MISSION GROUNDWATER
भूजल अभियान

Urban Rainwater Harvesting

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With special reference to Deccan Basalt Aquifers

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wipro foundation

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ACWADAM

Prepared & Published by: Bhujal Abhiyan

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About Bhujal Abhiyan

Bhujal Abhiyan is a registered non-profit trust under Maharashtra Public Trust Act 1950. It works in the groundwater sector of Maharashtra, with a focus on urban areas.

01 **Mission** - To make all round efforts to maintain sustainability of groundwater resources.

02 **Vision**: Enhance the ability of individuals and entities in urban areas to effectively manage groundwater resources by implementing strategies for governance, aquifer mapping, and Managed Aquifer Recharge (MAR) as well as utilizing monitoring tools.

Bhujal Abhiyan

Bhujal Abhiyan is a mission spearheaded by a diverse group of technical experts, including hydrologists, geo-hydrologists, social workers, doctors, IT specialists, and others. This mission collaborates with other organizations that share similar objectives, with the aim of promoting the conservation, restoration, and sustainable use of urban groundwater resources.

Bhujal Abhiyan conducts awareness campaigns aimed at various stakeholders, which include Urban Local Bodies, Industry Associations, Academia, Institutions, and the public.

Bhujal Abhiyan is promoting scientific groundwater recharge along with Pune Municipal Corporation, Pimpri-Chinchwad Municipal Corporation, PMRDA (Pune Metropolitan and Regional Development Authority), MIDC, GSDA (Groundwater Surveys and Development Agency, Government of Maharashtra), Ministry of Housing and Urban Affairs (MoHUA), Government of India, Nagar Parishads, and many educational institutions.

03 **Bhujal Abhiyan** actively participates in the formation of policies and governance strategies for the groundwater sector.

04 **Bhujal Abhiyan** stays connected with society through a YouTube channel as well as other social media, for dissemination of authentic technical knowledge and advice, related to groundwater management.

Youtube

https://www.youtube.com/@missiongroundwater

Facebook

https://www.facebook.com/groups/missiongroundwater

X(Twitter)

https://twitter.com/Bhujal_Abhiyan

Website

www.bhujalabhiyan.org

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Introduction

What is groundwater? - Water stored in underground porous rocks is groundwater. Groundwater occupies the pores inside the rock, as well as cracks and gaps in the rocks. The upper surface of this zone is termed as the water table (water level). The layers of porous (pervious) rocks that can store, and yield water, are known as an "aquifer" or water carriers. Aquifers are a source of groundwater for wells, borewells, tubewells and natural springs.

Rainfall is the primary source of groundwater. Rainwater travels through the layers of soil to reach the aquifers and is stored there. However, they may come to the surface through springs and rivers and return to the atmosphere sooner or later. This is the Earth's water cycle. Of the total freshwater available on Earth, 99% is from groundwater.

Approximately 90% of rural India's drinking water comes from groundwater, 75% of agriculture is groundwater based and 50% of the water supply in urban India is groundwater based. Rainfall is a major source of groundwater recharge. Other sources, such as water conservation measures, canals, irrigated fields, surface water bodies are indirect measures and direct measures of artificial recharge, such as Recharge Shafts, are also sources of groundwater recharge.

In the last decade, the urban population has mainly been dependent on groundwater. The water supply from dams and lakes is already utilised. Groundwater is under the threat of over-exploitation because groundwater is limited. The primary reason for over-exploitation is the increasing number of borewells owing to their low-cost construction. Additionally, the water supply through tankers is also responsible for stress. The natural recharge of groundwater is affected by the cement roads, concrete buildings, and concrete footpaths. Underground parking in large buildings destroys aquifers completely. Consequently, groundwater levels are constantly decreasing in urban areas. Hence, groundwater requires artificial recharging by rainwater harvesting.

Bhujal Abhiyan has documented the artificial groundwater recharging methods for the benefit for the community. Rainwater Harvesting is preferable for Deccan trap/basaltic aquifer systems, the methods were grouped according to the source of the recharge water. For example, rooftop water, direct rainwater falling on footpaths, and stormwater flowing over the surface are the three different techniques for harvesting rainwater. The fourth technique involves the use of basement seepage water (springs present at the basements) for deep aquifer recharge. Last but not least, is the direct storage of rainwater either over the ground or below the ground. Drawings useful for execution are enclosed for ready reference.

We hope that the handbook will be useful for all engineers and all other stakeholders who are undertaking rainwater harvesting.

The designs conformed to the IS standards and practices recommended by the GoI and GoM.

A. Rooftop Rainwater Harvesting

Rainwater is collected from the roof of a building. It is then channelled through the pipes and cleaned using a standard filter. This clean water is used for recharging the aquifer artificially through an existing good yielding borewell or a dug well, or for the construction of a new injection borewell (recharge shaft).

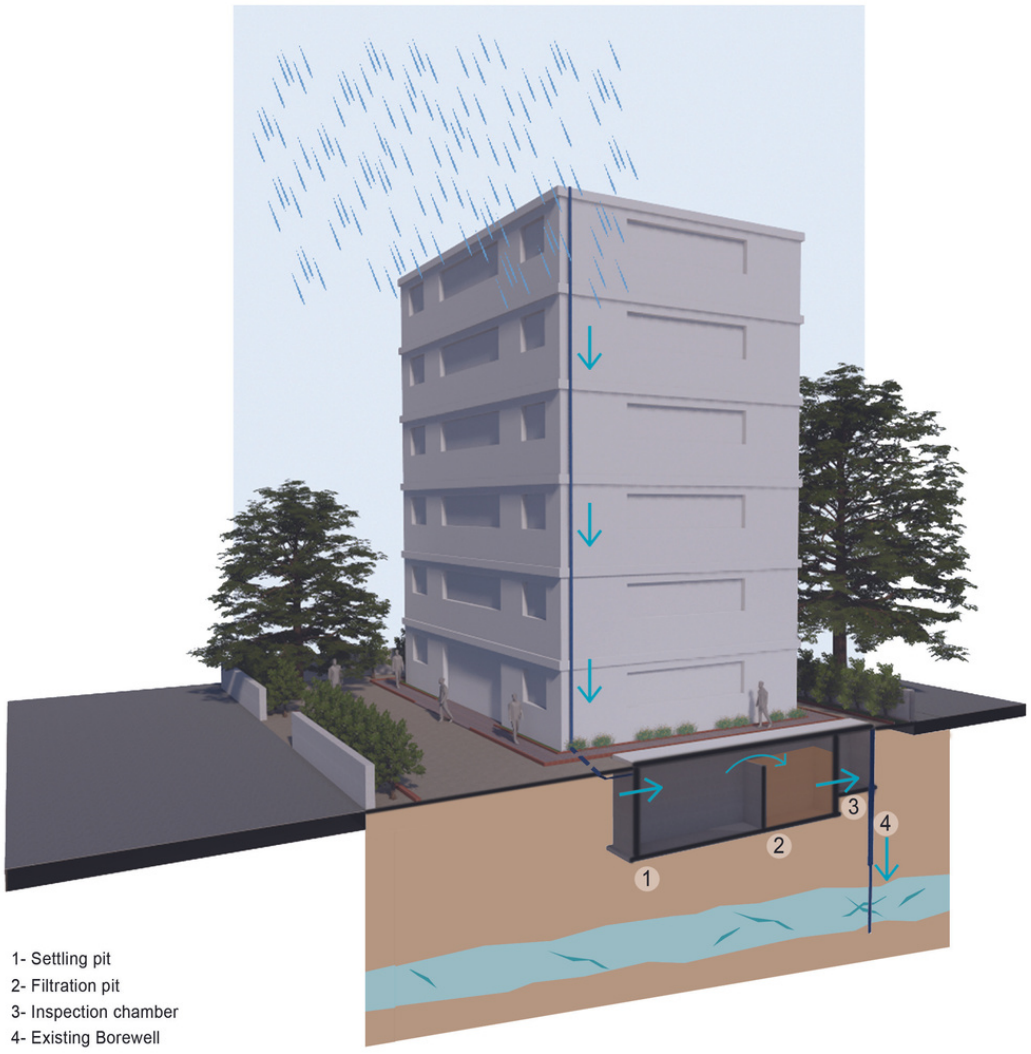
a. Recharging through an Existing Borewell

Recommended for

Roof Area between 1000 to 1500 sq. meters.

Annual rainfall up to 800 mm. with a daily limit up to 30 mm.

Existing Single borewell with yield > 2820 lits/hour indicating presence of productive shallow/ deep aquifer/s.



Methodology

01 Channelize the rainwater collected on the roof of the building/s into one or two vertical drainpipes of at least 4” in diameter. Bring this water through a single horizontal drainpipe of at least 4” diameter, laid down over or below the land surface. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

02 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of rain and allow the rooftop water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using RCC slab, construct a tank of 8 m x 2 m x 3 m (L x W x D) size with two chambers, one for settling & the other for filtration of rooftop rainwater. In continuation with this, construct a third chamber (inspection) of 2 m x 2 m x 2.5 m size to accommodate the existing borewell. Hence, take due precautions so that the borewell is not damaged during the construction of the chamber. Please refer to the drawing for further detail.

04 This tank is to be constructed below the ground. Hence, it is necessary to cover the tank with an RCC slab. Provide manholes within the slab as shown in the drawing.

05 Construct a partition wall between the settling and filtration chambers. In the filtration chamber create a filter bed composed of Sand, Gravel, Activated Charcoal, & Pebbles. This filter material is readily available in the markets.

06 Initially lay a 600 mm layer of pebbles at the bottom of the filter. Cover it with silicon mesh of < 70 micron from the top. Over this silicon mesh place a 750 mm thick uniform size layer of gravel (size 3 to 5 mm). This is also separated by a silicon mesh of the same size. Add an activated charcoal layer of 150 mm thickness over this followed by silicon mesh again. Put a sand layer of 600 mm thickness on the top, wrapped in silicon mesh. For more details, refer to the drawings.

07 For carrying the filtered & clean water from the filtration chamber, lay down a 2” dia PVC pipe at the bottom of the inspection chamber. Join this pipe with the borewell casing pipe by making an appropriate size hole into it. Put a two-way valve in the middle. This valve is to be connected to the drain chamber. This valve is also to be opened when the borewell starts overflowing.

08 In the settling chamber provide two overflow pipes to drain out the excess water collected in it. This is required for high intensity rainfall spells. This helps to maintain the appropriate hydrostatic pressure within the settling chamber and passes the water into the filtration chamber.

Process

01 The rooftop channelised water will come through the inlet pipe into the settling chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Slowly the settling tank will get filled by the roof top rainwater. Soon after the water level in the chamber reaches the top of the partition wall water will start flowing into the filtration chamber.

02 As soon as the water column increases into the settling chamber, slowly the water becomes stagnant. This helps in converting the turbulent flow into laminar flow. It also allows to settle the silt load present within the roof top rainwater.

03 When the water enters the filtration chamber, it will start spreading over the sand layer and because of high porosity it will go down naturally. During this movement heavier clay and silt particles present in the water will start depositing into the pore spaces present in the sand and gravel layers. After entering the pebble layer, the water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter.

04 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

05 After saturation of the pebble layer, the clean water will slowly start flowing through the outlet pipe and enter into the existing borewell. The velocity of this water will be very less. Hence the aquifer/s present within the borewell will accept this water continuously.

Precautions

01 During the first rainfall spell, close the inlet pipe two-way valve and drain the runoff water. This will help in avoiding the heavy contaminant load entering the chambers. During dry spells (dry days > 10) within the monsoon adopt the same procedure.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum roof top water will drain directly into the drain chamber.

03 When inflow of water increases in the settling chamber and outflow from the filtration chamber decreases, excess water collected there will automatically get drained out through two overflow pipes given in the settling chamber.

04 If the borewell starts overflowing, then immediately close the outflow valve and drain the excess water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will protect the borewell from siltation, contamination, or damage.

05 Carry out the flushing of existing borewell in alternate years.

06 For low yielding (between 1375 to 2020 lph) existing borewells reduce the inflow water by 50% i.e. reduce the catchment area of the roof and accordingly use only one vertical inflow pipe for rooftop water.

Maintenance

01 Every year, it is necessary to clean the roof of the building, settling chamber, and filter chamber prior to the monsoon.

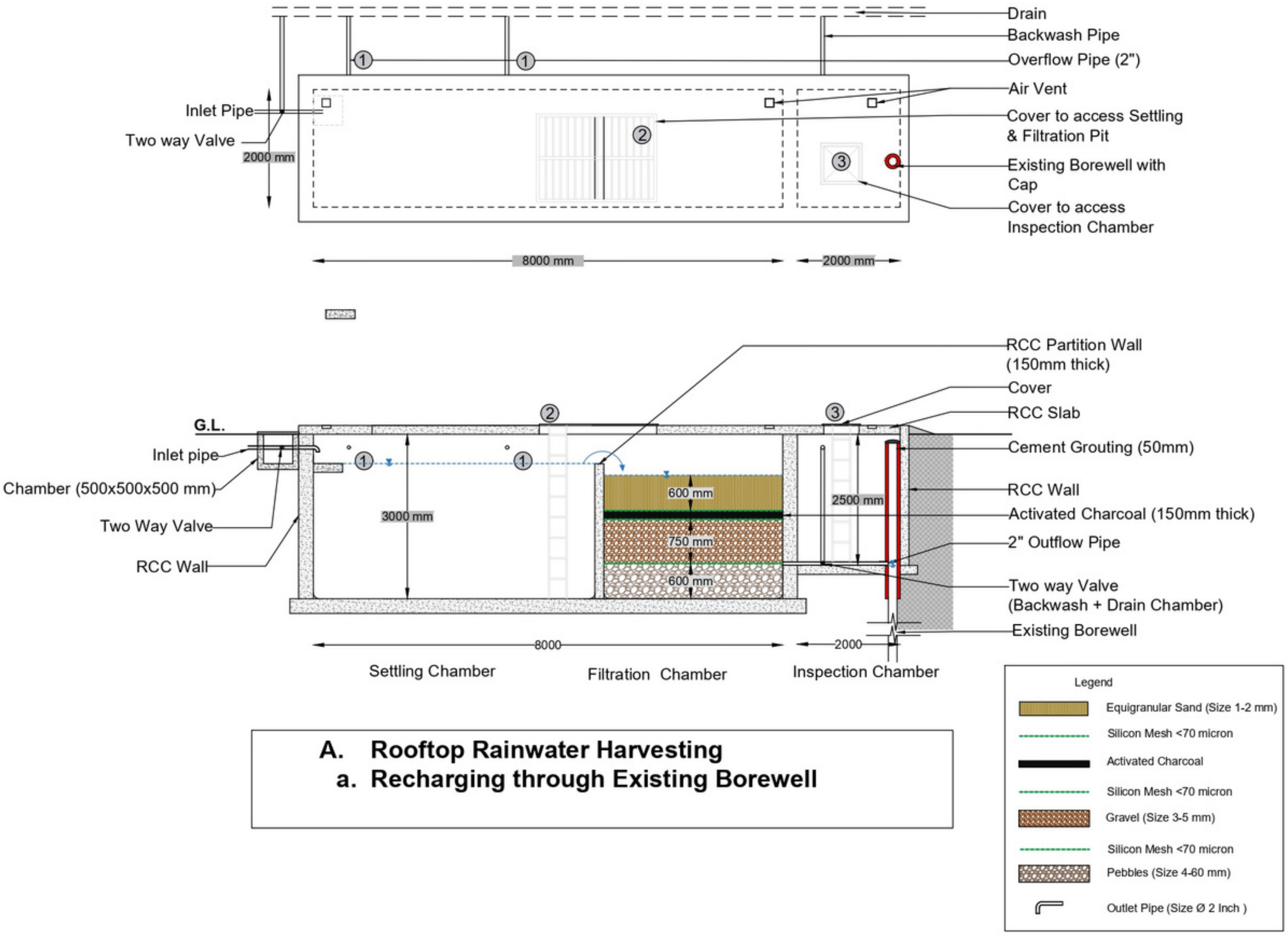
02 Immediately after the monsoon is over, take out the stagnant water in the settling chamber. Also take out the silt settled at the bottom of the tank. For cleaning, use the manhole placed between the settling and filtration chambers.

03 Every year during March-April take out the upper layer of sand and wash it thoroughly. After due drying, top up the sand layer with this washed sand.

04 Once in two years take out the complete filter bed i.e. sand, activated charcoal, gravel and pebble layers. They are to be cleaned, washed, dried properly, and then place in a filtration chamber. Replace the activated charcoal after 3 to 4 years.

05 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

06 Every year check the water quality parameters (chemical and bacteriological) of the borewell water at least during pre and post-monsoon seasons.



A. Rooftop Rainwater Harvesting

a. Recharging through Existing Borewell

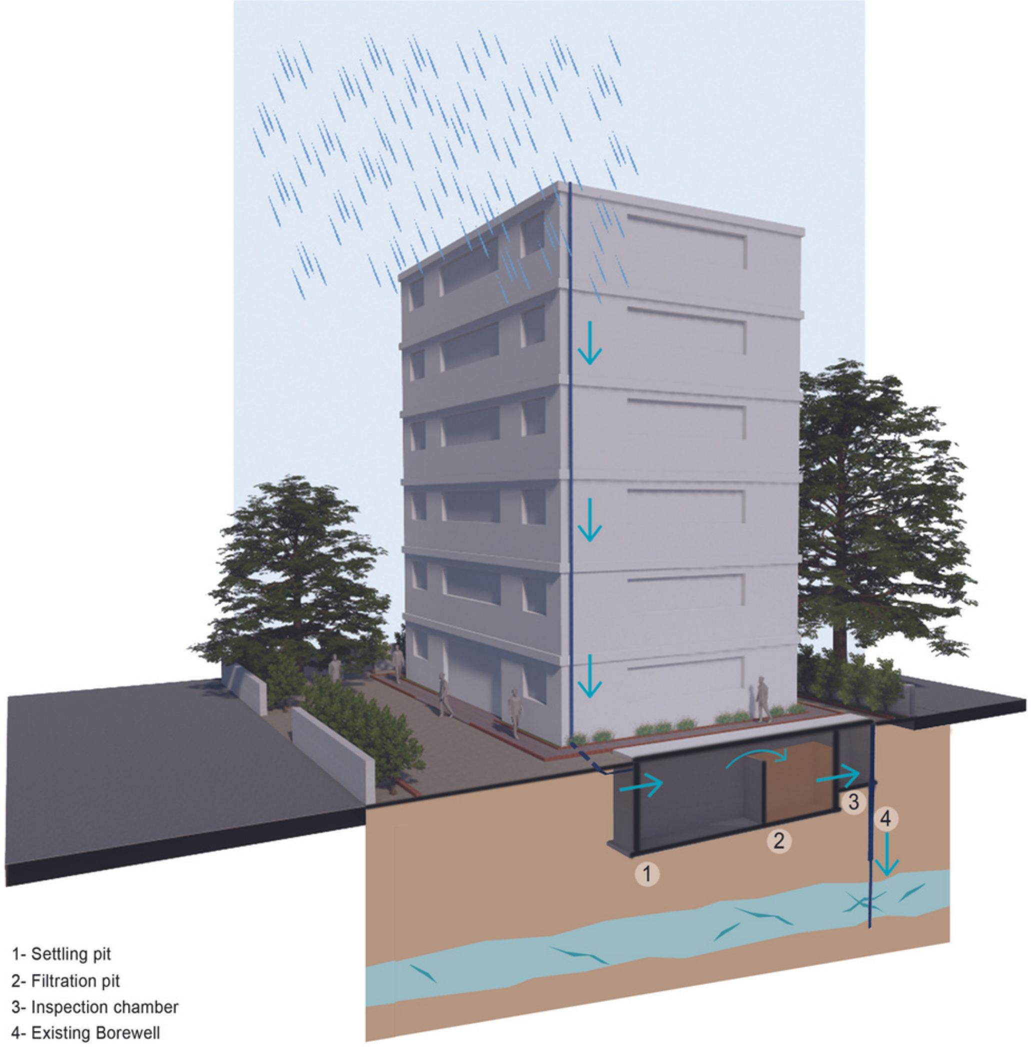
b. Recharging through an Injection Borewell

Recommended for

Roof Area between 1000 to 1500 sq. meters.

Annual rainfall up to 800 mm. With a daily limit up to 30 mm.

Drilling of new single Injection borewell with assured yield > 2820 lits/hour indicating presence of productive shallow/ deep aquifer/s.



Methodology

01 Drill a new borewell of at least 6” diameter within the premises at geohydrologically appropriate location. This borewell should yield at least 2820 lits/hour, then only it will accept good quantity of the filtered rooftop water and recharge the aquifer. Usually, this borewell is not used for pumping purposes. Hence, it is treated as a Recharge Shaft.

02 Preferably use perforated (slit type) M.S. casing pipe of at least 6 meters depth for the borewell during drilling. After drilling grout only, the lower 2 m part of the casing using cement slurry. Wrap silicon mesh of < 70 micron in upper 4 m part of the casing. Cover the borewell tightly with the metal cap.

03 Channelize the rainwater collected on the roof of the building/s into one or two vertical drainpipes of at least 4” in Diameter. Bring this water through a single horizontal drainpipe of at least 4” diameter, laid down over or below the land surface. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

04 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of rain and allow the rooftop water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

05 Using RCC slab, construct a settling tank of 3 m x 3 m x 3 m (L x W x D) size to collect the roof top rainwater. In continuation with this, construct a second small chamber (inspection) of 1.5 m x 1 m x 1 m size to lay down a horizontal pipe to carry the settled water from the settling chamber to the filter bed. In continuation with this inspection tank, construct a filtration tank of 2 m x 3 m x 3.5 m (L x W x D) size using RCC slab, to collect and filter the roof top rainwater. Please refer to the drawing for further detail.

06 This complete tank assembly is to be constructed below the ground. Hence it is necessary to cover the tank with an RCC slab. Provide one manhole to each chamber within the slab as shown in the drawing for cleaning and emergency purposes.

07 In the filtration chamber create a filter bed composed of Sand, Gravel, Activated Charcoal, & Pebbles. Lay down the material very carefully so that the casing and silicon mesh, wrapped over the borewell, will not get damaged. This filter material is readily available.

08 Initially lay a 700 mm layer of pebbles at the bottom of the filter. Cover it with silicon mesh of < 70 micron from the top. Over this silicon mesh place a 700 mm thick uniform size layer of gravel (size 3 to 5 mm). This is also separated by a silicon mesh of the same size. Add a sand layer of 400 mm thickness over the mesh followed by an activated charcoal layer of 150 mm thickness. Again, lay down 450 mm of sand bed over the activated charcoal. All these layers are necessarily separated by silicon mesh.

09 For carrying the filtered & clean water from the filtration chamber, lay down a 2” dia PVC pipe at the bottom of the inspection chamber. Put a two-way valve in the middle for safety. This valve is also to be connected to the drain chamber. This valve is to be opened when the borewell starts overflowing.

10 In the settling chamber provide two overflow pipes to drain out the excess water collected in it. This is required for high intensity rainfall spells. These holes will help to maintain the appropriate hydrostatic pressure within the settling chamber and only the stagnant water will pass into the filtration chamber.

Process

01 The rooftop channelised water will come through the inlet pipe into the settling chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Slowly the settling tank will get filled by the roof top rainwater. Soon after the water level in the chamber reaches the level of outlet pipe it will start flowing into the filtration chamber.

02 As soon as the water column increases into the settling chamber, slowly the water becomes stagnant. This helps in settling the silt load present in the settling chamber itself.

03 When the water enters the filtration chamber, it will start spreading over the sand layer and because of high porosity it will go down naturally. During this movement the heavier clay and silt particles present in the water will start depositing into the pore spaces present in the sand and gravel layers. After entering the pebble layer, the water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter. Only clean water will come up.

04 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

05 The clean water will slowly fill the pebble layer. Then it will start flowing through the PVC outlet pipe joined with the borewell. The velocity of this water will be very less. Hence the aquifer/s present within the borewell will accept continuously.

Precautions

01 During the first rainfall spell, close the inlet pipe two-way valve and drain the first rooftop runoff water. This will help in avoiding the heavy contaminant (including bacterial) load entering the chambers. During dry spells (dry days > 10) within the monsoon adopt the same procedure.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum roof top water will drain directly into the drain chamber.

03 When inflow of water increases in the settling chamber and outflow from the filtration chamber decreases, excess water collected there will automatically get drained out through two overflow pipes given in the settling chamber.

04 If the borewell starts overflowing, then immediately close the outflow valve present in the inspection chamber and drain the excess water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will help protect the borewell from siltation, contamination, or damage.

Maintenance

01 Every year, it is necessary to clean the roof of the building, settling chamber, and filter chamber prior to the monsoon.

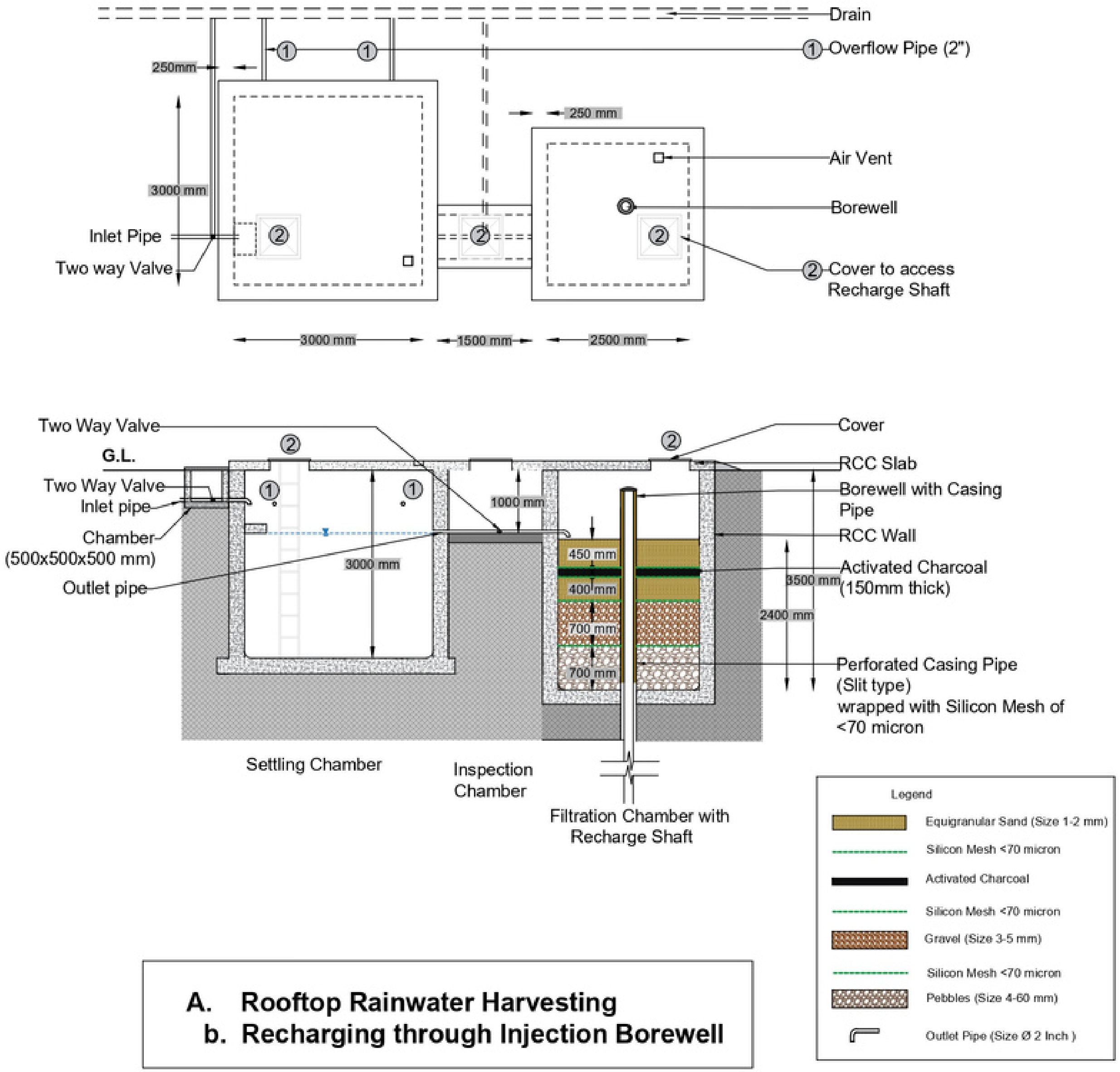
02 Immediately after the monsoon is over, take out the stagnant water in the settling chamber. Also take out the silt settled at the bottom of the tank. For cleaning purposes use the manhole given in the settling and filtration chambers.

03 Every year during March-April take out the upper layer of sand and wash it thoroughly. After due drying, top up the sand layer with this washed sand.

04 Once in two years take out the complete filter bed i.e. sand, activated charcoal, gravel and pebble layers. Clean, wash, dry them properly, and then place them again in a filtration chamber. Replace the activated charcoal after 3 to 4 years.

05 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

06 Every year check the water quality parameters (chemical and bacteriological) of the borewell water at least during pre- and post-monsoon seasons.



A. Rooftop Rainwater Harvesting
b. Recharging through Injection Borewell

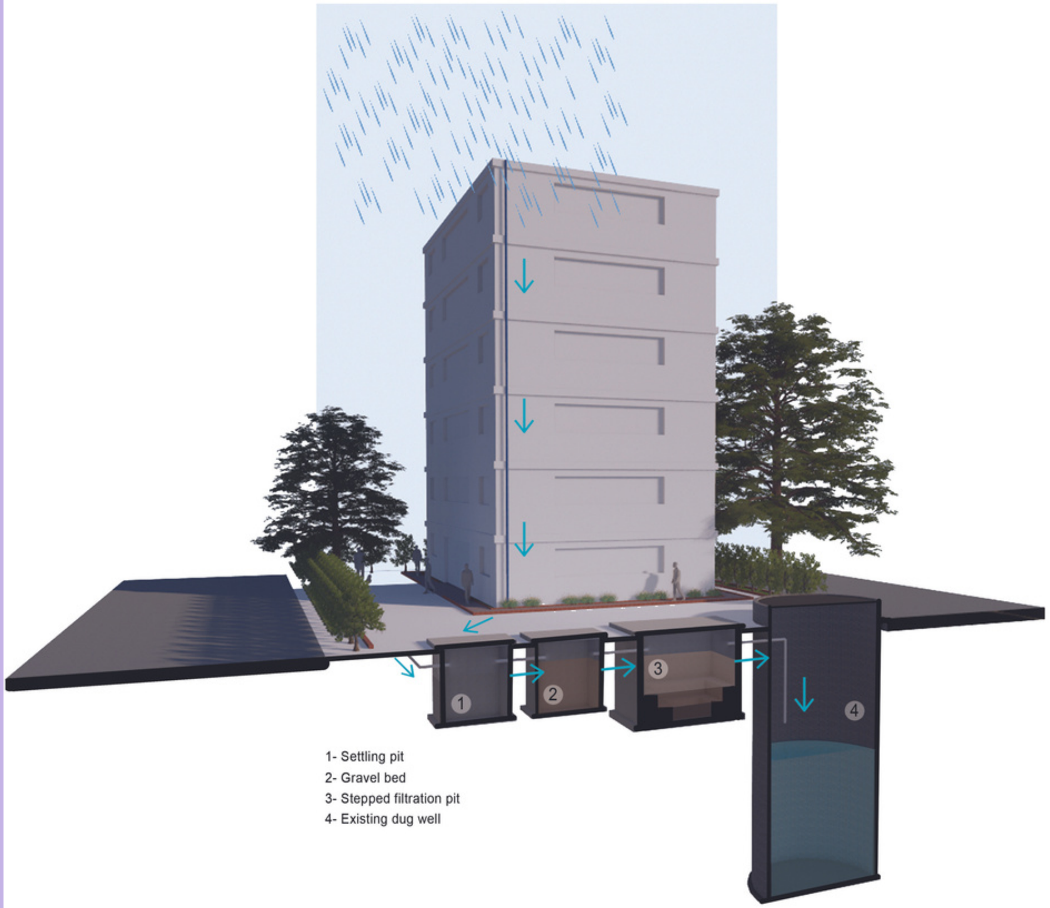
c. Recharging through an Existing Dug well

Recommended for

Roof Area up to 3000 sq. meters.

Annual rainfall up to 800 mm. With a daily limit up to 30 mm.

Existing single dug well with yield > 20000 lits/hr indicating presence of productive shallow aquifer/s.



Methodology

01 Channelize maximum rainwater collected on the roof of the building/s into one or two vertical drainpipes of at least 4” diameter. If the roof area is small, then collect roof top rainwater from adjoining buildings too. Bring this water through a single horizontal drainpipe of at least 4” diameter, laid down over or below the land surface. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

02 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of rain and allow the runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using RCC slab, construct a settling tank of 2 m x 2 m x 2.5 m (L x W x D) size to collect the roof top rainwater. In continuation with this, construct a second chamber of the same size (2 m x 2 m x 2.5 m) for the Gravel Bed tank. In continuation with this, construct a stepped filtration tank of 3.5 m x 3 m x 3.5 m (L x W x D) size using RCC slab, to collect and filter the roof top rainwater. Please refer to the drawing for further detail.

04 This complete 3 tank assembly is to be constructed below the ground. Hence it is necessary to cover the tank with an RCC slab. Provide one manhole to each chamber within the slab as shown in the drawing for cleaning and emergency purposes.

05 Make a hole at 80 cm down below the surface in the settling tank to insert a PVC pipe of 2.5” diameter. Make a same size hole in the Gravel Tank on left and right walls at a depth of 80 cm and 90 cm from the top respectively. In the filtration tank make a same size hole at 90 cm from top. Also make a hole in the filtration chamber at the bottom to carry the filtered water into the well. Join each tank by using a PVC pipe of 2.5” as shown in the drawing. Seal all these holes appropriately after insertion of PVC pipes, so that the water will not leak outside.

06 Initially fill the Gravel Tank with clean uniform size gravel up to a height of 1.5 m from the bottom. In the filtration chamber create a filter bed composed of Sand, Gravel, Activated Charcoal, & Pebbles. This filter material is readily available.

07 Initially lay a 500 mm layer of pebbles at the bottom of the filter. Cover it with MS mesh of < 75 micron from the top. Over this MS mesh place a 500 mm thick layer of gravel (size 3 to 5 mm). This is also separated by a MS mesh of the same size. Add a sand layer of 250 mm thickness over the mesh followed by an activated charcoal layer of 200 mm thickness. Again, lay down 750 mm of sand bed over the activated charcoal. All these layers are necessarily separated by MS mesh.

08 For carrying the filtered & clean water from the filtration chamber, lay down a 2.5” diameter PVC outlet pipe no. 3 at the bottom of the inspection chamber. Insert this pipe in the existing dug well by making a hole using a drill machine. Using elbow bend fix a vertical pipe of the same diameter to outlet pipe 3 and allow the filtered water to fall in the well at appropriate depth.

09 Install a two-way valve in the PVC outlet pipe no. 3 for safety. This valve is to be connected to the drain chamber. This valve is to be opened if the dug well starts overflowing or at the time cleaning of the filter.

Process

01 The rooftop channelised water will come through the inlet pipe into the settling chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Slowly the settling tank will get filled by the roof top rainwater. Soon after the water level in the chamber reaches the level of outlet pipe, it will start flowing into the gravel bed chamber.

02 As soon as the water column increases into the settling chamber, slowly the water becomes stagnant. This helps in converting the turbulent flow into laminar flow. It also allows to settle the silt load present within the roof top rainwater.

03 When the overflow water from the settling chamber enters the gravel chamber, it will start spreading over the gravel layer and because of high porosity it will go down naturally. During this movement heavier clay and some silt particles present in the water will start depositing into the pore spaces. As soon as it gets filled with water, the water will start flowing out from outlet no. 2 pipe present in the gravel bed tank.

04 This water will start entering the filtration tank from the top and start spreading in the sand bed and slowly moves down till it reaches the pebble layer. The water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter.

05 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

06 The clean water from the pebble bed will slowly start flowing through outlet pipe no. 3 into the dug well. The velocity of this water will be very less. Hence the aquifer/s present within the dug well will accept this water continuously.

Precautions

01 During the first rainfall spell, close the inlet pipe two-way valve and drain the first rooftop runoff water. This will help in avoiding the heavy contaminant (including bacterial) load entering the chambers. During dry spells (dry days > 10) within the monsoon adopt the same procedure.

02 During continuous high intensity rainfall spells (>25 mm/hour) partially open the inlet pipe two-way valve, so that maximum roof top water will drain directly into the drain chamber.

03 When inflow of water increases in the settling chamber and outflow from the gravel bed and filtration chamber decreases, excess water collected there will automatically get drained out through overflow pipe given in the settling chamber.

04 If the dug well starts overflowing, then immediately close the outflow valve present in the inspection chamber and drain all the water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will help in protection of the dug well from siltation, contamination, or damage.

Maintenance

01 Every year it is necessary to clean the roof of the building, settling chamber, gravel bed and the filter chamber before monsoon.

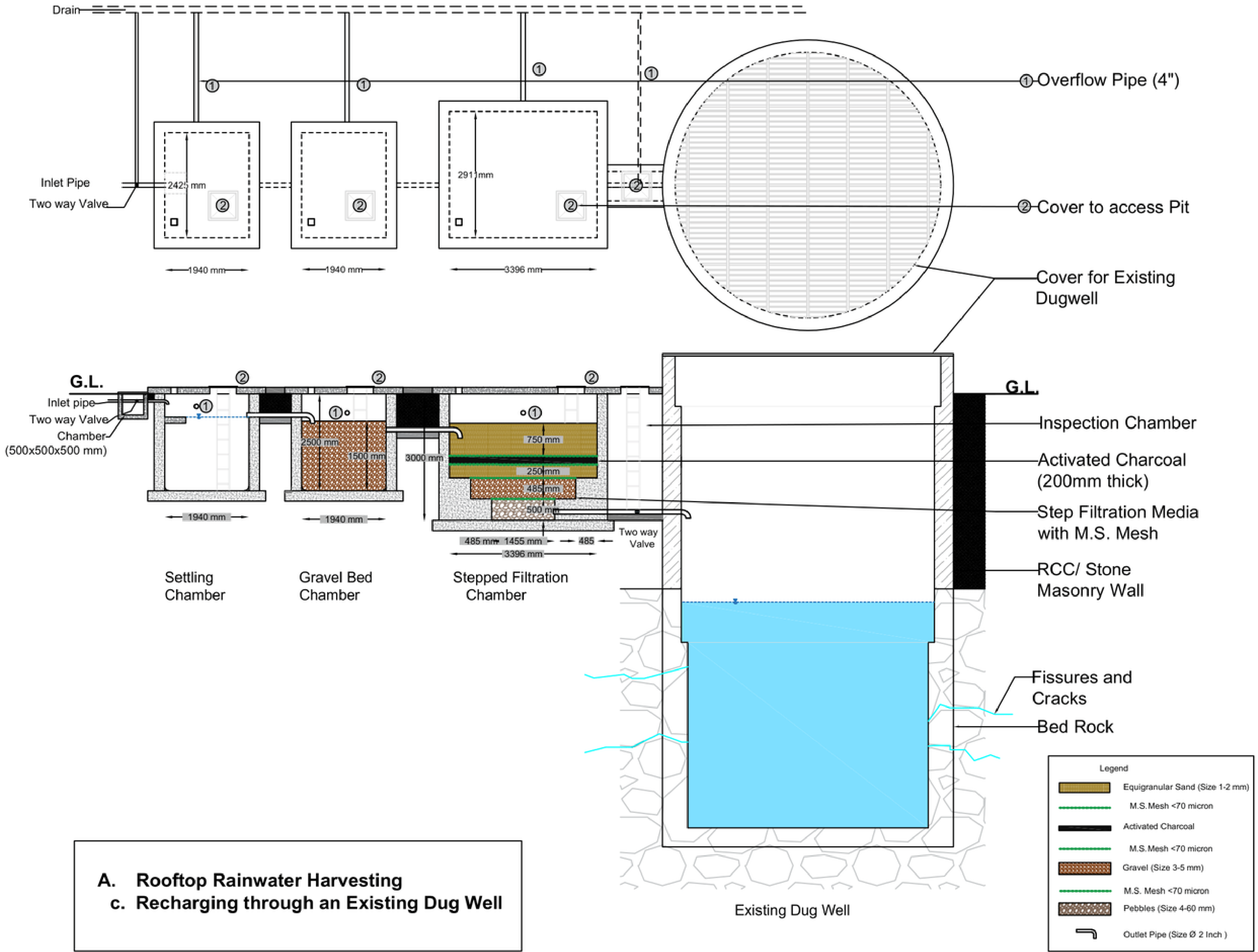
02 Immediately after the monsoon is over, take out the stagnant water present in the settling chamber. Also take out the silt settled at the bottom of the tank. For cleaning purposes use the manhole given in the settling and filtration chambers.

03 Every year during March-April take out the upper layer of gravel from the gravel bed and sand from the filtration chamber and wash it thoroughly. After due drying, top up the gravel and sand layers respectively.

04 Once in two years take out the complete filter bed i.e. sand, gravel, and pebble layers. Clean, wash, dry them properly, and then again place in a filtration chamber. Replace the activated charcoal layer with a new one after 3 to 4 years.

05 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

06 Every year check the water quality parameters (chemical and bacteriological) of the borewell water at least during pre- and post-monsoon seasons.



A. Rooftop Rainwater Harvesting

c. Recharging through an Existing Dug Well

B. Stormwater (surface runoff) Harvesting

Surface Runoff is the overland flow of water resulting from rainfall before it reaches a water course. It is generated because impervious areas do not allow water to soak into the ground. When there is heavy rainfall the surface water occurs in abnormal quantity resulting in stormwater. Stormwater is usually generated over various impervious surfaces like roads, pavements, pavered grounds, paved open spaces within society, institutions, houses, big buildings, auditoriums, malls, parks, industries etc. In cities due to paved surfaces stormwater is generated in large quantity. Hence, due to limitations of artificial filters, very limited quantity needs to be channelised through the pipes and used as a source water for artificial groundwater recharge. This contains lots of impurities, silt, clay etc, hence need to be artificially cleaned using scientific filters. This cleaned water is then used for recharging the aquifer/s artificially through one existing good yielding borewell or construction of a new recharge borewell (recharge shaft) or a dug well.

a. Recharging through Shallow Trench

Recommended for

Areas having slope up to 5%.

Presence of productive shallow aquifer/s.

Methodology

01 Shallow trenches break the slope at intervals and reduce the velocity of the surface runoff generated in an area. It also helps in arresting the soil erosion, increasing soil moisture and supports in enhancing the artificial groundwater recharge too.

02 Before construction of shallow trench, it is necessary to know the presence of the aquifer in the area.

03 Shallow trench is usually constructed along the contour (line of equal altitude) and perpendicular to the water flowing over the surface area. Surface runoff/ stormwater generated over the barren/ empty areas etc is captured in the shallow trenches and allowed to seep down into the soil and murum (weathered material) present below.

04 A pit of 1 m x 1 m x 2 m (L x W x D) is excavated using a JCB machine. Keep a berm or cushion of 30 to 50 cm (depending upon soil) after it and then excavate the next one. If shallow aquifer thickness is more than 2 meters, then the length can be increased up to 5 meters.

05 The pit is lined from two sides by construction of an unplastered double brick wall.

06 Fill the shallow trench with proper scientific filter media. Lay down boulders bed of 1 m thickness, overlain by gravel bed of 400 mm thickness. On the top add 300 mm of sand layer. Above the sand bed provide an outlet pipe in the trench to drain out excess water collected. This is helpful in cleaning the filter after the monsoon.

07 Depending upon the areal extent of shallow aquifer and presence of recharge area, construct such pits continuously along the contour line. Please refer to the drawing for further detail.

08 The excavated material from these pits is removed and disposed off properly.

Process

01 The shallow trenches are purposefully constructed across the slope. Hence, the runoff (stormwater) generated within the project area is captured & collected into the shallow trenches.

02 The stormwater consists of a heavy load of silt, clay, suspended material, etc. As soon as the stormwater starts collecting over the filter bed, the particulate matter will be filtered within sand, gravel, and pebble layers. This will also reduce the velocity of the stormwater and allow it to seep into the soil/murum/aquifer present down below.

03 Around 5 lac litres of rainwater will get stored and recharged if a recharge trench of 100 meters length is constructed. This is equivalent to arresting rainfall up to 100 to 120 mm.

04 The rate of absorption decreases after saturation of the soil moisture and aquifer and then water remains stagnant in the recharge trench.

Precautions

01 During heavy rainfall spells or flood prone situations, maximum stormwater should be diverted to stormwater drainage. Only a limited quantity should be allowed to flow into the recharge trenches.

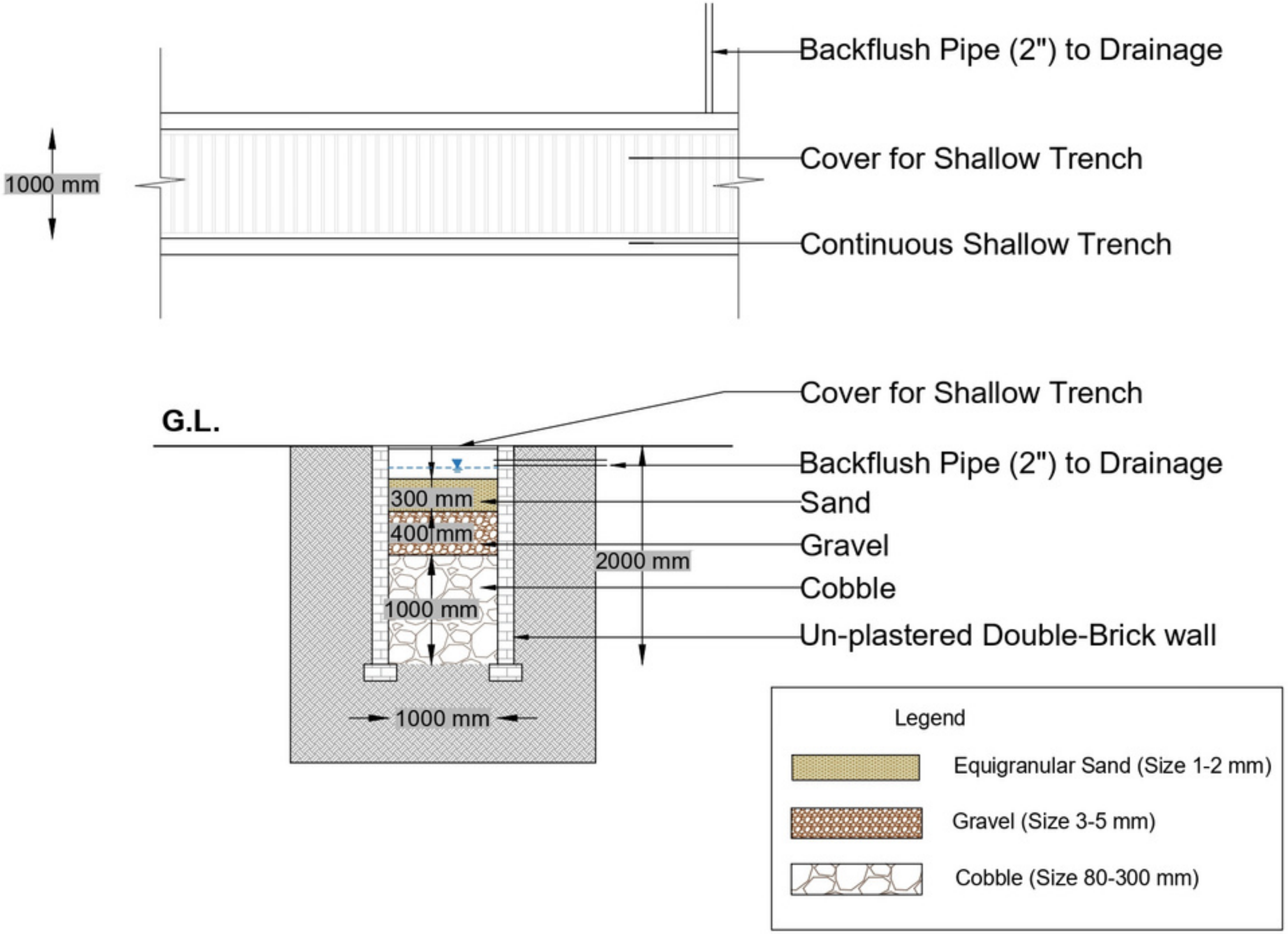
02 Cover the entire shallow trenches with MS grill to protect from any mishaps.

03 Strictly follow all the prescribed technical norms while constructing the recharge trenches. The faulty construction may lead to damage to the aquifer.

04 Maintain the thickness of the berm between two pits. The berm is helpful in maintaining the water pressure within the trench.

Maintenance

01 Depending upon the presence of silt load the recharge trench will get silted during every monsoon. Hence, immediately after monsoon remove the sand and gravel layers along with the silt. Wash them properly and again lay down in the trench. After every two years the pebbles should be removed and cleaned and add again in the recharge trench.



B - Stormwater (Surface Runoff) Harvesting
a. Recharging through Shallow Trenches

b. Recharging through an Existing Borewell

Stormwater recharge through existing borewell is a very sensitive option. Utmost care is necessary to clean the stormwater completely and then use it for artificial groundwater recharge. Do not allow the raw or partially filtered stormwater to enter the borewell.

Recommended for

Areas having slope up to 5%.

Areas where big roofs are not available.

Annual rainfall up to 800 mm. With a daily limit up to 50 mm.

Existing single borewell with yield > 2500 lits/hour indicating presence of productive shallow/ deep aquifer/s.

Methodology

01 From the stormwater drainage line channelize the stormwater, generated within the project area, through a 4" diameter flexible HDPE pipe. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

02 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of stormwater and allow the muddy, contaminated runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using RCC slab, construct a settling tank (first) of 4 m x 3 m x 2.5 m (L x W x D) size with two chambers, one for leaf/litter trap & the other for sedimentation. For making two chambers construct a RCC partition wall of 150 mm thick as shown in the drawing.

04 In continuation with this, construct a second tank of 4.5 m x 3 m x 2.5 m size for the gravel bed to arrest primary silt. Fill it completely with a gravel layer of 2 m thickness.

05 In line with the earlier tanks construct a third tank of 3.5 m x 3 m x 3.5 m size. By constructing a partition wall of 150 mm thickness, first make a settling chamber and a filtration chamber of 2 m x 3 m x 3.5 m and 1.5 m x 3 m x 3.5 m dimensions respectively.

06 At last, make an inspection chamber of 2 m x 3 m x 3 m size to accommodate the existing borewell. Hence, take due precautions so that the borewell is not damaged during construction of the chamber. Please refer to the drawing for further detail.

07 In the filtration chamber create a filter bed composed of Pebbles, Gravel, Activated Charcoal, Sand & Pebbles again. This filter material is readily available in the market.

08 Initially lay a 450 mm layer of pebbles at the bottom of the filter. Cover it with silicon mesh of < 70 micron from the top. Over this silicon mesh place a 700 mm thick uniform size layer of sand. This is also separated by a silicon mesh of the same size. Add an activated charcoal layer of 250 mm thickness over this followed by silicon mesh again. Add a gravel layer of 750 mm thickness & on the top again a pebble layer of 500 mm, wrapped in silicon mesh. For more details, refer to the drawings.

09 For carrying the water from one chamber to other and lastly to borewell lay down 2” dia PVC pipes by making holes in the tank walls as shown in the drawing.

10 In the inspection chamber join the last PVC pipe of 2” with the borewell casing pipe by making an appropriate size hole into it. Install a two-way valve in the middle. This valve is to be connected to the drain chamber. This valve is to be closed when the borewell starts overflowing.

11 In the settling chamber provide two overflow pipes to drain out the excess water collected in it. This is required for high intensity rainfall spells. This helps to maintain the appropriate hydrostatic pressure within the settling chamber and passes the water into the filtration chamber.

12 These tanks are to be constructed below the ground. Hence it is necessary to cover the tank with a RCC slab. Provide air vents and manholes within the slab as shown in the drawing.

13 Provide proper air vents to all the chambers as shown in the drawings. Also provide overflow pipes in sedimentation, settling chambers as shown in the drawing.

Process

01 The channelised stormwater will come through the inlet pipe into the leaf/ litter trap chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Soon after the water level in the chamber reaches the top of the partition wall, it will start flowing into the sedimentation chamber.

02 When it enters the sedimentation chamber, slowly the stormwater becomes stagnant. This helps in settling the heavy silt load present in the sedimentation chamber itself.

03 From this chamber the stormwater enters the gravel bed. There most of the silt, suspended material etc will get collected into the pores present in it. Soon after its saturation the water will start flowing into the settling chamber. Here 100% stormwater will not get cleaned.

04 When the water enters the settling chamber, it will start getting collected into it. After settling the water enters the filtration chamber from the top.

05 In the filtration chamber the water spreads over the pebble layer and because of high porosity it will go down naturally. During this movement the heavier clay and silt particles present in the water will start depositing into the pore spaces present in the gravel & sand layers. After entering the pebble layer, the water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter. Only clean water will come up.

06 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

07 The clean water will slowly fill the pebble layer. Then it will start flowing through the PVC pipe joined with the borewell. The velocity of this water will be very less. Hence the aquifer/s present within the borewell will accept continuously.

Precautions

01 When inflow of water increases in the sedimentation & settling chambers and outflow from the gravel bed chamber and filtration chamber decreases, excess water collected in those chambers will automatically get drained out through two overflow pipes given in both the chambers.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum runoff water will drain directly into the drain chamber.

03 During the first storm close the inlet pipe two-way valve and allow the runoff water to directly go to the drainage line. This will help in avoiding the heavy contaminant load entering the filter chambers.

04 If the borewell starts overflowing, then immediately close the outflow valve and drain the excess water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will help protect the borewell from siltation, contamination, or damage.

Maintenance

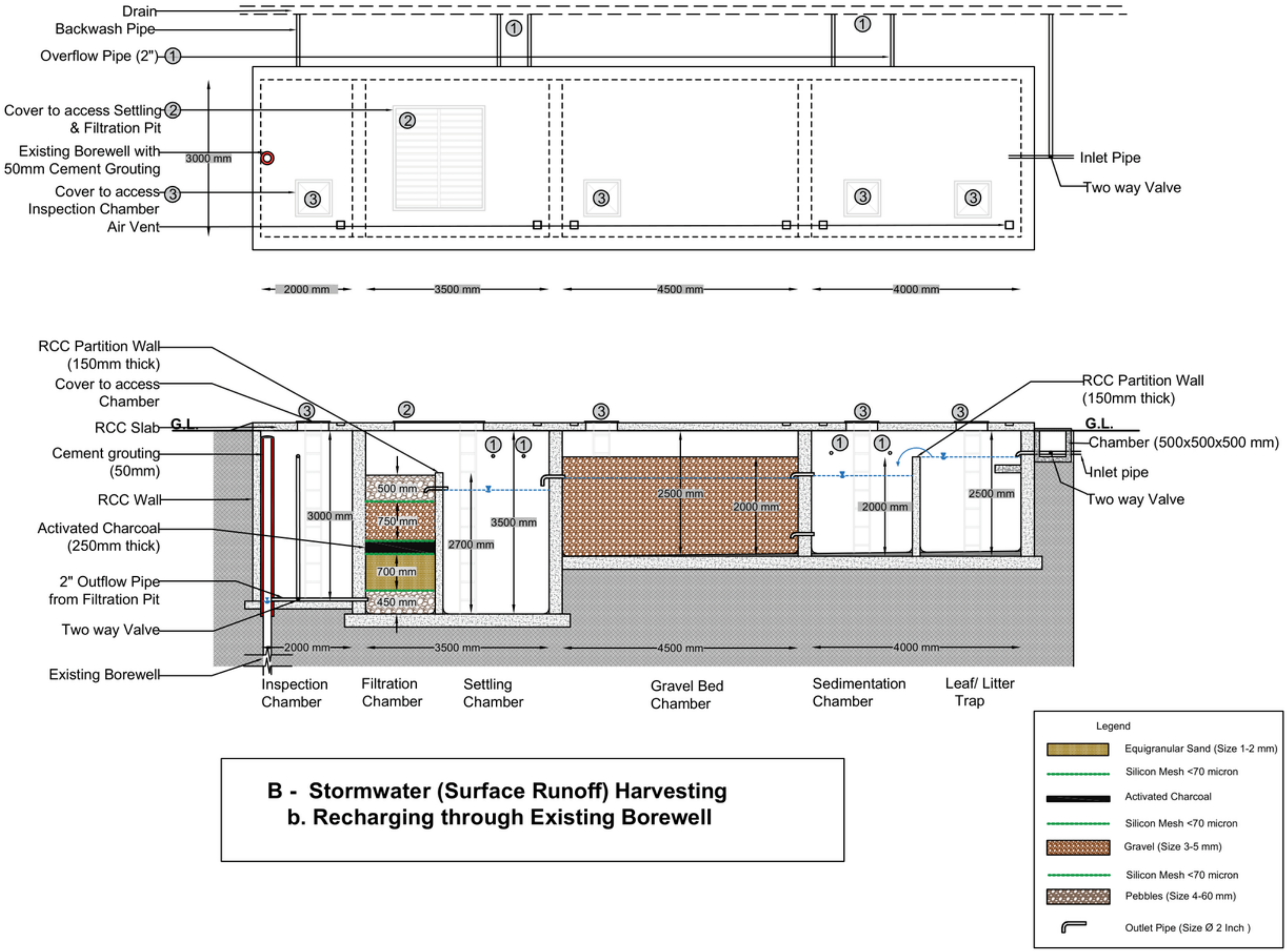
01 Every year immediately after the monsoon take out the stagnant water present in the leaf/ litter trap, sedimentation and settling chambers. Also take out the silt/clay settled at the bottom of these chambers. For cleaning purposes use the manhole given in all the chambers.

02 Every year during Mar-April take out the upper layer of pebble, gravel & sand layers. Wash them thoroughly. After due drying, top up all these layers again.

03 Every year replace the activated charcoal layer.

04 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

05 Every year check the water quality parameters (chemical and bacteriological) of the borewell water at least during pre- and post-monsoon seasons.



B - Stormwater (Surface Runoff) Harvesting
b. Recharging through Existing Borewell

c. Recharging through an Injection Borewell

Recommended for

Areas having slope up to 5%.

Areas where big roofs are not available.

Annual rainfall up to 800 mm. With a daily limit up to 50 mm.

Drilling of new single Injection borewell with assured yield > 2820 lits/hour indicating presence of productive shallow/ deep aquifer/s

Methodology

01 Drill a borewell of at least 6” diameter within the premises at geohydrologically appropriate location. This borewell should yield at least 2500 lits/hour, then only it will accept the filtered rooftop water and recharge the aquifer. Usually, this borewell is not used for pumping purposes. Hence, it is treated as a **Recharge Shaft**.

02 Preferably use perforated (slit type) M.S. casing pipe of at least 6 meters depth for the borewell during drilling. After drilling grout only lower the 2 m part of the casing using cement slurry. Wrap silicon mesh of < 70 micron in upper 4 m part of the casing. Cover the borewell with the cap.

03 From the stormwater drainage line channelize the stormwater generated within the project area through a 4” diameter flexible HDPE pipe. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

04 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of stormwater and allow the muddy, contaminated runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

05 Using RCC slab, construct a settling tank (first) of 5 m x 2.5 m x 2.5 m (L x W x D) size with two chambers, one for leaf/litter trap & the other for sedimentation. For making two chambers construct a RCC partition wall of 150 mm thick as shown in the drawing.

06 In continuation with this, construct a second tank of 3 m x 2.5 m x 3 m size for the gravel bed to arrest primary silt. Fill it completely with a gravel layer of 2.5 m thickness.

07 In continuation with this construct an inspection chamber of 1m x 1m x 1m size to lay down the outlet pipe 2 for carrying the filtered stormwater from the gravel bed. Install a two-way valve in it.

08 In line with the earlier tanks construct a third tank of 2.5 m x 2.5 m x 3.5 m size as a filtration chamber to accommodate the Recharge Shaft. Hence, take due precautions so that the borewell is not damaged during construction of the chamber. Please refer to the drawing for further detail.

09 In the filtration chamber create a filter bed composed of Sand, Activated Charcoal, Gravel, Pebbles. This filter material is readily available in the market.

10 Initially lay a 700 mm layer of pebbles at the bottom of the filter. Cover it with silicon mesh of < 70 micron from the top. Over this silicon mesh place a 700 mm thick uniform size layer of sand. This is also separated by a silicon mesh of the same size. Add a sand layer of 400 mm thickness & followed by an activated charcoal layer of 150 mm thickness. This is followed by silicon mesh again and a sand layer of 450 mm thickness. For more details, refer to the drawings.

11 For carrying the water from one chamber to other and lastly to borewell lay down 2" dia PVC pipes by making holes in the tank walls as shown in the drawing.

12 In the inspection chamber join the last PVC pipe of 2" diameter with the borewell casing pipe by making an appropriate size hole into it. Put a two-way valve in the middle. This valve is to be connected to the drain chamber. When the borewell starts overflowing this valve is to be closed and allow the stormwater to get drained into the drain chamber.

13 In the settling chamber provide two overflow pipes to drain out the excess water collected in it. This is required for high intensity rainfall spells. This helps to maintain the appropriate hydrostatic pressure within the settling chamber and passes the water into the filtration chamber.

14 These tanks are to be constructed below the ground. Hence it is necessary to cover the tank with a RCC slab. Provide manholes within the slab as shown in the drawing.

15 Provide proper air vents to all the chambers as shown in the plan view of the drawing. Also provide overflow pipes in sedimentation, settling chambers as shown in the drawing.

Process

01 The channelised stormwater will come through the inlet pipe into the leaf/ litter trap chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Soon after the water level in the chamber reaches the top of the partition wall, it will start flowing into the sedimentation chamber.

02 When it enters the sedimentation chamber, slowly the stormwater becomes stagnant. This helps in settling the heavy silt load present in the sedimentation chamber itself.

03 From this chamber the stormwater enters the gravel bed. There most of the silt, suspended material etc will get collected into the pores present in it. Soon after its saturation the water will start flowing into the settling chamber. Here 100% stormwater will not get cleaned.

04 When the water enters the settling chamber, it will start getting collected into it. After settling the water enters the filtration chamber from the top.

05 In the filtration chamber the water spreads over the pebble layer and because of high porosity it will go down naturally. During this movement the heavier clay and silt particles present in the water will start depositing into the pore spaces present in the gravel & sand layers. After entering the pebble layer, the water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter. Only clean water will come up.

06 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

07 The clean water will slowly fill the pebble layer. Then it will start flowing through the PVC pipe joined with the borewell. The velocity of this water will be very less. Hence the aquifer/s present within the borewell will accept continuously.

Precautions

01 During the first storm close the inlet pipe two-way valve and allow the runoff water to directly go to the drainage line. This will help in avoiding the heavy contaminant load entering the filter chambers.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum runoff water will drain directly into the drain chamber.

03 When inflow of water increases in the sedimentation & settling chambers and outflow from the gravel bed chamber and filtration chamber decreases, excess water collected in those chambers will automatically get drained out through two overflow pipes given in both the chambers.

04 If the borewell starts overflowing, then immediately close the outflow valve and drain the excess water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will help protect the borewell from siltation, contamination, or damage.

Maintenance

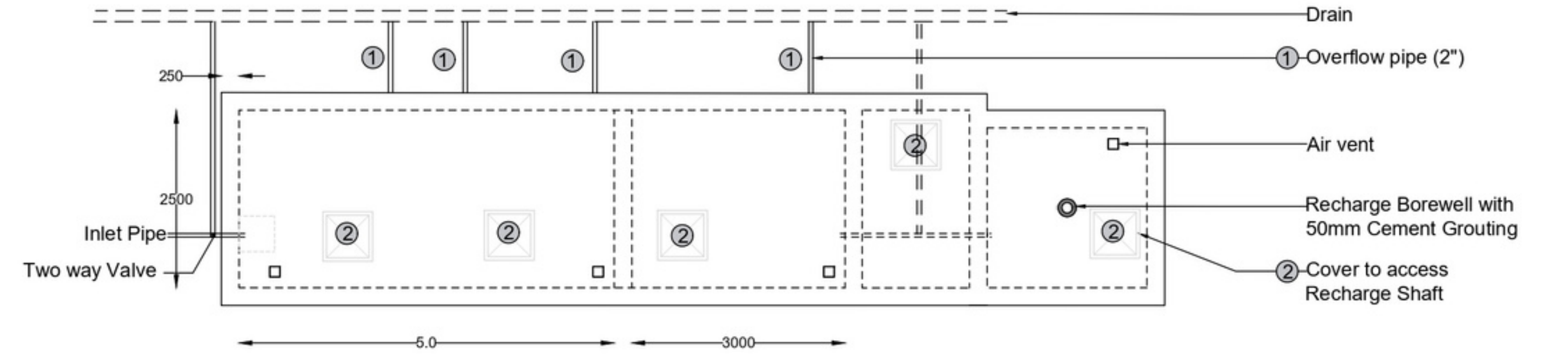
01 Every year Immediately after the monsoon take out the stagnant water present in the leaf/ litter trap, sedimentation and settling chambers. Also take out the silt/clay settled at the bottom of these chambers. For cleaning purposes use the manhole given in all the chambers.

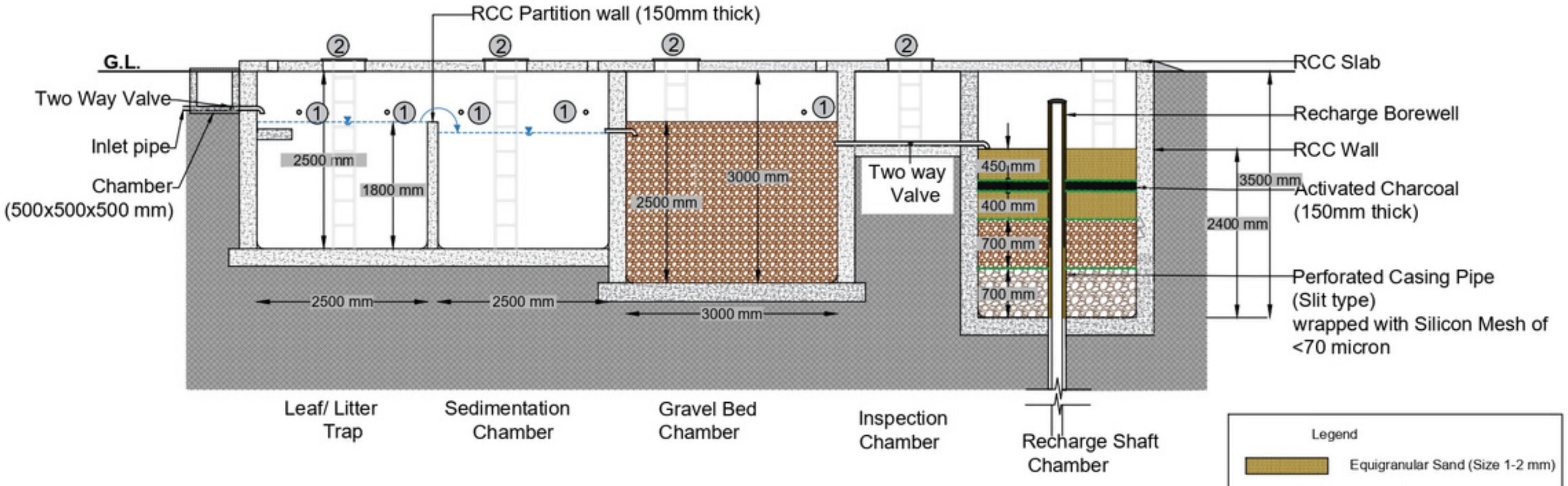
02 Every year during March-April take out the upper layer of pebble, gravel & sand layers. Wash them thoroughly. After due drying, top up all these layers again.

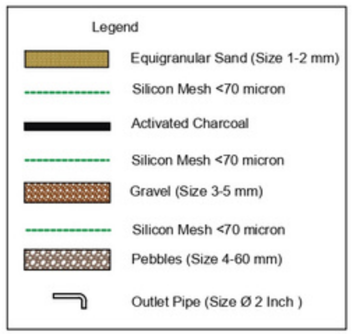
03 Every year replace the activated charcoal layer.

04 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

05 Every year check the water quality parameters (chemical and bacteriological) of the borewell water at least during pre- and post-monsoon seasons.







B - Stormwater (Surface Runoff) Harvesting

c. Recharging through Injection Borewell

d. Recharging through an Existing Dug Well

Recommended for

Areas having slope up to 5%.

Areas where big roofs are not available.

Annual rainfall up to 1000 mm. With a daily limit up to 50 mm.

Existing single dugwell with yield > 20000 lits/hour indicating presence of productive shallow/ deep aquifer/s.

Methodology

01 From the stormwater drainage line channelize the stormwater generated within the project area through a 4” diameter flexible HDPE pipe. Join this drainpipe to the inlet pipe. If required, construct a small chamber of 0.5 m x 0.5 m x 0.5 m dimension for installation of a two-way valve.

02 Install a two-way ball bearing valve to the drainpipe, where it connects the inlet pipe of the filter media. Close this valve during the first spell of stormwater and allow the muddy, contaminated runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using RCC slab, construct a settling tank (first) of 4 m x 2.5 m x 2.5 m (L x W x D) size with two chambers, one for leaf/litter trap & the other for sedimentation. For making two chambers construct a RCC partition wall of 150 mm thick as shown in the drawing.

04 In continuation with this, construct a second tank of 4.5 m x 2.5 m x 2.5 m size for the gravel bed to arrest primary silt. Fill it completely with a gravel layer of 2 m thickness.

05 In line with the earlier tanks construct a third tank of 3.5 m x 2.5 m x 3.5 m size. By constructing a partition wall of 150 mm thickness, first a settling pit and a filtration pits of 2 m x 2.5 m x 3.5 m and 1.5 m x 2.5 m x 3.5 m dimensions respectively.

06 At last, make an inspection chamber of 2 m x 2.5 m x 3 m size to accommodate the existing borewell. Hence, take due precautions so that the borewell is not damaged during construction of the chamber. Please refer to the drawing for further detail.

07 In the filtration chamber create a filter bed composed of Pebbles, Gravel, Activated Charcoal, Sand & Pebbles again. This filter material is readily available in the market.

08 Initially lay a 450 mm layer of pebbles at the bottom of the filter. Cover it with MS mesh of < 75 micron from the top. Over this MS mesh place a 700 mm thick uniform size layer of sand. This is also separated by a MS mesh of the same size. Add an activated charcoal layer of 250 mm thickness over this followed by silicon mesh again. Add a gravel layer of 750 mm thickness & on the top again a pebble layer of 500 mm, wrapped in MS mesh. For more details, refer to the drawings.

09 For carrying the water from one chamber to other and lastly to Dug well lay down 2” dia PVC pipes by making holes in the tank walls as shown in the drawing.

10 In the inspection chamber join 2" dia PVC pipe with the dug well by making an appropriate size hole into it. Put a two-way valve in the middle. This valve is to be connected to the drain chamber. This valve is to be opened when the dug well starts overflowing.

11 In the settling chamber provide two overflow pipes to drain out the excess water collected in it. This is required for high intensity rainfall spells. This helps to maintain the appropriate hydrostatic pressure within the settling chamber and passes the water into the filtration chamber.

12 These tanks are to be constructed below the ground. Hence it is necessary to cover the tank with a RCC slab. Provide manholes within the slab as shown in the drawing.

13 Provide proper air vents to all the chambers as shown in the drawings. Also provide overflow pipes in sedimentation, settling chambers as shown in the drawing.

Process

01 The channelised stormwater will come through the inlet pipe into the leaf/ litter trap chamber. This water is allowed to fall over a small slab (8” long and 2” thick) to avoid the erosion of the tank walls. This slab will also help in reducing the velocity of the inflow water. Soon after the water level in the chamber reaches the top of the partition wall, it will start flowing into the sedimentation chamber.

02 When it enters the sedimentation chamber, slowly the stormwater becomes stagnant. This helps in settling the heavy silt load present in the sedimentation chamber itself.

03 From this chamber the stormwater enters the gravel bed. There most of the silt, suspended material etc will get collected into the pores present in it. Soon after its saturation the water will start flowing into the settling chamber. Here 100% stormwater will not get cleaned.

04 When the water enters the settling chamber, it will start getting collected into it. After settling the water enters the filtration chamber from the top.

05 In the filtration chamber the water spreads over the pebble layer and because of high porosity it will go down naturally. During this movement the heavier clay and silt particles present in the water will start depositing into the pore spaces present in the gravel & sand layers. After entering the pebble layer, the water will settle down and remaining dust, clay and silt particles will get deposited at the bottom of the filter. Only clean water will come up.

06 The activated charcoal helps in adsorption of the chemical and bacterial contaminants present in the water. Hence, it is the most important and non-negotiable constituent of the artificial filter bed.

07 The clean water will slowly fill the pebble layer. Then it will start flowing through the PVC pipe joined with the Dugwell. The velocity of this water will be very less. Hence the aquifer/s present within the dug well will accept continuously.

Precautions

01 During the first storm close the inlet pipe two-way valve and allow the runoff water to directly go to the main drainage line. This will help in avoiding the heavy contaminant load entering the filter chambers.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum runoff water will drain directly into the drain chamber.

03 When inflow of water increases in the sedimentation & settling chambers and outflow from the gravel bed chamber and filtration chamber decreases, excess water collected in those chambers will automatically get drained out through two overflow pipes given in both the chambers.

04 If the dugwell starts overflowing, then immediately close the outflow valve and drain the excess water into the drain chamber. At the time of cleaning the filter keep the outflow valve closed. This will help in protection of the dug well from siltation, contamination, or damage.

05 It is necessary to carry and leave the filtered water within the water column available in the dug well.

Maintenance

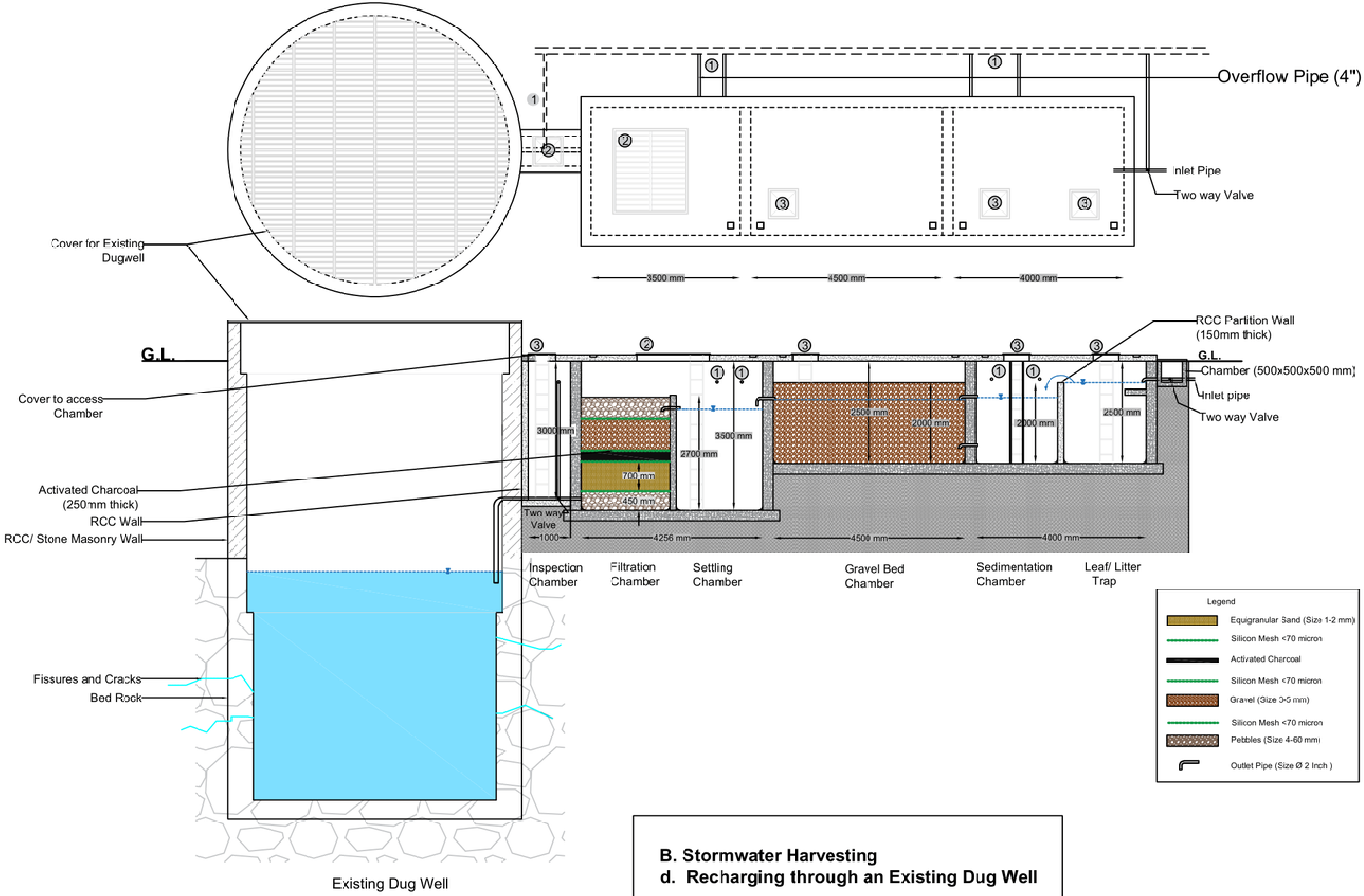
01 Every year immediately after the monsoon take out the stagnant water present in the leaf/ litter trap, sedimentation and settling chambers. Also take out the silt/clay settled at the bottom of these chambers. For cleaning purposes use the manhole given in all the chambers.

02 Every year during March-April take out the upper layer of pebble, gravel & sand layers. Wash them thoroughly. After due drying, top up all these layers again.

03 Every year replace the activated charcoal layer.

04 The society/management of the building should train their personnel for the annual maintenance of the filter and make appropriate provision of funds.

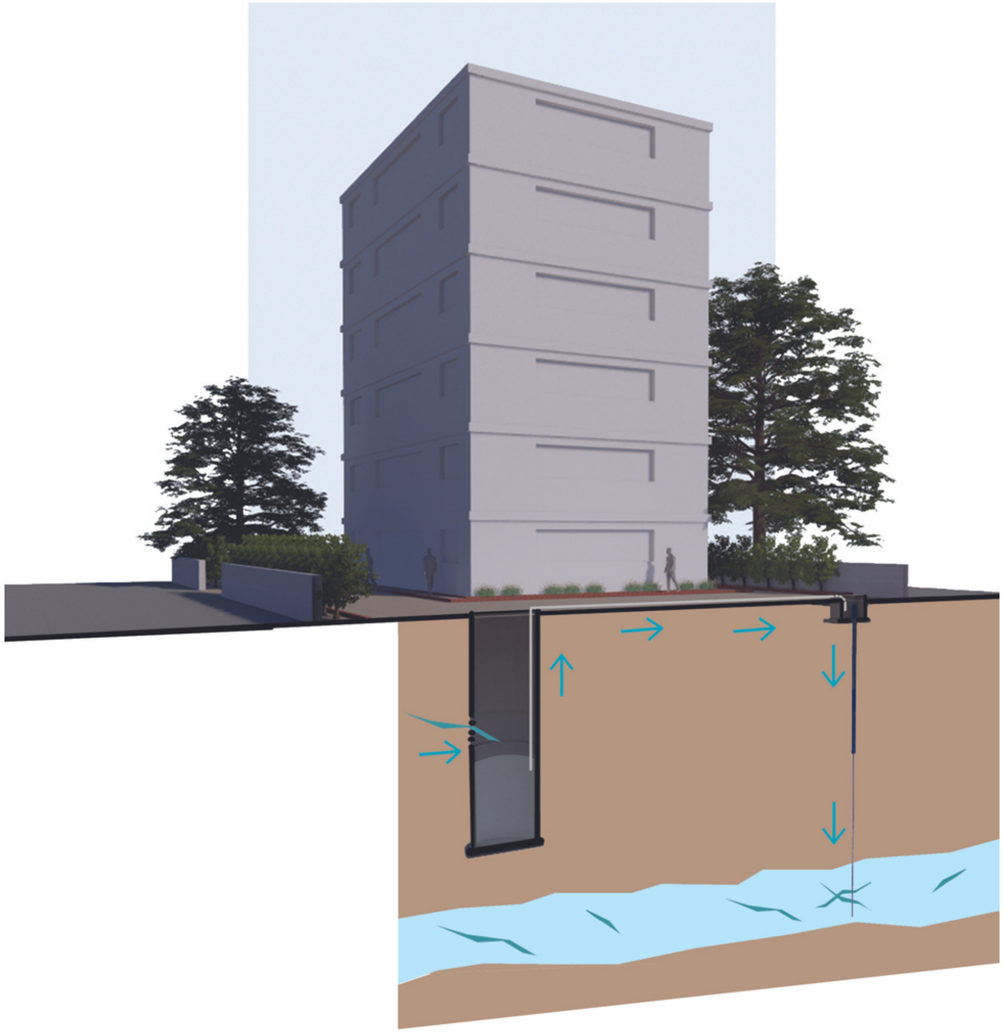
05 Every year check the water quality parameters (chemical and bacteriological) of the dug well water at least during pre- and post-monsoon seasons.



B. Stormwater Harvesting
d. Recharging through an Existing Dug Well

C. Basement Seepage Water Harvesting

Basement Seepage or basement spring is the concentrated discharge of groundwater appearing at the surface as a current of flowing water. Mostly in cities for construction of big buildings, usually deep excavations are carried out below the ground even in the hard rocks. Many times, during these constructions' aquifers are either punctured or partially removed or totally removed. Wherever the aquifers are cut/damaged the groundwater comes out in the form of seepages or spring/s. The seepage or spring discharge varies in time and space. In most of the cases this seepage water is being pumped out from the basements/ parkings etc and discharged into the municipal drainages. This is nothing but sheer wastage of good quality and quantity of groundwater. This can be used as a source of artificial groundwater recharge for the down below or deep aquifers using existing borewell or through a creation of injection borewell called Recharge Shaft. Hence it is necessary to check the chemical and bacteriological quality of the seepage or spring water. If both are within permissible limits, then only it should be considered for artificial groundwater recharge.



a. Recharging of Basement Seepage through an Existing Borewell

Recommended for

Areas having seepages at greater depths (>18 m) in the basements or parkings etc.

Potable quality seepage water.

Existing single borewell with yield > 2820 lits/hour indicating presence of productive shallow/ deep aquifer/s.

Methodology

01 Delineate the exact aerial extent of the shallow seepage.

02 Based on its location, construct a shallow ring well below the ground to tap the seepage and collect the water in it.

03 Based on the seepage discharge, construct the ring well of at least 2 m diameter. The depth will vary depending upon the location of the seepage.

04 If possible and feasible, channelize the seepage by constructing a bucket type structure. Near the seepage discharge point/s keep the ring perforated. This will allow the seepage water to fall naturally into the collection well.

05 Allow the seepage water to get collected into the collection well. Measure the seepage discharge. Based on this discharge decide the diameter of the HDPE pipe to carry the seepage water from the collection well to the borewell.

06 Lay down one single HDPE pipe of suitable diameter from the collection into the existing borewell. The depth of the HDPE pipe within the borewell will be more than the depth of the collection well. This difference is necessary for carrying the seepage water into the borewell using the syphon technique.

Process

01 Immediately after stopping the pump the seepage water will automatically start flowing from the collection well to the borewell.

02 It is advisable to install a water-meter for measuring the quantity of seepage water recharged artificially through the borewell.

Precautions

01 If necessary, construct the retaining walls all around the collection ring well for extra support.

02 Cover the collection well properly. Keep proper air vents while covering it.

03 If a submersible pump is installed in the existing borewell then the size of the HDPE needs to be adjusted according to the diameter of the pump.

04 Keep continuous monitoring of seepage discharge and the water level within the collection well. Usually, the flow of seepage or spring diminishes from January onward. Hence flow should be monitored on a fortnightly basis.

05 Periodically (once in a month) monitor the groundwater level within the borewell. If there is a fast rise in groundwater level and the borewell starts overflowing, then immediately the syphon should be stopped.

06 Keep the collection well isolated. Do not carry out any activity near it.

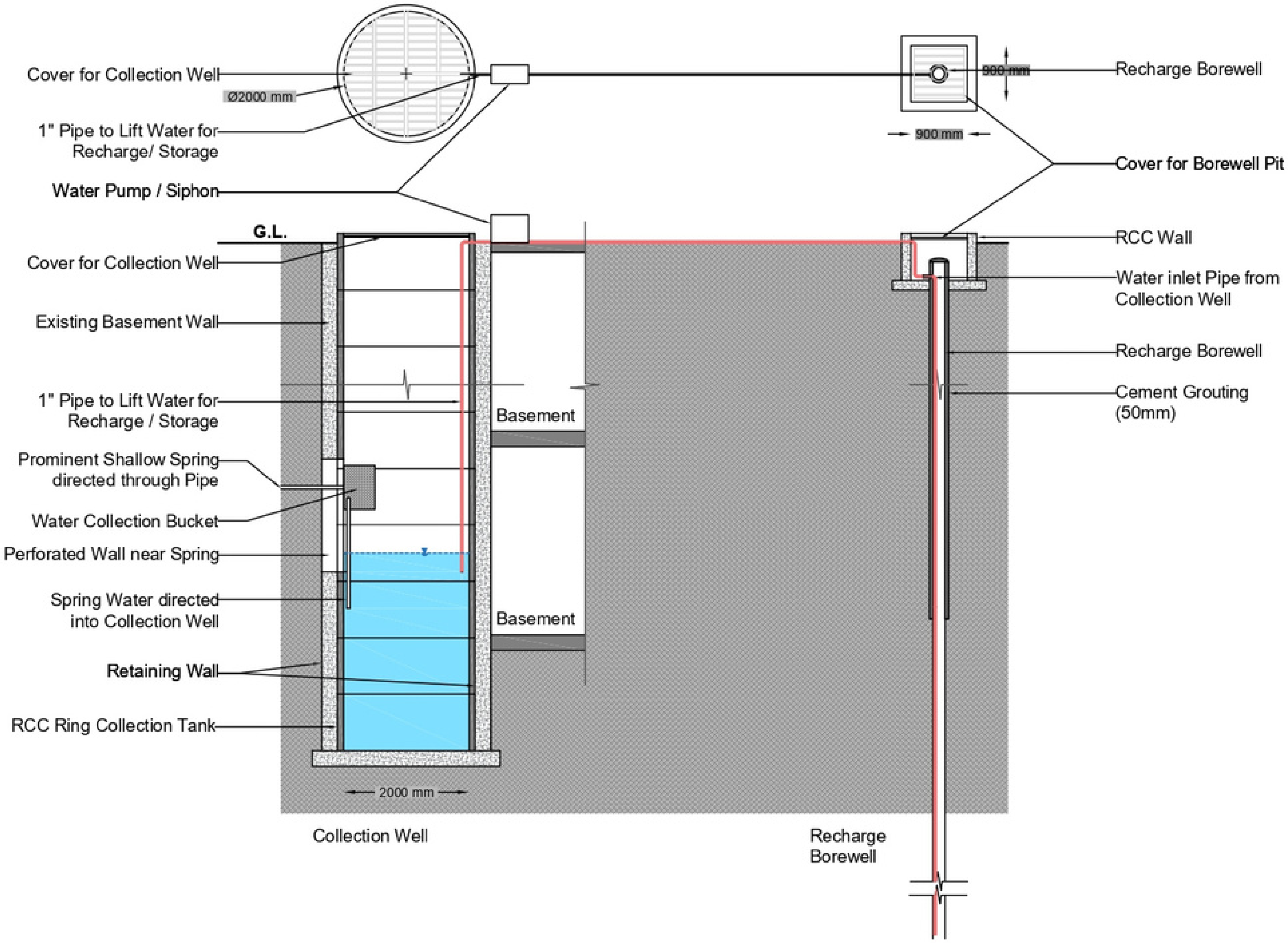
Maintenance

01 Every year during monsoon check the quality of seepage or spring water. If muddy water is coming from the seepage, then immediately the syphon should be stopped. Allow that water to get collected into the collection well and drain it out using a pump.

02 Every year check the water quality parameters (chemical and bacteriological) of the collection well water at least during pre- and post-monsoon seasons.

03 If there is bacterial contamination, then immediately syphon should be stopped. Chlorinate the water collected in the collection well as per GoI norms and then start the syphon.

04 Regularly clean the collection well at least once in every year.



C. Basement Seepage Water Harvesting

a. Recharging of Basement Seepage through an Existing Borewell

b. Recharging of Basement Seepage through an Injection Borewell

Recommended for

Areas having basement seepage (flowing shallow springs) either near the surface or oozing out in the form of boils near the surface or in the basements or parkings etc (up to 18 meters) which are exposed to the atmosphere.

Potable quality seepage water.

Channelised Basement Seepage Water into the surface drainages (Wastage of seepage water).

Drilling of a new single Injection borewell with assured yield > 2000 lits/hour indicating presence of productive shallow/ deep aquifer/s.

Prefer the dug well or good yielding borewell if present nearby.

Methodology

01 Delineate the exact aerial extent of the shallow seepage.

02 Based on its location, construct a shallow trench all along the open basement walls with slope between 2 to 5%. The trench will start from the seepage and end near the borewell. Accordingly, maintain the slope within the trench so that the seepage water will flow by gravity towards the borewell.

03 A trench of 600 mm thickness is sufficient. However, if the seepage discharge is more or if rainwater is also getting collected into it, then increase the width based on the flow of water. The length and depth will vary from site to site.

04 At the end of the trench and near the recharge shaft chamber make a provision to drain excess seepage water.

05 Near the seepage discharge point, construct a chamber at least of 1.5 m x 2 m x 3 m (Lx W x D) size. The depth of the trench will depend upon the depth of the seepage below the ground.

06 Near the recharge shaft, construct a chamber at least of 1.5 m x 2 m x 5 m (Lx W x D) size. Considering the slope provided for trench the depth of this chamber should be decided. Practically its depth should be more by at least 1 m than the depth of the seepage discharge chamber.

07 In the recharge shaft chamber entry wall, make channels to put temporary wooden gates to arrest the muddy water especially during the rainy season.

08 Allow the seepage water to get collected into the shallow trench.

09 Presence of a deeper aquifer is essential. Hence, drill a borewell of at least 6” diameter and 50 to 60 m depth within the project premises at geohydrologically appropriate location. This borewell should yield at least 2820 lits/hour, then only it will accept the seepage discharged water. Usually, this borewell is not used for pumping purposes. Hence, it is treated as a **Recharge Shaft**.

10 Preferably use perforated (slit type) M.S. casing pipe of at least 6 meters depth for the borewell during drilling. After drilling grout only lower the 2 m part of the casing using cement slurry. Wrap silicon mesh of < 70 micron in upper 4 m part of the casing. Cover the borewell with the cap.

11 Create a filter bed using pebbles (600 mm thickness), gravels (750 mm thickness) and sand (600 mm thickness) layers around the recharge shaft. As seepage water is passing through the open to sky shallow trench, there are chances of bacterial contaminations. Hence, it is necessary to add a 150 mm thick layer of activated charcoal in between sand and gravel layers. This filter material is readily available in the market.

12 For safety purposes and to trap the leaves/ litter, cover the complete trench with MS bars or grill.

Process

01 Seepage water will automatically get collected into the collection chamber.

02 As soon as the seepage chamber gets filled up to the trench level, slowly the collected water will start flowing towards the recharge shaft under gravity.

Precautions

01 Cover the seepage collection chamber and the filter chamber from the top. Keep proper air vents while covering it.

02 Protect the shallow trench from any activity like parking of vehicles, dumping of waste etc.

03 During the rainy season if muddy water enters the trench, then immediately insert the wooden gate into the recharge trench chamber. This will stop the muddy water there itself and drain through the given outlet directly into the stormwater drainage line.

04 If the borewell starts overflowing, then also the wooden gate should be inserted.

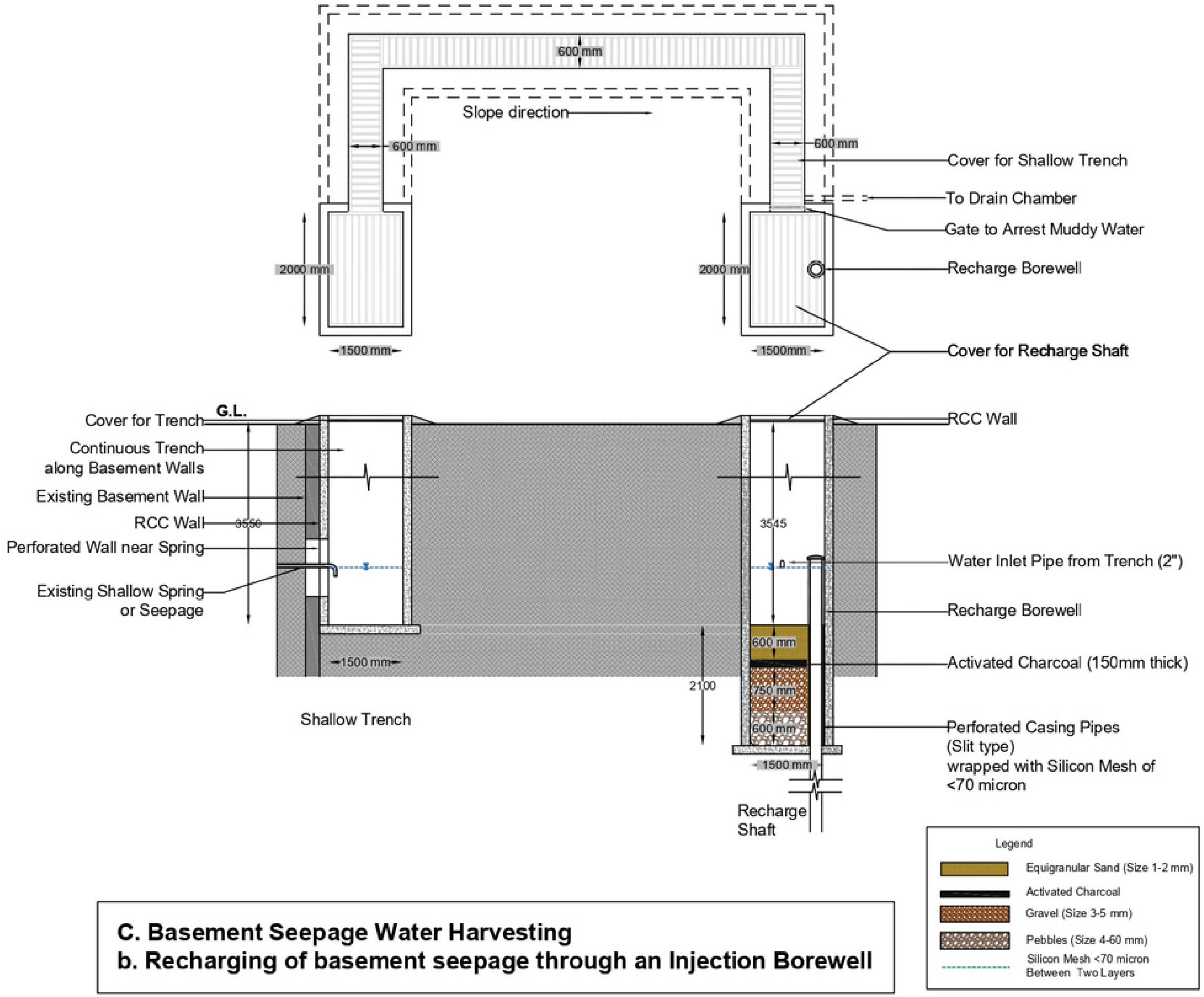
Maintenance

01 If muddy water comes during monsoon, then the trench should be cleaned immediately.

02 Every year check the water quality parameters (chemical and bacteriological) of the collection well water at least during pre- and post-monsoon seasons.

03 If there is bacterial contamination, then immediately stop the recharge process.

04 Regularly clean the shallow trench, collection chamber and the recharge shaft chamber along with the filter bed.



C. Basement Seepage Water Harvesting
b. Recharging of basement seepage through an Injection Borewell

D. Roadside Rainwater Harvesting

In cities pedestrian walks are constructed on both the sides of the roads. Based on the width of the road the width of the pedestrian walks also increases. These pedestrian walks are generally constructed using impervious cement paver blocks, hence rainfall falling over these areas are adding to the creation of surface runoff or stormwater. This being a pure rainwater, this runoff can be directly used for artificial groundwater recharge by retrofitting technique of drilling shot holes within the pedestrian walk areas.

a. Footpath Rainwater Recharge

Recommended for

Pedestrians walk area with at least 3 m width.

Areas where storm water drainage line or ducts are not present below the pedestrian walk.

Rainfall up to 800 mm.

Methodology

01 In the central part of the pedestrian walk select an area of 2 m x 2 m. (L x W). If non-porous paver blocks are installed, then remove these paver blocks within the selected 2 m x 2 m area.

02 If black dust is present in it, then remove it completely. If a pure gravel layer is present, then do not remove it.

03 Drill one shot hole of 2” to 3” diameter and up to 20’ depth using a hand operated drilling machine, within the center of 2 m x 2 m area.

04 Immediately insert a perforated PVC pipe of 2” diameter in the hole. Keep the height of this pipe 1” below the pedestrian walk. Fill the pipe with washed clean equigranular sand. Close the PVC pipe with a PVC cap.

05 Replace the black dust with a pure gravel bed up to a thickness of 6”. If a gravel layer is already present, then remove the upper 1” layer. Wash it and clean it and top it up after drying.

05 Replace the non-porous paver blocks by 100% porous paver blocks of the same size within 2 m x 2 m of area. Maintain the level of the porous block with the adjoining non-porous blocks. This will help to recharge around 2000 lits of rainwater from an average rainfall of 800 mm within monsoon months.

07 Replicate this design within the pedestrian walk at least up to a stretch of 50 m length.

08 After 5 m interval the same design can be replicated for another 50 m stretch.

Process

01 The rainfall falling over this porous surface of 2 m x 2 m area will seep down due to the raindrop intensity.

02 It will get stored in the gravel bed. As soon as the gravel bed gets saturated with water the water will start seeping into the shot hole.

03 Through the shot hole it will go down and start recharging the murum or the weathered material present over the aquifer.

Precautions

01 If a storm water drainage line or any other duct is passing below the pedestrian walk, then do not select that area for this project.

02 During the rainy season try to keep this project area clean. This will help in enhancing the seepage rate from the porous pavements.

03 Cleaning will not allow the dust to get stored within the joints of the paver blocks.

04 The porous paver blocks will not pass the dust, clay, silt etc present in the stormwater and the shot holes will be protected from clogging.

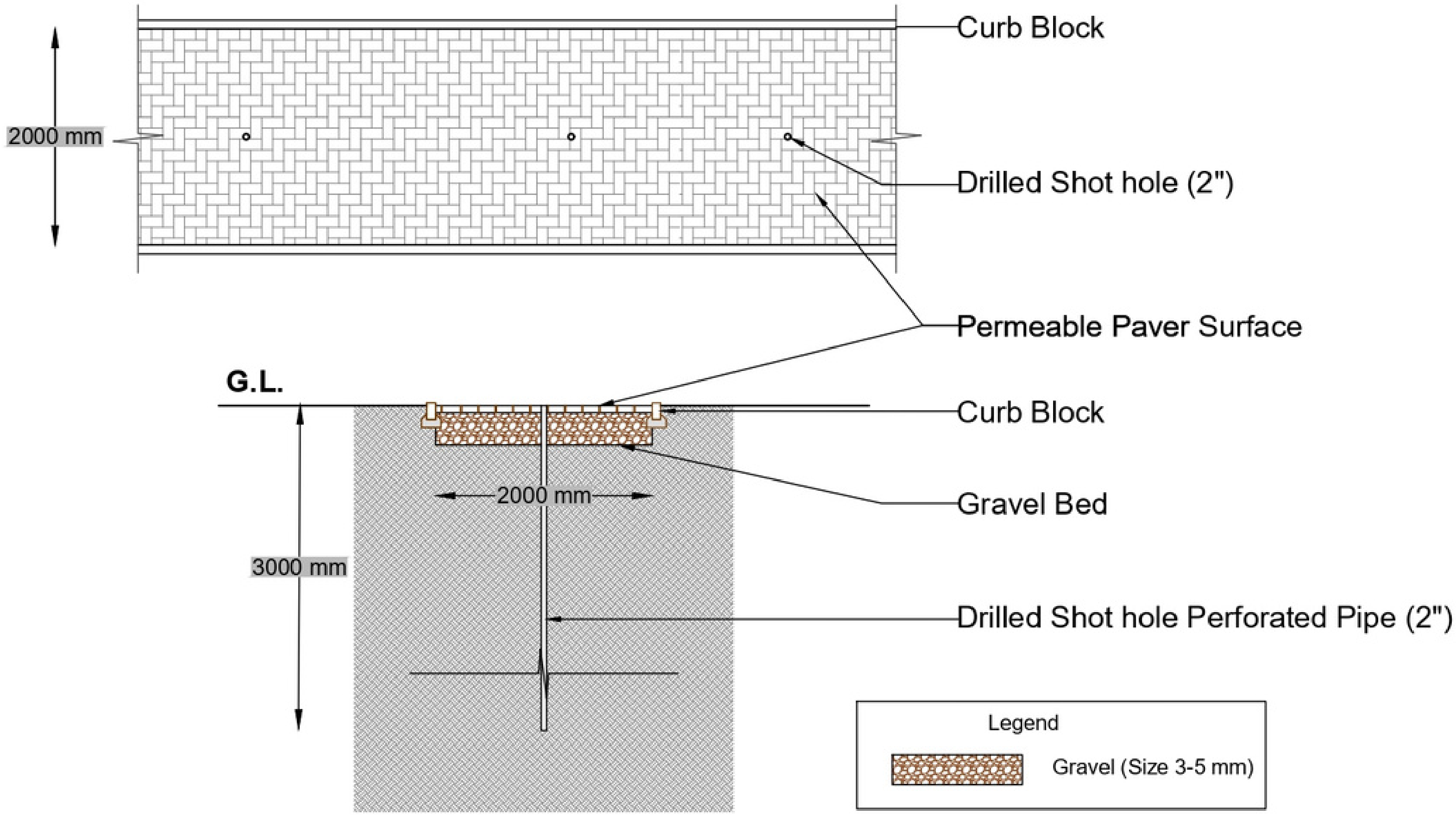
05 Immediately after the floods clean the upper surface of the paver blocks using pressurised water to reinstate their perviousness.

06 Do not allow parking of vehicles or hawkers to stand within the project area.

Maintenance

01 This structure is usually constructed in the public areas. Hence it is necessary to maintain the cleanliness over the pedestrian walk throughout the year.

02 Display a board showing the details of the project so that the community will also take care of it.



D. Roadside Rainwater Harvesting
a. Footpath Water Recharge

E. Storage of Harvested Rainwater

The collection and storage of roof top rainwater in a large pot / vessel kept on the surface or below the surface for later use is an equally important technique of Rainwater Harvesting. It is mostly used in areas where rainwater recharge is not possible and ample amount of rainfall is available. The water thus collected can meet immediate domestic needs. Tanks made of Zinc-Aluminium, iron sheets, cement, or bricks, ferrocement, PVC, or even hard rocks can be used for storing the water. In such tanks water can be stored for a long period. The water gets deteriorated only if it comes in contact with the sunlight and dust. In hard core, hilly villages this water is used for drinking after due chlorination.

a. Over the Surface Tanks

Recommended for

Regular rainfall - more than 500 mm.

Sufficient available space on the surface

Methodology

01 Channelize the rainwater collected on the roof of the building/s into one or two vertical drainpipes of at least 4" diameter PVC pipes. Bring this water through a single horizontal drainpipe of same diameter, laid down over a slab of the building. If slab support is not available, then lay down iron beams.

02 Install a two-way ball bearing valve to the drainpipe. Attach a first flush pipe to the gate valve to drain out the first rainfall water into the drainage. Close this valve during the first spell of rain and allow the runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using a reducer to the valve, carry the rooftop rainwater through a 3" diameter PVC down pipe to the storage tank.

04 Estimate the roof water availability using this relation = Annual Rainfall (in mm) x Roof area (in sq. m) x Runoff Coefficient.

05 Runoff Coefficients

Type of Roof	Coefficient
Concrete	0.7
Tiled	0.75
GI Sheet	0.9

06 Depending upon the water availability and need decide the size of the water storage tank. e.g. For 100 sq. m tiled roof with annual average rainfall of 800 mm ~ 60000 liters of water will be available.

07 The storage tank is usually constructed above the surface and covered from all sides. Three openings are kept in it. One is for the lid on the top, second is for allowing the filtered water to enter it from the top side and third is for the outlet at the bottom. Fix a valve to this outlet pipe. This is necessary to control the use of stored water.

08 Though the roof top rainwater appears to be clean it is necessary to use the online filters comprised of coarse sand, activated charcoal, coconut fibre, pebbles, and gravels. Such filters are readily available in the local market.

09 Immediately after the valve install the online filter either on the storage tank or before that.

10 Fix a small pipe & elbow to the filter to carry the filtered water into the storage tank.

Process

01 The rooftop channelised water will come through the online filter into the storage tank.

02 As soon as the storage tank gets filled, completely cover the lid tightly.

03 For domestic purposes the stored water can be directly used without any treatment. Just open the outlet valve and use the stored water.

04 For drinking water usage, the stored water is collected into a small tank of 1000 to 2000 lits. Chlorination will have to be carried using govt approved capsules.

Precautions

01 During the first rainfall spell, close the two-way valve and drain the rainwater through the drainpipe. This will help in avoiding the heavy contaminant load entering the chambers. During dry spells (dry days > 10) within the monsoon adopt the same procedure.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum roof top water will drain directly into the drain chamber.

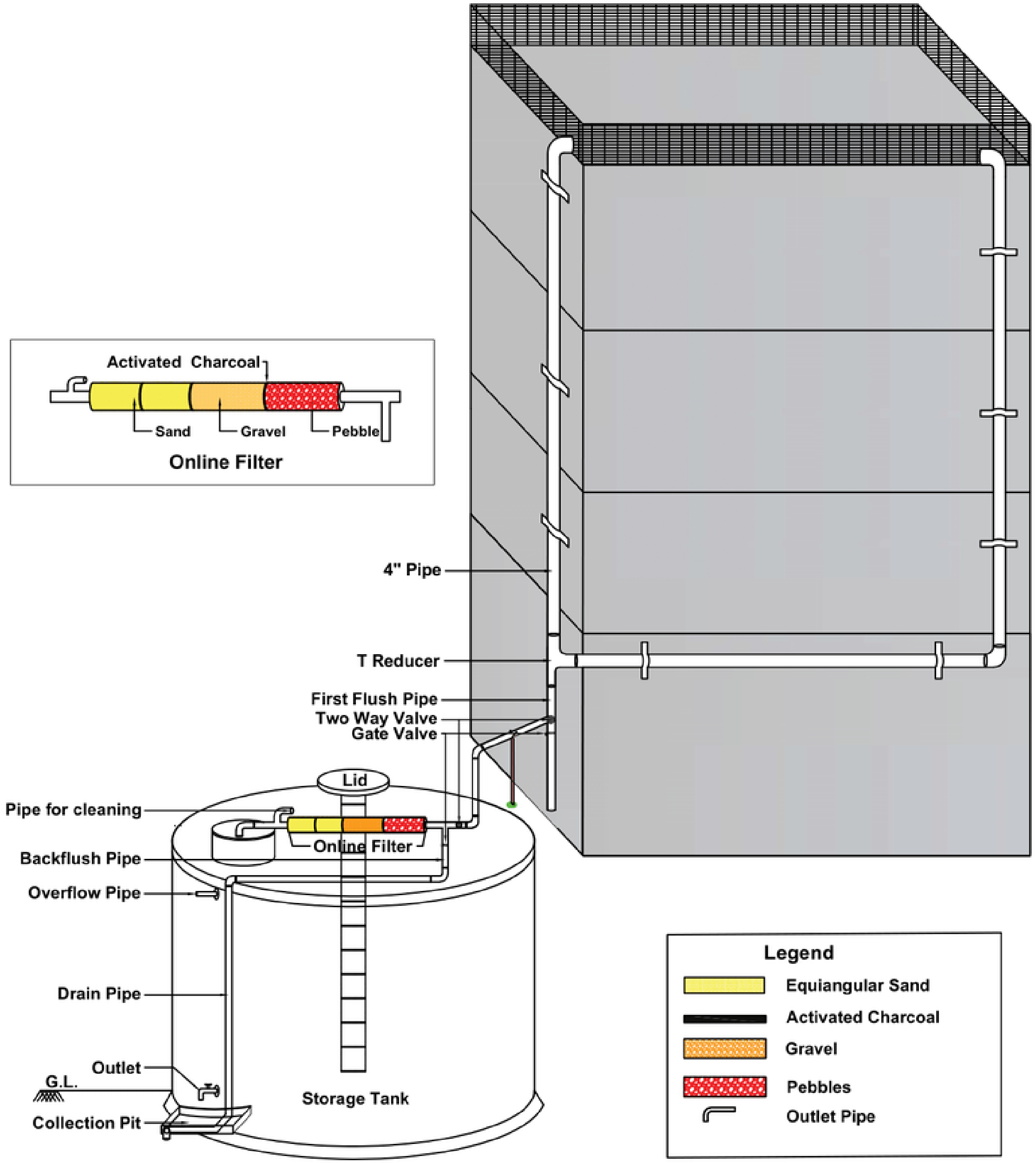
03 Do not allow the sunlight and dust to enter the storage tank.

04 Before using the stored for drinking purpose carry out the chemical and bacteriological analysis. If the results are within the permissible limits as per IS standard, then only use it.

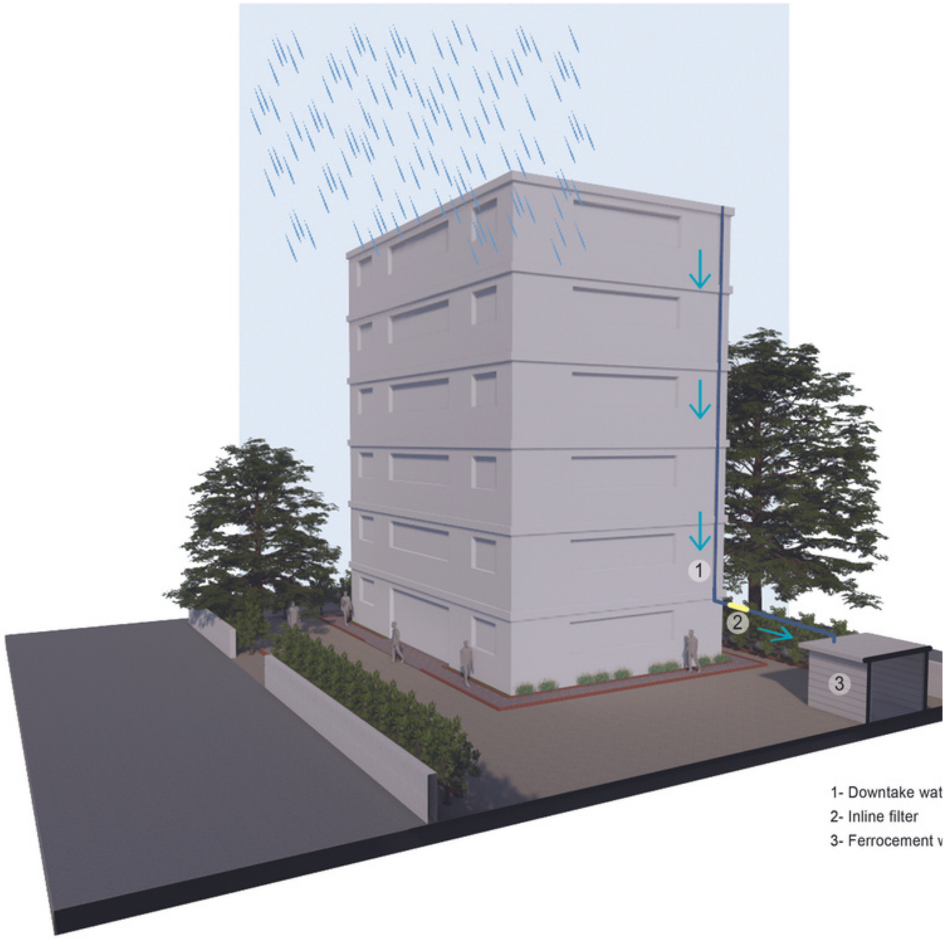
Maintenance

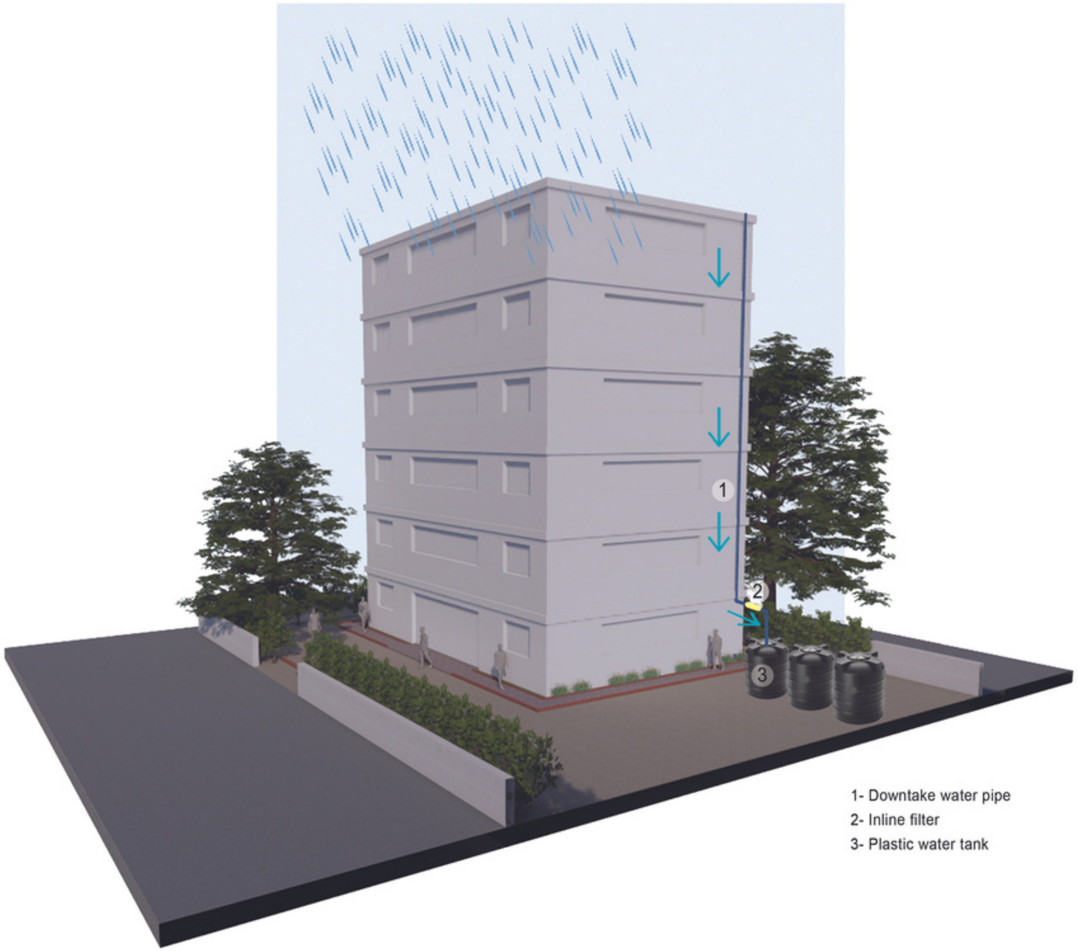
01 Every year before the monsoon, clean the roof area properly.

02 After complete usage of stored water clean and dry the storage tank in bright sunlight. For next year usage first rinse the tank by using the first inflow of rainwater.



Rooftop Rainwater Harvesting





Storage of Harvested Rainwater Over the Surface Tanks

b. Below the Surface Tanks

Recommended for

Regular rainfall - more than 500 mm.

Insufficient space on the surface.

Methodology

01 Channelize the rainwater collected on the roof of the building/s into one or two vertical drainpipes of at least 4” diameter PVC pipes. Bring this water through a single horizontal drainpipe of same diameter, laid down over a slab of the building or on the land surface depending upon the position of the storage tank. If slab support is not available, then lay down iron beams.

02 Install a two-way ball bearing valve to the drainpipe. Attach a first flush pipe to the valve to drain out the first rainfall water into the drainage. Close this valve during the first spell of rain and allow the runoff water to go into the drain chamber. Also close this valve during the high intensity rainfall spells.

03 Using a reducer to the valve, carry the rooftop rainwater through a 3” diameter PVC down pipe into the storage tank.

04 Estimate the roof water availability using this relation = Annual Rainfall (in mm) x Roof area (in sq. m) x Runoff Coefficient.

05 Runoff Coefficients

Type of Roof	Coefficient
Concrete	0.7
Tiled	0.75
GI Sheet	0.9

06 Depending upon the water availability and need decide the size of the water storage tank. e.g. For 100 sq. m tiled roof with annual average rainfall of 800 mm ~ 60000 liters of water will be available.

07 The storage tank is constructed/ installed partially below the ground.

08 The storage tank is usually covered from all sides. Three openings are kept in it. One is for the lid on the top, second is for allowing the filtered water to enter it from the top side and third is for outlet at the bottom. Fix a valve to this outlet pipe. This is necessary to control the use of stored water.

09 Though the roof top rainwater appears to be clean it is necessary to use the online filters comprised of coarse sand, activated charcoal, coconut fibre, pebbles, and gravels. Such filters are readily available in the local market.

10 Immediately after the valve install the online filter either on the storage tank or on the ground.

11 Fix a small pipe & elbow to the filter to carry the filtered water into the storage tank.

Process

01 The rooftop channelised water will come through the online filter into the storage tank.

02 As soon as the storage tank gets filled, completely cover the lid tightly.

03 For domestic purposes the stored water can be directly used without any treatment. Just open the outlet valve and use the stored water.

04 For drinking water usage, the stored water is collected into a small tank of 1000 to 2000 lits. Chlorination will have to be carried online using govt approved capsules.

Precautions

01 During the first rainfall spell, close the two-way valve and drain the rainwater through the drainpipe. This will help in avoiding the heavy contaminant load from entering the chambers. During dry spells (dry days > 10) within the monsoon adopt the same procedure.

02 During high intensity rainfall spells (>25 mm/hour) open the inlet pipe two-way valve, so that maximum roof top water will drain directly into the drain chamber.

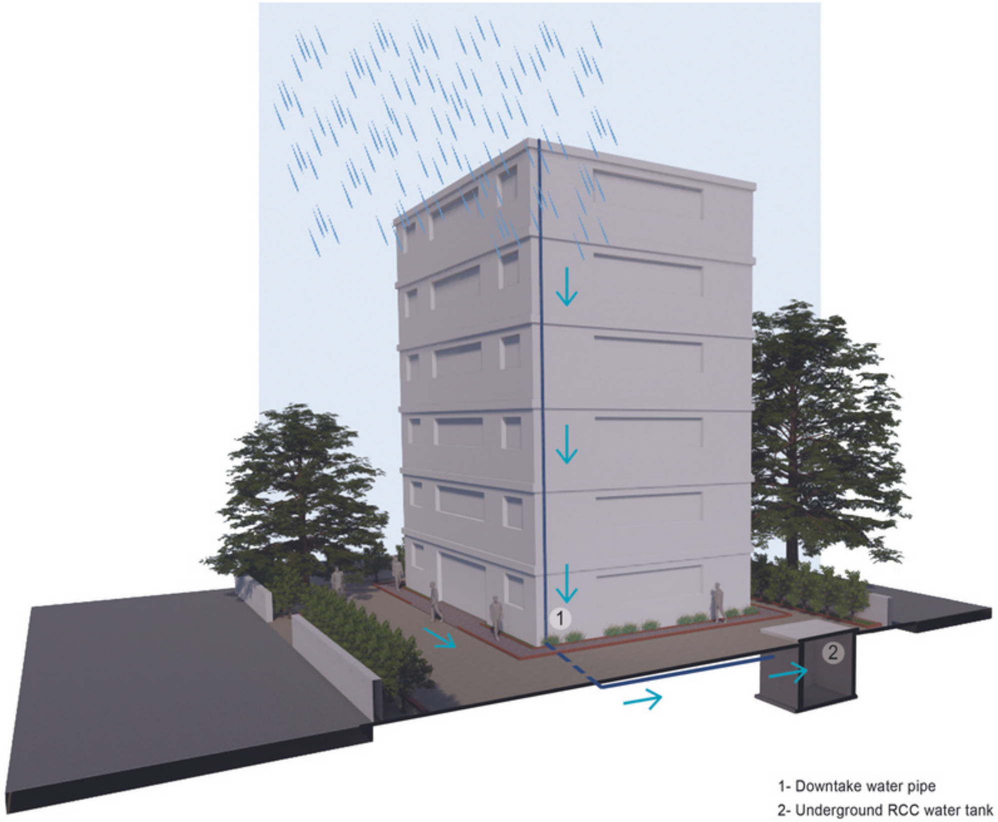
03 Do not allow the sunlight and dust to enter the storage tank.

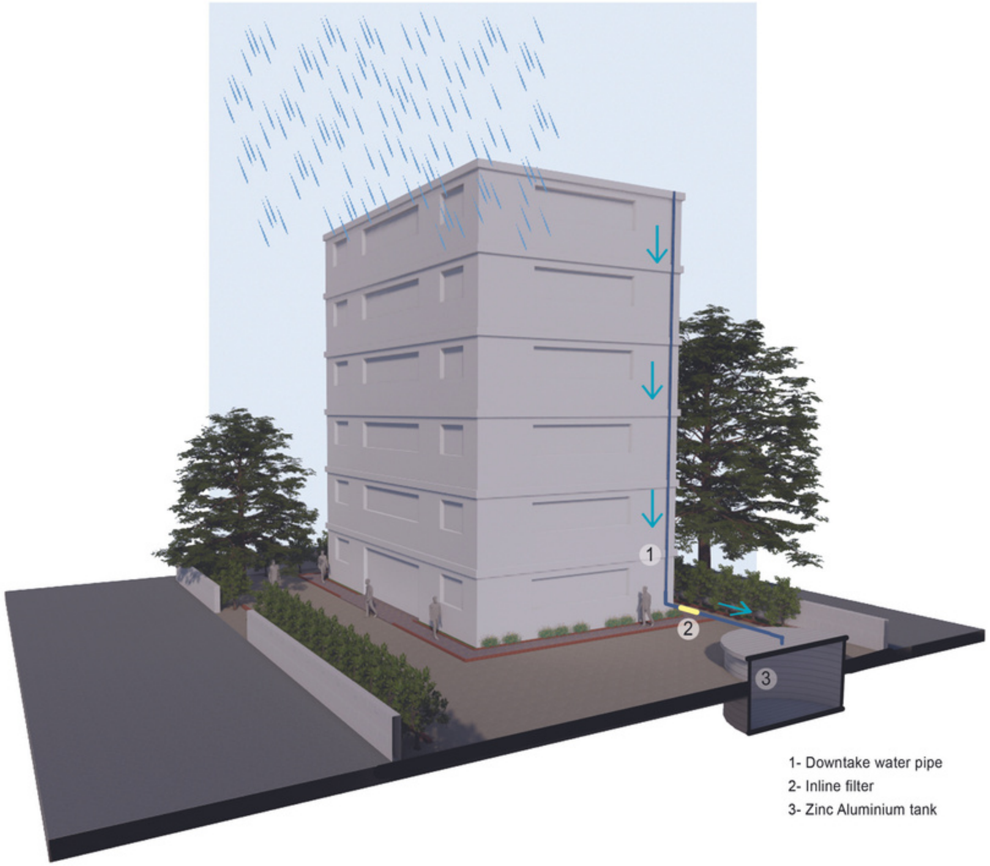
04 Before using the stored water for drinking purposes, it is necessary to get it tested for the chemical and bacteriological contaminations. If the results are within the permissible limits as per IS standard, then only use it after due chlorination.

Maintenance

01 Every year before the monsoon, clean the roof area properly.

02 After complete usage of stored water, clean and dry the storage tank in bright sunlight. For next year's usage first rinse the tank by using the first inflow of rainwater.





Storage of Harvested Rainwater Below the Surface Tanks

Science behind Rainwater Harvesting

In Maharashtra, the predominant aquifer is Deccan Trap (i.e. weathered vesicular or fractured, jointed massive Basalt). Mostly unconfined and annually replenishable aquifer is predominant and can be made sustainable through Managed Aquifer Recharge. Hence, Dug Wells are the most reliable source for groundwater withdrawal.

Due to technological advancements instead of dug wells the drilling of borewells is preferred in urban areas. But the yield of the borewells is not sustainable, as the deep aquifers are not that much productive and sustainable, like shallow & annually replenishable aquifers. Hence, they go dry after a few years. So, construction and use of dug wells in urban areas is the most dependable option.

The groundwater is a most reliable resource for drinking, domestic, irrigation and industrial uses in India. The increasing domestic demand of the Urban areas is being met through groundwater only. Because of excessive use of groundwater there is a threat of over-exploitation in urban areas. Over the years the groundwater level trend is declining. It warrants immediate need for Rainwater Harvesting in urban habitations to achieve sustainability of groundwater.

Rainwater harvesting in urban areas is a simple but technical strategy by which rainwater falling over the city establishments is gathered and recharged underground or stored.

In urban areas the properties are mostly individually owned, or society owned, or industry/company owned. Amenity spaces or ULB owned open spaces/properties or Govt. owned spaces/properties are very limited. So, the ULBs have limitations for implementation of measures for artificial groundwater recharge in public owned properties. Hence, Individual level Rainwater Harvesting is the principal option for the artificial groundwater recharge in ULBs. This needs to be promoted by the ULBs

The science of Hydrology & Hydrogeology plays a very vital role in Rainwater Harvesting. The methods included in the handbook are designed for specific capacity of rainfall-runoff & the hydrological properties of the aquifer/s. These two parameters are very important in deciding the type and dimensions of the RWH recharge structures. The drawings and designs need to be modified based on the availability of point runoff and water acceptability of the aquifer/s.

The body science and groundwater science are very similar. Hence, like a doctor, it is inevitable to take the scientific advice of a hydrogeologist.

With Best Wishes.

Shashank Deshpande
Principal Author
MTech (Hydrology), IIT Roorkee, M.Sc. (Tech) Applied Geology
Trustee - Bhujal Abhiyan Trust

Rainwater Harvesting and Groundwater Recharge

Groundwater recharge has become an extremely important subject of any water-related intervention in India. Much of the traction around rainwater harvesting has led to the concept of mobilising water from the surface of the earth and route it to the sub-surface. 'Natural' recharge to aquifers occurs through infiltration of precipitation, either directly to land or through the beds of streams and rivers. Unintentional or incidental recharge due to man's activities also occurs as a result of the effects such as excess irrigation and leakage from water mains, sewers and storm drains. However, the most obvious issue around recharge is the fact that aspects such as climate (changes in precipitation and temperature), land-use and land-cover in conjunction with over-pumping of aquifers has led to significant deficits in natural recharge in many regions.

Harvesting of rainwater for groundwater recharge must be perceived through the internationally accepted strategy of Managed Aquifer Recharge (MAR). MAR represents the intentional recharge, storage and treatment of water in aquifers. The term 'artificial recharge' has also been used to describe this activity hitherto. It must also be remembered that MAR is the intentional or designed recharge of water to aquifers for subsequent recovery for meeting anthropogenic needs and for environmental benefit such as revival of base flows in streams and rivers.

MAR also considers the quality of groundwater with the purpose of ensuring adequate protection of human health and the environment. In simple terms, aquifers may be recharged by diversion of water into wells or infiltration of water through the floor of basins, galleries or rivers. Harvesting such water (for recharge) also has a diverse typology across which such harvesting is possible. Water from rooftops, water from storm drains, water flowing through natural streams or water collected from runoff over roads and pavements are all possibilities for harvesting urban water. Routing such water into systems of MAR also requires different considerations of filtering and injection.

While MAR requires understanding RWH for recharge possibilities, it is equally important to understand that RWH also includes a few other contexts such as those of storing water artificially above or below the ground or harvesting of water for systematic usage from natural discharges of groundwater such as natural springs or water finding its way into excavations for urban development.

Urban rainwater harvesting strategies that are appropriate for managing recharge and discharges of groundwater in cities underlain by hard-rock aquifers, especially basalt rock aquifers is discussed in this handbook. A typology of case-specific solutions is provided as a guidance in rainwater harvesting for MAR and other applications in urban areas underlain by basalt geology.

Dr. Himanshu Kulkarni,
Founder Trustee, Scientist (Emeritus) and Formerly ED, Advanced Center for Water Resources Development and Management (ACWADAM); Trustee, Bhujal Abhiyan

Recommended Readings

- Centre for Science and Environment
- Ground Water, C.F. Tolman, McGraw-Hill Book Company
- Groundwater Prospect Maps of India, GoI
- Manual on Artificial Recharge of Groundwater, Central Groundwater Board, MoWR, GoI
- Rainwater Harvesting Techniques to Augment Groundwater, Central Groundwater Board, MoWR, GoI
- Rooftop Rainwater Harvesting Guidelines, IS 15797: 2008,
- Water Conservation Manual, Groundwater Surveys and Development Agency, MoDW, GoM
- Recharge Priority Maps of Maharashtra, Groundwater Surveys and Development Agency, MoDW, GoM
- Pune’s Aquifers, Report by ACWADAM, Pune

Scan this QR for website link

Do's

Examples of functional well maintained Rainwater Harvesting Structures

Dont's

Examples of non-maintained Rainwater Harvesting Structures

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