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APPROPRIATE TECHNOLOGIES IN THE WATER SECTOR IN SOUTH AFRICA

POSITION PAPER

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CONTENTS

EXECUTIVE SUMMARY

This position paper is one of the outputs of the project launched by the Department of Water Affairs and Forestry (DWAF) dealing with the management and coordination of cross-cutting areas, and deals with phase 1 of the section “Appropriate technologies in the water sector.” The paper first sets out the international viewpoints regarding appropriate technology, then discusses the South African context. The focus is mainly on low-income settlements, because it is in these areas that most funds for services implementation are being concentrated. However, many of the arguments brought forward are also relevant to higher-income settlements.

Appropriate technology has been known by various names – intermediate, alternative, labour-intensive, indigenous, community or low-cost technology. However, appropriate technology has become the accepted term for a development paradigm that considers, together, factors such as technical, environmental, institutional, community and financial. The definition of appropriate technology changes with each situation, and what exactly constitutes it in any given case is a matter of debate. However, in the arguments put forward in this paper, the term has been applied mostly to technology that is suitable for low-income settlements and that can be optimally operated and maintained with the resources available in the community concerned. However, this does not mean that appropriate technology is necessarily cheap or is suitable only for the poor.

For countries like South Africa, appropriate technologies should be intensive in the use of abundant factors such as labour, economical in the use of scarce factors such as capital and highly trained personnel, and intensive in the use of domestically produced inputs. Appropriate technology should make the most economical use of a country’s natural resources and its relative proportions of capital, labour and skills, and further national and social goals.

Appropriate technology is a set of techniques that makes optimum use of available resources in a given environment. It is the technology that maximises social welfare. Appropriate technology means providing technical solutions appropriate to the economic structure of the community: to their ability to finance the activity, to operate and maintain it, to the environmental conditions applicable, and to the management capabilities of the community.

Appropriate technology is a very broad-ranging subject – a philosophy as much as a technology; a way of seeing things. It is very context-dependent and is strongly related to environmental, developmental, economical, sociological and resource-orientated factors. However, there is no perfect technology or panacea that can resolve all the socio-economic problems of developing nations at once. Circumstances vary from one developing society to another, and what is appropriate for one country or social setting may not necessarily be appropriate for another.

Appropriate technology has been the subject of numerous criticisms despite its obvious advantages. A common criticism is that appropriate technology is inefficient and not supportive of growth or improving the standard of living. Appropriate technology may not be efficient from an engineering viewpoint, but it is unrealistic to describe any technology that enhances the capacity to satisfy community goals and aspirations as inefficient. The issue is not about opting for either productivity or job

creation but finding a good mix of techniques to promote both and to ensure a far-reaching distribution of the benefits of development. However, to ensure that long-term benefits do in fact accrue, the projects must be sustainable, which means appropriate technologies must be selected, and operation and maintenance (O&M) should be integrated into project development from the beginning. Appropriate technology has become synonymous with sustainability.

The DWAF's policy is to support the development and dissemination of appropriate and environmentally friendly technologies for the provision of affordable and reliable water and sanitation services to all South Africans. In line with this policy, the department organised a conference in November 2001 to address appropriate technologies and the sustainability of water services delivery. The conference was concerned with five central themes, namely, sustainable sanitation, capacity building, planning, technology choice and O&M. The common thread connecting all these factors was seen to be community involvement in the process, a subject that received much attention during the conference. Projects should be demand-driven rather than resource-driven, and problems and needs should be identified with the full participation of the community. This is the overriding prerequisite for the provision of appropriate and sustainable service delivery.

The issues of appropriate technology and capacity building and training within the communities are inextricably linked: capacity building and training serve as the interface between institutional and social development and the concept of appropriate technology. Many technologies fail not because of the innate qualities of the material or system being implemented, but because of the way they are introduced into local situations. There should be as much attention on the methods of transfer as on the technologies themselves.

Water services and infrastructure provision in South Africa are linked to a number of inter-departmental policies and initiatives. To determine the progress and impact that have been achieved in reaching policy goals and targets, as well as to systematically examine the effectiveness, efficiency and impact of programmes and projects on the beneficiaries, it is necessary to develop and implement coordinated and cooperative monitoring, evaluation and reporting (M, E & R) systems. This is in line with legislative and policy requirements as set out in the National Water Services Act, the National Water Act, the White Paper on Basic Household Sanitation and the Strategic Framework for Water Services. For successful and sustainable service delivery it is essential that projects are tested for compliance, not only with regard to policy but also for quality of design and construction.

1. INTRODUCTION

Problems of poverty, unemployment, inequality and basic needs fulfilment are common facts of life today in many developing countries. Worsening socio-economic conditions in developing countries have underscored the urgency of implementing a development path that de-emphasises growth and technological monoculture (Akubue 2000). This development paradigm has been variously called intermediate, alternative, labour-intensive, indigenous, appropriate, community or low-cost technology. However, appropriate technology has become the most accepted term representing the viewpoints associated by the other terms. Detractors and advocates of appropriate technology have made claims and counter claims about its strengths and weaknesses, but developing countries should not take an either/or stance regarding technology input; it requires both large- and small-scale appropriate technology. Further, development in these regions should start with less complex and expensive techniques and move forward (Akubue 2000).

This position paper is one of the outputs of the project launched by the Department of Water Affairs and Forestry (DWAF) dealing with the management and coordination of cross-cutting issues, namely:

- promotion of appropriate technology in the water sector;
- gender mainstreaming in the water sector;
- environmental management;
- promotion of Water for Growth and Development; and
- HIV and AIDS.

The cross-cutting issues are closely interrelated. For instance, appropriate technology plays an important role in both the environmental and growth and development issues. Many wastewater treatment systems are suffering from accumulated neglect, poor operation and under-staffing, leading to pollution. It is also recognised that water plays an important role in the country's economic growth rate, either directly through irrigation in the agricultural sector or as domestic water supply and sanitation. Water supply and sanitation are further linked to the gender and HIV/AIDS issues, as women are usually the care givers and appropriate water and sanitation facilities are essential in the treatment of the disease.

To meet the challenges in the water sector, technical innovation and appropriate technology must therefore be encouraged.

The paper deals with phase 1 of the section "Promotion of appropriate technologies in the water sector." The paper first sets out the international viewpoints regarding appropriate technology, then discusses the South African context. The focus is mainly on low-income settlements, because it is in these areas that most funds for services implementation are being concentrated. However, many of the arguments brought forward are also relevant to higher-income settlements.

2. APPROPRIATE TECHNOLOGY: BACKGROUND

2.1 What is appropriate technology?

A commonly accepted definition of appropriate technology is "technology that is appropriate to the environmental, cultural and economic situation it is intended for."

An appropriate technology, in this sense, typically requires fewer resources, as well as lower cost and less impact on the environment.

However, the definition of appropriate technology changes with each situation. It is not appropriate, for instance, to install solar modules in a place with very little sun, or a wind generator in a place with little or no wind. What is appropriate in a large urban location is very different from what is appropriate in a remote, isolated environment.

What exactly constitutes appropriate technology in any given case is a matter of debate, but generally the term is used by theorists to question high technology or what they consider to be excessive mechanisation, human displacement, resource depletion or increased pollution associated with industrialisation. The term has often, though not always, been applied to the situations of developing nations or underdeveloped rural areas of industrialised nations.

It could be argued that appropriate technology for a technologically advanced society may mean a more expensive, complex technology requiring expert maintenance and high energy inputs. However, this is not the usual meaning of the term.

One of India's early pioneers and practitioners of appropriate technology, Mohandas Gandhi, often spoke of the need for village industries in India, and maintained that the country's survival and future were dependent on the state of the villages where most Indians reside. Underlying Gandhi's notion of village industries was his expression that "the poor of the world cannot be helped by mass production but only production by the masses" (Schumacher 1973). Gandhi's work exerted a large influence on Schumacher (Akubue 2000). In using the term "intermediate technology" Schumacher envisioned a technology for the Third World that was midway between, for example, a hand hoe and a tractor. As Schumacher (1973) described it, "such an intermediate technology would be immensely more productive than the indigenous technology……but it would be immensely cheaper than the sophisticated, highly capital-intensive technology of modern industry." In order for the concept of intermediate technology to be considered useful, it must be conducive to meeting, inter alia, the following challenges:

- The production methods employed must be relatively simple, so that the demands for high skills are minimised, not only in the production process itself but also in matters of organization, raw material supply, financing and marketing; and
- production should be mainly from local materials and mainly for local use (Schumacher 1973).

Thormann (1979) quotes the USAID in June 1976, giving the following description of appropriate technology:

> "In terms of available resources, appropriate technologies are intensive in the use of abundant factors such as labour, economical in the use of scarce factors such as capital and highly trained personnel, and intensive in the use of domestically produced inputs. In terms of small production units, appropriate technologies are small-scale but efficient, replicable in numerous units, readily operated, maintained and repaired, low-cost and accessible to low-income persons. In terms of the people who use or benefit from them, appropriate technologies seek to be compatible with local cultural and social environments."

Akubue (2000) cited Harrison (1980) as follows:

> "Appropriate technology simply means any technology that makes the most economical use of a country's natural resources and its relative proportions of capital, labour and skills, and that furthers national and social goals. Fostering appropriate technology means consciously encouraging the right choice of technology, not simply letting businessmen make the decision for you."

Akubue (2000) further cited Todaro (1997):

> "Appropriate technology is technology that is appropriate for existing factors. For example, a technology employing a higher proportion of labour relative to other factors in a labour-abundant economy is usually more appropriate than one that uses smaller labour proportions relative to other factors."

Morawetz (1974) defined appropriate technology as the set of techniques that makes optimum use of available resources in a given environment. For each process and project, it is the technology that maximises social welfare.

Betz et al (1984) stated that appropriate technology means providing technical solutions appropriate to the economic structure of the community: to their ability to finance the activity, to operate and maintain it, to the environmental conditions applicable, and to the management capabilities of the community.

According to Village Earth (nd), appropriate technology is a way of thinking about technological change, recognizing that tools and techniques can evolve along different paths toward different ends.

Appropriate technology is also understood as "technology with a human face", in that it fits the socio-cultural, geographical, economic and environmental context of the community in which it is being applied (Schoeman 2001).

The suitability, or appropriateness, of a particular technology is defined by the interrelation between a technology and its context. i.e. people in their social, cultural, economic, institutional, organisational and physical environment (Co-Create 2004).

Whether a technology will be considered appropriate depends on:

- Accessibility for the people using the technology;
- functionality of the technology;
- quality of the technology;
- sustainability (economic, financial, social and ecological);
- manageability; and
- enabling environment (Co-Create 2004).

It is thus seen that appropriate technology is a very broad-ranging subject – a philosophy as much as a technology; a way of seeing things. It is very context-dependent and is strongly related to environmental, developmental, economical, sociological and resource-orientated factors.

2.2 Characteristics of appropriate technology

According to Akubue (2000), the appropriateness of technology is not limited only to job creation, the use of local resources and utilising renewable energy resources, but it is also about being affordable, easy to maintain, compatible with existing infrastructure, efficient in the use of scarce natural resources, environmentally benign, and partial to small-scale. However, appropriate technology is not always small, simple, cheap and labour intensive. Citing Anderson (1985), Akubue (2000) made the point that scale, complexity and expense are not always positively correlated – it is possible for a large machine to be both simple and cheap and for a small one to be highly complex and expensive.

It is important to realise that use of appropriate technology does not mean turning the clock back to the 18th or 19th century. Although the technology involves simple, easy-to-use-and-repair designs, it may be based on sophisticated 20th or 21st century technologies, e.g. the photovoltaic or solar cell that converts solar energy, a renewable energy source, into electricity.

2.3 Diversity in the choice of technology

Akubue (2000) pointed out that there is no perfect technology or panacea that can resolve all the socio-economic problems of developing nations at once. Circumstances vary from one developing society to another, and what is appropriate for one country or social setting may not necessarily be appropriate for another. Willoughby (1990) stated that the concept of appropriate technology attempts to discriminate between different technologies according to their relative suitability for specific purposes or situations. Commenting on this, Akubue (2000) noted that appropriate technology is about technology being a heterogeneous collection of social and technical options rather than a homogeneous phenomenon, and that the best choices between the alternatives are made based on the objectives to be accomplished and possible human and environmental effects. He made the further point that all alternatives should be researched for “best fit” and that the impression of advanced technology being invariably inappropriate for developing nations is an exaggerated and misleading interpretation of the intent of appropriate technology. It is not realistic to suggest that the development should be based almost entirely on technological monoculture. Brooks (1980) suggested that appropriate technology and current technology are complementary rather than mutually exclusive, and that the potential benefits of both will be enhanced when they coexist.

2.4 Criticisms of appropriate technology

Akubue (2000) notes that appropriate technology has been the subject of numerous criticisms despite its obvious advantages. A common criticism is that appropriate technology is inefficient and not supportive of growth or improving the standard of living. Appropriate technology may not be efficient from an engineering viewpoint, but it is unrealistic to describe any technology that enhances the capacity to satisfy community goals and aspirations as inefficient. The issue is not about opting for either productivity or job creation but finding a good mix of techniques to promote both and to ensure a far-reaching distribution of the benefits of development.

Appropriate technology has also been claimed to be an inferior technology and part of a scheme by Western industrialised countries to maintain their position of socio-economic and technological dominance over the Third World (Thormann 1980; Willoughby 1990). However, Akubue (2000) says that this depends on one's perspective and is supported by Hazeltine and Bull (1999) who make the following remark:

> "There is no evidence that a country which starts with simple technology cannot move into more complex technology, and there is much evidence that for countries starting with a simple technology the transition to industrialisation was easier than it was for those that shifted directly to a complicated case."

Willoughby (1990) stated that:

> "Many criticisms of appropriate technology are based upon either ignorance of available empirical evidence, distortion of the claims of leading protagonists, or reliance upon examples from the literature which differ from the consensus of the movement but which suit the biases of the critic."

Appropriate technology should be seen as "meeting the needs of a particular community at a particular time" (CSIR 2000) and as long as the technology selected for any specific case is chosen by the community members themselves, it should be seen as being appropriate. However, longer term needs should also be taken into consideration.

2.5 Appropriate technology and sustainability

One of the first and most often cited definitions of sustainability is the one created by the Brundtland Commission, led by the former Norwegian Prime Minister Gro Harlem Brundtland. The Commission defined sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987).

The term "appropriate technology" also means "sustainable technology at community level" (Brikké and Bredero 2003). Water supply and sanitation projects should not be viewed as an end in themselves, but as the initiators of benefits that continue long after the projects have been handed over to the community. However, to ensure that long-term benefits do in fact accrue, the projects must be sustainable, which means appropriate technologies must be selected, and operation and maintenance (O&M) should be integrated into project development from the beginning.

It has been repeatedly demonstrated worldwide that the selection of a particular technology can have far-reaching consequences for the sustainability of the service concerned (Brikké and Bredero 2003). For many years technical criteria and initial investments were emphasised when choosing such technologies. Although these aspects are important, the roles of financial, institutional, social and environmental factors are also germane for ensuring the sustainability of services.

As a signatory to Agenda 21, the Habitat Agenda and the Johannesburg Plan of Implementation, South Africa is committed to furthering the agenda of sustainable development. The support for sustainable development is entrenched in Section 24 of the Constitution which states that:

"Everyone has the right
a) to an environment that is not harmful to their health or well-being; and
b) to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that –
    i) prevent pollution and ecological degradation;
    ii) promote conservation; and
    iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

There is strong support from government at both local and national level for the wider use of technology alternatives that are environmentally sustainable and appropriate to local conditions. The issue of appropriate technology is closely linked to the debate on sustainable settlements.

2.5.1 Defining sustainable service delivery

According to IRC & WHO (2000), a service is sustainable when:

- It functions properly and is used.
- It provides the services for which it was planned.
- It functions over a prolonged period of time, according to the designed life-cycle of the equipment.
- The management of the service involves the community (or the community itself manages the system), adopts a perspective that is sensitive to gender issues, establishes partnerships with local authorities, and involves the private sector as required.
- Its operation, maintenance, rehabilitation, replacement and administrative costs are covered at local level through user fees or through alternative sustainable financial mechanisms.
- It can be operated and maintained at the local level with limited, but feasible, external support (e.g. technical assistance, training and monitoring).
- It has no harmful effects on the environment.

Sustainability of a service is achieved when the community wants and accepts the level of service provided, is able to pay for it and the skills are available locally to service the system. It makes sound economic sense if the scheme can be managed locally, as it not only reduces the cost of running the scheme but also ensures that money is retained in the local area. In the case of an advanced technology, however, this may not be possible if operator skills are not available.

2.5.2 Sustainability and subsidies

The above argument raises the issue of the economic viability of a service and the reliance on subsidies, both for provision of the service and for ongoing operation and maintenance. Wall and Jackson (1992) state that, for sustainability, it is not appropriate to see the provision of services solely as a state function, built with the aid of subsidies and maintained with the aid of further subsidies. The provision of water supplies and sanitation must be a replicable activity.

If subsidies are unavoidable, they must be carefully targeted and sustainable. Subsidies should not be treated as a panacea (Wall and Jackson 1992).

Given the above, it is evident that sustainable service delivery can be influenced by a range of factors.

2.5.3 Factors that undermine the sustainability of services

The following factors commonly undermine the sustainability of services (Brikké and Bredero 2003):

- The project is poorly conceived (e.g. a project that only increases the number of water points, or sanitation facilities, as a way of improving accessibility to these services, without considering the wider range of factors needed to sustain the benefits).
- The project does not sufficiently involve the community, who therefore do not feel that the project is theirs. As a result, demand for improved services suffers, and the services become unsustainable. Demand and community involvement (of both men and women) are key factors in generating long-term community commitment to improved services and in sustaining the services. Involvement also makes the community members responsible for the choice of technology and makes community members aware of the financial, managerial and technical implications of their choice, including the future O&M tasks associated with the technology.
- The performance of the project facilities is either not assessed, or is insufficiently monitored, during the O&M phase of the project cycle.

2.5.4 Factors that contribute to the sustainability of services

Brikké and Bredero (2003) argue that sustainability of services relies mainly on four interrelated factors: (i) technical; (ii) community; (iii) environmental; and (iv) the legal and institutional framework. A financial dimension underlies all these factors.

Technical factors:

- technology selection;
- complexity of the technology;
- the technical capacity of the system to respond to demand and provide the desired service level;
- the technical skills needed to operate and maintain the system;
- the availability, accessibility and cost of spare parts; and
- the overall costs of O&M.

Community factors:

- the demand or perceived need for an improved service;
- the feeling of ownership;
- community participation (men/women, social groups) in all project phases, including planning, designing, constructing and managing the services, and in the O&M of the services;
- the capacity and willingness to pay;
- management through a locally organized and recognized group;
- the financial and administrative capacity of management;
- the technical skills to operate and maintain the service, implement preventive maintenance activities and perform minor and major repairs are all present in the community;
- socio-cultural aspects; and
- individual, domestic and collective behaviour regarding the links between health, water, hygiene and sanitation.

Environmental factors:

- the quality of the water source (this will determine whether the water needs to be treated, and will influence the technology choice);
- adequate protection of the water source/point;
- the quantity of water and continuity of supply; and
- the impact of wastewater or excreta disposal on the environment.

It is fundamentally important to integrate the water, hygiene and sanitation practices, because poor hygiene or inadequate access to sanitation facilities can jeopardise health benefits gained from improving access to water supplies.

Legal and institutional framework:

All the above factors evolve within a legal and institutional framework. At national level, there must be clear policies and strategies that support sustainability. Support activities, such as technical assistance, training, monitoring and setting up effective financing mechanisms are all likely to influence the effectiveness of O&M.

2.5.5 Summary

Appropriate technology is inextricably linked with sustainability. If a service is not sustainable then it is not appropriate. However, technical and financial factors are not the only criteria involved in choosing an appropriate technology – social and environmental aspects are equally important and should be given due consideration. There are various definitions for the appropriateness of a service, but the common thread running through all of them is the involvement of the community in all aspects of the project, from planning through to O&M.

2.6 Appropriate technology and community development

Appropriate technology includes the belief that human communities can have a hand in deciding what their future will be like, and that the choice of tools and techniques is an important part of this. It also includes the recognition that technologies can embody cultural biases and sometimes have political and distributional effects that go far beyond a strictly economic evaluation. Appropriate technology therefore involves a search for technologies that have, for example, beneficial effects on income distribution, human development, environmental quality, and the distribution of political power – as well as productivity – in the context of particular communities and nations (Village Earth nd).

Appropriate technology may have been practised for many generations in the past, but there is something new about it today; it has evolved into a developmental approach that is aimed at tackling community development problems (Akubue 2000). Viewed in this way, says the author, appropriate technology cannot be seen simply as some identifiable technical device; rather it is an approach to community development consisting of a body of knowledge, techniques, and an underlying philosophy. Citing Dunn (1978), Akubue (2000) called it a complete systems approach to development that is both self-adaptive and dynamic, because as its

users become wealthier and more skilled, they can both afford and use more expensive technical means. Further citing Hazeltine and Bull (1999), Akubue (2000) noted that the experience of countries such as the United States appears to confirm that one of the advantages of appropriate technology is that it can be an effective way to shift to advanced technology; it follows, therefore, that as appropriate technology improves the productive capabilities of a community, the community influences and improves the level of technology as well. Akubue (2000) further defines appropriate technology as an approach to development that not only emphasises job creation and optimum use of skills and resources but also builds on the skills and resources to raise the productive capacity of a community.

Engineers must learn to give more attention to the process and less to the product (Wall and Jackson 1992). Development is about enabling people to help themselves, thus enhancing their self-worth and dignity, not only about producing physical facilities. Decisions must therefore be the result of an interactive process, inter alia permitting the genuine participation of the communities affected. The choice of the standard of service provided is reflected in their willingness to pay (Wall and Jackson 1992).

2.7 Appropriate technology and levels of service

It is widely recognized that the cost of providing engineering services forms a significant component of the overall cost of housing. Where capital subsidies for housing schemes are involved, the cost of engineering services could consume anything between 50% and 100% of the subsidy, depending on, among other things, site conditions and levels of service provided (Schlotfeldt 1995). Design of engineering services should therefore receive particular care and attention in order to optimise the levels of service within the given financial parameters. There needs to be space for incremental approaches to provide sustainable and affordable levels of service while ensuring acceptable and adequate functionality (CSIR 2000). Creative and varied solutions are thus required, while a balance between established practices and new ideas and developments should be sought.

Service levels should be appropriate, as a high level of service that fails (for whatever reason) may well pose a greater threat to public health and the environment than an inadequate lower level of service (CSIR 2000). An example is the provision of flushing toilets (whether connected to a sewer or to a septic tank) when the people are too poor to afford toilet paper, as severe blockages tend to occur with environmental damage being a direct consequence.

Various factors, for example high population densities or adverse geotechnical conditions, may also dictate that consideration be given to alternative types of service technology (CSIR 2000). However, only proven designs should be used.

2.8 Concluding remarks about the role and place of appropriate technology

Akubue (2000) quoted Jequier (1979) as follows:

> "Appropriate technology is not, and should not be viewed as a second-best solution. Conversely, neither should its role be over-estimated: appropriate technology is not a universal substitute for conventional technology. Appropriate and conventional technologies are

complementary rather than contradictory, and the emphasis given to the former does not and should not rule out use of the latter in those cases where they are particularly well adapted to local conditions."

Akubue (2000) goes on to say:

"Appropriate technology must be progressive and not retrogressive. Third World countries are advancing in socio-economic and technological development and must move forward, not backward, with this progress. Appropriate technology is not meant to be static or promote stagnation but to change as a country achieves progress in its level of development. In the end a new and different kind of appropriate technology with emphasis on environmental sustainability must take precedence as success is realised in the eradication of abject poverty and the reduction of unemployment and inequality."

These remarks apply equally to service provision in the water sector.

3. APPROPRIATE TECHNOLOGY IN THE WATER SECTOR IN SOUTH AFRICA

3.1 Background

Water supply and sanitation are key infrastructure items, having a marked effect on the quality of life in any low-income area (Wall and Jackson 1992).

The national government will support the development and dissemination of appropriate and environmentally friendly technology for the provision of affordable and reliable water and sanitation services to all South Africans. This will assist water services authorities to examine the full suite of options available before deciding on a particular technology for delivery of water and sanitation (DWAF 2003).

DWAF (2001) estimated that over the previous nine years more than R4,5 billion had been spent to provide water and sanitation services to the rural poor. According to a number of external evaluations carried out since 1995 it was found that the application of inappropriate technologies had led to some schemes being unsustainable, possibly as a result of the fact that not all role players involved in water supply and sanitation schemes were aware of changes in policy and strategy.

Consequently, the management of the DWAF resolved to organise a conference mainly targeting consultants (social, institutional, engineering and management) to address appropriate technologies and the sustainability of water services delivery seen against the Government's intention to deliver 6kl per month of water free to every household. The conference, which formed part of the Masibambane work plan for 2001/2002, took place from 21 to 23 November 2001.

The conference objectives were the following:

- To convey the Department's policies and strategies with respect to service delivery to all concerned people;
- to discuss changes to existing design standards and guidelines, monitoring and auditing, benchmarking, feasibility studies and life cycle management; and
- to create a learning and sharing culture in the water sector.

The conference was organised around five central themes, namely:

1. Sustainable sanitation.
2. Institutional, social and capacity building and training.
3. Planning.
4. Technology choice.
5. Operation and maintenance.

The following points were brought forward regarding the above five themes, which are largely in line with the foregoing discussions on appropriate technology and sustainability (DWAF 2001):

Sustainable sanitation

A sustainable sanitation service is generally understood to be a system that is affordable to the community and the local government over a long term period without having adverse effects on the environment. Thus:

- pollution is reduced to a minimum and water resources are available for future generations; and
- where affordability refers to the community and the local government's ability to operate, maintain, extend and replace the infrastructure to obtain a reliable service.

Institutional, social, capacity building and training

Well-planned and executed baseline studies, livelihoods assessments and community participatory appraisals are expensive and time consuming, as are participatory designs and development committee selection and training. But the lack thereof has led to systems failing and customers being sidelined. However, little evidence of real changes can be seen on the ground and situations continue where political imperatives dictate fast-track delivery, leaving institutional and social capacity building and training (the so-called soft issues) wanting. If the water sector is to be institutionally capacitated there must be a fundamental shift in the way project funds are allocated in order to allow for significant time and effort to be incorporated into meaningful training and capacity building. Great care should be taken to ensure that the planning and delivery of training and capacity building is guided by the needs of the beneficiary communities and water management authorities. Continuously neglecting these factors will result in a continued rise in the number of inappropriate projects that cannot be locally managed or maintained in the medium or long term.

Planning

Appropriate planning is the most powerful tool available to ensure sustainability of water and sanitation service delivery. Therefore planning should be holistic and not only of a technical nature. Planning is necessary to focus on the objective of local economic development and poverty alleviation. It is thus essential that the whole process is inclusive – involving, informing and consulting all stakeholders and role players – not planning for the people but planning with the people.

Technology choice

- The technology must be understandable and be physically within the capability of the people responsible for O&M;
- spare parts and equipment need to be easily obtainable, preferably in-country;
- the technology must be affordable for the people bearing the cost of O&M;
- the technology or level of service provided must be attractive and culturally acceptable to the users; and
- an appropriate technology is not necessarily a low-cost option.

Operation and maintenance

The sustainability of a particular technology will depend on the O&M of the technology with the institutional arrangements that are in place and the capacity building that has been undertaken to make available skilled operators, spares and materials.

Sustainability of water and sanitation services can be ensured through:

- Capacitating those who will be required to operate and maintain the systems. This training should not only be once-off, so that structures can be in place to replace skilled workers as they depart; and
- the implementation of partnerships with either public or private entities. Such entities can provide institutional support, stability in periods of change, funding, standardized approaches and best practices.

Some other issues related to appropriate technology that emerged during discussions at the conference included the following (DWAF 2001):

- Technology on its own is not a solution to all problems, and might become a "white elephant" when implemented in the wrong place and for the wrong purposes. Therefore, technology should be applicable to the South African environment and culture.
- Decisions regarding technology are not purely technical. They include, among others, cultural, political, environmental and economic dimensions. Determining aspects for end-users and beneficiaries include access to funds, materials, equipment, space and knowledge, land tenure issues and cultural aspects.
- Important aspects for service providers include the demand and availability of finance for the capital and operating costs of appropriate water and sanitation components and services. Many technologies are too expensive for implementation, therefore it is important to investigate more cost-effective and affordable technology. Asset management should form an integral part of management.
- Due to the skills shortage, the water sector needs technology to assist customers that cannot read or write (e.g. reading water meters and calculating consumption), which makes the exploration of alternative avenues, providing technology with easy, understandable graphics, imperative.
- Appropriate technology recognizes the need for job creation, not job destruction, and should not replace people. With high levels of unemployment in South Africa, technology is not appropriate if it replaces people.

3.2 Current policy developments with respect to appropriate technologies in the water sector in South Africa

The DWAF's policy on appropriate technology is currently in the process of being developed (Manus 2008). Together with the Department of Science and Technology (DST), the DWAF has set up a task team to carry out research into which technologies can be expected to accelerate service delivery (and be sustainable at the same time). An important question for the task team to examine is the reasons why some technologies have failed in certain areas. Research is to be done in four pilot areas in four provinces and the policy and strategy will develop from this. However, the research method has not been finalised yet (Manus 2008).

The DWAF is currently also in the process of revising the sanitation White Paper. Appropriate technology issues will feature in the revised document, which is expected to give direction to local authorities (Manus 2008).

The DWAF considers appropriate technology as technology that can be operated and maintained by the community and local Water Services Authority (WSA) (Mazubane 2008). It is expected of the WSAs to consult with the communities regarding gender issues, job creation, O&M, affordability, etc in order to determine an appropriate, sustainable technology for each particular case (Mazubane 2008).

A lack of understanding by the community of the O&M requirements of a particular technology is often a problem. The DWAF maintains that education should be a continuous activity in order to ensure that the services are used appropriately (Mazubane 2008).

4. SELECTING AN APPROPRIATE TECHNOLOGY

4.1 Introduction

The technology selection process will depend on the basic strategy adopted by planners, and on general trends in the water and sanitation sector. Two basic principles are that *communities need to be involved in selecting technologies from the start of the process, and that planners should adopt a demand-driven process* (Brikké and Bredero 2003).

The provision of water supply and sanitation improvements can be characterised as either demand-driven or resource-driven. With a resource-driven approach the intervention is selected with minimal involvement of the community, and the technology is based on current policies or replicates a blueprint or successful experience elsewhere (Brikké and Bredero 2003). There are several potential problems with this approach that could undermine the sustainability of projects. Such problems include lack of community acceptance and poorly-functioning improvements that are underused. O&M costs can be a concern if the technology was introduced without involving the communities and without a proper analysis of local needs and conditions (Brikké and Bredero 2003).

With a demand-driven project, by contrast, problems and needs are identified with the full participation of the communities. This may involve using extension workers to raise awareness in the communities prior to the start of the project. Communities can then choose a particular technology, with an understanding of the technical, financial

and managerial implications of their choice (Brikké and Bredero 2003). The advantages of such an approach are that the community is motivated to participate in the planning, construction and O&M phases, and that a community-based approach for managing the services will be better accepted and implemented. It is likely that a demand-driven approach will better foster a sense of ownership and responsibility (Brikké and Bredero 2003).

Agencies and communities should therefore work together as partners, and agree upon planned activities. This has become particularly important in South Africa, because communities are increasingly assuming the responsibilities of operating, maintaining and managing their water supply and sanitation systems.

4.2 The importance of community education and training

The issues of appropriate technology and capacity building and training are inextricably linked. One of the main reasons that technically inappropriate systems continue to be implemented is that there continues to be little or no attempt to include local authorities and community structures in making informed decisions about technology choice (Schoeman 2001). Institutions and practitioners involved in the provision of services need to have the knowledge and skills for applying a people-centred approach to water and sanitation related programmes and projects. Capacity building and training are integral to applying an appropriate technology approach to water and sanitation services delivery for it is at this juncture that the application of an appropriate technology perspective meets institutional and social development – in other words, capacity building and training serve as the interface between institutional and social development and the concept of appropriate technology (Schoeman 2001).

It is clear that many technologies fail not because of the innate qualities of the material or system being implemented, but because of the way they are introduced into local situations. There needs to be as much attention on the methods of transfer as on the technologies themselves, so as to ascertain relevance and appropriateness (CSIR 1999).

In the South African water sector innovations in technology are not the rule, and new technologies receive acceptance only very slowly. Part of the reason for the conservative attitude to new technologies is that they have often been applied for arguably misdirected reasons. Alternatives to the norm are almost always implemented to save costs. Ironically, in human settlements where the importance of affordability is seen as tantamount, residents are justifiably wary about being used as test cases for innovations (CSIR 1999).

Similarly developers, who in many cases seek to maximise profits and minimise risks, and local authorities whose interest is minimising the ongoing maintenance costs, are also aware that new technologies may carry problems in the long term. Negative experiences have occurred in the past when the implementation of innovative technologies has been seen purely as a cost saving measure. With this as the main motivation, little has been invested in education and training to introduce such technologies, or to ensure that the transfer of technology leads to a sustainable system. As a result many decision makers and beneficiaries shy away from choosing alternative, often better performing, technologies (CSIR 1999).

4.3 The technology selection process

4.3.1 Definitions of a basic facility and a basic service

Before proceeding with the discussion on the technology selection process, it is necessary to understand what is meant by a basic facility and a basic service for water supply and sanitation, as defined by DWAF (2003):

A *basic water supply facility* is the infrastructure necessary to supply 25 litres of potable water per person per day supplied within 200 metres of a household and with a minimum flow of 10 litres per minute (in the case of communal water points) or 6 000 litres of potable water supplied per formal connection per month (in the case of yard or house connections).

A *basic water supply service* is the provision of a basic water supply facility, the sustainable operation of the facility (available for at least 350 days per year and not interrupted for more than 48 consecutive hours per incident) and the communication of good water use, hygiene and related practices.

A *basic sanitation facility* is the infrastructure necessary to provide a sanitation facility which is safe, reliable, private, protected from the weather and ventilated, keeps smells to the minimum, is easy to keep clean, minimises the risk of the spread of sanitation-related diseases by facilitating the appropriate control of disease carrying flies and pests, and enables safe and appropriate treatment and/or removal of human waste and wastewater in an environmentally sound manner.

A *basic sanitation service* is the provision of a basic sanitation facility which is easily accessible to a household, the sustainable operation of the facility, including the safe removal of human waste and wastewater from the premises where this is appropriate and necessary, and the communication of good sanitation, hygiene and related practices.

4.3.2 Factors that influence the selection of community water supply and sanitation technology

This section reviews the general criteria, and criteria specific to O&M, that influence the selection of water supply and sanitation technologies. These criteria, which have been grouped into five factors (Table 1), should in practice be researched for all the types of technology under consideration for a particular project.

Experience has shown that the effectiveness of O&M is not solely connected to engineering issues, and personnel involved in O&M assessment and development should cover a range of relevant disciplines: social development, economics, health, institutional and management aspects, and engineering. It is important that the process be consultative and carried out in partnership with the operators and users of the services (Brikké and Bredero 2003).

Table 1: Factors that influence the selection of community water supply and sanitation technology (adapted from Brikké and Bredero 2003)

Factors of general relevance	Factors specifically relevant to O&M
1. Technical factors	
- demand (present and future water consumption patterns) versus supply; - capital costs; - compatibility with norms and legal frameworks; - compatibility with existing water supply systems; - comparative advantages; - technical skills needed within, or outside, the community; - design preference for toilets; - technical standards and expected lifetime of the technology; - availability of construction materials; - cost of construction.	- dependence on fuel, power, chemicals; - quality and durability of materials; - availability of spare parts; - O&M requirements; - compatibility with users' expectations and preferences; - availability of trained personnel within the community; - availability of mechanics, plumbers, carpenters and masons within and outside the community; - potential for local manufacturing; - potential for standardisation; - ease of access; - use of decomposed human excreta; - pit emptying technique.
2. Environmental factors	
- availability, accessibility and reliability of water sources; - seasonal variations; - water quality and treatment; - water source protection; - risk of a negative environmental impact; - soil texture, stability, permeability; - groundwater level; - control of environmental pollution; - possibility of flooding.	- O&M implications of water treatment; - O&M implications of water source protection; - existence and use of alternative traditional water sources; - O&M implications of wastewater drainage; - O&M implications for environmental protection; - protection from flooding.
3. Institutional factors	
- legal and regulatory framework; - existing national/local strategies; - existing institutional set-up; - support from government, NGOs; - stimulation of private sector; - transferring know-how; - training capacity; - availability of subsidies; - availability of sanitary workers, pit diggers.	- roles of different stakeholders and ability/willingness to take responsibility for O&M; - availability of local artisans; - potential involvement of the private sector; - training and follow-up; - availability and capacity of training; - skills requirements; - monitoring; - availability of pit-emptying services (municipal/private); - sewerage maintenance capacity.
4. Community factors	
- local economy; - living patterns, population growth; - living standards and gender balance; - household income and seasonal variations; - users' preferences; - village organisation and social cohesion; - taboos, habits, cleansing material, attitude to human faeces, gender-specific requirements; - convenience, accessibility, privacy, status and prestige, health, ownership; - role of traditional leadership, religious leaders, community-based health workers.	- managerial capacity and need for training; - acceptance of the organising committee by the community; - gender balance in committee; - perception of benefits from improved service; - availability of technical skills; - O&M costs; - health awareness.

5. Financial factors	
- capital costs;	- ability and willingness to pay;
- budget allocations and subsidy policy;	- level of recurrent costs;
- financial participation of users;	- tariff design and level of costs to be met by the community;
- local economy.	- costs and accessibility of spare parts;
	- payment and cost-recovery system to be put in place;
	- financial management capacity (bookkeeping, etc) of the community.

4.4 Monitoring, evaluation and reporting

Monitoring, evaluation and reporting (M, E & R) are the systematic examination of the effectiveness and efficiency of design and implementation of policies, programmes and projects. The idea is to learn from experience and apply the lessons learned in the designing of new policies, programmes and projects to make them more effective (Scheepers, Duncker and Wilkinson 2006).

Water services and infrastructure provision in South Africa are linked to a number of inter-departmental policies and initiatives. To determine the progress and impact that have been achieved in reaching policy goals and targets, as well as to systematically examine the effectiveness, efficiency and impact of programmes and projects on the beneficiaries, it is necessary to develop and implement coordinated and cooperative M, E & R systems (Scheepers, Duncker and Wilkinson 2006). This is in line with legislative and policy requirements as set out in the National Water Services Act (Act no 107 of 1997), the National Water Act (Act no. 36 of 1998), the White Paper on Basic Household Sanitation (2001) and the Strategic Framework for Water Services (2003). For successful and sustainable service delivery it is essential that projects are tested for compliance, not only with regard to policy but also for quality of design and construction.

5. SUMMARY AND CONCLUSIONS

There are various approaches and concepts around appropriate technology, which has been known by different names – intermediate, alternative, labour-intensive, indigenous, community or low-cost technology. However, appropriate technology has become the accepted term for a development paradigm that considers, together, factors such as technical, environmental, institutional, community and financial. The concept of appropriate technology may change with each situation, and what exactly constitutes it in any given case is a matter of debate. However, in the arguments put forward in this paper, the term has been applied mostly to technology that is suitable for low-income settlements and that can be optimally operated and maintained with the resources available in the community concerned. However, this does not mean that appropriate technology is necessarily cheap or is suitable only for the poor.

While appropriate technology has been criticized by some for being inefficient and inferior, this viewpoint is not shared by proponents of sustainability in the provision of water and sanitation, as the term appropriate technology has become synonymous with sustainability. However, sustainability can only be achieved if the service

functions properly, provides the desired end result, has no harmful effects on the environment, and O&M is integrated into project development from the beginning.

The use of appropriate technology also contributes to community development. It is not simply a device or an identifiable object, but rather an underlying philosophy that supports and enhances the productive capacity of the community. The process is thus more important than the product. However, the product should not be seen as a second-best solution as appropriate technology is progressive, not retrogressive. A balance should be sought between established practices and new ideas and developments.

Water supply and sanitation are key infrastructure items and have a marked effect on the quality of life in low-income areas. However, the application of inappropriate technologies has led to many schemes being unsustainable. At the DWAF conference on appropriate technologies in November 2001, much emphasis was placed on ways to achieve sustainability in water supply and sanitation projects; these centred on affordability, capacity building, appropriate planning, technology choice and O&M. The common thread connecting all these factors was seen to be community involvement in the process. Without this involvement a project is doomed to failure.

Projects should not be resource-driven but rather demand-driven. With the latter approach, also known as a people-centred approach, problems and needs are identified with the full participation of the community and the community is motivated to participate in all phases of the project, which then fosters a sense of ownership and responsibility. It is the overriding prerequisite for the provision of sustainable and appropriate service delivery, which in turn leads to the development of sustainable human settlements.

Cost is not always the most important factor in service delivery. Aspects such as job creation, capacity building in the community and environmental protection are equally important, while regular M, E & R coupled with suitable corrective action where required are crucial components for success.

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