For discussion
on 24 May 2011

Legislative Council Panel on Development

Findings of the Study on the Enhanced Use of Underground Space in Hong Kong

PURPOSE

This paper briefs Members on the findings of a strategic planning and technical study on "Enhanced Use of Underground Space in Hong Kong"[1] (the Study).

BACKGROUND

2. In the 2009-10 Policy Agenda, Development Bureau put forward a new initiative to launch strategic planning and technical studies to facilitate planned development of underground space aiming at promoting the enhanced use of rock caverns as part of Hong Kong's pursuit of sustainable development.

3. The Civil Engineering and Development Department (CEDD), with the support of the Planning Department, commissioned the above Study in March 2010. The Study explored the opportunities to enhance the effective use of land resources in Hong Kong from a new perspective through the planned development of underground space. The key tasks of the Study are listed at **Annex A**. The Study was substantially completed in March 2011 at a cost of $9.7 million.

Rock Cavern Development in Hong Kong

4. Hong Kong's topographical setting with steep natural hillsides pose significant constraints to development. Land, particularly in the urban areas, is a scarce resource. To support social and economic development, there is a pressing need to optimize and improve the supply of land for various uses by sustainable and innovative approaches.

5. The geology of Hong Kong is very suitable for rock cavern development. Furthermore, the hilly areas in the urban fringes are particularly suitable for cavern development as they allow easy access for construction as well as future uses.

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[1] Underground space generally encompasses purpose-built man-made spaces formed by large scale excavations in rock (i.e. rock caverns) as well as other large basement-type excavations formed by cut and cover methods. The Study focused on rock cavern development.

6. Since the early 1980s, the Geotechnical Engineering Office (GEO) of CEDD, in collaboration with the relevant government departments and regulatory authorities, has conducted studies related to the planning, design, construction and regulatory control on the development of rock caverns in Hong Kong. A few purpose-built rock caverns were constructed in the mid-1990s to accommodate government facilities to meet the needs of the community, namely the Island West refuse transfer station, Stanley sewage treatment plant and Kau Shat Wan explosives depot. The re-provisioning of two existing salt water reservoirs (i.e. Western Salt Water Service Reservoirs) at the University of Hong Kong in rock caverns in 2009 released land for its Centennial Campus development, which avoided substantial cutting of the hillside, thereby reducing the amount of spoil requiring disposal and minimising the disturbance to the natural habitat as well as the visual impact on the neighbourhood. The recently constructed West Island Line Explosives Magazine at Victoria Road is also located in a rock cavern. These purpose-built rock caverns are shown at **Annex B**.

7. To date, the development of cavern schemes to house suitable facilities in Hong Kong has been limited. Rock cavern development has generally been either out of necessity (e.g. underground railway stations), or reactive and only considered where over-riding circumstances exist (e.g. Island West refuse transfer station and Stanley sewage treatment plant).

Overseas Experience

8. Cavern construction is an established technology that has seen continual improvement in its application. Many cavern schemes have been successfully built around the world with notable examples in Canada, China, Finland, Japan, Korea, Norway, Singapore, Sweden and the USA. A diverse set of uses include municipal facilities (water and sewage treatment plants, refuse transfer stations and service reservoirs), storage facilities (archives, oil and gas, and food), community and recreational facilities (retail, sports halls and swimming pools), and special facilities (civil defence, laboratories and data centres). Some examples are shown at **Annex C**. Caverns have also been built as part of mass transportation networks in various cities around the world.

9. Increasingly, various cities around the world have recognised that the unplanned development of underground space based on the ‘first-come-first-served’ approach will have an adverse impact on the growth of the city. To address this, Helsinki in Finland has developed an underground master plan to reserve underground space for long-term development of public and private facilities. Singapore is also taking measures to catalyse the development of underground space, which include developing an underground master plan and creating an underground land bank.

10. To prepare for policy deliberations on the subject, the Secretary for

Development led a delegation to visit Oslo, Norway in September 2010. During the visit, meetings were held with Water and Sewage Department, Norwegian Geotechnical Institute and a leading Norwegian engineering and design consultant, and visits to some facilities located in rock caverns were made. Some members of the delegation also visited Helsinki, Finland to learn about their experience, including a meeting with the City Planning Department. A summary of the facilities visited is at **Annex D**.

FINDINGS OF THE STUDY

11. During the Study, we consulted and exchanged views with relevant professional institutions, including the Hong Kong Institution of Engineers, the Hong Kong Institute of Planners, the Institute of Quarrying (Hong Kong Branch), the Institute of Materials, Minerals and Mining (Hong Kong Branch) and the Association of Geotechnical and Geoenvironmental Specialists (Hong Kong). They were supportive of the Study and generally recognised the need to undertake a holistic approach to managing underground space and its development in Hong Kong.

12. The key technical findings of the Study are outlined below.

(a) The suitability of land for rock cavern development is shown in **Annex E**. About 64% of Hong Kong's land area, underlain by strong granitic and volcanic rocks, is potentially suitable for cavern development. Some 55% of this land area is located within statutory protected areas such as country parks, development below which would be subject to approval by relevant authorities.

(b) A stock taking exercise has identified over 400 existing government facilities that have the potential for relocation to rock caverns in line with the potential land uses listed in the Hong Kong Planning Standards and Guidelines.

(c) A preliminary ranking system for individual facilities has been developed to highlight the relative merits of relocating these facilities, which shows that some government facilities have high potential for relocation to rock caverns, subject to detailed planning and engineering studies to assess their overall feasibility.

(d) Preliminary technical feasibility assessments have broadly demonstrated that cavern schemes could be implemented to house some suitable existing government facilities, thereby releasing land for other beneficial and compatible uses. The facilities are -

(i) Sha Tin sewage treatment works (site area 28 hectares);

(ii) Mount Davis & Kennedy Town fresh water service reservoirs (total site area 2 hectares); and

(iii) Mui Wo sewage treatment works, refuse transfer station and neighbouring facilities (total site area 2.5 hectares).

(e) Financial viability, where land value is taking into consideration, has also been demonstrated for the Sha Tin sewage treatment works, and the Mount Davis & Kennedy Town fresh water service reservoirs. In general, the construction cost for housing facilities in caverns is more expensive than the surface option and, in some cases, operating and maintenance costs can also be higher.

(f) For some sensitive facilities, there are added benefits in terms of environmental and visual impact and the increased security of housing them underground.

(g) Five strategic cavern areas of each more than 20 hectares in size with potential to accommodate multiple facilities have been identified. These are located in the areas of Mount Davis, Lion Rock, Sha Tin (Shek Mun), Tuen Mun (Lam Tei) and Lantau Island (Siu Ho Wan). Their locations are shown at **Annex E**.

13. The Study has highlighted that there are significant opportunities and benefits for enhancing the use of rock caverns as part of Hong Kong's sustainable development strategy. The land so released, particular in the vicinity of the urban areas, is a valuable resource and may assist to resolve some of the land use incompatibility issues. These include -

(a) Placing 'Not-in-My-Backyard' (NIMBY) facilities in caverns (e.g. refuse transfer stations and sewage treatment plants) would minimize adverse impacts on the community and the environment.

(b) Relocating suitable existing facilities to caverns (e.g. service reservoirs) would release the surface sites for other more beneficial uses, such as housing and other community uses.

(c) Introducing innovative cavern usage would help accommodate those facilities that have difficulty in finding suitable surface sites (e.g. maintenance depots and columbaria) and those that could benefit from the stable environment underground (e.g. archives, data centres and laboratories).

(d) Facilitating private sector participation in the development of rock caverns would help optimize the release of surface land (e.g. oil and gas storage, bus depots and substations).

14. Some of the benefits to the community regarding placing facilities in rock caverns are intangible, e.g. removal of incompatible land uses from the local community, provision of additional open space and reduced traffic congestion by relocating urban facilities to the urban fringe, and these may help improve government/community relationships.

RECOMMENDED KEY INITIATIVES

15. The Study has concluded that with its natural setting being particularly suitable for rock cavern development, Hong Kong could create an environment in which cavern development forms part of the mainstream development process. To facilitate the planned use of underground space as part of Hong Kong's land supply and development strategy, the Study has recommended the following key initiatives for further study and public consultation -

(a) The cavern option should be considered in the early stage of project planning;

(b) Signature cavern schemes that would promote the use of underground space should be implemented;

(c) A long-term strategy should be developed to systematically relocate existing government facilities underground;

(d) Cavern development master plans should be developed so as to ensure that the strategic cavern areas are not compromised by future development projects; and

(e) A policy framework should be formulated to facilitate private sector involvement in rock cavern development.

16. An Executive Summary of the Study is available at CEDD website <http://www.cedd.gov.hk>.

WAY FORWARD

17. Public engagement will be carried out to present the Study findings and to initiate public discussion on rock cavern development as an innovative approach to increase land supply, in pursuit of sustainable development.

18. Some follow-up work with regard to the recommended key initiatives is being considered. They include -

(a) developing a long-term relocation strategy in conjunction with cavern development master plans;

(b) undertaking detailed planning and engineering studies to assess the feasibility of relocating to caverns some government facilities of high cost-benefit value to the community; and

(c) formulating policy guidelines to facilitate cavern development for both public and private sectors.

ADVICE SOUGHT

19. Members are invited to note and offer views on the findings of the Study and the proposed way forward.

Development Bureau
May 2011

Annex A

Study on Enhanced Use of Underground Space in Hong Kong

Key Tasks

The key tasks of the Study are -

(a) review the history and current status of use of rock caverns in Hong Kong and worldwide, and benchmark Hong Kong's practice with that elsewhere;

(b) examine the opportunities for enhanced use of underground space in Hong Kong, and identify strategic issues that need to be addressed, including selection of three existing above-ground government facilities that could be re-housed in rock caverns for further preliminary feasibility studies;

(c) carry out a preliminary feasibility study for each of the selected above-ground government facilities for replacement in rock caverns, covering broad technical and financial assessments;

(d) develop a territory-wide cavern suitability map, and evaluate the viability of demarcating strategic areas and sites for future underground space development; and

(e) recommend approaches and the way forward for planned development of underground space by promoting enhanced use of rock caverns in Hong Kong so as to provide land in the urban area for other beneficial uses.

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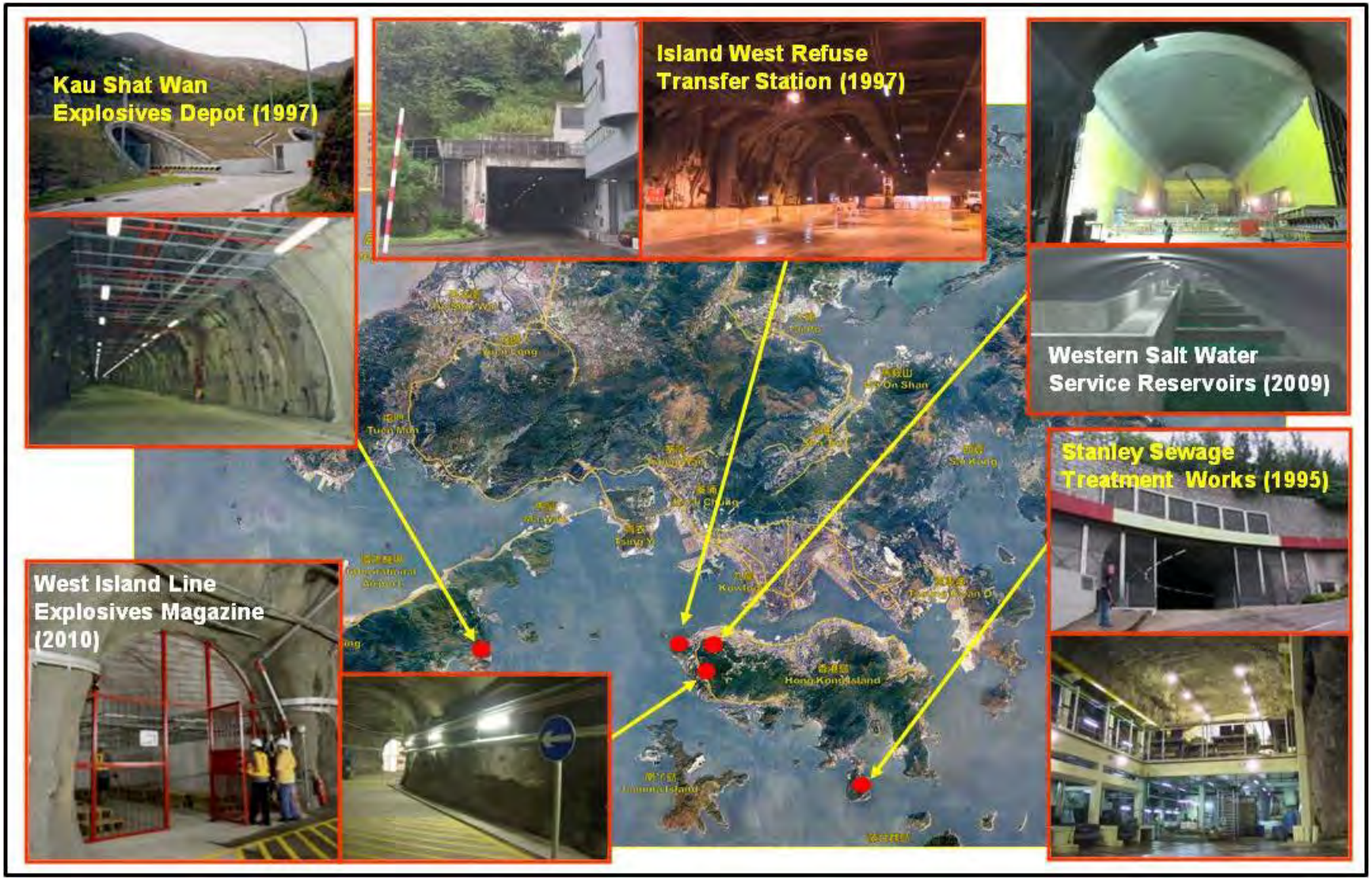
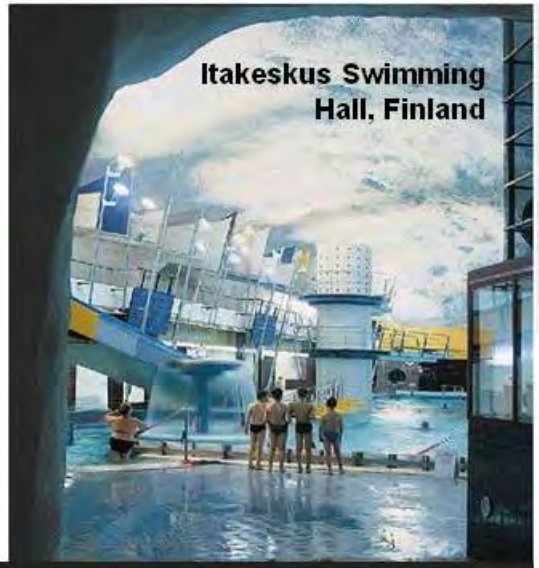
Annex B

Purpose-built rock caverns in Hong Kong



Annex C

Examples of cavern usage in other countries – Part I



Annex C

Examples of cavern usage in other countries – Part II

Annex D

Summary of Underground Facilities Visited – Part I

Bekkelaget Sewage Treatment Plant, Oslo

- The facility serves a community of about 280,000. On average, 1,100 litres per second is treated by the facility with mechanical and biological treatment. The completely enclosed sludge tanks produce biogas, which is being used as fuels for running city buses.


New Oset Water Treatment Plant, Oslo

- The facility is Europe's largest plant that is housed in rock caverns. It produces 390,000 cubic metres of drinking water per day at a rate of 4,500 litres per second, serving about 90% of Oslo's population with clean water that meets the requirements of the European Union.


Annex D

Summary of Underground Facilities Visited – Part II

Sandvika District Heating and Cooling Plant, Oslo

- The facility utilises heat pump technology in recycling heat from the waste water during the winter and transferring heat to the water during the summer. The two heat pumps system with capacity of 6.5 megawatts (heating) and 4.5 megawatts (cooling) derives half of its energy from the waste water energy recycling.

National Archives, Oslo

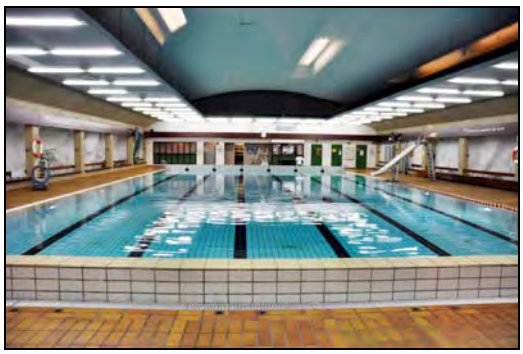
- The main considerations of housing the facility in rock caverns are good security and potential for expansion for the ever increasing archives. It now stores about 154,000 shelf-metres of paper archives as well as films, maps, pictures, drawings and digital archives. Each cavern houses a four-storey building with connections on every floor to adjacent caverns.

Annex D

Summary of Underground Facilities Visited – Part III

Holmlia Sports Hall, Oslo

- The facility with a total floor space of 7,550 square metres serves "multi-sports use" including swimming, various ball games, fitness training, boxing and dancing, and can house 7,000 persons as a civil defence shelter. The energy consumption was found to be far below that of compatible sports halls in normal buildings in Oslo.



KEHU City Service Tunnels, Helsinki

- The 4.2-kilometre tunnels form part of Helsinki's extensive utility tunnel networks. The facility, shared by several users, houses transmission lines and pipes for electricity and water supply systems as well as cable links. Pipes and cables in tunnels are easier to maintain than those buried under streets and any breakages pose a lesser danger to the general public.

Annex D

Summary of Underground Facilities Visited – Part IV

Underground Parking, Helsinki

- New parking space and service tunnels are being constructed underground below the newly built facilities and surrounding traffic roads. The land previously occupied by above-ground parking and service areas has been converted into city parks.

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Annex E

Cavern Suitability Map & Strategic Cavern Areas