Citizens demonstrate solutions the city can learn from:
Rainbow Drive Layout and its water reforms over a decade
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Abstract

This paper chronicles the water story of an urban community called Rainbow Drive.

The Rainbow Drive layout is a private gated residential layout that is representative of an increasingly common land-use pattern in growing cities like Bengaluru. Rainbow Drive is 34-acre layout which has a total of about 360 housing plots. At the time of writing this paper (August 2015) 127 plots are still vacant. On all the built up plots, a total of 258 households are residing and around 90 households are tenants. The layout has absolutely no formal water supply from the Bengaluru’s water utility, the BWSSB. The layout is completely dependent on its borewells as a water source. Groundwater in this area has been stressed since early 2000’s creating water scarcity problems in the layout. In addition, the layout had problems of flash flooding during the rains and the Sewage treatment plants constructed by the builder were dysfunctional.

The Plot owners’ association (POA) has responded to these various water problems of the layout in a very enlightened and exemplary manner. Over a decade the POA has tirelessly worked with the wider resident community of the layout to implement various measures geared towards equity, efficiency and sustainability of water use. It has firstly shown that engaging with the community is important and that such long term engagement is necessary to effect change. It has also shown what integrated urban water management is all about : Demand management through education and appropriate tariffs on water, rainwater harvesting and groundwater recharge for flood control and groundwater sustainability, and, wastewater treatment and reuse to reduce freshwater demand and ensure responsible discharge of waste water. It has also shown that such integrated management can be implemented at relatively decentralized scales. Through these measures the layout has successfully moved from being dependent on groundwater overdraft to being a source of artificial rainwater recharge in excess of withdrawal.

What the story also raises are critical questions about how we can re-imagine urban water management. It shows us that citizens have the capability to act as responsible stewards of water resources. It begs the city’s institutions to rethink policy so as to encourage all urban communities to emulate Rainbow Drive. It begs the city’s institutions to be very thoughtful when they do enter new areas with their services – so as not to kill and make irrelevant all the good work that has been done by the different Rainbow Drive’s of the city.

Key words : Intergrated urban water management, citizen stewards, groundwater management, recharge, waste water reuse, Rainbow Drive, decentralized water management.
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Introduction

Bengaluru Context

Today the challenge of water governance in India cannot be overemphasized. The urban regions in India are growing and with it, urban water demand. Across cities and towns in India water governance is becoming a subject of debate. While investments in water infrastructure and institutional models of service delivery are being debated, cities continue to suffer from water shortages and have increasing wastewater management issues. People of the city have responded to this situation on their own – various coping strategies have emerged and urban water markets are growing. Bangalore is a particularly telling case of such a situation. The single largest coping strategy of people in Bangalore has been recourse to groundwater. With a political and ecological limit to what Bangalore can avail from the River Kaveri, its current primary water source, the search for an alternative paradigm of urban water management is of paramount importance for Bangalore. The story that this paper tells, that of a private gated layout in Bangalore called Rainbow Drive, perhaps has many lessons to teach.

Above all it is a story that demonstrates that citizens and communities can become the centre of urban water management. Rainbow Drive can be interpreted as a story of how “coping strategies” – when adopted by a water literate citizenry with a sense of responsibility – has the potential to contribute positively to urban water management.

Rainbow Drive layout: A brief history

The Rainbow Drive layout is a private gated residential layout that is representative of an increasingly common land-use pattern in growing cities like Bengaluru. The layout is situated on Sarjapur Road in Bangalore not far from the Kaikondrahalli Lake. The layout is technically out of the Municipal area of Bangalore (Bruhat Bangalore Mahanagara Palike or BBMP) and comes under the Halanayakanahalli Panchayat though it is practically a part of Bangalore. The BBMP limits end very close to the Rainbow Drive layout on Sarjapur Road and most properties before Rainbow Drive on this Road are a part of BBMP. Sarjapur Road has been rapidly developing since 2000 and is now home to multiple apartments, layouts and large software technology campuses. This part of Bangalore does not receive any formal supply of water or sanitation services from Bangalore’s utility – the Bangalore Water Supply and Sewerage Board (BWSSB). All real estate development and occupied properties in this area depend on private borewells and/or tanker water markets – most often both sources. Tanker operators get water from borewells both within this area and outside this area, from further away from the city. Tanker water rates have steadily risen as demand for water has increased. People’s narratives in the area make it clear that borewells have been drying up and new borewells have to be dug to greater depths for them to yield water.
Fig 1: A Layout map depicting locations of STPs, borewells and recharge structures as of 2009
The development of the Rainbow Drive layout by the builder began around the year 2000. The plots in the layout began to be occupied by around 2002. The layout is a 34-acre gated community which has a total of about 360 housing plots. At the time of writing this paper (August 2015) 127 plots are still vacant. On all the built up plots, a total of 258 plots are occupied by residents out of which around 90 households are occupied by tenants. The builder had drilled six borewells which were the source of water for the layout. When the builder ran the services of the layout he promised and supplied water to the houses in the layout free of cost.

The builder had provided the following water related infrastructure for the layout:
   a) A storm water drain network that carried the storm water to leave the layout
   b) 6 community yielding borewells (of depths varying from 200 ft to 800ft)
   c) Two overhead tanks in the layout
   d) Piped water supply connections to all plots from these overhead tanks
   e) Piped sewage connection to each plot
   f) Two Sewage Treatment plants where the sewage is supposed to be treated.

By around 2004 the Plot owners association (POA) was formed and started taking over the maintenance of the layout.

The POA as water utility: The early years

The POA took over the maintenance of the layout in September 2004 with 12 elected members. The builder began to make his exit – this usually is a process that is staggered in time, as the occupancy of the layout increases. By 2006 the layout had nearly 60% occupancy. As occupancy increased, the layout began to face a number of challenges with respect to water and sanitation. These challenges, which now the POA had to respond to, can be summarized as below:

1. The area had already begun to experience water shortages. Community borewells left by the builder began to dry up.
2. Individual households that were being built in the layout began to dig their own borewells. Further individual households had to call in water tankers – which were not always reliable.
3. The Sewage treatment plants were dysfunctional and did not treat the waste waters generated adequately. Some of the waste waters stagnated in the low end of the layout (which was also the entrance to the layout).
4. During heavy rains upstream storm waters entered into the layout and caused significant flash flooding at the low end of the layout. This got mixed with the stagnating sewage and caused a lot of problems.

In short, the POA which was effectively the layout’s water utility faced problems of urban flooding, water scarcity and waste water management.
Water Reforms undertaken by Rainbow Drive Layout

The Rainbow Drive layout POA responded to these problems in an exemplary manner. It went about building its own capacity by seeking expertise from the outside but more importantly learning from each of its attempts to solve these problems. The history of these responses and the POA’s learning process is as below.

2004 to 2006 : Communitizing borewells and introducing consumption meters

The early pioneers in the POA realized that controlling private drilling of borewells and making people realize the value of water are critical to solving problems. One of the earliest moves Rainbow Drive residents took toward achieving water sustainability was to ban the digging of private borewells. This originated with the builder’s initial encouragement that residents depend on community borewells alone. When some residents sought to sink private borewells, the POA and concerned residents insisted that private borewells would increase water wastage and reduce the community borewell yields. At one point a group of residents prevented a borewell truck from entering the layout. The POA called upon a hydrogeologist who reported that the community could sustain 10-15 borewells at most, and any more would lead to faster depletion of the water table. This argument eventually prevailed.

In the early years of the decade, some residents observed that water wastage throughout the layout was rampant – many people hose-washed their cars each morning, overhead tanks at the layout and household level overflowed with regularity, water was used indiscriminately by construction crews building new homes, and household construction household sumps overflowed due to defective float valves that were not promptly replaced. It was in this context that consumption meters for each and every household and a tariff of 6 Rs / KL were introduced. Meter reading and billing were done once in two months.

At the same time, flooding was a growing water management challenge. Rainbow Drive, like many other Bangalore developments, was built in the midst of a natural water drainage path that led to frequent flooding. The flooding was even worse for the villagers outside the layout, because Rainbow Drive’s peripheral wall effectively dammed the floodwaters. During one heavy rainfall, the homes outside the layout were completely submerged in the floodwaters, prompting the villagers to knock down the peripheral wall. Within a half hour, Rainbow Drive’s front gate was flooded up to five feet deep, and residents were unable to exit the layout for work.

These incidents, – having to block a borewell rig at the layout’s gate, the flooding and observations that some residents were wasteful with their water despite water scarcity problems, – taught the POA a very important lesson. The POA and concerned residents were convinced that all residents needed to be a part of the solution. The importance of consensus building and the acceptance and enforcement of POA’s codes of conduct through social regulation became very clear – especially in the context of many of the POA’s rules unable to be legally enforced. This observation very critically influenced the rest of the POA’s water reform trajectory. It also meant that the POA had to try and deliver water services to its residents to their satisfaction or else enforcing these rules would become very difficult.
2006 - 2008: Water Reform begins in earnest

The water problems experienced during these and previous years set a crisis like context that made it very amenable for vigorous water reforms to begin in earnest. Water was the biggest problem faced by the layout. A group of residents led by one individual particularly committed to managing water sustainably in the layout got elected into the POA. Upon being elected a number of innovative practices intended to increase efficiency, equity and sustainability of the layout’s water management were enacted. These were:

A. Being data driven and arriving at scientific water tariffs
B. Banning of borewells for all construction purposes
C. Communicating and educating all residents of the layout – building a larger water consciousness
D. Introducing the idea of rainwater harvesting and its benefits

The new POA took a year to thoroughly investigate the layout’s water management practices and their sustainability. The data from this exercise would inform the process of developing necessary reforms. The most critical element of this research was to scrutinize consumption data that came from the water billing that was earlier done – having put the consumption meters therefore was critical. This research led to some major realizations and implementation of new rules.

1. A significant finding was that an enormous amount of water was used for new home construction, – construction crews had no incentive to save water and plot owners were absent during the construction process. Moreover, this water was potable, which is not necessary for construction. This immediately led to the banning of community water use for construction. All construction therefore, had to rely on water tankers whose water costs were much higher prompting owners to take more care that water use is optimized. This was relatively easy to implement.

2. Analysis of consumption patterns revealed that roughly one-third of the residents consumed 50% of the layout’s water. The most significant finding was that the water pricing was far too low. The flat rate of Rs. 6 per KL did not provide any incentive for water conservation. The POA member also found that water tariff only accounted for the electricity used to pump borewell water. It did not account for the maintenance costs of bore wells, or the costs of cleaning the water tanks, waterproofing leaks, or fixes to faulty piping. Most importantly, it was found that the cost of treating sewage was not accounted for in the household water bill at all. Rather, sewage treatment costs, which are much more costly than supply costs, were rolled into the layout maintenance fee that was divided equally among the residents. This was inequitable billing, however, since the sewage output per household is proportionate to its water consumption. The **POA determined that the true production cost of water was Rs. 16-17 per kilolitre**. In addition to the under-pricing of its water supply and treatment, the payment recovery was poor due to defaulting and lax enforcement of bills. These two factors led to cash crunches in 2007 and 2008 that required the POA to break its fixed Deposits. Based on this study a new tariff regime was arrived at and the POA had to try and implement the new tariff regime. For this, engagement with the community was necessary.

3. Another major finding was that the four unused borewells, intended as backups to the two functional borewells, were in fact dry. In the subsequent years the POA would then conduct hydrogeological studies to identify new points for borewells to be drilled. It was also found that
the POA did not document and maintain borewell data (depth, borewell logs, casing depths etc). Currently work is ongoing to establish all this data.

4. As the above research was underway, the POA searched for sustainability practices and investments. This led them to explore Rainwater harvesting and its role in the layout. It was in this exploration that Biome Environmental Solutions (Biome) started engaging with Rainbow Drive Layout. Biome helped design and evolve a rainwater harvesting strategy for the layout. Biome also helped think through and catalyse some of the aforementioned reform agendas as well as in communicating the role of rainwater harvesting to the community. Since flooding was a big problem, community recharge wells were proposed first as a flood control measure – with runoff from road and common area catchments. Along with this, rooftop and plot level rainwater harvesting was proposed for the households - where households could harvest rainwater and use stored rainwater or households could also recharge rainwater. The primary tool for recharging rainwater was the “Recharge Well”. Most recharge wells proposed were around 3 feet in diameter and 20 feet in depth. These wells could easily integrate with storm water drains. Each well had a simple filter and desilting chamber before the water would flow into the well.

5. Subsequent to all this research the POA then undertook an outreach and engagement program to the wider resident community of Rainbow Drive. The purpose of this was to make everybody aware of all the water problems, introduce the idea of sustainability practices such as rainwater harvesting and build a larger water consciousness. This exercise was intensive. The driving POA member organized multiple meetings where Biome presented the benefits of Rainwater harvesting and controlling demand. He also made many door to door visits to enroll people to do household level rainwater harvesting. The data research done was extensively shared through emails and discussed across the community.

2008 - 2010 : Implementation reforms – New Tariffs, Ground-water recharge and digging of new borewells

All the research and communication done during the years 2006 to 2008 helped the POA to actually implement the reforms. In 2008 the main things that were implemented were

New water pricing : New water tariffs were introduced based on the production cost of water. Billing cycles were changed to monthly billing cycles. Water pricing was based on the “source to sink” production costs (Rs 16-17) calculated which included cost of sewage treatment. Sewage treatment was clearly the costliest component of the production cost of water. Further, there was a penalty of Rs 10/- per day of delay in payment of water bills. Penalties were also applied when a household water meter remains faulty for more than a month. The new water pricing was designed with the following objectives:

a) To cover the production costs of water
b) To incentivize frugal use of water and penalize wasteful use
c) To incentivize households that do rainwater harvesting
Table 1: The tariff regime implemented in 2008

<table>
<thead>
<tr>
<th>Water consumption level</th>
<th>Tariff</th>
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<tbody>
<tr>
<td>First 10,000 litres (0-10KL)</td>
<td>Rs 10/KL</td>
</tr>
<tr>
<td>Next 10,000 litres (11-20KL)</td>
<td>Rs 15/KL</td>
</tr>
<tr>
<td>Next 10,000 litres (21-40KL)</td>
<td>Rs 25/KL</td>
</tr>
<tr>
<td>Next 10,000 litres (41-60KL)</td>
<td>Rs 40/KL</td>
</tr>
<tr>
<td>Above this i.e. &gt;60KL</td>
<td>Rs 60/KL</td>
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All households that have done household level rainwater harvesting or groundwater recharge get a discount of Rs 100/- on the bill.

**Implementation of ground water recharge:** Parallelly the POA invested in community recharge wells across these two years. This began with the demonstration of around 20 recharge wells in the first phase at the community level. Around 5 households invested in household level rooftop rainwater harvesting in which rainwater was stored in sumps or sintex tanks and used for domestic non-potable purposes. The 20 recharge wells were timed well for the 2008 monsoons. *This immediately demonstrated the of recharge wells in flood control. The recharge well caught the imagination of the residents of the community.* In this context, households were given the option of “sponsoring” a well in the storm water drain if they preferred to do so instead of doing Rainwater harvesting/recharge within their plots. By 2010, the POA and individual households together had invested in some 60 recharge wells in the layout contributing to both flood control and groundwater recharge.

**RECHARGE WELLS – THREE TYPES**

- Wells in Storm water drains invested in by House hold (Just outside the house - Individual Investment)
- Wells in Storm water drains Invested In by POA (Collective Investment)
- Wells Inside the House (Individual Investment)

*Fig 2: Three Types of Recharge wells in Rainbow Drive*

The primary tool used to implement all recharge was the “Recharge Well” a simple well which is 3 feet in diameter and around 20 feet in depth. The community has 3 recharge wells which are 5 feet in
diameter and around 30-40 ft in depth. The recharge well allows the water to percolate into the “shallow unconfined aquifer” (which is still not yielding water in Rainbow Drive). This was the preferred method of recharge because this method is the safest from the perspective of ensuring contamination of groundwater quality – it ensures that the recharge water does not directly enter deeper aquifers but only indirectly through the shallow aquifer. The recharge well as a recharge technique also lends itself to be “plugged” into every household, integrated with drains and be largely location independent. It is also more cost-effective than deeper aquifer recharge techniques.

By 2010, enough recharge wells were dug that the estimated annual rainwater recharge capacity was around 10 Million Liters a year.

Studies are still ongoing to estimate the impact of the recharge on borewell yields if any.

**Additional Investments in water infrastructure:** In 2008 and 2009, the POA commissioned surveys by a borewell specialist, a water diviner, and a hydrogeologist for the purpose of pinpointing new borewell locations. The rationale for new borewell exploration was that the layout was entirely dependent on only two borewells, and a back-up borewell was deemed a necessity in case either of them were to experience technical or supply problems. Additionally, the POA noticed that the supply from the two borewells was insufficient, as people at the end of the distribution network were not receiving as much as other residents. Consequently, three borewell locations were identified and attempted. One attempt failed without striking water. The other two wells struck water, though the yields were relatively low compared to the other yielding borewells. Due to the high cost of sinking a motor and laying the water pipeline from the borewell to the overhead tank, only one of the two wells was connected to the system. The other well will serve as a backup should it become necessary.

In addition attention was turned towards the high cost of the Sewage Treatment plants (STP). It was found that the STP were not fully functioning. The STP was clearly underperforming and the quality of treated water was hardly better than raw sewage. The layout then tightened contracts with the STP operator and refurbished some of the motors in the Sewage treatment plant. The POA would soon begin to take the responsible treatment of waste-water very seriously.

*At this stage with the help of Biome, a demand study was done 2010 based on data of 2008 and 2009. It was found that at this point of time, the per capita demand of the layout was 246 Liters per capita per day.*

**2010 - 2015: Demand management, Driving recharge compliance and waste-water reuse**

By 2010, by far the most important impact of the earlier years of water reform was that the POA and the wider community had far more water champions than the one individual who drove the earlier stages of water reform. The data driven arguments, the demonstration of recharge and flood control had appealed greatly to many and the idea of sustainability was now much more widely understood. The POA therefore had multiple members whose thought processes were aligned to the overall purpose and direction of all the reforms undertaken. This allowed the POA to continue to constantly push for more sustainable water management.

**Demand Management and Recharge Compliance:** The POA learnt that for augmenting and securing water supply with increasing occupancy and the cost of maintaining all water infrastructure were higher.
than what the initial tariff regime was able to recover. This was especially true if costs of new borewells were to be accounted for in the tariff regime. The fact was that borewells yields were falling and new borewells were not necessarily yielding well despite the investments in recharge. This was a result of real estate development happening around the layout in and around Sarjapur Road. The need to manage demand became the most important thing for the POA. The Supply side interventions were simply not enough.

The basic exercise of designing tariff based on consumption and production cost data was now a familiar exercise to both the POA and the larger community. Thus changing and implementing new tariffs became a regular and accepted process. Thus the POA during the 2010-2015 period revisited the tariff multiple times – knowing that tariffs were the key lever to influence demand. These different tariff changes were designed not only to cover costs but also primarily to drive household compliance in groundwater recharge and control demand.

The following graph summarizes all the Tariff changes from 2004 to 2015. As can be seen, as time progressed, the water got more expensive for the residents. More importantly
1. It got very expensive and equal to the tanker water costs at the highest slabs of consumption
2. The benchmark for what the “highest slab” has changed from 60 KL & above to 25 KL & above
3. In the 2014 Tariff change, any household which had not undertaken groundwater recharge at the household level was charged at the highest slab rate for every KL consumed irrespective of how much they consumed.

The combined outcome of the above tariff changes over these periods are depicted in the below two graphs.
**Outcome 1:** Increase in households compliance in doing household level groundwater recharge

![Fig 4: Compliance with household level rainwater harvesting](image)

It can be seen from above now that the last tariff change has ensured 100% compliance of household level recharge. Therefore currently, *Rainbow Drive layout has around 300 recharge wells (in 34 acres)! This is perhaps the highest density of recharge structures anywhere in urban India.*
**Outcome 2:** Decrease of per-capita-demand on community water supply from 246 LPCD to 150 LPCD

![Graph showing reduction in POA supplied water to households]

Fig 5 : Reduction in POA supplied water to households

The POA continued to try and dig more borewells to augment water supply. As of 2015 the layout totally has a total of 10 borewells out of which 4 borewells are yielding. The experience of digging new borewells has reinforced that only supply side interventions do not have great impact. At the same time the effectiveness of controlling demand has been very evident over time. Currently observations by the POA suggests that the shallower borewells are yielding better because of the combined effect of nearly a decade of community recharge and increased compliance of household level recharge. Studies are ongoing to establish the hydrogeological impact of this recharge.

**Waste water management and reuse:**

As the POA became successful in achieving demand management and recharge across the layout, the POA began to turn its attention more and more towards the waste water of the layout.

The Rainbow Drive layout had two STPs. Analysis of these STPs by the POA indicated that:
1. Nearly 50% of the production costs of water was contributed through the operations of the STP at Rainbow Drive.
2. The quality of waste water treatment was very poor. Expert consultation indicated that the state of affairs was “sewage in sewage out”. The treated waste water did not meet the Karnataka State Pollution Control Board’s (KSPCB) discharge norms. The treated water was mostly discharged outside into storm water drains.
3. The STPs had insufficient capacities and insufficient infrastructure to handle the load of the layout, especially at the earlier levels of water consumption. The designed capacities of the STPs itself was unknown.
The POA also realized that wastewater treatment is a very critical component of its overall water management, and reusing treated wastewater could greatly contribute to the layouts self-reliance on water. The POA also realized that given that demand management practices were in place and people had begun to reduce demand, it was not appropriate to investigate and implement improvements in waste water management. The POA began to investigate different investment options for waste water treatment – preferably options that allowed easy reuse of waste-water for gardening purposes, had simpler operations and cost less to operate. Among the options the POA seriously investigated were

1) Soil-Bio Technology (SBT) – an innovative soil based water treatment technology developed by Professor Shankar of Indian Institute of Technology. Professor Shankar and the company was even flown down to Bangalore for discussions and presentations to the community. Select members of the POA actually flew to Mumbai to see a Municipal 1 Million Liter per day (1 MLD) SBT plant that was operating.

2) NEERI’s Phytorid Technology that used anaerobic digestion, followed by a root zone treatment to treat the waste water. The root-zone is a select species of plants that can become a landscape feature. This technology requires minimal energy input. The POA engaged extensively with a company that implemented NEERI’s phytorid technology.

After around three-four years of due diligence and consideration of various options, the POA decided to invest in NEERI’s Phytorid technology. The POA found its operations simple and cheap and the STP could be integrated into the park of Rainbow Drive.

The POA was able to mobilize finances from the community to contribute to a 250 Kilo Liter / Day Phytorid bed Sewage treatment plant. This design capacity was arrived at in the light of the new reduced demand of 150 LPCD. Thus the capacity necessary was far less than would have been necessary if the households continued to consume the earlier amounts of water of around 250 LPCD. This meant that investment costs for waste-water treatment were much lower.

This construction of this STP began in mid 2014. The STP was inaugurated on World Water Day 2015. At the time of writing this paper (Aug 2015) the STP has been in operation for three months. Quality monitoring of the water quality from the STP is ongoing and has so far indicated improvement from earlier STP. It has been found to be conforming to the Karnataka State Pollution Control Board’s discharge norms. This STP has now become a part of the landscape of this layout. The treated water from this STP is passed through an ozonizer and pumped into the overhead tank of the old STP where it is further aerated. As a part of these investments the POA invested in a PVC pipe network that carries the treated waste water to every household to be used for gardening. Each household was charged a one time fee of Rs 500/- to get a connection to this treated waste water.

The STP cost the community a total of Rs 85 Lakhs. It has achieved a savings of Rs 80,000/- per month on operations costs. It is observed currently that around 100 - 150 KLD of waste water is received for treatment (the current occupancy of the layout is around 258 households). The extent of reuse of this waste water for gardening and consequent reduction in use of fresh water for gardening is still being studied. The POA also supplies 10-20 KLD of this waste water to a nearby farmer @ Rs 25 / KL. The POA is now closely monitoring the quality of treated waste water – so far it has conformed to KSPCB’s discharge norms. Recharge of excess treated waste water is being considered upon satisfactory results from quality monitoring. The POA is now in conversation with the KSPCB to get all regulatory clearances.
Re-investment in Waste water reuse

Fig 6 : Pictures of the New Phytorid STP

Conclusion

The story of Rainbow Drive’s response to water scarcity is exemplary. Over a decade the community has changed from having very significant groundwater overdraft to being very significantly water positive. The total estimated recharge of the layout now exceeds the groundwater withdrawn from its borewell (See fig 7). To achieve this, it has firstly shown that engaging with the community is important and that such long term engagement creates multiple “water champions”. It has also shown what integrated urban water management is all about: Demand management through education and appropriate tariffs on water, rainwater harvesting and groundwater recharge for flood control and groundwater sustainability, and, wastewater treatment and reuse to reduce freshwater demand and ensure responsible discharge of waste water. It has also shown that such integrated management can be implemented at relatively decentralized scales.
Fig 7: Estimated water balance of Rainbow Drive layout in 2010 and 2015
This story therefore raises critical questions for urban water management. Can a decentralized strategy for urban water management be imagined? One in which responsible and enlightened citizen driven water management is at the heart of the strategy. How can the city catalyse the replication of the principles Rainbow Drive has demonstrated across different urban communities and what would be the effect of such large scale replication? Do the answers to the city’s difficult water questions lie in this?

When the city’s utility does enter a Rainbow Drive with its services, how should it do so? Should it just make all the good work done by Rainbow Drive irrelevant with its piped water supply or is there a more imaginative role for the city’s formal institutions as they engage with pro-active communities like Rainbow Drive.

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References:
“When Pigs Fly: Citizens at the centre of Integrated urban water management” authored by Mr Avinash Krishnamurthy, Mr Nate Stell, Mrs Shubha Ramachandran, Mr Karan Singh and Mr M S Sunil. This gives a detailed view of Rainbow Drive efforts as of the year 2009-2010. Paper supported by Arghyam Foundation, Bangalore and published on India water Portal by Arghyam. Paper can be downloaded from here: [http://www.indiawaterportal.org/articles/when-pigs-fly-rainbow-drive-layouts-efforts-towards-water-sustainability-citizens-centre](http://www.indiawaterportal.org/articles/when-pigs-fly-rainbow-drive-layouts-efforts-towards-water-sustainability-citizens-centre)