practically eliminated. Nevertheless, the Administration also advised that there could be ground settlement due to consolidation of soil layers overlying the bedrock where groundwater was lost to the tunnel. The maximum amount of settlement that might occur in these circumstances in developed areas would only be in the region of 20 millimetres. The Administration considered that settlement of such magnitude would not impose danger to buildings or structures at ground surface.

28. With regard to the subsidence at Tseung Kwan O, the Administration advised in December 1999 that heavier water inflows into the tunnel did occur during tunnel boring at about one kilometre away from the Tseung Kwan O town centre. Prompt mitigation measures had been taken to halt the inflow of groundwater into the tunnel and the overlying buildings and facilities were not affected. The Administration assured members that no groundwater would enter the sewage collection tunnels after they were put into operation, as these tunnels would be permanently lined with concrete and would carry sewage at the same hydrostatic pressure to that of the external groundwater.

29. The Territory Development Department conducted an investigation into the causes of the unusual ground settlement in Tesung Kwan O, through the Maunsell Consultants Asia Ltd. which was also the consultant responsible for the design and supervision of the reclamation of the area. The Legislative Council Brief on the investigation findings was issued by the Works Bureau in November 2000.

Recent developments

Progress of SSDS Stage I works

30. The Stonecutters Island Sewage Treatment works and the interim outfall have been completed and is currently treating sewage generated in North West Kowloon. Excavation of all deep tunnels for SSDS Stage I were completed in November 2000. The Administration estimated that all Stage I works could be completed by the end of 2001 and within an overall budget of $8,323.7 million which was the total of the approved project estimates for Stage I before additional funding of $115 million for one of the individual project items was approved by Finance Committee on 15 December 2000.

Review by the new IRP

31. Given the public concern on the subsequent stages of SSDS, the Administration decided in October 1999 to conduct an independent review of the SSDS in the light of the experience of Stage I before proceeding further. The Administration consulted the EA Panel at three meetings in the last quarter of 1999 on the composition of the IRP and the approach for the review. It was agreed that the review process should be open and participatory and that the public would be given full access to all information prepared for the review.

32. The new IRP comprised three international and three local experts in waste water treatment, marine biology, tunnelling and financial analysis. The two members from the United States and China were also members of the previous IRP appointed in 1994. Before commencement of the review, the new IRP met with the EA Panel on 27 May 2000 to gauge members' views on the SSDS. The Panel urged the new IRP to adopt a completely open mind and an independent role in reviewing the various options for the subsequent stages of SSDS. The new IRP also attended public forums and discussions with interested parties to obtain views on the future direction of SSDS.

33. The new IRP presented its report to the Panel on 1 December 2000. It recommends that SSDS Stage I be completed as soon as possible and proposes four options for the subsequent stages of SSDS. The IRP considers that a higher level of wastewater treatment with a short, low dilution outfall is the preferred approach for Hong Kong. The IRP also proposes upgrading the CEPT effluent by means of biological aerated filters (BAF) at the Stonecutters Island.

34. For the analysis of the outfall location options, the new IRP has provided a comparison of the beneficial uses of the Victoria Harbour and waters south of Lamma Island. The new IRP considers that disposal of treated sewage effluents from an outfall in southern waters may pose significant risk to the southern marine ecosystem due to depletion of dissolved oxygen. As the CEPT effluent at the Stonecutters Island plant can be improved with the use of BAF, the new IRP disagrees with the previous EIA that the use of Stonecutters Island outfall should be ruled out for Stage II. The new IRP stresses that further EIA studies will need to be carried out for the four options recommended.

35. The new IRP considers that the experience of the tunnel construction in Stage I shows that the rock masses along the tunnel alignments are fairly competent. It advises that a better definition of the sensitive areas and a correct choice of the techniques for excavation and water inflow reduction can significantly reduce the construction risks in subsequent stages of SSDS.

36. Although the EA Panel generally welcomes the IRP recommendations, some members have expressed concern about the technology recommended, the costs of the options and the implications on the future sewerage charges, as well as the longer-term measures to tackle the Pearl River pollution.

Way forward

37. The EA Panel has requested the Administration to provide a response to the new IRP report after examining the recommendations in detail. Further Panel meetings may be held to discuss the merits of the four options proposed by the IRP.

38. To enable members to have a better understanding of the overseas experience in applying the new technology recommended by the IRP, the EA Panel has proposed to conduct an overseas visit to Europe in April 2001.

Prepared by
Mrs Constance LI
Council Business Division 2
30 December 2000

LegCo Paper No. PL259/94-95
(These notes have been seen
by the Administration)

Ref: FP/P/15/1

LegCo Panel on Environmental Affairs

Notes of Meeting
on Wednesday, 18 January 1995 at 8:30 am
in Chamber of the Legislative Council Building

Present	:	Hon Peter WONG Hong-yuen, OBE, JP (Chairman) Dr Hon Samuel WONG Ping-wai, MBE, JP (Deputy Chairman) Hon Mrs Peggy LAM, OBE, JP Hon J D McGregor, OBE, ISO, JP Rev Hon FUNG Chi-wood Hon Emily LAU Wai-hing Hon Man Sai-cheong Hon Christine LOH Kung-wai
Absent with Apologies	:	Hon Simon IP Sik-on, OBE, JP Hon Edward S T HO, OBE, JP Dr Hon LEONG Che-hung, OBE, JP
By invitation	:	Review Panel Members Professor QIAN Yi Professor Poul Harremoes Professor Donald Harleman Pypun Engineering Consultants Limited Mr Ronald Ledbury Representatives from the Administration Mr James Blake, JP Secretary for Works Mr Tony Cooper, JP Deputy Secretary (Environment) Ms CHANG King-yiu Principal Assistant Secretary (Environment) Planning, Environment and Lands Branch Dr Stuart Reed, OBE, JP Director of Environmental Protection

Mr Mike Stokoe
Assistant Director of Environmental Protection (Waste Facilities)

Mr Vic McNally
Principal Environmental Protection Officer (Liquid Waste Projects)

Dr Malcolm Broom
Principal Environmental Protection Officer
(Waste and Water Services)

Mr K L CHUNG
Assistant Director of Drainage Services

In Attendance: Mr Stephen MA, CAS(P)1
Mrs Mary TANG, SAS(P)2

Action

Strategic Sewage Disposal Scheme (SSDS) - Review of Stage II Options

The Chairman welcomed the three Review Panel members, the representative of the Pypun Engineering Consultants Limited (Pypun) and the government officials to the meeting. In his opening remark, he expressed the green groups' concerns over the use of lime for treating sewage in Stage I of the SSDS and the proposal to discharge treated effluent to the South China Sea in Stage II of the Scheme. He pointed out that disinfection for the discharges would now be the greatest concern after the introduction of measures and removal of industries to China had reduced the level of toxic metals. He also questioned the desirability of restricting Pypun's study to the Stage II options only as there was not yet a consensus among the Review Panel members on such an approach when they visited Hong Kong last time. The Administration was reminded that funds for the Stage I works were approved by the Legislative Council subject to reviews of both the Stage I and Stage II projects. Concluding his remark, the Chairman informed the meeting of his criteria for assessing the SSDS, namely cost effectiveness, substainability of the treatment process in the Hong Kong context, and the risk inherent in concentrating most facilities at one site.

2. At the invitation of the Chairman, Mr Mike Stokoe gave Members a short briefing on the background to the reviews of SSDS. He explained that Pypun had been commissioned to examine the alternatives to the Lema Channel oceanic outfall that was proposed to be Stage II under the sewage strategy developed in 1989. At the same time, an international review panel had been convened to oversee the work done by the consultant and to offer advice on the best approach to the problem of treating Hong Kong's urban sewage. Mr Ronald Ledbury then briefed Members on the major findings of the draft final report prepared by Pypun, making reference to the information paper tabled at the meeting (Annex I). Members were informed that the consultant had developed a total of nine options which compared the primary, chemically enhanced primary, and biological (with and without nutrient removal) treatment processes on the basis of their ability to achieve water quality objectives (WQOs), costs and operational reliability.

3. The Chairman then invited each of the Members of the international Review Panel to express their views on the SSDS Stage II options. Professor Poul Harremoes from Denmark explained the approach used by the Review Panel members to examine the Stage II options. All the options were assessed on the basis of whether they could meet the WQOs of the waters into which the treated effluent would discharge. On *bacteria levels*, it was found that disinfection would be required irrespective of the outfall location and the type of treatment technology used. For this reason, the option of discharging sewage after primary treatment alone was eliminated as primary treated effluent could not be disinfected satisfactorily and the process also failed to meet the bacterial and dissolved oxygen WQOs. On *the discharge of ammonia*, analysis on WQOs indicated that the option to discharge at the Stonecutters outfall without converting ammonia into nitrates through biological treatment was not acceptable because the ammoniated effluent would be toxic to fishes. The construction of a biological treatment plant at Stonecutters Island although technically feasible was also not recommended in view of the space constraints. Regarding *the nitrogen issue*, studies indicated that the overall impact of nitrogen loads due to the Pearl River was so predominant that treatment processes to remove nitrogen under the SSDS would have negligible effect with outfall locations outside the harbour. As for the problem of *toxic metals*, the most effective way was to deal with it at source. By elimination, *the dissolved oxygen objective* became the most important parameter in considering the appropriate treatment process to be used. Based on the above analysis, the preliminary conclusion of the Review Panel members was the use of (i) chemically enhanced primary treatment (CEPT) or (ii) biological treatment with nitrogen removal or (iii) CEPT and biological treatment would be required. The choice of having an outfall into the harbour was also eliminated.

4. Professor Donald Harleman from the United States briefed Members on his observations and recommendations on the SSDS Stage I Project which was undertaken with a view to achieving rapid water quality improvements in the harbour while allowing maximum flexibility for future development. The review on the SSDS Stage II options indicated that CEPT should continue to be used at Stonecutters Island for treating the sewage flows. There were three main advantages of using CEPT. First, by taking advantage of the state-of-the-art technology, it could double the capacity of the treatment plant and achieve the WQOs in a more cost-effective way. Second, by enlarging the capacity of the plant at Stonecutters Island, it could make provisions for future population growth and allow an advanced implementation of the sewage treatment plans for Hong Kong Island. Third, by enhancing the effectiveness of biological treatment, it would help reduce the costs if such a process was considered necessary. Professor Harleman went on to explain that the use of lime for treating sewage was no longer desirable because of the large amount of sludge produced. The use of ferric chloride supplemented by polymers had been found to be more effective. He suggested immediate steps be taken to upgrade the Stonecutters Treatment Plant by chemical addition and to build a mobile treatment plant of the right size for conducting pilot tests on chemically enhanced settlement at different locations.

5. Professor QIAN Yi from China voiced support to the recommendations made by the other two Review Panel members and reiterated that primary treatment alone could not meet the WQOs set by the Hong Kong Government. However, she was of the opinion that Stage I and Stage II of the SSDS should be reviewed together. Quoting the number and location of sedimentation tanks to be built in Stage I as an example, she urged the Administration to review the physical design of the treatment plant at Stonecutters in light of the findings of the

Stage II study. She supported the idea of maximising the capacity of the treatment plant to handle the sewage collected from Hong Kong Island as well as those from the Kowloon side. She also stressed the need for more extensive pilot plant testing on both the CEPT and biological treatment processes as there was no experience of operating this kind of facility on such a scale in Hong Kong or anywhere else in the world. Given the strong influence of the Pearl River on the water quality of the South China Sea, Professor QIAN further suggested the Hong Kong Government to work closely with the Chinese authorities when formulating its sewage disposal plans.

6. Members raised questions and the Review Panel Members provided explanations as follows:

Scope of the Review

(a) Their review was not restricted to the Stage II options. The implications of these options on the Stage I Project had also been considered. The Review Panel was commissioned to analyse the proposed options independently and to make practical recommendations. No unnecessary restrictions had been imposed upon the Review Panel by Government.

Water Quality Objectives (WQOs)

(b) The choice of technology and treatment method would depend on the WQOs set by the authorities concerned. The setting of WQOs was a political rather than a technical decision.

(c) WQOs for dissolved oxygen and nitrogen were set with a view to safeguarding marine ecology.

Chemically Enhanced Primary Treatment (CEPT)

(d) Enhanced by the use of advanced coagulant technology, the chemical treatment plant at Stonecutters would be able to reduce the sludge production and increase its sewage handling capacity significantly. As a result, the plant could now be used to treat sewage flows from both Kowloon and Hong Kong Island to CEPT standards.

(e) The conventional primary treatment would remove 30% of the organic materials in the sewage flow, while CEPT and the secondary biological treatment could remove 60% and 90% of the materials respectively.

Environmental Impact on Lamma Island

(f) Provided the level of treatment and outfall location were designed so as to ensure WQOs were met, there should not be any adverse effects on the marine life at the outfall locations.

Nitrogen Issue

(g) Nitrogen was not necessarily a pollutant. Marine ecology would be endangered only when the level of nitrogen was very high. Water quality analysis at proposed outfall locations outside the harbour showed that the nitrogen loads there mainly came from discharges of the Pearl River and natural sources. The treated effluent

from Hong Kong, whether with or without nitrogen removal, would have no significant impact on the level of nitrogen and algae growth.

Risk Assessment

(h) The risk inherent in concentrating the treatment facilities at one site was not high when compared with the risk of not maximising the capacity of available facilities to make prompt improvements in water quality. Climatic conditions would not normally affect the treatment plant and the deep underground sewage tunnels would be safe unless there was a major earthquake.

Analysis of Options

(i) The ninth option proposed by Pypun was close to the preliminary recommendations of the Review Panel Members except that biological treatment might have to be added to achieve the dissolved oxygen WQO. This option proposed to treat Kowloon and Hong Kong Island sewage flows at Stonecutters to CEPT standards and discharge off Lamma Island.

(j) The seventh option proposed primary treatment of the Kowloon and Hong Kong Island flows at Stonecutters and secondary treatment by Biological Activated Filter (BAF) at Green Island. As a newly developed technology, BAF was inherently complex and required highly qualified personnel to operate. Extensive pilot plant testing had to be conducted before a final decision could be made.

(k) Both the fifth option and the sixth option involved biological nutrient removal (BNR) treatment at Lamma Island. Both options would meet the bacterial and dissolved oxygen WQOs and were reliable and easy to operate. However, they would be most costly. The Review Panel had not decided on the use of BNR because it would have negligible effect with outfall locations outside the harbour and might be seen to be a waste of public money.

7. In reply to a Member's question, Mr Mike Stokoe informed Members that the fees for commissioning the services of Pypun and the international Review Panel Members were estimated to be around $4.8 million and $1 million respectively.

8. When asked to comment on whether Government had changed its original plan of discharging primary treated sewage to the South China Sea through an oceanic outfall, Mr Stokoe explained that in the original plan the precise location of the outfall had not been fixed as it would depend on further water quality investigations and computer modelling which were proposed to be carried out as part of the EIA on Stage II. Subsequently, existing water quality models were extended to cover the waters that would be affected by discharges in the Southern Water Control Zone and the adjoining Lema Channel. This model was first available to test the water quality impact of the options considered in Pypun's study, and the results showed that a discharge of primary treated effluent to the Lema Channel would unlikely meet the presumed WQOs. As a result, it was probable that the SSDS Stage II would need to be amended to incorporate a higher level of treatment, but perhaps a shorter outfall. Mr. Stokoe added that the same conclusion would have been reached during the EIA process, but might have taken more time than embarking on Pypun's study in July 1994. The recommendations of the Review Panel to improve the process at the Stonecutters Island Treatment Plant and to advance SSDS Stages III and IV by delivering

their flows to Stonecutters would be given careful consideration by the Administration. Some of the recommendations had been acted on as soon as the Review Panel's advice was received, others would need further investigation. The Administration would carry out an EIA on the alternative outfall options for Stage II after having consulted appropriate Chinese authorities on the scope and methodology.

Admin

9. At the request of the Chairman, Mr Stokoe agreed to provide a copy of Pypun's draft final report on the SSDS Stage II options for Members' reference. However, he stressed that the report was still being finalised and some statistical figures might need to be changed. Members also noted that findings of the Review Panel would be incorporated into Pypun's final report together with an executive summary for consultation with the Advisory Council on Environment, the LegCo Panel on Environmental Affairs and the public. The Chairman further requested the Administration to prepare a time table for the consultation process for Members' information.

Admin

10. The Chairman suggested and the Administration agreed that Members would be briefed on the subject of Water Quality Objectives in the near future.

11. The meeting closed at 10:35 a.m.

LegCo Secretariat
15.2.1995

Annex I

Strategic Sewage Disposal Scheme (SSDS)

Review of Stage II Options

The Options

An Interim Report setting out all the treatment technologies which could be considered as alternative SSDS Stage II arrangements was made available to the LegCo Panel on Environmental Affairs in October 1994. The consultant has now completed the water quality modelling of the appropriate technologies and developed a total of 9 options which compare the following treatment processes:-

i. primary;
ii. chemically enhanced primary; and
iii. biological with and without nutrient removal.

2. The biological process was examined using conventional activated sludge technology (as already used in Hong Kong) and using the recently developed Biological Aerated Filter (BAF) technology.

3. There are three principal ways in which the sewage flows can be treated. These include:

i. treating all flows at Stonecutters Island;
ii. separately treating flows at Stonecutters Island and Mount Davis;
iii. separately treating flows at Stonecutters Island / Mount Davis and Lamma Island.

Water Quality Objectives (WQO)

4. All the options were considered on the basis that they must achieve water quality objectives of the waters into which the treated effluent would discharge. The water quality analysis was conducted using the following possible outfall locations:-

i. Stonecutters Island;
ii. Mount Davis;
iii. East Lamma; or
iv. West Lamma.

The water quality analysis was conducted using the extended WAHMO hydraulic model and the effects of the outfall discharges on bacteria, dissolved oxygen and nitrogen levels were assessed.

5. Subject to more detailed examination of the modelling work, preliminary indications are that disinfection may be required for all outfall locations, including Stonecutters Island, Mount Davis, East or West Lamma outfalls. The need for

disinfection for the Lema Channel outfall will depend on the bacterial water quality objective determined by PRC authorities.

6. Following from the finding in para. 5 above, if disinfection will be necessary to meet bacterial water quality objective in Hong Kong, the primary treatment options would not be acceptable because primary treated effluent cannot be disinfected satisfactorily. The process also fails to meet dissolved oxygen objectives.

7. The analysis of the nitrogen issue so far indicates that the overall impact of nitrogen loads due to the Pearl River is so predominant that treatment processes to remove nitrogen under the SSDS would have negligible effect with outfall locations outside the harbour.

8. The water quality analyses have therefore concluded that the dissolved oxygen objective becomes the most important parameter in considering the most appropriate treatment process.

9. Chemically enhanced primary treatment (CEPT) or biological treatment or a combination of the two should be chosen to achieve the dissolved oxygen objective of the outfall location finally chosen. For reasons of the dilutions achievable, the treatment achievable at Stonecutters Island to remove ammonia, and considering the possibility of nitrogen enrichment, a long term outfall into the harbour is not recommended and a more southerly outfall is required.

Costs

10. The consultant has provided comprehensive costings in both capital cost and net present value (NPV). For projects of this type reference to the NPV analysis which includes the operating costs over a 50 year period is considered relevant. The cost analysis indicates that the CEPT process is significantly less expensive than any biological treatment processes (brief comparison at Annex).

Operational Reliability and Complexity

11. Both CEPT and conventional biological treatment technology using the activated sludge biological processes are relatively easy to operate and the treatment processes are operationally reliable to produce the desired effluent qualities. However, the more compact biological processes such as BAF are inherently complex to operate and there is no operational experience in Hong Kong or anywhere else in the world of operating such a facility on this scale. It is therefore necessary to consider this new technology only with extensive pilot plant testing before a final decision may be taken.

Annex

SSDS Stage II Option		Meeting Bacterial and Dissolved Oxygen Water Quality Objectives	Reliable and easy to operate	Capital/Annual Operating Cost (Rough Indication of Costs)
Option 1	Treat Kowloon and Hong Kong Island flows at SISTW to primary effluent standard. Outfall off S.I., M.D. or L.I.	X	√	$7B / $422M
Option 2	Treat Kowloon flows at SISTW and H.K. Island flows at M.D. Both to primary effluent standard. Outfall off S.I., M.D. of L.I.	X	√	$7.5B / $450M
Option 3	Treat Kowloon flows at SISTW and H.K. Island flows at M.D. Both to secondary treatment standard by BAF. Outfall off S.I., M.D. or L.I.	√	X	$10B / $700M
Option 4	Similar to Option 3 but BAF works incorporates nitrogen removal. Outfall off S.I., M.D. or L.I.	√	X	$11B / $850M
Option 5	Treat Kowloon sewage to primary standard at SISTW, then convey to Lamma Island. Untreated flows from H.K. Island connect into tunnel and join H.K. flows to L.I. Both receive biological nutrient removal (BNR) treatment at L.I. Outfall off L.I.	√	√	$12.5B / $870M
Option 6	Treat Kowloon and H.K. Island flows at SISTW to primary standard then convey to L.I. for BNR. Outfall off L.I.	√	√	$12.5B / $870M

SSDS Stage II Option		Meeting Bacterial and Dissolved Oxygen Water Quality Objectives	Reliable and easy to operate	Capital/Annual Operating Cost (Rough Indication of Costs)
Option 7	Treat Kowloon and H.K. Island flows at SISTW to primary standard then convey to Green Island for secondary treatment by BAF. Outfall off L.I. or G.I./M.D.	√	?	$10.5B / $780M
Option 8	Similar to Option 7 but incorporate nitrogen removal by BAF at G.I. Outfall off L.I. or G.I./M.D.	√	X	$11.5B / $920M
Option 9	Treat Kowloon and H.K. Island flows at SISTW to chemically enhanced primary treatment standards. Outfall off L.I.	?	√	$6.5B / $450M

Abbreviation

SSDS	Strategic Sewage Disposal Scheme
SISTW	Stonecutters Island Sewage Treatment Works
SI	Stonecutters Island
MD	Mt. Davis
LI	Lamma Island
BAF	Biological Activated Film
GI	Green Island