Piped Water for Everybody
Technical Solutions Outline

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This note outlines technical aspects of the drinking water distribution systems we are proposing. Readers should note that system designs will evolve with time as further detail becomes available. We will retain several different designs for elements of the system until we eliminate less favoured ones. This note only describes one arrangement, and even then with limited detail, however readers will appreciate that there are several different arrangements that could be equally acceptable.

The aim is to provide a 24/7 piped drinking water distribution service appropriate for a community with 5,000 or more people. At this stage, we have not specified the size of the local community: the smallest community size may be less.

Principal technical requirements

- Target cost for end-users: US$3 per tonne.
- Bulk water supply to be treated appropriately depending on local conditions.
- Water quality: Better than or equal to WHO and international standards for potable water (to be defined).
- Nominal delivery capacity: 50 litres per person per day.
- Nominal social water supply (without credit): 20 litres per person per day (nominal, to be set by local community), to meet the "pregnant woman with broken pipe" scenario described below, not necessarily at household tap.
- Water supply to house and workplace taps to be paid service, sufficient credit must be established in advance (pre-paid account, line of credit, etc.).
- Automatic built in leak detection and location, tamper-proof controllers and valves.
- Automatic self-monitoring control system.
- Installation, operation and maintenance by local people with introductory technical training only.
- Backup supplies to cover all normal fault conditions – reliability specification to be defined.

The "pregnant woman with broken pipe" scenario: A pregnant woman, possibly with children, lives in a house and the pipe inside the house has broken. It is possible for water to run continuously because of the broken pipe and she cannot afford to have it fixed. Once she has run out of water credit, she cannot access any more water through the prepaid meter. It is essential to ensure that she has adequate access to safe drinking water at all times.

Target Communities

The project team will choose target communities, initially close to Islamabad which is located in a water-scarce area of Pakistan where people rely on rain for agriculture and water supplies. These communities fall into three logical situations with respect to water supply:

i. A water supply system exists, operated by a government agency such as the Islamabad Capital Development Authority (CDA). The dedicated drinking water supply would be operated under a private-public partnership (PPP) arrangement to be negotiated.
ii. No piped water is available, but a government water service has been planned, to be operated by a Town Council or Provincial Government. The dedicated drinking water supply would be operated under a private-public partnership (PPP) arrangement to be negotiated, and may provide a complete water service (for all purposes) or a separate untreated water supply for non-drinking water purposes such as animals, toilet flushing, etc.
iii. No piped water is available, and no government water service has been planned. The dedicated drinking water supply would be operated under a fully private or private-public partnership (PPP) arrangement to be negotiated, and may provide a complete water service (for all purposes) or a separate untreated water supply for non-drinking water purposes such as animals, toilet flushing, etc.

Bulk water supply

Depending on the situation of the target community, bulk water supplies for drinking water service may be provided from existing government sources, ground water, desalination of salty ground water or sea water or a purpose-built reservoir. In some areas, it may be possible to use innovative methods such as ground water recharge using technologies developed in Australia and other advanced countries.

A bulk water supply with an appropriate treatment facility will provide the drinking water supply. The treatment plant will be designed to suit the selected bulk water source and will incorporate the necessary treatment steps to bring the water to the required drinking water standards. These steps will typically include:

a) Input filtration,

b) Removal of unwanted salts and/or biological contamination,

c) Final filtration,

d) Chemical dosing with disinfectants such as chlorine, taste modifiers, and possibly fluoride,

e) Automatic sampling and water quality sensing.

Filter performance will be monitored with appropriate sensors and filter cartridges will be replaced either automatically or with semi-manual equipment as required.

Typically the maximum cost of such bulk water supplies is around $0.50 per tonne. The greater part of the final $3 per tonne cost lies in distributing the water to taps in homes and workplaces.

For communities where a dual drinking water and semi-treated supply is needed, the semi-treated water will be withdrawn after the initial filtering step.

Distribution Network

Figures 1 and 2 provide a schematic diagram of a distribution network using storage tanks at the treatment plant and at high locations in buildings. Many other solutions are possible for the water distribution network.

The treatment plant provides water at a controlled supply pressure, sufficient for water to flow through metering valves that regulate flow into building tanks.

Each neighbourhood of 50-100 connections would be monitored with a separate "master" meter to cross-check calibration of individual connection metering valves. There are two reasons. First, the master meter can detect leaks or unauthorized access to the main pipes. Second, the master meter can cross-check calibration of the individual connection metering valves, enabling low cost components to be used for individual connections.

As it is likely that systems will be installed in areas without reliable electricity, solar PV systems with back-up batteries will provide power. Elevated intermediate storage tanks enable energy to be stored in the form of water pressure, allowing minimal power consumption when solar energy is not available.

Connection controller and metering valve

Figure 2 illustrates one possible arrangement for a connection to a building tank and metering valve.

The tank is arranged such that the outlet connection for building taps is made at a height above the base of the tank. This means that, in the event of an internal pipe or tap failure, there will always be water remaining in the bottom of the tank which cannot flow out through the broken pipe. This water can be accessed using a suitable hand pump. The hand pump is designed so that it is not possible to attach tubing to the pump outlet and siphon water out of the tank. The bottom of the tank contains the "social" supply of drinking water which is always available even if the user has run out of credit. The controller provides sufficient water to ensure enough is there even if no credit has been provided. In the arrangement shown in figure 2, it would be necessary for someone in the building to go to the tank (on or near the roof) and fill one or more buckets of water using the hand pump. Alternative "social supply" arrangements could be provided, depending on community requirements.

The control system for the valve admitting water to the tank can be solar powered as the tank would be either on the roof of a dwelling or close to the roof.

The level of water in the tank can be measured with either a pressure sensor in the base of the tank, or a displacement sensor measuring the position of a float, or an acoustic sensor measuring the distance from the top or bottom of the tank to the water surface. A pressure sensor at the supply connection can be used to detect unauthorised attempts to access the water service, for example by cutting a supply pipe. Because the system can choose times at which water is supplied to the tank through the valves, it is possible to detect leakage by monitoring flow and supply pressure at building controllers when none of the metering valves are open.

In practice, a system like this would supply drinking water to perhaps 15 – 200 supply tanks from a central metering point. Larger systems would be made up of smaller systems in parallel with each other.

Embodied expertise

Just like a mobile phone provides a complex piece of technology in a package that a 2-year-old can use, the aim would be to provide a community-based water supply service with built-in technology to enable local people to install the service without requiring highly trained water supply engineers to be present.

Avoiding Tank Contamination

Water storage tanks have significant disadvantages, particularly in controlling contamination. It is extremely important to ensure that no contamination can enter the tank. By ensuring that the water supply pressure is present 24 hours a day, we can guarantee that no contaminated water enters the pipe network through leaking joints. However, guaranteeing that no contamination can enter the storage tank is not so easy. For example, a conventional tank requires an air vent to allow for air to be induced into the tank when the water level drops or exhausted from the tank when the water level rises. However, air vents can attract insects or even small animals. If they can enter the tank through the vent, then the tank will be contaminated with their corpses as it is unlikely that they will escape. Air vents must be insect-proof.

Remote monitoring and control

All operating attributes of the system will be measured by sensors to enable the service quality to be remotely monitored. We envisage that one or more major corporations would provide the equipment for communities with an appropriate financing package. These corporations would employ highly skilled engineers and technicians to provide operating oversight for community systems and would have appropriate authority to intervene when needed, following strict protocols to be agreed by government regulators. The same corporations would run the systems needed for collecting payments.

There are well engineered sensors available that would allow the quality of the drinking water to be monitored remotely and automatically with sufficient confidence.

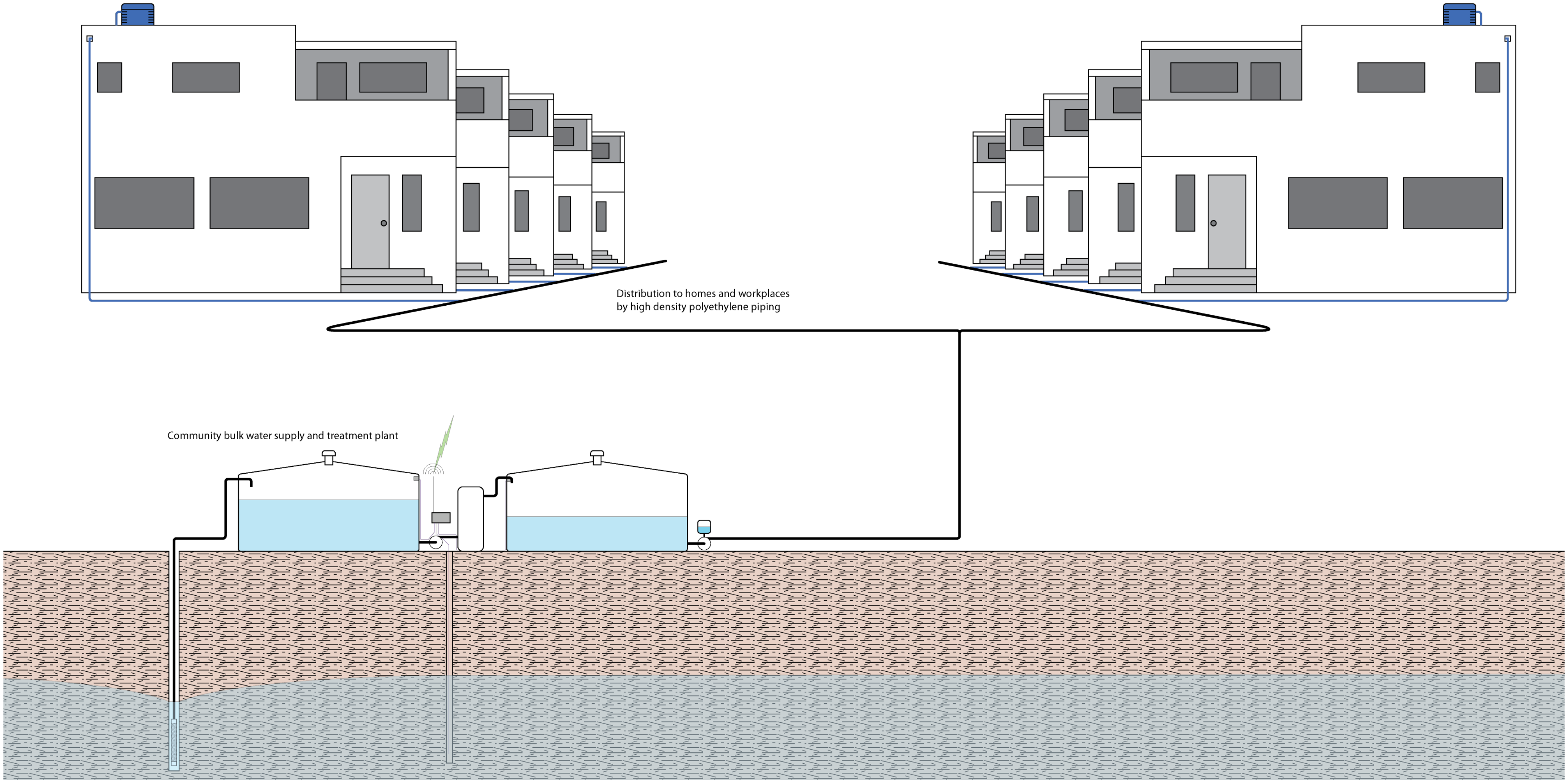

Figure 1: Schematic diagram of drinking water distribution system using ground water for the bulk supply.

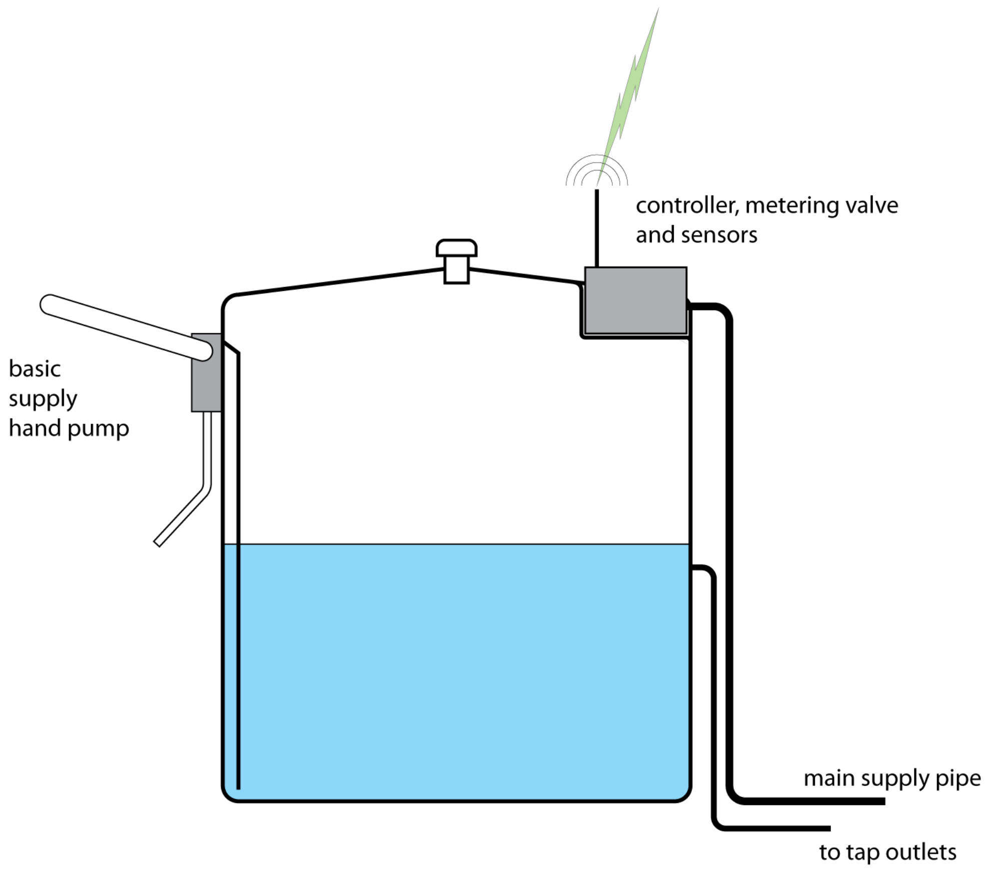

Figure 2: Schematic diagram of building tank