

**Section 12A Application**

**To amend Discovery Bay Outline Zoning Plan  
For rezoning the permissible use from staff quarters to flats**

**At Area 6f, Discovery Bay**

**Planning Statement**

**January 2016**

**Applicant**

**Hong Kong Resort Company Limited**

## Section 12A Application

To Amend Discovery Bay Outline Zoning Plan for rezoning the permissible use from staff quarters to flats at Area 6f, Discovery Bay

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### Consultants

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## Executive Summary

- S1 Hong Kong Resort Company Limited has a long term vision to better utilise the existing land resources at Discovery Bay to serve a larger population while retaining the character of the development. It has conducted site analysis, and subsequently identified development potentials at Area 6f which is the subject site of this application, and Area 10b for which a separate application is made concurrently. The Concept Plan for the two areas will create about 1,600 units for 4,000 persons in total.
- S2 This application seeks to amend the Discovery Bay Outline Zoning Plan No.S/I-DB/4. It refers to Area 6f, which is the land area generally around Discovery Valley Road to the south and Parkvale Village to the east. Its objective is to modify the permissible form of accommodation, from staff quarters which are no longer required to general residences, with an increased development density. The proposed development is sensitive to the adjacent development and natural setting.
- S3 This Concept Plan is considered responsive to the Chief Executive's Policy Address 2015 advocating for additional housing supply, and development at Lantau Island where Discovery Bay is located. It has identified Area 6f, given its already approved development yet to be implemented, in close proximity to existing development, at a site of minimal natural conservation value. The proposal is supported by technical studies quantifying the infrastructure requirement to accommodate the population increase. It has given due regard for the mountain backdrop and the relationship with the existing residents. In summary, the proposal is considered satisfactory in addressing the general planning intention of the area.
- S4 Accordingly, the Town Planning Board is invited to favourably consider this application to enable the proposed Concept Plan at Area 6f.

## 行政摘要

- S1 香港興業有限公司有長遠計劃去運用現有愉景灣土地，以保留現有的環境的同時，增加當中的人口，包括此規劃申請涉及的第 6f 區和另一申請涉及的第 10b 區。兩區計劃將會總共供應大約 1,600 單位容納 4,000 人口。
- S2 此第 12 條規劃申請地點位於愉景灣分區計劃大綱核准圖編號 S/I-DB/4 上愉景山道以北和寶峰徑以西的第 6f 區。方案擬議把現在批准但無需要的員工宿舍更改為住宅，和增加建築密度。方案考慮到鄰近的發展和環境。
- S3 此擬議方案配合 2015 年行政長官施政報告所提倡的增加住宅供應和規劃發展愉景灣所屬於的大嶼山。方案用意為利用第 6f 區的已批准的項目和附近的發展環境。方案包括影響評估報告以證實基礎設施足夠應付擬議的人口增長。其設計考慮到附近的觀景和附近居民的生活環境。總括而言，此計劃附合大綱圖的整體規劃意向。
- S4 因此，懇請城市規劃委員會批准此申請，容許擬議的發展方案。

**Development Schedule 發展參數**

Site Area 地盤面積 (approximately 大約)	8,300 m <sup>2</sup> 平方米
Gross Floor Area 建築面積 (max 上限)	21,600 m <sup>2</sup> 平方米
Plot Ratio 地積比率	2.6
Number of Buildings 樓宇數目	2
Number of Storeys 樓宇層數 (max 最高)	18
Building Height 建築物高度 (max 最高) Measured to the highest usable floor space 至最高的實用樓面空間	120 mPD 最高主水平基準上
Measured to the top most structure 至構築物	128 mPD 最高主水平基準上
Number of flats 住宅單位數量 (approximately 大約)	476

## **1 Introduction**

- 1.1 Hong Kong Resort Company Limited (HKR) has a long term vision to better utilise the existing land resources at Discovery Bay to serve a larger population, while retaining the existing character of the area.
- 1.2 HKR has conducted site analysis, taken into consideration of the topography and landscape around Discovery Bay, and recognised the value of the natural environment. It has subsequently identified development potentials at Area 6f and Area 10b around already approved development to be implemented or already disturbed sites. Their development is considered to reduce disturbances to the natural environment, as opposed to alternative pristine locations.
- 1.3 Concept Plans have been prepared at Area 6f and Area 10b creating about 1,600 units for 4,000 persons in total.

## **2 The Application**

- 2.1 To enable the Concept Plan at Area 6f, an application pursuant to Section 12A of the Town Planning Ordinance is required. This planning statement is prepared in support of an application to amend the Discovery Bay Outline Zoning Plan No.S/I-DB/4 (the OZP). The application proposes to amend the OZP regarding the permissible development type and density at Area 6f.
- 2.2 A separate planning application for the proposals at Area 10b is made concurrently.

## **3 Relevant Background**

### Chief Executive's Policy Address in 2015

- 3.1 Reference is made to the Chief Executive's Policy Address in 2015, which advocates increased housing supply, and future development at Lantau Island where Discovery Bay is located. Relevant paragraphs read as follows:

*69. The Government will continue to maintain the stable and healthy development of the private property market through steady and sustained land supply...*

*72. What Hong Kong lacks is not land, but land that is developable... We also lowered the development intensity of land newly planned for development. These are causes of the serious shortage of housing supply that we have been facing in recent years.*

*74. We have to take into consideration more and more factors such as the impact on traffic, environment, conservation and even air ventilation in the planning process. As a result, the supply of developable land has decreased or decelerated...*

*75. ...Increasing and expediting land supply is the fundamental solution to resolve the land and housing problems of Hong Kong.*

85. *At the same time, we will continue to actively explore with the MTRCL and the Kowloon-Canton Railway Corporation the development potential of stations and related sites along the existing and future rail lines, such as Siu Ho Wan in Lantau.*

93. *...The Stage Three Public Engagement of the Tung Chung New Town Extension Study was also completed. The new town extension will provide about 48,000 residential units, and a commercial hub will be established in Tung Chung East.*

100. *...In the medium term, we will continue with the development of the Tung Chung New Town Extension, and proceed to commence studies in connection with the reclamation in Sunny Bay and topside commercial development on the Hong Kong boundary crossing facilities of the Hong Kong-Zhuhai-Macao Bridge...*

- 3.2 Accordingly, this application is responsive to the government's drive for housing supply, and to create synergy and capitalise on the envisaged development at Lantau Island.

#### Preliminary Concept Plan Submission to the Government

- 3.3 HKR has submitted Preliminary Concept Plans to optimise the land use in Discovery Bay to the Government in July 2013 and July 2014, and received comments on them. There are minimal comments on the Concept Plan at Area 6b. This planning application is for implementing the consolidated Concept Plan at Area 6f, which has taken account of the comments received.

#### Land Administration

- 3.4 Approved development at Discovery Bay is shown in a Master Plan under the lease. The current Master Plan No.6.0E1 has been in effect since February 2000, and the premium offer of the latest Master Plan No.6.0E7h(a) has been accepted by HKR.
- 3.5 Subsequent to the approval of this planning application, application to Lands Department will be made to amend the Master Plan to enable the proposed development at Area 6f.

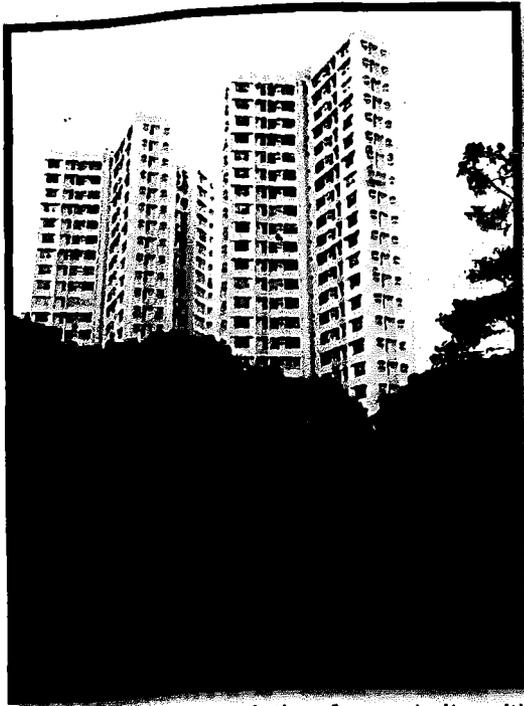
#### **4 The Application Site**

- 4.1 The application site at Area 6f is located near Discovery Valley Road to the south and Parkvale Village to the east. It is about 8,300 square metres in area. Its location plan is provided in **Figure 1**.

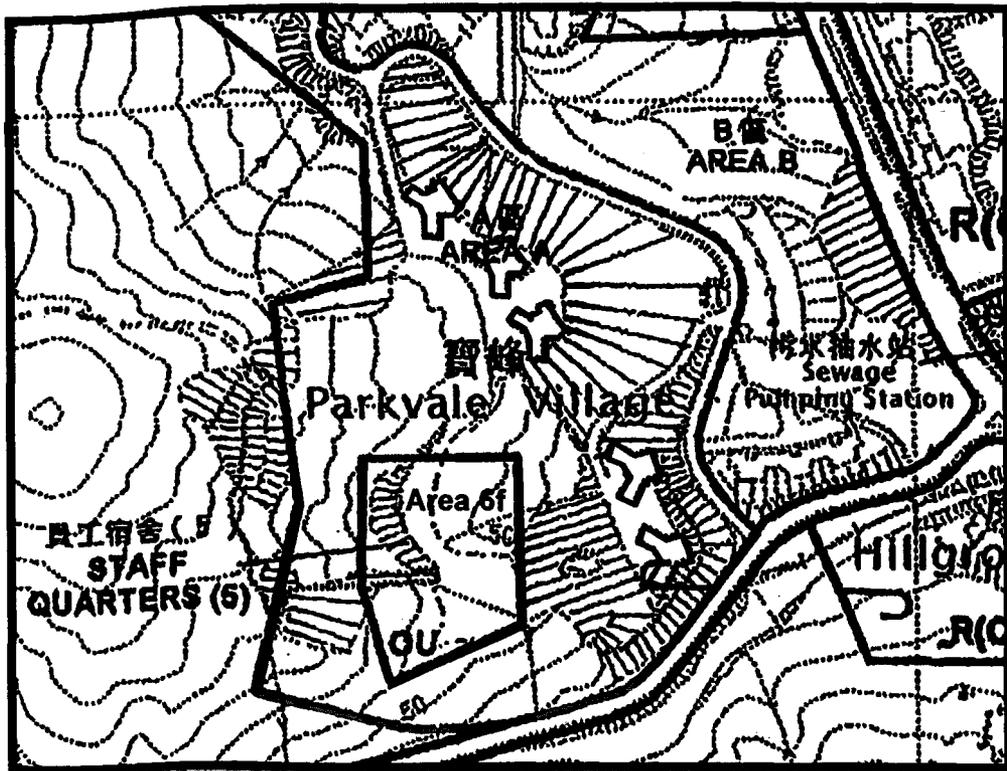


**Figure 1.** Location plan indicating the application site at Area 6f. (Source: Google map)

- 4.2 The site is located on a slope rising from 44mPD to 70mPD towards the west. Large part of it has been formed about 30 years ago, including a rock cut bench and artificial slopes at the northern part, and a flat platform and steep tree clad artificial slopes at the southern part. It is grassed, with surrounding shrubland, as shown in the photos in Figure 2.
- 4.3 There is a hiking track leading from the hilltop to Discovery Bay around the site.
- 4.4 The site is zoned as "Other Specified Uses (Staff Quarters)(5)", as shown in an extract of the OZP in Figure 3. It is subject to a maximum gross floor area of 170 square metres, and a maximum building height of 3 storeys and 9 metres. However, the intended development for staff quarters has never been implemented. In this regard:
- i. Area 6f is intended for residential accommodation provision. The designated staff quarters use for 170 square metres gross floor area is insignificant, and poor utilisation of the site.
  - ii. The permissible staff quarters use has not been implemented. Meanwhile, staff quarters are no longer in need in Discovery Bay, as a result of the completion of Discovery Bay Tunnel facilitating connection with the other districts at all times.
  - iii. Area 6f is an enclave within which Parkvale Village is located with development of greater density and building height, as shown and indicated in Figure 2 and 3 respectively.



**Figure 2.** The existing formed site with grass and surrounding scrubland at Area 6f, and Parkvale Village in the background.



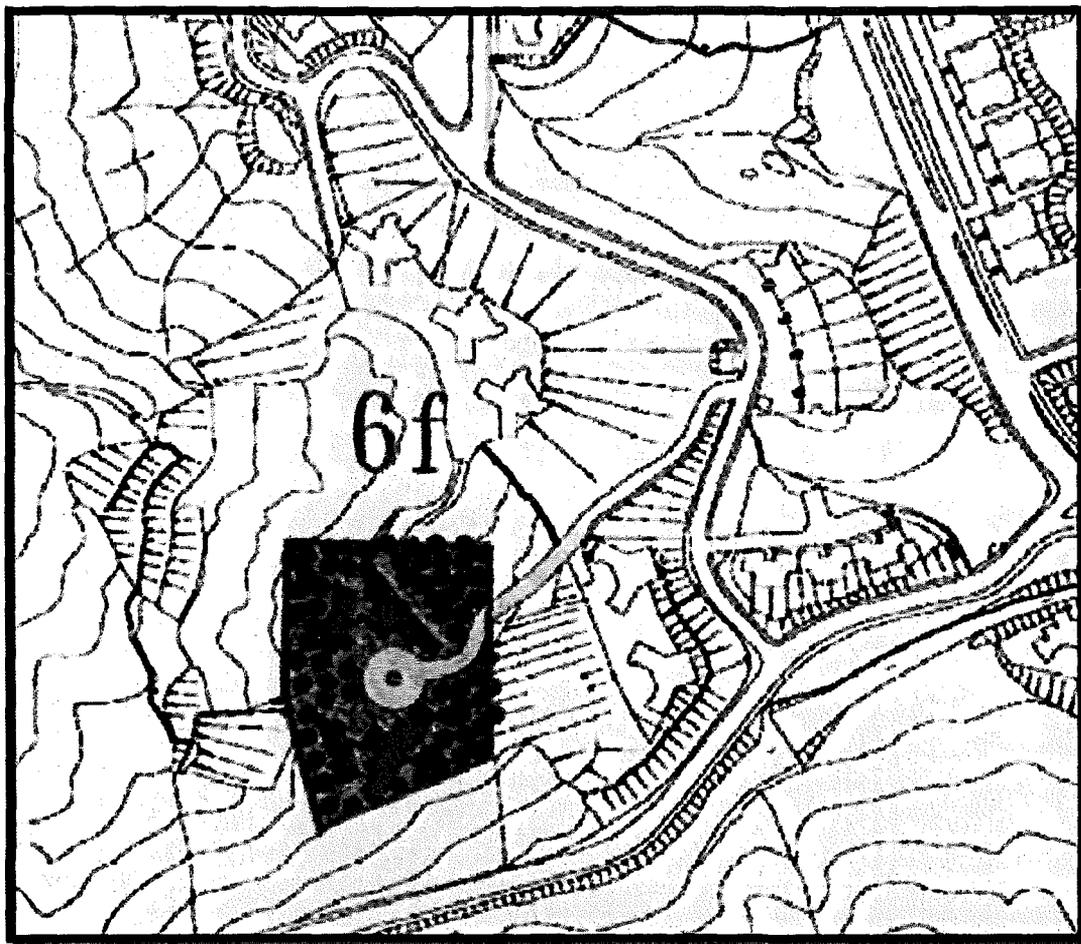
**Figure 3** Area 6f, being an enclave for staff quarters located within a larger "Residential (Group C)" zone, indicated on an extract of the OZP.

## 5. The Concept Plan

- 5.1 The Concept Plan for Area 6f seeks to change the form of the currently permissible accommodation and increases its density, to create two residential buildings.
- 5.2 The development of the Concept Plan has explored and discussed with Government Departments alternative design schemes with various development intensity and building mass. Some of these are included in **Figure 4**.
- 5.3 The current Concept Plan for this application is shown in **Figure 5** and an indicative section is provided in **Figure 6**, and is described as follows:
- i. The building footprint maximises the use of the already formed site area.
  - ii. The building height is compliant with the Deed of Restrictive Covenant (between the HKSAR Government and Hong Kong International Theme Park Limited), while relating to the adjoining topography of the site and Parkvale Village buildings.
  - iii. It will create about 476 units for 1,190 persons.
  - iv. The existing Parkvale Drive to the north will be extended to serve Area 6f.
  - v. There will be suitable provisions for parking and servicing vehicles, such as residential golf cart and loading/ unloading facilities. (Vehicle types and numbers are restricted in Discovery Bay, golf cart is the main form of vehicle ownership).
  - vi. There will be open space, more than 1 square metre per person required under the Hong Kong Planning Standards and Guidelines.
  - vii. The proposal will be capable of compliant with the building setback, building separation and greenery requirement of the Sustainable Building Design Guidelines.
- 5.4 A comparison of the currently permissible land uses and the proposal under the Concept Plan is described in **Table 1**.

**Table 1** Comparison of the currently permissible and the proposed uses at Area 6f.

	<b>Permissible development under the current OZP</b>	<b>Proposal under the Concept Plan</b>
Land use	Staff quarters	Two apartment buildings
Gross floor area (max)	170m <sup>2</sup>	21,600 m <sup>2</sup>
Building height (max) No of storeys Measured to the highest usable floor space Including structure	3 storeys Not applicable 9 metres ( <i>i.e. at about 64mPD</i> )	18 storeys 65 metres at 120 mPD 73 metres at 128 mPD



**Figure 4a.**

2013 July Design Scheme:

2 residential buildings

Building height: 25 storeys

Plot ratio 3

No of units: 340

Population: 830

Access driveway

Branch off Parkvale Drive



**Figure 4b.**

2014 August Design Scheme:

2 residential buildings

Building height: 19 storeys

Plot ratio 2.6

No of units: 288

Population: 720

Access driveway

Extend from Parkvale Drive

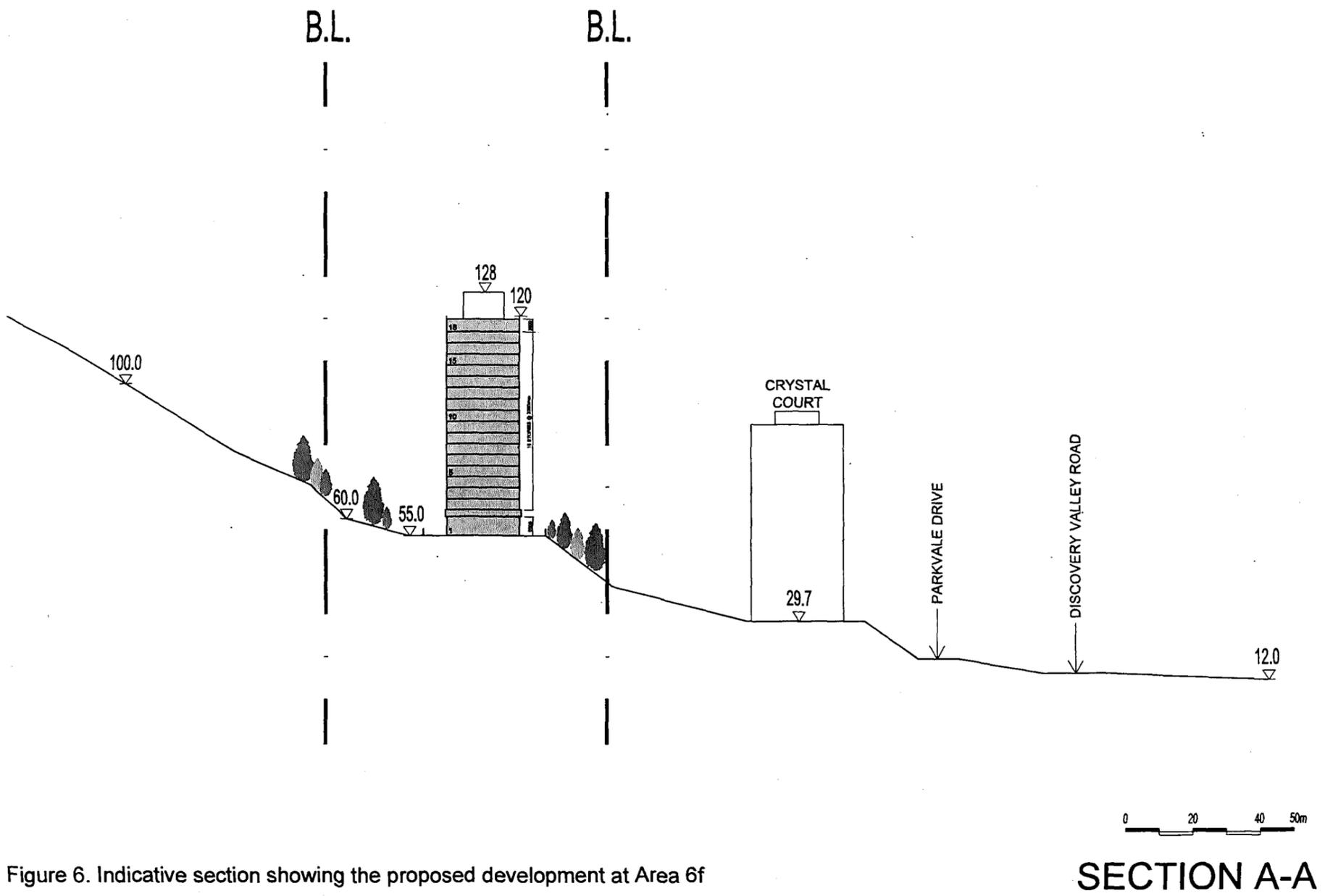
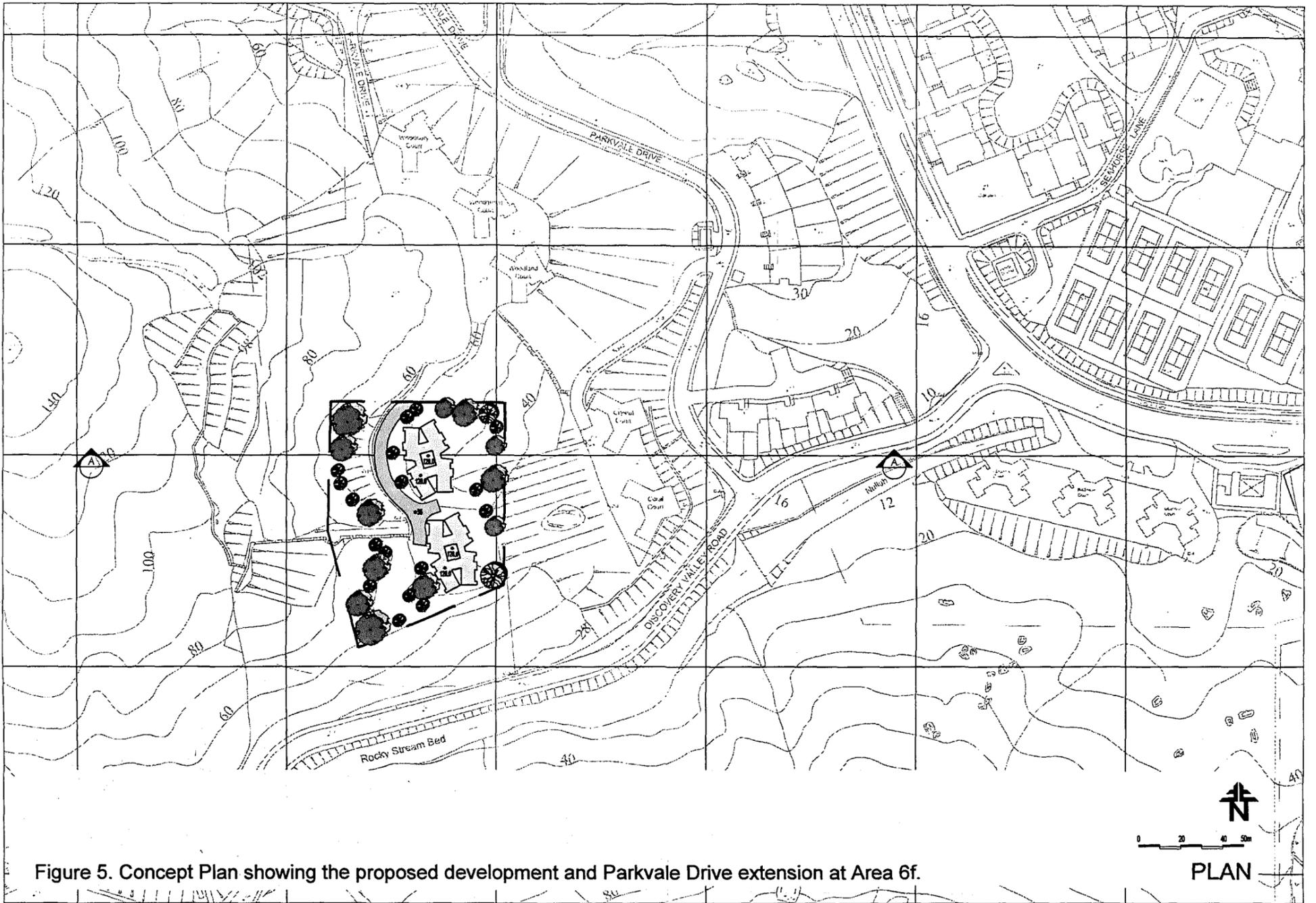


Figure 6. Indicative section showing the proposed development at Area 6f

**LEGEND**

--- BOUNDARY LINE

EXISTING TREES

PROPOSED TREES

PROPOSED SHRUBS

Existing trees to be retained as buffer planting

Existing slope planting

Focal arrival area with feature paving pattern

Staircase to/from hiking track

Focal arrival area with water feature

Existing trees to be retained as buffer planting

+120.0  
18/F

+55.0

+55.0

+120.0  
18/F

+55.0

+55.0

Existing trees to be retained as buffer planting

Grand staircase

Focal point with feature plaza

Grand cascade water feature

Terraced planter

Seating area

Children's play area

Existing slope planting



SCALE 1:350 @A3



Figure 7. Landscape proposal for Area 6f.

## 6. Engineering Studies

- 6.1 The Concept Plan is supported by engineering studies quantifying the infrastructure requirement. The Studies on Drainage, Sewerage and Water Supply Systems (**Appendix A**) and Traffic Impact Assessment (**Appendix B**) find that, subject to upgrade works where required, the infrastructure is capable of accommodating the proposed population increase at Discovery Bay. The studies have been previously submitted to Government Departments for preliminary review, and have taken account of their comments.

### Study on Drainage, Sewerage and Water Supply Systems

- 6.2 The Drainage, Sewerage and Water Supply Studies are based on about 1,600 units and 4,000 population increase (also taking into account of the Concept Plan at Area 10b). The studies conclude the following:

#### *Stormwater*

- i. The existing box culverts are capable of catering for the increased surface runoff at Area 6f, which will be drained to them via the existing stream.

#### *Sewage*

- ii. Siu Ho Wan Sewerage Treatment Works (SHWSTW) requires upgrade works to cater for the existing and concurrent developments, irrespective of the proposed developments at Discovery Bay. The upgrade works could cater for the 0.8% sewerage increase as a result of the proposal (including Area 10b).
- iii. Should the government not upgrade SHWSTW, alternative on-site sewage treatment plant could be provided, either at Area 6f or Area 10b. This is not preferred, having numerous STW in the area is considered to be ineffective in achieving economies for scale for the infrastructure and land area.

#### *Water supply*

- iv. Siu Ho Wan Water Treatment Works (SHWWTW) and its planned expansion works will be able to cater for the increased water demand as a result of the proposal accounting for only around 0.17% (or 0.57% including Area 10b) of the total upgraded capacity of SHWWTW.
- v. Siu Ho Wan Fresh Water Pumping Station (SHFWPS) requires upgrade works to cater for the existing and concurrent developments, irrespective of the proposed developments at Discovery Bay.
- vi. Should the government not upgrade SHWWTW and SHFWPS in time for this proposal, alternative water supply is possible from the existing Discovery Bay Reservoir, which has adequate storage for the increased fresh and flushing water demand (including Area 10b), together with a new water treatment works, and new fresh water and flushing water mains.

## Traffic Impact Assessment

- 6.3 The Traffic Impact Assessment forecasts the following as a result of the proposal:
- i. Minimal impact on the existing pedestrian and cycle track network.
  - ii. There will be increase in internal bus trip, external bus trip and external taxi trip as a result of the proposal. Taking into account also the Concept Plan at Area 10b, The critical road links and key junctions in Discovery Bay, Tung Chung and Sunny Bay areas would operate with ample spare capacity during both AM and PM peak hour in year 2026 and 2031 (3 and 8 years subsequent to targeted occupation respectively).
  - iii. The existing ferry services between Discovery Bay and Central would continue to operate with sufficient capacity.

In summary, the proposal is considered acceptable from traffic point of view.

## **7. Environmental Considerations**

- 7.1 Large portion of Area 6f has been disturbed, or formed and ready for development. Its surrounding shrubland is not of significant natural environmental conservation value. As such, development of Area 6f will not have any direct and indirect ecological impacts.
- 7.2 With regards to the amenity of the future residents at Area 6f, the Environmental Study (**Appendix C**) takes into account the development setback from the local roads compliant with the Hong Kong Planning Standards and Guidelines, and the insignificant traffic increase. It is unlikely to result in adverse vehicular emissions, air quality impact or road traffic noise impacts. The Environmental Study also concludes that the fireworks at Disneyland Theme Park will not result in adverse air quality or noise impact on the application site.
- 7.3 In summary, the proposal is considered to be acceptable in relation to the surrounding environment.

## **8. Trees and Landscaping**

- 8.1 The Concept Plan will affect a tree centrally located at the site and part of the tree groups along the eastern perimeter of Area 6f. A Tree Preservation Scheme and Compensatory Planting Proposal is provided in **Appendix D**, as part of the Landscape Design Proposal. Considerations are given to the following:
- i. The affected trees are on sites that were previously been disturbed in the formation of the site 30 years ago.
  - ii. Careful siting to minimise landform modification and optimise development of the existing rock cut bench and artificial slopes, while gearing the buildings towards the lower part of the site to form better local built skyline in relation to the adjoining Parkvale Village buildings.

- iii. The proposed access road and circulation space sit largely on the already formed flat platform. The building footprints do not extend excessively into the surrounding slope greenery.
- iv. The balance of the mountain backdrop will continue to provide a great extent of slope greenery and pleasant landscape setting.

8.2 The landscape proposal as shown in **Figure 7** seeks to retain the tree groups at the western part of the site, and to reinstate the disturbed vegetation along the eastern perimeter to maintain the existing vegetated character. In addition, the proposal includes a footpath link to the hiking trail to the west to avoid adverse impacts on the user of the hiking trail around the site. There will also be water features and landscape furniture for the amenity of the future residents.

## 9. Visual Amenity

9.1 The Visual Impact Assessment (**Appendix E**) identifies visually sensitive receivers in relation to the Concept Plan at Area 6f, and concludes that visual impact as a result of the proposal would be slightly adverse. Due to the low density development, the varied topography, and the open and expansive views, the proposed development will be perceived as a relatively minor element within the broader landscape context. The new buildings take advantage of the screening effect of the existing building mass in the vicinity and will be of compatible development scale. They will not significantly exceed beyond the existing building lines or protrude above the existing skyline.

9.2 Considerations are also given to the immediately adjoining private development's view sheds in this case, given the development typology in natural settings in Discovery Bay. Reference is made to the floor plans of Parkvale Village units in **Appendix F**:

- i. The proposed buildings will face the western elevation of Coral Court and Crystal Court that have windows associated with bedrooms, living rooms, and kitchen/ utility rooms, views from which are generally less sensitive to visual change compared with views from living rooms. The living rooms have dual aspects and will elevated sea views to the east will be unaffected by the proposed development.
- ii. The proposed buildings will also face the southern elevation of Woodland Court, Woodgreen Court and Woodbury Court that have bedrooms windows, which are generally less sensitive to visual change. The elevated sea views to the east from the living rooms will be unaffected by the proposed development.
- iii. The proposed buildings are set back from the affected windows by approximately 70 metres. There will also be view corridors to the greenery backdrop at an angle through the building separations.

Notwithstanding that TPB PG-No.41 stresses that the protection of public views is the priority rather than private views, the preservation of uninterrupted sea views from the living rooms of the existing blocks and restriction of visual impacts to the rear bedroom, kitchen and utility rooms is considered to be a reasonable mitigation of visual impact to the existing private viewers. Detail considerations will be given to architectural modulations and façade finishes to provide visual interest to the buildings.

## 10. Planning Assessment and Justifications

### Consistent with Chief Executive's Policy Address and the Broader Strategic Planning for Lantau

- 10.1 The preparation of a site analysis and Concept Plan, followed by this planning application, together with the supporting technical studies are private sector initiatives for a sensitive long term increase in the residential capacity at Discovery Bay. It helps achieve the objective of the Chief Executive's Policy Address in increasing and expediting land supply to optimise residential development and to contribute to the housing supply. However, in achieving this, it is also sensitive to the scale of existing development and character of the neighbourhood.
- 10.2 The long term planning for Discovery Bay (including Area 10b) is consistent with the envisaged development at Siu Ho Wan, Sunny Bay and Tung Chung New Town Extension at Lantau. It is also consistent with the considerations by the Lantau Development Advisory Committee for Lantau, where Discovery Bay is located and conveniently connected by a tunnel. It gives certainty to the infrastructure requirement and provision in the region, and expedites delivery of land and development.

### Consistent with the General Planning Intention of the OZP

- 10.3 The Concept Plan is considered to have addressed the various components of the general planning intention, as stated in paragraph 7 of the Explanatory Statement of the OZP. In particular, consideration has been given to ensuring the proposals are of a high quality, with consideration given to compatibility with the natural setting and with existing forms of residential development. This is explained in the following paragraphs, which includes quotations from paragraph 7:
- 10.4 *"7.1 In line with the strategic planning context provided by the South West New Territories Development Strategy Review, the general planning intention of the Area is for conservation of natural environment and to provide for low density developments compatible with the surrounding natural setting. Existing natural features including the undisturbed backdrop of woodlands and slopes and the natural coastlines with inlets, bays, beaches at Tai Pak, Yi Pak, Sam Pak and Sze Pak should be conserved. Areas of high conservation value and natural habits including woodland, stream valleys, stream courses and stream/ tidal lagoons should also be protected."*
- i. Reference is made to the Chief Executive's Policy Address setting a regional strategic planning context for housing supply and future Lantau Island development, as discussed in paragraphs 10.1 and 10.2 above.
  - ii. The Concept Plan is a result of a careful site analysis, located at an already formed platform already approved for development, to be implemented. It has avoided areas with natural features, high conservation value and natural habitats.

10.5 *"7.2 Having regard to the character of the area, environmental considerations and the existing and planned infrastructure provision, in particular the limited capacity of external links, the plan provides for a planned total population of about 25,000 persons for the Discovery Bay development. Any further increase in population would have to be considered in the context of the general planning intention for the Area and subject to detailed feasibility investigations on infrastructure and environmental capacities."*

- i. The accompanying engineering studies of this application have quantified the infrastructure requirement and the potential environmental impact, and demonstrated to be feasible. They are considered to satisfactorily justify the proposed expansion of the planned additional population.

10.6 *"7.2 In particular, the unique sub-urban low-density and car-free character of the development should be maintained in keeping with the surrounding natural setting. In line with the original concept as a holiday resort, a variety of recreation and leisure facilities are allowed for."*

*"7.3 The general urban design concept is to maintain a car-free and low-density environment and to concentrate commercial and major community and open space facilities at more accessible locations."*

- i. The Concept Plan will maintain the existing car-free character, given that the number of vehicles at Discovery Bay is restricted.
- ii. The proposal at Area 6f adjacent to the existing residential development will not detract from the surrounding mountain backdrop setting or the regional holiday resort concept.
- iii. The future residents at Area 6f will be adequately served by recreation and leisure facilities.

10.7 *"7.2 Future development at Discovery Bay should also be in keeping with the theme park development and its adjoining uses at Penny's Bay to ensure compatibility in land use, height, visual and environmental terms."*

- i. With regards to the theme park development and its adjoining uses at Penny's Bay:
  - a. The separation distance and the existing development in between help prove that the Concept Plan at Area 6f to be suitable in land use and environmental terms.
  - b. The proposal is compliant with the building height provision contained in the Deeds of Restrictive Covenant (between the HKSAR Government and Hong Kong International Theme Park Limited), and is appropriate in height and visual terms.

10.8 *"7.2 The existing rural settlements at Nim Shue Wan and Cheung Sha Lan would be retained with the planning intention of upgrading or redeveloping the existing temporary domestic structures with the provision of basic infrastructure."*

- i. The Concept Plan will not affect the existing rural settlements at Nim Shue Wan and Cheung Sha Lan.

10.9 *7.3 A stepped height approach with low-rise on the headland and coastal lowland and high-rise further inland is adopted. This complements the visual presence of the mountain backdrop and maintains the prominent sea view. Variation in height is also adopted within individual neighbourhood to add variety in character and housing choice. The interplay of the natural and man-made landscape elements such as beaches, waterfront promenades, parks and golf courses helps integrate developments with the natural surroundings.*

- i. The building height at Area 6f is considered to be suitably related to the adjacent Parkvale Village around the mountain backdrop, complementing the built skyline.
- ii. The proposal is considered to have given careful regard to the siting, building height and building form, and integrated with the surrounding topography and greenery.

10.10 In summary, the Concept Plan is considered to be consistent with the general planning intention for Discovery Bay stated in the OZP.

#### Adequate Infrastructure Provision

10.11 The accompanying engineering studies of this application quantify the infrastructure requirement of the proposed development. They consider that, subject to improvement works where necessary, they would be feasible to support the planned population.

#### No Adverse Environmental Impact

10.12 Area 6f is identified for development as a result of a careful site analysis, having taken into consideration of the topography and landscape around Discovery Bay, and recognised the value of the natural environment. Being at a site located at an already formed platform and already approved for development around existing development, its development will not have inadvertent disturbances to the natural environment compared to alternative more pristine environment.

10.13 There will be unlikely potential noise or air impact on the future residents.

#### Logical Location for Increased Residential Development Intensity

10.14 The currently restricted accommodation provision in Area 6f is underutilising the readily available land resources and the locational advantage of the locality, for the following reasons:

- i. The proposed residential blocks are replacement of the approved staff quarters which are no longer in need. It is a change in the form of accommodation provision.
- ii. Area 6f is readily accessible, with an extension to the existing Parkvale Drive, which is currently served by public transport. It is in close proximity to commercial and leisure activities. These make it a logical location for development.
- iii. The proposed building height and footprint is of similar scale to the surrounding existing residential blocks.

- 10.15 The 476 units and 1,190 population increase as a result of the proposal is very modest development intensities, having been planned in balance with the mountain backdrop setting and the surrounding amenity.

Due Consideration for Trees and Landscaping

- 10.16 The proposal has given careful consideration to the proposed building siting, disposition and footprint, and the proposed access road alignment to minimise site formation and vegetation clearance as much as possible. It seeks to maximise development on the already formed platform, and the part of the site without any significant vegetation. The removal of slope greenery along the perimeter is the minimum necessary, and does not excessively extend into the surrounding large slope greenery within the site. Overall, there will not be an adverse impact on the landscape setting in the area that will be substantially maintained.
- 10.17 Considerations have also been given to the existing hiking trail around the site. The proposal will not have an adverse impact on the users of the hiking trail.

Compatible Visual Form

- 10.18 The siting, disposition and height of the proposed development has given careful consideration to the following design objectives:
- i. The new buildings are a new visual element additional to the existing Parkvale Village development cluster. It takes advantage of the existing building mass in the vicinity and will be of compatible development scale. It will be a relatively minor element within the broader landscape context
  - ii. The building height is considered to suitably relate to Parkvale Village and the mountain backdrop so that they generally contribute to the existing skyline. They step up generally in accordance to the topography of the site, and is consistent with the general urban design guideline.
  - iii. The existing residents at Parkvale Village will continue to have uninterrupted sea views, and view corridor to the mountain and building separation for a sense of openness. Detail considerations will also be given to architectural modulations and façade finishes.
  - viii. The proposal will be capable of compliant with the Sustainable Building Design Guidelines, providing suitable building separation and thereby air ventilation, and greenery provision.
  - ix. The proposal is set back from Discovery Valley Road by more than 45 metres, and does not have a direct street frontage. It will not be visually prominent or dominant to the street.

**11. Proposed Amendments to the OZP**

- 11.1 This application seeks to amend the OZP to enable the development in the Concept Plan for Area 6f to be implemented. It is proposed to amend the land use zoning from "Other Specified Uses (Staff Quarters)(5)" to "Residential (Group C)12" zone, as shown in **Figure 8**.
- 11.2 The proposed "Residential (Group C)12" is a new sub area under the existing "Residential (Group C)" zone. The current Planning Intention in the Notes to

the OZP remains relevant. The Remarks will generally reflect the development density indicated in Table 1 above.

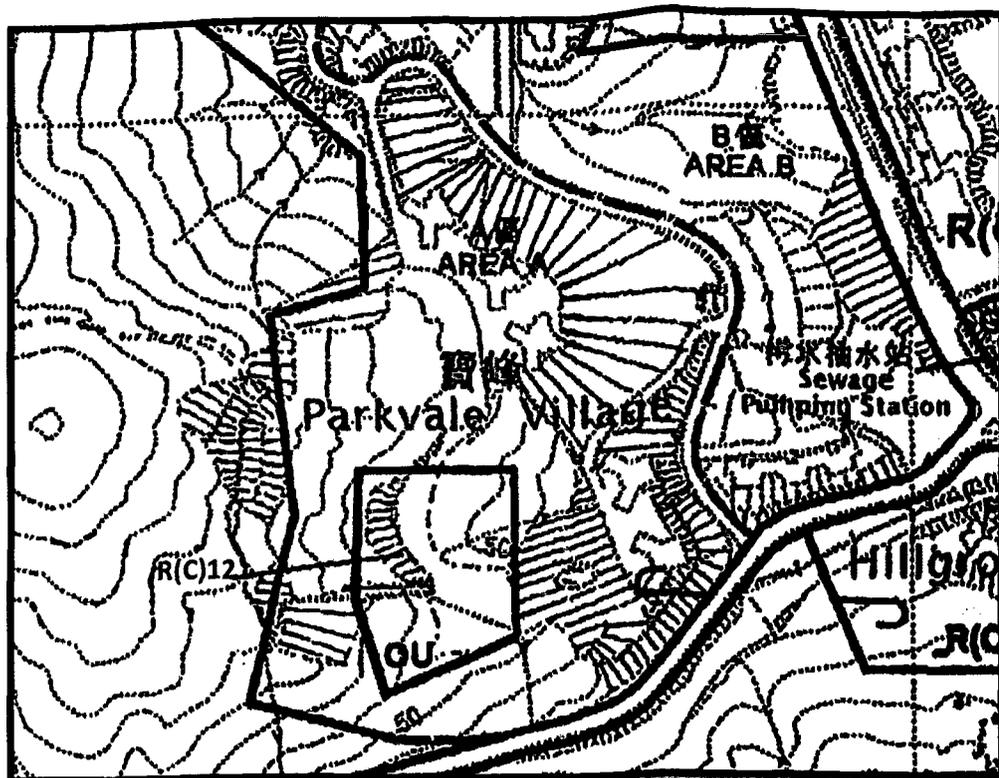


Figure 8. Proposed amendment, from Other Specified Uses "(Staff Quarters)(5)" to "Residential (Group C)12".

## 12. Conclusion

- 12.1 HKR's long term vision is to develop a high quality residential area and to better utilise the existing land resources at Discovery Bay. This is responsive to the broader strategic planning objective of Hong Kong to provide additional housing capacity.
- 12.2 The Concept Plan at Area 6f at an already formed platform, already approved for development, adjacent to existing residential buildings of similar scale is considered logical planning. The proposed flat buildings in place of the currently permissible staff quarters, of increased density are responsive to the housing demand. The proposal is considered appropriate for the location, having balanced the mountain backdrop setting and the surrounding amenity.
- 12.3 Accordingly, the Town Planning Board is invited to favourably consider this application to amend the zoning as proposed above to facilitate implementation of the Concept Plan at Area 6f.

**Appendix A  
Study on Drainage, Sewerage and  
Water Supply Systems**

Hong Kong Resort Company  
Limited

**Optimization of Land Use in  
Discovery Bay**

**Study on Drainage, Sewerage and  
Water Supply Systems for Area 6f**

235928-REP-002-02

Rev 02 | January 2016

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 235928

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The ARUP logo is positioned in the bottom right corner of the page. It consists of the word "ARUP" in a bold, sans-serif font. The background of the page features a large, faint, grayscale architectural rendering of a building with a prominent central tower and multiple wings, which serves as a backdrop for the text.

# Document Verification

# ARUP

<b>Job title</b>		Optimization of Land Use in Discovery Bay		<b>Job number</b> 235928	
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00	Dec 2015	<b>Description</b>	Study on Drainage, Sewerage and Water Supply Systems for Area 6f		
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>	Various	Kenneth Kwok	Franki Chiu
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01	Dec 2015	<b>Filename</b>	REP-002-01		
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02	Jan 2016	<b>Filename</b>	REP-002-02		
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		<b>Description</b>			
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>			
	<b>Signature</b>				

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## **Appendices**

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Capacity Checking Calculations on Existing Box Culvert

#### **APPENDIX B2**

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#### **APPENDIX B3**

Capacity Checking Calculations on existing Discovery Bay Reservoir, Fresh Water Service Reservoir and Proposed Water Supply System

## Executive Summary

---

The Hong Kong Resort Company Limited (HKRCL) has been considering the feasibility of implementing additional development areas within the existing boundary of Discovery Bay to provide additional housing supply. A planning statement, titled "Optimisation of Land Use in Discovery Bay" was submitted to Planning Department (PlanD) in July 2013. A round of comments from various government departments was received on December 2013 (ref PlanD.'s letter ( ) L1/L/DBNC/352-17 dated 17 December 2013). Another round of submission was made in August 2014 and the corresponding set of comments was received from various Government departments in December 2014 (ref. PlanD's letter ( ) L1/L/DBNS/352-17(CR) dated 23 December 2014). In order to address those comments, the development proposal has been refined accordingly and a further round of submission was made in March 2015 and corresponding set of comments was received from Environmental Protection Department (EPD) in May 2015 (ref. PlanD's letter L1/L/DBNS/352-17(CR) dated 19 May 2015). In order to address those comments, the report has been revised accordingly.

The latest current scheme only refers to Area 6f and Area 10b. All the potential development areas are included in the latest approved Discovery Bay Master Plan 6.0E7h(a) for development and some has been implemented.

A study has been conducted on the latest development proposal to address the issues relating to drainage, sewerage and water supply for Area 6f and 10b. Those relating to noise, air quality, water quality, land contamination and ecology are separately presented in another report.

### *Drainage*

Discovery Bay has a network of engineering drainage system that originates from the foot of the hills to convey the surface runoff east to the sea. The potential development is located at the catchment with total area of 202.5 ha.

In the drainage catchment, a number of drainage box culverts [from sizes of 2m(H) x 3m(W) to 3.8m(H) x 4.5m(W)] exist and mainly run along existing carriageway. The existing box culverts collect surface runoff from nearly half of Discovery Bay. They collect the runoff from natural streams of hillside as well as the urban paved area in the centre of Discovery Bay.

The potential developments will generate increase in surface runoff due to 0.22 ha of land area changed from unpaved to paved (equivalent to 0.1% of 202.5 ha total catchment area). As the existing box culverts is capable to cater for the increase of surface runoff from potential development at Area 6f, no mitigation measure is recommended to the existing box culverts.

### *Sewerage*

Sewage generated from existing Discovery Bay developments is collected by four existing sewage pumping stations at Discovery Bay and then lifted up to DSD Siu Ho Wan Sewage Treatment Works (SHWSTW) for further treatment and disposal via the internal rising mains between the sewage pumping stations and existing 450mm diameter twin rising mains laid along Discovery Bay Tunnel to

SHWSTW. SHWSTW is a chemically enhanced primary treatment (CEPT) with design treatment capacity of 180,000 m<sup>3</sup>/d and a design peak flow of 3,750 l/s.

EPD commented in May 2015 that the current capacity of SHWSTW has been allocated for other existing and planned future developments so SHWSTW has no spare capacity to cater for the additional sewage from the potential development at Discovery Bay despite that additional flow due to potential developments for both 6f and 10b is only 0.8% of the current SHWSTW design treatment capacity. EPD also advised that there is currently no plan to increase the design capacity of the SHWSTW in the short and medium terms.

Nevertheless, the possibility of discharging additional sewage flows generated from the Discovery Bay potential development to SHWSTW in the long term should not be totally ruled out. For example, the Government is actively seeking cavern development as a new source of land supply. If in the future, it is deemed suitable that the existing SHWSTW can be relocated into a cavern site to vacate valuable land for development, the relocated SHWSTW can be such designed to accommodate the increased sewage flows from the Discovery Bay.

If SHWSTW will not be able to cater for the additional sewage generated from Discovery Bay potential developments, two alternative sewerage options of discharging the sewage from the Area 6f to an on-site small Discovery Bay Sewage Treatment Works (DBSTW) to be located at either Area 6f or site of other potential development are recommended.

### *Water Supply*

Discovery Bay falls within supply zone of Siu Ho Wan Water Treatment Works (SHWWTW) via the Siu Ho Wan Fresh Water Pumping Station (FWPS). SHWWTW and Siu Ho Wan FWPS have a nominal capacity of 150,000 m<sup>3</sup>/d. Allowance has been made in SHWWTW for expansion to an ultimate capacity of 300,000 m<sup>3</sup>/d. An existing 1000mm / 1200 mm pumping main delivers fresh water from Siu Ho Wan FWPS to Tung Chung Fresh Water service reservoir. Fresh water is further pumped by Discovery Bay Fresh Water Booster Pumping Station via a 450mm branch-off pipe from the existing 1200 mm fresh water main. A 450 mm diameter outlet pumping main of Discovery Bay FWPS, laid along Discovery Bay Tunnel, delivers fresh water to Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 for fresh water supply to Discovery Bay.

The existing capacity of the SHWWTW is already insufficient to supply the existing developments and other concurrent developments within the supply zone of SHWWTW. Therefore, SHWWTW and Siu Ho Wan FWPS are expected to be upgraded to a reported capacity of 300,000 m<sup>3</sup>/d irrespective of the Discovery Bay potential developments. Spare capacity of the upgraded SHWWTW and upgraded Siu Ho Wan FWPS with 300,000 m<sup>3</sup>/d capacity will then be adequate to supply additional fresh water to Discovery Bay potential development at Area 6f, which has estimated mean daily fresh water demand of 512 m<sup>3</sup>/d (equivalent to 0.17% of the ultimate upgraded capacity of SHWWTW).

If the expanded SHWWTW still cannot provide fresh water supply to the potential development areas of Discovery Bay, an alternative fresh water supply scheme to abstract raw water from Discovery Bay Reservoir, treat by a new water treatment

plant and distribute by new water mains is recommended. An analysis has been carried out and confirmed that the existing reservoir has sufficient storage volume to supply the additional fresh water demand even during a drought year.

Additional flushing supply to the potential development Area 6f will be provided from the existing Discovery Bay Reservoir. It has been checked that the existing reservoir has enough storage even during a drought year to meet this additional flushing water demand.

To facilitate the Discovery Bay potential developments, new water mains including fresh and flushing water mains are required for water supply to potential development Area 6f.

# 1 Introduction

---

## 1.1 Background

- 1.1.1 The Hong Kong Resort Company Limited (HKRCL) has been considering the feasibility of implementing additional development areas within the existing boundary of Discovery Bay to provide additional housing supply. A planning statement, titled "Optimization of Land Use in Discovery Bay" was submitted to Planning Department (PlanD) in July 2013. A round of comments from various government departments was received on December 2013 (ref PlanD's letter (L1/L/DBNC/352-17 dated 17 December 2013).
- 1.1.2 Another round of submission was made in August 2014 and the corresponding set of comments was received from various government departments in December 2014 (ref. PlanD's letter ( ) L1/L/DBNS/352-17(CR) dated 23 December 2014). A further round of submission was made in March 2015 and only comments from Environmental Protection Department (EPD) were received in May 2015 (ref. PlanD's letter L1/L/DBNS/352-17(CR) dated 19 May 2015).
- 1.1.3 Ove Arup & Partners HK Ltd (Arup) has been appointed by HKRCL to conduct assessments to address those comments relating to environmental aspects including noise, air quality, water quality, land contamination, ecology, sewerage and drainage, and water supply.
- 1.1.4 This report addresses those comments relating to drainage, sewerage and water supply for Area 6f, taking into account the cumulative impact of the concurrent development at Area 10b. Those relating to noise, air quality, water quality, land contamination and ecology are separately presented in another report.

## 1.2 Overview of Potential Development Proposal

- 1.2.1 After receiving the comments from various government departments in December 2013, December 2014 and May 2015, HKRCL has been optimising the development proposal to address those comments. Under the current planning proposal, a total of 476 nos. of flats with an estimated total population of 1,190 would be developed in Area 6f, which has a site area of 8,300 m<sup>2</sup>.
- 1.2.2 Figure 1 illustrates the locations of the potential development area 6f and more relevant description on the details of the potential development area are given in Section 2.
- 1.2.3 It is noted that there is another potential development in Area 10b of Discovery Bay for residential development (site area of 63,000 m<sup>2</sup> and estimated total population of 2,813). For the purpose of the study on drainage, sewerage and water supply, the cumulative impacts from both potential developments at Area 6f and Area 10b have been considered.

**1.2.4** It should also be noted that all the potential development areas are included in the latest Discovery Bay Master Plan (some developments has already been implemented), despite the fact that some of their development parameters are proposed to be amended. The latest Discovery Bay Master Plan was approved in principle awaiting only revised land premium offer from Lands Department.

### **1.3 Key Objectives and Scope of this Study**

**1.3.1** The key objectives and scope of this study are given below:

- Obtain and examine existing drainage, sewerage and water supply records;
- Carry out site inspections;
- Estimate the surface runoff based on the proposed development scheme and determine capacity of existing drainage system immediately downstream of the potential developments;
- Assess the effect of the potential development on the existing drainage system and assess any mitigation measures are required;
- Describe in board terms the new sewerage infrastructure needed to serve the potential development;
- Conduct a detailed water demand assessment for the proposed development scheme and examine rainwater collection in existing catchment of the Discovery Bay Reservoir in the drought year as the worst scenario for flushing water supply;
- Recommend conceptual water supply to meet the demand of the additional development; and
- Describe in board terms the new water supply infrastructure and/or upgrading requirements of the existing reservoir and water treatment facilities are required.

## 2 Project Description

---

### 2.1 Background

2.1.1.1 The Discovery Bay development is a self-contained sub-urban residential development comprising mainly low-density private housing, situated in the eastern part of Lantau Island covering a total land area of about 650 hectares. There are currently around 8,300 nos. of residential flat with total population around 15,000.

2.1.1.2 Discovery Bay falls within the ambit of the Discovery Bay Outline Zoning Plan (Discovery Bay OZP) which was first approved on 21 March 2003. The current approved OZP limits the population to 25,000 (i.e. 10,000 nos. of residential flat), which is reflected in the latest Master Plan.

### 2.2 Development Area Description

2.2.1.1 Area 6f is located south of Parkvale Village in Parkvale Drive. Site observation reveals that the site has partly been previously formed and cleared, and is mainly occupied by grassland.

2.2.1.2 The current permissible land use for Area 6f in the Discovery Bay OZP is "Other Specified Uses" for staff quarters. Within Area 6f, it is proposed to have residential buildings, together with the necessary infrastructure and landscaping elements.

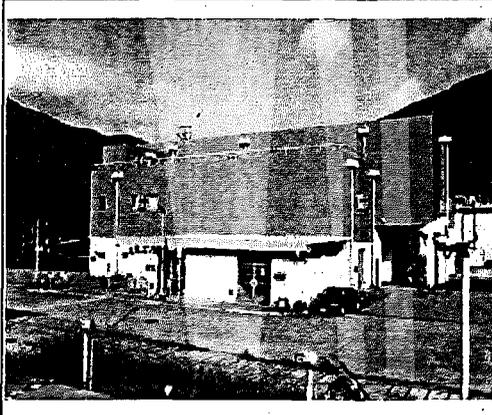
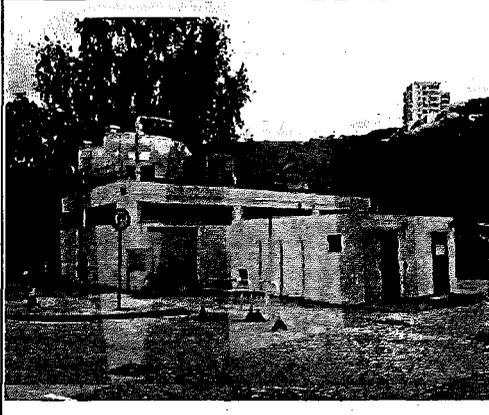
### 2.3 Tentative Implementation Programme

2.3.1 According to the latest design, the tentative time for the occupation of the potential development areas would be beyond 2020 and this actual date would be reviewed throughout the design process.

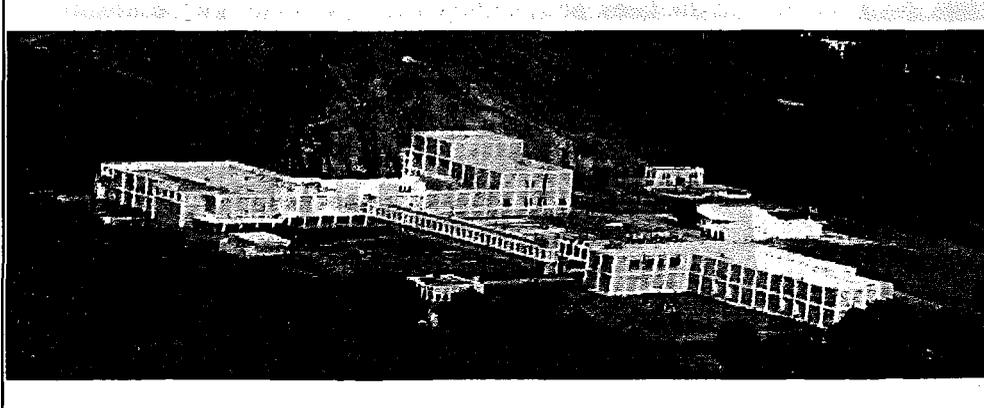
### 3 Site Inspection

3.1 Several site visits were carried out in April – June 2014 to inspect existing public and Discovery Bay’s private drainage, sewerage and water supply infrastructures. The following tables present the site photos for some major infrastructures components, which will be discussed in this study. Figure 1 illustrates respective location of these infrastructures.

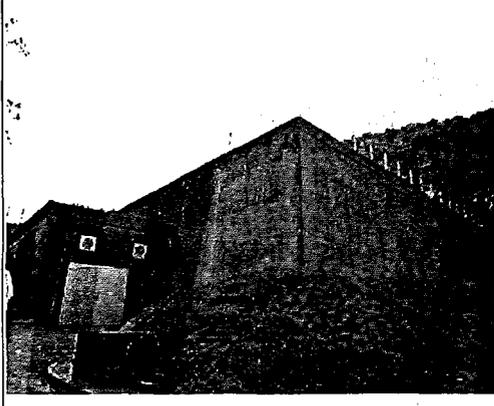
**Table 3.1a Existing Government and Private Sewerage Infrastructure**

DSD Siu Ho Wan Sewage Treatment Works	Sewage Pumping Station No. 2 at Discovery Bay
	

**Table 3.1b Existing Government Water Supply Infrastructure**

WSD Siu Ho Wan Water Treatment Works


**Table 3.1c Existing Private Water Supply Infrastructure**

Fresh Water Service Reservoir No. 1 at Discovery Bay	Discovery Bay Reservoir
	

## 4 Drainage Study

### 4.1 Methodology and Guidelines

4.1.1.1 The drainage study reviews the existing drainage catchment and systems at the Discovery Bay. It assesses the potential drainage impacts due to the potential development Area 6f and identifies the necessary drainage mitigation measures and proposed drainage system for Area 6f. This section presents the design method, parameters and criteria used for this drainage study.

### 4.1.2 Design Method

4.1.2.1 Stormwater drain capacity will be calculated based on the Continuity Equation:

$$Q = AV$$

Where  $Q$  = full flow capacity in  $m^3/s$

$A$  = cross-sectional area in  $m^2$

$V$  = velocity at full bore flow in  $m/s$

4.1.2.2 Velocity at full-bore flow is based on the Colebrook-White equation:

$$V = -(32gRS)^{0.5} \log \left\{ \frac{(ks/14800R)}{(1.255v/R(32gRS)^{0.5})} \right\}$$

Where  $g$  = acceleration due to gravity in  $m/s^2$

$R$  = hydraulic radius in  $m$

$S$  = gradient

$ks$  = roughness in  $mm$

$v$  = kinematic viscosity of water in  $m^2/s$

4.1.2.3 Peak stormwater runoff rate will be calculated using Rational Method:

$$Q = 0.278 C i A$$

Where  $Q$  = peak stormwater runoff in  $m^3/s$

$C$  = runoff coefficient

$i$  = design mean intensity of rainfall ( $mm/hr$ )

$A$  = area of catchment in  $km^2$

The design mean intensity of rainfall is based on Gumbel Solution in accordance with DSD Stormwater Design Manual, 4<sup>th</sup> Edition, 2013 (DSD SDM):

$$i = a / (tc + b)^c$$

Where  $tc$  = time of concentration in minutes

$a, b, c$  = storm constants

### 4.1.3 Codes of Practice and Design Manuals

4.1.3.1 The assessment has been carried out in accordance with DSD SDM.

## 4.2 Design Parameters

### 4.2.1 Drainage System Capacity

4.2.1.1 Capacity of the proposed stormwater drainage system will be designed to cater for return period design peak flow as follows:

- 1 in 50 years return period design peak flow for urban drainage branch systems
- 1 in 200 years return period design peak flow for urban drainage trunk systems (equivalent to 1,800 mm diameter pipe or larger)

4.2.1.2 To account for the effect of materials deposited in the drainage systems between desilting cycles, the following reduction of flow area is assumed in accordance with DSD SDM:

- 5% reduction of flow area if the pipe gradient is greater than 1 in 25
- 10% reduction of flow area in other cases

4.2.1.3 Return period storm constants for calculation of rainfall intensities are obtained from DSD SDM and listed as follows:

- 1 in 50 years return period:  $a = 687$ ;  $b = 4.2$ ; and  $c = 0.42$
- 1 in 200 years return period:  $a = 766$ ;  $b = 4.1$ ; and  $c = 0.40$

### 4.2.2 Runoff Coefficient

Surface Characteristics	Runoff Coefficient, C
Paved Area	1.0
Unpaved Area	0.3

### 4.2.3 Time of Concentration

Time of concentration ( $tc$ ) is the shortest time in which all parts of the upstream catchment will contribute to the flow at the point of calculation. This is given by the equation:

$$tc = te + tf$$

Where  $t_e$  = time of entry  
 $t_f$  = time of flow

The time of entry, which is equivalent to time of concentration for a natural catchment, is calculated using the Brandsby William's Equation as follows:

$$t_o = \frac{0.14465L}{H^{0.2} A^{0.1}}$$

Where  $t_o$  = time of concentration of a natural catchment (min.)  
 $A$  = catchment area ( $m^2$ )  
 $H$  = average slope (m per 100m) of the natural flow  
 $L$  = distance (m) of the natural flow

### 4.3 Existing Drainage System

- 4.3.1 Discovery Bay has a network of engineering drainage system that originates from the foot of the hills to convey the surface runoff east to the sea. The existing drainage layout plan is illustrated in **Figure 2**. A description of this existing drainage system is provided below.
- 4.3.2 The potential development at Area 6f is located in a natural hillside catchment with a total area of 202.5 ha, shown as the green catchment in the following Figure.



*Discovery Bay Drainage Catchment Plan*

- 4.3.3 There are a number of drainage box culverts of varying sizes from 2m (H) x 3m (W) to 3.8m (H) x 4.5m (W) that mainly run along the existing Discovery Bay Road. These existing box culverts collect surface runoff from nearly half of Discovery Bay, including runoff from the natural hillside slopes as well as the urban paved area in the centre of Discovery Bay.
- 4.3.4 The uphill catchment of Discovery Bay, i.e. Steep natural vegetated terrain at high elevation, is collected by a catchwater system to intercept and divert the hillside surface runoff southwest to the existing Discovery Bay Reservoir.

### 4.4 Potential Drainage Impacts

**4.4.1** The total site area of Area 6f is 0.83 ha. The potential Area 6f development will increase surface runoff due to 0.22 ha of land area changed from unpaved to paved surface (equivalent to 0.1% of 202.5 ha total catchment area). The expected impact on the existing drainage system and the requirement for any measures to accommodate the increase of surface runoff are discussed below.

**4.4.2** Table 4.1 summarizes the change in catchment area from existing to proposed conditions.

**Table 4.1: Summary of Catchment Area Changes**

Downstream Drainage System	Existing / Potential Development Area	Total Catchment Area (ha)	Paved Area (ha)		
			Existing	Proposed	Increase
2.0m x 3.0m BC	Existing Area	44.2	16.1	16.1	-
3.4m x 4.5m BC	Area 6f	140.6	6.2	6.44	0.22
3.8m x 4.5m BC	Existing Area	17.7	17.7	17.7	-
Total =		202.5			0.22

## **4.5 Evaluation of Drainage Impacts, Mitigation Measures and Proposed Drainage**

**4.5.1.1** The peak flow discharge to the existing box culverts due to the increase in surface runoff from potential development Area 6f as well as the capacities of existing box culverts have been estimated and attached in **APPENDIX B1**. It shows that all the existing box culverts are capable to cater for the increase in surface runoff. Return periods of 50 and 200 years are adopted for branch and trunk system respectively for assessment (see Section 4.2.1.1).

**4.5.1.2** As the existing box culverts are capable to cater for the increase of surface runoff, no mitigation measure is recommended to the existing box culverts. Proposed drainage system should be provided to convey surface runoff from the potential development Area 6f to these existing box culverts via the existing stream.

**4.5.1.3** Area 10b is located at a different catchment, and no cumulative drainage impact is anticipated.

## 5 Sewerage Study

### 5.1 Methodology and Guidelines

**5.1.1.1** The sewerage study estimates the sewage flows to be generated from potential development Area 6f. It reviews the existing sewerage system within the Discovery Bay and its discharge to the public sewerage and sewage treatment facilities at Siu Ho Wan. It recommends the sewerage collection, treatment and disposal scheme for the potential development Area 6f. This section presents the design method, parameters and criteria used for this sewerage study.

#### 5.1.2 Design Method

**5.1.2.1** Sewer capacity will be calculated based on the Continuity Equation:

$$Q = AV$$

Where  $Q$  = full flow capacity in  $m^3/s$

$A$  = cross-sectional area in  $m^2$

$V$  = velocity at full bore flow in  $m/s$

**5.1.2.2** Velocity at full-bore flow is based on the Colebrook-White equation:

$$V = -(32gRS)^{0.5} \log \left\{ \frac{ks}{14800R} + \frac{1.255v}{R(32gRS)^{0.5}} \right\}$$

Where  $g$  = acceleration due to gravity in  $m/s^2$

$R$  = hydraulic radius in  $m$

$S$  = gradient

$ks$  = roughness in  $mm$

$v$  = kinematic viscosity of water in  $m^2/s$

#### 5.1.3 Codes of Practice and Design Manuals

**5.1.3.1** The assessment has been carried out in accordance with the guidelines set out in EPD Report No. EPD/TP1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewage Infrastructure Planning Version 1.0 and in accordance with DSD Sewerage Manual (2013) [(Part 1: Key Planning Issues and Gravity Collection System (3<sup>rd</sup> Edition) and Part 2: Pumping Station and Rising Main (2<sup>nd</sup> Edition)]

## 5.2 Design Parameters

### 5.2.1 Unit Flow Factors

5.2.1.1 Unit flow factor is the average sewerage flow (average dry weather flow or ADWF) contributed by one unit of sewage source (person, employee or unit area) per day. According to Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF) published by EPD, the recommended unit flow factors are summarized in following **Table 5.1**:

**Table 5.1: Unit Flow Factors**

Type	Unit Flow Factor (m <sup>3</sup> /person/day)
<b>Domestic</b>	
Public Rental Housing	0.19
Private R1	0.19
Private R2	0.27
Private R3	0.37
Private R4	0.37
Traditional Village	0.15
Permanent Housing	0.23 <sup>(1)</sup>
<b>Commercial</b>	
Commercial Employee	0.08
Commercial activities:	
S1 (J7)	-
S2 (J1)	0.45
S3 (J2)	0.25
S4 (J9)	0.15
S5 (J5)	-
S6 (J4)	-
S7 (J4)	-
S8 (J3)	0.10
S9 (J10)	1.50
S10 (J10)	1.50
S11 (J3)	0.10
S12 (J6)	-
S13 (J6)	-
S14 (J6)	-
S15 (J12)	-
S16 (J11)	0.20
S17 (J11)	0.20
S18 (J11)	0.20
S19 (J11)	0.20
<b>Industrial</b>	
Industrial Employee	0.08
Industrial Activities	0.20
<b>Institutional</b>	
School Student	0.04

Note: <sup>(1)</sup> Permanent housing for North Lantau catchment wide planning

## 5.2.2 Peaking Factors

5.2.2.1 Peaking factors cater for seasonal/diurnal fluctuation and normal amount of infiltration and inflow. The peaking factors shall be in accordance with GESF and are shown in Table 5.2.

**Table 5.2: Peaking Factors for Various Population Ranges**

Population Range	Peaking Factor (including stormwater allowance) for facility with existing upstream sewerage	Peaking Factor (excluding stormwater allowance) for facility with new upstream sewerage
<b>Sewers</b>		
< 1,000	8	6
1,000 – 5,000	6	5
5,000 – 10,000	5	4
10,000 – 50,000	4	3
> 50,000	Max (7.3/N <sup>0.15</sup> , 2.4)	Max (6/N <sup>0.175</sup> , 1.6)
<b>Sewage Treatment Works, Preliminary Treatment Works and Pumping Stations</b>		
< 10,000	4	3
10,000 – 25,000	3.5	2.5
25,000 – 50,000	3	2
> 50,000	Max (3.9/N <sup>0.065</sup> , 2.4)	Max (2.6/N <sup>0.065</sup> , 1.6)

Note:

N = Contributing population in thousands.

Contributing population = Calculated total average flow (m<sup>3</sup>/d) / 0.27 (m<sup>3</sup>/d)

## 5.3 Sewage Flow Estimation

5.3.1 The potential development at Area 6f will generate 440 m<sup>3</sup>/d as shown in Table 5.3 below.

**Table 5.3: Sewage Flow Estimation Summary**

Area	Proposed Uses	Population	Unit Flow Factor (UFF) (m <sup>3</sup> /person/d) <sup>(1)</sup>	ADWF (m <sup>3</sup> /d)
Area 6f	Residential	1,190	0.37	440

Note: <sup>(1)</sup> R3 residential type is adopted for potential development



*Siu Ho Wan Sewage Treatment Works Catchment Area***5.5 Evaluation of Sewerage Impacts and Mitigation Measures****5.5.1 Siu Ho Wan Sewage Treatment Works**

- 5.5.1.1** EPD advised in May 2015 that the design capacity of the SHWSTW has been allocated for the treatment of the sewage arising from the development of the Expansion of Hong Kong International Airport into a Three Runway System, the new town development under Tung Chung New Town Expansion and the Penny's Bay Phase 2 development, etc. Therefore, SHWSTW has no spare capacity to cater for the sewage arising from any proposed Discovery Bay further development and the Sewerage Authority has no plan to increase the design capacity of the SHWSTW in the short and medium terms.

**5.6 Proposed Sewerage System****5.6.1 Option 1 – Discharge to Siu Ho Wan Sewage Treatment Works**

- 5.6.1.1** Although EPD has indicated that the SHWSTW has no spare capacity to cater for the sewage arising from any proposed Discovery Bay further development, the possibility of discharging additional sewage flows from the potential development Area 6f to SHWSTW in the long term should not be totally ruled out. For example, the Government is currently actively seeking cavern development as a new source of land supply. If in the future, it is deemed suitable that the existing SHWSTW can be relocated into a cavern site to vacate valuable land for development, the relocated SHWSTW can be such designed to accommodate the increased sewage flows from the Discovery Bay.

**5.6.2 Option 2 – New Discovery Bay Sewage Treatment Works at Area 6f**

- 5.6.2.1** Under option 2, a new small DBSTW at Area 6f will be proposed to only treat the sewage generated from potential development at Area 6f. The treatment capacity of this new proposed DBSTW at Area 6f is required to be 440 m<sup>3</sup>/d according to Table 5.3.
- 5.6.2.2** This STW will treat sewage only from 2 single residential towers for 476 units at Area 6f so it is considered not an efficient sewage planning strategy.
- 5.6.2.3** The quality of the treated sewage effluent from the new DBSTW at Area 6f will be required to meet the WPCO standards.
- 5.6.3 Option 3 – New Discovery Bay Sewage Treatment Works at Other Potential Development Area (Area 10b)**
- 5.6.3.1** It is noted that there is another potential development in Area 10b of Discovery Bay and it proposed a new local DBSTW is proposed at this Area 10b. It is proposed that the treatment capacity of the new DBSTW be 1,481 m<sup>3</sup>/d, i.e. to cater for the additional sewage flows generated from both potential development Areas 6f and 10b.
- 5.6.3.2** Since the proposed development Area 6f and Area 10b are located about 1 km apart, it will require long length of new sewerage works along the Discovery Valley Road and Discovery Bay Road to convey the sewage from Area 6f to new DBSTW located at Area 10b. To optimise the new sewerage system design to be more cost-effective, it is proposed to discharge the sewage generated from Area 6f (i.e. ADWF 440 m<sup>3</sup>/d) to the adjacent existing Sewage Pumping Station No. 1 through a new 150mm gravity sewer connection (see APPENDIX B2 for calculation detail). At the same time, it is proposed that the existing sewerage network near Area 10b will be modified such that existing sewerage system conveying some 440 m<sup>3</sup>/d sewage from the existing Discovery Bay Development will instead be discharged to the new DBSTW at Area 10b. As a result, the total sewage flow to SHWSTW remains the same as existing and the total sewage flow to DBSTW at 10b is still 1,481 m<sup>3</sup>/d.
- 5.6.3.3** Since there will be no increase in the sewage flow discharge to any section of the existing sewerage network, no upgrading of the existing system is required.
- 5.6.3.4** Similarly, the quality of the treated sewage effluent from the new DBSTW at Area 10b will be required to meet the WPCO standards.

## 5.6.4 Septicity of Sewage due to New Sewage Pumping Station and Rising Main

5.6.4.1 Septicity becomes a problem when the retention time of sewage in the main is long and the temperature is high or the incoming sewage to the pumping station is already septic. If there is lack of oxygen during degradation process, septic conditions will occur which will result in the formation of hydrogen sulphide. This causes an offensive smell and is health hazard. Detailed study to examine necessary control measures of septicity will be carried out during detailed design. Example of septicity measures to be considered include:

- Pre-aeration in the wet well of the pumping station
- Adding controlled dosage of nitrate solution
- Frequent maintenance of wet well
- Injection of oxygen into rising main
- Twin or multiple rising mains with different size to suit for different flow conditions

## 6 Water Supply Study

### 6.1 Methodology and Guidelines

6.1.1.1 The water supply study reviews the existing water supply systems for Discovery Bay. It estimates the fresh and flushing water demands from potential development Area 6f and recommends water supply options to supply the new development area. This section presents the design method, parameters and criteria used for this water supply study.

#### 6.1.2 Design Method

6.1.2.1 Water main capacity will be calculated based on the Continuity Equation:

$$Q = AV$$

Where Q = full flow capacity in m<sup>3</sup>/s

A = cross-sectional area in m<sup>2</sup>

V = velocity at full bore flow in m/s

#### 6.1.3 Codes of Practice and Design Manuals

6.1.3.1 In accordance with WSD's DI No. 1309 "Design Criteria", the following design parameters and peak demand factors are adopted for the design of proposed fresh and salt water supply systems.

### 6.2 Design Parameters

#### 6.2.1 Unit Demand

6.2.1.1 The unit water demands for the residential water demand estimate listed in WSD's DI 1309 are shown in **Table 6.1** below. Since no detailed breakdown of zone types is available at this stage of Study, water unit demand for R3 has been adopted to suits the potential developments.

**Table 6.1: Fresh and Flushing Water Unit Demand for Demand Estimate**

Zone Type	Fresh Water		Flushing Water	Unit
	Residential	Service Trade		
<b>Residential</b>				
Public Rental Housing	140	40	70	Litre/head/day

Zone Type	Fresh Water		Flushing Water	Unit
	Residential	Service Trade		
R1	230	40	70	Litre/head/day
R2	300	40	70	Litre/head/day
R3	390	40	70	Litre/head/day
R4	390	40	70	Litre/head/day
Village	230	40	70	Litre/head/day
<b>Commercial</b>				
General	40	--	20	Litre/m <sup>2</sup> GFA/day
Hotel	1200	--	140	Litre/room/day
Hospital	455	--	295	Litre/bed/day
School Student	25	--	25	Litre/head/day

### 6.2.2 Water Treatment Works Capacity:

- Fresh water system – 1.2 times mean daily demand

### 6.2.3 Service Reservoir Capacity:

- Fresh water system (Secondary) – 85% of mean daily demand for isolated supply zones.

### 6.2.4 Peak Flow Rates in Pumping Main:

- Fresh water system – 1.5 times mean daily demand
- Salt water system – 1.5 times mean daily demand

### 6.2.5 Peak Flow Rates in Distribution Main:

- Fresh water system – 3 times mean daily demand
- Salt water system – 2 times mean daily demand

### 6.2.6 Residual Head Requirement:

- Fresh water system – 20m
- Salt water system – 15m

### 6.2.7 Maximum Flow Velocity for Pumping Main:

- 3 m/s under peak flow, for pumping main

### 6.2.8 Maximum Flow Velocity for Distribution Main:

- $> \text{DN}700 \leq 3 \text{ m/s}$
- $\text{DN}700 \text{ to } \text{DN}525 \leq 2.5 \text{ m/s}$
- $\text{DN}450 \text{ to } \text{DN}375 \leq 2 \text{ m/s}$
- $\text{DN}300 \text{ to } \text{DN}200 \leq 1.5 \text{ m/s}$



### *Siu Ho Wan Water Treatment Works Supply Zone*

#### **6.4.2 Siu Ho Wan Water Treatment Works**

**6.4.2.1** SHWWTW was commissioned in November 1996 and has a nominal capacity of 150,000 m<sup>3</sup>/d. Allowance has been made for expansion to an ultimate capacity of 300,000 m<sup>3</sup>/d. Currently, the average water supply is approximately 46,000 m<sup>3</sup>/d. This includes flushing water supply to Tung Chung, Siu Ho Wan, Tai Ho Wan and Ngong Ping.

#### **6.4.3 Siu Ho Wan Fresh Water Pumping Station**

**6.4.3.1** Treated water from SHWWTW with capacity of 150,000 m<sup>3</sup>/d is delivered by Siu Ho Wan FWPS to Tung Chung Fresh Water Service Reservoir via existing 1000mm / 1200mm fresh water main.

#### **6.4.4 Discovery Bay Fresh Water Booster Pumping Station**

**6.4.4.1** Discovery Bay Fresh Water Booster Pumping Station delivers fresh water to Discovery Bay via a 450mm branch-off pipe of the existing 1200 mm fresh water pumping main from Siu Ho Wan FWPS to Tung Chung Fresh Water Service Reservoir. A 450 mm outlet pumping main of Discovery Bay Fresh Water Booster Pumping station, laid along Discovery Bay Tunnel, delivers fresh water to the Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 for distribution to the Discovery Bay.

#### **6.4.5 Discovery Bay Fresh Water Service Reservoir**

**6.4.5.1** There are two fresh water service reservoirs in Discovery Bay, namely Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2. They are interconnected and located at the same level of around +95 mPD with top water level of +101 mPD. Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 have capacities of 7,250 m<sup>3</sup> and 2,992 m<sup>3</sup> respectively. Total capacity of these two service reservoirs is 10,242 m<sup>3</sup>.

### **6.5 Existing Flushing Water Supply System**

**6.5.1.1** Discovery Bay has its own flushing water supply system by intercepting existing hillside runoff by catchwater to the Discovery Bay Reservoir for flushing purpose. Existing flushing water supply system is illustrated in **Figure 4**.

**6.5.1.2** The existing Discovery Bay Reservoir also provides both fresh and flushing water supply to the adjacent Nim Shue Wan Village.

**6.5.1.3** Discovery Bay Reservoir collects and stores rainwater to supply flushing water to existing Discovery Bay developments and fresh and

flushing water to Nim Shue Wan Village. It has a rainwater catchment area of around 138 ha, including 18 ha of the reservoir itself (at top water level). Summary details of the Discovery Bay Reservoir are provided in Table 6.3.

**Table 6.3: Description of Discovery Bay Reservoir**

Name of Reservoir	Supply Zone	Capacity (m <sup>3</sup> )	Invert Level (mPD)	Top Water Level (mPD)
Discovery Bay Reservoir	Discovery Bay and Nim Shue Wan Village	3,400,000	+125	+175

## 6.6 Evaluation of Fresh Water Supply Impacts and Mitigation Measures

### 6.6.1 Fresh Water Supply Option 1 – Supply from Siu Ho Wan Water Treatment Works

#### 6.6.1.1 Siu Ho Wan Water Treatment Works and Siu Ho Wan Fresh Water Pumping Station

6.6.1.2 Fresh water to the potential development areas (both Areas 6f and 10b) is proposed to be supplied by the SHWWTW.

6.6.1.3 The existing capacity of the SHWWTW is already insufficient to supply the existing developments and other concurrent developments within the supply zone of SHWWTW. However, the future expansion works of SHWWTW and Siu Ho Wan FWPS to a capacity of 300,000 m<sup>3</sup>/d should be adequate to supply both its catchment and additional fresh water (1,721 m<sup>3</sup>/d) to Discovery Bay potential developments at both Area 6f and 10b (i.e. 0.57% of 300,000 m<sup>3</sup>/d ultimate upgraded capacity of SHWWTW).

6.6.1.4 Existing capacity of Siu Ho Wan FWPS is same as SHWWTW (150,000 m<sup>3</sup>/d). Upgrading of Siu Ho Wan FWPS to 300,000 m<sup>3</sup>/d would be necessary.

#### 6.6.1.5 Discovery Bay Fresh Water Booster Pumping Station

6.6.1.6 Existing Discovery Bay Fresh Water Booster Pumping Station has four pump bays and house three pump sets (2 duty and 1 standby) with a reliable output of about 15,120 m<sup>3</sup>/d (87.5 L/s each with 100.5m head) to deliver fresh water to Discovery Bay. It will be capable of delivering the total fresh water demand of Discovery Bay including the Discovery Bay potential developments at both Area 6f and 10b (12,574 m<sup>3</sup>/d) as shown in Table 6.6.

**Table 6.6: Total Fresh Water Demand of Discovery Bay**

Supply Zone	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/d)	Fresh Water Demand (m <sup>3</sup> /d)
Existing Discovery Bay Development	25,000	Residential	0.390 + 0.04	10,750
	4,100	School	0.025	102.5
Discovery Bay potential development Areas 6f	1,190	Residential	0.390 + 0.04	512
Discovery Bay potential development Areas 10b	2,813	Residential	0.390 + 0.04	1,210

Total MDD = 12,574

**6.6.1.7** The existing 450 mm pumping main from Discovery Bay Fresh Water Booster Pumping Station to Discovery Bay has been checked to be capable of meeting total fresh water demand of Discovery Bay and potential development. No upgrading of this trunk main would be envisaged. Detailed calculations are provided in APPENDIX B3.

### 6.6.1.8 Fresh Water Service Reservoirs at Discovery Bay

6.6.1.9 According to WSD's DI 1309, fresh water service reservoir requires total storage capacity of 0.85MDD (for isolated water supply zones), i.e.  $11,136 \text{ m}^3/\text{d} \times 0.85 = 9,660 \text{ m}^3$  (to supply additional potential development at Area 6f only) and  $12,574 \times 0.85 = 10,688 \text{ m}^3$  (to supply additional potential development at both Area 6f and 10b). Detailed calculations are provided in APPENDIX B3 and summary of total fresh water demand of Discovery Bay is provided in above Table 6.6.

6.6.1.10 Total capacity of existing Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 is  $10,242 \text{ m}^3 (7,250 \text{ m}^3 + 2,992 \text{ m}^3) > 9,660 \text{ m}^3$ . Therefore, the storage volume is adequate for the existing Discovery Bay development and potential development at Area 6f. The storage volume of the existing reservoirs is marginally below 0.85MDD of the ultimate fresh water demand from the existing Discovery Bay and the potential developments for both 6f and 10b (total  $10,688 \text{ m}^3$ ). Therefore, additional fresh water storage of  $446 \text{ m}^3$  will be required considering the cumulative effects including both Area 6f and Area 10b. Detailed calculations are provided in APPENDIX B3.

### 6.6.2 Fresh Water Supply Option 2 – Supply from Discovery Bay Reservoir

6.6.2.1 If in the event that the SHWWTW and Siu Ho Wan FWPS cannot be expanded to match with the programme of the potential development at Discovery Bay, alternative fresh water supply proposal that does not rely on the expansion of SHWWTW will be required.

6.6.2.2 It is proposed that a new private fresh water supply system within Discovery Bay to supply the additional fresh water demands from the potential developments Areas 6f and 10b. Fresh water is proposed to be supplied from the existing Discovery Bay Reservoir.

6.6.2.3 Discovery Bay Reservoir has an invert level of 125mPD, a top water level of 175mPD and total of  $3,400,000 \text{ m}^3$  storage. The existing Discovery Bay Reservoir supplies flushing water to Discovery Bay and both fresh and flushing water to the nearby Nim Shue Wan Village. Under this fresh water supply option 2, the existing Discovery Bay Reservoir will be extended to also supply fresh (and flushing) water supply for the potential development areas, as shown in Table 6.7 below.

**Table 6.7: Total Water Demand from Discovery Bay Reservoir**

Supply Zone	Population	Population Type	Unit Flow Factor ( $\text{m}^3/\text{person}/\text{d}$ )	Flushing Water Demand ( $\text{m}^3/\text{d}$ )

Supply Zone	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/d)	Flushing Water Demand (m <sup>3</sup> /d)
Flushing Demand from Existing Discovery Bay Development	25,000	Residential	0.07	1,750
	4,100	School	0.025	102.5
Fresh and Flushing Water Demand from Existing Nim Shue Wan Village	150	Residential + Service Trades	0.23+0.04+0.07	51
Fresh and Flushing Demand from Discovery Bay potential development Areas 6f and 10b	4,003	Residential	0.39+0.04+0.07	2,001.5

Total = 3,905

**6.6.2.4** An analysis has been carried out to check the adequacy of water supply for the Discovery Bay Reservoir during a drought year. From the data collected from Hong Kong Observatory between year 2000 to 2014, the 12 month period from October 2010 to September 2011 has been selected as the drought year for assessment. Based on the lowest reservoir water level recorded between March 2008 and March 2014 (including the drought year), it has been conservatively estimated by taking into consideration all inflows and outflows to and from the reservoir that the remaining storage volume of Discovery Bay Reservoir after the drought year is around 0.36 million m<sup>3</sup>. This means after taken into account of the various water demands from the existing and proposed developments of Discovery Bay and Nim Shue Wan Village and the reservoir evaporation loss throughout the drought year, the remaining reservoir volume after the drought year still has more than equivalent of 3 months of total water demand of 0.35 million m<sup>3</sup>. (i.e. 3,905 m<sup>3</sup>/d x 90 days). It demonstrates the Discovery Bay Reservoir has adequate storage to provide additional fresh (and flushing) water supply to both the potential developments at Area 6f and 10b. The relevant calculations for checking the capacity of Discovery Bay Reservoir in drought year are provided in APPENDIX B3.

**6.6.2.5** A new water treatment works will be needed to treat the abstracted water from the Discovery Bay Reservoir before distribution to the end users.

## **6.7 Evaluation of Flushing Water Supply Impacts and Mitigation Measures**

### **6.7.1 Discovery Bay Reservoir**

**6.7.1.1** Discovery Bay Reservoir provides flushing water to existing Discovery Bay and both fresh and flushing water to Nim Shue Wan

Village. Following the current flushing water supply arrangement, flushing water for the potential development Areas 6f and 10b is proposed to be supplied by the Discovery Bay Reservoir. Detailed calculations are provided in APPENDIX B3 and a summary of total water supply from Discovery Bay Reservoir is provided in Table 6.8.

**Table 6.8: Total Water Demand from Discovery Bay Reservoir**

Supply Zone	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/d)	Flushing Water Demand (m <sup>3</sup> /d)
Flushing Demand from Existing Discovery Bay Development	25,000	Residential	0.07	1,750
	4,100	School	0.025	102.5
Fresh and Flushing Water Demand from Existing Nim Shue Wan Village	150	Residential + Service Trades	0.23+0.04+0.07	51.0
Flushing Demand from Discovery Bay potential development Areas 6f and 10b	4,003	Residential	0.07	280.2
Total =				<u>2,183.7</u>

**6.7.1.2** A similar analysis has been carried out to check the adequacy of water supply for the Discovery Bay Reservoir during a drought year. The assessment considered all inflows and outflows into and out of the reservoir during the drought year (12 months between October 2010 and September 2011). It estimated that after the drought year, the Discovery Bay Reservoir will still have around 0.99 million m<sup>3</sup> storage volume, which is still more than total water demand for a whole year (2,184 m<sup>3</sup>/d x 365 = 0.80 million m<sup>3</sup>). It shows that it is feasible to provide flushing water supply for the new potential developments from the Discovery Bay Reservoir. Capacity checking calculations for Discovery Bay Reservoir in the drought year are provided in APPENDIX B3.

**6.7.1.3** Since the Discovery Bay Reservoir is feasible to provide flushing water supply for developments at both Area 6f and Area 10b, the Discovery Bay Reservoir is then adequate to provide flushing water supply for individual development at Area 6f.

## **6.7.2 Existing Flushing Water Main**

**6.7.2.1** The existing 300 mm diameter flushing water main from Discovery Bay Reservoir has been checked to be capable to supply flushing water to Discovery Bay as well as both fresh and flushing water to Nim Shue Wan Village. No upgrading of flushing water main would be envisaged. Checking calculations are attached in APPENDIX B3.

## 6.8 Proposed Fresh and Flushing Water Supply Systems

- 6.8.1 New 150 mm fresh water mains and new 50mm flushing water mains are proposed for water supply to potential development Areas 6f. **Figure 4** shows the proposed water supply layout plan (based on fresh water supply option 1) and water main sizing calculations are attached in **APPENDIX B3**.

## 7 Conclusions

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**7.1.1** Sections 4 to 6 have provided a baseline review and preliminary impact assessments on drainage, sewerage and water supply systems. Mitigation measures to existing facilities and recommendation on new facilities to cater for the potential developments have also been proposed.

### 7.2 Drainage System

**7.2.1** The major existing drainage systems, such as box culverts, are checked to be capable of catering for the increase of surface runoff generated from the potential development Area 6f.

### 7.3 Sewerage System

**7.3.1** Two options involving the provision of new DBSTW at either Area 6f or another potential development area (Area 10b) are proposed. The option of providing the DBSTW at Area 10b with some re-distribution of the existing sewerage system in Discovery Bay is recommended as it is considered to be a more cost-effective design.

### 7.4 Water Supply System

#### 7.4.1 Fresh Water Supply System

**7.4.1.1** The existing capacity of the SHWWTW is already insufficient to supply for the existing developments and other concurrent developments within the supply zone of SHWWTW irrespective of the Discovery Bay potential developments. However, the future expansion of SHWWTW and Siu Ho Wan FWPS to the capacity of 300,000 m<sup>3</sup>/d is expected to take into account the 0.57% fresh water demand of Discovery Bay potential developments at both Area 6f and 10b. Upgrading SHWWTW and Siu Ho Wan FWPS to the capacity of 300,000 m<sup>3</sup>/d would be adequate.

**7.4.1.2** Existing Discovery Bay Fresh Water Booster Pumping station has four pump bays and house three pump sets (2 duty and 1 standby) with a reliable output of about 15,120 m<sup>3</sup>/d (87.5 L/s each with 100.5m head) to deliver fresh water to Discovery Bay including the potential developments. It will be capable to deliver total fresh water demand of Discovery Bay.

**7.4.1.3** The two existing service reservoirs within Discovery Bay have been checked to have adequate storage volume for potential development at Area 6f.

**7.4.1.4** In the event that the existing or planned SHWWTW cannot provide fresh water supply to the potential development areas, an alternative

fresh water supply scheme has been developed. This will abstract water from the Discovery Bay Reservoir. New water treatment facilities and water mains will be provided for water treatment and distribution of the treated fresh water.

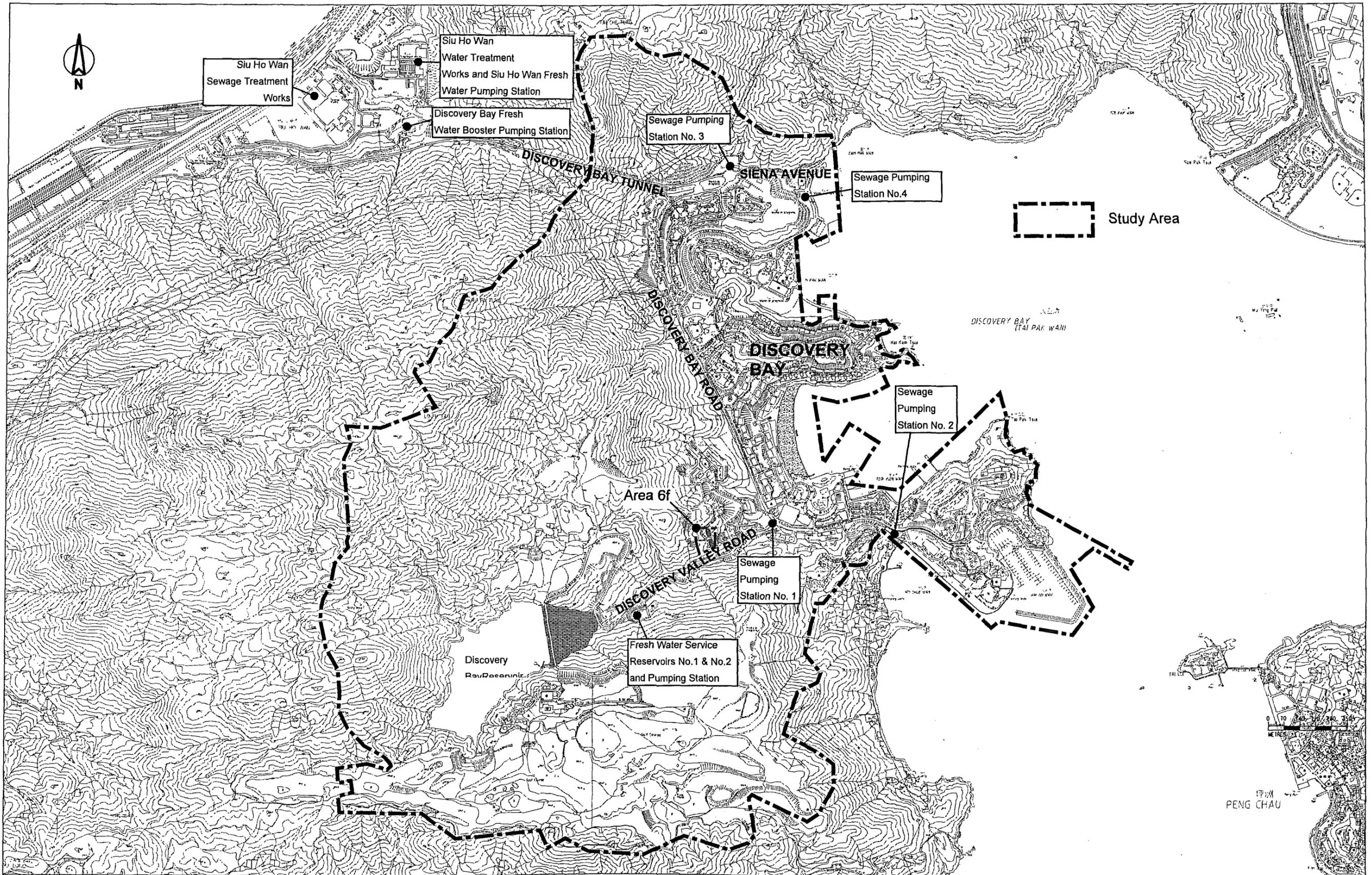
## **7.4.2 Flushing Water Supply System**

**7.4.2.1** Discovery Bay Reservoir, has been checked to be capable of flushing water supply to both the existing and potential developments including the existing water supply to Nim Shue Wan Village. No upgrading of Discovery Bay Reservoir would be envisaged.

## **7.4.3 Proposed Fresh and Flushing Water Supply Systems**

**7.4.3.1** New fresh and flushing water mains are proposed for water supply to potential development Areas 6f. The fresh water mains are proposed to have size of 150mm and the flushing water mains are proposed to have size of 50 mm.

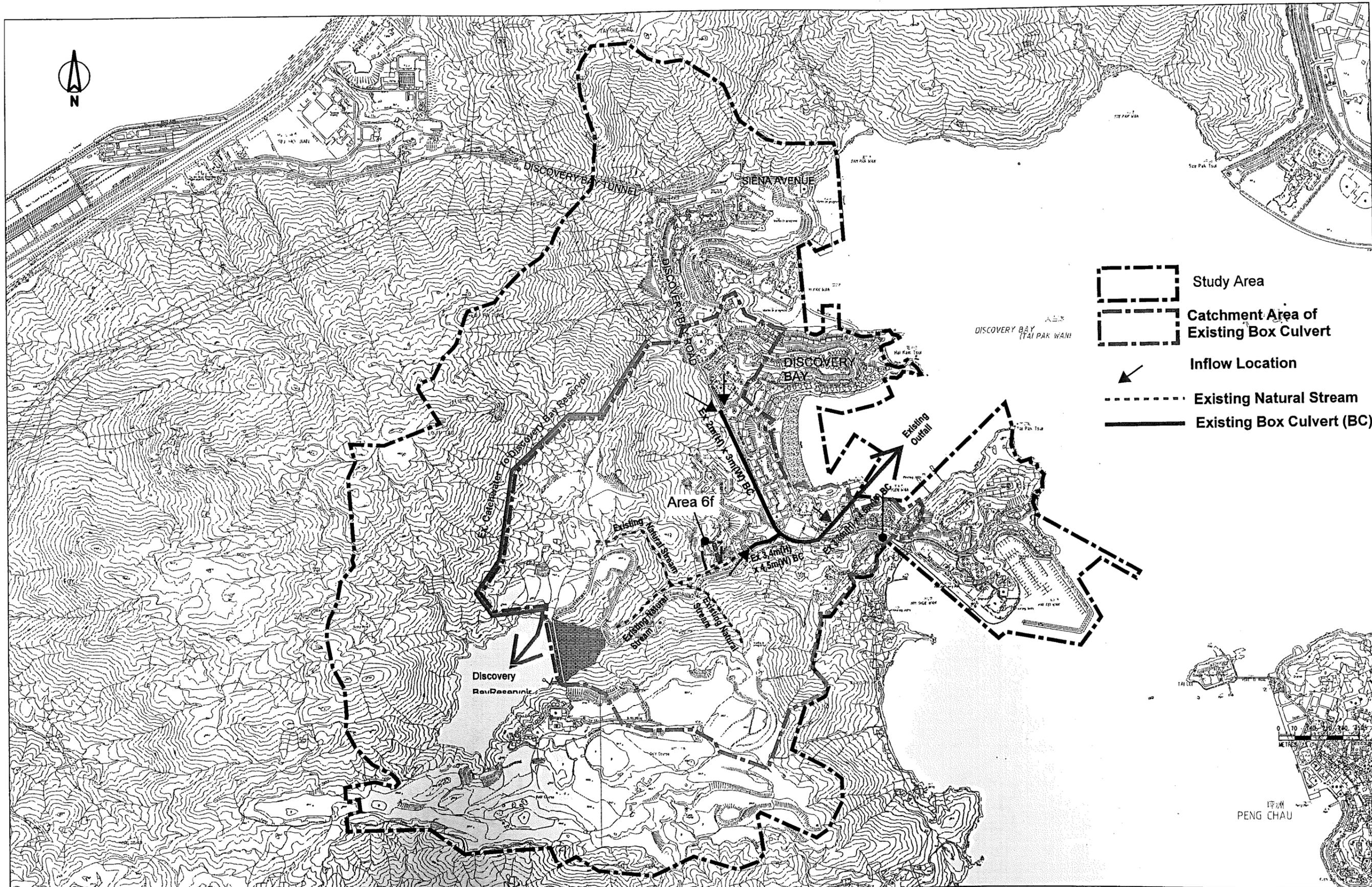
## Figures



Job Title			DISCOVERY BAY - OPTIMIZATION OF LAND USE		
Date	Scale	Drawing Title	PROPOSED DEVELOPMENT AREAS IN DISCOVERY BAY		
	1:15000				
Drawn	Job No.				
	71607R				

FIGURE 1

**ARUP**



Job Title  
**DISCOVERY BAY - OPTIMIZATION OF LAND USE**

Date	Scale 1:15000	Drawing Title
Drawn	Job No. 226078	

**EXISTING AND PROPOSED DRAINAGE LAYOUT PLAN**

FIGURE 2

**ARUP**

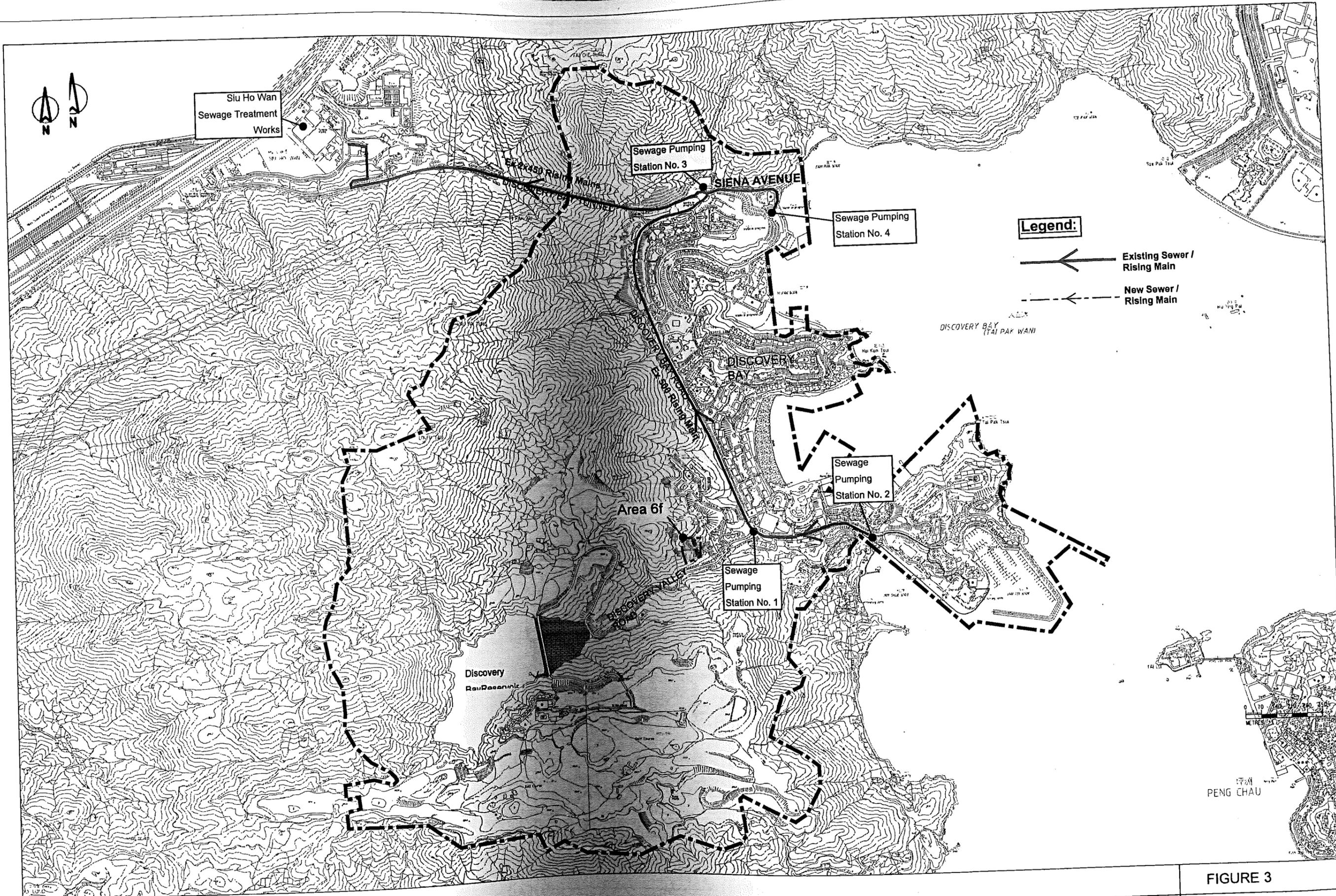


FIGURE 3

ARUP

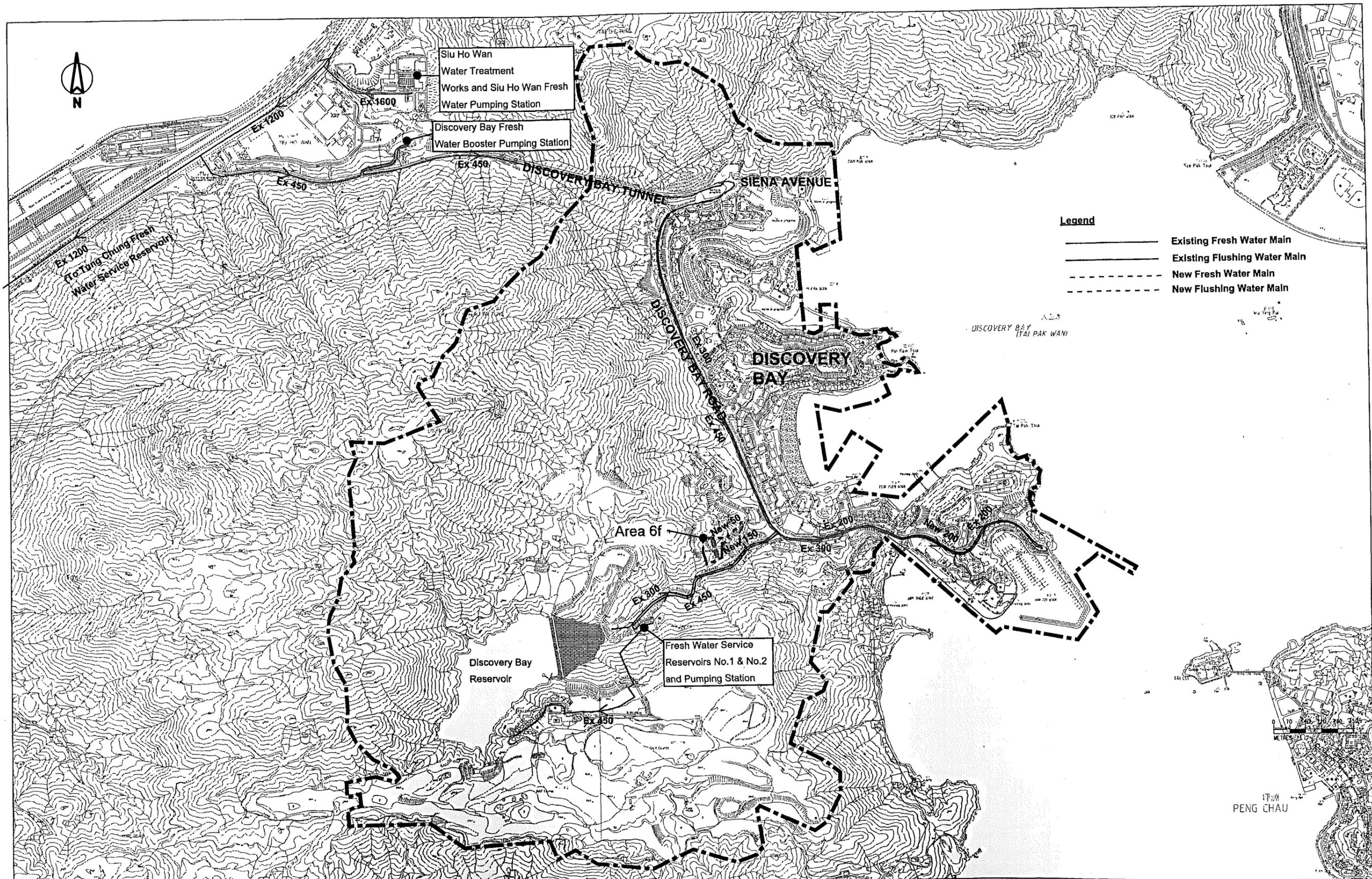
Job Title  
DISCOVERY BAY - OPTIMIZATION OF LAND USE

Date  
DEC 2015

Scale  
1:15000

Drawing Title  
EXISTING AND PROPOSED SEWERAGE LAYOUT PLAN

Drawn  
Job No.  
22607R



Job Title  
**DISCOVERY BAY - OPTIMIZATION OF LAND USE**

Date	Scale 1:15000	Drawing Title
Drawn	Job No. 226672	

**EXISTING AND PROPOSED WATER SUPPLY LAYOUT PLAN**

FIGURE 4

**ARUP**

## APPENDIX B1

### Capacity Checking Calculations on Existing Box Culvert

**ARUP**

Job Title: Discovery Bay Optimization of Land Use

Prepared By: NY  
Checked By: KK  
Rev.: A

Rational method to estimate runoff and determination proposed drainage pipe / box culvert (BC) sizes

Use  
1 in 200 year design event for sizing trunk system  
1 in 50 year design event for sizing branch system

to = time of concentration of a natural catchment (min.)  

$$t_c = 0.14465L$$
 where A = catchment area (m<sup>2</sup>) = 32,810 m<sup>2</sup>  
 H = average slope (m per 100m) of the natural flow = 72m  
 L = distance (m) of the natural flow = 473m

Design Assumptions:  
 (50 year) a= 987 b= 4.2 c= 0.42  
 (200 year) a= 756 b= 4.1 c= 0.40  
 u = 1.0E-6  
 ka = 3  
 C (Paved) = 1.00  
 C (unpaved) = 0.30

Potential Development Area	Pipe / BC Size	Length (m)	No. of Pipe / Cell	BC Width (m)	BC / Pipe Height (m)	Gradient (%)	Gradient (1 in X)	Area (m <sup>2</sup> )	Perimeter (m)	R-AP (m)	32qRS	Velocity (m/s)	Tl (min)	Tc (min)	Intensity (mm/hr)	Total Catchment Area (paved & unpaved) (m <sup>2</sup> )	Catchment Area (paved) (m <sup>2</sup> )	Cumulative Catchment Area (paved) (m <sup>2</sup> )	Catchment Area (unpaved) (m <sup>2</sup> )	Cumulative Catchment Area (unpaved) (m <sup>2</sup> )	Cumulative Runoff From Catchment (m <sup>3</sup> /s)	Pipe/BC Capacity (m <sup>3</sup> /s)	% Full Flow
Existing catchment	3 x 2 BC	473	1	3.0	2.0	0.5%	200	8.00	10.00	0.50	0.97	3.37	2.34	10.54	262	442,000	161,000	161,000	281,000	281,000	17.9	20.2	88%
Existing catchment + Site 6f	4.5 x 3.4 BC	250	1	4.5	3.4	0.7%	143	15.30	15.80	0.97	1.46	5.38	0.71	11.28	257	1,408,000	94,400	225,400	1,341,600	1,622,600	50.9	82.1	62%
Existing catchment	4.5 x 3.8 BC	260	1	4.5	3.8	0.7%	143	17.10	16.60	1.03	1.50	5.57	0.78	12.03	252	177,000	177,000	402,400	0	1,622,600	82.3	95.3	65%

## APPENDIX B2

### Calculations on Proposed Sewerage System

# ARUP

Job Title: Discovery Bay Optimization of Land Use

Prepared By: NY  
 Checked By: KK  
 Rev.: A

Sewer Sizing Calculation for Discovery Bay New Developments (6f)

ks= 1.5

Development	No. of Residential Unit	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	ADWF (m <sup>3</sup> /d)	Cum. ADWF (m <sup>3</sup> /d)	Peaking Factor for Sewer	Peak Flow (L/s)	Proposed Sewer Size (mm)	Proposed Sewer Gradient (1x)	Capacity of Proposed Sewer (L/s)	Occupied % of Proposed Sewer
6f	476	1190	Residential	0.37	440.3	440.3	8	40.8	150	10	49.2	83%

Total ADWF (m<sup>3</sup>/d) 440.3

## APPENDIX B3

### Capacity Checking Calculations on existing Discovery Bay Reservoir, Fresh Water Service Reservoir and Proposed Water Supply System

# ARUP

Job Title: Discovery Bay Optimization of Land Use

## Calculation on Water Main, Service Reservoir and Reservoir

Table 1  
Portable Water Consumption of Discovery Bay New Development (6f)

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m <sup>3</sup> /d)
6f	1190	Residential + Service Trade	0.43	511.7
Total Demand (m <sup>3</sup> /d)				511.7

Table 2  
Flushing Water Consumption of Discovery Bay New Development (6f)

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m <sup>3</sup> /d)
6f	1190	Residential	0.07	83.3
Total Demand (m <sup>3</sup> /d)				83.3

Prepared By: NY  
 Checked By: KK  
 Rev.: A

**Sizing for Fresh Water Distribution Main Supplying Discovery Bay New Development (6f)**

Total Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (L/s)	Proposed Distribution Main (mm)	Cross Section Area (mm <sup>2</sup> )	Proposed Main Velocity (m/s)
5.9	3	17.8	150	17663	1.0

Note: To take into account the fire flow, minimum size of 200mm diameter fresh water main is proposed.

**Sizing for Flushing Water Distribution Main Supplying Discovery Bay New Development (6f)**

Total Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (L/s)	Proposed Distribution Main (mm)	Cross Section Area (mm <sup>2</sup> )	Proposed Main Velocity (m/s)
1.0	2	1.9	50	1963	1.0

**Calculation on Water Main, Service Reservoir and Reservoir**

**Table 3**  
Total Fresh Water Consumption for Discovery Bay New Developments

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m <sup>3</sup> /d)
6f	1190	Residential + Service Trade	0.43	511.7
10b	2813	Residential + Service Trade	0.43	1209.6
Total Demand (m <sup>3</sup> /d)				1721.3 ( 19.9 L/s)

**Table 4**  
Total Flushing Water Consumption for Discovery Bay New Developments

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m <sup>3</sup> /d)
6f	1190	Residential	0.07	83.3
10b	2813	Residential	0.07	196.9
Total Demand (m <sup>3</sup> /d)				280.2 ( 3.2 L/s)

**Table 5**  
Capacity Checking of Existing Service Reservoirs No. 1 and No. 2

Existing Fresh Water Demand (241)	10853 (m <sup>3</sup> /d)	( 145.5 L/s)
New Fresh Water Demand	1721 (m <sup>3</sup> /d)	
Total Fresh Water Demand	12574 (m <sup>3</sup> /d)	
Service Reservoir Capacity Required for Fresh Water System (85% of MDD)	10688 (m <sup>3</sup> )	
Capacity of Existing Service Reservoirs No. 1 (7,250m <sup>3</sup> ) & No. 2 (2,992m <sup>3</sup> )	10242 (m <sup>3</sup> )	

The existing Service Reservoirs No. 1 and No.2 are marginally below capacity (96%). Additional 446m<sup>3</sup> volume required to meet 0.85MDD storage suggested by WSD.

**Table 6**  
Capacity Checking of Existing Reservoir Supply Flushing Water (Including both Portable and Flushing Water of Nim Shue Wan Village)

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m <sup>3</sup> /d)
Existing Discovery Bay Developments (241) + the OZP (DB)	25000	Residential	0.07	1750.0
	4100	School	0.025	102.5
Existing Nim Shue Wan (244)	150	Residential + Service Trade	0.23+0.04+0.07	51.0
New Discovery Bay Development	4003	Residential	0.07	280.2
Total Demand (m <sup>3</sup> /d)				2183.7 ( 25.3 L/s)

Capacity Checking of Existing 450mm Dia. Fresh Water Pump Main to Service Reservoir

Total Water Demand (L/s)	Factor of Pump Main	Total Peak Flow (L/s)	Existing Pump Main (mm)	Cross Section Area (mm <sup>2</sup> )	Proposed Main Velocity (m/s)
145.5	1.5	218.3	450	158963	1.4

Capacity Checking of Existing 300mm Dia. Water Main of Reservoir

Total Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (L/s)	Existing Distribution Main (mm)	Cross Section Area (mm <sup>2</sup> )	Proposed Main Velocity (m/s)
25.3	2	50.5	300	70650	0.7

Summary of Historic Monthly Rainfall Data Collected from Hong Kong Observatory

Rainfall Data (In mm) for Discovery Bay (from Hong Kong Observatory, HKO)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	0.0	40.0	165.5	139.5	547.0							
2013	1.5	1.0	95.0	223.0	434.5	502.5	329.5	309.0	297.0	0.5	46.0	114.0
2012	50.5	44.0	26.5	338.0	200.0	182.5	443.5	122.0	128.0	63.0	72.5	52.0
2011	7.5	27.0	29.0	47.0	193.5	379.5	182.0	219.5	120.5	115.0	97.5	1.0
2010	27.0	110.0	22.0	128.0	233.0	422.0	306.0	217.5	543.5	19.5	43.5	29.0
2009	0.0	2.5	119.0	143.5	257.5	342.5	321.0	238.0	248.0	10.5	31.5	48.5
2008	40.0	21.5	70.0	188.5	175.5	1204.5	546.0	266.5	165.5	110.5	1.0	8.5
2007	29.5	8.0	25.0	141.5	302.0	509.5	54.5	340.5	116.5	36.5	13.0	16.0
2006	16.5	44.0	58.5	171.5	394.5	382.0	377.0	266.5	230.0	32.5	93.5	15.5
2005	10.0	26.0	41.0	14.5	348.5	587.5	286.0	755.5	146.0	5.5	6.5	5.0
2004	33.5	45.5	77.5	105.0	257.0	184.5	347.5	411.5	79.5	3.5	0.5	0.0
2003	15.0	5.0	75.0	112.5	42.5	474.5	97.0	310.5	346.0	10.0	54.0	1.5
2002	22.5	4.0	111.0	10.5	252.0	162.5	292.5	431.0	446.0	82.5	29.5	70.5
2001	49.0	11.0	60.5	102.0	166.5	785.5	575.5	305.0	413.5	5.5	3.5	42.5
2000	48.5	31.0	45.5	515.0	153.0	279.5	265.0	374.0	88.5	130.5	89.0	51.0

(Driest Year \*)

\* The driest year with minimum rainfall during a 12-month period is considered, i.e. Oct 2010 to Sep 2011

Summary of Discover Bay Reservoir Volume and Water Levels

Top water level of the Reservoir =	175	mPD	
Invert level of the Reservoir =	125	mPD	i.e. 50m water depth
Total Capacity of the Reservoir =	3,400,000	m <sup>3</sup>	
Average surface area of the Reservoir =	68,000	m <sup>2</sup>	
Lowest water level of the Reservoir = (from record data during March 2008 to March 2014)	168.6	mPD	i.e. 43.6m water depth (Assumed to be min. water level during the driest year in 2010/2011)
By pro-rata, storage volume of the Reservoir at lowest water level of +168.6 mPD =	2,964,800	m <sup>3</sup>	
To be very conservative, assume only 50% of the Reservoir volume is available for water supply =	1,482,400	m <sup>3</sup>	

Checking of Adequacy of Existing Discovery Bay Reservoir to Meet Existing and New Water Demand during Driest Year

Water Demand Case 1: Only Flushing Water of New DB Development (Areas 6f and 10b) to be Supplied by Discovery Bay Reservoir

Development	Population	Population	Fresh Water /	Unit Flow Factor	Water Demand
Existing Discovery Bay	25000	Residential	Flushing Water	0.07	1750.0
Developments	4100	School	Flushing Water	0.025	102.5
Existing Nim Shue Wan	150	Residential + Service	Fresh & Flush	0.23+0.04+0.07	51.0
New Discovery Bay	4003	Residential	Flushing Water	0.07	280.2
Total Water Demand Required =					2183.7 m <sup>3</sup> /d

(a) Inflow to Discovery Bay Reservoir

a1. Runoff collected by catchwater from catchment			
Total rainfall depth	=	1,297.5	mm
Catchment Area	=	120	ha
(assume runoff coefficient 0.3)			
Annual rainfall volume	=	467,100	m <sup>3</sup>
a2. Direct Rainfall on Reservoir Area			
Total rainfall depth	=	1,297.5	mm
Average surface area of Reservoir	=	68,000	m <sup>2</sup>
Annual rainfall volume	=	88,230	m <sup>3</sup>

(b) Outflow from Discovery Bay Reservoir

b1. Evaporation from Reservoir Surface			
Annual evaporation rate in 2010 / 2011	=	1380.7	mm
Reservoir top surface	=	18	ha
Annual evaporation volume	=	248,526	m <sup>3</sup>
b2. Water demand from Existing and Proposed New Development (Water Demand Case 1)			
Daily total water demand	=	2,184	m <sup>3</sup>
Annual water demand	=	797,054	m <sup>3</sup>

(very conservative assumption)

Remaining Volume of Discovery Bay Reservoir

Reservoir Volume	+	Inflow volume	-	Outflow volume	=	
1,482,400 m <sup>3</sup>		555,330 m <sup>3</sup>		1,045,580 m <sup>3</sup>		992,150 m <sup>3</sup>
(Therefore Reservoir has adequate volume to meet water demand)						

**Water Demand Case 2: Fresh and Flushing Water of New DB Development (Areas 6f and 10b) to be Supplied by Discovery Bay Reservoir**

Development	Population	Population	Fresh Water /	Unit Flow Factor	Water Demand
Existing Discovery Bay	25000	Residential	Flushing Water	0.07	1750.0
Developments	4100	School	Flushing Water	0.025	102.5
Existing Nim Shue Wan (244)	150	Residential + Service Trade	Fresh & Flushing Water	0.23+0.04+0.07	51.0
New Discovery Bay	4003	Residential + Service	Fresh &	0.39+0.04+0.07	2001.5

Total Water Demand Required = 3905.0 m<sup>3</sup>/d

**(a) Inflow to Discovery Bay Reservoir**

a1. Runoff collected by catchwater from catchment				
Total rainfall depth	=	1,297.5	mm	
Catchment Area	=	120	ha	
(assume runoff coefficient 0.3)				
Annual rainfall volume	=	467,100	m <sup>3</sup>	
a2. Direct Rainfall on Reservoir Area				
Total rainfall depth	=	1,297.5	mm	
Average surface area of Reservoir	=	68,000	m <sup>2</sup>	
Annual rainfall volume	=	88,230	m <sup>3</sup>	

**(b) Outflow from Discovery Bay Reservoir**

b1. Evaporation from Reservoir Surface				
Annual evaporation rate in 2010 / 2011	=	1380.7	mm	
Reservoir top surface	=	18	ha	(very conservative assumption)
Annual evaporation volume	=	248,526	m <sup>3</sup>	
b2. Water demand from Existing and Proposed New Development (Water Demand Case 2)				
Daily total water demand	=	3,905	m <sup>3</sup>	
Annual water demand	=	1,425,325	m <sup>3</sup>	

**Remaining Volume of Discovery Bay Reservoir**

Reservoir Volume	+	Inflow volume	-	Outflow volume	=	363,879 m <sup>3</sup>
1,482,400 m <sup>3</sup>		555,330 m <sup>3</sup>		1,673,851 m <sup>3</sup>		

(Therefore Reservoir has adequate volume to meet water demand)