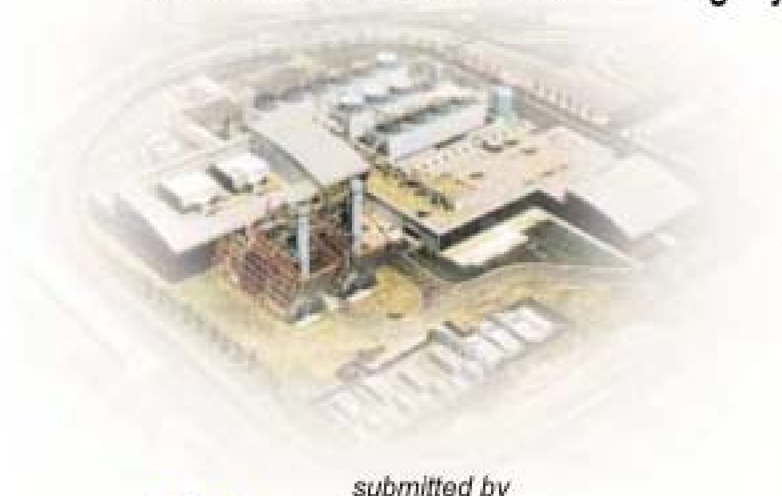
Agreement No. CE 26/2000

Territory-Wide Implementation Study
for Water-cooled Air Conditioning Systems in Hong Kong



Executive Summary

submitted by

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in association with

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and
City Planning Consultants Limited

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1. INTRODUCTION

1.1 Study Background.

- Energy Consumption on Air-Conditioning

  Over 30% of total electrical energy is estimated to be consumed by air-conditioning systems. The ever-increasing population and further economical development will continue to drive up the demand for air-conditioning. Water-cooled air-conditioning systems (WACS) are more energy efficient than their conventional air-cooled counterparts. Wider adoption of WACS, especially in commercial buildings, is an effective measure to conserve energy. This Study examines how this can be done.

- Preliminary Study

  A Preliminary Phase Consultancy Study (PPCS) on the Wider Use of WACS in Hong Kong, commissioned by the Electrical and Mechanical Services Department (EMSD), was completed in April 1999.

  The PPCS established the technical viability of the wider application of WACS and concluded that economic and environmental benefits can be gained by adopting WACS. It also identified the need for further studies to examine the requirements, and implementation plans for the phased development of WACS in Hong Kong.

- Implementation Study

  A consultancy assignment titled "Territory-wide Implementation Study for Water-cooled Air-conditioning Systems in Hong Kong" was commissioned in 2000 to examine in greater details the implementation issues on technical viability, financial viability, infrastructure works requirements, planning and lands impact, traffic impact, environmental and health impact, regulatory control and implementation plan associated with the wider adoption of WACS in non-domestic buildings throughout Hong Kong.

  Three types of WACS schemes were studied:

  - **Cooling Tower Scheme**
    Centralized Piped Supply System for Cooling Tower Systems (CPSSCT)

  - **Central Seawater Scheme**
    Centralized Piped Seawater Supplies System for Condenser Cooling (CPSSCC)

  - **District Cooling Scheme**
    District Cooling System (DCS).

1.2 Key Objectives

This Study on Territory-wide Implementation for WACS in Hong Kong aims to:

- Identify and prioritize areas for potential adoption of various WACS schemes
- Evaluate technical and financial viability
- Quantify infrastructure demands such as water supply, sewage and land requirements
- Assess impacts on the environment, health and traffic
- Advise on regulatory control and institutional framework
- Formulate WACS implementation plans.

This Executive Summary aims to summarize the salient features of the proposed schemes and the proposed implementation plans.

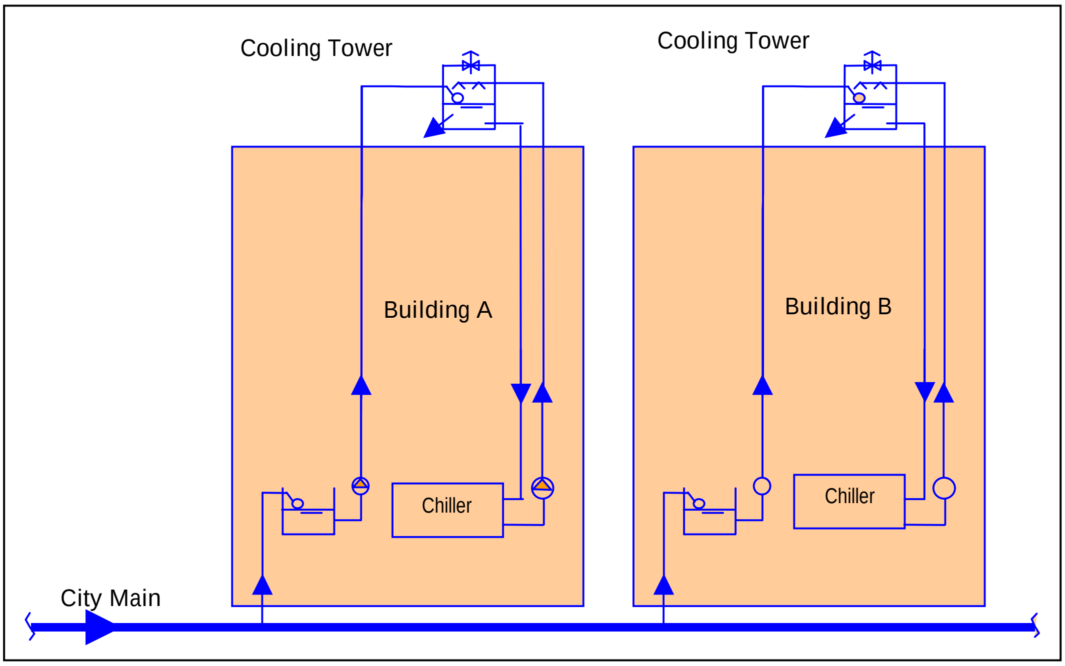
2. WACS SCHEMES FEATURES AND COMPARISONS

2.1 Generic Features

In general, air conditioning systems for buildings work on refrigeration principles, using a cooling medium to lower the temperature of the rooms in the buildings and rejecting waste heat outside, either directly to the atmosphere (air cooling), by evaporation through cooling towers, or by seawater discharge to the sea. The air is also dehumidified at the same time. These processes, together with the filtering of room air by air-filters in the air conditioning system, make the room comfortable to work and to live in.

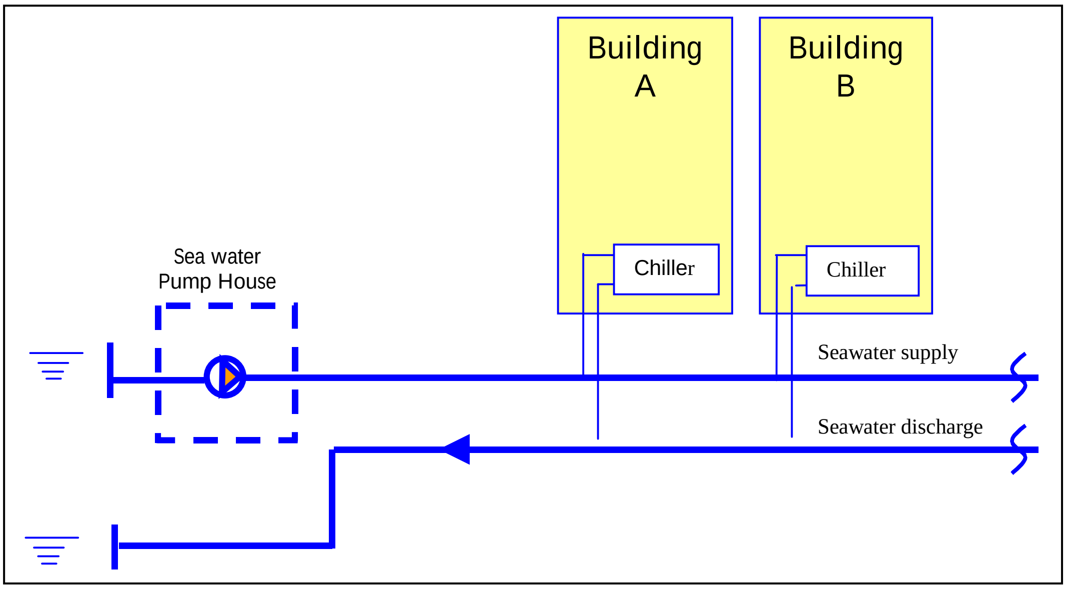
The generic features of the Cooling Tower Scheme, Central Seawater Scheme and District Cooling Scheme are outlined below for easy reference:

2.1.1 Cooling Tower Scheme



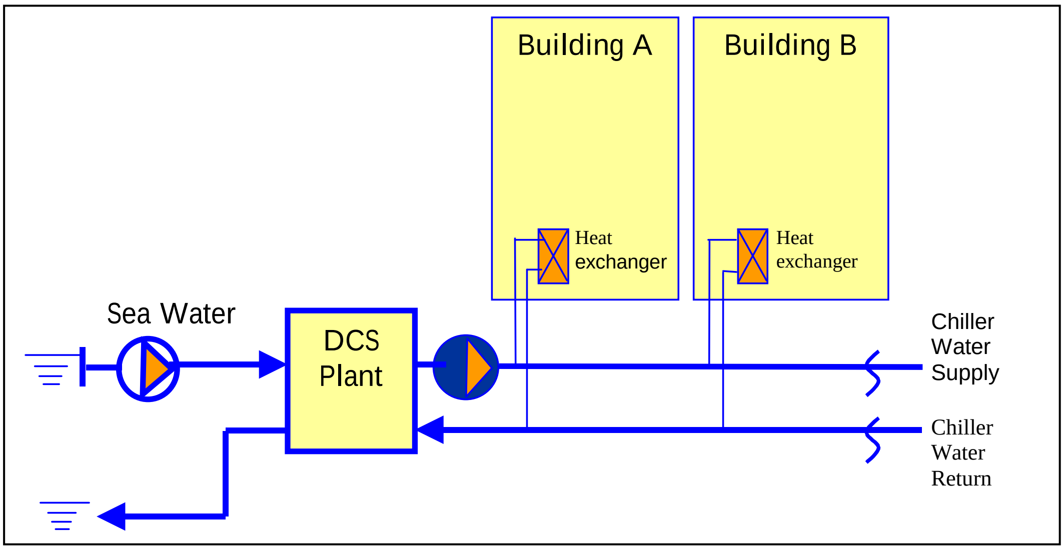
For a building adopting Cooling Tower Scheme, its air conditioning system uses an evaporative cooling tower for heat rejection. Water in the cooling tower will be lost due to the continuous evaporation, wind drift and bleed-off. The water lost will be replaced by water coming from city water mains. For this scheme, only city water main is used and no other infrastructure provisions are required.

2.1.2 Central Seawater Scheme



For a building served by Central Seawater Scheme, its air conditioning system uses seawater for cooling the chiller condenser. A dedicated central seawater supply system distributes seawater from the sea to the user building. The rejected warm seawater from the chiller condensers will be discharged to the sea through another dedicated outfall pipe. For this scheme, a central seawater pump house and a central distribution pipeline network are required.

2.1.3 District Cooling Scheme



For a building served by District Cooling Scheme, its air conditioning system uses chilled fresh water produced by a central chiller plant for air-conditioning. Individual user buildings purchase chilled water from the DCS operator and do not need to install their own chiller plants. For this scheme, a central chiller plant, a pump house and a central distribution pipeline network are required.

2.2 Comparisons of the three WACS Schemes

The Cooling Tower Scheme, Central Seawater Scheme and District Cooling Scheme are more energy efficient than the conventional air-cooled air-conditioning scheme. Based on the Energy Modelling Analysis (see Section 3.1 for details), the District Cooling Scheme is the most energy efficient among the three schemes.

For Cooling Tower Scheme, city main water is used and individual buildings have their own chillers and cooling towers for air-conditioning. They do not require central plant nor central distribution pipework, and therefore the capital investment is relatively low and the infrastructure impact is minimal. Technically, individual buildings may install this scheme immediately provided that there is adequate city main water in the relevant areas to cater for the additional water demand from the cooling towers.

Both the Central Seawater Scheme and District Cooling Scheme require a central pumping station and a central distribution piping network for service delivery. District Cooling Scheme further requires a central chiller plant. When compared with the Cooling Tower Scheme, their infrastructure requirements and capital investment are much higher and their implementation time will also be longer.

Apart from the benefits of saving energy, District Cooling Scheme can eliminate the need of chiller plant rooms in individual buildings. This scheme can also provide the following intangible benefits:

- Better city building design by allowing more flexible and innovative building design (no need for space and external louver provision for chillers or cooling towers)
- More efficient and effective utilization of building floor space
- More environmental friendly, as there are less noise and air pollution, global warming and ozone layer depletion

2.3 Competitiveness of Various WACS Schemes in a same district

Adopting more than one WACS schemes within a same district may or may not be practical. The analysis is presented below:

2.3.1 Mutual Exclusiveness Between District Cooling Scheme and Central Seawater Scheme

Since both the District Cooling Scheme and Central Seawater Scheme will require substantial capital investment and public road space for installing a centralized distribution pipeline network, it would not be practical to allow the two systems to co-exist in the same area from the points of view of cost-effectiveness and overall infrastructure efficiency.

With respect to energy efficiency, District Cooling Scheme is superior to Central Seawater Scheme because the central chiller system of the District Cooling Scheme is more energy efficient than the decentralized chiller systems of Central Seawater Scheme. With respect to overall floor space utilization, District Cooling Scheme is preferable since the plantroom floor area occupied by the central chiller plantroom is much smaller than the total plantroom floor area occupied by all decentralized chiller plants in individual buildings under the Central Seawater Scheme. The overall project life cycle cost, (including capital cost, recurrent operation, maintenance and energy cost), of District Cooling Scheme is also lower than that of Central Seawater Scheme because the overall cost of a central chiller plant is much less than the aggregate cost of all individual buildings' chiller plants.

Given the District Cooling Scheme outperforms the Central Seawater Scheme in most aspects, the later should only be considered under special circumstances. For example, potential users consider that full control of their chiller plant systems is essential. Central Seawater Scheme may be preferred in case of reprovision of sea water to existing buildings which are already using seawater cooling plants and are affected by reclamation.

2.3.2 Co-existence of District Cooling Scheme and Cooling Tower Scheme

District Cooling Scheme and Cooling Tower Scheme could however co-exist in the same district zone to allow choices of building owners and operators to encourage healthy competition. The developers/owners should be allowed to choose their air conditioning schemes to suit the characteristics and constraints of their own buildings.

Buildings with centralized air-conditioning systems and with adequate city main water supply and floor space for operating the cooling towers may select the Cooling Tower Scheme instead of the District Cooling Scheme if the building developers/owners wish to have full control of their air conditioning systems to suit their particular cooling needs even when the Cooling Tower Scheme is not as energy efficient and cost effective as the District Cooling Scheme.

On the other hand, large building complex with very high cooling demand would be more concerned about the operating cost of air-conditioning systems and may find District Cooling Scheme more attractive.

2.4 Recommended WACS Schemes

Based the above comparisons on the three WACS schemes, Government is recommended to focus on implementation of the two WACS schemes: the Cooling Tower Scheme and the District Cooling Scheme. The subsequent parts of this Executive Summary will concentrate on these two Schemes. But it should be noted that Central Seawater Scheme may be preferable to District Cooling Scheme under special circumstances.

3. METHODOLOGIES FOR TECHNICAL, FINANCIAL AND ENVIRONMENTAL EVALUATION

3.1 Energy Model and Energy Assessment

Energy Models are developed for evaluating energy performance of different schemes of WACS for non-domestic buildings.

By inputting the cooling consumption data of a building into the energy model such as the building floor area and other design characteristics, operation schedule and occupancy schedule, the cooling load of the building can be computed.

By inputting the characteristics of air-conditioning scheme into the energy model such as the configuration of air-conditioning scheme, its design parameters and operation schedule, the energy consumption of the air-conditioning scheme can be estimated.

For Cooling Tower Scheme, water consumption and bleed-off wastewater amount can also be computed by the energy model.

Energy evaluation by energy model shows that the District Cooling Scheme, Central Seawater Scheme and Cooling Tower Scheme are more energy efficient than the conventional air-cooled air-conditioning scheme by 30% to 35%, 22% to 28% and 14% to 20% respectively depending on the building type, air-conditioning plant configurations and the piping layout for the particular district zone.

3.2 Cost Model and Financial Assessment

Cost Models are developed for assessing project life cycle cost and evaluating the financial viability of different WACS schemes in different zones (See section 4.1).

Project life cycle cost of different air-conditioning schemes for a zone can be computed by feeding into the cost model the cooling load demand of all relevant buildings in the zone, air-conditioning scheme configuration, piping layout, plant site land cost and pipeline wayleave charges, etc.

Financial viability assessment is carried out to compare the project life cycle costs of different air-conditioning schemes based on a life cycle of 20 years.

For Cooling Tower Scheme, its capital cost is comparable or slightly higher than the conventional air-cooled scheme. However, Cooling Tower Scheme can provide substantial savings in the recurrent electricity cost. The pay back period for the capital investment is generally within a few years. Therefore in terms of life cycle cost, the Cooling Tower Scheme is much more competitive than the air-cooled scheme.

For District Cooling Scheme and Central Seawater Scheme, although they are more energy efficient than Cooling Tower Scheme and Air-cooled Scheme, both of them demand substantial capital investments, particularly due to the need to install expensive distribution pipelines, resulting in a long pay-back period. Subject to land availability, District Cooling Scheme and Central Seawater Scheme are generally financially viable in those areas with high consumer cooling demand and cooling load density. These areas are most likely commercial centers and/or new developments with high density of non-domestic buildings. However, the pipeline wayleave charges for distribution pipelines of District Cooling Scheme and Central Seawater Scheme is a critical factor affecting their financial viability given alternatives such as the Cooling Tower Scheme.

3.3 Marine Water Quality Model and Water Quality Assessment

A Marine Water Quality Model is developed for assessing the impact of seawater discharge from the Central Seawater Scheme or District Cooling Scheme using seawater as heat rejection medium.

Upon specifying the seawater intake location, intake flow, discharge location, discharge flow and residual chlorine content of the seawater discharge etc., the Marine Water Quality Model computes seawater temperature and chlorine content, which are used as indicators of environmental impact on marine water quality.

In general, seawater discharge to Victoria Harbour is environmentally acceptable and seawater discharge to the marine water sensitive zone of Deep Bay and Tolo Harbour should be avoided.

3.4 Territory-wide Non-domestic Cooling Load Distribution

The potentials of non-domestic developments in the territory in connection with the implementation of WACS have been identified and reviewed. The data sets and inventory maps for four scenarios namely the present, year 2010, year 2020 and the ultimate development potentials have been gathered, developed and established. Such data sets and maps provide an overview of territory-wide non-domestic building Gross Floor Area (GFA) distribution.

Based upon the non-domestic GFA distribution, the territory-wide distribution of non-domestic cooling load demand can be computed by making use of the energy model as described in Section 3.1.

As mentioned earlier, district zones with high density of cooling demand would be the likely potential zones for application of the District Cooling Scheme.

4. POTENTIAL ZONES INDENTIFICATION FOR WACS IMPLEMENTATION

4.1 Territory-wide Zonings for Zone-by-Zone Evaluation

In order to carry out zone-by-zone evaluation for identifying and prioritizing potential zones for the implementation of Cooling Tower Scheme and District Cooling Scheme, the territory has been divided into a number of district zones. Based on the non-domestic building gross floor area distribution, cooling load demand/density distribution, and development planning of the territory from now to the year 2020, 49 zones with high non-domestic cooling load density and cooling demand are identified. The rest of the territory with low non-domestic cooling density is grouped under one “catch-all” zone, making a total of 50 zones. Zones with high non-domestic cooling load density and cooling demand will generally be more cost effective for WACS implementation.

A zone-by-zone evaluation has been carried out to evaluate the potentials of individual zones for implementing Cooling Tower Scheme and District Cooling Scheme implementation. Details on the potential zones identification for Cooling Tower Scheme and District Cooling Scheme implementation are presented in Section 4.2 and 4.3.

4.2. Potential Zones Identification for Cooling Tower Scheme

4.2.1 Zoning Identification

Availability of fresh water supply for cooling tower is the key criterion for Cooling Tower Scheme implementation.

The sequence of the zoning identification is :

a. Analyze zone-by-zone cooling load demands and densities

b. Evaluate zone-by-zone fresh water demands

c. Assess zone-by-zone impact on city water main supply adequacy

d. Prioritize zones for implementation by selecting those with higher cooling demands and densities, that is, those that will attain higher energy and cost savings and effectiveness

4.2.2 Zoning Evaluation Results

In consultation with the Water Supplies Department, detailed evaluation of the adequacy of water supply for each of the 50 zones has been carried out. The results of the evaluation are as follows:

In 28 out of 50 zones, the existing/proposed water supply system should be adequate to meet the estimated make up water demand by making use of the water supply capacity for planned developments yet to be realized. It is recommended to open up city main fresh water as soon as possible in these 28 zones for cooling tower make-up water.

In 18 out of 50 zones, the proposed water supply system by the year 2005 / 2008 should be adequate to meet the estimated make up water demand. It is recommended to open up city main fresh water in these 18 zones for cooling tower make-up water by year 2005/2008.

In 4 out of 50 zones, the water supply system may not be able to meet the estimated make up water demand and therefore full-scale implementation of Cooling Tower Scheme is not recommended for these 4 zones for the current planning phase.

List of cooling tower district zones and water supply adequacy evaluation are shown in the appendix 10.3.

4.3 Potential Zones Identification for District Cooling Scheme

4.3.1 Zoning Identification

High cooling load demand and density are the major selection criteria for District Cooling potential zones identification and implementation.

The sequence of the zoning identification is :

a. Identify district zones with high non-domestic cooling load demands and densities

b. Analyze district zones against cooling load demand and development programme

c. Evaluate performance using energy models and cost models on energy and investment performance assessments

d. Prioritize zones for implementation based on financial effectiveness and capital investment pay back periods

4.3.2 Zoning Evaluation Result

Based on the financial assessment as mentioned in the section 3.2, a total of 20 zones with relatively high customer cooling load demands and densities are identified as the initial list of potential zones for detailed evaluation to ascertain the financial and technical viability for District Cooling Scheme implementation.

District Cooling Scheme is unlikely to be financially viable in the remaining zones because of lower customer cooling load demands and densities.

The result of evaluation on the above 20 zones are as follows:

a. In 5 zones, the results show that the District Cooling Scheme are financially more competitive than the Cooling Tower Scheme even at full charge for pipeline wayleave fee;

b. In 10 other zones, District Cooling System can be made financially more competitive than Cooling Tower Scheme provided that pipeline wayleave charges can be waived;

c. The remaining 5 zones do not show a financial advantage over the Cooling Tower Scheme even if pipeline wayleave charge could be waived.

That is, in totally 15 zones, District Cooling Scheme is found financially more competitive than Cooling Tower Scheme if pipeline wayleave charges can be waived.

5. KEY ISSUES FOR COOLING TOWER SCHEME IMPLEMENTATION

5.1 Fresh Water and Seawater Cooling Tower Comparison

Cooling towers may use fresh water and seawater. Both options are evaluated. Moist air or mists emitted from seawater cooling towers are more corrosive. Due to the large amount of dissolved solids in seawater, the amount of bleed-off wastewater from seawater cooling tower will also be higher, therefore imposing greater impact to the sewerage system.

Moreover, comparing with the city main fresh water supply, the city main seawater system for flushing water is under greater capacity constraint.

In view of the above, use of fresh water in cooling towers is recommended to meet the additional water demand for wider adoption of cooling towers.

5.2 Adequacy of City Main Water Supply

Water demand for cooling towers in each zone has been computed, based on which, the Water Supplies Department has evaluated the adequacy of their fresh water supply facilities to meet the projected additional water demand for more cooling towers. The facilities evaluated include services reservoirs, water treatment plants and distribution networks. Result of the evaluation is presented in Section 4.2 and appendix 10.3. In short, the capacity of city main water supply is not a constraint for wide-use of Cooling Tower Schemes in most of the 50 zones.

5.3 Additional Load to the Sewerage System

It is proposed that the wastewater from cooling towers should be reused for toilet flushing. In general, a typical building requires more water for toilet flushing than the amount of wastewater produced by cooling towers. Therefore there is no additional water discharge to the drainage system. In exceptional cases, a retention tank should be built so that the surplus wastewater can be temporarily stored in the tank and only discharged to sewers during off-peak hours. Therefore wider adoption of cooling towers is unlikely to increase the burden on the sewerage system.

5.4 Financial Viability Evaluation

Financial viability assessments of the identified potential zones for Cooling Tower Scheme have been carried out. The results indicate that Cooling Tower Scheme is very competitive as compared with the air-cooled air-conditioning scheme and the investment pay-back periods are a few years only in general, depending on the characteristics of individual buildings. Large commercial buildings with high cooling demand and long operation hours such as hotels and shopping complexes and buildings that are already using other kinds of less energy efficient water-cooled air-conditioning systems would have the shortest pay-back periods and are more likely to use cooling towers.

5.5 Strategic Environmental Assessment

5.5.1 Environmental Benefits

The Cooling Tower Scheme is more energy efficient than the conventional air-cooled air-conditioning scheme. The savings in electricity will reduce the demand for power and hence the carbon dioxide emissions from the power generation process.

Assuming a 50% penetration rate of Cooling Tower Scheme in non-domestic buildings in the whole territory by the year 2020, the annual energy savings over the conventional air-cooled air-conditioning scheme for non-domestic buildings is estimated to be 1,170,000,000 kWh, which is about 3.1% of total electricity consumption of Hong Kong in 2002. In monetary term, annual electricity bill is saved by HK$1.05 billion, assuming an electricity tariff of HK$0.9/kWh.

Considering carbon dioxide emission per kWh electricity generation from the two power companies (CLP Power and Hong Kong Electric), the annual reduction in carbon dioxide emission by the year 2020 is estimated to be 830,000 tonne, equivalent to about 2.34% of total carbon dioxide emission of Hong Kong in 2002.

5.5.2 Environmental Impacts and Mitigation Measures

Residual chemical in the wastewater discharged from cooling towers may have impact on the effectiveness of the standard sewerage treatment process. Proper treatment such as ultra-violet (UV) irradiation, or disinfection by dosing of ozone, peroxide or chlorinated compounds (with discharge chlorine concentration of not exceeding 0.3ppm) should be given before the wastewater is discharged into the sewerage system so as to minimize impact on the sewerage treatment works.

5.6 Public Health Issues

A poorly maintained fresh water cooling tower may become a breeding ground for Legionnaire bacteria. To ensure public health, Government should publish a set of guidelines for the owners and operators on how to operate and maintain fresh water cooling towers. Apart from the control measures in the Guidance Notes and Procedures for "Pilot Scheme for Wider Use of Fresh Water in Evaporative Cooling Towers for Energy-efficient Air-conditioning Systems" (Cooling Tower Pilot Scheme) and Code of Practice for Prevention of Legionnaires' Disease, owners or operators of cooling towers should regularly carry out microbiological and water quality testing including Legionella and Total Bacteria Count.

Moreover, Government should carry out surveillance and inspection on installation, operation and maintenance activities on cooling towers including independent testing of water samples to ensure compliance with the guidelines. Breaching of the guidelines may result in revocation of permission for using city main water for cooling towers.

5.7 Regulatory Control

5.7.1 Regulatory Control Frameworks

Under the existing legislative and administrative frameworks, one cannot use city main water for cooling towers without the permission of the Water Supplies Department. The established Government's policy is not to grant such permission unless under special conditions such as the buildings are for essential uses or industrial uses. Exceptional permission may be granted to commercial buildings within the areas under the current Cooling Tower Pilot Scheme.

Since the fresh water supply capacity is not a constraint in most of the 50 zones, for the benefits of energy efficiency and conservation, it is recommended that the Government should approve the use of city main fresh water for cooling towers unless there is overriding reason suggesting otherwise, for example, inadequate water supply in the four zones mentioned in Section 4.2.

5.7.2 Control Measures

The permission to use fresh water for cooling purpose should be granted on conditions that full compliance with the mitigating/preventive/control measures in sections 5.3, 5.5.2 and 5.6 above. The cooling tower owners/operators should also allow authorized government officers to enter into their premises to inspect the relevant cooling towers to ensure the compliance. Failure to comply with any of the conditions may result in revocation of the permission.

The owner/operator of cooling towers should engage appropriate experts, specialists and professionals to ensure their cooling towers are operated efficiently and safely. The specialist services companies and professionals providing services such as bacteriological testing, water treatment, cleansing and disinfection of fresh water cooling towers should be properly trained with suitable qualification to ensure that they are capable of maintaining the system efficiency and detecting/eradicating the risks associated with improper operation and maintenance of cooling towers.

5.7.3 Education and Training

To facilitate wider adoption of Cooling Tower Scheme in the territory, Government is recommended to take a more active role in raising the awareness on environmental and health issues of owners/operators and installation, operation and maintenance personnel of cooling towers. Tertiary institutions, engineering professional institutions, and building management organizations may be encouraged to hold seminars, training courses etc. to provide more training opportunity to better equip them with the relevant knowledge.

6. COOLING TOWER SCHEME IMPLEMENTATION PLAN

6.1 Recommended Action Plan

Government is recommended to incorporate the following actions for wider scale implementation of the Cooling Tower Scheme as soon as practicable:

a. Confirm new district zones in the territory for opening up city main fresh water for cooling tower air-conditioning applications according to the evaluation of the water supply adequacy as stated in Section 4.2.2.

b. Specify conditions for granting permission for fresh water cooling towers. The conditions should cover the control measures as stated in Section 5.7.2.

c. Evaluate and approve applications for using city main fresh water for cooling towers

d. Carry out site surveillance and inspection on installation, operation and maintenance activities of cooling towers to ensure their compliance with the conditions for granting permission to use city main water for cooling towers

e. Seek funding for wider-adoption of cooling tower scheme

f. Review control measures against their effectiveness in enforcing cooling tower operators to comply with the conditions of granting permission of using city main fresh water for cooling towers.

For effectively carrying out the above actions for wide-scale cooling tower scheme implementation, Government is recommended to set up a working group (Regulator Office) similar to the existing working group for the Cooling Tower Pilot Scheme.

6.2 Cooling Tower District Zones

Potential zones for Cooling Tower Scheme have already been identified in Section 4.2.3. It is recommended that Government would open up city main fresh water for cooling tower air-conditioning applications for non-domestic buildings in all areas of the territory except the 4 zones which does not have adequate fresh water supply to meet the demand of additional cooling towers. These 4 zones are located in Sha Tin, Tsuen Wan, San Po Kong and Fo Tan.

A Master Key Zoning Plan of Cooling Tower Scheme is shown in Appendix 10.1.

A List of Cooling Tower District Zones and Water Supply Adequacy Evaluations are shown in Appendix 10.3.

7. KEY ISSUES FOR DISTRICT COOLING IMPLEMENTATION

7.1 Financial Viability Evaluation

In Section 4.3, we have identified an initial list of 20 potential zones for implementing District Cooling Scheme. Financial viability evaluation is carried out for each zone by comparing 20-year project life cycle cost of District Cooling Scheme and Cooling Tower Scheme. District Cooling Scheme is considered more financial competitive in a zone if project life cost of District Cooling Scheme is lower.

The evaluation is based on an assumption of a cost of capital of 9% for implementing District Cooling Scheme by the private sector.

If wayleave charge for the distribution pipework are not payable, District Cooling Scheme was found to be more competitive than Cooling Tower Scheme in 15 zones. The payback period of the capital investment in such cases would be within 20 years.

If pipeline wayleave charges are payable, District Cooling Scheme is more competitive in only 5 zones. Please see Appendix 10.4 Table 10.4.1. for detail description of the 5 zones.

It follows that the pipeline wayleave charge is the most critical cost component affecting the financial viability of District Cooling Scheme. Waiving the wayleave charge can therefore facilitate the implementation of District Cooling Scheme in more zones. Please see Appendix 10.4 Table 10.4.2 for detail description of the additional 10 zones.

7.2 Infrastructure Requirements

District Cooling Scheme requires a central plant and a central pipeline network for its services delivery. The central plant will mainly consist of central chiller plant and central heat rejection plant.

We have identified possible locations for building central chiller plants and heat rejection plants in each of the 15 zones where District Cooling Scheme can be more competitive than Cooling Tower Scheme. These locations are public open space and/or other Government unleased land. Underground plants are recommended so that the land use above can be maintained. Seawater is recommended for heat rejection because the proposed chiller plants are close to seafront.

Based on the planning information at the time of the Study, we have proposed a preliminary pipeline routing map for each of the 15 zones which demonstrates how the distribution pipeline network and dedicated seawater supply and discharge pipes for heat rejection can be laid under public carriageways without affecting private land and private developments.

7.3 Planning and Lands

7.3.1 Land Site Selection for Central Plant

In consideration of the environmental benefits of District Cooling Scheme in terms of energy saving and reduction of carbon dioxide emissions, Government is advised to give higher priority in land allocation and land administration to provide space of district cooling plants.

Incorporation of the site requirements for district cooling facilities in the overall planning and programming process for the Strategic New Development areas in an early stage is essential to ensure smooth implementation of District Cooling Scheme.

7.3.2 Join User Development

Incorporation of district cooling plant as joint user development is generally feasible. It is recommended that district cooling plant can be built underneath land zoned for open space to better utilize land resources. This is also in line with the current practice of allowing seawater pumping stations to be built underneath public open space along the waterfront for supplying seawater for air conditioning purposes.

7.3.3 Land Disposal

7.3.3.1 Land for Central Plant

The Government is recommended to establish a standing practice to allow district cooling operators to operate on unleased Government land to facilitate the implementation of District Cooling Scheme. Otherwise, the district cooling operators would have to undergo the time-consuming land auction process. This can be done by allocating the relevant land to a government department, which then grants a license to an operator through open tendering. The market value of the right to use the land would be reflected by the bids submitted by the tenderers.

7.3.3.2 Land for Central Distribution Pipelines

The Study identified that the value of pipeline wayleave fee can greatly affect the financial viability of district cooling scheme implementation. To promote wider adoption of District Cooling Scheme for the energy and environmental benefit to the society, the Government is recommended to waive wayleave charge or levy a nominal fee for district cooling pipelines.

Alternatively, amending the Land (Miscellaneous Provisions) Regulations so that district cooling distribution pipelines within the definition of “Utility” could enable a licence to be granted for the right of laying district cooling scheme distribution pipelines in unleased Government land at nominal fee.

7.3.4 Obsolete Floor Space in Building

When an existing building is connected to District Cooling Scheme, it no longer needs to install its own chiller plants. The Government should consider allowing user buildings to convert the original chiller plant room spaces for other beneficial or commercial uses so that they have more incentives to use the service of District Cooling Scheme.

7.4 Strategic Environmental Assessment

7.4.1 Noise

The central chiller plant and pumps of the district cooling scheme are proposed to be accommodated in underground plantrooms, the noise impact would be greatly reduced and adverse impact to the surrounding environment is not anticipated.

Since buildings connecting to District Cooling Scheme will not be required to install their own chiller plants, the district cooling user buildings will be completely free from noise impact from chiller plants.

With proper noise mitigation measures, the noise impact during construction stage of district cooling scheme can be controlled to an acceptable range.

7.4.2 Air Quality

The proposed district cooling schemes are to use seawater as heat rejection medium. Adverse impact to air quality is not expected. Since district cooling can save electricity energy and hence reduce carbon dioxide emission, the adoption of district cooling will improve air quality.

7.4.3 Water Quality

Environmental impact on District Cooling Scheme using seawater as medium for heat rejection has been carried out. Suppressing the growth of marine organism in seawater pipework by appropriate seawater treatment is necessary. Seawater treatment could be by electro-chlorination which has long years of experience in Hong Kong and has been proven to be effective for seawater treatment. The electro-chlorination water treatment method is to make use of seawater directly extracted from sea for on-site generation of chlorine solution by electrolysis for seawater treatment by chlorination. This can eliminate storage of large amount of chlorine for water treatment. After the seawater treatment process, despite the fact that most of the chlorine content will be used up or oxidized, there are residual chlorine content in seawater discharge. The residual chlorine content of the seawater discharge should be properly controlled to meet the water quality standards.

A hydrodynamic model has been set up to assess the impact of water temperature and residual chlorine content of the discharges from seawater heat rejection system of the District Cooling scheme and confirmed that seawater discharge from the district cooling systems in all the 15 District Cooling Zones would be able to comply with the water quality standards.

The Victoria Harbour Water Control Zone was found to be the best region to place the intakes and discharges as the impact on marine life would be the smallest. Discharges to sensitive marine areas such as Deep Bay, Tolo Harbour and other fish culture zones should be avoided.

7.4.4 Additional Environmental Benefits Over Cooling Tower Scheme

Assuming a 35% penetration rate in existing developed areas and 90% penetration in new areas, by implementing District Cooling Scheme in the above mentioned 15 district cooling zones, the overall environmental benefits projected to the year of 2020 are estimated to be as follows:

a. Energy Reduction
The estimated annual total non-domestic air-conditioning energy consumption reduction will be in the order of 190,000,000 kWh, that is, about 0.5% of total electricity consumption of Hong Kong in year of 2002. The annual monetary saving will be HK$171 million based on electricity tariff of HK$0.9/kWh.

b. Carbon Dioxide Reduction
The corresponding estimated total carbon dioxide emission reduction from the power plants in Hong Kong will be in the order of 116,000 tonne, that is, about 0.33% of total carbon dioxide emission of Hong Kong in year of 2002.

7.5 Traffic Impact Review

Traffic Impact Review on the preliminary pipeline routing map of each of the 15 zones have been conducted.

The Review shows that in general, laying District Cooling pipelines can be made viable by implementing one of the following mitigation measures:

- For locations where pipe laying during daytime is not feasible, pipeline could be laid during night and off-peak periods

- For locations where any interruption to traffic cannot be tolerated, pipe laying could be carried out by employing trenchless technologies.

However, as some of the proposed pipeline laying works will be carried out in busy roads, detailed Traffic Impact Assessments are necessary at the detailed design stages.

7.6 Regulatory Control

7.6.1 Regulatory Control and Institutional Framework aims to facilitate wider adoption of District Cooling Scheme in a systematic manner to the best interest of the community.

7.6.2 Major Barriers to Wider Adoption of District Cooling

District Cooling is new to Hong Kong. The major barriers to wider adoption of District Cooling Scheme in Hong Kong are:

- Risks and Uncertainties faced by District Cooling Customers

  - Lack of bargaining power in negotiating with the District Cooling Services Provider once a building is connected to District Cooling Scheme
  - Lack of confidence in the reliability and quality of District Cooling Services
  - Uncertainties over future tariffs.

- Risks and Uncertainties faced by District Cooling Investors

  - Uncertainties in District Cooling Services demand
  - Uncertainties in negotiation with building owners on District Cooling Supply Agreement (Negotiations could be time consuming)
  - Uncertainties over the land related costs for District Cooling plantroom and distribution pipelines
  - High initial capital investments and long payback periods.

7.6.3 Issues to be covered by Regulatory & Institutional Framework

Taking into account of the potential energy and environmental benefits of district cooling to the community as well as the above-mentioned barriers to wider adoption of district cooling in Hong Kong, the regulatory and institutional frameworks for district cooling scheme implementation are recommended to cover the following aspects:

- District Cooling tariff related issues, including the mechanism for District Cooling Service Tariff adjustment
- District Cooling service quality, efficiency and reliability in terms of the chilled water temperature, supply pressure and standby capacity provision
- Provision of land or land use rights for district cooling plants and pipework.

7.6.4 Regulatory Control & Institutional Framework Approach

The Government can opt for either a Contract Approach or a Legislative Approach for regulatory control.

When compared with the Contract Approach, the Legislative Approach provides a more powerful enforcement framework for regulatory control. For example, legislation may authorize the Government to resume private land for district cooling plant site and/or pipe route, and where necessary impose mandatory subscription to district cooling services. However, enacting new legislation for District Cooling Scheme will be time consuming.

The plant sites and pipelines of the District Cooling Schemes in all the 15 zones are located in public open space or Government unleased land without occupying private land. As resumption of private land is not required for the implementation of district cooling scheme in these zones, the District Cooling Schemes could be implemented without enacting new legislation.

For the Contract Approach, it is recommended that the "Build-Operate-Transfer" (BOT) or similar type of contract should be adopted. Having been awarded a BOT contract, the private operators will undertake the design, building, finding and operation of District Cooling facilities and transfer the titles of the facilities to Government at expiry of the contract period and, depending on the BOT terms, may recover the residual values of the District Cooling facilities. This procurement model will encourage private sector participation in District Cooling services delivery and provide high flexibility to the private sector in the aspects of design, building, operation and capital investment.

8. DISTRICT COOLING SCHEME IMPLEMENTATION PLAN

District Cooling is new to Hong Kong. It is recommended that Government should carefully select district zones for pilot implementation prior to wider scale implementation. The pilot implementation enables the Government and prospective services providers to accumulate experience. The implementation plan and regulatory framework can then be reviewed and adjusted as appropriate before a wider application of District Cooling Scheme.

8.1 Recommended Action Plan

For implementation of District Cooling Scheme, the Government is recommended to carry out the following actions:

a. Reserve selected land areas in the 15 zones for District Cooling plantroom sites

b. Obtain relevant Government policy approvals regarding
   - Land for Plantroom
   - Pipeline Wayleave Fee

c. Formulate and confirm District Cooling Zones

d. Stipulate conditions for granting land rights for district cooling plant site and pipeline laying

e. Select district cooling services provider for granting land rights for district cooling plant site and pipeline laying

f. Monitor and Control
   - District Cooling services quality
   - District Cooling services tariff

Similar to our recommendation for Cooling Tower Scheme implementation, Government is recommended to set up a working group (Regulator Office) for effectively carrying out the above actions for district cooling scheme implementation. Composition of this working group could be similar to that of the current working group for this Study.

8.2 District Zones for District Cooling Scheme

The 15 district cooling zones in which District Cooling Scheme can be more competitive than Cooling Tower Scheme are summarized below. For more details, please refer to the Appendix 10.4

8.2.1 5 Potential District Cooling Zones based on full pipeline wayleave charges

WACS Zone ID No.	District Cooling Zones Description	Development Status
C3	Located in Chek Lap Kok Airport North-east Corner New Commercial District: Follow planning boundaries of the new area	New Development Area
B8	Located in Tseung Kwan O Area 137 New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area
A3	Located in Central District (Central) Zone Boundaries: (North-bound: Connaught Road; South-bound: Lower Albert Road; West-bound: Pedder Street & Wyndham Street; East-bound: Cotton Tree Drive)	Existing Developed Area
A2	Located in Central District (West) Zone Boundaries: (North-bound: Connaught Road; South-bound: Queen's Road Central; West-bound: Rumsey Street; East-bound: Pedder Street	Existing Developed Area
A4-5	Located in Wan Chai Zone Boundaries: (North-bound: Gloucester Road; South-bound: Hennessy Road; West-bound: Arsenal Street; East-bound: Canal Road	Existing Developed Area

8.2.2 Additional 10 Potential District Cooling Zones based on waive of pipeline wayleave charges

WACS Zone ID No.	District Cooling Zones Description	Development Status
B6	Located in Penny Bay New Reclamation Area for Theme Park Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area
B5	Located in North Lantau Foreshore New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area
C6	Located in Tesung Kwan O New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area
B1	Located in Central & Wan Chai New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area
A6-7	Located in Causeway Bay Zone Boundaries: (North-bound: Gloucester Road; South-bound: Leighton Road; West-bound: Canal Road; East: Gloucester Road	Existing Development Area
A11-A13	Located in Tsim Sha Tsui Zone Boundaries: (North-bound: Granville Road & Cheong Wan Road; South-bound: Salisbury Road; West-bound: Canton Road & Nathan Road; East-bound: Science Museum Road	Existing Developed Area

WACS Zone ID No.	District Cooling Zones Description	Development Status
B3	Located in West Kowloon New Reclamation Area (Proposed Art & Performance Venue) Zone Boundaries: Follow planning boundaries of the new area	New Development Area
C2	Located in Tuen Mun Area 38 New Reclamation Area Zone Boundaries: Follow planning boundaries of the new area	New Development Area
B2	Located in South East Kowloon New Redevelopment Area (Former Kai Tai Airport) Zone Boundaries: Follow planning boundaries of the new redevelopment area	New Redevelopment Area
B7	Located in Tung Chung New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 WACS Schemes Evaluation and Comparison

The three WACS Schemes (Cooling Tower Scheme, Central Seawater Scheme and District Cooling Scheme) are evaluated and compared.

As both the Central Seawater Scheme and District Cooling Scheme will require substantial capital investment and public road space for installing a centralized distribution pipeline network, it would not be practical to allow the two systems to co-exist in the same area from the points of view of cost-effectiveness and road space utilization efficiency. Since the District Cooling Scheme is superior to the Central Seawater Scheme with respect to energy efficiency, building floor space utilization, and project life cycle cost, the Central Seawater Scheme should only be considered under special circumstances.

District Cooling Scheme and Cooling Tower Scheme could however co-exist in the same district to provide building owners and operators with more choices so as to encourage healthy competition.

9.2 Recommended WACS Schemes

Given the above evaluations and comparisons on the three WACS Schemes, Government is recommended to focus on implementation of the two WACS schemes : the Cooling Tower Scheme and the District Cooling Scheme.

9.3 Major Findings and Recommendations Relating to Cooling Tower Scheme

It is recommended that –

a. fresh water, instead of seawater, should be used for cooling towers because of high corrosive effect of mist from seawater cooling towers and higher capacity constraints of city main seawater supply to cater for make-up water demand of cooling towers (section 5.1);

b. application for using fresh water by cooling towers in zones with adequate water supply should be opened as soon as possible to capitalize the energy saving potential of cooling towers(section 4.2)

c. applications should be required to comply with the following conditions:

   (i) Engage appropriate professionals to conduct regular water sample testing, apart from the current Code of Practice for Prevention of Legionnaires' Disease and Guidance Notes and Procedures for Cooling Tower Pilot Scheme (section 5.6);
   (ii) Recycle of cooling tower wastewater for toilet flushing (section 5.3)

(iii) Implement mitigation measures to avoid net additional sewerage loadings due to cooling tower wastewater . For example, install a holding tank for cooling tower wastewater discharge during non-peak hours (section 5.3)

(iv) Adopt environmental friendly cooling tower water treatment methodologies such as ultra-violet irradiation, or disinfection by dosing of ozone, peroxide or chlorinated compounds (with discharge chlorine concentration of less than 0.3ppm) (section 5.5.2)

d. Relevant Government departments should carry out site surveillance and inspection to ensure that cooling tower operators comply with the conditions of granting permission of using city main fresh water for cooling towers (section 6.1)

9.4 Major Findings and Recommendations Relating to District Cooling Scheme

It is recommended that –

(a) The Government should establish a standing practice to allow district cooling operators to operate on unleased Government land to facilitate district cooling implementation. Land for the plantrooms can be allocated to a government department, which then grants the land right to an operator through open tendering (section 7.3.3.1)

(b) The Government should consider waiving the pipeline wayleave charge or levy a nominal fee so as to further improve the viability of DCS in more districts. (section 7.3.3.2)

(c) "Build-Operate-Transfer" (BOT) or similar type of contract should be adopted to encourage private sector participation in district cooling services delivery (section 7.6.4)

(d) Government should reserve land areas for the proposed plantroom sites (section 8.1)

(e) Government should select district zones for pilot implementation to accumulate experience prior to wider scale implementation because District Cooling is new to Hong Kong (section 8.1)

9.5 Energy Savings and Reduced Carbon Dioxide Emission

The Study confirms that the territory-wide implementation for water-cooled air-conditioning systems in Hong Kong can be implemented to achieve significant energy savings and reduce carbon dioxide emission.

	Annual Energy Saving by 2020 (kWh)	**Annual Carbon Dioxide (CO_2) Reduction by 2020 (tonne)**
Benefits By implementing Cooling Tower Scheme in all zones (see Note 1)	**1,170,000,000** That is, equivalent to 3.1% of total electrical consumption of Hong Kong in 2002	**830,000** That is, equivalent to 2.34% of total CO_2 emission of Hong Kong in 2002
Additional benefits by implementing District Cooling Scheme in 15 DCS Zones (see Note 2)	**190,000,000** That is, equivalent to 0.5% of total electricity consumption of Hong Kong in 2002	**116,000** That is, equivalent to 0.33% of total CO_2 emission of Hong Kong in 2002
	Total = **1,360,000,000** That is, equivalent to 3.6% of total electricity consumption of Hong Kong in 2002; OR equivalent to 4.7% of total non-domestic electricity consumption of Hong Kong in 2002; OR equivalent to annual saving of HK$ 1.20 billion based on HK$0.9 per unit kWh.	**Total = 946,000** That is, equivalent to 2.67% of total CO_2 emission of Hong Kong in 2002.

Note 1: In Cooling Tower Scheme Zones, cooling tower scheme penetration rate in non-domestic buildings is taken to be 50%.

Note 2: In District Cooling Zones, district cooling scheme penetration rate in non-domestic buildings is taken to be 35% in existing development areas and 90% in new development areas.

APPENDIX

Appendix 10.1

Appendix 10.2

Appendix 10.3 – Table 10.3.1 (Sheet 1 of 5)
Cooling Tower District Zones and City Mains Fresh Water Supply Evaluations

(Remark: City main fresh water supply is adequate / marginally adequate for 46 zones as listed below)

WACS Zone ID No.	Cooling Tower Zone	Additional Fresh Water Demand from Cooling Tower CPSSCT by 2020 (cu.m/day)	Evaluation of Adequacy of City Mains Fresh Water System to meet the Additional Water Demand from CPSSCT by 2020	Adequate to Absorb CPSSCT Water Demand	Adequate / Marginally Adequate To Absorb subject to conditions
A1	Western District	4,120	The capacity of the water supply systems is adequate to absorb the WACS demands provided that TMF can be converted to offset the increase in fresh water demands for WACS after the uprating of Central and Western LL SW supply systems		√
A2	Central District (West)	5,872	- ditto -		√
A3	Central District (East)	4,936	- ditto -		√
A4	Wan chai	3,441	Considering A4, A6 and A7, the S/Rs will be overloaded by about 11%. It is considered marginally acceptable		√
A5	Wanchai	2,214	The capacity of the water supply system is adequate to absorb the WACS demand	√	
A6	Causeway bay	1,904	Considering A4, A6 and A7, the S/Rs will be overloaded by about 11%. It is considered marginally acceptable		√
A7	Causeway Bay	2,334	- ditto -		√
A8	North Point	2,005	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
A9	Taikoo Shing	3,135	To take up the WACS demand, the water supply system will be overloaded by about 7%. This is considered marginally acceptable. However, the local distribution mains, mainly those within private streets, are under-sized. Consent from developer concerned to lay new mains in private streets has to be obtained before meeting the ultimate WACS demand in the zone.		√
A15	Aberdeen	1,109	The capacity of the water supply system is adequate to absorb the WACS demand.	√	

Appendix 10.3 – Table 10.3.1 (Sheet 2 of 5)
<u>Cooling Tower District Zones and City Mains Fresh Water Supply Evaluations</u>

(Remark: City main fresh water supply is adequate / marginally adequate for 46 zones as listed below)

WACS Zone ID No.	Cooling Tower Zone	Additional Fresh Water Demand from Cooling Tower CPSSCT by 2020 (cu.m/day)	Evaluation of Adequacy of City Mains Fresh Water System to meet the Additional Water Demand from CPSSCT by 2020	Adequate to Absorb CPSSCT Water Demand	Adequate / Marginally Adequate To Absorb subject to conditions
B1	Central & Wan Chai	1,667	The capacity of the water supply systems is adequate to absorb the WACS demands provided that TMF can be converted to offset the increase in fresh water demand for WACS after the uprating of central and Western LL SW supply systems		√
B4	Telegraph Bay	387	In PR No. 9/99, the WACS demand from the Cyberport development has been allowed in the water supply system.	√	
E1	Wong Chuk Hang	1,861	The capacity of the water supply system is adequate to absorbs the WACS demand.	√	
E2	Chai Wan	3,450	To take up the WACS demand, the S/Rs will be overloaded by about 7%, it is considered marginally acceptable.		√
A10	West Kowloon Station Development	714	The capacity of the water supply system is adquate to absorb the WACS demand. However, the supply situation may change subject to the review on the development of Arts District in West Kowloon/TST by Plan D.		√
A11	Tsim Sha Tsui	1,846	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
A12	Tsim Sha Tsui	497	- ditto -	√	
A13	Tsim Sha Tsui	1,123	- ditto -	√	
A14	Hung Hom (KCRC Station)	563	- ditto -	√	
A16	Yau Ma Tei	465	- ditto -	√	
A17	Mongkok	944	- ditto -	√	
A18	Prince Edwared	629	- ditto -	√	

Appendix 10.3 – Table 10.3.1 (Sheet 3 of 5)
Cooling Tower District Zones and City Mains Fresh Water Supply Evaluations

(Remark: City main fresh water supply is adequate / marginally adequate for 46 zones as listed below)

WACS Zone ID No.	Cooling Tower Zone	Additional Fresh Water Demand from Cooling Tower CPSSCT by 2020 (cu.m/day)	Evaluation of Adequacy of City Mains Fresh Water System to meet the Additional Water Demand from CPSSCT by 2020	Adequate to Absorb CPSSCT Water Demand	Adequate / Marginally Adequate To Absorb subject to conditions
B2	South East Kowloon	4,328	The capacity of the water supply system is adequate to absorb the WACS demand. TDD will construct the 2nd SEKD FWSR at Jordan Valley by 2014 but this project has not been implemented	√	
B3	West Kowloon (Art & Performance Venue)	330	The capacity of the water supply is adequate to absorb the WACS demnad. However, the supply situation may change subject to the review on the development of Arts District in West Kowloon/TST by Plan D.		√
E3	To Kwa Wan	1,096	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
E4	Cheung Sha Wan	2,426	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
E6	Kwun Tong	4,026	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
E12	Kowloon Bay	2,559	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
A20	Tuen Mun	3,441	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
B8	Tseung Kwan O Area 137 (New Area)	1,349	Considering both B8 and C6, the FWSRs will be overloaded by about 3% and it is considered marginally acceptable.		√
C1	Pak Shek Kok	313	The capacity of the water supply is marginally adequate to absorb the WACS demand.		√
C2	Tuen Mun Area 38 (New area)	927	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
C4	Tai Po (Industrial Estate)	1,346	The capacity of the water supply system is adequate to absorb the WACS demand.	√	

Appendix 10.3 – Table 10.3.1 (Sheet 4 of 5)
Cooling Tower District Zones and City Mains Fresh Water Supply Evaluations

(Remark: City main fresh water supply is adequate / marginally adequate for 46 zones as listed below)

WACS Zone ID No.	Cooling Tower Zone	Additional Fresh Water Demand from Cooling Tower CPSSCT by 2020 (cu.m/day)	Evaluation of Adequacy of City Mains Fresh Water System to meet the Additional Water Demand from CPSSCT by 2020	Adequate to Absorb CPSSCT Water Demand	Adequate / Marginally Adequate To Absorb subject to conditions
C5	Yuen Long (GBE)	1,135	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
C6	Tseung Kwan O (New Area)	1,029	Considering both B8 and C6, the FWSRs will be overloaded by about 3% and it is considered marginally acceptable		√
D1	Hung Shui Kiu NDA	150	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
D2	Kwu Tung North NDA	200	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
E7	Sha Tin Shek Mun	1,326	Assuming that To Shek FWSR will be reparied and fully functional, the capacity of the water supply system is adequate to absorb the WACS demand.		√
E9	Fanling	610	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
E10	Yeun Long (TIA)	659	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
D13	Kwai Chung	5,691	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
B5	North Lantau Foreshore	694	The capacity of the water supply system is adequate to absorb the WACS demand.	√	
B6	Penny's Bay	2,609	In PR No. 21/2000, CE/Des has been requested to form site at Yam O Tuk for additional S/R to cater for WACS demand from Theme Park.	√	
B7	Tung Chung (New Area)	1,080	Considering B7 and C3, the S/Rs will be overloaded by about 10%. If the situation persists, it is unacceptable. However, the supply situation may change if there is any changes to Tung Chung Tai Ho Developments.		√
C3	Chek Lap Kok Airport	7,613	- ditto -		√

Appendix 10.3 – Table 10.3.1 (Sheet 5 of 5)
Cooling Tower District Zones and City Mains Fresh Water Supply Evaluations

(Remark: City main fresh water supply is adequate / marginally adequate for 46 zones as listed below)

WACS Zone ID No.	**Cooling Tower Zone**	**Additional Fresh Water Demand from Cooling Tower CPSSCT by 2020 (cu.m/day)**	**Evaluation of Adequacy of City Mains Fresh Water System to meet the Additional Water Demand from CPSSCT by 2020**	**Adequate to Absorb CPSSCT Water Demand**	**Adequate / Marginally Adequate To Absorb subject to conditions**
	Other parts of HKSAR	3,750	By considering that the WACS demand is not substantial and scatters over a very large area in the territory, it is anticipated that the capacity of individual water supply systems is adequate to meet the water demand. Applications for mains water supply for WACS may be on a case-by-case basis.		√
		Total = 106,798			

Note:

a. The above table is based on the evaluation of the fresh water supply system by the Water Supplies Department on 6 May 2002 Ref. (16) in WSD 1655/7/2/00 Pt.15 based on CPSSCT penetration rate of around 50%.

b. There are 4 WACS zones where city mains fresh water supply is not adequate to cater for the additional water demand of CPSSCT. These 4 zones are: WACS Zone ID No. A19 (Sha Tin); WACS Zone ID. No. E5(San Po Kong); WACS Zone ID No. E8 (Fo Tan) and WACS Zone ID No. E11(Tsuen Wan). Full scale relaxation of mains fresh water for CPSSCT in these 4 zones is not recommended for the time being.

Appendix 10.4

Table 10.4.1

<u>List of the 5 Potential District Cooling Zones based on full pipeline wayleave charges</u>

WACS Zone ID No.	District Cooling Zones Description	Development Status	Estimated Zone Cooling Load (kW)	Estimated DCS Penetration (Customer Uptake)	Estimated DCS Customer Cooling Load (kW)
C3	Located in Chek Lap Kok Airport North-east Corner New Commercial District: Follow planning boundaries of the new area	New Development Area	195,700	90%	176,100
B8	Located in Tseung Kwan O Area 137 New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	129,000	90%	116,100
A3	Located in Central District (Central) Zone Boundaries: (North-bound: Connaught Road; South-bound: Lower Albert Road; West-bound: Pedder Street & Wyndham Street; East-bound: Cotton Tree Drive)	Existing Developed Area	312,300	35%	109,300
A2	Located in Central District (West) Zone Boundaries: (North-bound: Connaught Road; South-bound: Queen’s Road Central; West-bound: Rumsey Street; East-bound: Pedder Street	Existing Developed Area	363,700	35%	127,300
A4-5	Located in Wan Chai Zone Boundaries: (North-bound: Gloucester Road; South-bound: Hennessy Road; West-bound: Arsenal Street; East-bound: Canal Road	Existing Developed Area	341,700	35%	119,600

Appendix 10.4

Table 10.4.2 (Sheet 1of 2)

List of Additional 10 Potential District Cooling Zones based on waive of pipeline wayleave charge

WACS Zone ID No.	District Cooling Zones Description	Development Status	Estimated Zone Cooling Load (kW)	Assumed DCS Penetration (Customer Uptake)	Estimated DCS Customer Cooling Load (kW)
B6	Located in Penny Bay New Reclamation Area for Theme Park Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	121,400	90%	109,300
B5	Located in North Lantau Foreshore New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	90,800	90%	81,700
C6	Located in Tesung Kwan O New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	86,000	90%	77,400
B1	Located in Central & Wan Chai New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	93,400	90%	84,100
A6-7	Located in Causeway Bay Zone Boundaries: (North-bound: Gloucester Road; South-bound: Leighton Road; West-bound: Canal Road; East-bound: Gloucester Road	Existing Development Area	295,700	35%	103,500

Appendix 10.4

Table 10.4.2 (Sheet 2 of 2)

List of Additional 10 Potential District Cooling Scheme (DCS) Zones based on waive of pipeline wayleave charge

WACS Zone ID No.	District Cooling Zones Description	Development Status	Estimated Zone Cooling Load (kW)	Assumed DCS Penetration (Customer Uptake)	Estimated DCS Customer Cooling Load (kW)
A11-A13	Located in Tsim Sha Tsui Zone Boundaries: (North-bound: Granville Road & Cheong Wan Road; South-bound: Salisbury Road; West-bound: Canton Road & Nathan Road; East-bound: Science Museum Road)	Existing Developed Area	432,900	35%	151,500
B3	Located in West Kowloon New Reclamation Area (Proposed Art & Performance Venue) Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	46,300	90%	41,700
C2	Located in Tuen Mun Area 38 New Reclamation Area Zone Boundaries: Follow planning boundaries of the new redevelopment area	New Development Area	78,100	90%	70,300
B2	Located in South East Kowloon New Redevelopment Area Zone Boundaries: Follow planning boundaries of the new redevelopment area	New Redevelopment Area	222,200	90%	200,000
B7	Located in Tung Chung New Reclamation Area Zone Boundaries: Follow planning boundaries of the new reclamation area	New Development Area	124,200	90%	111,800