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For discussion
on 4 November 2004

Harbour-front Enhancement Committee

Way Forward for the Harbour Area Treatment Scheme Stage 2

PURPOSE

Since the full commissioning of the Harbour Area Treatment Scheme (HATS) Stage 1 in December 2001, the water quality of Victoria Harbour has improved significantly. As a key component of HATS, the Stonecutters Island Sewage Treatment Works (SCISTW) is now providing chemical treatment to 75% of the sewage generated in the HATS catchment and stopping some 600 tonnes of sludge from entering the harbour daily. To cater for future sewage flow increase and to provide the necessary treatment for the remaining 25% of sewage currently being discharged into the harbour after screening only, we need to implement the next and final stage of HATS - HATS Stage 2. This paper consults Members on our proposal for HATS Stage 2.

BACKGROUND

2. HATS is one of the most important environmental projects ever undertaken in Hong Kong which aims to improve the water quality of Victoria Harbour. In April 2000, the Administration invited an International Review Panel (IRP) to carry out a review of further stages of HATS. In its report released on 30 November 2000, IRP proposed four siting options of different degrees of decentralization for the treatment facilities (hereafter referred to as Option A, B, C and D). These options all involve the use of Biological Aerated Filters (BAF) technology for treatment, deep tunnels for transfer and short outfalls for disposal of sewage. In proposing the four options, IRP recognized that there were several uncertainties that needed to be addressed. The IRP therefore recommended that the Administration should carry out a series of trials and studies (the Studies) to evaluate and select a final configuration for the next stage of HATS. The Studies have been duly completed and this paper provides a summary of Study findings with focus on the selection and planning of our preferred option and the expected benefits of HATS Stage 2.

THE PROPOSAL

The Preferred Siting Option – Option A

3. The Studies conclude that all the four siting options would be environmentally acceptable and technically feasible. The Studies also confirm that biological treatment and disinfection, in addition to the current chemical treatment process, should be provided in order to enhance and sustain our harbour water quality. Moreover, according to the Studies, even if the most compact sewage treatment technology is used in the biological treatment process, we will still require extra land of at least 12 hectares outside the current boundary of the SCISTW to accommodate the biological treatment facilities. Of the four options, the Government prefers Option A because it gives the best overall performance in terms of cost, environmental, social and engineering considerations (see Annex for detailed comparison). In particular, as Option A only involves the provision of new chemical treatment and disinfection facilities within the existing SCISTW and new underground biological treatment facilities at a site in the vicinity of the SCISTW, it is likely to cause the least nuisances to the surrounding developments during both the construction and operation stages.

Justification for two-phase implementation

4. Although our assessment has shown that the provision of biological treatment is essential for protecting the harbour in the long term, owing to the need to secure land for the biological treatment facilities, the substantial capital and recurrent costs involved and the complexity of building a compact biological treatment system of the scale required using the public-private partnership approach, we consider it prudent to implement Stage 2 in two phases (See Figure 1) –

(a) Stage 2A – we will construct deep tunnels for transferring sewage from the remaining parts of Hong Kong Island to Stonecutters Island and upgrade the existing SCISTW to provide chemical treatment and disinfection for an ultimate sewage flow of 2.8 million cubic metres per day, which doubles the existing flows being treated at SCISTW.

(b) Stage 2B – we will provide additional biological treatment facilities to enhance the pollutant removal rate to cater for the anticipated population build-up in the HATS catchment. These biological treatment facilities will be constructed underground on a site in the vicinity of the SCISTW so that the surface land can be used for other purposes.

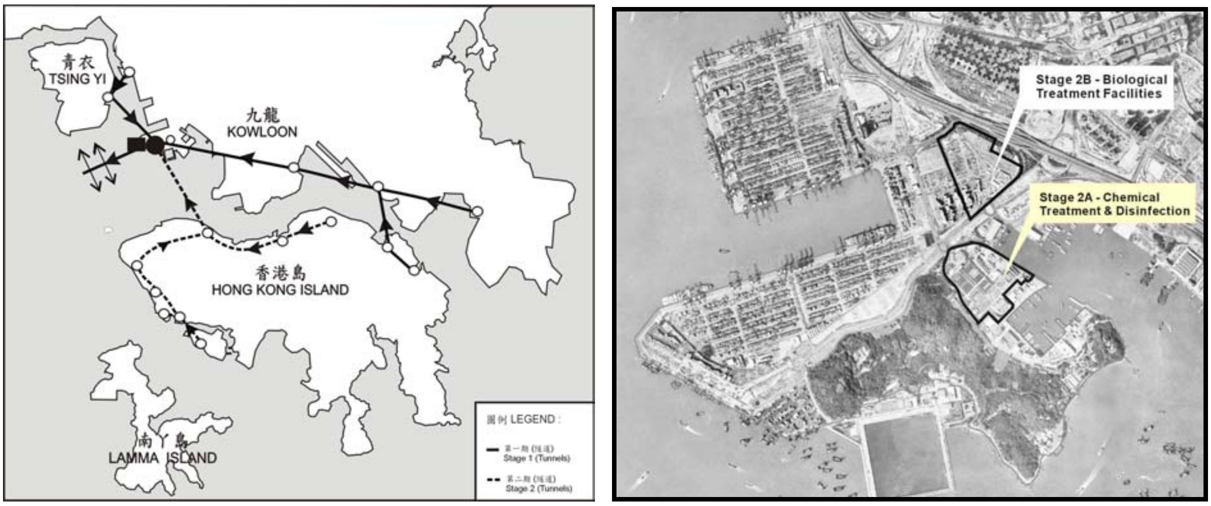

Figure 1 The Preferred Option for HATS Stage 2

5. The current water quality modelling results suggest that the provision of chemical treatment and disinfection to all HATS flows under Stage 2A would result in compliance with most of the water quality criteria, including those set for dissolved oxygen and ammonia, in most parts of the harbour area. The potential exception is that the minimum dissolved oxygen (DO) and unionized ammonia criteria[1] might not be met on an infrequent basis in the region off the coast of West Kowloon due to the proximity to the HATS discharge. Implementation of HATS Stage 2B would enable full compliance with the above two water quality criteria even in that specific locality. It is worth pointing out that the above potential occasional non-compliance has been predicted on the basis of the modelling results generated based on current population growth projections. As the actual population build-up rate can be different from the projections, the actual extent and frequency of non-compliance can also change. Given that HATS Stage 2A would result in substantial improvement of harbour water quality and that the potential occasional non-compliance in the locality in question would unlikely cause any unacceptable threats to the environment, the environmental risk of proceeding with Stage 2A first and implementing Stage 2B in the light of the actual water quality monitoring results and sewage flow build-up is clearly acceptable. Therefore, it should be a pragmatic approach to implement HATS Stage 2 in two phases from the environmental point of view.

6. Turning to the financial perspective, the additional capital cost of splitting Stage 2 into two phases is $0.4 billion, which is low compared with the overall capital cost of $19.5 billion (Table 1). The overall recurrent cost is about the same with and without phasing. Given that the annual cost of operating Stage 2B is roughly $0.72 billion, the additional (deferred) capital cost that would be incurred by a phased approach would be more than compensated for by the present value savings in

[1] The DO level at the sea bottom is usually lower than that at the surface waters. If the bottom DO level drops too low, some bottom dwelling organisms such as crabs or shrimps may suffocate and die. The odour problem may arise when the DO level approaches zero. The minimum DO criterion (> 2 mg/L) is set to avoid this. For ammonia, if the level is too high, it may cause damage / death to some sensitive marine organisms, such as fish fries. The four-day average unionized ammonia criterion is set to avoid this.

recurrent costs. As such, it is likely that substantial savings can be achieved if we can optimize the introduction of the biological treatment process in the light of the actual need instead of upfront from the outset, particularly having regard to the fact that Stage 2A alone would enable most of the water quality criteria to be met in most parts of the harbour area.

Table 1 Cost Implication for Phased Implementation of HATS Stage 2 Based on the Preferred Option

HATS Stage 2 Implementation	Capital Cost (HK$billion)	Recurrent Cost (HK$billion/year)
Without Phased Implementation	19.1	1.18
With Phased Implementation		
Stage 2A	8.4	0.44
Stage 2B	11.1	0.72
Total	19.5	1.16

7. Notwithstanding the various considerations in support of a two-phase implementation approach, Stage 2B would be required ultimately. Therefore we need to make preparations for Stage 2B in parallel with implementing Stage 2A, including undertaking the environmental impact assessments (EIA), conducting site investigations and making available the site identified for the biological treatment facilities, such that Stage 2B can move full steam ahead once there is a clear indication that the actual population in the harbour area is growing as forecast and that the water quality monitoring results demonstrate the need. To this end, we will closely monitor sewage flow build-up and water quality to allow an early decision to be made to trigger the implementation of Stage 2B in a timely manner.

Procurement Arrangement

8. For the design and construction of HATS Stage 2A and Stage 2B, together with the operation of all the new and existing treatment facilities under HATS, we will explore the "Public Private Partnership" arrangement. We currently envisage that the "Design, Build and Operate" approach can be used for providing the new treatment facilities under Stage 2 and subsequently operating them together with the existing facilities. As for the underground tunnels, as they would not require much operation and maintenance upon completion, the "Design and Build" approach will be considered. As our technology trials have confirmed that there are trade-offs between compact treatment technologies and conventional treatment technologies, we intend not to specify the biological treatment technology under Stage 2B but only the performance of the treatment plant required. In this connection, we will attempt to reserve adequate land in the vicinity of the existing SCISTW to enable tenderers with expertise in different biological treatment technologies, both compact and conventional ones, to compete for the provision of the biological treatment facilities.

Implementation Timetable

9. We will conduct a four-month public consultation exercise to foster a general consensus in the community on HATS Stage 2. With the support of the community, we will start the site investigations and EIA of HATS Stage 2A in 2005 to enable the major construction works to commence in 2007/08. Such a timetable would mean the completion of the Stage 2A treatment facilities in about 2011/12 to bring further water quality improvements. The more challenging tunnelling works under Stage 2A are expected to be completed by 2013/14 to bring about the full benefits of Stage 2A. In line with our commitment to re-opening the Tsuen Wan beaches as soon as possible, we will also explore ways to expedite the completion of part of the disinfection facilities of Stage 2A by 2008/09. As for Stage 2B, we will target at completing all the preparatory work, including the EIA, land reservation and ground investigations during the implementation of Stage 2A to shorten its delivery time.

IMPORTANCE AND BENEFITS OF HATS

Improvements due to HATS Stage 1

10. Since the full implementation of HATS Stage 1, the SCISTW has been treating 75% of the sewage (about 1.4 million cubic metres per day) in the HATS catchment. The SCISTW is one of the most efficient chemical treatment plants in the world, with very high pollutants removal efficiency, namely -

a) 70% of the organic pollutants in terms of biochemical oxygen demand;
b) 80% of the suspended solids; and
c) 50% of sewage bacteria, *E.coli*.

Overall, it is stopping 600 tonnes of sewage sludge and its pollutants from entering the harbour every day.

11. Before the implementation of HATS Stage 1, the average compliance with the dissolved oxygen water quality objective in the harbour area was low, only 65% for 2000 – 2001. With the implementation of HATS Stage 1, the average dissolved oxygen level in the harbour has increased by 10% (see Figure 2), resulting in an increase of the compliance rate to 97% in 2002 – 2003. Similar improvements have been observed in other water quality parameters, such as the total inorganic nitrogen objective, for which the compliance rate has increased from 76% for 2000 – 2001 to 94% for 2002 – 2003. In addition, the levels of key pollutants in the harbour area have generally decreased -

a) ammonia (harmful to marine life) has declined by 25%;
b) nutrients in terms of total inorganic nitrogen and phosphorus (which in rich supply can promote excessive algal growth) have dropped by 16% and 36% respectively, and

c) the overall *E.coli* level, which is an indicator of disease-causing organisms, has reduced by some 50%, although the *E.coli* level at the localized area in the western harbour and Tsuen Wan beaches has increased.

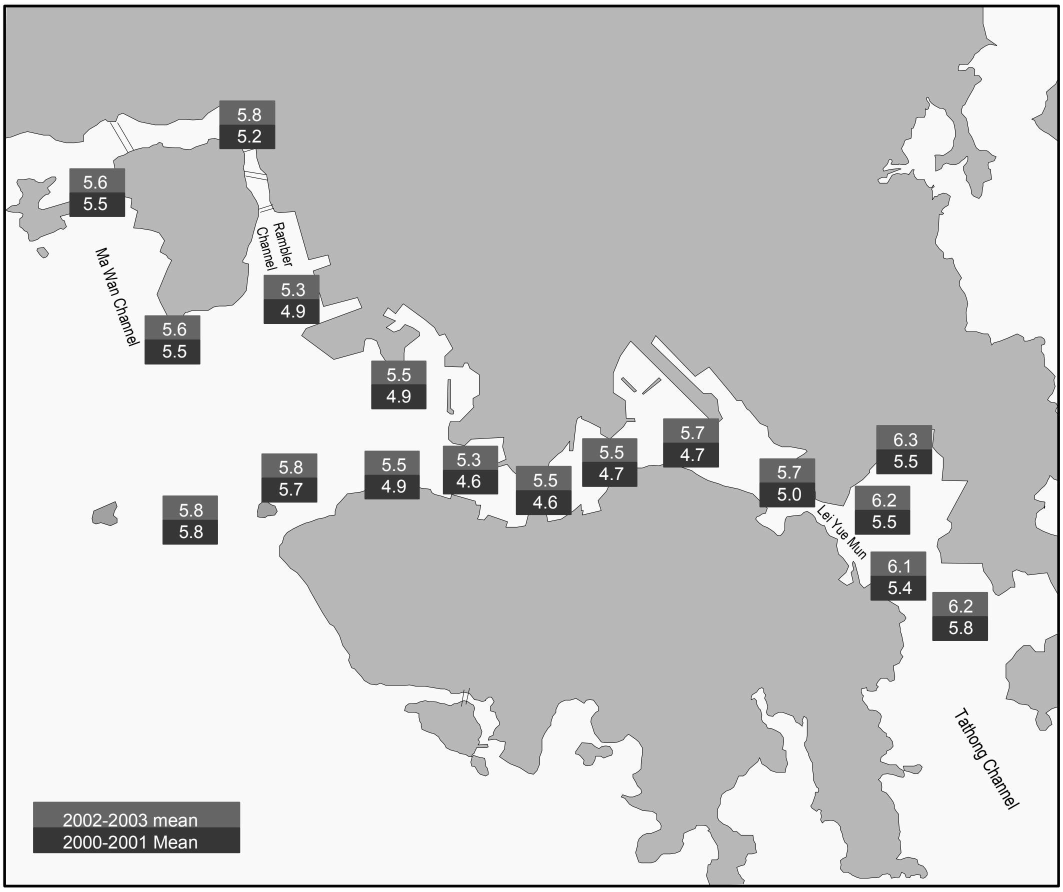

Figure 2 Map showing changes in dissolved oxygen (mg/L) at 17 stations in the HATS enhanced monitoring (comparison of mean difference between Jan 2002 – Dec 2003 and Jan 2000 – Dec 2001)

Improvements to be brought about by HATS Stage 2

12. Although HATS Stage 1 has greatly improved the water quality in the harbour, the water quality will deteriorate again as a result of the increase of sewage flow due to future developments and population growth if we do not implement Stage 2. Commissioning of HATS Stage 2A would increase the average dissolved oxygen level by 5% and commissioning of Stage 2B would increase the level by a further 5%. The compliance rate for the dissolved oxygen criteria will increase to 100% on completion of Stage 2. The provision of disinfection under Stage 2A would remove over 99.9% of the sewage bacteria from the sewage, allowing the Tsuen Wan beaches to be re-opened for swimming. Other pollutants, such as toxic ammonia and nutrients would also be reduced substantially to enable full compliance with water quality criteria in the harbour after completion of HATS Stage 2.

13. Overall, the water quality improvements from HATS Stage 2 would result in a

much improved environment for marine life, a cleaned up harbour and re-opened beaches, and would allow the real possibility of staging major water events such as ad hoc cross-harbour swimming contests.

Polluter Pays Principle

14. Tackling pollution is always costly and the "polluter pays principle" has been widely accepted as a means of sharing out the cost fairly. The implementation of HATS Stage 2, which is essential for handling the million tonnes of wastewater created by us, would result in additional recurrent expenditure for the operation and maintenance of the scheme. In line with the "polluter pays principle", adjustment of the rates of sewage charges would be inevitable with the commissioning of the various components of HATS Stage 2 in the years to come.

PUBLIC CONSULTATION

15. As there is a clear need to move forward with HATS Stage 2, and as the heavy capital investment and recurrent expenditure would ultimately require a significant contribution from the public one way or another, we consider it important to reach a consensus within the community before making a final decision on the way forward. The five-month public consultation exercise on HATS will last from June to November 2004. In-depth briefings will be provided to major stakeholders such as green groups, academics, professional bodies and community representatives. A public hearing will also be held to collect the views of the public directly on the proposed way forward for HATS Stage 2. We will take into account comments received during the public consultation exercise before finalizing the proposal.

ADVICE SOUGHT

16. Members are welcome to provide views on the preferred option, the proposed two-phase implementation approach and any other issues on the implementation of HATS Stage 2.

Environment, Transport and Works Bureau
October 2004

Comparison of the Four IRP Options

The four options proposed by the International Review Panel mainly differ by the degree of decentralization. They all involve the use of deep tunnels to convey the sewage, the provision of biological treatment and, if necessary, disinfection, in addition to the current chemical treatment process. The highly treated effluent would then be discharged into the Harbour through short outfall(s). The four options are as shown in Figure 3 below –

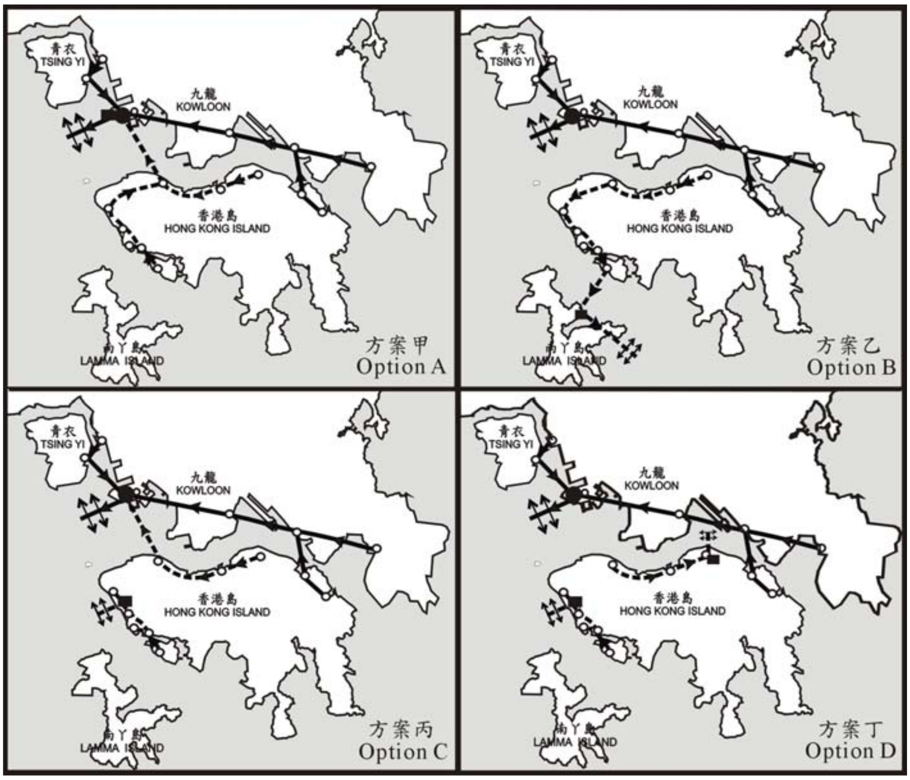

Figure 3 The Four IRP Options for HATS Stage 2

2. As far as sewage treatment works are concerned, Option A involves the expansion of the existing Stonecutters Island Sewage Treatment Works (SCISTW). Option B involves the expansion of the SCISTW and the construction of a new treatment works at the ex-quarry site at Lamma Island. Option C involves the expansion of the SCISTW and the construction of a new treatment works in a cavern to be excavated at Sandy Bay. Option D involves the expansion of the SCISTW and the construction of two new sewage treatment works in caverns to be excavated at Sandy Bay and Braemar Hill, North Point, respectively. The locations of the sewage treatment works sites for the four options identified in the EEFS are shown in Figure 4 and the cost comparisons are provided in Table 2.

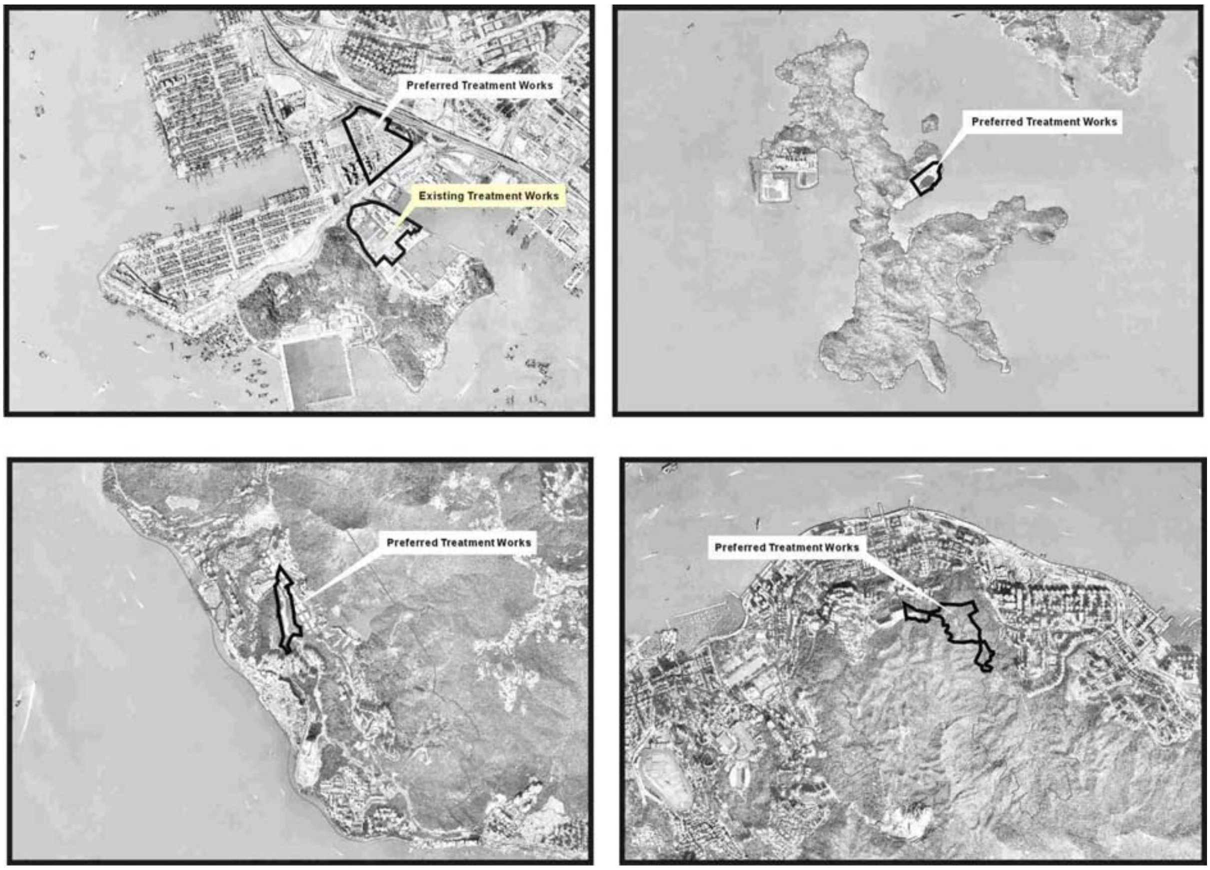

Figure 4 Treatment Works Site at Stonecutters Island, Lamma Island, Sandy Bay and North Point

Table 2 Cost Comparison of the Four IRP Options, Assuming the Provision of Biological Nutrient Removal and Disinfection

	Capital Cost[2] (HK$billion)	Recurrent Cost (HK$billion/year)
HATS Stage 1	8.2	0.32
HATS Stage 2[3]		
Option A	19.1	1.18
Option B	19.2	1.18
Option C	19.5	1.25
Option D	20.1	1.35

[2] The capital cost includes the upgrading of the preliminary treatment works, construction of tunnels and the sewage treatment works. However, this has not included the sludge incinerator which costs around $2.2 billion. The sludge incinerator will form part of the integrated waste treatment facilities to be considered in a separate exercise, as it will need to handle other sludge apart from those generated by HATS.

[3] These cost estimates assume all the steps of the biological treatment process will be provided. If denitrification, i.e. the removal of nitrogen, which is currently included as a step of the biological treatment process on the ground of following the precautionary principle is not to be provided eventually, the capital and annual recurrent cost estimates would be lowered by $1.9 billion and $0.27 billion respectively.

3. The four IRP Options have been evaluated against five main criteria, viz. environmental, engineering, social, economic and land resources factors. Results of the detailed comparison of the four IRP Options are tabulated in Table 3 below -

Table 3 Performance Comparison of the Four IRP Options

Criteria		Ranking of the Four Options[4]			
		Option A	Option B	Option C	Option D
Environment and Public Health Criteria					
1	Water Quality - Harmful Algal Blooms	All Equal			
2	Marine Ecology	1	4	1	1
3	Fisheries	1	4	1	1
4	Public Health	All Equal			
5	Hazard to the Public	1	1	3	4
6	Air Quality	1	1	3	4
7	Noise	1	1	3	4
8	Terrestrial Ecology	1	1	3	4
9	Landscape and Visual	1	4	2	3
10	Waste Management Implications	2	1	3	4
Engineering / Technical					
11	HATS System Resiliency	4	2	3	1
12	Tunnel / Outfall Construction Risk	3	4	2	1
13	Sewage Treatment Works Construction Risk	1	2	3	4
14	Operational Risk	1	2	3	4
15	Ability to Cope with Change	1	2	3	4
Social					
16	Community Facilities Impact	All Equal			
17	Road Traffic	2	1	3	4
18	Marine Traffic	1	3	1	4
19	Potential Public Concern	1	2	2	4
20	Job Creation	All Equal			
Economics					
21	Total Lifecycle Cost	1	2	3	4
Land Resources / Statutory Land Procedures					
22	Surface Land Resource	1	4	1	1
23	Land Zoning	All Equal			
24	Land Status	1	2	3	4

4 Ranking 1st performs the best while ranking 4th performs the worst.

4. Option A is the best among the four IRP options. The general comparison of the four options against the five key criteria are summarized below -

a) **Environmental Criteria** – As all the four options have adopted a very high level of treatment, their effects on water quality and public health are almost identical. Nevertheless, as Option B requires the construction of an outfall in the more sensitive southern waters, its impact on fisheries and marine ecology would be potentially higher than the other three options, in the event of mishaps during construction or operation. On the other hand, as Options C and D require the construction of sewage treatment works in caverns adjacent to the residential areas at Sandy Bay and Braemar Hill, these two options are inferior to the other two in terms of air, noise and terrestrial ecological impacts. On landscape and visual impacts, Option B is the worst because it requires surface land for construction of treatment works at the ex-Lamma Quarry whilst the others assume the construction of underground / cavern sewage treatment facilities.

b) **Engineering Criteria** – Option A is a centralized treatment system and therefore the inherent drawbacks would be the need for a more extensive tunnel system and a comparatively lower transfer system resiliency. Nevertheless, the substantially lower construction and operational risk as compared with treatment works in caverns and the higher flexibility to cater for any future upgrading of a centralized treatment system makes Option A more favourable than the other options in terms of engineering performance.

c) **Social Criteria** – As Options C and D require the construction of caverns next to residential areas, the associated traffic impacts would inevitably be higher than the other options. Moreover, as Option A only involves the construction of new treatment facilities adjacent to an existing sewage treatment works while the other options require construction of new treatment facilities on virgin land, it is expected that the potential impacts of Option A on public would be smaller.

d) **Economics** – Construction and operation of sewage treatment works in caverns would be expensive. As detailed in Table 2, the overall capital and recurrent costs of Option A are lower than the other options and therefore it compares favourably with the other options.

e) **Land Resources** – The feasible choice of minimizing surface land take under Option A by building the biological treatment facilities underground makes it the most favourable. As Option B requires surface land at ex-Lamma Quarry for the construction of sewage treatment facilities whilst the others assume construction of underground / cavern sewage treatment works, it is inferior to the other options. Separately, as the statutory land allocation exercise for each additional piece of land will take time, Options B, C & D would be less favourable than Option A.