Intermittent Water Distribution
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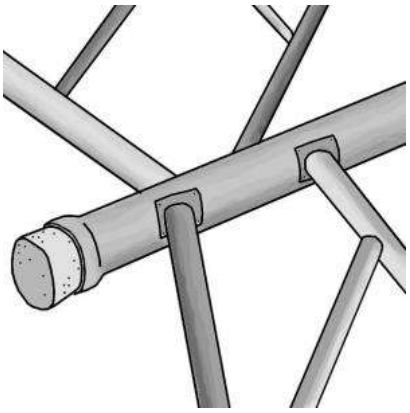

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Intermittent water supply is a piped water supply service delivering water to users for less than 24 hours in one day, and is used when the available supply and/or the hydraulic capacities of the water supply system are too weak. Such systems are prevalent in many countries in the South, encouraged by low tariffs and investments, often in a will to optimise water and economic resources. Paradoxically, more water is needed for such systems due to high wastage. They also require heavy technical and human adjustments compared to continuous systems, thus causing additional costs. Moreover, intermittent supplies are a major inconvenience, mainly to the poor, and represent serious health risks. Efforts should therefore be made to move to continuous systems through technical, social and policy measures.

Water supply is the process of self-provision or provision by third parties in the water industry, commonly a public utility, of water resources of various qualities to different users. In the case of provision by third parties, it is the responsibility of the water authority to provide a satisfying water supply in terms of quantity and quality. However, when material and/or water resource are limited, only intermittent supplies can be provided.

Principles, Process and Design

Slum area in Bangalore. The pots are deposed so they are ready when the water comes. Source: CONRADIN (2006)

Water supply systems are usually designed and built to make water available under continuous pressure 24 hours a day in order to fully meet demand. In case of water shortage, the supply can be adapted to an intermittent water supply, which serves different users at different times. The components of the water supply system (transport, storage and distribution) have to be designed in order to cope with the strain induced by the shortage of water, but can still deliver the designed flow and pressure (TATA Consulting Engineers, n.y.).
Abundant literature is available for continuous water supply system's planning, design, operation and maintenance, whereas operation of intermittent systems is mainly based on experience, analysis of the supply and demand and the search for compromise (TWORT et al. 2000). Generally, continuous supply systems are designed using the following main parameters (EXPERT COMMITTEE CONSTITUTED BY THE GOVERNMENT OF INDIA, 1999):

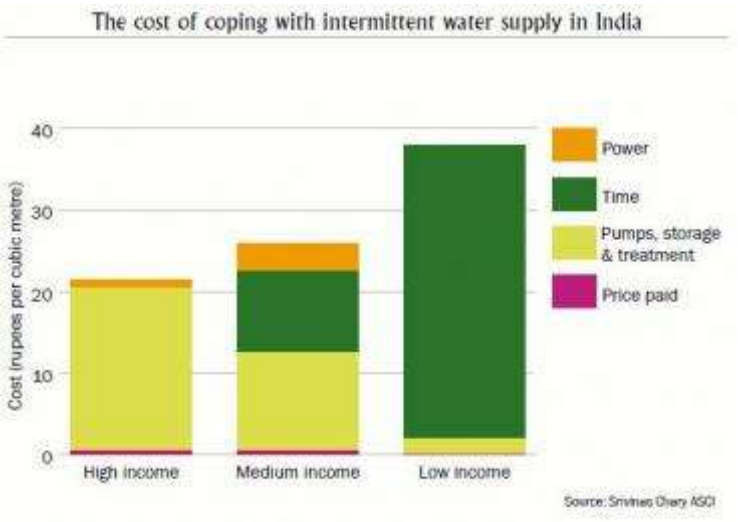
- Flow of raw water: based on water quantities variations over time, account taken of pumps' and motor capacities.
- Water treatment plant: based on total available water to be treated, with anticipation of seasonal variations in flow and flow growth over the years.
- Water transmission system: often designed for 22 hours of operation allowing 2 hours spare for maintenance. 10% extra capacity in the water mains can help if more water is needed due to extra unforeseen demand or delays in network augmentation
  In intermittent systems, the pumping capacities need to be much higher as to run almost continuously with a high rate, and storage capacities also need to be extended. The water transmission system must be adapted to low pressures by enlarging pipe diameters to reduce pressure loss. Note that larger pipes also mean a higher flow, reducing even more supply hours for a constant water volume.

It is sometimes possible to maintain uninterrupted water supply to some zones through proper system design and appropriate demand management. This should allow systematic metering and billing to be gradually installed, and continuous water supply to be extended to other zones.
Note, that even though intermittent water supply is intended as a response to water shortage to minimise water consumption, consumers need to store water between supplies and tend to throw away remnant store, which causes much more water wastage in intermittent supplies. This is emphasised by the fact that taps are often left opened during the whole supply time.

Storage

At treatment or pumping plants, master balancing reservoirs are used for the case of treatment failures or the need for supplement flow. A number of service reservoirs are also to be provided along the supply network: often, both ground level and overhead storage are provided at distribution stations. Direct pumping into the distribution pipes can also be offered. As a rule of thumb, planners usually provide about 80-90% of total storage at the distribution station complexes as underground/ground level storage and the rest as elevated service reservoirs. It is necessary to provide a pumping capacity slightly lower than the considered peak flow rates in the distribution outlets so that the elevated storage does not deplete too fast: 2-3 hours of supply can thus be maintained.

Cost Considerations



Real cost of intermittent water supply for consumers in India. Source: CHARY (2009)

Maintenance costs are higher in intermittent supply systems: the pipes are alternately exposed to air and water and corrode faster. They need to be repaired and changed more often to control leakage and avoid bursts. Operation costs, i.e. pumping costs, are also higher since pumps work for 20 to 24 hours to fill storages, whereas they only balance consumption when needed in continuous systems (MCINTOSH, 2003).

Because of the poor service provided and the low quantities of water sold, tariffs are often low in such systems. Low tariffs add to problems related to excessive pumping, since utilities that lack funds struggle to meet operating and

maintenance costs if there are long pumping hours. No money is then available to invest in adapted infrastructures to extend the network and its supply hours. This cycle is hard to break without reducing leakage and rehabilitating pipelines. Non-revenue water is a major parameter since illegal pumping, leaks and non-metered or free water drastically reduce the income. Planned augmentations should improve the water supply system to meet the total demand and extend supply hours.

When the service improves, higher tariffs can be applied. These are well accepted once consumers are aware that intermittent supplies are not the norm, and that a better service can be achieved. The willingness to pay is not an obstacle, since often consumers pay more in case of intermittent water supply: material costs are important for storage, treatment or pumping, and so are the costs in time (CHOE et al. 1996). Especially for the poor, bribing is sometimes necessary to get adequate service, and one person in the household is dedicated to securing the daily water supply, thus lowering the total family revenue. The real cost of water obtained through intermittent supply is therefore much higher than the simple water bill, and depends on the income as shown below.

Operation and Maintenance

Intermittent water supply requires much more valve operations, requiring more operators to fill the water tanks and direct water towards the appropriate zones. The flow rates are high and the pressures low: more control is also necessary to bring equitable supply. Corrosion and pressure variations make more frequent maintenance necessary on the pipes, joints and valves. Pumps are also more solicited than for continuous supply. Maintaining residual chlorine in water is necessary to try to avoid re-contamination coming with the percolation of extraneous substances out of supply hours.

Health Aspects

Consumers are advised to treat water coming from intermittent water supply (see Household Water Treatment and Storage). As water becomes stagnant in service reservoirs, bleaching powder is often used to maintain a residual chlorine level.

From intermittent to 24 x 7

Introducing equitable costs, reducing leakage and installing proper storage can be the beginning of continuous water supply. Higher tariffs are to be set for 24-hours supply zones, as long as they are fully equipped with exact water meters, while the whole network's expansion is stopped. Little by little, 24-hours supply zones are to be enlarged, and the number of connections too. It is to be noticed that technical solutions are not to be addressed before water policy and governance are adapted. A most important thought to bear in mind is that the water quantity does not need to be bigger with a continuous water supply.

Intermittent Supply : Problems	Intermittent Supply: Solution
High prevalence in South Asia.	Promote awareness among stakeholders.
Caused by extending distribution networks beyond their hydraulic capacities, often at the behest of elected officials.	Address governance issues related to the autonomy of utilities.
Low tariffs and poor collection contribute to intermittent supply.	Introduce higher tariffs for 24-hour zones.
Compared with 24-hour supply, more water is used.	Place moratoriums on new connections.
Higher costs and greater inconvenience for consumers and utilities.	Invest in hydraulic modification of distribution systems.
Consumers risk contracting diseases from contaminated water.	Start with 24-hour zones, and then expand these.
Can lead to the exploitation of the poor who often have to use bribes to get adequate service.	Enforce strict metering and collection.
Expectations of consumers are low due to a lack of awareness.	Reduce non-revenue water.

Key problems and some solutions to intermittent water supplies. Source: MCINTOSH (2003)

Applicability

Designing an intermittent water supply network is often considered when there is a scarcity in total water availability vis-à-vis the net water demand of a considered supply area, or when the hydraulic capacities of the network are too low. Usually water supply networks are designed for continuous conditions: the water system should be operated the way it has been designed to in order to approach equitable and efficient water distribution. However, efforts should go towards transition to continuous systems, even when water resources are low: less water is wasted with continuous systems, and proper demand management optimises the resources better than distribution restrictions.

Advantages

- For older distribution systems having weaker joints and more leakage, restrained supply hours can limit leakage
- Reduced pressure also helps lowering leakage
- Overall scarcity may sometimes be managed by interrupting the water supply and equally balancing the resources (controversial)
- Time is available for repair and maintenance out of supply hours

Disadvantages

- Systems do not operate as designed: components are underused, others are overexploited and damaged
- Inconvenience to consumers, mostly the poor (often, one person per household is devoted to storing the water at supply times)
- Pipelines are subjected to vacuum condition after supply hours, which can cause groundwater infiltration into the pipelines with contamination of the supply or pipes deformation
- Frequent contamination requires household-level water treatment, as well as higher doses of residual chlorine by the supplier
- Consumers need to store water between supplies and tend to throw away remnant store. This causes water wastage and storage costs
- Frequent wear and tear on valves, water meters malfunction
- More manpower and infrastructures needed
- High capital cost of making the system stronger compared to a continuous water supply system, Often, no immediate supply and pressure in case of fire

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