

## Chapter 2

# Nursery Techniques

**Abstract** Planting of nursery-raised seedlings is a major component of afforestation and reforestation programmes, especially in arid and semiarid areas where potential of afforestation by natural regeneration and direct sowing is limited. Quality of plants going out of the nursery is the first step towards success of the overall programme. Nurseries can be permanent (also known as central or main nursery) or temporary (also known as site nursery or field nursery), depending upon the duration of the afforestation programme or project. In a continuing programme that is likely to go on for more than 5 years, it is desirable to have at least a few permanent nurseries with proper infrastructure. However, in case of an afforestation project lasting 5 years or less, temporary or semipermanent nurseries can be established in which the cost can be reduced by dispensing with some of the infrastructure elements such as buildings, water reservoirs, and tube wells.

## 2.1 Establishment of a New Nursery

### 2.1.1 Site Selection

Site for a new nursery should be selected with a view to minimising cost of transportation of plants to the plantation site. Many times a suitable plot of land or suitable water source is not available near the plantation site and it becomes necessary to transport plants over long distances which, apart from resulting in higher cost of transportation, entails higher mortality and wastage of plants. In case of a temporary nursery, some arrangement can be made with a local farmer for utilising his private source of water. If a nursery is located near a natural source of water inside forest area, it should be ensured that good quality loam or forest soil is available nearby to minimise the cost of transportation of soil for preparing potting mix. The site must be approachable by the means of transport available, such as animal carts or motor vehicles.

Quality and quantity of available water must be checked before incurring further expenditure on creation of a nursery. Salinity of water is a common constraint in arid and semiarid areas, although most plants have some tolerance to salinity in water

**Table 2.1** Quality parameters for water suitable for use in nursery

Parameter	Safe limits
Alkalinity or acidity (pH value)	6.5–7.5; though a great deal depends upon the nature and pH of the soil
Salinity (total dissolved solids (TDS)): electrical conductivity (EC) value in mS/cm <sup>2</sup>	0.75 or less is standard; up to 2.25 in soils with good drainage or with salt-tolerant species
Sodium absorption ratio (SAR)	10 or less; more problematic in soils with high cation exchange capacity (fine-textured soils)
Boron cations	0.50 ppm or less; though concentration in the range of 0.03–0.05 ppm is desirable for normal plant growth
Residual sodium carbonate (RSC)	2.50 mEq/l, though 1.25 mEq/l is perfectly safe for all situations

and soil. Accordingly, the quality stringency of water will depend upon the plant species used in afforestation and also upon other factors such as presence or absence of salinity in soils of the plantation site (Table 2.1). Water with salinity less than 0.75 mS/cm<sup>2</sup> will suit most of the species commonly used in arid zone afforestation.

The terrain that suits a nursery best is a gently sloping terrain, or a flat terrain as a second choice. Steep slope should be avoided because it involves greater costs in terms of terracing and levelling of the ground. Area required depends upon size of nursery (its capacity in terms of plant production per season) and also upon whether large-scale growing fields (mother beds) will be used for producing tall plants. However, for a nursery of 100,000–300,000 plants—to be raised primarily in polypots—an area of 1 ha will be sufficient.

A nursery should be provided with a cattle-proof fence. If wild animals like blue bulls (*Boselaphus tragocamelus*) are present in the area, they might even jump the fence and destroy the plants. Therefore, choice of fence will depend upon local conditions, upon whether the nursery is permanent or temporary and how much expenditure can be justified on the fence.

### 2.1.2 Nursery Infrastructure

The essential infrastructure elements of a nursery are a water source, nursery beds, water conveyance channels or hydrants and working tools (Fig. 2.1). However, a permanent nursery should also have other infrastructure elements, such as one or more ground-level water reservoir (GLR) or overhead water reservoir (OHR), a seed store, staff quarters, and irrigation sprinklers. Choice of infrastructure is largely a question of availability of funds and the size and importance of the nursery.

Discharge and quality of water are the two parameters that decide suitability of a water source. Quality has already been discussed earlier. Discharge of water required in a nursery will depend upon the plant production capacity of the nursery and the method of irrigation adopted. On an average 25,000 l of water is required daily for

irrigating 100,000 plants (considering peak demand in summer, assuming sprinkler method of irrigation). It will be better to have at least 20 % extra water for contingency and to account for losses involved in the irrigation method.

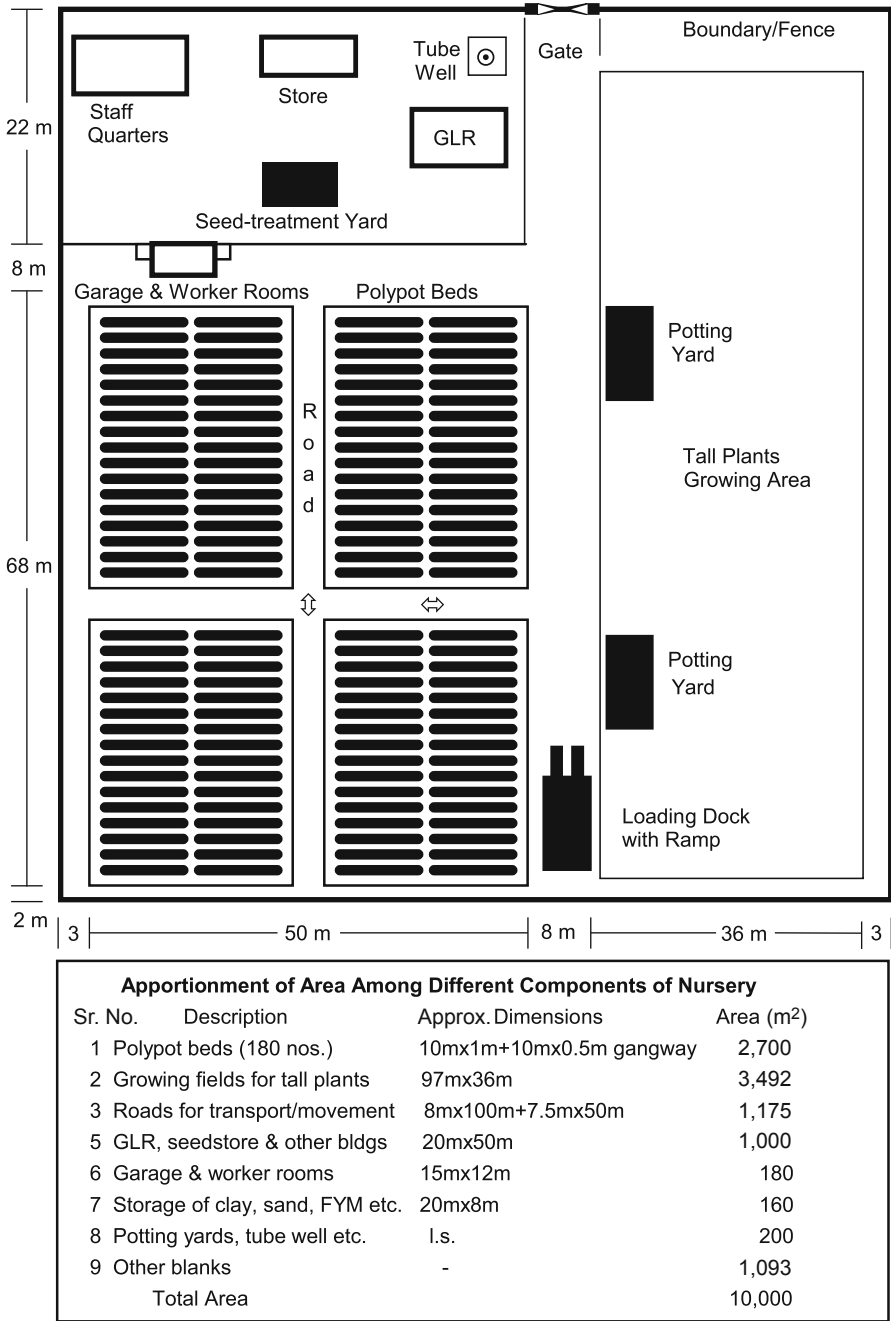
A tube well (bore well) is an ideal source of water (Fig. 2.2) for a nursery. Water from a tube well can be directly pumped to an OHR to drive sprinklers or to feed a network of pipes fitted with hydrants (Fig. 2.6). The cost of a typical tube well for a nursery having a capacity of producing 300,000 plants per year could be 5,000 mdeq. Of course, this can vary greatly, depending upon the type of strata found in drilling and other factors.

An open well (dug well)—or a dug-cum-bore (DBC) well—can be a better alternative to a tube well in many cases. When a tube well is not feasible or is too expensive, this is the second best choice. Such a well should be fitted with an electric motor coupled with a pump (Fig. 2.3) or a diesel pumping set of sufficient discharge and head. Many types of pumps are available to choose from, although monoblock pumps of centrifugal type and multistage submersible pumps are the best alternatives.

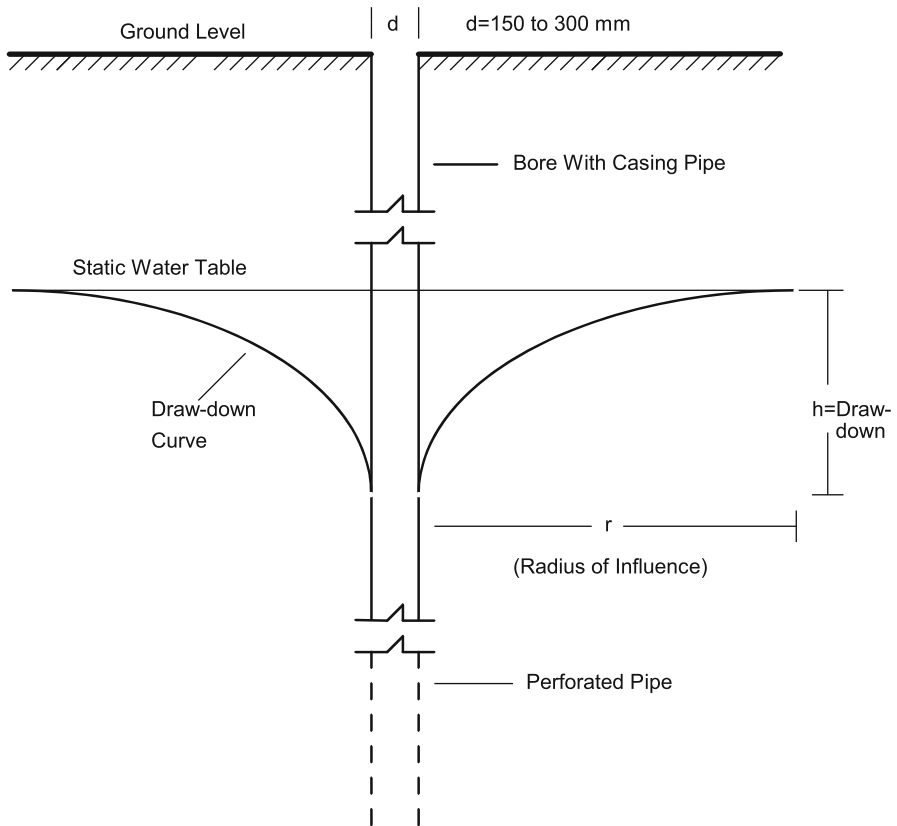
Wherever surface water is available, it should be used without exploring alternative sources of water. Although it is less likely to be feasible in arid areas, yet many times a canal or a tank with perennial storage is available near nursery site. In such a case, only a pumpset of mild power is required, and the quality of water is assured. The need for pumping may be obviated altogether if water can be drawn by siphon or gravity. It should be assured, however, that water supply will not be interrupted during any part of the year. A closure in the canal or a sudden dry-up in the tank due to insufficient rain may bring all the efforts to a nought or else the expensive alternative of transporting water from distance should be kept at hand.

Choice between a GLR and an OHR will be based on the twin criteria of the cost and the necessity of using a sprinkler system. Large nurseries will have beds spread over too great a distance to be irrigated through a single GLR. In the case of a sloping terrain and locating the GLR at the point of highest elevation, it will be feasible to irrigate plants by gravity flow in pipes. In other cases, a number of GLRs should be located in different parts of the nursery, each located higher than the beds it irrigates. If the cost of labour required for manual irrigation is high, installation of a pressure-driven sprinkler system driven by an OHR of sufficient head will be a better alternative.

A GLR should be located at the point of greatest elevation within the nursery premises in order to have good pressure of water at all points. Its construction will depend upon local conditions, but the one of masonry (Fig. 2.4) will be simpler and cheaper, unless a very large capacity is required. A reinforced cement concrete (RCC) structure should be opted when the masonry alternative is nearly as expensive or where a storage capacity of more than 100 m<sup>3</sup> is required. Normally, a GLR should be of sufficient capacity to serve as a backup source of water even if the tube well is out of working order for a week. If the mean time between failures of the tube well is low and the mean time to repair is high, the GLR should be designed for an even larger capacity.



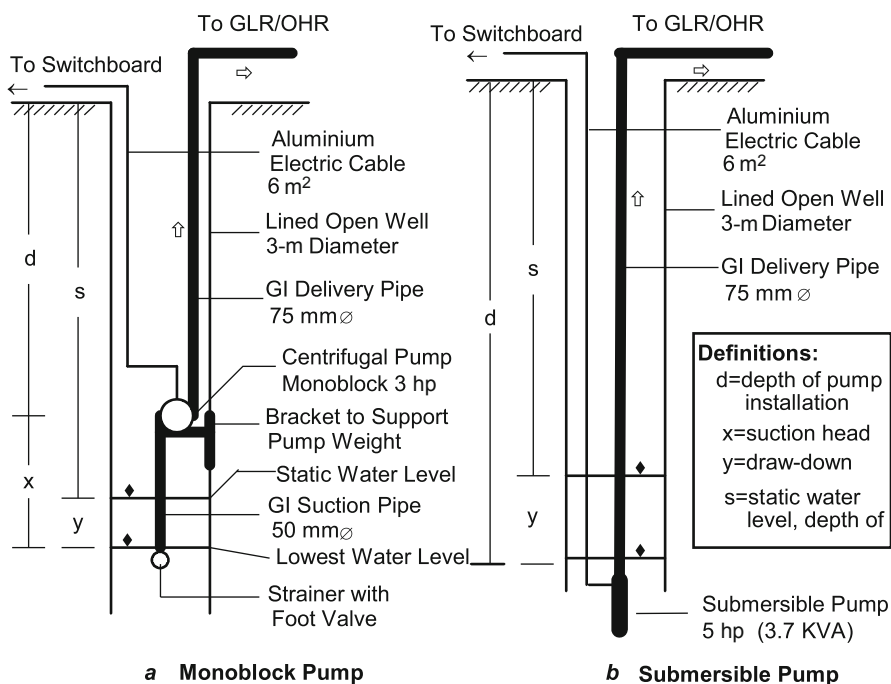
**Fig. 2.1** Layout of a permanent nursery. *GLR* ground-level water reservoir, *FYM* farmyard manure



#### Computing Head, Discharge & Horsepower of a Pump

- Head is computed as follows:
  - Depth of static water level =  $s$
  - Add static draw-down =  $s+h$
  - Add height of reservoir =  $s+h+r$
  - Add frictional losses =  $s+h+r+f = H$ , head for pump
- Discharge is obtained by test pumping the well for sufficiently long time to allow it to reach steady state of flow. This is **maximum** discharge; actual discharge is a trade-off between total volume of water required daily and pumping hours.
- Horsepower of pump is computed from the formula  $p = 13.3 \text{ hQ}/\eta$ , where  $Q$  is the discharge required, in cum/s or cumec, and  $\eta$  is the efficiency factor of pump normally ranging from 0.70 to 0.90. Note also that  $1 \text{ hp} = 0.73 \text{ kw or KVA}$

**Fig. 2.2** Schematic diagram of a tube well



### Pumps & Pumping: General Considerations

- Centrifugal pumps with rotodynamic impellers are standard equipment these days. Reciprocal and jet pumps are used only under special circumstances.
- Pumps can be driven by electric motor or diesel or petrol engine. Motors are often built into the pump body (the monoblock pumps).
- Submersible pumps are specially encased multistage pumps with motor built in. These have small diameter (from 100 mm to 300 mm), but high power ratings, head, and efficiency. These are standard choice in tube wells.
- Pumps are available in different ratings of head, discharge, and power and with different delivery pipe bore sizes. Choosing the right pump involves these steps:
  - a Compute the total head and discharge required, assuming daily pumping hours and total volume of water to be pumped.
  - b Compute the horsepower of pump from the formula  

$$hp = 13.3 \frac{Qh}{\eta}$$
 where Q=discharge (cumec),  
 h=total head, and  $\eta$ =efficiency factor (0.7–0.9)
  - c Given the head, discharge, and power, select the right pump.
- While installing pumps above water surface, ensure suction pipe is < 5 m long.

**Fig.2.3** Schematic diagram showing installation of water pumps. GLR ground-level water reservoir, OHR overhead water reservoir, GI galvanised iron

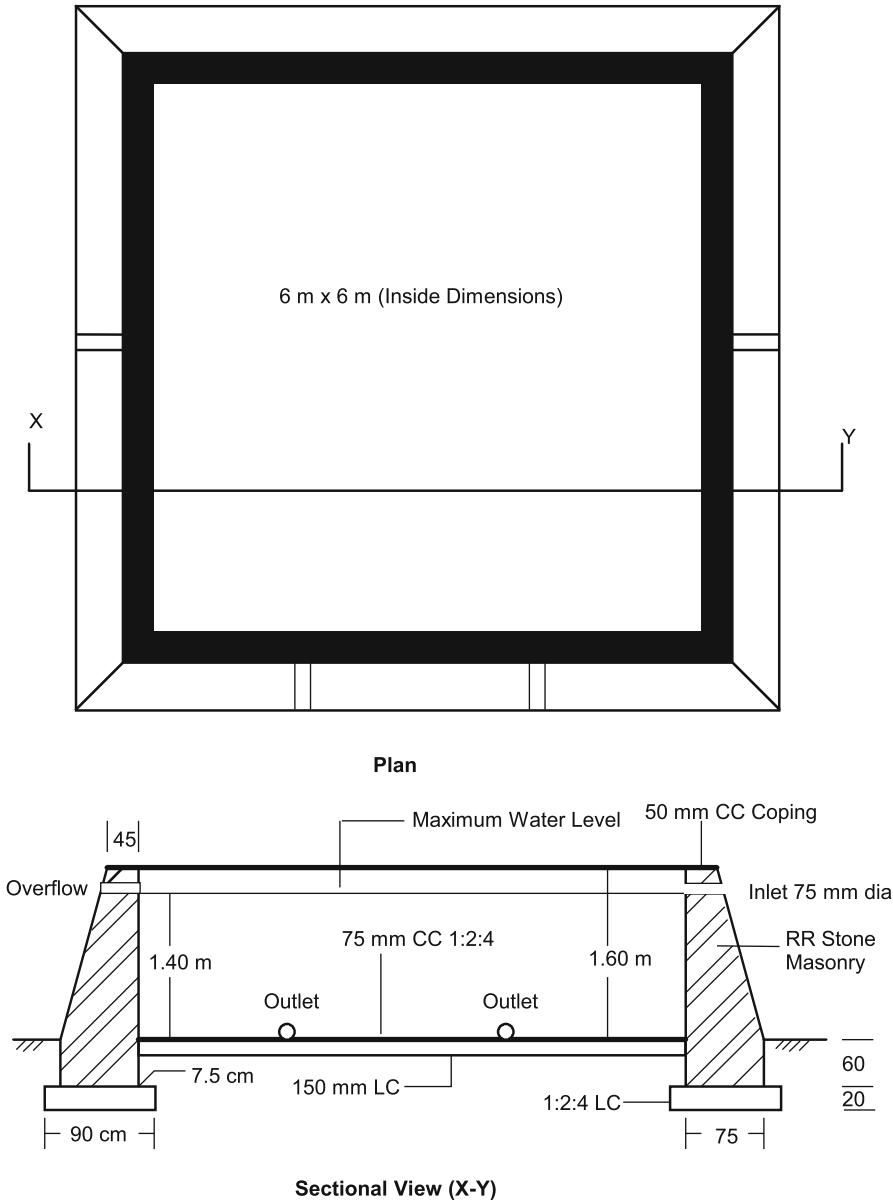
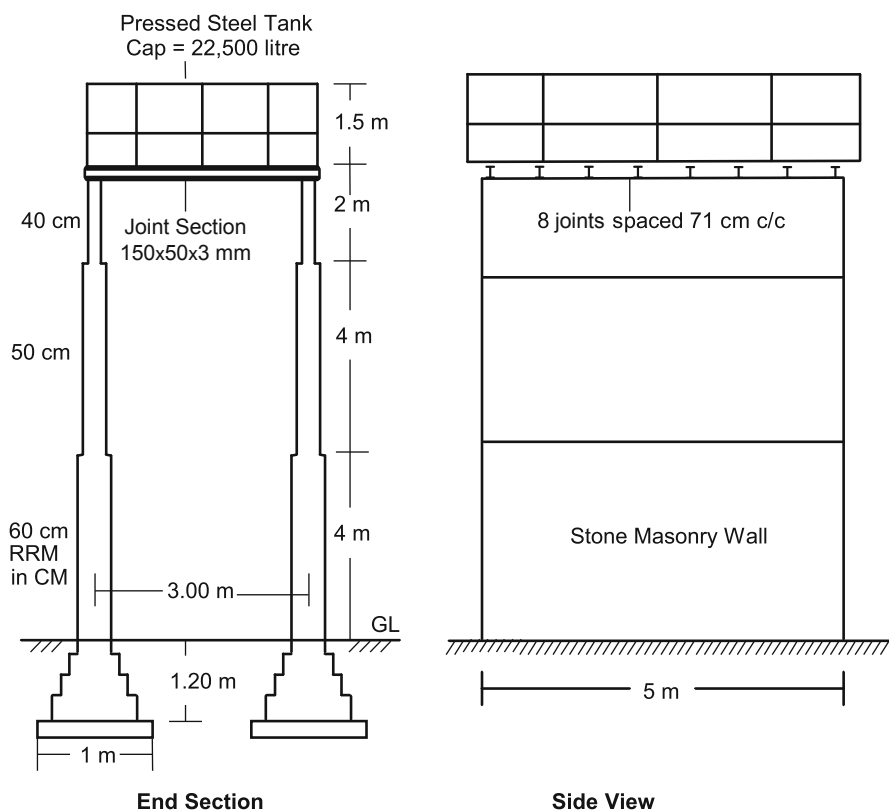


Fig. 2.4 Plan and sectional view of a GLR of 50,000-l capacity

An OHR is a structure of considerable cost and complexity. Nevertheless, it becomes an indispensable part of a nursery if labour costs are so high that pressure-driven sprinklers must be installed for irrigation. The cost of an OHR can be brought down by designing it for a lower capacity (Fig. 2.5) if availability of electric power

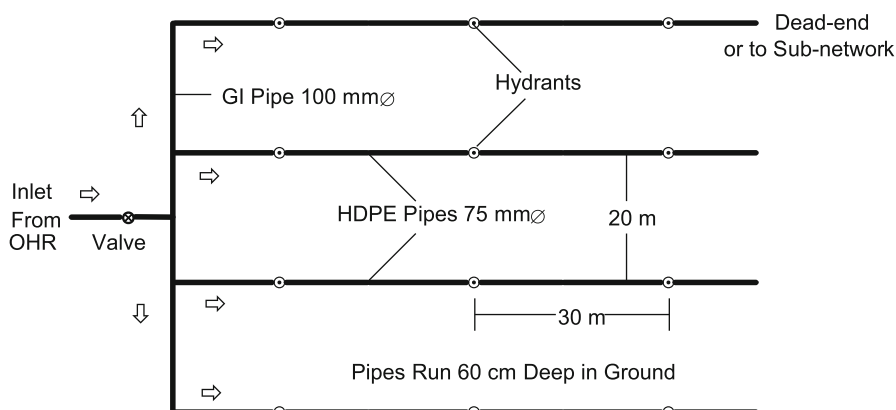


**Fig. 2.5** Design of an overhead water reservoir (OHR) for a central nursery. *c/c* Centre to centre, *GL* Ground level, *RRM* Random rubble masonry, and *CM* Cement mortar

is good enough to fill it more frequently than once per day (e.g. every morning and evening). It is also possible to drive sprinklers directly from the submersible pump of the tube well or by using a pressure boosting pump attached to a GLR. In that case, assured power supply for at least 8 h a day must be available and the additional costs incurred on the booster pump and the GLR should be less than the cost of an OHR. In any case, if an OHR is constructed, it should be designed for a pressure head and a capacity that will serve its purpose well.

Irrigation sprinklers are valuable not only because they save on labour but also because they economise water use. These should be designed keeping in view the daily requirement of water and its pressure and the salinity level in water. Perforated pipes will be suitable only if water salinity is low and the pores do not get clogged too frequently. Short of this, they are the best choice because of their linear geometry and efficient irrigation of the beds on both sides. Rotary type sprinklers connected to hydrants are more suited for irrigating mother beds and other large blocks of plants growing in field (Fig. 2.6).



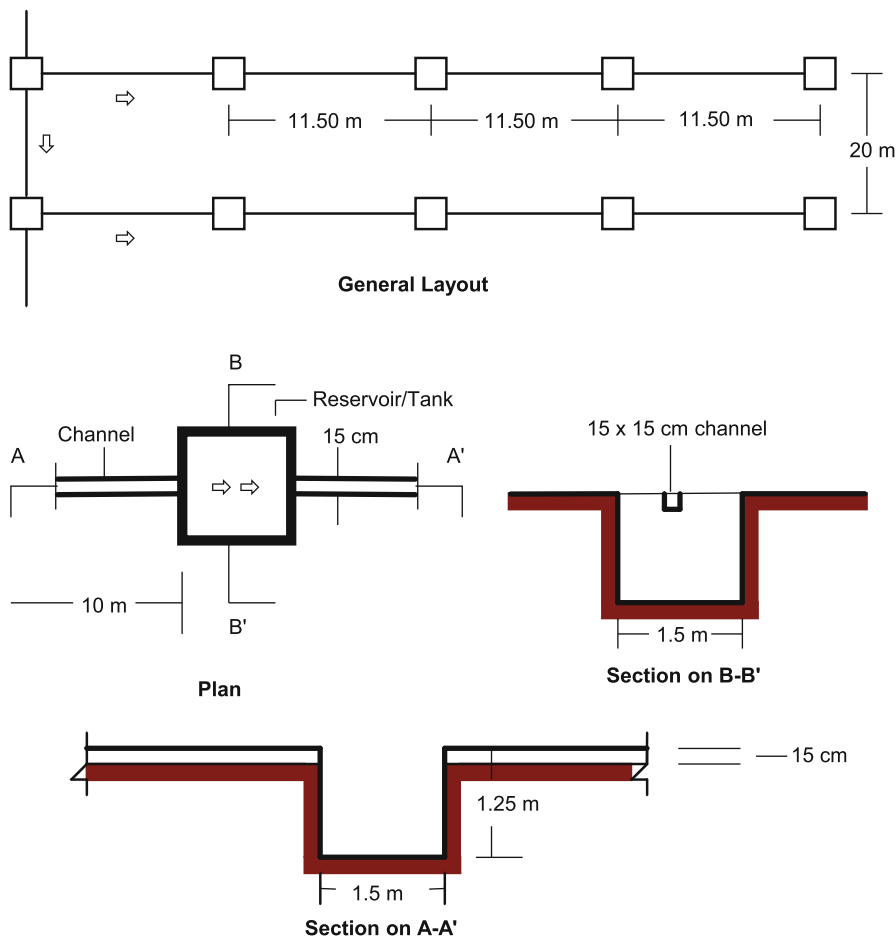


**Fig. 2.6** Schematic layout of a pressure-pipe network for water distribution in a central nursery. *GI* galvanised iron, *OHR* overhead water reservoir, *HDPE* high-density polyethylene

Water conveyance channels (WCCs) are required if irrigation is manual—with the help of hand-held rose cans. When only a GLR is available and it does not provide adequate pressure to operate hydrants, this is the only choice left. Water is conveyed through channels to small underground water reservoirs (UGR). Rose cans are then used for lifting water manually and spraying it on the plants in beds. WCCs must be laid out carefully on regular gradient or else these will overflow and water will spill out. A network of channels will be required to cover the nursery (Fig. 2.7). The cost of all the WCCs and the associated UGRs may add up to that of a pipe-and-hydrant system, and where the latter is feasible, it should be preferred.

A pressure-pipe network with hydrants (outlet nozzles) suitably distributed in the nursery will enable manual irrigation with roses attached at the end of flexible rubber pipes, thus increasing labour productivity as water need not be manually filled into cans. Sufficient water pressure should be available throughout the network. Inadequate pressure will slow down flow of water and will take longer to irrigate, effectively leading to higher labour costs. Given sufficient operating pressure head (of at least 2 m at all points), this should be a cost-effective and reliable solution. Care should be taken while designing a network of this type to ensure uniform pressure throughout the network. A number of hydrants open simultaneously may suddenly bring down pressure in certain branches of the network and make these inoperative.

Beds are essential elements of a nursery. Beds are used to hold pots in position (container beds) or to hold soil or potting mix in which seeds germinate (germination beds or seedbeds). Beds can also be the identified field plots where plants grow to a height sufficient for preparing cuttings or for transferring to pots (mother beds or growing beds). Beds for different purposes should be laid out carefully and labelled systematically by organising these into blocks, sectors, or series so as to make it easy to identify these for the purposes of recording plant inventories. Layout of beds should be drawn on a signboard fixed at a prominent place in the nursery.



Properties of Precast RCC Channels for Conveyance of Water					
Section (Inside) (cm)	Web Thickness (mm)	Flow Area (cm <sup>2</sup> )	Weight (kg/m)	Gradient (1/x)	Discharge (lpm)
10 x 15	20	150	16	500	71
15 x 15	25	225	26	500	118
15 x 25	25	375	32	500	242
25 x 25	30	625	52	500	461

Fig. 2.7 Layout and details of water conveyance channels in a nursery

Container beds are sunken beds, often in rectangular shape. A standard bed could be 10 m long and 1 m wide. The length can be doubled, but the width should not be

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