

CAVERN MASTER PLAN

EXPLANATORY STATEMENT

INTRODUCTION

- (1) This Explanatory Statement is intended to provide the key information on the Cavern Master Plan (CMP) prepared under the “Long-term Strategy for Cavern Development – Feasibility Study” (Strategic Cavern Study) (2017) and in the subsequent “Pilot Planning and Engineering (P&E) Study on Development of Selected Strategic Cavern Areas – Feasibility Study” (Pilot P&E Study) (2025).
- (2) The CMP provides a broad strategic framework to guide and facilitate territory-wide planning on the uses of caverns in Hong Kong. Areas that are considered strategic for accommodating multiple cavern facilities (referred to as Strategic Cavern Areas (SCVAs)) to support possible future uses are delineated on the CMP. The CMP aims to make known these areas and their essential information to project proponents such that they can identify suitable sites and potential uses in rock caverns for development projects considering cavern options as and when needed. The CMP is non-statutory, only serving as user guidelines for options on uses of rock caverns and is not a blueprint for systematic development of caverns in all the identified SCVAs. The use of rock caverns, including sizes and locations, would be subject to the need of individual development projects and detailed technical feasibility studies, and would be assessed on individual merits and prevailing policy.
- (3) Attached to the CMP is a set of Information Notes with reference drawings which show the spatial context of each SCVA and denote the extent of potential portal locations. The rationale of boundary delineation of each SCVA is also set out along with key development constraints.

BACKGROUND

- (4) The hilly terrain and underlying geology of Hong Kong pose challenges, as well as offer opportunities for development of the city. Whilst this setting has limited the supply of sizable developable flat land, the hilly terrain underlain by massive hard igneous rocks (i.e. granitic and volcanic rocks), particularly in

the fringe of development areas is suitable for the uses of rock caverns. Housing suitable facilities in caverns could be an alternative source of land supply in addition to the traditional land development approaches (e.g. large-scale reclamation and open-cut site formation), especially for the continued growth of the city and the increasing call to preserve the landscape, ecological and geological attributes of the territory.

- (5) Around the mid-1990s, a number of government facilities in Hong Kong were purpose-built in rock caverns to meet the needs of the community while overcoming the lack of suitable surface sites at the locality, namely the Island West Transfer Station, Stanley Sewage Treatment Works and Kau Shat Wan Government Explosives Depot. In 2009, the University of Hong Kong constructed rock caverns to re-house the Western Salt Water Service Reservoirs in order to release land for the Centennial Campus development. These projects have demonstrated that rock caverns can be a cost-effective alternative, while yielding additional safety, environmental and security benefits. The location of these existing cavern facilities are shown on the CMP.
- (6) In March 2010, the Civil Engineering and Development Department (CEDD) commenced the “Enhanced Use of Underground Space in Hong Kong – Feasibility Study” (Cavern Feasibility Study) to take forward the policy initiative of promoting the enhanced use of rock caverns as part of Hong Kong’s pursuit of sustainable development. The Cavern Feasibility Study was completed in March 2011. It showed that about 64% of the total land area in Hong Kong was considered broadly suitable for cavern development from the geological perspective.
- (7) In the 2013 Policy Address, the need to conduct a study on the long-term strategy for cavern development with a view to preparing a CMP was stressed. In 2017, 48 SCVAs were delineated under the Strategic Cavern Study.
- (8) Under the Pilot P&E Study, a review of the CMP was carried out including the updating of the example of potential uses in rock caverns¹ in **Appendix I**.

¹ A review has been carried out on the list of potential uses in rock caverns in Appendix I. Two new potential uses (i.e. concrete batching plant and animal waste management facility) were added and six potential uses (i.e. civic centre, cultural/performance venue, incinerator, indoor games/sports hall, indoor swimming pool/complex and recreational complex) were deleted.

BENEFITS OF HOUSING FACILITIES IN CAVERN

- (9) There are distinct benefits of the use of rock caverns towards Hong Kong's sustainable land development strategy. The land so created in the vicinity of urban areas, new towns and new development areas, is a valuable resource and would assist in resolving some of the land incompatibility issues. These could include:
- a. Relocating suitable existing government facilities to caverns thereby releasing the surface land;
 - b. Placing new facilities in caverns thereby reducing surface land take;
 - c. Reserving valuable cavern space for future developments and future expansion of cavern facilities;
 - d. Housing "Not-In-My-Backyard" (NIMBY) / obnoxious type of facilities in caverns for minimising their nuisance to the community; and
 - e. Providing other intangible benefits such as removing incompatible land uses in the community.
- (10) The cavern setting possesses some unique features that are particularly suitable for certain types of facilities. The hard rocks surrounding the caverns reduce the risk against natural and man-made disasters by offering excellent physical barriers for facilities requiring high level of security. The isolation from sunlight and seasonal changes inside caverns also leads to year-round steady ambient temperatures for optimising power consumption, which contributes to achieving the target of carbon neutrality. These features offer a unique edge to cavern development to accommodate a range of modern industrial uses such as research/testing laboratories, and digital infrastructure such as data centres.

PURPOSE OF THE CAVERN MASTER PLAN

- (11) The long-term strategy for cavern development and in particular the CMP offer a holistic approach in releasing the potential applications of rock caverns, facilitating the establishment of a sustainable means of enhancing land supply and increasing land reserve for future development, as well as playing a

strategic role and providing systematic guidelines for implementation of the use of caverns in the territory. Private sector participation can also be an integral part of the implementation because many private sector facilities, such as concrete batching plant, warehousing/logistics and data centres, can benefit from the stable and secure setting offered by caverns. The CMP provides the basic information needed to consider the option of caverns for accommodating their facilities.

(12) The objectives of the CMP include:

- a. Territory-wide planning on the uses of rock caverns – to delineate SCVAs that are suitable for developing rock caverns to meet the existing or future development needs. Reference should be made to the sections on SCVAs in paragraphs (13) to (16) and Criteria for Delineation of SCVAs in paragraphs (17) to (42) below for further details;
- b. Promulgation of information – to disseminate and publicise information on SCVAs that could enable both government departments and private sector organisations to identify suitable cavern sites for their developments. Reference should be made to the section on Information Notes in paragraphs (43) and (44) below for further details; and
- c. Optimal utilisation of SCVAs – to enhance the use of land resources through a pragmatic mechanism for managing cavern and other subsurface developments in SCVAs, without compromising beneficial surface land use and developments. Reference should be made to the section on Implementation in paragraphs (45) to (54).

STRATEGIC CAVERN AREAS

(13) A SCVA is defined as an area that is easy to access and can accommodate multiple facilities in rock caverns to meet the need of development. The area should be sufficiently large and located at the fringe of development areas with supporting infrastructure network. The following key selection criteria have been considered in identifying SCVAs:

- a. Suitable settings – the area should have favourable topography and geology for developing caverns;

- b. Easy access – the area should be located in the proximity of urban areas, new towns and new development areas and could be easily connected to the surrounding infrastructure network, either existing or committed, by constructing minor access roads;
- c. Accommodating multiple facilities – the area should be suitably large with sufficient number of portal locations that could enable multiple cavern facilities to be developed; and
- d. Meeting development needs – the area should be located in a region to meet the possible needs of development, such as relocation of existing government facilities, new development (e.g. provision of new facilities to serve new developments or to support the expansion/upgrading of existing urban areas/new towns) or private sector demand.

The criteria for delineation of SCVAs are further elaborated in paragraphs (17) to (42) below.

- (14) The 48 SCVAs as delineated on the CMP cover a total area of approximately 4,600 hectares. There are 11 on Hong Kong Island, 5 in Kowloon, and 32 in the New Territories (of which 7 on Lantau Island). The size of individual SCVAs ranges from approximately 30 to 200 hectares. SCVAs with size over 30 hectares are considered large enough for accommodating multiple facilities in caverns. Some SCVAs are in close proximity to each other. They are not combined into larger SCVAs due to the presence of some topographic features (e.g. deep valley), geological features (e.g. major fault) or existing infrastructures (e.g. road tunnel) between them.
- (15) The total area of SCVAs does not represent the actual developable cavern space because provisions have to be made for features like buffer zones between individual facilities, intervening rock pillars for support and adits for portal access and inter-connection. Making an allowance for such provisions, the maximum usable footprint area is estimated to be in the range of about 1,200 to 1,800 hectares. Notwithstanding the reduction (i.e. in the range of about 60% to 75%), the usable area may be increased by constructing caverns at different elevations or by forming a multiple-floor facility within a single cavern (e.g. National Archives of Norway and National Library of Sweden).

- (16) SCVAs identified so far only represent areas that are found strategic for the planning of rock caverns in terms of geological considerations and the current planning perspectives. They are not meant to be exhaustive because there may be other areas that could be suitable for planning of rock caverns but do not meet the selection criteria of SCVAs as given in paragraph (13) above, e.g. relatively small hillsides that can merely accommodate a single facility or remote areas that are not easy to access.

CRITERIA FOR DELINEATION OF STRATEGIC CAVERN AREAS

- (17) A number of factors have been considered to determine the location, boundary and extent of potential portal locations of SCVAs shown on the CMP. These factors include terrain, geological suitability, land status, proximity to development area, infrastructural support and environmental constraints.

Terrain

- (18) SCVAs are delineated in hilly terrain with steep hillsides and shallow rock head, which offers a favourable site setting for planning the rock caverns. Steep hillsides could minimise the length of access tunnels required and hence reduce the extent of portal formation works. Shallow rock head could also provide adequate rock cover to support the development of sizable caverns. For example, terrain at Braemar Hill above North Point is considered to have suitable topography for such purpose. Similar topography could be found in quarry sites, e.g. Anderson Road Quarry, where rock is exposed and the quarry face provides convenient access for portal formation.
- (19) The preference for the potential portal locations is to be close to steep hillsides and/or have sufficient surrounding space for providing a staging area for cavern construction and for the siting of above ground structures if needed to support the main caverns. Typical above ground structures include ventilation and administration buildings.

Geological Suitability

- (20) The abundance of strong igneous rocks (i.e. granitic and volcanic rocks) in Hong Kong, which covers some 80% of the land area, offers an opportunity for placing facilities in rock caverns. The hilly areas at the fringe of development areas are particularly suitable for housing a cavern as they allow easy access into the ground to construct the caverns.
- (21) As a whole, about 64% of the total land area in Hong Kong is potentially suitable for cavern development, i.e. caverns are considered to be more easily developed in these areas. SCVAs possess geological and spatial characteristics appropriate for cavern development, such as hilly terrain comprising strong rock. Areas underlain by sedimentary and metamorphic rocks are less favourable for cavern development although not technically infeasible.
- (22) SCVAs are not included in areas below landfill sites and Scheduled Areas under the Buildings Ordinance where geotechnical difficulty of cavern development is high. SCVAs also avoid geological features which may adversely affect the constructability of caverns, such as major faults.

Land Status

- (23) In general, development zones (e.g. residential zone, village type development zone), private lots and burial grounds are excluded from SCVAs at the time of boundary delineation. Boundaries are defined to cover government land and prevent extension into private land for ease of implementation. Nevertheless, some of this government land may be rezoned and disposed of in the future for private development. Suitable provisions would be incorporated in the lease conditions to safeguard the integrity of the SCVAs (see paragraphs (45) to (54) on Implementation).
- (24) Due to the small scale of the CMP, there are small individual private lots located midway on the hillsides within some SCVAs. These small private lots are also excluded from the SCVAs on the reference drawings and they would not physically pose constraints on the potential application of SCVAs, and vice versa.

Proximity to Development Area

- (25) The spatial context of the surrounding areas had been considered when identifying individual SCVAs.
- (26) SCVAs may serve the adjacent urban areas, new towns and new development areas. They also serve as alternative land resources for relocating existing and/or accommodating additional government, institution or community facilities like service reservoirs in order to support possible future demand. In areas with a concentration of commercial/industrial/innovation and technology developments, SCVAs may support adjacent existing and planned economic activities, such as storage/warehousing facilities and data centres. For the relatively remote and/or isolated areas, SCVAs may house facilities considered to be of high safety risk or NIMBY in nature. SCVAs are not included in areas of impounding reservoirs or military land even though they might be highly suitable for cavern development from the geological perspective.
- (27) Due to the large size of SCVA, multiple facilities may be developed in phases in a cavern. Project proponents shall ensure the facilities accommodated at different time would not jeopardise the development potential of the remaining part of the SCVA in future. The facilities in a cavern shall also be compatible with each other or suitable mitigation measures shall be imposed. Shared use of common provisions, e.g. access, should be considered.
- (28) Potential uses in rock caverns have also been identified through consultation with the private sector, such as storage/warehousing/logistics facility, data centre, columbarium, vehicle parking, bus depot, retail/shopping arcade, oil storage, wine storage, electric substation, research/material testing laboratory, underground quarrying and concrete batching plant, etc.
- (29) A list showing examples of potential uses in rock caverns is given in **Appendix I** for reference. The list is not exhaustive and should be used for general guidance only and the suitability, feasibility and compatibility of the potential use(s) at individual SCVAs will be subject to detailed assessments as development proceeds.

Infrastructural Support

- (30) Connectivity to the existing and planned major infrastructure is one of the key factors in the determination of the location of SCVAs. The proximity to and capacity of existing as well as planned infrastructure, such as highways and railways, which can support the future potential uses of rock caverns to be accommodated within SCVAs, has been taken into account in the delineation of their boundaries.
- (31) The forecast capacity of adjacent road network should be considered in the identification of potential uses with regards to the surrounding infrastructure. In general, potential uses which would typically generate larger traffic volumes, such as warehousing and refuse transfer facility, should only be considered for recommendation where the surrounding infrastructure has reasonable residual capacity. The need for any upgrading of the existing infrastructures to support any future caverns in the SCVAs is highlighted in the respective Information Notes as appropriate.
- (32) In addition to considering proximity to the existing road network, the proximity to MTR stations and other modes of public transport should also be taken into account in the identification of potential uses which will require easy access by staff and/or the general public.
- (33) The location of existing and planned underground infrastructure, including tunnels, has also been considered in the delineation of SCVA boundaries. The boundaries of SCVAs would be at a reasonable distance away from existing and planned underground infrastructure on similar elevations in order to provide a buffer zone to reduce potential impact to these infrastructures. Those tunnels that are located at different elevations with sufficient buffer would not be avoided since they would unlikely pose any insurmountable constraint on future cavern developments in the SCVAs. The respective Information Notes of each SCVA has also highlighted the interface issues with the existing and planned underground infrastructure, should there be any within the SCVA.

Environmental Constraints

- (34) Environmental issues have been an important consideration in the formulation of the CMP. A range of environmental factors have been considered when determining the boundary of each SCVA. Major conservation areas have been

used as the basis for consideration of environmental and heritage related factors. These include, but not limited to, constraints such as Country Parks and Special Areas (hereafter referred to as Country Parks), Conservation Areas, Coastal Protection Areas, Sites of Cultural Heritage, Sites of Archaeological Interest and Sites of Special Scientific Interest. The identification of potential portal locations has avoided encroaching onto Country Parks, conservation areas, valuable woodland, watercourses and other ecologically significant areas and sensitive parts of the natural environment as far as practicable to avoid possible adverse environmental impacts on these areas.

- (35) About 64% of the total area in Hong Kong is considered potentially suitable for cavern development. Some 55% of this land is located within the statutory protected Country Parks. Given this high proportion, it is inevitable that most SCVAs identified encroach onto Country Parks in varying degrees. As a whole, about 40% (i.e. 1,800 hectares) of the total area of SCVAs are within Country Parks, accounting for about 4% of the total Country Parks area.
- (36) Cavern construction, including rock excavation, rock support and waterproofing works, and implementation of environmental mitigation measures, is an established technology. Numerous underground infrastructures have been built below Country Parks, for example, road tunnels such as Lion Rock Tunnel, Tate's Cairn Tunnel and Tai Lam Tunnel, as well as numerous railway, water, drainage and cable tunnels. There are over 160 km of underground infrastructure within Country Parks. Given the similar engineering practice in construction of tunnels and caverns, these examples provide reference that cavern developments underneath Country Parks could be acceptable provided that they are in compliance with the statutory requirements and appropriate engineering measures are implemented to mitigate the potential adverse environmental impacts.
- (37) The CMP does not exempt any cavern development projects, either within or outside SCVAs, from the statutory requirements, including applications for approval of environmental impact assessment (EIA) report or for obtaining permission to apply directly for an environmental permit and environmental permit under the Environmental Impact Assessment Ordinance (EIAO). For developing caverns within Country Parks, prior approval from the Lands Department is required, in which project proponents will seek the views and comments from the Country and Marine Parks Authority. Further consultation with the Country and Marine Parks Board or its Country Parks

Committee may be required. All projects must be justified on their own merits of developing caverns within Country Parks.

- (38) An underground rock cavern with a portal that is less than 100m from the nearest boundary of an existing or planned environmental sensitive area listed under Item Q.2, Part I, Schedule 2 of the EIAO constitutes a Designated Project. The environmental acceptability of a cavern development project, its potential environmental impacts, including cumulative environmental impacts, arising from the construction and operation of a cavern development and its associated facilities, and environmental mitigation or compensation measures required shall be determined on an individual project basis in the EIA under the EIAO requirements.
- (39) Environmental constraints relevant to each SCVA are included in the corresponding Information Notes (reference should be made to the section on Information Notes in paragraphs (43) and (44) below for further details). For example, air, noise, water, waste, ecological, heritage, visual and landscape impacts should be considered in the selection of potential portal locations where there may be adverse impacts on the environmental sensitive receivers during construction and/or operation of the cavern project. Project proponents should also endeavor to locate surface supporting infrastructures of the cavern projects, such as ventilation shafts and administration buildings, outside major conservation areas and Country Parks as far as practicable. If such encroachment cannot be avoided, project proponents should justify the need, seek approvals from the relevant authorities and incorporate suitable environmental mitigation measures in the cavern scheme.
- (40) Graded historic buildings and declared monuments located within or close to SCVAs, which may pose constraints on the application of caverns, are highlighted in the respective Information Notes. Project proponents must comply with the statutory requirements on heritage conservation where appropriate and consult the Antiquities and Monuments Office of the Development Bureau if necessary.
- (41) A Strategic Environmental Assessment (SEA) was carried out as part of the Strategic Cavern Study and provided environmental information on the CMP. The SEA Report of the Strategic Cavern Study strategically addresses the environmental aspects of the uses of rock caverns, including potential environmental impacts that may be induced by cavern development,

recommendations of environmental design and mitigation measures, for cavern development proposals to make reference. The SEA Report also contains a set of environmental guidelines on cavern development for individual project's reference when conducting EIA in future.

- (42) The detail of site and facility, specific environmental protection measures to be incorporated in the design and any other further environmental implications will be addressed in an EIA study or a project profile for obtaining permission to apply directly for an environmental permit under the EIAO. Project proponents will normally be required to set up and carry out an environmental monitoring and audit (EM&A) programme to ensure compliance with the conditions stipulated in the environmental permits, assess the effectiveness of the recommended mitigation measures and identify any further need for additional mitigation measures or remedial actions. Where appropriate, post-construction monitoring including ecological, landscape and groundwater monitoring may need to be implemented for cavern projects to allow comparison with baseline data before works commencement. The build-up of experience and monitoring data would help to establish a scientific basis to address potential knowledge gap regarding the long-term ecohydrological impact of cavern development. Furthermore, ecological compensation and enhancement programme could be implemented as part of the cavern projects where appropriate.

INFORMATION NOTES

- (43) Information Notes set out the characteristics of and development constraints on each SCVA. Brief descriptions are provided for the geographical and district context of the SCVA and its delineation rationale. It also summarises the geological, planning, environmental and traffic characteristics and other key issues/constraints on cavern development. The extent of potential portal locations is also outlined in the Information Notes.
- (44) Appended to the Information Notes is a reference drawing which provides the spatial context of each SCVA.

IMPLEMENTATION

- (45) SCVAs are valuable potential land resources. This alternative source of long-term land supply should be managed in a judicious manner. Synergy effect on housing a cavern in SCVAs including the optimal utilisation of cavern space and economies of scale should be pursued through better integration with other surface (e.g. site formation works) and subsurface (e.g. tunnels) developments within the SCVAs.
- (46) The CMP provides a strategic framework to guide and facilitate territory-wide cavern development in Hong Kong. The CMP should be referenced to alongside the Hong Kong Planning Standards and Guidelines in the course of planning and engineering studies and the application of caverns in the territory. Due consideration should also be given to relocating existing facilities and/or placing new facilities in rock caverns when opportunity arises in order to release surface sites for other beneficial uses, reduce surface land take and remove incompatible land uses.
- (47) The approach in using caverns for accommodating/relocating government facilities with due consideration of technical feasibility, cost-effectiveness and tangible/intangible benefits of the cavern option is set out in DEVB Technical Circular (Works) on Rock Cavern Development, which is applicable to all government projects. According to the circular, when cavern development is considered as an option, the project proponent should first check if there is a lack of suitable surface site and there are specific needs or strong merits to relocate existing government facilities or accommodate new suitable government facilities inside caverns. Preliminary option assessments comparing cavern and non-cavern options should be carried out. If the cavern option is recommended, the option assessments report should be submitted to the Sub-Committee on Cavern Development (SCCD) established under the Committee on Planning and Land Development of the Government for vetting.
- (48) The Sub-Committee on Cavern Development is also responsible for vetting proposals involving either government projects or land disposal/alienation proposals (including lease modification and land exchange) that wholly or partly fall within SCVAs, including surface, subsurface and cavern development proposals, and recommend suitable provisions for optimising the use of the SCVAs.

- (49) The Information Notes as described in paragraphs (43) and (44) above should be used to facilitate the early stage development of proposals for cavern development and provide a summary of information on the characteristics of SCVAs including reference drawings which show the development constraints on each SCVA.
- (50) The CMP is intended to provide systematic guidelines for the application of rock caverns and the SCVAs identified are not exhaustive to possible uses in rock caverns in Hong Kong. Detailed planning and engineering feasibility studies and assessments, such as environmental impact assessment and traffic impact assessment, should be conducted for application proposals in rock caverns on a case-by-case basis whether these are within or outside of SCVAs. It also does not exclude the possibility of private land owners from exploring cavern development potential within land under their ownership and land not delineated in the CMP.
- (51) Proponents for cavern development projects should follow the relevant statutory and administrative procedures/requirements at the implementation stage. Relevant statutory requirements, such as applications for approval of EIA report or for obtaining permission to apply directly for an environmental permit under the EIAO, planning applications or amendments to Outline Zoning Plans under the Town Planning Ordinance, consent from the Country and Marine Parks Authority and any specific land lease conditions will need to be fulfilled as required.
- (52) The CMP will be reviewed and updated as necessary taking account of changing cavern policy, circumstances and development needs.
- (53) The CMP, Explanatory Statement and the accompanying Information Notes are available on the website of the Civil Engineering and Development Department: (<http://www.cedd.gov.hk/eng/our-projects/topics-in-focus/index-id-27.html>)
The digital format of the SCVAs can be downloaded from website: (<http://www.ginfo.cedd.gov.hk/GEOOpenData/eng/Cavern.aspx>).

- (54) For public enquiry, please contact the Geotechnical Engineering Office of the Civil Engineering and Development Department or the Planning Department:

Geotechnical Projects Division
Geotechnical Engineering Office
Civil Engineering and Development Department
5/F, Civil Engineering and Development Building
101 Princess Margaret Road
Homantin, Kowloon
Hong Kong

Technical Services Section
Planning Department
17/F, North Point Government Offices
333 Java Road,
Hong Kong

EXAMPLES OF POTENTIAL USES IN ROCK CAVERNS

	Types of Uses
1.	Commercial Uses
	-Food and beverage -Food/Wine storage -Retail
2.	Industrial Uses
	-Concrete batching plant -Container storage -Data centre -Industry -LPG bulk storage -Oil bulk storage -Research/Testing laboratory -Storage/Warehousing
3.	Government/Institution/Community and Other Specified Uses
	-Animal waste management facility -Archives -Columbarium/Mausoleum/Mortuary -Explosives depot/magazine -Maintenance depot -Refuse transfer facility -Service reservoir -Sewage/Water treatment plant -Slaughterhouse -Transport connection & network -Underground quarrying -Vehicle parking -Vehicle (including bus) depot -Wholesale market
4.	Public Utilities
	-Power station -Public utility installation

Notes: Potential uses for each SCVA should be assessed on a case-by-case basis on their suitability and feasibility for housing in rock caverns in consultation with the relevant bureaux/departments having regard to, amongst others, safety, operational, environmental, technical and financial considerations. The list of potential uses of rock caverns is not exhaustive and should be used for general guidance only.