NATIONAL CLEANER PRODUCTION CENTRE, SRI LANKA

Introduction to Water Auditing and Water Conservation

1.1 WATER CONSERVATION

Globally, water conservation means limiting or modifying the use of water by human beings, so that our use of water does not cause fluctuations of water quantity and quality within any cycle beyond those fluctuations caused by natural events (Imberger, J. 1971) within the time-scale of human history. The definition applies to both global and local water cycles, to sources, reservoirs and sinks. This very general definition can be simplified in concrete situations and is often relaxed in its requirements. Water conservation in a local setting often means reducing the volume of water used for a single purpose or for complex systems of purposes. At the same time it implies improving the quality of discharge water and, if possible, reducing the quality of water required for the inputs to the purpose or purposes. By practising water conservation, we seek to provide social, economic, environmental and ecological benefits for the total global community of life, both now and into the indeterminate future.

Efficiency of water use is the complement of water conservation. In this case the quantity and quality of the water source is specified (likewise for the discharge or sink). The aim is to maximise the social, economic, environmental and ecological benefits from the given quantity and quality of water.

Water management is concerned with water source investigation, water allocation and pricing and water source protection and, when protection has not succeeded, putting into practice remedial actions.

Practising water conservation, efficiency of water use and water management in general requires action by human agencies, communities and individual humans. These actions might include legislation or licensing, pricing and other economic instruments and human lifestyle and behavioural changes. We will look at an example.

We choose to focus initially on water resource allocation. Consider the situation where available surface water streams near a city are almost fully utilised by dams, where there is limited groundwater available and yet the city's water usage is rising. Legislation protects further surface streams but one from being tapped, with environmental and ecological protection being among the reasons that the legislation was enacted. Regulations strictly limit the amount of groundwater that might be withdrawn, to forestall the ingress of seawater into the fresh water aquifer. The water provider(s) to the city might increase the price of water in order to limit demand and to avoid the capital expenditure needed to dam the one remaining surface water source, which is allocated for water supply to the city. A consequence of this action will be a change in the behaviour of water users. People and businesses will need to change their lifestyles and modify habitual behaviour, which uses excessive water.

From this example we draw the conclusion that water source allocation implies a complex interaction between government, water supply providers, the human community, the environment and ecosystems. This complex interplay is a feature of all aspects of water management as well as both water conservation and water use efficiency. The example above, where economic instruments are used to compel a community to maximise the benefits from a given quantity of water demonstrate the interaction between water management and water use efficiency. They in turn interact with water conservation. Suppose the number of businesses grows in the city in the example; the businesses will then need to reduce their water use. While from the viewpoint of the city as an entity the issue is water use efficiency, from the viewpoint of the businesses the issue will become water conservation.

1.2 WATER AUDITING

Water auditing is the discipline concerned with quantifying water usage. It provides the means to develop precision in schemes for water conservation, water use efficiency and water management. Take some defined boundary around natural or human-made processes. (See Figure 1.1.) We assume that the system is at steady state and note that other balances are required for water quality assessment (silts for example).

The form of the quantitative heart of a water audit is to measure the quantity and quality of water outputs from within the boundary. The water outputs are compared with the water inputs; they should match within a pre-determined tolerance to regard the quantitative water audit as satisfactory. A water audit as we use the term is concerned with more than just this; water conservation and water use efficiency both inside and outside the boundary of the water audit domain are part of the water audit. In addition it will take account of water management issues outside the boundary as well as inside the boundary as appropriate. Viewing this another way, water auditing focuses upon the processes within the bounded region, with its inputs and outputs, yet it interacts with the wider world as appropriate. While water auditing is concerned with quantifying water usage, it is also value laden, relating to the vision, targets and mechanisms discussed above. Although water auditing was located in the 'mechanisms' above, it is related in a holistic way to the vision and to the targets.

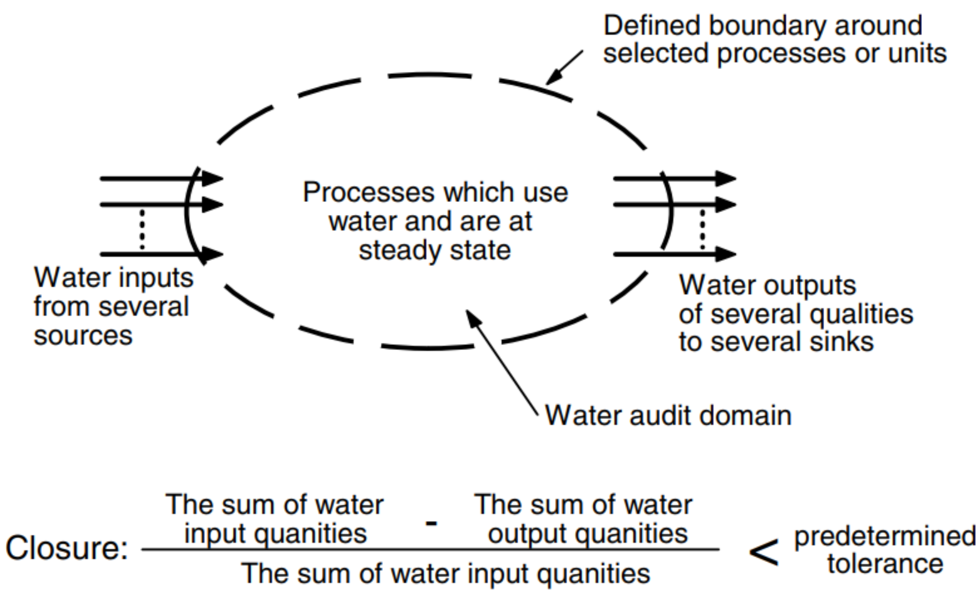

Figure 1.1 The form of the quantitative heart of a water audit

The form of the quantitative heart of a water audit is to measure the quantity and quality of water inputs into the bounded region, evaluate the processes in which water is used within the boundary, and measure the quantity and the quality. Water auditing can be carried out in a wide variety of arenas. Natural systems such as a lake can be audited. The distribution systems of public water suppliers can be audited (This is sometimes called supply-side auditing). End users of water, whether domestic, commercial, industrial, mining or agricultural can be audited. Our focus within this book will be upon end users, with relatively little attention paid to the other categories. There is already work available to the public in the former categories. For example some issues of supply side auditing are treated in a work by the American Water Works Association (1999).

Water auditing costs money; do the benefits of conducting a water audit outweigh the costs? In general terms we answer 'yes', though to quantify an answer requires each actual case to be examined. Why then do we answer 'yes'? In our experience and in the experience of colleagues with whom we have spoken, most enterprises, which use of the order of 105 kL of water per year or more, handsomely benefit from a water audit in purely financial terms and with a payback period on outlays normally of a few years at most. Smaller water users than this, including domestic users, will often benefit from a water audit, but the financial situation might require preliminary assessment before proceeding with a full audit. We answer 'Yes' for other reasons too, with benefits thoroughly canvassed in the outline on a vision for water and life. We have little doubt that the supply of water for human use will become more restricted in the future. The establishment of water auditing as a usual practice is highly desirable now, so that a bank of talent and experience is available for auditing when water supply becomes a yet more urgent problem in the future. Indeed water management is not possible at all without quantitative information. We believe that the same is true for water conservation and water use efficiency if they are to be taken seriously. Thus water auditing might be viewed as quantitative water conservation in the broadest sense.

1.3 THE GENERAL WATER AUDIT PROCESS

'Water auditing is a repetitive, systematic and documented process of objectively obtaining a balance between water input to, and water output from, an operation. Water quality is measured as needed. Opportunities are sought for a reduction of water use, for water reuse, recycling and for water resource substitution. Financial evaluations are made of all opportunities identified. A water management strategy is devised which is consistent with legal requirements, the enterprise's environmental policy and its movement towards sustainable development. The results of this process are communicated to the client and to the auditee where different'.

In Figure 1.2 we present a diagrammatic overview of the water audit process as practiced by the water auditor so as to flesh out diagrammatically the skeleton of the definition. Figure 1.2 is a reworked version of a similar figure in Dawson (1997). It is a simplified representation of the process as viewed by the auditor, rather than a global account. The standard's definition of auditing investigates whether that which is being audited matches pre-established criteria. That is, it focuses upon deviation from criteria. The audit finds out what is wrong or what is right.

Our approach to water auditing and that of our experienced academic and industry colleagues is to go beyond mere compliance with laws, regulations, external or internal standards in an enterprise. A water audit finds opportunities for improvement in water conservation strategies, water recycling and reuse, improvement of discharge quality and for improved financial performance of the enterprise subject to audit.

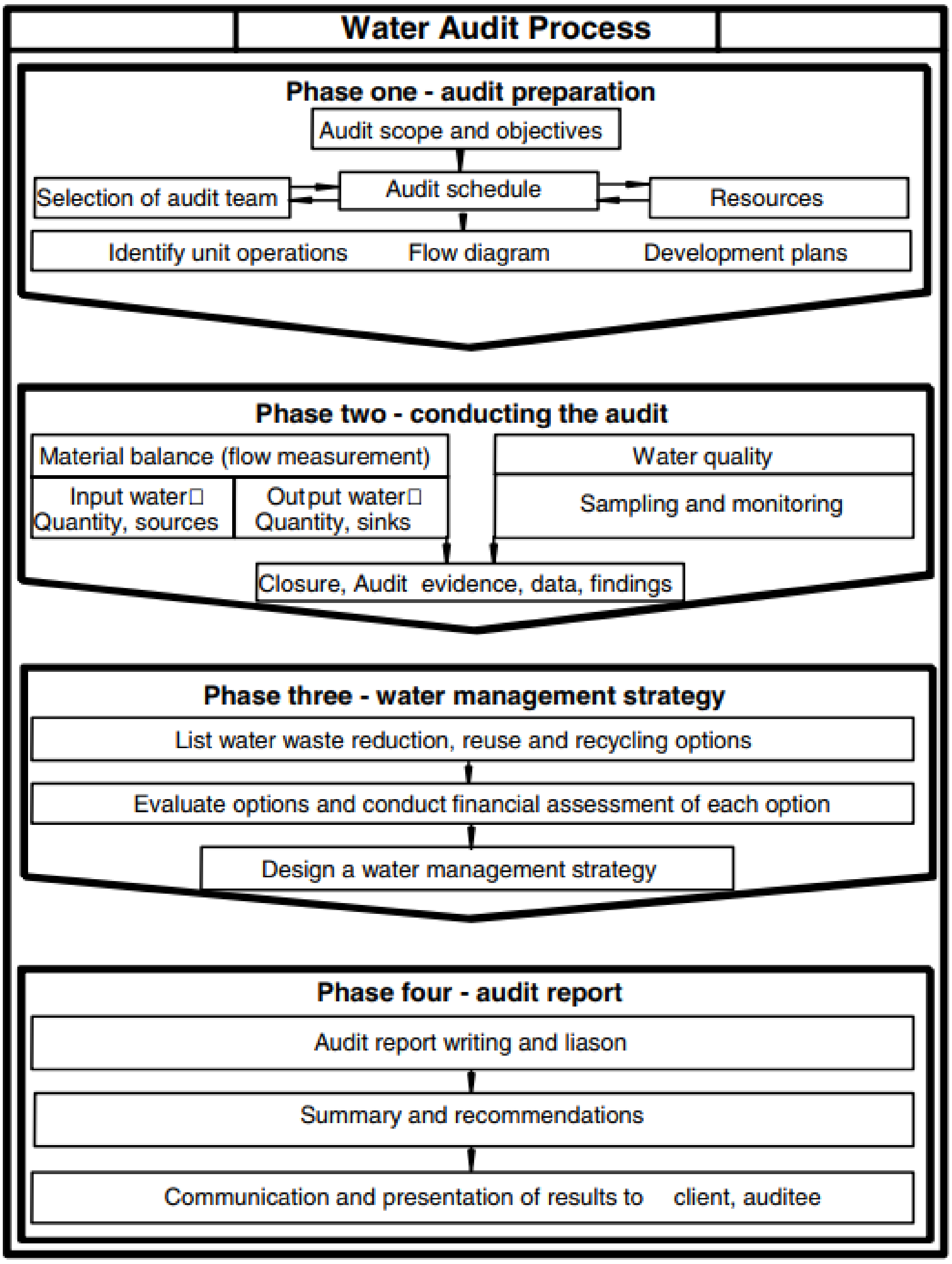

Figure 1.2: A diagrammatic overview of the water audit process as practiced by the water auditor

1.4 QUALIFICATIONS OF THE WATER AUDITOR

ISO 14012:1996 is a guidance standard for criteria for qualification of environmental auditors. The standard lists five areas where their knowledge, skills and understanding should be addressed in work experience, formal training and maintenance of competence. We list the five areas in Table 2.2 in column one, with modified areas in column two to match more closely the needs of water auditors as we see them. Notice that we see the general requirements for water auditors as being very parallel to those of environmental auditors, with water auditors also needing familiarity with environmental science and technology, and with environmental management systems and standards.

Personal skills and attributes of the auditor are addressed in ISO 14012 too. We interpret them as good communication skills, personal and interpersonal skills, autonomy or the ability to be appropriately objective, personal organisation skills, deductive and inferential skills, and cultural and inter-cultural sensitivity.

We believe that these are essential for the water auditor too and should receive great prominence in planned experience, formal training and maintenance of competence. ISO 14012:1996 attends also to work experience and education, to training of auditors both on the job and formally. Most of the standard is very pertinent to water auditor training, yet some special requirements exist for water auditors. The standard requires that auditors have completed at least secondary education (or its equivalent). This requirement seems too loose for water auditors.

Table 1.1: Areas in which environmental auditors and water auditors should have work experience, formal training and should maintain their competence. Items in column one that have an asterisk are requirements for water auditors too

Areas in which environmental auditors should have work experience, formal training and should maintain competence ISO 14012:1996	**Areas in which water auditors should have work experience, formal training and should maintain competence. (The items with an asterisk in column one are to be included too.)**
Environmental science and technology *	Water science and technology
Technical and environmental aspects of facility operations	Technical and water aspects of facility operations
Relevant requirements of environmental laws, regulations and related documents	Relevant requirements of water laws, regulations and related documents
Environmental management systems and standards against which audits may be conducted*	Water management strategies and professional and industry audit conventions in the light of which audits may be conducted
Audit procedures processes and techniques	Audit procedures processes and techniques

In our experience of teaching water auditing, students at second year university level often lack understanding of the principles behind facilities' operations and are at a great disadvantage in trying to learn technical aspects of facilities' operations. (See Table 1.1) We believe a tertiary degree is a necessary prerequisite for water auditors. Especially suitable degrees for potential water auditors are in mechanical, civil, environmental, chemical or agricultural engineering. Environmental Science courses also provide a suitable foundation. Physics or chemistry degrees likewise are suitable foundations. We teach water auditing in second year as part of an Environmental Science degree. Two years work experience with a water auditor is a satisfactory prerequisite for certification as a water auditor by a professional body for graduates with such a degree.

Lead auditors are distinguished from auditors in ISO 14012:1996, requiring further experience. This seems entirely appropriate when applied to lead water auditors.