For discussion
on 5 November 1999

Legislative Council Panel on Environmental Affairs

Sewerage Improvements for
(i) Ting Kau, Sham Tseng and Tsing Lung Tau
(ii) Outlying Islands

INTRODUCTION

On 11 June 1999, as a prelude to a submission to the Public Works Sub-Committee (PWSC), Members considered two papers related to the proposed provision of new sewerage infrastructure. One was concerned with the upgrading of sludge dewatering capability and the extension of the outfall at Cheung Chau (PWP item 208DS, Figure 1). The other dealt with the proposal to construct a sewage treatment works (STW) and outfall at Sham Tseng (item 52DS and 126DS, Figure 2) to provide proper treatment and disposal for the sewage that currently pollutes the beaches in the area. While Members in general acknowledged the need to press ahead with the provision of this infrastructure there were concerns expressed as to the adequacy of the treatment level.

2. On 16 June 1999 the Administration sought PWSC's approval for the relevant works items to be upgraded to category A. However PWSC Members felt they had had insufficient opportunity to consider the appropriateness of the projects in relation to the declared environmental goals. The Administration withdrew the papers for further discussion at the Panel on Environmental Affairs.

3. The purpose of this paper is to provide more background on the environmental need for the facilities.

SHAM TSENG / TING KAU

Background

4. The pollution problems along the stretch of coastline between Ting Kau and Tsing Lung Tau have been recognised for many years. There is no mains sewerage and as a result many local sources of pollution produce unhygienic conditions in nullahs and watercourses and at beaches. A review of sewerage provision was commissioned in 1989 and a Public Works Programme (PWP) item covering the treatment facilities and outfall was created in 1990. However

for various reasons[1] progress in building the sewerage network and associated facilities has been slow. The position at present is that the reclamation to accommodate the proposed STW has been completed, and work for Sham Tseng sewerage commenced in July 1999. Since the original study, the water quality of the beaches has declined even further (Figure 3). At the moment three beaches are closed to the public because of their consistently poor water quality. Conditions in the Sham Tseng nullah are very unpleasant.

Water quality and environmental improvement issues

5. Under the proposed scheme, existing untreated sewage from Ting Kau, Sham Tseng and Tsing Lung Tau will be collected and centrally treated at a chemically enhanced primary treatment (CEPT) plant at Sham Tseng. (CEPT is a well-established technique gaining increasing popularity around the world, even for major discharges. On the Mediterranean coast in the cities of Marseilles and Menton there are CEPT plants dealing with flows from populations of up to a million people. Similar plants exist in Canada at La Piniere and in the USA at San Diego, discharging into equally sensitive areas. In Norway there are around 100 CEPT plants in operation). Disinfection will also be provided. Treated effluent will be discharged via a submarine outfall into deep (>20 m) fast-flowing water to achieve a high level of dilution.

6. In the dry season, the disinfected plume will mix over the whole water column and a high degree of dilution will be achieved within a short distance. During the wet season the plume will be trapped at a depth of more than 10 m from the sea surface. The mixing rate will consequently be lower but is nevertheless sufficient to ensure rapid dilution. Figures 4 and 5 show the path and dilution of the disinfected plume under typical wet and dry season conditions respectively.

7. Figure 6 shows the *E. coli* concentration of the disinfected sewage plume downstream of the outfall under different discharge conditions, current speed and seasonal conditions. When the plume follows the ebb current and reaches the waters off the nearest bathing beach (i.e. Gemini beach), it will be diluted between 200 and 500 times in the wet season, and between 2000 and 4000 times in the dry season. These are equivalent to *E. coli* concentrations of between 8 and 20 counts /100 mL for the wet season and below 3 counts /100 mL for the dry season. Therefore, the new discharge, being disinfected, will have negligible effect on bacteriological conditions at the adjacent beaches.

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[1] A principal reason for the delay was the requirement by the Town Planning Board to investigate a cavern option for the treatment plant before the idea of building it on a reclamation could be accepted.

8. There will be little impact on the existing receiving water quality beyond a small mixing zone of about 50m radius from the point of discharge. The Water Quality Objectives (WQOs) for the general marine water quality parameters relating to organic pollution will continue to be met. Upgrading the Sham Tseng STW to a higher level of treatment would not further improve water quality significantly.

9. Under the proposed scheme, water quality at local beaches will be improved as the existing untreated flows are removed and collected by the new sewer system and properly treated. The following table (Table 1) illustrates the estimated improvement that will be achieved through construction of the new facilities. The near field dilution study indicates that the treated effluent discharge would have a negligible effect on nearby beaches. Further reduction of *E. coli* levels beyond those projected will depend upon the elimination of pollution from more distant sources and the implementation of other sewerage schemes within the Administration's wider sewage treatment strategy.

Table 1 Predicted Improvements in Bathing Water Quality Following Commissioning of the Sham Tseng STW

Beach	1998 Observed Mean *E.coli* Concentration (no. of counts /100ml)	Predicted reduction in *E.coli* Concentration after Commissioning	Estimated *E.coli* Concentration after Commissioning (no. of counts /100ml)
Approach	435	30 %	305
Ting Kau	1045	71 %	303
Lido	262	40 %	157
Casam	239	34 %	158
Hoi Mei Wan	280	9 %	255
Gemini	399	17 %	331
Anglers'	502	60 %	201

CHEUNG CHAU

Background

10. PWP item 208DS, which was discussed at the PWSC meeting on 11 June 1999, comprises two components. They are to upgrade the existing sludge dewatering facilities and to construct a new sewage outfall to replace the existing one. The proposed upgrade of sludge dewatering facilities is urgently needed to eliminate the odour from the existing sludge drying beds and improve the hygiene conditions. The background to the Administration's recommendation to reprovision the existing outfall is presented below.

11. The existing STW discharges through a relatively short outfall on the west side of Cheung Chau into the Adamasta Channel, approximately 800 m south of the non-gazetted Tai Kwai Wan. The discharge point lies approximately 400m from an area demarcated as secondary contact recreation subzone. The water quality in the secondary contact recreation subzone is marginally acceptable, with somewhat elevated bacterial levels. The water quality outside the secondary contact recreation subzone is reasonable but appears to be on a slow deteriorating trend with respect to bacteria. The "Outlying Islands Sewerage Master Plan (SMP)" completed in December 1994 recommended replacing the existing submarine outfall with a new one for better dispersal capacity.

Water quality and environmental improvement issues

12. The "Outlying Islands Sewerage, Stage 1 Phase 1 Study" considered different alignments for the new submarine outfall. The recommended alignment is further away (compared with the existing outfall) from the secondary contact recreation zones (about 750 m) and Tai Kwai Wan (about 1.3 km). This new outfall will serve two purposes, namely:

(i) to improve the existing bacterial water quality inshore; and

(ii) to provide an additional measure of security for environmental quality to accommodate increased future sewage flows as a result of further implementation of SMP works.

13. With the new replacement outfall, the sewage plume will be rapidly diluted and mixed over the water column during the dry season. Under stratified conditions in the wet season, the plume will be trapped at about 2 to 3 m above the seabed and thus the degree of dilution is less (see Figures 7 and 8).

Nevertheless, due to the better design of the new outfall and the longer distance between this outfall and Tai Kwai Wan, the bacteria concentration at Tai Kwai Wan is predicted to be reduced by at least 60%.

14. Regarding the secondary contact recreation subzones on both sides of the Adamasta Channel, the near field plume study indicates that annual geometric mean *E. coli* concentration would drop to about 180 count/100mL, which falls within the WQO of 610 count /100mL for the secondary contact recreation subzone.

15. For all other water quality parameters except total inorganic nitrogen, WQOs will be met except inside a small mixing zone at a distance less than 20 m away from the outfall. The WQO for total inorganic nitrogen is exceeded due to the high background level brought about by the influence of the Pearl River in Hong Kong's south-western waters. Upgrading the Cheung Chau STW to a higher level of treatment would not further improve water quality significantly.

IMPLICATIONS FOR SEWAGE CHARGES

Sham Tseng/Ting Kau

16. We estimate the annual recurrent expenditure for operation and maintenance of the proposed sewerage facilities to be $12.0 million. Based on the current level of expenditure on operation and maintenance of sewerage facilities, the proposed works by itself will lead to a 1.7% real increase in the recurrent expenditure of providing sewage services which will need to be taken into account in determining sewage charges.

Cheung Chau

17. We estimate the additional annual recurrent expenditure for maintenance works to be $2.1 million. Based on the current level of expenditure on operation and maintenance of sewerage facilities, the proposed works by itself will lead to a 0.4% increase in the recurrent expenditure of providing sewage services which will need to be taken into account in determining sewage charges.

POSSIBLE ALTERNATIVES

18. The principal criterion adopted by the Administration in recommending suitable sewage treatment and disposal facilities at Sham Tseng /

Ting Kau and Cheung Chau relates to compliance with the WQOs. In both cases the Administration has concluded that the recommendations as detailed in the relevant PWSC papers are adequate for the purpose. Other key issues that must be considered are the cost implications and the land requirements. The WQOs could be met at Sham Tseng / Ting Kau by using different treatment technology e.g. by using biological treatment in place of CEPT provided that this is also complemented with disinfection as currently proposed. Likewise at Cheung Chau, rather than replace the existing outfall with a better positioned new outfall with an improved diffusion system, the WQOs could be met by upgrading the treatment to secondary level with disinfection and continuing to use the existing outfall. However there are serious cost, land take and programming implications associated with these alternatives as discussed below.

Sham Tseng / Ting Kau

19. The present STW site at Sham Tseng is constrained on all sides with an effective area of 0.85 ha only. This is just sufficient for a CEPT plant. If a normal secondary treatment plant is to be built, we estimate that an extra 0.3 ha is required, which is not available. A multi-storey plant within the designated site could be considered. However, this option might end up with a plant reaching a height of about 35 metres above ground, which would cause considerable visual impact to the nearby residents.

20. A secondary sewage treatment plant will cost more than a CEPT plant. The capital cost for a CEPT plant is about $220 million. If a multi-storey plant is pursued, the capital cost will be increased by about 80% to $400 million. In terms of operation and maintenance costs, we estimate that a secondary sewage treatment works will cost two to three times more than the $12 million estimated for a CEPT plant, depending on the actual design of the plant. This additional cost would have to be recovered through sewage charges in due course.

21. If a CEPT plant is approved, the plant can be in operation in year 2003 to bring much needed environmental improvement to the area. Changing the sewage treatment level to secondary treatment will involve substantial changes in planning and design. This will delay the project.

Cheung Chau

22. The present site designated for the STW is occupied to a large extent by the existing plant. The remaining area is not adequate for a secondary

treatment plant. If the existing plant is upgraded to secondary treatment level, an extra piece of land up to 1.5 ha is required, depending on the process selected, and this can only be provided by additional reclamation.

23. If the existing plant is upgraded to secondary treatment level, we estimate that the capital cost involved will be approximately $165 million. In terms of operation and maintenance costs, a secondary sewage treatment works will cost three to four times more than a primary treatment plant, depending on the actual design of plant. This additional cost would have to be recovered from sewage charges in due course.

SCOPE FOR FUTURE UPGRADES

24. The Administration is confident that the proposed sewage treatment and disposal facilities would comfortably meet the WQOs. Nevertheless, as a precautionary measure, the performance of the new facilities and the actual impact on the receiving environment will be closely monitored following implementation. For Sham Tseng / Ting Kau the key parameter of concern relates to bacterial pollution of bathing water. For this reason it is already proposed to provide disinfection prior to discharge. Based on the assessment studies undertaken to date, it is considered extremely unlikely that a future upgrade to secondary treatment would be required. For Cheung Chau, one benefit of the proposed improvements to the sludge dewatering facilities from bed drying to mechanical dewatering is that there will be significant space saving. As a result, the possibility exists to upgrade the plant to a higher standard of treatment, such as CEPT with disinfection, should this be found necessary in the future. The Environmental Protection Department is currently carrying out a study entitled "Outlying Islands Sewerage Master Plan Stage 2 Review". This includes consideration of the possible future need for upgrading Cheung Chau STW to a higher treatment level in the future. The proposed new sludge dewatering facilities and replacement outfall would not prevent any future upgrading works and so become abortive or obsolete.

CONCLUSIONS

25. It is necessary to upgrade the sewage dewatering facilities at Cheung Chau to eliminate the odour from the existing sludge drying beds and improve the hygiene conditions.

26. There is a need to provide sewage treatment at Sham Tseng to improve the serious existing pollution problem in that area. It is also necessary to

take action to improve bacterial conditions in the vicinity of the existing sewage outfall at Cheung Chau and to ensure compliance with the WQOs established to protect users of the adjacent secondary contact recreation zone.

27. The STW and the associated submarine outfalls for PWP item 208DS (Cheung Chau) and items 52DS and 126DS (Sham Tseng / Ting Kau) provide an adequate and cost effective means to ensure the protection of the aquatic environment in the vicinity of the facilities.

28. The provision of more sophisticated treatment processes than are currently proposed for Sham Tseng / Ting Kau and Cheung Chau would greatly increase the costs and land take requirements. Possibly they would necessitate land reclamation. There would also be delays to the completion dates. The options currently proposed are already adequate to ensure compliance with the WQOs. The more expensive treatment processes would not bring about any noticeable difference in compliance. For these reasons the Administration does not see the need to adopt a higher level of treatment than is currently proposed.

Environmental Protection Department
Drainage Services Department
October 1999

Figure 1 Location Plan of the Cheung Chau Sewage Treatment Plant and the Cheung Chau Replacement Outfall

圖一 長洲污水處理廠及長洲新排污渠的位置圖

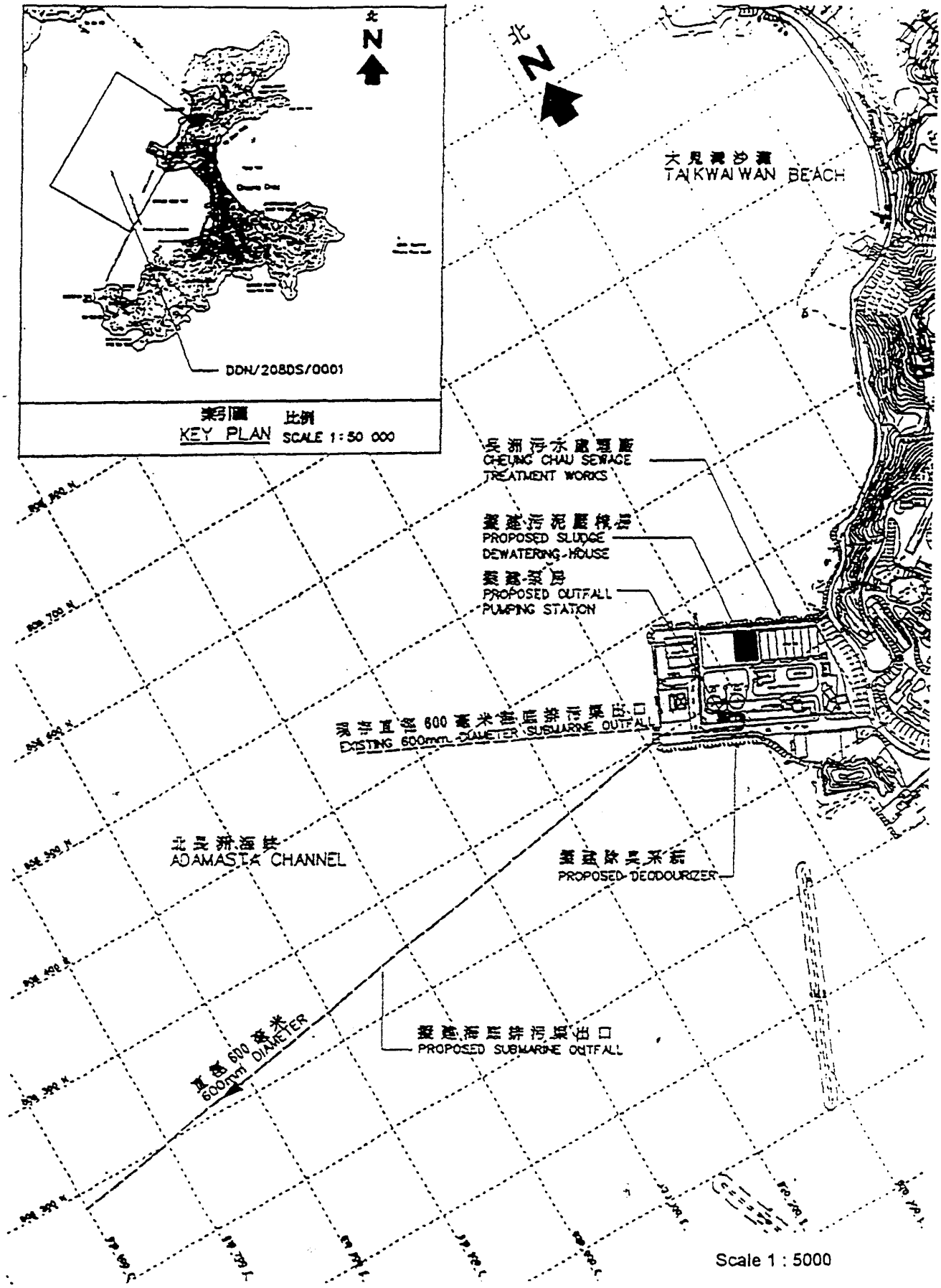
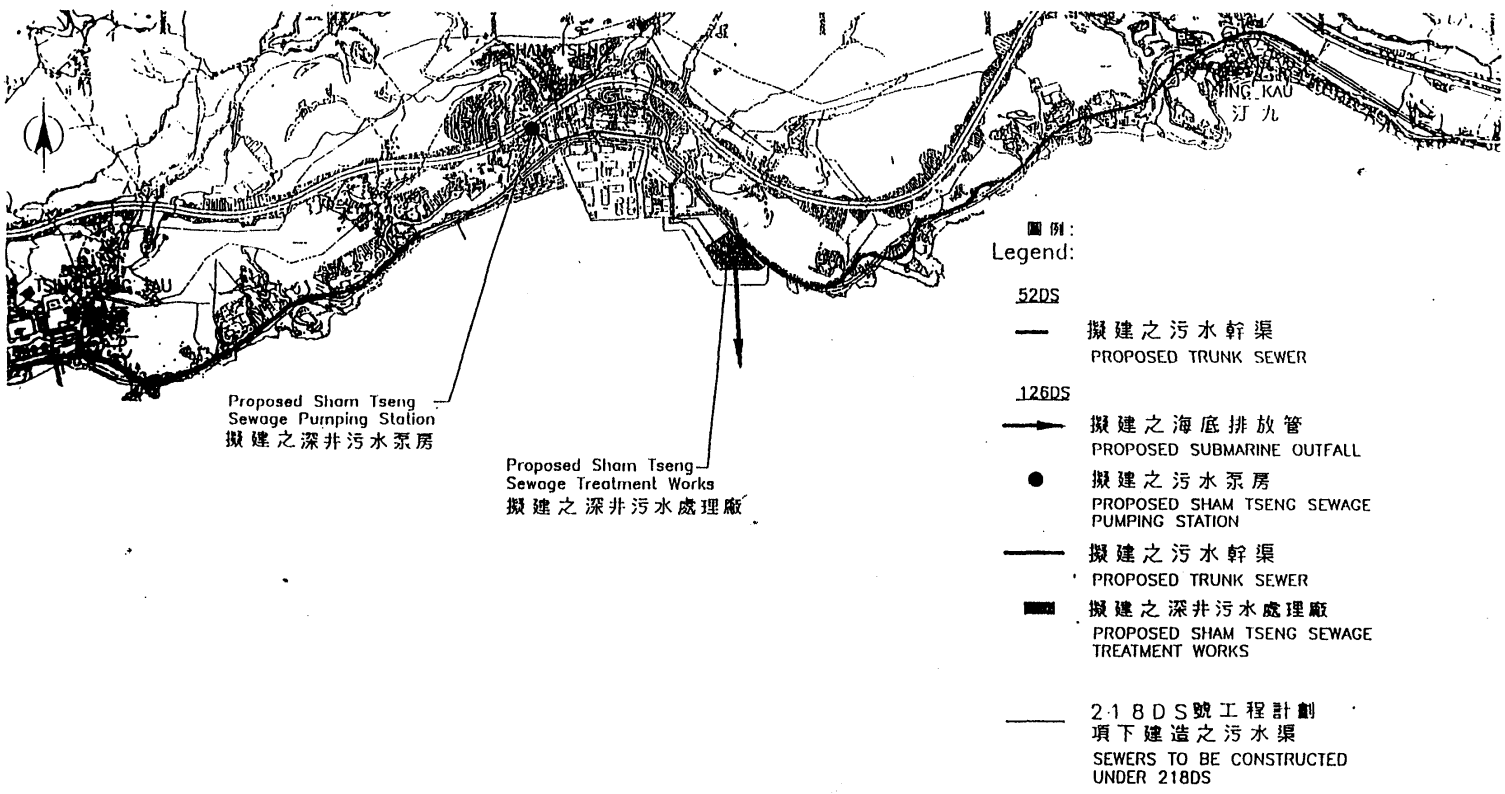


Figure 2 Location Plan of the Sham Tseng Sewage Treatment Plant and the Sham Tseng Outfall

圖二 深井污水處理廠及排污渠的位置圖



Scale 1 : 16000

Figure 3 Trend Line of *E. coli* at Tsuen Wan Distric Beaches

圖三 荃灣區泳灘水中大腸桿菌平均走勢線

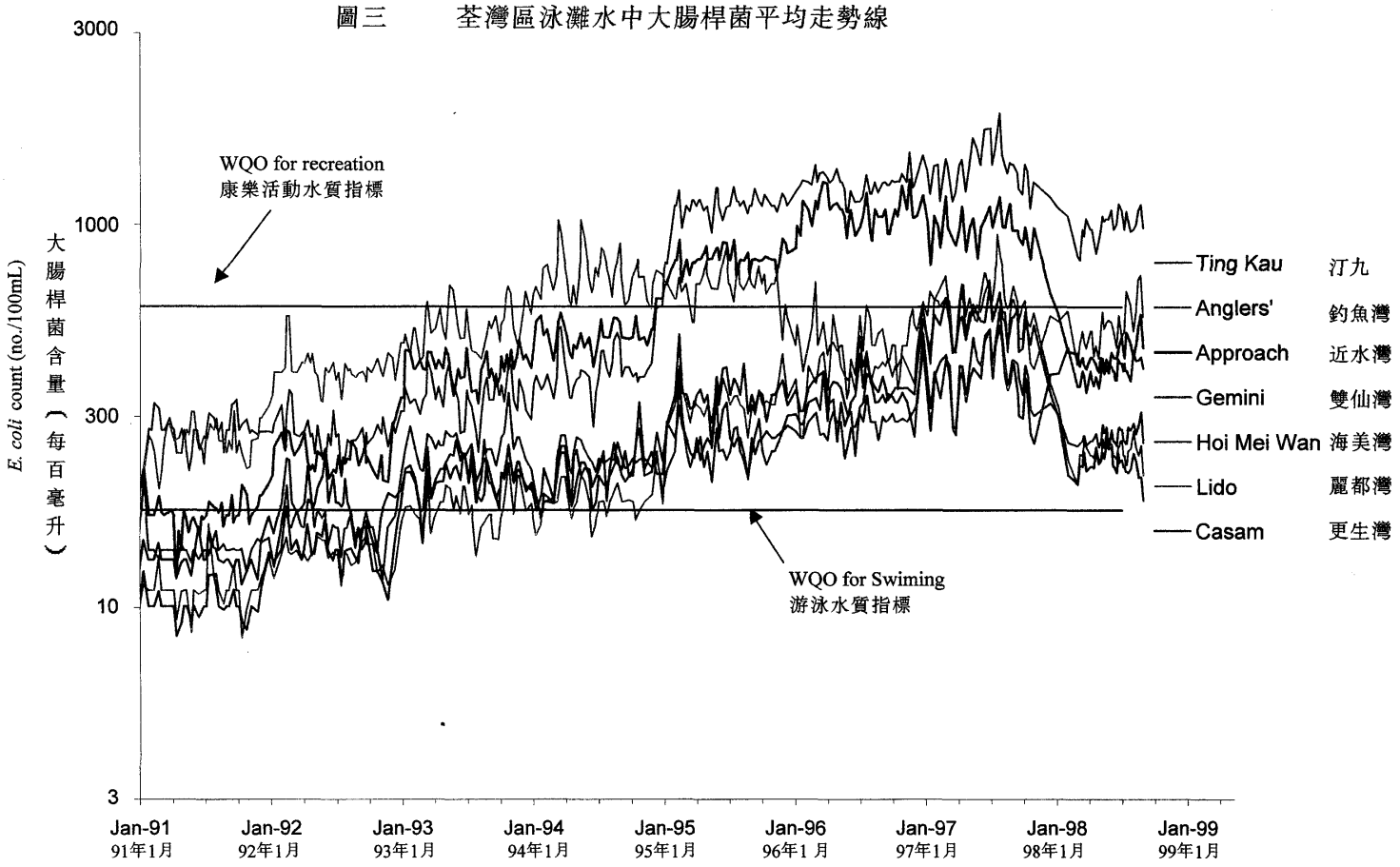


FIGURE 4
圖四

Near Field Plume Modelling Results for Sham Tseng Outfall -
深井排污口的近區污水帶模擬結果 —
Plume trajectory, dilution and bacteria concentration for an average wet season condition
在一般雨季情況下污水帶的流動途徑，稀釋度及含菌量

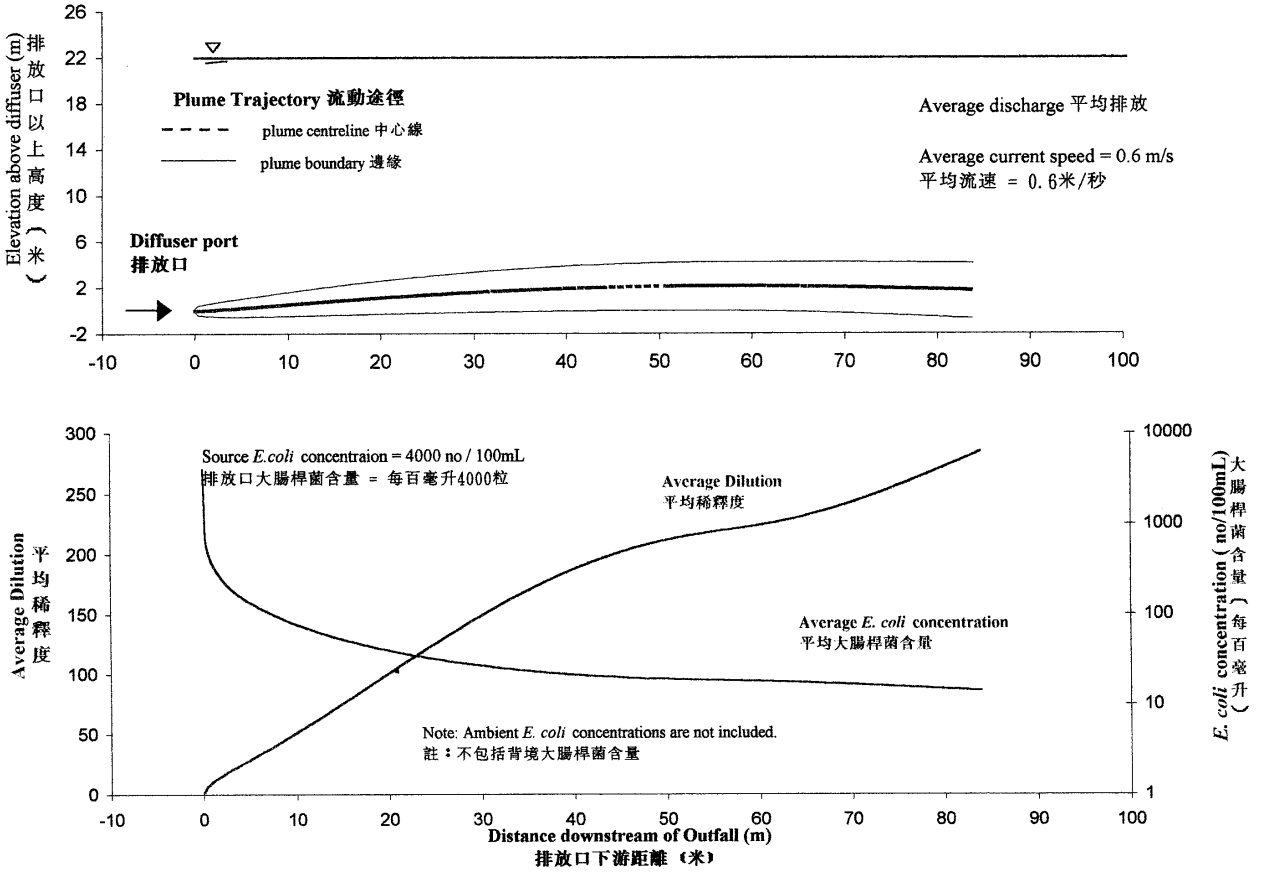


FIGURE 5
圖五

Near Field Plume Modelling Results for Sham Tseng Outfall -
深井排污口的近區污水帶模擬結果 —

Plume trajectory, dilution and bacteria concentration for an average dry season condition
在一般旱季情況下污水帶的流動途徑，稀釋度及含菌量

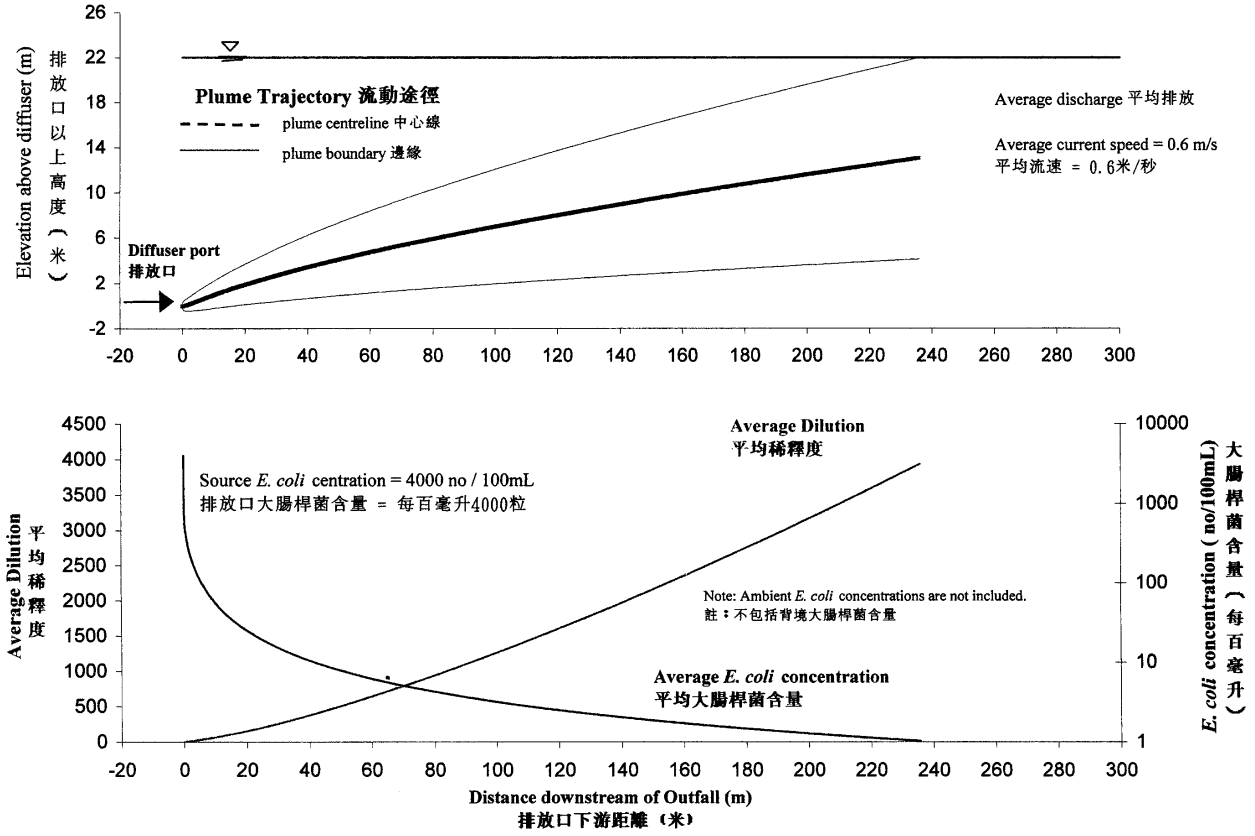


FIGURE 6
圖六

Average *E. coli* concentration downstream of the Sham Tseng Outfall
深井排放口下游的平均大腸桿菌含量

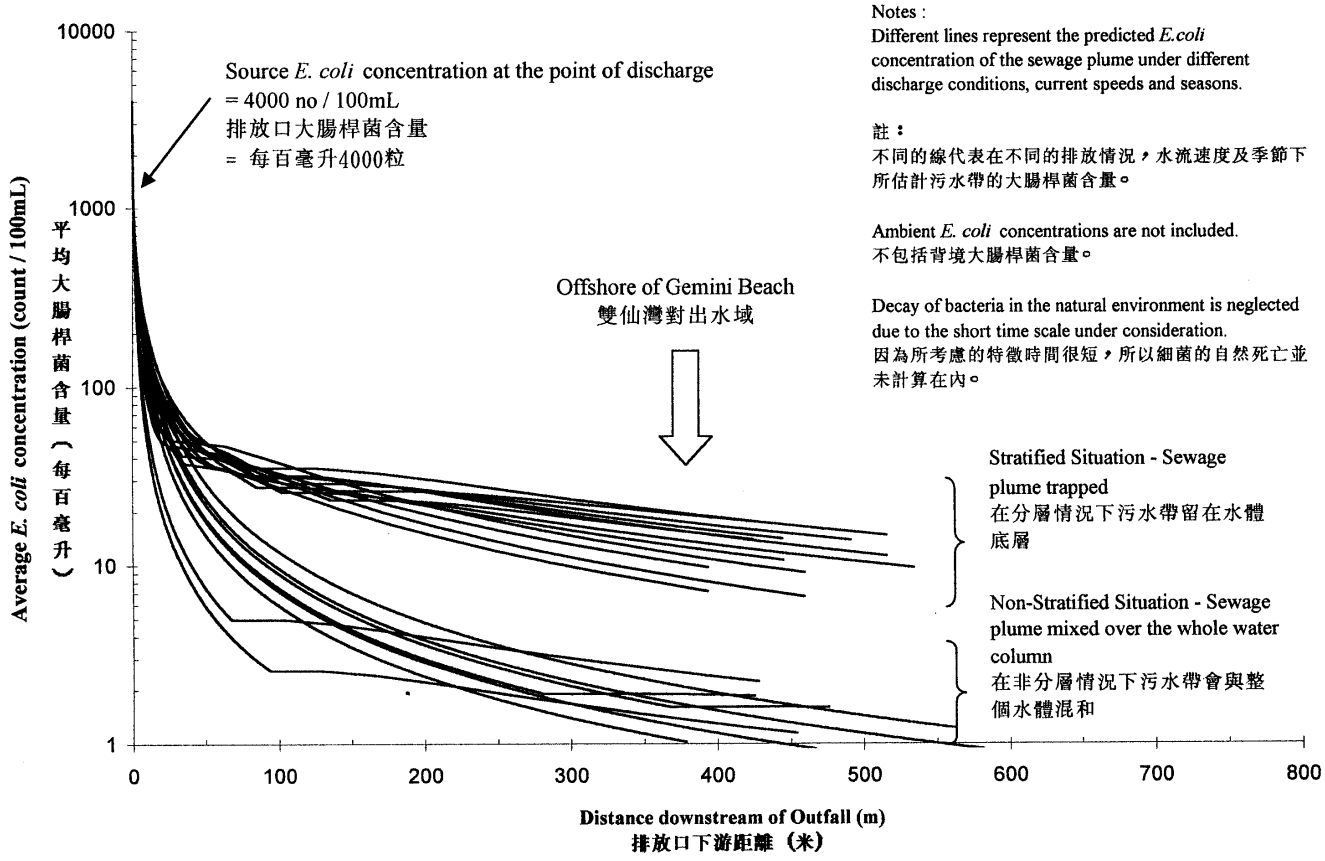


FIGURE 7
圖七

Near Field Plume Modelling Results for Cheung Chau Outfall -
長洲排污口的近區污水帶模擬結果 —
Plume trajectory and dilution for an average wet season condition
在一般雨季情況下污水帶的流動途徑及稀釋度

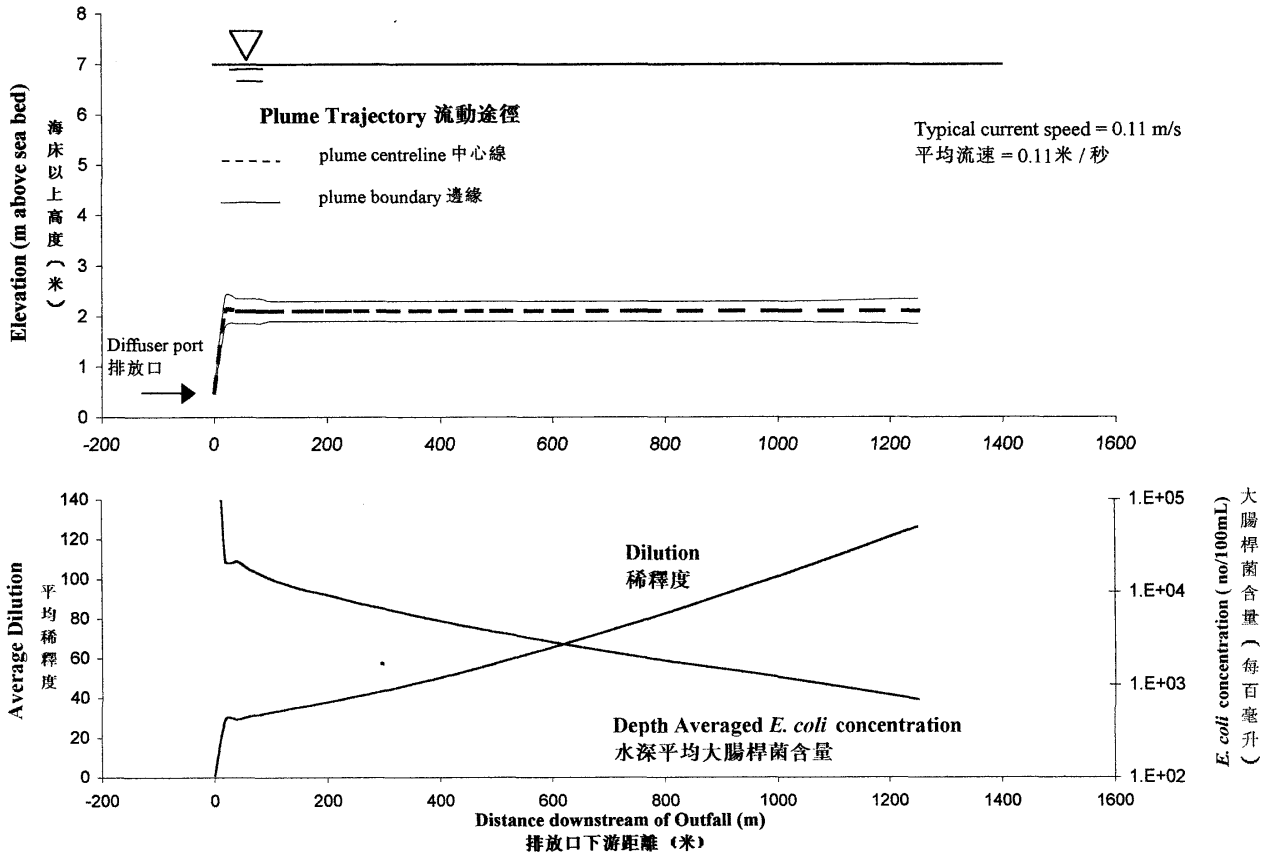


FIGURE 8
圖八

Near Field Plume Modelling Results for Cheung Chau Outfall -
長洲排污口的近區污水帶模擬結果 —
Plume trajectory and dilution for an average dry season condition
在一般旱季情況下污水帶的流動途徑及稀釋度