Manual for Conducting Water Audits and Developing Water Efficiency Programs at Federal Facilities

Preface

This project was carried out by the Economics and Conservation Branch of Environment Canada under the sponsorship of the Office of Environment Stewardship and the Interdepartmental Advisory Group on Water Conservation at Federal Facilities. It shows the considerable importance attached to water conservation and the significant role played by government departments. The present manual, it is hoped, will have important implications for facility managers involved in water conservation efforts, developing resource policies, planning programs, and in evaluating current water efficiency programs.

This project represents the combined efforts and expertise of many agencies in the federal government. Such an undertaking would not have been possible without the cooperative efforts of the agencies involved, enabling information useful to themselves and other concerned parties to be gathered. However, the ultimate beneficiary of this exercise will be the ecosystem of Canada.

Introduction

The Government of Canada, through its Code of Environmental Stewardship, is dedicated to improving the natural environment. One of the ways this goal can be achieved is by reducing loadings on municipal wastewater treatment plants. To this end, the Government has accepted the Green Plan goal of seeking cost-effective ways to make federally owned facilities water efficient in their operation. This objective is the focus of the Water Conservation Plan at Federal Facilities. The Plan describes the various steps that need to be taken, from inception through financing, for the implementation of water conservation programs. This manual is a critical element of the Plan.

The water use rate in Canada is among the highest in the world. The Canadian per capita water use is nearly three times that of European countries. This is partly due to the perception of an unlimited supply of fresh water available in Canada. Most water uses, from domestic to industrial, involve contamination of the water even if only through discharge to a municipal wastewater system. Increasingly large quantities of water must be treated before discharge back to the natural environment with less than perfect results. The maintenance costs of municipal water systems are correspondingly increasing, with those of wastewater treatment systems increasing faster.

Studies indicate that lower hydraulic loading on treatment plants leads to improved effluents and to reduced incidences of storm-induced discharges of untreated sewage. As non-flat rate municipal water billings consist of a charge for the water supplied and a significant surcharge for wastewater treatment based on that volume of water, reductions in water use can also produce significant savings in water bills.

Continuation of wasteful practices threatens to deteriorate the quality of Canada's freshwater resources for future generations, results in costly development of alternative municipal water supplies and poses potential harm to human health. In many cases, such practices cause beach closures and the abandonment of fish resources. It is clear, therefore, that the status quo is unacceptable.

Water must be considered as an invaluable asset. Water management ought to be part of any organization's business plan. In keeping with the federal government's commitment to environmental stewardship, departmental managers are asked to develop action plans to rationalize water use.

This manual is designed to assist facility managers to take the first steps necessary to establish and to meet objectives for a water efficiency program. These guidelines outline the procedures for conducting a water audit and for designing and implementing a successful water efficiency program.

The first step in developing such a program is to assess the current state of water use at the facility being investigated. This is done by conducting a water audit. A water audit can be done by hiring consultants or by using in-house resources. Either way, the water audit will determine if and where excess water is being used and ways in which its volume can be reduced. The main activities involved in conducting a water audit are

1. defining the water distribution system components (Chapter 1)
2. developing an inventory of the water use operations at the facility (Chapter 2)
3. preparing a water balance for the facility (Chapter 3)

The results of the water audit will indicate the amount and variability of water demanded by each operation. These factors are then totalled for the whole facility.

Next, a water efficiency program is designed and implemented (Chapter 5) to optimize water usage and water savings for the facility by

1. identifying potential water reduction alternatives for the facility
2. evaluating the potential alternatives against the facility's goals and the social/political, technical, environmental, and financial impacts
3. developing a recommended water efficiency program for the facility
4. implementing the program and ensuring its success with user education programs and evaluations for further water reduction opportunities

A schematic representation of the facility's water infrastructure should be prepared to show the entire distribution system from where the incoming water passes through a meter to the final use or distribution points.

Water demands may be accounted for as

- **use** – water used in operations and either consumed, reused, or discharged into the storm or sanitary sewer
- **consumption** – water used in operations but not discharged to the sewer system
- **losses** – all unaccounted-for water, such as distribution system leaks, leaking meters, and leaking connections

Thus by the above methodology, the facility's water uses are assessed, the potential water and financial savings are estimated, and water efficiency plans are established and adhered to.

The results of the pilot studies that follow should recommend easily adapted modifications to common water uses to make them more efficient. The modified processes would result in significant reductions in water use, contribute to protect our environment, and provide financial benefits.

Audit Methodology - Chapter 1: System Components

Description of facility and scope of study

Regardless of whether the audit is done by consultants or in-house resources, effective use of existing information ensures rapid progress in completing the task. All relevant descriptive statements, plans, and tabulations about the physical and geographical characteristics, including details of buildings, should be collected often from various sources.

If possible, a reference on the source of supply and natural quality of water should be included. Both the age of the building distribution system and of the municipal infrastructure connections need to be determined. Some summary remark on water usage might also be made at this point.

The objective of a water audit is to identify each facet of the water distribution system and thus define the system as a whole such that

1. areas of the facility with hot and cold water supplies are identified
2. measured and unmeasured water supplies are accounted for
3. all points in the system where water can be extracted are identified
4. distribution system design details are defined

Such investigation should provide enough information to set specific objectives for a water efficiency program, such as:

1. a definition of the water distribution system and an outline of procedures for conducting a comprehensive inventory

2. assembly of a comprehensive inventory, including descriptions, of all water use operations at the facility
3. outline of procedures to account for all water used at the facility
4. outline of procedures for developing a list of potential water reduction techniques that could be applied to specific operations, areas, or the facility as a whole
5. outline of procedures to design and implement a water efficiency program at the facility

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Elements of a water distribution system

The elements of a facility's water distribution system that are considered necessary for the system definition may be grouped in four broad categories:

- distribution
- measurement
- storage
- extraction

Relevant information on the various categories may be obtained from plumbing plans, previous reports, publications, etc.

Site inspections and discussions with area personnel allow for a true understanding of the water-using activities at the facility.

Basic procedures

Specific steps that may be used to define the system at the facility include

- a visual inspection of the facility
- a review of base maps of buildings(s)
- an inspection of plumbing drawings and transferral of key information to the base maps
- an extensive site investigation to verify information

During the investigation, an unbalanced water flow account might be encountered that may indicate leaks or losses. In addition, insufficient pressure or supply in system areas might indicate that pipe sizes and capacities should be examined. Sensitive operations may require the installation of flow meters to measure the delivery of desired flows in a particular locality.

Circumstances cited above may warrant the identification of detailed design components such as

- water supply pipe sizes
- valves
- joints and splits
- elbow turns
- any other component beyond standard plumbing

An area site plan is to be prepared with all of the facility's water meters shown, along with a schematic representation of the meters in use, depicting installations and buildings served. Plans of each section of the facility should show the major water distribution system elements. A description of the meters shown on the schematic drawing is required, complete with supply source, meter reading intervals, and purpose of metering.

Additional procedures required for water audit

There might be several other elements of the water distribution system at a facility (in addition to supply lines, meters, and use points) that need to be identified as part of the audit:

- Fire hoses, located throughout the facility, do not actually use water and therefore are not likely to be identified. These could be located during further site investigations.
- Water supply pipe sizes are determined by inspection (with reference to the plumbing drawings), since many of the water pipes at the facility may be exposed.
- Valves, joints, and elbow turns that are not identified could also be located by site investigation with the plumbing drawings used as reference.

For the water audit, the drawings of the water distribution system should be completed to include all of the above.

Audit Methodology - Chapter 2: Inventory of Water Use Operations

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Introduction

The primary reason for describing the water uses for each point of extraction is to develop a comprehensive inventory of water uses at the facility and to identify potential water reduction strategies.

To obtain such information, one might

- contact area personnel and arrange for meetings
- survey area personnel about the water uses in their area
- transfer information from questionnaires to spreadsheets and floor plans
- verify information with plumbing drawings and building personnel

The information regarding water use operations might be obtained through the use of aspecifically designed questionnaire (e.g., Appendix A).

With all system components defined and located, the water uses for all of the points of extraction are described, including

- category of water use
- volume, rate, and frequency of use
- water lost or consumed

There are some situations in which further investigation of flow quantity for a water use is not warranted, for example:

- uses that occur rarely (e.g., fire hoses)
- uses that are very small compared to the total facility use
- uses that will not affect the water balance (e.g., non-city water)

The results of a water use survey are best summarized in computer-generated table forms for effortless retrieval and review.

Procedures for estimating flows

Past experience suggests that although during the audit, descriptions of water uses are readily attainable, in most areas volumes of water used are not measured. If a flow estimate is needed, published values or field measurements may be acceptable.

Tabulated values from published information are available for most conventional water uses to estimate flow use by specific operations. These may be augmented by estimates regarding the number of users per day or duration of use.

Estimation of flows might be based on field measurements, which may be more appropriate for some water use operations. Methods of field measurement include

- flow meters on either the water distribution system or the water-using equipment (e.g., cooling water pipe)
- bucket and stopwatch measurement of water extracted for a specific operation
- volume/frequency measurement of water used for a specific operation

Indirect methods of flow measurement (such as logging the operation of water pumps, and displacement tests on water storage tanks) are likely to produce lower quality data.

It is important to measure flows over the same general time period, because the periodicity and seasonality of flows may affect the water balance equation. Part of the margin of error at a pilot site was due to unknown flows for irrigation and lawn watering. If outdoor use is suspected, the water audit should be carried out during the summer season.

However, any other method for measuring flow that appears to be reasonable for the application may be used.

Flow meters

An essential element of any water audit is the measurement of the main flow entering the facility. Additional flow measurement into sub-areas is occasionally warranted when significant portions of the total flow need to be ascertained.

Flows can be measured by either permanent flow meters, which give the most reliable results both during the investigation and after the water audit is finished, or temporary recorders, typically situated at a specific location for the short audit period. Temporary flow meters, if not installed correctly, may give corrupt results.

Permanent flow meters are costly and have to be fitted into the pipe run. However, they will give highly accurate daily, weekly, monthly, seasonal, and unusual-event data during the water audit, and then continue to give long-term results and trends.

There are two basic types of temporary flow meters, namely, external clamp-on devices and insertion flow recorders.

External clamp-on meters send ultrasonic signals through the pipe wall and across the water flow. They are useful where only an indication of the flow range is required and they need no pipework modifications. However, they require a straight section of pipe at least 30 diameters in length for installation.

The insertion flow meter requires a point of entry into the main via a small (5 cm or 2 inch diameter) tapping. An electromagnetic head, or a small turbine, measures the velocity of flow at one point in the pipe. The pipe has to be traversed to obtain a flow profile, from which the relationship between measured point velocity and total flow can be calculated.

Varying flow profiles and internal pipe corrosion can cause distortions. Results from insertion meters are likely to be more accurate than those from clamp-on meters.

Bucket and stopwatch estimation

If the flow is constant and free flowing, as in some cooling waters, a bucket and stop watch approach can be used to estimate flow. The time it takes a bucket of a known volume to be filled by the free-flowing source is measured and a flow can be calculated.

Volume/frequency estimation

If the flow is not free flowing but fills a known volume, the frequency with which the volume (tank) is emptied or replaced can be used to estimate flow.

Occasionally, logging the operation of a domestic cold water pump is the last resort to obtain a set of (indirect) flow measurement. The method produces lower quality of data but gives an understanding of the water using pattern at a facility and also provides information on the operation and control of the pumped system.

Leakage detection surveys

Significant lengths of outside underground mains are potential areas for leakage of water. Such conditions may warrant the consideration of a leakage survey.

The leak detection technique involves using an electronic leak correlator and a noise sounder. The leakage of water from a pipe produces unique noises, which the electronic equipment is able to detect. Sensing devices are usually attached to the watermain fittings, such as hydrants and valves, and the survey is completed in a methodical manner around the site. If the results are "quiet," there is no leakage.

Audit Methodology - Chapter 3: Water Balance

Introduction

A flowmeter reading program and subsequent water balance calculation ensure that all water uses in a facility are identified and adequately quantified. If available, historical monthly and yearly average daily flows, along with schematic diagrams of the domestic hot/cold water systems, should be assembled to determine the relationship between the flowmetering period and annual variations. Other actions, such as plotting flowmeter readings and making an inventory of fixtures, further contribute to a speedy audit process. Because of the short time frame of most audits, it is necessary to establish a program of manual meter reading by the staff on site at each facility.

The next step in water balance calculation uses the information gathered from site inspections, measurements, and discussions with site operators and users. An opportunity should be taken to provide more than just a volumetric total in the balance. For example, each individual water use may be placed in its appropriate category: domestic, cooling, process, outdoor, or fire. The location and period of use during the day are to be shown, along with the method of discharge to the storm or sanitary sewer. An analysis is then completed of the average daily, peak, and base flow for each facility.

If the results show that the sum of water used in all operations is less than the total water supplied, it is assumed that water uses exist that have not been included in the balance, or that either the main meter or its reading is inaccurate. The water balance should be re-examined until the auditor is satisfied that all operations have been considered.

Distribution system water losses (leaks) are normally considered as part of the water balance. However, since the distribution system pipes are visible in the facility's buildings, water leaks would be noticed and repaired without delay, so such losses may not necessarily be considered.

Water meter reading program

The water meter reading approach was successfully employed for the pilot audits, because it provided the level of data required for a water audit. Readings are usually taken at least twice a day, in the morning before the main daytime activity begins and late in the afternoon at the end of the normal working day. For a continuous period of several weeks, including weekends at most sites, the daily readings were recorded. In this manner the daytime and nighttime base flows were established. It should be noted that more frequent readings were taken at many pilot audit sites for greater accuracy.

The alternative method of obtaining flow data from the existing and newly installed flow meters would have been to use data loggers with recording heads attached to the meters. With this technique one can gather data much more frequently, by recording the flows at short time intervals. In most cases, however, the cost to hire or purchase the equipment, set up, check weekly, and remove meters at a large number of locations would be far greater than that of the manual method chosen.

It is advantageous to use standardized forms for meter reading purposes before the audit. An example sheet is presented in Appendix A. Upon completion, these should be forwarded to an established location for safekeeping.

In the absence of earlier records, several months lead time in flowmeter readings may reduce the costs of the audit.

Facility-wide water balance

The objective of the facilitywide water balance is to add up all of the individual categorized water use volumes and equate them to the volume of water supplied to the facility as recorded by the main meter. The first step in preparing the water balance is to examine the facility as a whole. It might also be advantageous to divide the complex into smaller, individually metered water-using sub-areas.

The smaller sub-areas are chosen to represent a logical area of water use, while respecting geographical boundaries. When buildings are located beside each other, but have separate meters and different management, they should be divided for the purposes of the water balance.

The water balance for the entire facility can be presented in figures showing meters and sub-areas, and in tables showing a comparision between individual water uses by incoming water volume to the total volume of water used in each sub-area.

Main meter water balance

The methodology for conducting a main meter water balance is to equate the total water volume supplied to the facility with the total water volume supplied to each sub-area of the facility. Results from the main meter water balance are most easily presented in flow chart form.

The main meter water balance considers only the total water supplied to the facility and the total water volume supplied to each sub-area. It aims to

- identify sub-areas of major water use
- identify major discrepancies between the main water volume supplied to the facility and the sum of water volumes supplied to each sub-area
- highlight sections of concern around which an individual water balance can subsequently be carried out

Depending on the magnitude of unknown flow values, a decision will be made whether to

- consider the mass balance complete
- install new flow meters to monitor areas of concern
- use water use estimations for the sub- areas within the unmetered areas to estimate the total water supplied

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Sub-area water balances

The primary objectives of the sub-area water balances are to identify the volumes of water used by each operation in the area and to sum these to account for the total volume of water used in the area. This information may be shown as flow diagrams for the water balance in each sub-area.

Summary

The completion of facility water balances, in which all major water uses are accounted for (within a reasonable margin of error) concludes the water audit part of the process. The water audit results are then used in the next phase for designing a water efficiency program specific to the facility under study.

Audit Methodology - Chapter 4: Water Reduction Measures

Introduction

The areas of water reduction will mainly be associated with physical changes, but user habit change will also be an ingredient in a successful water efficiency program. Implementing water reduction measures will have no effect on human comfort.

Many water reduction measure alternatives will become obvious during the water audit and will aid in the development of a water efficiency strategy. Demand management methods that involve reducing the demand for water at the user end of the distribution system include

- system optimization
- water-saving systems (retrofitting and replacement)
- reuse/recycle systems
- process changes
- alternative water sources
- user habit changes
- metering

General supply management approaches, such as leak detection and repair as well as pressure reduction, are effective in reducing the water used by controlling the supply and distribution system.

System optimization

Because the system optimization measures are specific to the water use operation, opportunities for water reduction cannot be identified until the water audit has been completed. However, based on the audit, several systems can be considered for optimization, including

- regular calibration of all water flow meters
- implementation of a preventative maintenance program including leak detection for water-using operations such as toilets and faucets
- optimization of the individual processes and equipment in major water-using areas

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Water-saving systems

Selecting water-saving devices that reduce the harm an activity would otherwise cause to the environment could be considered a good environmental choice. The Environment Choice Board was created to help users find products that ease the burden on the environment. As the range of products identified by EcoLogo, the Board's symbol of certification, grows, it will become easier to decide on environmentally sensitive purchases.

Retrofitting systems

Standard retrofitting devices are common for domestic water use components such as toilets, showerheads, faucets, and outdoor hoses. Components that may be considered for retrofitting include

- **toilets** – if the toilets at the facility are valve-operated and use 19-25 L per flush. A toilet retrofitted with flow control valve would use less than 15 L.
- **urinals** – Standard urinals use 7-9 L/flush; water-saving flush valves reduce this to the 3 L range. Moreover, using infrared sensing equipment further saves water by "flushing when required," thus eliminating double or stack flushing common with manual valves.
- **showers** – Standard showerheads, using an estimated 100 L per use, could be retrofitted with flow restrictors.
- **faucets** – Sink faucets could be fitted with flow restrictors or aerators. For washroom sinks, timed on/off valves may prove to be water efficient.
- **drinking fountains** – Drinking fountains could be fitted with flow restrictors or timed on/off valves.
- **sprinklers** – Water sprinklers could be fitted with timers so that they could be operated and shut off automatically during the night, when water lost to evaporation is at a minimum.

Replacement systems

Water efficient toilets, showerheads, faucets, and appliances (e.g., dishwashers and washing machines) are being developed for conventional water uses.

Replacement of water-using devices with new, low water-using fixtures should be considered facilitywide for toilets, taps, showers, hoses, and drinking fountains. Current sprinklers could be replaced with more water-efficient systems.

Reuse/recycle systems

Reuse and recycle systems are those that use water that has previously been used in another operation; however, treatment may be required before the second use.

The pilot audit identified the following opportunities in this regard. Water used in various air-handling equipment should be reused for humidification. Well-timed and well-maintained recycling fountains can reduce water use without affecting business.

Both reuse and recycle systems should be considered to reduce water use if large volumes of uncontaminated water are to be discharged to municipal sewers.

Process change

Process change describes the replacement of water-using practices with those that perform the same function in a different manner. Process change can also refer to the complete elimination of a water-using practice.

Basic approaches that appear to save significant quantities of water include regular equipment maintenance, conversion to chemical or dry processes, and elimination of once-through air conditioning units. Consideration should be given to convert all water-cooled equipment to chilled water or closed-loop glycol cooling systems. This list is for illustration purposes and is not exhaustive since process change steps are regarded as site-specific in nature.

Alternative water sources

If the water required for the operation does not need to be municipal grade, then there may be a large cost savings associated with using an alternative supply. Alternative water sources could include direct surface water supply, groundwater supply, and stormwater.

User habit changes

Changes in people's water-use habits could include

- organizing work to minimize water loss
- ensuring that taps are completely turned off and not left running unnecessarily
- reporting leaking faucets, toilets, urinals, and water fountains to appropriate maintenance personnel
- insulating hot water pipes serving faucets or showers to reduce the time water must run to become hot
- adjusting lawn watering schedules to low evaporation periods of the day

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Metering

Metering water use is a good way for the facility to gain the support of users involved in the water reduction program, as they will see the results of their efforts. Placing and monitoring a flow meter on a supply line allows both management and employees of a facility to immediately recognize how much water has been used and whether that use falls within the normal range.

Based on the information gathered in the water audit survey, it might be possible to obtain enough flow monitoring data

- to assess the progress of a water efficiency program
- to ensure that the reductions are maintained and not allowed to be eroded

Audit Methodology - Chapter 5: Designing the Water Efficiency Program

- **Development of recommended water efficiency program**

Introduction

The water efficiency program should be designed to incorporate water reduction measures that best achieve the goals set out for the activities at the facility. Steps leading to such a program may include

1. establishment of the goals of the water reduction program
2. identification of all reasonable reduction measures
3. identification of positive and negative impacts of the reduction measures
4. preliminary evaluation to screen out undesirable measures
5. a cost-benefit analysis
6. development and evaluation of the recommended water reduction program

Goals

A government facility may implement the water efficiency program to achieve several goals. Some examples are listed below:

- participation of the water users
- water and/or cost savings
- long-term solution
- improved public image

The management of the facility will likely play a major role in establishing goals for the program.

Alternative reduction measures

For each water use category, water reduction measures and practices can be identified specific to the facility. When the list of available measures has been completed, then the intangible impacts, as well as financial and water savings impacts of each measure, must be evaluated against the goals set by water efficiency program of the facility.

Impacts of water reduction measures

The following impact categories need to be considered: economic, social/political, and environmental/technical. Specific impacts that should be determined for the measures include public (user) and political acceptance, environmental impacts, reliability, short- or long-term effectiveness, and other impacts specific to the goals of the program. The impact of water reduction measures on the goals of the facility needs to be determined.

Cost-benefit analysis

A cost-benefit calculation will determine the net savings that would be made by the most cost-effective water reduction measure. To obtain the information needed to derive the costs and savings, a detailed examination of the potential water reduction measure must be undertaken.

The general approach to calculating the net benefits of a reduction measure is shown below:

TANB ($ / y) = AECS ($ / y) - ACCO ($ / y) - AAOC ($ / y)

Where

- the total annual net benefit (**TANB [$ / y]**) is the net economic benefit that would result if the measure were implemented
- the annual expected cost savings above existing operation (**AECS [$ / y]**) includes savings in water supply and sewer charges, surcharges, and possibly energy
- the amortized capital cost of operation (**ACCO [$ / y]**) includes the equipment, materials, and installation of the measure, amortized over the projected life of the measure
- the additional annual operating cost above existing operation (**AAOC [$ / y]**) is the additional cost of labour, maintenance, energy, materials, and waste disposal that would result if the measure were implemented

In most cases, however, a simple cost-benefit analysis involving the estimated capital cost of the modification works, the net revenue savings, and the resulting payback period should suffice. Other non-quantifiable benefits, including those related to the environment, social well-being of water users, political image and goals, must always be considered although they cannot be included in the calculation of net benefits.

Development of recommended water efficiency program

The results of the impact assessment and cost-benefit analysis may be used to develop a water efficiency program to meet the goals of the facility. The resulting program will consist of a number of compatible water reduction measures and will have a net benefit and net water volume savings, as well as a number of non-quantifiable benefits.

Audit Methodology - Chapter 6: Water Efficiency Program Implementation

Introduction

Major elements that may be considered in the implementation plan include

1. selection of a water efficiency program management and staff
2. establishment of a schedule of implementation
3. development of a user education program
4. implemention of programs
5. assessment of program effectiveness
6. update of program elements, if necessary

Program management and staff

A dedicated and efficient staff organization, working as a team, is required for the implementation of a successful water conservation program at any facility. Lines of responsibility for developing an implementation schedule and coordinating required activities need to be established. Assessing the program's success and updating the program, if necessary, may also be the responsibility of this team. The ability to delegate authority to specific activities is considered to be a key element in ensuring the program's success.

Implementation schedule

The water efficiency program management and staff may have to develop a schedule for implementing water reduction measures. This may include all components of the water efficiency program, including education program, installation, and follow-up activities, based on

- the goals for water savings
- the available and projected budget for the current and future years
- the staffing available for education and assessment activities

User education

It is vital to any long-term water efficiency program that the water users know why it is important that they use their water wisely. This education has two primary purposes:

- to encourage the users to follow reduction program procedures
- to facilitate the users' acceptance of water reduction measures implemented by management

Key elements of an effective education program may include

1. a theme, representing the water efficiency program
2. an education coordinator to coordinate the distribution of educational materials and the educational programs
3. educational materials, such as in-house newsletters, water reduction guides, posters, to communicate the goals and encourage user participation
4. an education plan, including communication methods and a schedule of implementation and follow-up
5. follow-up of the educational program, especially if user habit or attitude changes are required as part of the water efficiency plan of the facility. The follow-up will either encourage user participation or inform the educator whether the education program is inadequate or too infrequent
6. modification of the water efficiency program where the education program has not accomplished the expected user involvement

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Program assessment

Routine progress assessment of water savings may reveal the areas where measures are successful or ineffective. It would also indicate where modifications to the program may be required.

Modifications may be carried out and evaluated by the program management and staff of the facility based on

- examination of the main meter records as well as the various internal meter records to determine overall water savings and water savings in individual sub-areas
- surveys of user participation and attitude
- acceptance by facility management
- reports from the education coordinator

Program effectiveness reports should be submitted routinely to the facility management and in turn to the users to encourage further participation.

Update of program elements

The routine assessment of the program will help to identify which measures are not effective and could potentially be replaced or modified.

Replacement measures should be thoroughly evaluated, by impact analysis and cost-benefit analysis, prior to implementation.

Sample Request for Proposal (RFP) and Evaluation Criteria

Request for Proposal

1. Background

A plan of action for national and global environmental problems was introduced by the federal government in 1990. Under this Green Plan, a federal Code of Environmental Stewardship was established. Part of this code involves the development of a Water Conservation Plan at Federal Facilities. Relevant practical and realistic technical information, to formulate such a plan, is obtained through a series of pilot water audit projects for typical government establishments (these are listed in Supplement A). The results of the pilot water audits will aid federal departments to plan and implement water conservation measures at their facilities throughout the country.

A water audit can determine if and where excess water is being used and recommend ways in which its use can be reduced. It involves the definition of the water distribution system infrastructure, development of an inventory of water use operations at the facility, and preparation of a water balance for the facility. The result of a water audit will be an account of the water volumes used by and discharged from, and flow variations for, each operation -- summed up for the whole facility.

Next, a facility-wide water efficiency program is designed to optimize the water usage and water savings by identifying potential water reduction alternatives. These potential alternatives are evaluated against the facility's goals, and associated social/political, technical, environmental, and financial impacts are considered. A water efficiency program is then recommended and later implemented, its progress monitored, and if necessary, user education programs and follow-up activities are devised to ensure its success.

2. Scope of requirements

The purposes of the present project are to conduct the water audit and to develop a successful water efficiency program that can result in significant savings to the selected facilities through reduced water supply and sewer charges. Therefore, the following work is required for each of the individual facilities (see Supplement A):

1. Prepare graphic representations showing the integration of various items of the water distribution system infrastructure;
2. Define and document an inventory of all of the water use operations at the facility being audited;
3. Prepare a water balance for the facility taking into account the volume of water supplied to the water uses in each area of the facility;

4. Develop and document a series of potential water reduction alternatives for the facility;
5. Evaluate the potential alternatives against the facility's goals, their various impacts, and develop a recommended water efficiency program for the facility; and
6. Provide a comprehensive summation of the study's findings, including a slide presentation package.

3. Deliverables

In the following, procedures for conducting water audits and for the design and implementation of successful water efficiency programs at the listed federal facilities are outlined. For a proposal to be considered, the cost associated with each facility is to be identified separately, taking into account a share of common overhead costs as well as individual costs particular to each facility. Subsequently, "facility" refers to any of the facilities itemized in Supplement A (Fact sheets are included in Supplement B).

3.1 Identification of system components

The objective of this initial phase is to identify each facet of the water distribution system, and thus define the system as a whole such that all areas of the facility with hot and cold water supplies are identified, and measured and unmeasured water supplies are all accounted for. Every point in the system where water can be extracted are to be identified and the distribution system design details are to be defined. Plans of each section of the facility should show the major water distribution system elements. A verbal description of the meters shown on the schematic drawing is required, complete with supply source, meter reading intervals, and purpose of metering.

The elements of a facility's water distribution system that are considered necessary for the system definition may include the following:

- distribution (hot and cold water pipes)
- flow meters, their types and ratings
- storage (reservoirs, holding tanks)
- extraction locations, including brand names, model numbers, and flow rate
- specifications (lavatories, faucets, showers, AC cooling water lines, etc.).

These may be obtained from plumbing plans, visual inspection of the facility, discussions with area personnel, or from previous reports or publications.

3.2 Inventory of water use operations

The primary objective of describing the water uses for each point of extraction is to develop a comprehensive inventory, including descriptions, of water uses at the facility, and to identify potential water reduction strategies. In order to obtain such information, area personnel might be contacted and meetings arranged to learn about the water uses in their area. Alternatively, the actual information regarding water use operations might be obtained through the use of a specifically designed questionnaire (see Supplement C for an example).

During the audit, descriptions of water uses will easily be obtained, but in most areas, volumes of water used are not measured. If a flow estimate is required, published values or field measurements are to be used. Methods of field measurement used are to be described.

It should be noted that any method for measuring flow which appears to be reasonable for the application may also be used. Note the importance of measuring flows over the same general time period, because the periodicity and seasonality of flows may affect the water balance equation.

3.3 Water balance

A water balance calculation ensures that all water uses in the facility have been identified and adequately quantified. If the results show that the sum of water used in all operations is less than the total water supplied, it is assumed that water uses exist which have not been included in the balance, or there is inaccuracy in the main meter. The water balance should be re-examined until all operations have satisfactorily been considered. Distribution system water losses (leaks) are normally considered as part of the water balance.

Existing meters are to be monitored for a reasonable time period for water balance calculation. Note that if additional meters are justifiably needed, they should be recommended in the proposal including purchase costs.

3.3.1 Facility-wide water balance

The objective of the facility-wide water balance is to add up all of the individual water use volumes, and equate them to the volume of water supplied to the facility as recorded by the main meter. It might be advantageous to divide the complex into smaller, individually metered water-using sub-areas.

The smaller sub-areas are chosen to represent a logical area of water use, while respecting geographical boundaries. When buildings are located beside each other, but have separate meters and different management, they should be divided for the purposes of the water balance.

The water balance for the entire facility can be presented in figures showing meters and sub-areas, and in tables showing a comparison between individual water uses by incoming water volume to the total volume of water used in each sub-area.

3.3.2 Main meter water balance

The main meter water balance considers the total water supplied to the facility and the total water volume supplied to each sub-area only. It serves to identify sub-areas of major water use and to pinpoint major discrepancies between the main water volume supplied to the facility and the sum of water volumes supplied to each sub-area. The main meter water balance might also highlight sections of concern (e.g., unknown flow values) around which an individual water balance can subsequently be carried out.

Depending on the magnitude of unknown flow values, a decision is required whether to consider the mass balance complete and proceed with the audit or to install meters to monitor these uses. It is also acceptable to use water use estimations for the sub-areas within the unmetered areas to estimate the total water supplied.

3.3.3 Sub-area water balance

The primary objectives of the sub-area water balances are to identify the volumes of water used by each operation in the area, and to sum these to account for the total volume of water used in the area. This information may be shown as flow diagrams for the water balance in each sub-area.

3.4 Water reduction alternatives

Many water reduction measure alternatives will become obvious during the facility audit and will aid in the development of a water efficiency strategy. Demand management methods that involve reducing the demand for water at the user end of the distribution system include

- System optimization – such as meter calibration, preventative maintenance program (these are specific to the water use operation).
- Water-saving systems – including retrofitting and replacement of toilets, showers and faucets.
- Reuse/recycle systems – systems using water that has previously been used in another operation (treatment may be required before the second use).
- Process change – replacement of water-using processes with ones that perform the same function in a different manner.
- Alternative water sources – If the water required for the operation does not need to be municipal grade, there may be large cost savings associated with using an alternative supply.
- Metering – Metering water use is a good way for the facility to gain the support of users involved in the water reduction program, as they will see the results of their efforts. Based on the information gathered in the water audit survey, it might be possible to obtain enough flow monitoring data to assess the progress of a water efficiency program.

General supply management approaches, such as leak detection and repair as well as pressure reduction, are effective to reduce the water used by controlling the supply and distribution system.

3.5 Designing the water efficiency program

The water efficiency program should be designed to incorporate alternatives that best achieve the goals set out for the activities at the facility, including the establishment of the goals of water reduction program and construction of alternative reduction measures. Identification of positive and negative impacts of potential alternatives should be followed by a cost evaluation to screen out the undesirable ones. Finally, the development and evaluation of alternative water reduction programs conclude the project.

3.5.1 Alternative reduction measures

For each water use category, water reduction measures and practices will be identified specific to the facility. When the list of alternative measures has been completed, then financial and water savings impacts of each measure must be evaluated.

3.5.2 Impacts of water reduction measures

The impact categories that might be considered are economic and environmental/technical. Specific impacts that should be determined for each measure may include public (user) acceptance, environmental impacts, reliability, short or long term effectiveness, and others specific to the goals of the program. The impact of each alternative measure on the goals of the facility needs to be determined.

3.5.3 Cost-benefit analysis

A simple payback period calculation will show the number of years that the most cost-effective water reduction measure would require to recover costs if that measure was to be implemented. For payback purposes, the net yearly savings is compared to the sum of the cost of the proposed measure and the cost of all related expenses. To obtain the information needed to derive the costs and savings, a fairly detailed examination of each potential water reduction alternative must be undertaken.

3.5.4 Development of recommended water efficiency program

The results of the impact assessment and cost evaluation are used to develop alternative water efficiency programs to meet the facility's goals. Each program will consist of a number of compatible water reduction measures and will have a longer or shorter payback period and corresponding water volume savings, as well as a number of non-quantifiable benefits. The recommended plan will be comprised of the most cost-effective alternatives.

3.6 Reporting requirements

A comprehensive report, including a stand-alone executive summary is required. The draft version of the report will be presented to the departmental technical authority (DTA) in English. The final report, in 10 (ten) copies, is to be submitted after all concerns raised in the draft review process were attended to. The report format must approximate the suggestions contained in Supplement D.

For demonstration purposes, a presentation package (preferably 35-mm slides or overheads) reiterating the findings and recommendations is required.

4. Information supplied with the Request for Proposal

The following documents and reports are supplied with this request for proposal:

- 4.1 List of federal facilities selected for in-depth study (Supplement A)
- 4.2 Fact Sheets and other information on the facilities (Supplement B)
- 4.3 Copy of a sample survey questionnaire (Supplement C)
- 4.4 Reporting requirements (Supplement D)

5. Information supplied upon contract commencement and available services

Upon commencement of this contract the information itemized on the fact sheets of Supplement A will be supplied to the selected consultant.

6. Expected output/milestones

Milestone 1. Water audit for all facilities completed and documented, textual bligations of this part submitted.
Milestone 2. Water efficiency program for all facilities completed and documented, draft report submitted.
Milestone 3. Delivery of final report and demonstration of presentation package. (holdback amount)

7. Co-ordination

All work will be carried out in close cooperation with IWD. The contractor will report directly to the departmental technical authority (DTA), at Water Conservation and Project Evaluation Section, Engineering and Development Division, IWD, Environment Canada.

7.1 Departmental technical authority (DTA)

The DTA on this project is Gerry MacMillan, P Eng., or his delegate, Engineering and Development Division, Water Planning and Management Branch, IWD, Environment Canada, Place Vincent Massey, Ottawa, Ontario K1A 0H3; telephone 819-997-2072.

7.2 Target Schedule

The project's target starting date is December 9, 1991, and is to be completed by March 15, 1992. Brief interim reports will be submitted to the DTA, no later than the 20th day, monthly. The final report is targeted for review by IWD by March 1, 1992.

7.3 Total Cost

Any proposal exceeding $130,000 will not be considered. The total cost shall be presented subdivided among the establishments according to the list of Supplement A.

Supplement A - List of federal facilities

Water Audit Pilot Projects

Agency	Facilities	Departmental contact*
Agriculture	Animal Research Centre, Nepean, ON	Sylvie Demers 995-5118
Customs and Excise	Lacolle, QC, border crossing Douglas, BC, border crossing	Marcel Pariseau 994-0235
Energy, Mines and Resources	555 and 562 Booth Street	Albert Potvin 943-0785
Health and Welfare	Sir Frederick G. Banting Building	Richard Renaud 957-1000
House of Commons	Parliament Hill, Centre Block	Jim Taylor 943-8738
Indian and Northern Affairs	Curve Lake, First Nation School (Peterborough Area) Walpole Island, First Nation School (London Area)	Tony Dias 519-758-2414

Water Audit Pilot Projects

Agency	Facilities	Departmental contact*
Public Works	Major-General G.R. Pearkes Building, 101 Colonel By Drive	Pierre Menard 996-6769

* In the unlikely case when a site tour is deemed necessary, please contact the appropriate person below for arranging a visit.

Supplement B - Fact sheets

All fields left blank in the fact sheets, and other information provided on the facilities are to be ascertained by the contractor upon commencement of the contract.

Site and building plans are not reproduced in this manual. For a copy of the complete RFP please call the Water Issues Branch of Environment Canada at 819-953-1515.

- Agriculture Canada - Animal Research Centre
- Customs and Excise - Douglas, B.C. and Lacolle, P.Q.
- Energy, Mines and Resources - 555 Booth Street and 562 Booth Street
- Health and Welfare - Sir F.G. Banting Laboratory Building
- House of Commons - Parliament Buildings, Centre Block
- Indian and Northern Affairs - Curve Lake and Walpole Island First Nation schools
- Public Works - Major-General G.R. Pearkes Building

Agriculture Canada - Animal Research Centre (ARC)

Total building area:	varies	
Person count:	staff:	110
Animal count:	cattle:	520
	chickens	25 000
	sheep	400
	swine	800
	lab animals	8 000
Main water meter location:	The main water meter is located off the site's Woodroffe Avenue principal entrance. Said meter is the only one on site and serves, in addition to ARC, the nearby Animal Disease Institute (ADI). No provisions exist to isolate ARC from ADI, nor to separate group of buildings within ARC.	
Type:		
Particulars:	New meters scheduled to be located according to the attached priority list of buildings on site.	
Previous metering:	Prior to switching to municipal service, the entire site was supplied by local well system. Municipal meter records are available from Public Works (PWC).	
Fixtures (no. of units):	lavatory	
	water closet	
	urinals	
	drinking fountain	
	showers	
Air conditioning:	Details will be supplied after awarding the contract.	

Miscellaneous:	Only the overall site and a few representative building plans are included. Records and blueprints in possession of PWC including underground infrastructure detail, as well as additional building plans will be available after the contract is awarded.		

Customs and Excise - Douglas, B.C. and Lacolle, P.Q.

Total building area:			
Volumes:			
Traffic:	Douglas, B.C.	1989 -	2 210 164
		1990 -	2 612 886
	Lacolle, P.Q.	1989 -	984 491
		1990 -	930 490
Travellers:	Douglas, B.C.	1989 -	4 586 911
		1990 -	5 360 914
	Lacolle, P.Q.	1989 -	2 794 635
		1990 -	2 687 294
Main water meter location:	There are no confirmed meter readings at either site. In fact, meter locations need to be confirmed.		
Type:			
Particulars:			
Previous metering:			
Fixtures (no. of units):	lavatory water closet urinals drinking fountain showers		
Air conditioning:			
Miscellaneous:	Collected wastewater is disharged to septic systems. This is of interest to us and is of a size that a new/additional meter would be installed if recommended. Basic building layouts attached, additional/more complete drawings available after awarding contract.		

Energy, Mines and Resources - 555 Booth Street and 562 Booth Street

Total building area:	555 Booth Street	19 512 m^2
	562 Booth Street	2 758 m^2
Person count (approx.):	555 Booth Street	228
	562 Booth Street	23
Main water meter location:	The main meters are located in the basement of each building (see drawings). There are also auxiliary meters attended by Public Works operators. 562 Booth Street has only one main meter, whereas 555 Booth Street has submetering. However, the exact location is not available.	
Type:		
Particulars:		

Previous metering:	Readings (monthly totals) by Public Works are attached. Further information on consumption and costs could be obtained from Public Works.
Fixtures (no. of units):	lavatory water closet urinals drinking fountain showers
Air conditioning:	
Miscellaneous:	Typical floor layout of 555 Booth, and all floors of 562 Booth are attached, additional/more complete drawings available after awarding contract.

Health and Welfare - Sir F.G. Banting Laboratory Building

Total building area:	36 170 m^2	
Person count:	employees:	400
Main water meter location:	In basement mechanical room. All water supplied through this one meter, from city mains.	
Type:		
Particulars:		
Previous metering:	Readings (monthly totals) by Public Works are attached.	
Fixtures (no. of units):	lavatory water closet urinals drinking fountain showers	
Air conditioning:		
Miscellaneous:	Drawings supplied with the RFP indicate three distinct operational parts to this building. The establishment of details, such as the method of supply to each part, is a study requirement. The internal cold water pipeline arrangement allows for the installation of additional submeters at various locations throughout the building. Only typical floor layouts attached, additional/more complete drawings available after awarding contract.	

House of Commons - Parliament Buildings, Centre Block

Total building area:	28 189 m^2	
Person count:	employees:	(unknown)
	visitors:	700 000 (approx.)
Main water meter location:	All the water used by Centre Block is measured by two meters located in the basement of the East Block and approximately 2-4 meters in the West Block. These flow meters may serve other areas on Parliament Hill in addition to the Centre Block. The actual areas controlled by these meters are to be ascertained by the consultant after commencement of the contract.	

Type:	
Particulars:	
Previous metering:	Readings (monthly totals) by Public Works are attached.
Fixtures (no. of units):	lavatory water closet urinals drinking fountain showers
Air conditioning:	There are approx. 100 DCW air conditioning units using once-through cooling water. Locations for most of them are available after awarding contract.
Miscellaneous:	The facility may be treated as a standard office building with no evidence of a large unique use. Basic floor layouts attached, additional/more complete drawings available after awarding contract.

Indian and Northern Affairs - Curve Lake and Walpole Island First Nation schools

Total building area:	Curve Lake		780 m^2
	Walpole Island		4 515 m^2
Person count:	Curve Lake	staff:	(unknown)
		students:	48 (approx.)
	Walpole Island	staff:	(unknown)
		students:	387 (approx.)
Main water meter location:	There is no installed water meter at Curve Lake school. While a meter exists on the Walpole Island school supply line, the quality of data is uncertain due to the fact that the band keeps records and these have not yet been obtained.		
Type:			
Particulars:			
Previous metering:			
Fixtures (no. of units):	lavatory water closet urinals drinking fountain showers		
Air conditioning:			
Miscellaneous:	The Curve Lake school can be found in the Peterborough area, whereas the Walpole Island school is located in the London area. Both schools are used for community activities after school hours and on the weekends. Building plans and other information will be supplied after awarding the contract.		

Note: For site visit the consultant needs to obtain written permission (INAC will assist) from the band council to enter the site.

Public Works - Major-General G.R. Pearkes Building, 101 Colonel By Drive, Ottawa

Total building area:	75 224 m^2
Person count:	3 900 (approx.)
Main water meter location:	North Tower basement
Type:	Neptune 4" turbine, R/S=2.625
Particulars:	No ports to connect a flow recorder.
Previous metering:	One-day 5-min interval readings in February, 1991, using a clip-on type flow meter (recorded values available after awarding contract). Additional readings (monthly totals) by Public Works are attached.
Fixtures (no. of units):	lavatory 450 water closet 2 360 urinals 410 drinking fountain 19 showers 40
Air conditioning:	Both dry and wet cooler types installed in self-contained circuit with glycol cooler media circulated by Armstrong type pumps. There are 22 DCW air conditioning units using once-through cooling water. Locations available after awarding contract.
Miscellaneous:	The facility may be treated as a standard office building with no evidence of a large unique use. Typical floor layouts attached, additional/more complete drawings available after awarding contract.

Supplement C - Example survey questionaire

Water Audit Questionnaire

Contact:	Phone:
Section:	
Area:	
Description of operation:	
Age of operation and expected useful life:	
Quantity of water used (estimate if metered values unavailable):	
Daily pattern of water usage (e.g. constant, periodic):	
Seasonal use variations:	
Location of supply lines (to be drawn on floor plan, include hot, cold, other):	
Quantity discharged to sanitary sewer (estimate if metered values unavailable):	
Quality of water discharged to sanitary sewer (suspected contaminants and levels):	
Quantity (or portion) of water used that is discharged to storm sewer estimate if metered values unavailable):	
Quality of water discharged to storm sewer (suspected contaminants and levels):	
Quantity (or portion) of water consumed in operation (i.e. does not reach sewer - estimate if metered values unavailable):	
Have any reduction/reuse/recycle measures been implemented? Describe:	
Possible reduction/reuse/recycle measures for this operation:	
Comments re: historical operating problems identified (i.e. leaks, inaccurate metering	

maintenance, etc.):

Supplement D - Suggested report profile

1. Executive summary

A stand-alone document containing concise summation and analysis of the contractor's findings for the facilities under investigation, including

- a general assessment on the water audit process and results
- identification of water efficiency program opportunities for immediate action
- future water efficiency program enhancement possibilities to resolve problems
- total water savings and potential payback of the selected alternative

2. Water audit

2.1 Methodology

This section is to outline the procedure used by the contractor in the audit process to investigate and review water sources and use. This section should outline the need and use of checklists, assumptions, and criteria used to judge water use and any instrumentation or software used during data collection in the course of the study.

2.2 Identification and quantification of sources and uses

This section is to outline the results of the water audit including the identification and quantification of sources and uses of water by the extensive use of graphical representations. Separate sub-sections required for each facility.

3. Identification and analysis of options

This section is to outline the alternatives (i.e., options and proposals) to achieve the objective of enhancing water use efficiency at the selected facilities. Separate sub-sections required for each facility.

Sample Contract Proposals Evaluation Criteria

A firm's proposal must be submitted in triplicate (3) and presented in two (2) parts:

1. Proposed services and personnel; and
2. Proposed basis of payment.

Proposals will be evaluated and scored using the requirements below and on a cost per point rating. Consultants must ensure that the following criteria are addressed in sufficient depth to enable a thorough assessment:

1. Proposed Services and Personnel

The Firm (10 points): Importance Factor: 3

The proposal must clearly demonstrate that the firm possesses extensive experience in the conduct of at least two (2) projects similar in scope and nature to the work described in this RFP.

Point rating will be based on the number and similarity of projects carried out in the last five years.

Proposed Personnel (25 points): Importance Factor: 4

The proposed personnel must have experience in at least 2 projects similar in scope and nature to the proposed project.

For all personnel and firm requirements, consultants must provide the following information on previous projects:

- Title/scope/description of project
- Client
- Year completed
- Person-days expended and fees received
- Individual's/firm's responsibility on the project

Proposals must include resume of proposed resources which support the skills/expertise being offered. Names and telephone numbers of business references must be provided for each project.

The proposed personnel will be rated for experience in projects similar in scope and nature to the proposed project.

Understanding (30 points): Importance Factor: 1

A clear understanding of the scope and nature of management of water use and re-use must be demonstrated. In addition, proposals should illustrate an understanding of the problem and the rationale leading to the undertaking of this development project, and an understanding of its scope and objectives.

Approach and Methodology (25 points): Importance Factor: 2

Proposals should outline the general approach and specific tasks, steps or phases to complete all aspects of the project. Specific detail should be provided to allow for a complete understanding of the consultant's approach to the work and the characteristics of the deliverables that their approach will produce.

Work Plan (10 points): Importance Factor: 5

A workplan and schedule for completion of the work phases should be provided including anticipated dates for major milestones.

The workplan shall indicate the degree of involvement of the project leader and proposed personnel for each task.

The workplan must illustrate a commitment to meeting the assignment's objectives and target dates.

B. Proposed Basis of payment **Importance Factor: 6**

Proposals must provide a fixed price for the services herein described, including travel and living costs but excluding GST. The amount quoted for travel and living costs will establish the maximum that can be invoiced under the contract.

Bidders are requested to prepare a payment schedule for specific deliverables.

Evaluation using requirements and point rating

In order to qualify, the proposal must meet all requirements of this Request for Proposal and achieve a minimum of 70 points for the criteria that are subject to point rating. The rating is performed on a scale of 100 points.

Proposals not meeting the requirements or achieving 70 points in the point rated requirements will be given no further consideration.

Neither the valid proposal that scores the highest number of rating points nor the one that contains the lowest cost estimate will necessarily be accepted. The selection of the consultant will be made on the basis of the best overall value in terms of technical merit and cost, which will be determined by dividing the proposed cost by the total technical score so as to establish the lowest cost per point.

Right to negotiate

Environment Canada reserves the right to further negotiate with bidders in order to arrive at the most cost effective contract that is in keeping with terms and conditions of this request for proposal or not to award a contract at all.

Appendix A – Forms

Water Audit Questionnaire for Federal Facilities

Contact:	Phone:
Section:	
Area:	
Description of operation:	
Age of operation and expected useful life:	
Quantity of water used (estimate if metered values unavailable):	
Daily pattern of water usage (e.g. constant, periodic):	
Seasonal use variations:	
Location of supply lines (to be drawn on floor plan, include hot, cold, other):	
Quantity discharged to sanitary sewer (estimate if metered values unavailable):	
Quality of water discharged to sanitary sewer (suspected contaminants and levels):	
Quantity (or portion) of water used that is discharged to storm sewer estimate if metered values unavailable):	
Quality of water discharged to storm sewer (suspected contaminants and levels):	
Quantity (or portion) of water consumed in operation (i.e. does not reach sewer - estimate if metered values unavailable):	
Have any reduction/reuse/recycle measures been implemented? Describe:	
Possible reduction/reuse/recycle measures for this operation:	
Comments re: historical operating problems identified (i.e. leaks, inaccurate metering maintenance, etc.):	

{DEPTNAME} {FACILITY} {ADDRESS} {LASTLINE}	Date:		Page:___________of______
	Fax to:	Name:	
Water Conservation Pilot Project		Fax No.:	Tel. No.:

Month:	Year:
Meter Location/Identification:	Flow meter units:

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
						Sample: 1500 hrs 38567

Please enter date, the time and reading for each. When month completed forward promptly.			
FROM	Name:	Fax No.:	Tel. No.:
NOTES (enter unusual event description or other remarks below):			

Appendix B

Case Studies

- Animal Research Centre (AgrC) *
- Sir F.G. Banting Building (HWC) *
- Chemical Radioactive Ores Building (EMR) *
- Canadian Centre for Inland Waters (EC)
- Curve Lake First Nation School (INAC) *
- Douglas Border Crossing (RC-CE) *
- Fuel Research Laboratory (EMR) *
- Lacolle Border Crossing (RC-CE) *

- **Major General G.R. Pearkes Building (PWC)***
- **Ottawa International Airport (TC)**
- **Parliament Hill Centre Block (HofC)***
- **Walpole Island First Nation School (INAC)***
- **Warkworth Institution (CSC)**

Note: The facilities marked with an asterisk were part of a water audit study completed by Proctor and Redfern Limited between December 1991 and April 1992, on behalf of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities. Due to time limitations, the study examined only portions of the water supply system for a two-week period, so projected savings and costs are preliminary in nature. Nevertheless, the study concluded that excellent opportunities exist to achieve significant water reduction at the ten audited sites.

All cost estimates reflect expenditures necessary to procure and install only the recommended devices, and exclude any incidental engineering and construction costs that may in fact be necessary to achieve the stated water reduction at those facilities.

All payback periods are based on these preliminary cost estimates and on current water charges.

Animal Research Centre (AgrC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Agriculture Canada chose the Animal Research Centre as its nominee to demonstrate water conservation/efficiency opportunities with short payback period characteristics.

The Centre is a collection of buildings housing various domestic animals and support materials scattered around the site. Water from a regional main is supplied to 11 animal and maintenance groups. In addition to the predominant water consumption by animals, water is used by laboratories, laundry facilities, cooling, and staff showers, as well as for drain flushing, boiler make-up water and feed preparation process.

The objectives for this study were twofold, to

- identify and quantify uses of water for each building group and for the entire facility
- identify and recommend options, based on cost-benefit analysis, for reducing the overall water requirement.

The cost of the study was $27 000.

2. Water audit

To test the integrity of the extensive underground water distribution network, a leak detection survey was undertaken. No leakage was found. Due to the diversity of uses on site, several new water meters were installed. For a 3 week period in January these and the existing meters were read twice a day. The water balance, completed for the main meter and for all individually metered buildings, indicated a 9% loss in the system. The extensive flow monitoring and on-site water use survey indicated that the average estimated water demand for the Centre was 310,000 L/d. During the summer months this demand is expected to increase because of cooling water used in air conditioners.

An estimated 20 000-130 00 L/d of water is used at many barns for 4-5 days in the spring and fall to wash out the manure that has collected over the previous season. In one building over 40% of the total water used by the whole site runs continuously 24 h/d; most of it is used by a drain flushing system, which accounts for an estimated 129 000 L/d. This is a far higher volume than would normally be expected. At the processing plant, an estimated 34 000 L/d is used for walk-in coolers.

3. Water management program

Immediate water reductions can be achieved by replacing the self-flushing urinals with flush valves. The cost of the modifications is $1 500, and with savings of $4 550, a payback period is 4 months. Major water reduction would result from the elimination of once-through cooling at a number of buildings with a payback period of 1.5 years, from the net $23 900 saving and $35 000 modification cost. Pending the outcome of further investigations, there is a potential for savings of up to $35 000/year for the continuously flushing drain lines.

The recommended program includes a range of measures, including routine monitoring of all meters, installations of low-flow devices, replacement of once-through with closed-loop cooling systems, and reduction of flow rate to floor drains. The overall cost of the program, which has 56% volume savings potential, is estimated at $36 600 with a 5-month payback period.

Sir F.G. Banting Building (HWC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Health and Welfare Canada chose the Sir F.G. Banting Building as its nominee to demonstrate water conservation/efficiency opportunities with short payback period characteristics. This institution is a multi-discipline research facility with laboratories and offices in two wings and a large animal wing. Water is supplied from the regional network and, beyond a main meter, the system branches into the three distinct wings of the building. The recirculated hot water system is arranged similarly and serves the animal handling wings for cage washing and hydrobrushing. There is a "shower in" and "shower out" requirement for personnel entering the area. Cold water is used for cooling, the cafeteria, the washrooms, and laboratory use. A distilled water unit fulfills requirements for the research areas of all wings. Since the facility had only one meter and was a high consumer of both cold and hot water, it was decided to submeter both systems for all three wings. The main objectives of this study were to identify and quantify uses of both hot and cold water for each wing and for the entire facility. The study was to identify and recommend options, based on a cost-benefit analysis, for reducing the overall water requirement. The cost of the study was $20 000.

2. Water audit

Over the 3 week monitoring period the average cold and hot water demands of 188 000 L/d and 41 000 L/d, respectively, were measured. The Laboratory wing was the largest user of cold water at 144 000 L/d, of which two-thirds was used for cooling, and an estimated 33 800 L/d consumed by various laboratory uses. A further 39 000 L/d of cold water was used by the air handling units in the Laboratory wing. In the Animal wing total cold water use was estimated at 35 500 L/d, of which the air handling units used 27 500 L/d. The coolant for storage rooms was the major user of cold water (12 600 L/d) in the Communal wing. The greatest volume of hot water (24 000 L/d) was utilized by cage and bottle washers in the Animal wing. A further 9 600 L/d was estimated for use in experiments, cleaning, and washing equipment in the Laboratory wing. Most of the hot water (3 000 L/d) in the Communal wing was used by the kitchen dishwasher.

3. Water management program

Due to the sensitive nature of processes dealing with the animals drinking water supply, cleaning, etc., water reductions in these areas have not been included. Replacing all the fittings in the washrooms and showers with low-flow devices would save $5 000/year in water and energy costs. The $7 650 for the work would give a payback period of 1.5 years. Installation of low-flow valves in washrooms would save $1 430. The installation cost would be $250, and the payback period 0.2 years. Converting water-cooled refrigeration equipment to closed-loop systems would result in yearly savings of $14 000. The modification costs of $30 000 would give a payback period of 2.1 years. A sewer charge rebate could be negotiated with the region to take into account the over $5 600/year in sewer charges currently charged for water that does not discharge to the sewer. Cooling water should be reused for process purposes such as humidification. While hot water use for showers and washrooms would be reduced by the same proportion as cold water, water savings would also contribute to energy cost savings. The overall cost, which has 41% volume savings potential, is estimated at $39 900 with a 10-month payback period.

Chemical Radioactive Ores Building (EMR)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group On Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Energy, Mines and Resources Canada selected the Chemical Radioactive Ores Building (555 Booth Street) as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics.

The building, constructed in the early 1960s, has three wings accommodating laboratories and administrative offices. All water supplied to the building from a regional water main passes through a meter before being distributed by a riser system in a continuous common loop. All air handling units, drinking water chillers, the domestic hot water system and the hot water perimeter heating system are located in the basement. All special water use equipment (a water distillation unit, a de-ionizer/water purifier, and a cooling tower) are located in the west wing. There are water-cooled AC units throughout the laboratory wings.

Identification of the uses of water at the building and recommendation of options for reducing the overall requirement for water, as well as a cost-benefit analysis for each option were requested of the consultant. The cost of the study was $11 000.

2. Water audit

A 4-week period of flow monitoring indicated that half of the estimated 136 000 L/d average weekday water demand for 555 Booth Street was used by air handling units. Primarily during the winter, these units use approximately 70 000 L/d for air wash and humidification. In the summer months, the air handling demand is replaced by 44 000 L/d needed to cooling water requirements in air conditioner units. Continuously operating flush tank urinals use 15 000 L/d, whereas compressor after-cooling and pump lubrication/cooling account for another 13 000 L/d and 11 000 L/d respectively.

3. Water management program

The installation of low-flow valves on the self-flushing urinal tanks at 555 Booth Street would save $3 450, with a payback of 0.5 years for the $1 750 installation cost. Many water-cooled air conditioning units should be replaced by air-cooled units or converted to a closed-loop cooling system. The latter would cost $20 000 with a 4-year payback period, from the net annual saving of $5 000. A number of cooling loads in the basement, which include drinking fountain chillers, air compressor cooling, and tenant equipment, should be converted to a closed-loop cooling system. The savings of $12 000 and modification cost of $10 000 will give a 10-month payback period. A sewer charge rebate could also be negotiated with the municipality to take into account over $6 000 in sewer charges currently charged for water that does not discharge to the sewer. When water must be used for cooling, it should be reutilised for process purposes such as humidification. The overall cost of the program, which has 42% volume savings potential, is estimated at $32 250 with a 12-month payback period.

Canada Centre for Inland Waters (EC)

Abstract

1. Background

The CCIW research/laboratory establishment, built around 1967 in Hamilton, occupies 47 700 m^2 of mixed use floor area in seven wings of a single structure. The facility has, in the past, taken a number of water conserving and cost saving actions. Since 1985, uncontaminated water has been diverted through a storm sewer outlet to Hamilton harbour. This resulted in decreased flows to the Hamilton Wastewater Treatment Plant, and as a consequence, credit continues to be received on sewer surcharges from the local water authority. Further actions included

- replacement of manual flush units with automatic ones in urinals
- installation of water meters to monitor water use and to allocate costs
- use of harbour water for lawn watering

- reduction in flush/refill frequency in tanks and flumes by cutting back the algae growth rate

All these actions have resulted in an annual water and sewerage bill of about $160 000 after rebates. To further enhance water conservation at the facility, a consultant was retained to complete a water efficiency audit. The cost of the study was $35 000.

2. Water audit

A 3-week period of flow monitoring and an on-site water use survey indicated that the average estimated water demand for the institution was 23 800 m^3/month. Over the recording period, the base load of water use was about 70% continuous flow. Water use tended to concentrate in two main areas:

- fisheries laboratory (183 m^3/d average, of which 174 m^3/d is discharged)
- administration and laboratory wing (299 m^3/d average, of which 200 m^3/d is used for once-through cooling and subsequently discharged)

Water use was split into four categories represented by a percentage of the city water intake: cooling (50%), process (36%), domestic (7%), and laboratory (7%). Water intake totalled 717 m^3/d including 7% unaccounted-for water flow. The estimated per capita domestic use in the facility is 65 L/d.

3. Water management program

The main recommendation concerns the curtailment of cooling water demands. Due to CCIW's fortunate location, all cooling water may be drawn directly from the harbour. The cost of intake development to replace ca 327 m^3/d of city water was estimated at $101,000. The estimated savings at current water costs are $53 000/year for a payback period of under 2 years.

At 36%, the fisheries laboratories' tanks use the second largest volume of city water. The cost of reusing some of the once-through cooling water for process applications ($23 350) would result in annual savings of $22 600, for a 1.03-year payback.

With water-saving devices already in place, only user habit changes could produce small savings. It was also proposed to

- move certain operations at the laboratories to periods when lower volumes of water are used
- reactivate the existing pressure-reduced cold water network to achieve water use reductions
- more thoroughly use existing/new water meters to monitor use and ensure that reductions maintained in the future

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Curve Lake First Nation School (INAC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Indian and Northern Affairs selected the Curve Lake First Nation School as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics.

It is primarily an elementary school but offers some adult education programs, operating 194 days per year with a current enrollment of 53 students and 8 staff members. Adult education classes, with 7 students and one instructor, are conducted 335 days/year in a portable classroom located on the elementary school site. Generally, both elementary and adult students occupy the school weekdays between 0845 and 1600 hours. The domestic cold water supply at the elementary school and the portable classroom is pumped from a well (no permanent flow meter) located on the school site.

The objective for this study was the identification of present water uses at the school site. A cost-benefit analysis of the recommended measures for reducing the overall requirement for water was also included. The cost of the study was $6 000.

2. Water audit

As stated previously, there was no existing water meter at the facility and a pump supplied water to the school on demand. To document water consumption by the facility, a clip-on meter was used to record pump operation.

A week of flow monitoring indicated that the average estimated water demand for the institution was 3 500 L/d, which was reasonable for a small facility. The domestic portion of the water, 2 500 L/d, is used in the washrooms. This includes a system loss of 270 L/d, attributed to a leaking toilet in the boys' washroom. Process water, 1 060 L/d in total, was estimated for general use (including cleaning) in the classrooms and daily flushing of the pipes at the drinking fountain.

Commencing with the summer of 1992, a lawn watering program will be implemented; however, its effects were not considered in the audit.

3. Water management program

The only water reduction alternative is in the domestic uses. Retrofitting the plumbing fixtures with low-flow devices would give an annual saving of $850. The observed leak in the boys' washroom could cost as much as $400/year. At an estimated cost of under $50 to fix it, this would pay back in about one month.

The overall cost of the program, which has 39% volume savings potential, is estimated at $3 300 with a 32-month payback period.

Douglas Border Crossing (RC-CE)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Revenue Canada, Customs and Excise, selected the Douglas, B.C., border crossing station as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics. It is a smaller than average facility with the Customs and Immigration departments contained in a common block processing primarily noncommercial border traffic. In 1990, there were about 5.3 million cross-border travellers processed by this facility. At one time, domestic cold water was supplied to the facility from the United States, but in the past few years the water main was replaced, and water is now purchased from Canadian sources. Two existing meters are located in hand holes at the municipally operated water main, making the water supply to the Immigration and Customs areas entirely separate. The water supply is generally limited to drinking fountains, washrooms, and make-up water for the domestic hot water heater and the hot water heating system.

The water audit study was to identify and quantify uses of water for the entire facility as well as to identify and recommend options for reducing the overall requirement for water and to carry out a cost-benefit analysis for each option. The cost of the study was $10 000.

2. Water audit

Flowmeter reading for the Immigration building was intended to continue for a 3-week period, but seasonal rains flooded the meter chamber so that the meter could not be read. No flooding problems arose in the meter chamber for the Customs building, and the meter was monitored over a 5-week period. Separate individual balances for the Immigration and Customs building totalled 18 100 L/d and 3 800 L/d respectively. Most of the water, 17 900 L/d, in the Immigration building is consumed for domestic purposes in the public washrooms and drinking fountains. Process water is used in the kitchen at an estimated 190 L/d and the lawns are watered in the summer. The domestic water use at the Customs building is estimated to be 3 020 L/d. During the busier summer months the above figures will increase significantly. The process water uses are in the kitchen and at the alcohol disposal tank with 780 L/d. An exterior sprinkler system waters the lawns in the summer.

3. Water management program

If all the lavatories were fitted with aerators and/or flow restrictors, and all the water closets and urinals were fitted with low-flow flush valves, the total domestic water consumption would be reduced by an estimated 4 700 L/d. This would amount to savings of $450/year. The cost of the proposed renovations would be approximately $3 150 for an estimated payback period of 7 year. Since summer time will bring more people and more domestic water use, a significantly shorter payback period can be expected. Reducing the present flush rate by throttling back the valve to the flush tank in the men's public washroom would produce an immediate savings of approximately 7 000 L/d. Water and cost savings would amount to 2 555 000 L/yr or $670.

The overall cost of the program, which has 39% volume savings potential, is estimated at $3 150 with an 34-month payback period.

Fuel Research Laboratory Building (EMR)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Energy, Mines and Resources Canada chose the Fuel Research Laboratory Building (562 Booth Street) as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics.

The Laboratory, constructed about 1930, is a three-storey building and was selected for water audit because its historical water use was high for its building size. The building has a floor area of 2 758 m^2 and a staff of 18. The domestic cold water is supplied to the facility by city water mains operated by the Regional Municipality of Ottawa-Carleton. Beyond the water meter, the domestic cold water branches into three lines to serve the south, north, and centre of the building. At one time, the south branch was used to supply air conditioning units and laboratory sinks; however, most of the air conditioning units and sinks have been disconnected. The centre branch supplies make-up water to the domestic hot water system. The north branch supplies the remainder of the building, including washrooms, laboratories, one large walk-in refrigeration unit, and one small unit. Identification of the uses of water at the building and recommendation of options for reducing the overall requirement for water, as well as a cost-benefit analysis for each option, were requested of the consultant. The cost of the study was $7 000.

2. Water audit

Meter readings for the two 2-week periods produced an average estimated water demand of 8 500 L/d. As a note of interest, a video camera was used to take hourly readings for two days due to the lack of personnel available.The completed water balance indicated that domestic water was used by the 18 staff in the washrooms at an estimated 600 L/d. The largest flow, 3 000 L/d, is at two flush tanks in the men's washrooms. The once-through cooling for the building has been reduced in recent years. Two large walk-in refrigerator/freezers have been removed, and the use of room air conditioning units in the summer months has been significantly reduced. The remaining walk-in refrigerator/freezers use an estimated total of 3 000 L/d. An estimated 1 900 L/d is used in the laboratories and support rooms in the building. The historical water records for 562 Booth Street indicated a ten times greater flow into the building than was recorded during the audit. The facility staff have been alerted to this discrepancy and will investigate the matter.

3. Water management program

The installation of new flush valves on 2 self-flushing urinals in the washrooms will save $1 300/year, with a 0.3-year payback period, for a modification cost of $375. A closed-loop cooling system could be installed for the water-cooled refrigeration systems for a savings of $900/year. The modifications cost would be $5 000 and the resulting payback period 5-6 years. The water-cooled air conditioning units should continue to be removed or replaced with air-cooled units. The ten times discrepancy in flowmeter reading has the potential for a reduction in the water bill of $33 600/year.

The overall cost of the program, which has 97% volume savings potential, is estimated at $5 375 with a 2-month payback period.

Lacolle Border Crossing (RC-CE)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Revenue Canada, Customs and Excise, selected the Lacolle, P.Q., border crossing station as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics. The crossing, regulating both commercial and noncommercial cross border traffic, comprises several buildings for Immigration and Customs operations. It processed approximately 2.7 million travellers in 1990. Domestic cold water for the site is supplied by a well and reservoir system. Some treatment of the water is undertaken at the reservoir before its discharge to the site distribution system. The main meter is located immediately after the domestic cold water pumps, and a sub-meter is in the Duty Free Shop. All water used on the site passes through the main meter except during periods of high flow, at summer weekend evening hours. On these occasions when the domestic cold water system pressure drops, the fire pumps operate to increase the water supply. Most water is used in the washrooms and some air conditioning units; a small amount of make-up water is needed for the hot water heating system. Water use by the sewage treatment plant is minimal and infrequent. The water audit was to identify and quantify uses of water as well as to identify and recommend options for reducing the facility's overall water requirements and to carry out a cost-benefit analysis. The cost of the study was $11 000.

2. Water audit

A 2-week period of flow monitoring indicated that the average estimated water demand for the facility is 22 900 L/d. Because of the nature of operations, the busier summer months will increase this demand significantly. As the station has an extensive underground network, about 3 000 m, there is potential for leakage. Routine detection survey indicated no leaks. The main areas of water use at the station are in the public washrooms, with an estimated 8 400 L/d used. The staff washrooms, lunchrooms, and locker rooms use an estimated 4 100 L/d; the Duty Free Shop uses 3 700 L/d of water in the washrooms; and an air conditioning unit uses an estimated 10 000 L/d. Summer cooling water demand will increase with the use of two additional air conditioners.

3. Water management program

If all the lavatories were fitted with flow restrictors and all washroom fixtures were fitted with low-flow flush valves, the total domestic water consumption would be reduced by an estimated 3,600 L/d. For the estimated $8,650 retrofit cost, a 1.6-yr payback period would result. A closed-loop cooling system for the air conditioning units could be installed for approximately $10,000. This system would save 7 300 000 L/yr. The estimated annual cost savings would be the water saved, less the cost of electrical energy required to run the pump and fans on the closed-loop cooler. The estimated water savings are $30 150/year; when the operating cost of $1 300 is taken into account, the net savings are $28 850. The resulting payback period is 0.4 years. An additional benefit would be the elimination of seasonal demands, thereby reducing the need for the fire pump to operate in summer months to maintain system pressure. The overall cost of the program, which has 69% volume savings potential, is estimated at $18 650 with a 7-month payback period.

Major-General G.R. Pearkes Building (PWC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Public Works Canada chose the Major-General George R. Pearkes Building (101 Colonel By Drive) as its nominee to demonstrate water conservation/efficiency opportunities with short payback period characteristics. The complex is essentially an office building comprised of two 20-storey towers and a central building of 12 storeys. The domestic cold water supply system for the entire complex is controlled from the North Tower, where city water enters at the basement level mechanical room. The system consists of three components: the city pressure system, a low rise pressure system, and a high rise pressure system serving various heights of the complex. Domestic water is used in the washroom facilities, for air conditioning units, and kitchen refrigerators and freezers, as well as in cooling tower make-up during the summer months. This water audit study was to identify and quantify uses of water for the entire facility as well as to identify and recommend options for reducing the overall requirement for water and to carry out a cost-benefit analysis for each option. The cost of the study was $10 000.

2. Water audit

The existing water meter was read twice daily for a 3-week period and exhibited typical water use patterns for an office complex with an estimated average of 429 000 L/d. Most of the 20 floors have two women's and two men's washrooms, which use an estimated 117 500 L/d of water. In addition, continuously operating self-flushing urinals in many of the washrooms account for an estimated 116 000 L/d. Cooling is accomplished by once-through city water, a closed-loop cooling tower between the 11th and 20th floors, and chilled water from the central plant. The city water air conditioning units located throughout the building account for an estimated 129 800 L/d. A further estimated 17 300 L/d is used as cooling tower make-up in the summer. Kitchen fridges and freezers and serving hatches use an estimated 25 000 L/d of cooling water. The kitchen dishwasher and pre-scrubbing machine is the largest process water user at an estimated 13 000 L/d. In the summer, the outside lawns are watered by an estimated 70 000 L/d a day.

3. Water management program

The installation of low-flow valves on up to 40 self-flushing urinal tanks will save $40 000/year. For a modification cost of $10 000, the payback period will be 3 months. The large number of water-cooled air conditioning units should be converted to chilled water or a closed-loop cooling system. A net savings of $20 000 would result in a payback period of 2 year when the modification cost of $40 000 is taken into account.

Other water-cooled equipment, including drinking fountain chillers and the cafeteria fridges and freezers, should be converted to a chilled water or closed-loop cooling system at a cost of $10 000. The savings of $4 500/year will give a payback period of 2.2 years. At the soil table in the cafeteria, control of water use could save up to $1 580/year. When cooling water is unavoidable, it should be reused for process purposes such as plant watering or floor drain priming. It was noted during the audit that generally the larger pump operates continuously and the small pump infrequently. There was no installed standby large pump, so consideration should be given to improve the current standby provision. The overall cost of the program, which has 54% volume savings potential, is estimated at $60 000 with an 11-month payback period.

Ottawa International Airport (TC)

Abstract

1. Background

Under the sponsorship of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, Transport Canada has selected the Ottawa International Airport (OIA) as its test site to demonstrate water conservation/efficiency opportunities. The OIA shares the airport complex with NRC and DND areas of operations. The audit was restricted to only those Transport Canada facilities where most of the water consumption was assumed to occur, including the terminal and support/maintenance buildings, hangars, and control tower. The airport complex receives potable water from regional municipality sources via storage and treatment on DND territory. It is pumped to all users with OIA being served by two unmetered water mains.

The audit objectives included

- undertaking a system balance to account for water used throughout the facility
- identifying and quantifying characteristic water uses for each selected building
- identifying and recommending options, based on cost-benefit analysis, for improving water efficiency and reducing the overall water requirement

The cost of the study was $30 000.

2. Water audit

Temporary insertion meters and clamp-on meters, attached on supply lines, and all existing meters were monitored for up to 2 week. The average estimated water demand was found to be 672 m^3/d, indicating that the audited buildings accounted for almost 62% of the total demand. Over the recording period, the base nighttime flow was 192 m^3/d. Almost 50% of all OIA consumption was concentrated in the main terminal building (218 m^3/d) where both the restaurant and flight kitchen are located. Washrooms for the travelling public and staff used 70 m^3/d. Consumption demands, due to air conditioning and lawn watering, will likely increase during the summer. Several washrooms and a canteen contribute to the 27 m^3/d used in the flight services hangar representing approximately 10% of all OIA uses.

Leak detection survey indicated a tight system; therefore, buildings not monitored account for the balance of water use. Further investigations are necessary to determine whether any of these buildings consume significant volumes of water.

3. Water management program

The main recommendation concerns the replacement of most existing flow meters, which are oversized and underrate the flow, particularly those used for billing purposes. A number of discrepancies between the maintenance computer and the site meters were observed. Relays should be checked to ensure that all communications with the computer are accurate. In addition, permanent meters should be installed on both supply lines to confirm billing from DND and to monitor consumption trends for possible losses.

Throughout the audit some wastage were identified in the walk-in coolers. Savings may be realized by changing to a closed-loop system but payback periods would be high. The practice of supplanting automatic shut off valves on washroom fixtures should continue. Low-flow nozzles should be installed in the maintenance hangar to reduce equipment cleaning water use. A method of billing customers for the water used in the Aircraft Sewerage Disposal Building should be investigated.

Supplying lawn irrigation needs from local reactivated backup wells and implementation of an annual leakage detection survey should be investigated.

Parliament Hill, Centre Block (HofC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. House of Commons officials selected the Centre Block to demonstrate water conservation/efficiency opportunities with short payback period characteristics. Most of the internal piping and appurtenances in the Centre Block date to the reconstruction of the early 1920s. The external domestic cold water supply is unique in that it actually forms part of the internal system with entry to Centre Block from the East and West Blocks. It is therefore possible for water to flow out of Centre Block at either end of the building. There are no water meters located on the internal watermain system in the building, and past water usage rates have been assessed from meters recording water consumption for all of Parliament Hill. City water pressure being insufficient, most of the building is supplied from a pumped storage system. Water is pumped to storage reservoirs located in the sixth floor towers. Domestic cold and hot water supply systems are duplicated for the Commons and the Senate sides. Special water use areas are the cafeteria and restaurant. During the summer, offices located on the south side of Centre Block are supplied with air conditioning units which operate with once-through cooling water. The water audit was to identify the uses of water for the entire facility as well as to recommend options for reducing the overall requirement for water and to carry out a cost-benefit analysis for each option. The cost of the study was $23 400.

2. Water audit

Due to the lack of installed flow meters and the unacceptability of both insertion meters and clamp-on devices, the times of operation of the domestic cold water pumps in Centre Block were measured indirectly, and flow was calculated as 204 000 L/d for a 3-week period. For future monitoring purposes, the most accurate water consumption data will be generated by the installation of permanent flowmeters. Public washrooms used an estimated 63,000 L/d, and private washrooms for MPs' offices an estimated 6 000 L/d. In the summer an estimated 160 000 L/d is used by water-cooled room air conditioning units and 45 000 L/d for other cooling purposes. A compressor after-cooler accounted for an estimated 13 000 L/d. The main volume in the process category was an unusually high estimated 33 000 L/d for heating system make-up. Two dishwashers at the restaurant and cafeteria use a further 12 000 L/d. In the summer the lawns are watered by an estimated 87,000 L/d, and a continuous flow of 33 000 L/d is estimated to be used at the Centennial Flame Fountain.

3. Water management program

All washrooms should be fitted with low-flow, or flow restrictive devices. The cost of the modifications is $18 750, and the savings of $6 275/year will give a payback period of 3.0 years. Installation of low-flow valves on 8 self-flushing urinal tanks will save $6 000 for a 4-month payback period on the modification cost of $2 000. The water-cooled refrigeration equipment should be converted to closed-loop systems. The modifications would result in a net saving of $24 700/year, and with the cost of the works being $30 000, the resulting payback period would be 1.2 years. Fixing an assumed leak in the hot water heating system would save over $8 000/year in water losses. The overall cost of the program, which has 34% volume savings potential, is estimated at $51 250 with a 12-month payback period.

Walpole Island First Nation School (INAC)*

Abstract

1. Background

Under the auspices of the Interdepartmental Advisory Group on Water Conservation at Federal Facilities, member agencies pledged to conduct water audits at selected sites. Indian and Northern Affairs selected the Walpole Island First Nation School as one of its two nominees to demonstrate water conservation/efficiency opportunities with short payback period characteristics.

Walpole Island First Nation School, located on the Walpole Island Reserve in southern Ontario, is an elementary school, from kindergarten to grade 8, with some special amenities. It operates a normal school year with 365 students and 30 teachers. Generally, the school is occupied between 0830 and 1530 hours on weekdays. Occasionally, extracurricular functions take place, including after-school sports events and weekend craft shows. An existing flowmeter records the domestic cold water supplied from the Reserve's water distribution system.

The objective for this study was the identification of present water uses at the school site. A cost-benefit analysis of the recommended measures for reducing the overall requirement for water was also included. The cost of the study was $6 000.

2. Water audit

Most of the fixtures within the school (lavatories, water closets, and laboratory sinks) represent no extraordinary water uses. Drinking fountains within the facility have been turned off as a result of misuse by the students. The student cafeteria serves breakfasts to students during the winter season. The average daily flow for the entire 7-week flowmeter monitoring period was 12,100 L/d. The main area of water use is for domestic purposes in the washrooms at 10,100 L/d. Visible leaks at six locations throughout the school account for a total of 1 460 L/d of water. The process water used in the laundry room is estimated at 230 L/d. The kitchen dishwasher operates seasonally and accounts for an estimated 100 L/d of water. Janitor's sinks and the laboratories use a further 100 L/d each. A small amount of lawn watering is performed in the summer.

3. Water management program

If all the lavatories were fitted with aerators and/or flow restrictors, and all the water closets and urinals (excluding the self-flushing ones) fitted with low-flow flush valves, the total domestic water consumption would be reduced by 3 480 L/d. The cost of the proposed renovations would be approximately $11 300 for an estimated payback period of over 28 years, an unacceptably long period. The major area for reduction of domestic water lies in the self-flushing urinals. The installation of low-flow valves on the self-flushing urinal tanks would save an estimated $300/year. A 1.7-year payback would result from the $500 installation cost. The need for proper maintenance is also very important. As observed during our site visit, several leaks were detected and, unchecked, these leaks could cost as much as $300/year. The estimated cost of $100 to repair these leaks would give a payback period of 0.33 years.

The overall cost of the program, which has 35% volume savings potential, is estimated at $600 with a 12-month payback period.

Warkworth Institution (CSC)

Abstract

1. Background

The Warkworth Institution is a medium security federally owned correctional facility, located in Brighton Township, Ontario.The penitentiary accomodates up to 590 inmates and 308 daytime staff in over; 40 buildings on the site. Water is supplied to the institution from its own filtration plant which draws water from the Trent River. The collected sanitary sewage receives secondary treatment in wastewater treatment plant on site.

The Institution currently undertakes a rejuvenation program of the water supply and treatment and of sewage treatment facilities. Several objectives were established for this study at the Institution: to identify and quantify sources and uses of water (peak flow, time series of flows, losses, etc.) for each building and for the entire facility as well as amounts and types of wastewater; to identify and recommend options for reducing the overall requirement for water {water saving devices, user habit changes, etc.) and analyze their impacts; to carry out a cost-benefit analysis for each option. The: cost of fhe study was $56 000.

2. Water audit

A 4-week period of flow monitoring and an on-site water use survey indicated that the average estimated water demand for the institution was 259 000 L/d. During the summer months this demand increases to 519 000 L/d, primarily attributed to cooling water used in air conditioners. When the institution's facilities expand and if all uses remain unchanged, the projected demand will increase by 9%. A 262 000 L/d difference is detected between measured water supply rate and estimated demand, indicating losses in the system. Results from sewage flow monitoring at the treatment plant do not exhibit these losses resurfacing as infiltration. The calculated per capita water demand of 668 L/d is comparable to similar facilities; however, it is markedly higher than values quoted in literature.

It was recommended to verify wastewater treatment plant flows by additional flow monitoring.

3. Water management program

Reduction in water use and peak demand at the Institution is attainable by altering components at various points in the supply system (toilets, showers, air conditioners, etc.). Evaluation of cost effectiveness of water reduction measures for toilets and handsinks indicates insignificant gains, whereas the same for all other uses turn out to be acceptable. Implementation of the recommended program would result in 115 ML/yr water savings with a corresponding 40% drop in peak demand. Total cost of the program is estimated at $38 000 with a 2-year payback period. The cost excludes distribution system repair.

The recommended program includes measures from routine monitoring of new meters and eliminating system leaks through installation of low-flow showerheads and tap aerators, replacement of water with air cooled AC units with or without auto timers, and reduction of flow rate to compressors, to installation of auto shut-off outdoor spraying devices.

To maintain the success of the program, staff education, daily flow monitoring, routine inspection and repair of the supply system, installation of water efficient devices, and periodical assessment and update of this program is recommended.