DRAFT (7 June, 2001)
This paper is for internal circulation
only and not to be quoted without prior
consultation of the task manager.

Multi-Village Water Supply Schemes in India
Discussion Paper [1]

Abstract

Rural water supply systems that cover more than one village are becoming increasingly common in India. The desire to provide full water supply coverage to rural areas, despite local water scarcity and increasingly contaminated sources, is leading planners to examine ever more distant sources. However, treating and piping water from these remote sources is often complex and expensive, and planners have realized that costs can be reduced, and options broadened, if villages band together and share water supply systems.

Multi-village water supply schemes have the potential to capture economies of scale and to facilitate higher levels of service, and they appear to offer a feasible and long-term solution to the acute water scarcity faced by many regions in India. However, some water sector professionals feel that multi-village schemes are not an appropriate option in rural India, despite these theoretical advantages. They point out that multi-village schemes require significant investment, substantial technical capabilities and involve coordination and cooperation between large and diverse groups. It is argued that, in a context of limited funds and low capacity, multi-village schemes may not be an efficient use of the scarce resources available.

The empirical evidence examined[2] confirms that multi-village water supply schemes have enjoyed limited success in India. It appears that the diseconomies of dispersion and complexity associated with large multi-village schemes, and the relatively small economies of scale, mean that the schemes rarely provide the desired level of service. However, almost all of the schemes considered have been constructed and operated by the state line department (typically the Public Health Engineering Department). The unsustainable supply-driven approach of the PHEDs is widely accepted in single village schemes; however similar analysis has not been conducted for multi-village schemes. Whether the poor performance of multi-village schemes are due to inefficiencies of the PHEDs or due to the nature of MV schemes is not clear.

---

[1] The Discussion Paper was prepared by Andy Robinson (an independent consultant for WSP, Email: andy@roxhat.demon.co.uk) with inputs and task management by Michael Webster. For more information on multi-village schemes in India contact the Water and Sanitation Program – South Asia (WSP-SA) or email the task manager at mwebster@worldbank.org

[2] The data used for the study draws on a limited literature review. The empirical evidence is derived from limited project documents, records of the Government of India and discussion with people involved in projects.

There is scope for enhancing the operational and financial performance of multi-village water supply schemes, notably through the use of improved management models and more demand responsive approaches to planning, implementation and operation, but many of the difficulties associated with multi-village schemes appear to relate to their fundamental nature (complexity and dispersion), or to structural problems that are resistant to change. In India, the most intractable problem is the unreliable rural power supply. Multi-village schemes do not operate efficiently under erratic power supplies, and there is ample evidence that increasingly intermittent services result. This problem is not unique to multi-village schemes, but the costs of intermittent supply are unusually high in these schemes, and the impact on willingness to pay is significant.

In the absence of more rigorous research, the central conjecture of this paper is that multi-village schemes that do not offer continuous water supply are unlikely to provide efficient or cost effective services and, therefore, that multi-village schemes should only be considered when assured power supplies are available. This is not to suggest that multi-village schemes are an infeasible option, but rather to encourage policy makers to focus on cheaper and more reliable water supply options until rural power supplies are made more dependable and institutional reforms allow improved management options.

In cases where there is no alternative to a multi-village scheme, the key factors for success are the unbundling of management functions, demand-responsive planning and choice of management institutions, and meaningful involvement of users in decision-making bodies.

The key message to take from this discussion paper is that existing multi-village schemes have a very low success rate and, therefore, that considerable attention needs to be paid to economic issues, institutional arrangements and external factors prior to the planning and implementation of any scheme.

INTRODUCTION

Rural water supply systems that cover more than one village are becoming increasingly common in India. The desire to provide full water supply coverage to rural areas, despite local water scarcity, is leading planners to examine ever more distant and more contaminated water sources. However, treating and piping water from these remote sources is often complex and expensive, and planners have realized that costs can be reduced, and options broadened, if villages band together and share water supply systems.

Multi-village water supply schemes have the potential to capture economies of scale and to facilitate higher levels of service, and they appear to offer a feasible and long-term solution to the acute water scarcity faced by many regions in India. However, some water sector professionals feel that multi-village schemes are not an appropriate option in rural India, despite these theoretical advantages. They point out that multi-village schemes require significant investment, substantial technical capabilities and involve coordination and cooperation between large and diverse groups. It is argued that, in a context of limited funds and low capacity, multi-village schemes may not be an efficient use of the scarce resources available.

This discussion paper examines the arguments for and against multi-village water supply schemes in India, and considers how improved institutional arrangements might affect their success. It opens with a look at the extent of multi-village schemes in India, before moving on to examine the factors that drive the implementation of multi-village schemes and their theoretical advantages and disadvantages. The next section considers the empirical evidence from evaluations of existing multi-village schemes in India, and uses this analysis to draw out the key issues to be addressed. The discussion paper closes with suggestions on the way forward, and on how to develop appropriate management models. The paper intends to frame future research requirements, and attempts to inform the development of a workable approach for the planning, implementation and management of future multi-village schemes.

The Water and Sanitation Program (WSP) has instituted a global initiative on multi-village schemes, and this discussion paper draws both on the early findings of this global undertaking, and on the results of a literature review undertaken by the author for the Water and Sanitation Program – South Asia (Annex 1).

BACKGROUND

Multi-village schemes tend to fall outside the sphere of interest of most rural and urban water supply specialists. As such, there has been little rigorous or consistent research on the topic:

> "multi-village systems serve settlements that are sufficiently large and dense to benefit from the economies of scale offered by piped systems, but too small and dispersed to be efficiently managed by a conventional urban water utility" WSP draft fieldnote (2001a)

Existing multi-village schemes range in size and complexity from simple cooperatively managed schemes supplying water to a handful of villages, to huge regional schemes that cover hundreds of widely scattered villages (Annex 2).

Data on the number of multi-village schemes in India, and on the number of villages that these schemes cover, are incomplete. However, unofficial figures provided by the Rajiv Gandhi National Drinking Water Mission (RGNDWM) show more than 25,000 multi-village water supply schemes in 18 states[3] (Annex 3).

The situation within states is also unclear, as little disaggregated data is available. However, even states with few multi-village schemes may have significant coverage. For instance, a recent report (GSDWICL, 2000) confirms that there are only 390 multi-village schemes in Gujarat, but notes that the state faces serious water scarcity and water quality problems and that these schemes (known as regional water supply schemes) supply water to more than 4,400 villages. Another 165 large schemes are currently under construction in Gujarat (expected to cover a further 5,200 villages) and their completion will mean that some 55 to 60% of all villages in the state are served by multi-village schemes[4].

THEORY

The relevant counterfactual for a multi-village scheme (MVS) is the set of alternative water supply schemes[5] that would be needed to provide an equivalent level of service to an identical population. For the purposes of this analysis, it has been assumed that both the multi-village scheme in question, and the set of equivalent alternative schemes that the multi-village scheme is being compared to, provide the same level of service and reliability. Empirical evidence concerning the level of service and reliability of multi-village schemes will be discussed in a later section.

Why multi-village?

There is only one valid reason for implementing a multi-village scheme. Namely, that the multi-village scheme is a cheaper and more effective way of providing the required level of service than the alternative methods of water supply.

The minimum level of service is a key issue, as it determines the viability of local water sources for water supply. RGNDWM has adopted the following norms for the provision of safe drinking water to the rural population (RGNDWM, 2000):

a) 40 liters of safe drinking water per capita per day
b) one handpump or standpost for every 250 persons
c) water source should exist within 1.6 km of the habitation (in the plains), or within 100m elevation (in the hilly areas)

---

[3] 88% (22,000) of the schemes are in four states - Rajasthan, Uttar Pradesh, Madhya Pradesh and Punjab
[4] Note: multi-village scheme village coverage will rise further (to about 65 – 70%) when the Sardar Sarovar Project (SSP) is completed
[5] Private supplies, single village schemes, or smaller multi-village schemes

In many rural communities, particularly in the drier areas of India, competition for local water resources is intense. In a context of rising demand, these resources are often unable to provide the stipulated minimum level of service. As a result, planners tend to turn to more plentiful but more distant water sources, and multi-village schemes become attractive as a means of sharing the high investment and production costs of the bulk water supply system (intake, treatment plant, pump station, pipeline), and thus of reducing per capita costs and increasing affordability.

Another concern is drinking water quality. RGNDWM has identified more than 215,000 habitations[6] (15% nationally) that have serious water quality problems related to excess fluoride, arsenic, salinity, iron or nitrate. Many of these water quality problems are caused by naturally occurring substances in groundwater, and extend over large areas (e.g. serious arsenic contamination in 50% of the districts in West Bengal; excess fluoride affecting 30 million people nationally). The provision of water treatment at every village would be expensive, whereas centralized water treatment by multi-village schemes may capture economies of scale and simplify management and regulation.

Economics of multi-village schemes

As flow rate (m^3/sec) increases, most of the individual components of a water supply system exhibit economies of scale[7]. The particular predicament of multi-village schemes is whether the economies of scale gained in the bulk water system (headworks, treatment works, storage tanks, pipelines) are offset by the diseconomies linked to the dispersion of the population served (greater coordination costs, longer pipe lengths, higher leakage).

Economies of scale are generally exponential (Annex 4), thus are more significant at high flow rates (e.g. when population and per capita water consumption are high). They are also more evident when technologies are complex, due to the higher fixed costs involved. Therefore, multi-village schemes are most likely to be economically beneficial when:

- bulk system is large relative to the branch and local systems (Annex 2)[8]
- amount of water supplied is high (liters per capita per day)
- complex water treatment is required

Economic benefits (compared to the equivalent alternative schemes) are likely from lower bulk system costs (in planning, implementation, management, operation and regulation), and from the ability to attract more proficient support organizations and generate greater political support (for cost sharing and for improved power supplies).

[6] A habitation is a sub-village settlement (the smallest administrative unit in India)
[7] Unit investment and production costs fall as the flow rate rises
[8] Note: research is needed into developing metrics, such as the ratio of bulk to local system size (related to population density?), for use in planning multi-village schemes

Comparative costs are likely from:
- more complex schemes[9]
- additional social intermediation (use of demand-responsive approaches[10])
- higher coordination costs[11]
- greater legal requirements (buying land, obtaining rights-of-way)
- higher transaction costs (contracting in or building capacity)
- higher opportunity costs (users' time spent in planning, implementation, and institutional development)

These financial and economic comparisons confirm the opposition of size and complexity. As the population served rises, the scheme begins to capture the economies of scale of the bulk water system, and political leverage increases. However, the scheme also starts to become more complex and dispersed, and this introduces higher coordination and management costs.

EMPIRICAL EVIDENCE

The literature reviewed highlights serious technical, institutional and financial problems associated with multi-village schemes. The few case studies that document successful MVS in India are of simple, cooperatively managed schemes[12], and it appears that large multi-village schemes rarely provide the planned level of service.

In particular, evaluations of existing multi-village schemes noted the following:
- simple, cheap WS solutions excluded by selection criteria (high supply norms, long design life, insistence on 95% source reliability)
- water resources problems (groundwater depletion and shortages in dry season)
- poor planning, design and construction (leading to under utilization of facilities, high water losses, limited flexibility)
- intermittent and inadequate water supplies (low reliability)
- inequitable water distribution (tail-end users and the poor receive little or no water)
- extremely poor cost recovery (no incentives for tariff collection, no sanctions, tariffs capped at State level, low reliability linked to low willingness to pay)
- ineffective management (time and cost overruns, coordination problems)

Despite extensive investment and effort, the main donor agencies involved with large multi-village schemes in India (DFID, DANIDA, NAP, KfW) are now unanimous in the conclusion that multi-village schemes are not an efficient or cost-effective method of

[9] Larger and more complex schemes require more experienced and expensive planners, engineers, managers and support organizations
[10] Involves an iterative process with each village (as demand is based on costs that are affected by the number of villages in the scheme and the level of service that each requires)
[11] Costs associated with coordinating horizontally (between villages) and vertically (between users, operators, village level management, support organizations, scheme level management, local and State government)
[12] For example, the four village scheme in Kohlapur, Maharashtra (WSP, 1999)

providing rural water supply[13]. Most external support agencies are now focusing on small, demand-responsive water supply schemes rather than multi-village schemes.

Many of the problems mentioned above are not unique to multi-village schemes, but the lack of data makes it difficult to trace out intermediary variables, such as poor implementation, and thus it is hard to determine causality. However, it is clear that several of these problems are more prevalent and more severe in multi-village schemes than in equivalent schemes, and therefore warrant further investigation.

The key issues identified can be grouped under three headings: economic issues; institutional arrangements; and external factors. The three sections that follow examine these issues in greater detail.

ECONOMIC ISSUES

Multi-village schemes provide a relatively simple method for planners and engineers to provide water supply to a large number of people. Hugely expensive schemes are justified because their extensive coverage results in relatively low per capita costs. However, in practice, these schemes often provide services to only a fraction of the intended beneficiaries.

One of the key shortcomings uncovered during the research for this discussion paper has been the dearth of information on the real investment and production costs of existing multi-village schemes, and on their operational performance. In the absence of consistent data or analysis, this discussion paper draws heavily on the isolated case studies and evaluations discovered during the literature review[14]. However, it is apparent that further research into costs and operational performance would be an important foundation for the benchmarking of multi-village schemes (Annex 5), and provide a useful basis for improving their management.

Scheme costs

A World Bank review of the rural water supply sector in India (The World Bank, 1999) suggests that typical per capita costs for multi-village (regional) water supply schemes are significantly higher than for 'small' or 'mini' piped water supply schemes.

Typical scheme costs (per capita)*

Technology	Design life (years)	Population	Capital (Rs/cap.)	Operational (Rs/cap.)	Maintenance (Rs/cap.)	O&M (Rs/cap.)
Handpump	10	250	160	0	8	8
Mini piped WS	15	750	500	25	17	42
Small piped WS	20	2,000	1,500	70	37	107
Regional WS	**25**	**5,000**	**2,500**	**117**	**50**	**167**
Town WS	30	10,000	3,500	175	58	233

*Source: State rural water supply agencies and GOI, in The World Bank (1999)

[13] Based on personal communications with the author during January – March 2001
[14] Notably the critical evaluations of Indo-Dutch multi-village water supply schemes conducted by the Netherlands Assisted Program (Royal Netherlands Embassy, 1989; 1992; 2000)

Another recent study (GSDWICL, 2000) notes that the capital costs per capita for multi-village schemes in Gujarat are estimated to be 600 – 1000% higher than those of existing single village schemes, with annual O&M costs estimated to be 8 – 9% of these high capital costs.

These limited data suggest that average per capita costs are significantly higher in multi-village schemes than in single village schemes. However, these comparisons exaggerate the relative cost of multi-village schemes, as many single village schemes not only provide a lower level of service, but also have shorter design lives and cater for cheaper water supply scenarios.

As rural water supply coverage in a region increases, the best sites for water supply are exhausted and the marginal cost of water supply tends to rise. Generally, multi-village schemes are only considered when single village schemes are not viable, and thus often serve ‘problem’ villages with high water supply costs. For instance, many of the multi-village schemes in Gujarat involved huge investments in developing water resources and in constructing transmission pipelines (some up to 200 km in length).

The rising marginal costs may explain the rather counter intuitive fact that the average per capita costs of the multi-village schemes examined are significantly higher than average costs for single village schemes. However, there is also some evidence to suggest that the theoretical economies of scale of multi-village schemes rarely materialize in India (Annex 4). Factors that might explain smaller economies of scale include:

- greater physical constraints (climatic conditions, water resources)
- lower planning efficiency (information base, social intermediation costs[15])
- lower implementation efficiency (less competition, long delivery times, inexperience)
- lower level of service (supply norms, hours of service, reliability, water quality)
- excessive design criteria (design life, expected rates of growth, ease of expansion)
- low prices of local resources (materials, labor and transportation)
- extensive bureaucracy (approvals, licenses, taxes, rent seeking)

Cost recovery

Most existing multi-village schemes have been planned using a ‘top-down’ approach. Schemes are designed based on technical criteria rather than demand, and up-front financial commitments are rarely required from the communities involved. Schemes initiated to provide water for remote water scarce villages often end up including the relatively water rich villages that lie nearby the source, in order to reduce per capita costs and improve scheme economics. As a result, many of the scheme users have alternate water supplies, and thus have little interest in or commitment to the scheme.

Low utilization and low reliability have serious implications for cost recovery and sustainability. It seems clear that people are not willing to pay for services that are

[15] Social intermediation involves engaging, facilitating and building the capacity of the community to implement and manage all or part of their water supply scheme

unreliable, or do not provide the level of service that they require. However, low levels of cost recovery are often assumed to be a symptom of over-priced services, thus many states provide substantial subsidies for the O&M of multi-village schemes. In Gujarat, the State Government pays all scheme electricity charges and as much as 80% of other O&M costs. Yet, despite these subsidies, tariff collection rates remain at only 3-5% and schemes struggle to cover O&M expenses.

Impact on the rural poor

Multi-village schemes are often implemented using funds from poverty alleviation programs, and most existing schemes provide subsidized water supplies. However, the majority of the subsidy rarely reaches the poor, as water distribution is seldom equitable.

Inequitable water distribution occurs at two levels: inter-village and intra-village. Villages close to the headworks tend to receive more water than the remote tail-end villages[16], and households with private connections tend to receive more water than those using public standposts[17]. In both cases, the least needy consume the lion's share of the water, and hence the subsidy, while nominal collection systems and political resistance to higher tariffs ensure that they pay only a fraction of the full price of their consumption.

INSTITUTIONAL ARRANGEMENTS

The discussion so far has focused on the technical and financial issues associated with multi-village schemes, but there can be little doubt that institutional arrangements lie at the heart of the matter. High technical standards and viable economics are important, but without appropriate and sustainable management, even multi-village schemes implemented using international technical assistance and participatory approaches have been known to fail.

The challenge facing the rural water supply sector in India is to provide reliable, affordable and sustainable services to villages with inadequate local water resources. A key aspect of this challenge is the tension between the desire to provide sustainable services and the desire to increase coverage. There is increasing recognition among water sector professionals of the strong link between demand-responsiveness and sustainability, and of the advantages of local water supply management by a small, homogeneous group[18]. As a result, the preferred option for rural water supply is generally small community-managed schemes implemented using demand-responsive approaches. However, when local water resources are limited, small community-managed schemes may not be viable or affordable. In these situations, multi-village schemes are attractive to planners and politicians as they provide a rapid and comprehensive means of improving water supply coverage. Unfortunately, in most cases, there are no institutions capable of implementing or managing a multi-village scheme, and little experience in mobilizing and training groups of communities.

---

[16] Due to fewer operational problems (higher pressures and lower losses) and greater political influence
[17] Illegal house connections often result in little or no water being available at public standposts
[18] Reference the large bodies of literature on common property resources (Robert Wade, Elinor Ostrom) and water user associations (Subramanian et al, 1997)

The remainder of this section provides a sketch of the typical institutional arrangements used for multi-village schemes in India, and attempts to examine what bearing these arrangements have on scheme outcomes.

Typical institutional arrangements*

Scheme	Type	Planning	Implementation	Management	Funding	Support
Deola *Maharashtra*	10 villages Groundwater	MJP	PHED	ZP GP	MNP ARWSP	-
Kohlapur *Maharashtra*	4 villages Groundwater	MJP	MJP	ZP[†] CMA	MNP ARWSP	-
Lathi Liliya *Gujarat*	37 villages Surface water	GWSSB	GWSSB	GWSSB	Dutch Govt. ARWSP	Tech. Consult NGOs
Ulana *Uttar Pradesh*	4 villages Gravity WS	Jal Nigam	Jal Nigam	Jal Sansthan[†] Jal Nigam	MNP ARWSP	-
Sarup-ka-tala *Rajasthan*	21 villages Groundwater	PHED	PHED	PHED	MNP ARWSP	-
Ranigunj CFA *West Bengal*	215 villages Surface water	PHED	PHED	PHED	MNP (60%) ECL/CMWO (40%)	-

*Data from WSP draft report (2001b) [†] Refused to take over O&M (due to lack of funds)

Key:		
	ARWSP	Accelerated Rural Water Supply Programme
	CMA	Cooperative Management Association
	CMWO	Coal Miners Welfare Organization
	ECL	Eastern Coalfields Limited
	GWSSB	Gujarat Water Supply and Sanitation Board
	MJP	Maharashtra Jeevan Pradhikaran
	MNP	Minimum Needs Programme
	NGO	Non Governmental Organization
	PHED	Public Health Engineering Department
	ZP	Zila Parishad

As suggested by the table above, most large multi-village schemes in India are planned, implemented and managed by State level engineering departments. In these schemes, the users generally have little or no involvement in the planning, implementation or management of the scheme (particularly the bulk system). Accordingly, users feel minimal ownership of the schemes (and often have no legal ownership) and have little control over policy or administrative issues.

In the case of multi-village schemes, the conventional approach has been that an appropriate central institution is chosen based on the overall size and complexity of the scheme, and this institution then manages all functions relating to planning, implementation, operation and maintenance. This approach ignores the functional distinction between the centralized mechanisms needed for coordination and enforcement, and the decentralized arrangements needed for user participation and local level solutions (ibid).

These problems are beginning to be recognized, and four increasingly common institutional variants are:

- delegation of management to Panchayati Raj Institutions (particularly small schemes)
- use of NGOs for social intermediation and capacity building
- creation of autonomous agencies to manage bulk water supply systems (e.g. Gujarat State Drinking Water Infrastructure Company Ltd.)

- technical assistance from international consultants
  (notably on projects implemented with aid from External Support Agencies)

The delegation of management functions, including the growing use of local support organizations[19], are positive responses to the institutional problems associated with multi-village schemes, but there is scant evidence that these approaches have been successful to date.

Typical problems are illustrated by a recent institutional review of DFID assisted multi-village schemes in Maharashtra (DFID, 1999):

- multiple WS institutions result in competing schemes in many villages
  (prefer to construct new schemes rather than repair existing ones)
- lack of ownership (supply-driven approach, minimal community contributions)
- no separation of regulatory and planning/implementation functions
- some GPs and ZPs have refused to take over management of schemes

A common remark in evaluations of multi-village schemes is that the number of intermediating groups needs to be reduced. Coordination is important, but overly complex institutional structures create delays, reduce efficiency, stifle innovation, pose problems of accountability (to whom should communities complain) and lead to unnecessary political intervention (Waddell, 2000).

A central problem is that too much government involvement in water development, and the resultant bureaucratic control of scheme operation, tends to create passive users and administrative systems that are incapable of responding to demand (Saleth and Dinar, 1999). Institutional reform and new management models are essential to the development of sustainable multi-village schemes. It should be noted that current GOI support for decentralization and water sector reform are promising steps in this direction.

EXTERNAL FACTORS

Factors beyond the control of the scheme management, such as water resource policy, 'load shedding' strategies[20] and political preferences, can have serious impacts on scheme reliability. Water allocation conflict is on the rise, and failure to address the pricing and control of irrigation extractions will have serious implications for the sustainability of large multi-village schemes. In the electricity sector, demand regularly exceeds supply, and rural areas experience frequent power cuts and large voltage variations, with adverse effects on operational performance. Finally, adequate cost recovery is often hindered by political resistance to the raising of water tariffs, and by ill-informed perceptions of what rural users are willing to pay for reliable water supplies.

[19] NGOs, self-help groups, training institutions, private consultants, Gram Panchayats etc.
[20] Schedules for disconnecting power supply to specific feeder zones in rotation in order to conserve electricity

Water resources

Large multi-village schemes have significant impacts upon regional water resources. There are two effects specifically related to multi-village schemes. The first is the increased risk of groundwater depletion[21] (multi-village schemes tend to concentrate groundwater extraction in one area), and the second is the high leakage level found in most multi-village schemes.

Multi-village schemes allow villages with limited local groundwater reserves to access larger regional resources. In doing this, they aggregate extractions at key water resources, while local reserves may remain untapped (as groundwater resources within the area may not be connected). These water supply extractions are often minor in comparison to irrigation extractions[22], but in a context of competing water uses, declining recharge[23] and rising water demands[24], multi-village schemes risk finding themselves dependent on inadequate groundwater reserves.

Large multi-village schemes are complex and generally involve lengthy pipelines (high pipe length per capita ratios). Much of the system is located outside the villages served, and empirical evidence confirms that 'physical losses'[25] are generally higher in multi-village schemes than in single village schemes.

High physical losses mean that less water reaches the users, and that extractions need to be increased in order to meet demand. In many cases, multi-village schemes exploit water resources inefficiently[26], and the concentration of these inefficient extractions greatly increases the risk of water resource depletion. It can be argued that some proportion of these physical losses will contribute to groundwater recharge, but the water lost has normally been extracted, treated and pumped, and thus has already consumed energy, chemicals and capacity.

Power supply

Most existing multi-village water supply schemes provide an unacceptably low level of service and reliability[27], particularly to tail-end villages and users. Irrespective of the number of hours service per day that the multi-village scheme was originally designed to provide (e.g. 24 hours, or 4 hours) it is typical to find that operational and financial problems have reduced average supply periods to only 1-2 hours per day, and that no water is received on some days.

[21] Falling groundwater levels (with consequent rises in pumping costs and electricity use)
[22] Irrigation use is often subsidized and effectively unregulated
[23] Increased run-off (development leading to higher proportion of impermeable surfaces) and rainwater harvesting reducing infiltration
[24] Notably due to unexpected population growth (migration) and demand for house connections
[25] Differentiated from revenue losses – physical losses include: transmission losses, reservoir and storage tank leakage, distribution system losses, and service connection losses
[26] Levels of unaccounted for water are higher than in alternative schemes
[27] Based on surveys of users conducted during scheme evaluations (from literature review)

Typical reliability of a multi-village scheme*

Scheme	Nr villages sampled	% villages receiving water on: 0 days	1-10 days	11-20 days	21-30 days	31 days
Darsi	100/111	2	2	11	34	51
Chand'm	25/25	12	24	12	52	0
Kurichedu	6/6	50	17	17	17	0
	Average†	**21%**	**14%**	**13%**	**34%**	**17%**

*Data from March 1991 reported in RNE (1992) † Weighted average (each scheme given equal weighting)

Complex systems involving multiple pumping stations and storage tanks require appropriate design, reliable power supplies and low physical losses for efficient operation. Erratic power supplies force managers to adopt shorter, more intensive pumping regimes[28] in order to fill storage tanks, while high physical losses cause pipelines and storage tanks to empty during lengthy periods of non-supply. Consequently, a proportion of each brief pumping session is spent refilling the pipelines and storage tanks in the bulk system. When power is available for only limited periods, multiple pumping phases often result in only a small amount of water reaching the end of the system.

The costs of intermittent water supply are well recognized (Yepes et al, 2000). However, the complexity and spread of multi-village schemes intensifies these problems:

- higher capital costs (larger pumps required, distribution systems up to 40% more expensive due to 'peaky' flows)
- increased coping costs (additional time spent collecting water, private investments in alternative water supply systems, storage, water treatment, pumps)
- increased maintenance (more pipe bursts and larger physical losses due to frequent pressure changes)
- higher staffing levels (estimates suggest 15% more staff for 6 hr supply)
- more illegal connections and larger revenue loss (due to dissatisfaction)
- greater health externalities (higher contamination levels due to low pressures)

Several water supply programs in India have implemented multi-village schemes designed to provide 24 hour water supply. However, in practice, the majority of these schemes have not been able to provide continuous supply.

In Andhra Pradesh, Netherlands Assisted Programs (NAP) constructed several large schemes with exempted power feeders and expensive systems intended to provide 24 hour supply (16 hours pumping and 8 hours storage). Despite these investments, a combination of acute power shortages, low cost recovery and poor management resulted in services becoming increasingly intermittent and unreliable.

An exception is the ongoing KfW aided multi-village scheme in Rajasthan (Annex 6). This huge scheme aims to supply 400 villages, and is being implemented by the Public Health Engineering Department of Rajasthan. Like the Andhra Pradesh NAP schemes, it has exempted power feeders and is designed for 24 hour supply. At present, only 25% of the scheme is operational, but the villages already connected are reported to be receiving continuous supply and, as a result, cost recovery has been exceptional. It is not clear why

[28] For example. two hours in the morning and two hours in the evening

this scheme has been more successful than the ostensibly similar schemes in Andhra Pradesh, or whether its impressive operational performance will be sustainable once all 400 villages are connected. However, it appears that differences between the power sectors in Rajasthan and Andhra Pradesh[29] are a factor in the success of the Rajasthan scheme, as is the use of an ‘unbundled management’ model (Annexes 6 & 7).

Political economy

Unreliable power supplies and political resistance to cost sharing are serious problems for the managers of multi-village schemes. Below cost tariffs and minimal tariff collections result in dependence on inadequate government subsidies, which in turn give rise to unpaid power bills. In this situation, managers often have to minimize costs by reducing the hours of pumping and cutting back maintenance, resulting in unreliable services and lower willingness to pay. This vicious circle is unlikely to be broken by better scheme management, as its origins lie in the local political economy.

In the competition for scarce power supplies, rural services generally lose out to urban services. The allocation of power and water supplies are sensitive political issues, and local elites involved in industry and agriculture are predictably resistant to preferential allocations for rural water supply.

There are exceptions. The Government of Gujarat has adopted a populist approach and sanctioned the construction of enormous bulk water systems and the provision of huge subsidies for the operation and maintenance of multi-village water supply schemes. However, the schemes remain unreliable, the subsidies rarely reach the rural poor, and the massive drain on state finances limits the provision of services to the rest of the rural population.

LESSONS LEARNED

The empirical evidence examined confirms that multi-village water supply schemes have enjoyed limited success in India. It appears that the diseconomies of dispersion and complexity associated with large multi-village schemes, and the relatively small economies of scale, mean that the schemes are rarely effective or economic, particularly when a low level of service is provided. Despite significant expenditures on planning, implementation and management, operational problems and external factors frequently combine to reduce reliability and supply, and multi-village water supply schemes rarely provide the desired level of service[30]. Consequently, stakeholders are beginning to question whether these schemes are a cost effective method of providing water supply to the rural poor.

[29] Presence of thermal power stations in Rajasthan; recent unbundling of Rasjasthan State Electricity Board into a generation Company, transmission Company and three regional distribution companies; World Bank Power Sector Restructuring Programs in Rajasthan and AP

[30] NAP schemes in Andhra Pradesh that were designed to provide 40 lpcd, were found to produce 20-30 lpcd, but large losses resulted in only 10-15 lpcd being available from public standposts

There is clearly scope for enhancing the operational and financial performance of multi-village water supply schemes through the use of more demand responsive approaches and improved management models. However, many of the difficulties associated with multi-village schemes appear to relate to their fundamental nature (complexity and dispersion), or to structural problems that are resistant to change.

In India, the most intractable problem is the erratic power supply found in rural areas. Multi-village schemes do not operate efficiently when power supplies are erratic, and there is ample evidence that increasingly intermittent services result. This problem is not unique to multi-village schemes, but the costs of intermittent supply are unusually high in these schemes, and the impact on willingness to pay is significant.

In the absence of more rigorous research, the central conjecture of this paper is that multi-village schemes that do not offer continuous supply are unlikely to provide efficient or cost effective services and, therefore, that multi-village schemes should only be considered when assured power supplies are available. This is not to suggest that multi-village schemes are an infeasible option, but rather to encourage policy makers to focus on cheaper and more reliable water supply options until rural power supplies are made more dependable and institutional reforms allow improved management options.

The provision of alternative water supply options depends on demand and on local context. Proponents of multi-village water supply schemes argue that low cost schemes[31] cannot provide the level of service demanded by increasingly sophisticated rural communities, or meet the minimum levels of service laid down by state and national bodies. However, these arguments neglect that existing planning processes and criteria are rarely demand-responsive. In practice, the viability of low cost options is restricted by imposed water supply norms; the real costs of higher levels of service are concealed by unsustainable subsidies; and the substantial risk that a multi-village scheme will provide an unreliable service is seldom discussed.

Despite these concerns, there can be little doubt that multi-village schemes have an important part to play in the water sector in India. It should be remembered that there are more than 25,000 existing multi-village schemes, and that in water scarce areas, and in villages where the users demand higher levels of service than local water resources can provide, multi-village schemes are likely to be the preferred water supply option. The key message to take from this discussion paper is that existing multi-village schemes have a very low success rate and, therefore, considerable attention needs to be paid to economic issues, institutional arrangements and external factors prior to the planning and implementation of any scheme.

[31] Lined ponds, tanks, check dams, groundwater recharge, handpumps, rooftop rainwater harvesting

RECOMMENDATIONS

Economic issues

It is clear that supply driven approaches exacerbate cost recovery problems. Therefore, communities should be offered a choice of water supply options, using demand responsive approaches to ensure that schemes provide appropriate services that users are willing to pay for. This will require less rigid design criteria and supply norms, and will incur higher planning costs. The benefit should be that communities are prepared to demonstrate their commitment to the scheme by making cash contributions towards the capital cost and by agreeing to meet O&M costs, and that expensive but unwanted schemes may be avoided.

By way of example, the use of demand-responsive approaches and cost sharing in the Swajal Project in Uttar Pradesh demonstrated that, in areas where piped supplies are perceived to be unreliable, low-income users often prefer cheaper and more dependable water supply technologies, such as handpumps[32].

Planners also need to examine ways of increasing economies of scale, such as improving institutional arrangements to increase efficiency, and reducing the bureaucracy involved. More detailed research is needed to determine whether there is a minimum level of service below which multi-village schemes become uneconomic.

Finally, multi-village schemes need to be made more pro-poor. This will involve monitoring both the utilization of the schemes and their operational performance, in order to verify whether subsidies actually reach the poor.

Institutional arrangements

The key to successful scheme management is in the demand-responsive choice of institutions. This process needs to take account of existing relationships between communities, local authorities and elected representatives, and to build on institutions that the communities trust and value. It is imperative that institutional choices are made in a participatory manner, through extensive stakeholder consultation, and that management models based on purely technical criteria are not imposed on communities.

In small multi-village schemes, the management functions are relatively simple and a single management body, such as a cooperative management association (Annex 8) is normally capable of managing the whole scheme. However, when the functional requirements of the bulk and local systems vary greatly (Annex 2), as they do in large multi-village schemes, there is a strong case for 'unbundling' their management functions.

There are five key functions to consider:

- management (bulk system)
- management (branch and local systems)

[32] Personal communication with Clarissa Brocklehurst, WSP-SA

- coordination (horizontally and vertically)
- regulation
- professional support services (technical, financial, social)

An unbundled management model provides flexibility. By breaking the management of the scheme down into separate functions, it allows a range of institutions to play the different roles, depending on the scheme characteristics and on their comparative advantages in the local or state context. The bulk water provider might be the Zila Parishad, the State Water Board, an autonomous water company, a private entity, or a consortium involving any or all of the stakeholders. Similarly, the local management body (in each village) could be the Gram Panchayat, a community group (such as a Village Water and Sanitation Committee), or a local NGO[33].

One disadvantage of the unbundled management approach is the larger coordination costs. Coordination will be necessary at several levels, although by far the most important institution will be the scheme level coordination body. It should comprise representatives from each local system (village), the bulk water provider, relevant local authorities and any partner organizations (e.g. water management units). This coordination body should facilitate more meaningful involvement of the users in decision-making. In general, the separation of management functions and the use of simple institutional arrangements should enhance transparency and accountability, and these benefits are expected to outweigh any additional costs of unbundled management.

Unbundling also allows improved regulation of rural water supplies. At present regulation is problematic, as state governments lack a regulatory framework, and Panchayati Raj Institutions (PRIs) lack the financial or technical resources required to act as local regulators. The key message from the literature review is to adopt an incremental approach. Specifically, to proceed slowly with regulation and to focus on priorities, rather than developing complex regulatory structures and attempting overly ambitious capacity building programs (Rosenweig, 2001).

The establishment of water management units (WMU) is one method of providing effective regulation, and professional support services (Annex 11). Water management units can serve large schemes or entire regions, and their audits can be built into the contractual relationships between management bodies and local authorities, and between local authorities and State Government (Collignon & Vezina, 2000). This type of audit can improve transparency and constitute a powerful decision-making tool to:

- regulate water services
- establish fair prices for users and a fair return for the operators/provider
- resolve disputes between local authorities and the bulk water provider
- motivate the provider to improve performance (to match or exceed peers)
- keep users and management bodies informed of the performance of their provider

[33] Annex 10 provides more detail on direct management, autonomous management and regional utilities

External factors

External factors such as agricultural water use, power cuts and the political economy influence scheme reliability. And, if a scheme is unreliable, people's willingness to pay will be low, no matter how demand-responsive the planning, implementation and management of the scheme. Therefore, it is important that any institutional reforms also tackle the wider issues of water allocation, power supply and cost sharing, and that schemes are not sanctioned until credible arrangements have been negotiated.

Financial and operational autonomy have been identified as key factors in the sustainable management of multi-village schemes, and appear to be the best way of protecting a scheme from political interference. Institutional arrangements that allow autonomy, and political support for cost sharing are essential ingredients for the success of a multi-village scheme.

The following sections recommend general principles and approaches intended to enhance the performance of existing schemes and improve the planning, design, implementation and operation of new multi-village schemes.

Approach for existing schemes

The first step should be a rapid assessment of the cost effectiveness and sustainability of the scheme. This will involve examining the current (and potential) operational performance of the scheme, the capacity of the water resource, the demand for the service and any alternative water supply options (in each village). Assessments of operational performance (see Annex 6) and demand are complex, particularly if the scheme is poorly managed and heavily subsidized. However, where multi-village schemes are under utilized, it is important to determine what effect reliability and pricing are having on demand.

The purpose of this assessment is primarily to determine whether:

- a cost effective service is provided to any, or all, of the villages served (i.e. would alternative water supplies provide a cheaper and more effective service?)
- communities would be prepared to pay tariffs that reflect the real costs of managing the scheme (if the scheme was more reliable)
- water resource use is sustainable (at current or future levels)

Abandonment of multi-village schemes is unlikely to be politically acceptable, despite the huge opportunity cost of the funds used for managing dysfunctional schemes. An alternative approach is to try and lower costs and improve reliability by reducing the scope of the scheme so that it only serves villages that can be supplied effectively, and are willing to pay for the service. In large multi-village schemes, there are often villages with viable alternate water supplies that would reduce their consumption considerably (by switching to their alternate supplies) if full cost tariffs were introduced. There are also usually some villages that receive little or no service because of structural system problems (poor design, erratic power supplies), and would benefit from investment in alternative low cost local water supply systems.

There is little point in rehabilitating dysfunctional multi-village schemes unless: the communities served have a felt need for the scheme; the key stakeholders are genuinely committed to the management of the scheme; and, the negative effects of structural constraints and externalities can be reduced to ensure more reliable operation of the scheme. Therefore, stakeholder consultation and participatory approaches to decision-making are essential in planning rehabilitation. Furthermore, community commitment should be secured by an up-front 10% cash contribution towards any rehabilitation of the branch or local systems, and a further (nominal) cash contribution towards the rehabilitation of the bulk system.

Rehabilitation should aim to increase reliability by:

- introducing more efficient management models (unbundling management functions)
- reducing unaccounted for water (both physical and revenue losses)
- establishing performance targets and monitoring (bulk water meters)
- simplifying rules and institutional arrangements (reducing transaction and coordination costs)

Approach for new schemes

The selection of the group of villages to be served is the first step for new schemes. The use of demand-responsive approaches for planning will involve a lengthy iterative process, during which the level of service demanded by each village (without adequate local sources) is aggregated, costs are calculated, and demand is rechecked (as costs will be influenced by the number of villages served and their aggregate level of service).

In all cases, the villages served should be restricted to water scarce villages that are prepared to make up-front cash contributions towards the capital cost of the scheme. The proportion of the community contribution should be kept constant for all schemes (e.g. 10%) so that problem villages are not excluded by per capita cost criteria. This approach should also provide incentives for villages with viable alternative water sources to re-examine the development of more cost effective local water supplies.

Planning should involve:

- use of selection criteria (to limit political interference)
- detailed water resource surveys
- negotiation of water allocations (with central, state and local bodies)
- economic studies (to check that the scheme is the most cost effective water supply)
- use of demand-responsive approaches (extensive stakeholder consultation)
- social intermediation by experienced local support organizations

Implementation should involve:

- use of an unbundled management model
  (for implementation, operation and maintenance)
- establishment of dedicated power supplies
  (exempted power feeders, back-up power generation, priority supply)
- design of most reliable scheme possible given external factors

- political support for increased cost sharing
- professional support services (establishment of water management unit)

Research questions

A number of research questions have been raised.

1. Is ‘24 hour’ supply a realistic goal (given the limited success in urban schemes)?
2. What are the key indicators of successful performance for multi-village schemes?
3. Is it possible to improve the economies of scale of multi-village schemes?
4. Are there lessons to be learnt from:
    a) recent attempts to contract out management of RWS schemes in Rajasthan?
    b) KfW assisted multi-village scheme in Rajasthan
5. What role should PRIs assume in multi-village schemes?
6. What is the best tariff structure for multi-village schemes?

References

Collignon, B and Vézina, M (2000) 'Independent water and sanitation providers in African cities', Washington DC: Water and Sanitation Program

De Silva, Samantha (2000) 'Community-based contracting: a review of stakeholder experience', Washington DC: The World Bank

DFID (1999) 'Mahapani Rural Water Supply and Sanitation Project: Institutional review', New Delhi: Unpublished

GSDWICL (2000) 'Gujarat Jal-Disha 2010: A vision of a healthy and equitable future with drinking water, hygiene and sanitation for all', Ahmedabad: National Institute of Design, Report by a working group of Gujarat State Drinking Water Infrastructure Company Limited

Heaney, James P, Sample, David and Wright, Len (2000) 'Cost analysis and financing of urban water infrastructure', Chapter 10 in www.epa.gov/ednnrmrl/publish/book

Komives, K and Mas, J-P (2000) 'South Africa's BoTT program: an integrated "one stop shop" approach to developing sustainable water and sanitation services in rural and peri-urban communities', Unpublished

OED (1989) 'Oxford English Dictionary: Second Edition', Oxford: Oxford University Press

Rosenweig, Fred (ed.) (2001) 'Case studies on decentralization of water supply and sanitation services in Latin America', USAID EHP Strategic Paper No.1

RGNDWM (2000) 'Rural drinking water supply programme', New Delhi: Rajiv Gandhi National Drinking Water Mission, Ministry of Rural Development, Government of India

RNE (1989) 'AP-22: Report on Mission 22 to Andhra Pradesh RWSS', New Delhi: Government of Netherlands, Netherlands Assisted Programme

RNE (1992) 'AP-25: Rural water supply in Andhra Pradesh', New Delhi: Government of Netherlands, Netherlands Assisted Programme

RNE (2000) 'DGIS' future role in the rural water supply and sanitation sector in India: a reconnaissance mission', New Delhi: Royal Netherlands Embassy

Saleth, R M, and Dinar, A (1999) 'Water challenge and institutional response: a cross-country perspective', Washington DC: The World Bank

Schulz, C and Okun D (1982) 'Surface water treatment for communities in developing countries', London: IT Publications

The World Bank (1999) 'India: Rural water supply and sanitation', Washington DC: World Bank, South Asia Rural Development Series

Waddell, S (2000) 'Increasing local government responsibility for water services: the future for BoTTs', Johannesburg: The Mvula Trust

WSP fieldnote (1999) 'Sustainable community management of a multi-village water supply scheme in Kohlapur, Maharashtra, India', New Delhi: Water and Sanitation Program – South Asia, Small Private Initiatives Series Fieldnote Nr.2

WSP draft fieldnote (2001a) 'Multi-village water supply systems', Washington DC: Water and Sanitation Program

WSP draft report (2001b) 'Assessment of multiple village water supply schemes', New Delhi: Unpublished study conducted by Development Management Consultants

Yepes, G, Ringskog, K and Sarkar, S (2000?) 'The high costs of intermittent water supplies', Unpublished: draft World Bank document

Annex 1
Literature review

Documents Reviewed

Nr	Author	Date	Title
1	AIMS	1998	Evaluation of Rural Piped Water Supply Schemes in 5 States
2	Asit Biswas	1999	Clean water for all: big cities need big ideas
3	Courtenay Sprague	2000	Amanz'abantu: water for the people
4	Daniel Rivera	2001	Management models for small towns: management contract in Marinilla, Colombia
5	DFID	1999	Mahapani rural water supply and sanitation project: institutional review
6	DFID	1998	Impact assessment of Maharashtra RWSS project
7	E Ostrom	1996	Crossing the great divide: coproduction, synergy and development
8	EHP	2001	Case studies on decentralization of WSS services in Latin America
9	Elizabeth Kleemeier	2000	The impact of participation on sustainability: an analysis of the Malawi Rural Piped Scheme Program
10	G Yepes et al (draft)	2000	The high costs of intermittent water supplies
11	GSDWICL	2000	Gujarat Jal-Disha 2010: a vision of a healthy and equitable future with drinking water, hygiene and sanitation for all
12	Guillermo Yepes	1999	Creating the incentives for productive benchmarking of water supply services
13	Guillermo Yepes	1995	Reduction of unaccounted for water: the job can be done!
14	IRC	2000	Case study on KfW Small towns WS, Mali
15	K Choe et al1996		Coping with intermittent water supply: problems and prospects, Dehra Dun UP
16	Kristin Komives & Jean-Pierre Mas	2000	South Africa's BoTT program
17	Lucien Angbo	1999	Community based management of piped water supply systems
18	Lynette Dreyer	2000	The dynamics of community non-compliance with basic water supply projects
19	Marie-Helene Zerah	1997	Some issues in urban water management: household response to water supply availability in Delhi
20	Meena Watts and Mike Webster	1999	Preliminary visit of BPD to South African focus project
21	Network CDS	2000	Peddie rural villages Cisira, Ncala, Mgwangqa and Nqwenerhana case study: water services provision utilizing a community-based structure
22	Richard Franceys, WEDC	1994	Maharashtra water supply and sanitation project: institutional review
23	Royal Netherlands Embassy	1992	Report on mission 25 to Gujarat RWSS: progress evaluation and review of regional water supply schemes (GU-25)
24	Royal Netherlands Embassy	1992	Indo-Dutch RWSS Projects UP: Report of evaluation mission

25	Royal Netherlands Embassy	1995	Report on mission 35 to Uttar Pradesh RWSS (UP35)
26	Royal Netherlands Embassy	1989-1992	Reports on mission to Andhra Pradesh RWSS (AP-22 to 26)
27	S Manikutty	1998	Community participation: lessons from experiences in 5 water and sanitation projects in India
28	Steve Waddell	2000	Case study: intersectoral collaborations in the provision of water services
29	Steve Waddell	2000	Increasing local government responsibility for water services
30	Subramanian et al.	1997	User organizations for sustainable water services
31	Vijay Kumar	2001	Email on DANIDA MVS
32	WASH	1986	Malawi self-help RWS program: final evaluation
33	WaterAid (draft)	2001	Community management and financial sustainability of large-scale gravity-fed water supply schemes in Ethipia
34	WEDC	2000	Summary report on small towns water and sanitation e-conference
35	World Bank	2000	Small towns e-conference
36	World Bank	2000	UP WSESP: Eighth supervision mission Aide memoire
37	World Bank Research Observer	1993	The demand for water in rural areas: determinants and policy implications
38	WSP	2000	Assessment of multiple village water supply schemes (unpublished study by DMC Consultants)
39	WSP	1999	Community partnership in operation and maintenance
40	WSP	2001	Case studies on multi-village schemes
41	WSP draft fieldnote	2001	Launching sector reforms
42	WSP fieldnote	2001	Why some village water and sanitation committees are better than others: a study of Karnataka and Uttar Pradesh
43	WSP fieldnote	2000	Sustainable community management of a multi-village water supply scheme in Kolhapur, Maharashtra, India
44	WSP fieldnote	2000	Villagers treat water as an economic good, Olavanna, Kerala, India

Annex 2
Typologies of multi-village schemes

Multi-village water supply systems come in many different forms, both in their physical and their institutional arrangements. The following categories give some idea of the variations found in India:

1. Small, simple schemes

Pumping from a local source (e.g. nearby tubewell) to a small group of villages with minimal water treatment. These schemes involve relatively simple technology and generally have low O&M costs. They are often locally managed by a ‘cooperative management association’ (Annex 6 Classification of management models).

2. Small, complex schemes

Pumping from a remote source (e.g. a tubewell or canal) to a treatment works or storage tank, then secondary pumping to a small group of villages. Increased O&M requirements, higher costs (capital and recurrent) and more complex institutional arrangements.

3. Large, complex schemes

Pumping from a remote source (e.g. a canal or river) to one or more treatment works, then secondary pumping to storage tanks and/or booster pump stations that supply a large group of villages. High technical capacity needed for design and implementation; significant O&M requirements (reliable power supply, technical capacity, regular supply of chemicals and spare parts); and complex management and coordination problems. Large, complex schemes are often managed by a state or district body (State Water Board, PHED, Zila Parishad).

Schematic approach

A schematic approach has been used to simplify the analysis. Each multi-village scheme (MVS) has been divided up into:

- bulk system (from bulk intakes, treatment works, storage tanks and pump stations to branch system)
- branch system (connecting the bulk system to the local system)
- local system (within the village or its immediate surroundings)

Each single village scheme (SVS) has been divided up into:

- single system (from the intake, treatment works and pump station to the local system)
- local system (within the village or its immediate surroundings)

There are three scenarios to consider:

1. Both SVS and MVS possible within village group

In Scenario 1, water sources adequate for both single village schemes and multi-village schemes exist locally. Multi-village schemes may have financial benefits if single system costs are high (e.g. if water treatment is required). However, this scenario is the least problematic (as water resources are plentiful) so is not considered further.

2. Only SVS possible within village group

In Scenario 2, water sources adequate for single village schemes exist locally, but a multi-village scheme is only possible if a more distant source is used. Single village schemes are always the preferred option in this case, as they are simpler (fewer technical, social and institutional problems) and thus more likely to be sustainable.

Multi-village schemes are unlikely to have financial benefits under this scenario, unless:

- bulk system costs are shared between a large number of villages
- average branch costs are limited (all villages lie relatively close to the bulk system)
- average cost of single system is substantial (e.g. water treatment is required)

3. Neither SVS nor MVS possible within village group

In Scenario 3, no local sources are available. All water supply systems must be based on remote sources, thus system costs are high. Multi-village schemes are likely to have financial benefits over single village schemes, but per capita costs will remain high unless a large number of villages are served.

Annex 3
1999 RGNDWM data

State	Handpumps		Piped Water Supply Schemes					
			Mini-village		Multi-village		Public Standposts	
	Installed	Working (%)	Installed	Working (%)	**Installed**	**Working (%)**	Installed	Working (%)
Andhra Pradesh	235300	100	21320	99	**110**	**97**	0	
Arunachal Pradesh	1490	100	3701	100	**0**		23300	100
Assam	144000	88	3063	86	**0**		0	
Bihar	886786	86	889	48	**0**		0	
Goa	648	100	0		**295**	**100**	11829	100
Gujarat	91268	96	7620	99	**378**	**100**	0	
Haryana	75	100	0		**0**		234783	100
Himachal Pradesh†	7237	98						
Jammu & Kashsmir	1573	79	1783	77	**529**	**81**	164659	86
Karnataka†	162769	99						
Kerala			1365	99	**241**	**100**	132415	99
Madhya Pradesh	365273	86	1904	84	**3950**	**87**	0	
Mahrashtra†	160376	92						
Manipur	1770	81	1415	87	**235**	**85**	6848	89
Meghalaya	1065	87	2467	95			0	
Mizoram	1536	74	896	100	**0**		0	
Nagaland	174	60	951	84	**0**		0	
Orissa	172077	95	211	100	**167**	**99**	10507	100
Punjab	523	96	789	96	**1665**	**97**	58043	100
Rajasthan	161870	95	0		**9066**	**99**	3474	100
Sikkim	0		1914	70	**41**	**95**	0	
Tamil Nadu	164881	98	32420	98	**476**	**100**	252490	100
Tripura	27055	90	456	100	**0**		9120	100
Uttar Pradesh	802043	95	2150	89	**7371**	**0***	36089	97
West Bengal	346420	67	568	100	**451**	**100**	38784	100
A & N Islands	0		234	100	**26**	**100**	504	100
D & N Haveli	1205	100	40	100	**1**	**100**	612	100
Daiman & Diu	625	100	25	100	**2**	**100**	1105	100
Delhi†								
Lakshadweep	0		10	100	**0**		1293	100
Pondicherry	0		271	100	**6**	**100**	0	
Chandigarh	0	0	18	100	**0**	**0**	0	0
Total	3738039	90%	86480	95%	**25010**	**67%***	985855	97%

† No figures are available for piped schemes in Himachal Pradesh, Karnataka, Maharashtra & Delhi
* No breakdown (working/not working) is provided for Uttar Pradesh, but it has been mistakenly included in the calculation of the percentage of schemes working (i.e. if UP figures are removed the proportion claimed to be working rises to 95%)

Annex 4
Economies of Scale

An empirical analysis of the cost of urban water supply infrastructure in the USA (Heaney et al., 2000) produced power functions for estimating the capital cost of pipelines, pump stations, water treatment plants, and storage facilities, in the following form:

$$C = a X^{b}$$

where:
C = cost
X = size (flow, volume)
a = constant
b = economies of scale factor

The exponent 'b' represents the 'economies of scale' factor. If 'b' is less than one, then unit costs decrease as size increases. All of the water supply components examined show economies of scale for the output measures of flow or volume ($0.40 < b < 0.75$), with pipelines and water storage facilities exhibiting particularly strong economies of scale ($b < 0.50$). A typical factor for the overall economies of scale found in water supply schemes is about 0.60.

Cost curves for direct filtration water treatment plants used by the US Environmental Protection Agency (EPA) show a decrease in unit cost of 70% for a tenfold increase in size (economy of scale factor of 0.48), whereas an analysis of costs for slow sand filters in India show a decrease in unit cost of only 28% (Schulz & Okun, 1982) for a tenfold increase in size (economy of scale factor of 0.86).

The following table uses 'economies of scale' factors of 0.60 and 0.80 to illustrate the ratio of the construction cost of one large water supply scheme to the combined cost of an equivalent number of small water supply schemes:

Cost of combined scheme / cost of multiple small schemes $= (P_c)^{b} / nP_i$

where:
P_c = combined scheme population
P_i = individual scheme populations
n = number of individual schemes
b = economies of scale factor
and, $P_c = nP_i$

	Population (000s)		
Combined population, P_c	1	10	100
Individual population, P_i	1	1	1
Number of schemes, n	1	10	100
Cost ratio (b = 0.6)	**100%**	**40%**	**16%**
Cost ratio (b = 0.8)	**100%**	**63%**	**40%**

Annex 5
Benchmarking

Adapted from: The World Bank (2000) 'Benchmarking water and sanitation utilities: a start-up kit', Washington DC: http://www.worldbank.org/html/fpd/water/toolkits.html

Performance assessment of multi-village schemes is likely to be difficult, as few existing schemes collect dependable information. The development of indicators for benchmarking of multi-village schemes is an area that requires further research. In particular, the problem is how to assess the performance of schemes that provide a highly variable service across a dispersed supply system

Core Indicators

A. Coverage	population served (nr of villages) service provided number of standposts number of house connections
B. Water consumption and production	volume of water produced volume of water sold
C. Unaccounted for water	physical losses revenue losses
D. Metering practices	bulk water meters standpost meters household meters
E. Pipe network performance	length of bulk system length of local systems average length per capita
F. Cost and staffing	total and average production costs number of staff (per 1,000 connections) labor costs
G. Quality of service	per capita supply (standposts, house connections) hours of service (per day, month, village)
H. Billing and collection	connection charges fixed charges volumetric charges billing rate collection rate
I. Financial performance	total operating revenues total operating expenses year end accounts receivable
J. Capital investment	financing of debt expansion investment replacement investment

Annex 6
'Aapni Yojna' multi-village water supply scheme, Rajasthan

A huge multi-village water supply scheme is currently nearing completion in the districts of Churu and Shri Hanumangarh in Rajasthan. Technical and financial assistance from the German development bank (KfW) and the Government of Rajasthan has been used to establish a project management cell (PMC) in the State PHED, and a community participation unit (CPU) comprising an association of five local NGOs. These new organizations have worked with international technical consultants and communities to design and implement a scheme that will eventually cover 400 villages and 2 towns, and supply water to about 800,000 people.

The scheme has been implemented using an 'unbundled management' model. The bulk water system is managed by the PMC, but each village has a water user association (WUA) and manages its local system separately. Bulk water meters measure the supply to each village, and bulk water charges are made monthly according to a progressive tariff. The scheme has been designed to provide continuous supply, with a dedicated power system that allows 16-20 hours pumping per day (the balance of supply being provided by storage tanks). Rajasthan suffers acute water shortages, so no house connections have been provided, and the system has been designed to provide 30 lpcd through public standposts.

The scheme was planned using a 'top down' approach based on technical criteria, with no capital cost contribution from the communities. A phased program is being used for O&M cost sharing, in which the community share is scheduled to increase from 35% to 100% over five years. Supply started in March 2000, and 100 villages are now connected.

KfW report that the scheme is operating well. The standposts are being well maintained by the WUAs, with 100% billing and 98% collection claimed from the villages currently connected[34]. Interestingly, water consumption appears to have declined, from about 60 lpcd initially to 40 lpcd today. KfW suggest that this reduction results from an increasing familiarity with the progressive tariff, and note that WUAs are now actively managing demand, using the bulk water meters (which are can be read by anyone) to monitor aggregate consumption[35].

It is too early to make a meaningful judgement about the sustainability of the Churu scheme, except to comment that the approach seems promising. Key issues appear to be their success in providing a reliable service, and in the creation of transparent and straightforward mechanisms for cost recovery. However, there are already signs that the current PMC does not have the capacity to manage the entire scheme, and KfW are currently investigating more sustainable management models[36]. *Note: Further research on this scheme would provide a useful basis for future WSP-SA work on multi-village schemes, and could provide the basis for a practical contribution, e.g. a case study, to the global initiative on multi-village schemes being run by WSP in Washington D.C.*

---

[34] Note: tariffs are currently only at 35% of the full O&M cost
[35] Personal communication from Peter Hilliges (Project Manager, India Division, KfW) on 12 Feb 2001
[36] KfW are currently funding an institutional development study and an operation and maintenance study

Annex 7
Classification of management models

Adapted from: The World Bank (2000) 'Summary report on the small towns water and sanitation electronic conference'

Direct Management

The Works or Water Department concerned with operations is integrated into the local administration with revenues mixed with the overall budget. Revenue collection and accounting may be under the Works or Water Department or under a separate finance department. Water quality regulation, if any, is usually provided by a higher level of government (e.g. a health ministry). Price regulation is usually provided by a water ministry or public utility commission.

Autonomous Management

Although the local government owns the facilities, an independent and financially autonomous water company with an elected or appointed board oversees planning and operations. Water quality regulation, if any, is usually provided by a higher level of government (e.g. a health ministry). Price regulation is usually provided by a water ministry or public utility commission.

Co-operative Management Association

Ownership may be with local government or with the co-operative (community) that manages and operates the services. Co-operatives normally are made up of members of the community who meet annually in a general assembly, an executive board that meets periodically to make management decisions, and an operating group. The co-operative is normally financially autonomous, but is not always formally recognized as an independent legal entity by government. Water quality regulation, if any, is usually provided by a higher level of government (e.g. a health ministry). Price regulation is usually done by the community itself but may be provided by a water ministry or public utility commission.

Regional or National Utility (State Owned or Private)

A government or private utility owns the facilities and is charged with planning, construction and operations. Oversight is provided by a board usually appointed by the water ministry. The utility is financially autonomous but the revenue from more than one scheme or town may be pooled, with individual schemes or towns operating on a budget controlled by central management.

Private Sector Participation (Delegated Management)

Private sector participation (delegated management) may be employed under local, regional or national management. Operations are wholly or partially contracted out to a private company. Contract options include management contracts (the company is paid a set fee or a fee plus a share of profits, 2-5 year contract); lease contracts (the company finances operations and maintenance from its own revenue at its own risk, 7-15 year contract); and concessions (the company finances investments, operations and maintenance from its own revenue at its own risk, 20-30 year contract).

Professional Support to Community Operators

Local Water Departments, Water Boards and Cooperative Management Associations (e.g. Water User Associations) typically employ members of the community to operate their water supply system. In order to get the professional support needed to resolve technical problems, plan and supervise system expansion and provide sound financial management, assistance is required. May involve pooling resources to hire engineers and financial advisors, private sector participation, or professional support from a higher level organization:

- Several schemes or co-operatives group together to hire professional services
- Operating contract or franchise arrangement with private sector

Professional support from higher level organization (e.g. a regional or national utility, or regional or national NGO)

Annex 8
Cooperative management

In small multi-village schemes, management of the bulk water system is relatively simple, and cooperative management associations (see Annex 7) are often capable of undertaking all coordination and management functions. However, monitoring and enforcement should remain functions of the lowest appropriate tier of local government.

An example of successful cooperative management is the Kohlapur water supply scheme in Maharashtra (WSP fieldnote, 1999). Following the refusal of the Zila Parishad to take over management of the scheme from the MJP[37], the four villages served by the scheme formed a 'mandal' and began managing the scheme cooperatively. The scheme has now been running for 20 years without external assistance or funding[38]. An interesting finding of the Kohlapur study was that:

> "mandal officials were strongly opposed to the idea of multi-village piped water schemes serving more than five villages because this would hamper effective decision-making in the mandal. This, they felt, was the main reason for the failure of larger multi-village water supply projects" WSP fieldnote (1999)

Decision-making is not the only problem associated with cooperative management of common resources, but it is generally recognized that cooperative management is more likely to succeed when it involves small homogeneous groups. Therefore, while the threshold of cooperative management may not be a five-village scheme, it is unlikely to be much higher.

The scale at which cooperative management becomes untenable will depend on the scheme and on the local context: the size and density of the villages served; the level of social cohesion (or conflict) between the villages; the functioning of existing cooperative institutions; the extent of political support; the complexity of the scheme; the availability of skilled technicians and managers; and so on.

[37] Due to a shortage of funds (allocated for O&M)

[38] Although free public standposts are provided through a levy added to the annual Gram Panchayat tax, and major repairs are carried out by the MJP

Annex 9
Unbundled management

There are five key functions to consider:

- management (bulk system)
- management (branch and local systems)
- coordination (horizontally and vertically)
- regulation
- professional support services (technical, financial, social)

An unbundled management model provides flexibility. By breaking the management of the scheme down into separate functions, it allows a range of institutions to play the different roles, depending on the scheme characteristics and on their comparative advantages in the local or state context. The bulk water provider might be the Zila Parishad, the State Water Board, an autonomous water company, a private entity, or a consortium involving any or all of the stakeholders. Similarly, the local management body (in each village) could be the Gram Panchayat, a community group (such as a Village Water and Sanitation Committee), or a local NGO[39].

The planning, design and implementation of bulk water systems for multi-village schemes requires considerable technical expertise. The obvious institutions to assume this role are state water boards or engineering departments, but it is remarkable that the schemes designed by these institutions are generally both expensive and unreliable, even when international technical assistance has been involved.

State engineering institutions have little incentive to produce efficient, cost effective schemes. Overly bureaucratic procedures, poor cost recovery, rent-seeking and political interference combine to reduce efficiency and increase costs. Unfortunately, there are few alternative institutions that are both technically capable and politically acceptable.

The introduction of private sector participation (PSP) is the most obvious method of improving efficiency and reducing costs, and bulk system management is the area in which private sector involvement is most likely to be beneficial. However, full PSP is unlikely to be viable for some time (except in very progressive states), as it would require substantial sector reform and institutional development[40]. Furthermore, rural schemes have low value and high risk (when compared to urban schemes, for instance) thus are relatively unappealing to the private sector.

The early findings from experimentation with regional BoTT[41] contracts for rural water supply in South Africa (Komives & Mas, 2000; Waddell, 2000) highlight problems of high contract values (high transaction costs and high risk), complex institutional arrangements (high coordination costs) and overly strict controls (reducing innovation

[39] Annex 10 provides more detail on direct management, autonomous management and regional utilities
[40] Note: very few schemes in India have been implemented with private sector participation, so there is limited experience of the complex contracts and regulation required, or of the institutional reform that state governments need to undertake
[41] BoTT = Build, operate (for a short time), Train and Transfer

and efficiency). It was also noted that the BoTT contract created a conflict of interest, as poor implementation of the train and transfer components increased the likelihood of subsequent management contracts being offered.

It may be possible to attract the private sector to less risky contracts involving well-defined functions (i.e. unbundling still further). Possibilities include:

- design and construction of separate components (headworks, bulk treatment works, storage tanks, pipelines)
- management contract for operation and maintenance of bulk system
- social intermediation

The role of the state engineering institutions should be reduced to monitoring and enforcing state regulations (e.g. on water allocation, water quality, construction standards) and reviewing scheme designs for technical fitness.

Bulk water tariffs and metering

The installation of bulk water meters in the branch line supplying each local system should improve the management of both bulk and local systems. Bulk water meters improve operation and assist in leakage detection by providing vital information on how much water each local system is taking (improving transparency). They also greatly reduce administrative requirements by allowing bulk water tariffs to be billed and collected directly from local system managers (rather than individual households).

The bulk water provider should negotiate bulk water tariffs with the local system management, and any local or state government institutions involved, through the coordinating body (thus allowing the easy incorporation of subsidies). All costs associated with the bulk water system (including O&M, major repair and replacement costs) should be covered by the bulk water tariff.

The local system management body should draw up an agreement with the bulk water provider that details the amount of water to be supplied (per day/month/year), and the tariff schedule. Payments are then made based on the actual amount of water supplied, with lower tariffs if supply does not meet the agreed target, and higher tariffs if the local system uses more water than agreed (or some such similar arrangement). Agreements should contain mechanisms to allow the local system management to negotiate a larger supply (and appropriate tariff) if demand increases.

This type of agreement may be vital to the success of multi-village schemes, as it provides the local system management with some guarantee of the level of service to be provided (and thus should improve willingness to pay). The agreement may also provide an incentive to improve the supply to end-of-line users (as tariffs decline with supply), and a simple mechanism for regulatory bodies to monitor the operational performance of the bulk water provider. Sanctions for non-payment of bulk tariffs will have to be negotiated by the coordinating body.

Local system management

Local and branch systems generally comprise simple pipelines and distribution systems (supplied by the bulk water system). Most of these systems should be suitable for design by a local support organization (SO), and for implementation using ‘community contracting’. Where branch systems are more complex (e.g. containing storage tanks and pumping stations), it may be beneficial to have their design and implementation included in the bulk system.

There is little documentation or rigorous analysis of the benefits of community contracting[42], but a recent World Bank review (de Silva, 2000) found that, where “users are a clearly identifiable group of households in the same community”, and the works are simple[43], community contracting can be more efficient, more transparent, and obtain lower prices than centralized bidding[44] (although some economies of scale may be lost[45]).

Local control is likely to result in more accountability and better services.
This approach will allow the community to have full control over the layout of the distribution system, the level of service provided (proportion of individual house connections and standposts), monitoring of water use (whether to install water meters), and keep costs to a minimum (by using local resources and capacity). It should also improve the users’ sense of ownership, and allow the management body to become familiar with the village system and develop some of the skills needed to maintain it.

The local management body should be responsible for all aspects of the operation and maintenance of the local systems. The local management needs to negotiate tariffs with the standpost and house connection users that cover both local costs (staff salaries, billing, collection, leakage detection, maintenance) and bulk water costs. Key issues are the allocation of water between public standposts and private house connections, and the control of illegal connections.

Coordination

Key responsibilities of the coordination body should include:

- award of implementation and management contracts
- periodic renegotiation of bulk tariffs
- monitoring of operational performance of bulk water provider
- review of financial performance (bulk and local systems)
- provision of legal basis for ownership and management of scheme
- negotiation of increases to bulk water agreements
- decisions on appropriate (graduated) sanctions, e.g. for non-payment
- determination of delegated authorities of executive bodies

---

[42] Community involvement in procurement and disbursement activities during project implementation
[43] Construction of more complex projects, such as storage reservoirs, requires technical support (notably to complete technical specifications, drawings, cost estimates and environmental protection)
[44] Through better awareness of local prices and use of trustworthy contractors
[45] Volume-driven bargaining power is not available to small communities

Typical arrangements for large coordination bodies involve a general assembly that meets a few times a year, and an elected executive committee with delegated authorities that meets more regularly

Regulation

Some form of regulatory body is required to resolve conflicts, to ensure that water regulations are observed, to develop tariff guidelines, and to enforce sanctions.
This role may be taken by: cooperative coordination body (for small schemes if authorized by GO); state water board; engineering department; panchayati raj institutions; autonomous body (e.g. water management unit).

Annex 10
Alternative management models

Direct management

In this model, scheme management (O&M, coordination, regulation) is carried out by local authorities, and is integrated with the other functions of local government (i.e. the management budget comes from general funds rather than water revenues). Planning and implementation may be contracted out, but the local authorities are responsible for all other functions. Direct management is suitable for mature local authorities with well-established infrastructure and solid revenue bases, and allows the capture of economies of scale, the streamlining of related functions, and the use of cross-subsidies.

This model is close to that currently being adopted in much of India. Its major weakness is its dependence on capable local authorities and existing revenue bases. The delegation of power to Panchayati Raj Institutions (PRIs) following the 73rd Constitutional Amendment is ongoing, as is the transfer of scheme management from state engineering institutions, and many PRIs are still adjusting to their new responsibilities. At present, the majority of PRIs do not have adequate capacity or funding to manage multi-village schemes, particularly existing schemes with negligible cost recovery. This has been clearly demonstrated by the refusal of some PRIs to accept the transfer of schemes from state water boards and engineering departments.

Direct management is an option to consider where well-organized PRIs have strong links with local communities, but there are still sizeable problems to overcome. Two fundamental issues are financial autonomy[46], and the separation of regulatory and operational functions (including planning and implementation)[47].

Autonomous management

In this model, an independent and financially autonomous water company (with an elected or appointed board) is responsible for management of the scheme, but local or state authorities own the facilities. Clearly, the high transaction costs involved in setting up such an entity are only likely to be justified for very large multi-village schemes (or regional bodies).

Autonomous management allows the institutional arrangements to be tailored to the scheme, and can attract experienced and capable personnel through the use of competitive salary packages. However, properly autonomous entities challenge political control of strategic resources, and this threat often leads to the creation of parallel government institutions rather than efficient independent bodies.

---

[46] PRIs tend to have rigid financial controls, which require authorization by elected representatives for most expenditures

[47] PRIs are ideally placed to conduct monitoring and enforcement activities at each local level (village, block, district), but combining these regulatory activities with responsibility for operational performance may create conflicts of interest, and reduce transparency and accountability.

Regional utility

In the regional utility model, a government or private utility owns the facilities and is charged with planning, and operations. The utility is normally financially autonomous and revenues from schemes are pooled. Individual schemes operate on a budget controlled by central management. A board, usually appointed by a state institution, provides oversight.

In theory, regional utilities can capture economies of scale, and use their size and potential income to raise finance and deal with externalities. Regional utilities also provide the opportunity for cross subsidies within regions.

However, the introduction of regional utilities would require political support for wholesale transfer of multi-village assets and radical reform of local and state level bodies (down sizing, decentralization, de-bureaucratization), plus enormous funding to finance the rehabilitation and improvement of existing schemes. Despite some success with regional management of rural water supply schemes in South Africa (Amanz'abantu) and Cote d'Ivoire (SODECI), there is little evidence that this approach will improve the operational performance of schemes unless major reforms have already taken place.

Annex 11
Professional support services

Professional support agencies can play a significant role in the planning, implementation and management of multi-village projects. Support services include social intermediation, technical assistance and financial support. Advice can be provided on technology choice, cost estimates, construction management, financial management, tariff setting, expansion planning, water quality, and legal issues such as the registration of local management bodies (WSP draft fieldnote, 2001a).

The use of local support organizations to provide social intermediation and technical assistance to rural communities is relatively well established in India. However, in multi-village schemes, more sophisticated support services are required.

Water management units (WMU) are a model that could be used to provide financial, management and training services to the management bodies, as well as independent monitoring of scheme performance. Case studies of the CCAEP (a WMU that has been very successful in assisting the management bodies of small town water supply systems in Mali) suggest that the type of services that have proved useful are:

- semi-annual financial audits of operating accounts
- advisory services for infrastructure maintenance (assisted by daily radio contact)
- accounting and technical training for local management officers
- regular communication among local management bodies and with WMU board
- monitoring of water consumption, production costs, fuel costs, profits

In Mali, CCAEP is funded through a fee of $ 0.03 for each cubic meter of water distributed by the WUA. The arrangement in Mali has led to a steady reduction in unit operating costs (from $0.70 to $0.30 over a 5 year period) through economies of scale (more reliable services leading to higher demand and production) and more efficient management (better information on production costs).