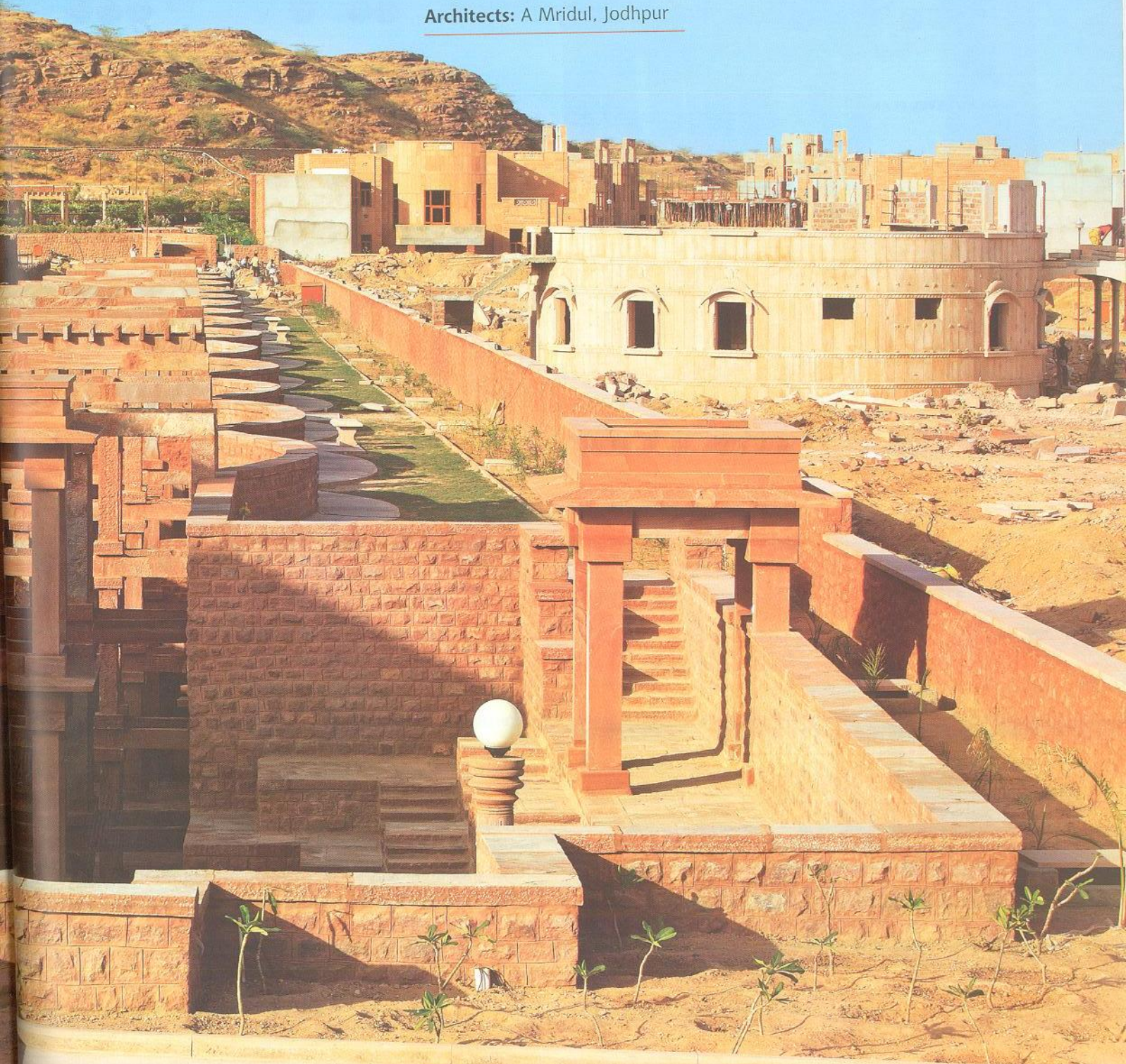


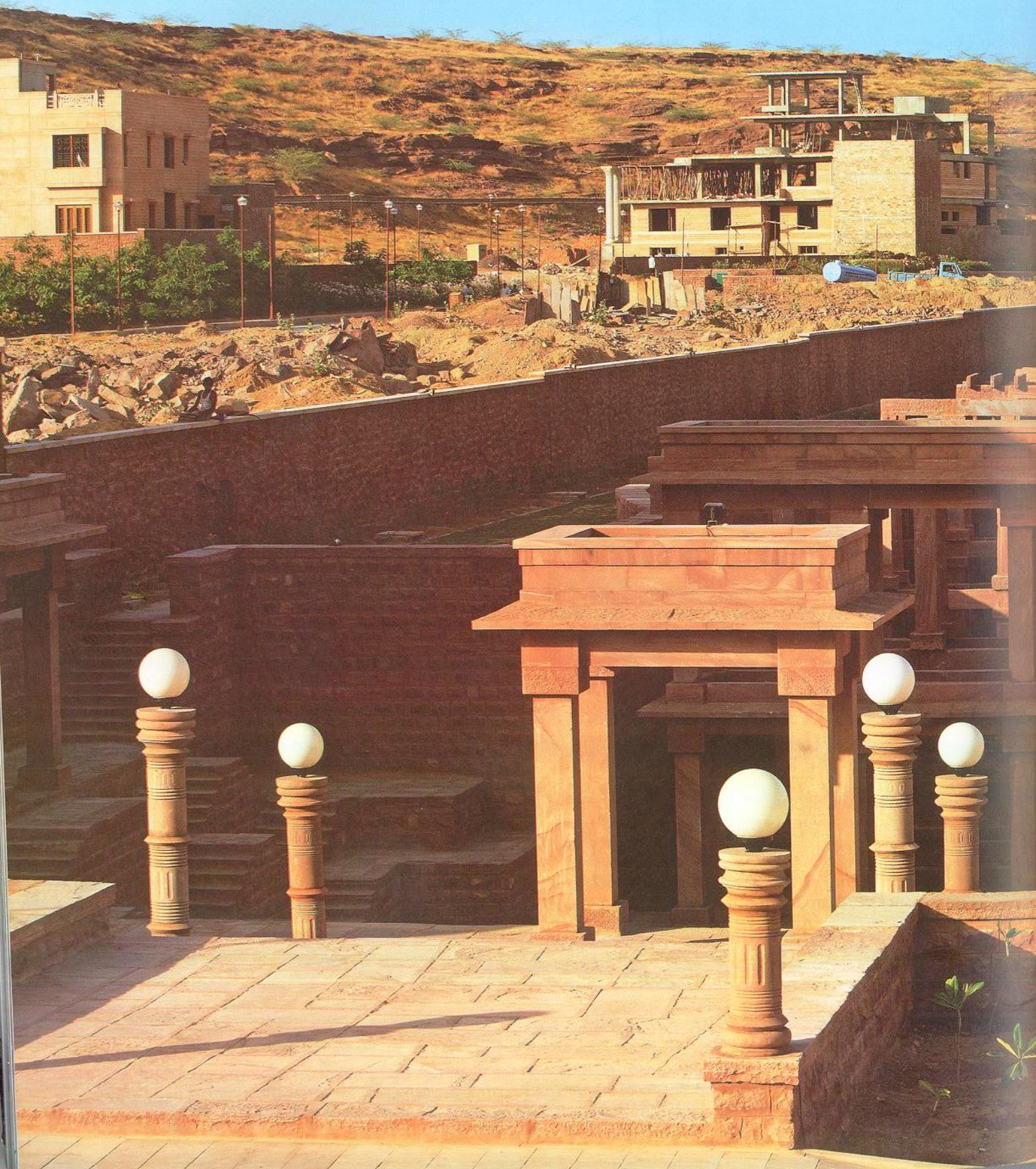
A Linear Step-well

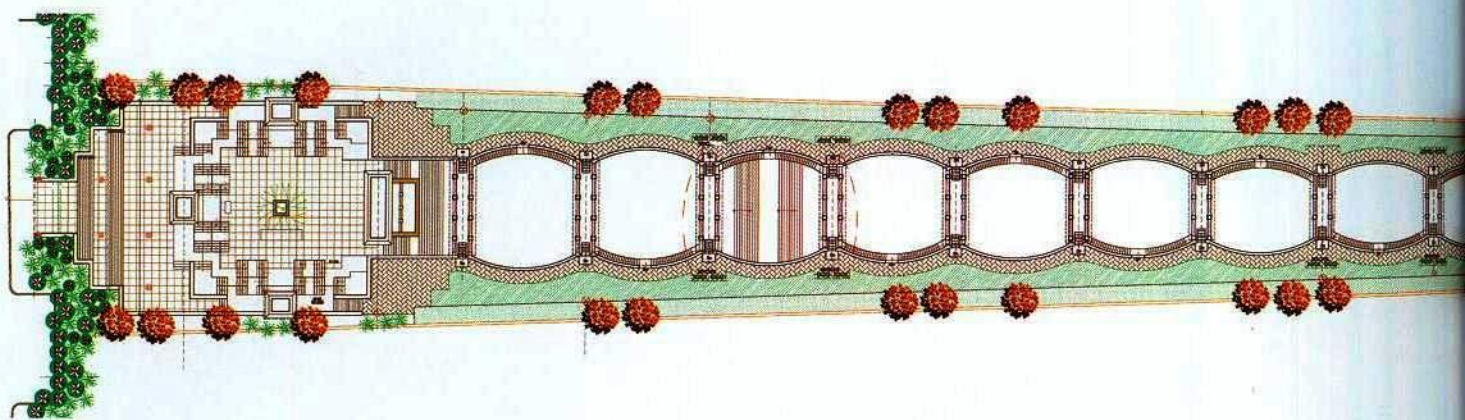
Project: Birkha Bawari, Jodhpur

Architects: A Mridul, Jodhpur

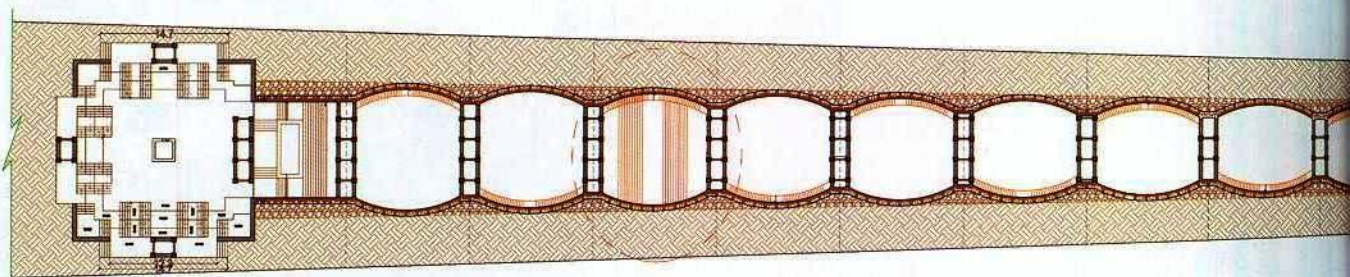


Project Features

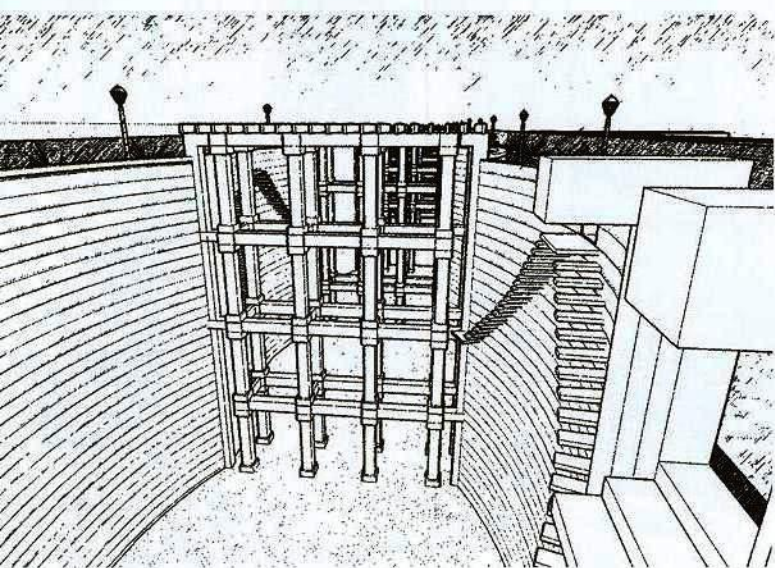




GROUND LEVEL PLAN

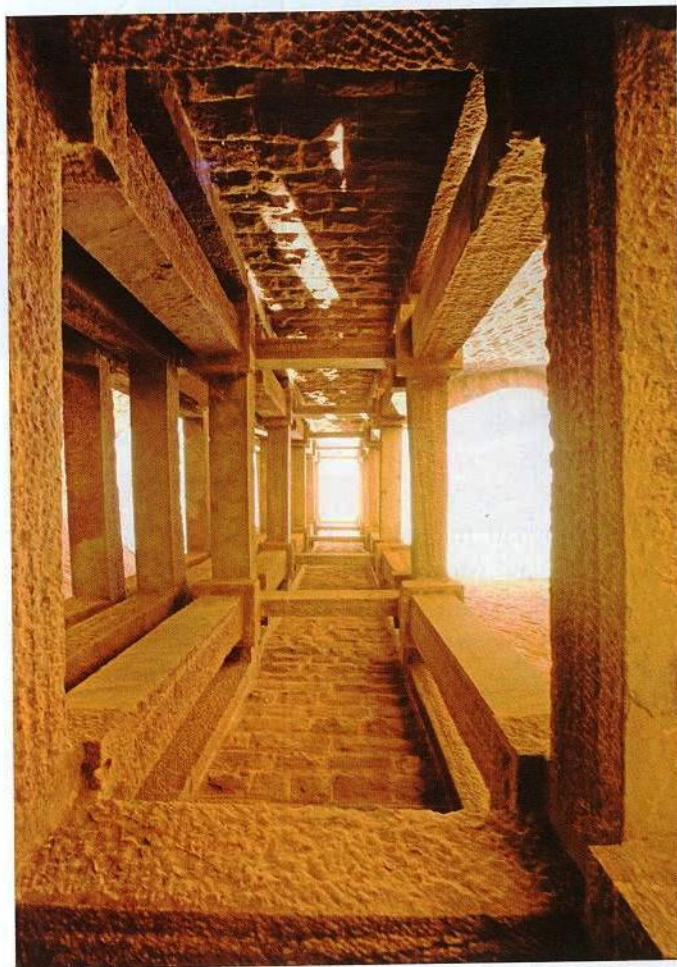
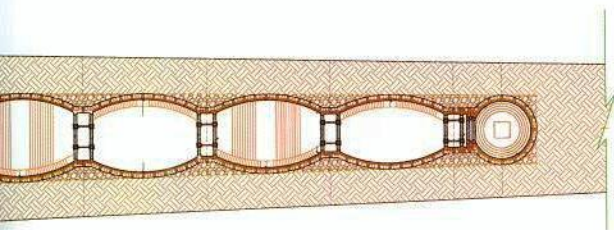
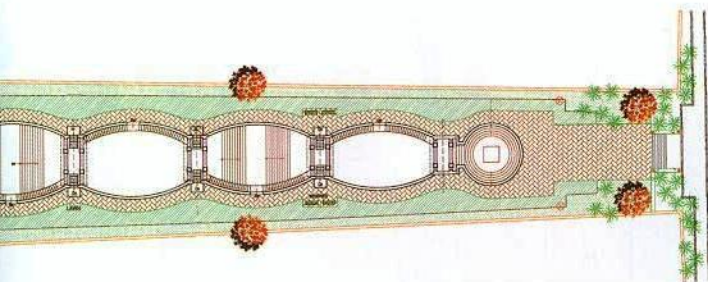


LOWER LEVEL PLAN



Abundance and scarcity of natural resources have always affected the worth and value of the resources. In the semi-arid regions of Rajasthan and Gujarat, water is a scarce resource. So it is highly valued, respected, revered and almost worshipped. Intricately crafted well structures, step ponds, step-wells and ponds were built to draw water from the earth or to collect rainwater. These exquisitely built structures to store and conserve water in these regions bear testimony to the worship-like value people attach to water. This survived through centuries, through changing times, changing regimes, till these regions remained water-scarce and arid.

It was only in the last quarter of the 20th century that a slow but determined movement was initiated to preserve water conserving structures and restore their value and glory. The movement gradually gained momentum and at the end



of the century government mandated construction of rainwater harvesting structures through bye-laws.

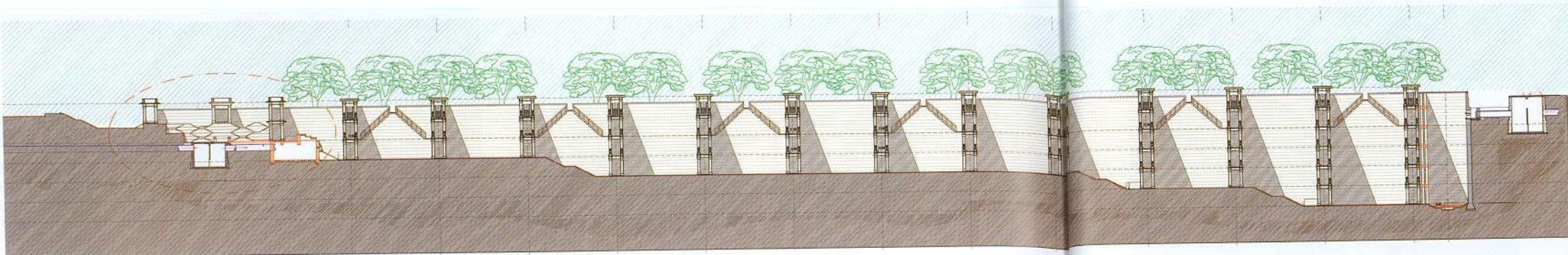
The 'Birkha Bawari', in Jodhpur, is a project envisaged in the semi-arid region of Rajasthan. It is a massive sandstone reservoir for harvesting rain water from a 110-acre catchment of an under-construction private housing township. The housing located in Jodhpur is a water stressed city situated on the fringe of the Thar desert of India in Rajasthan. The climate of Jodhpur is characterised by scorching hot sun (temperatures rising upto 48°C), sand-laden storms and is arid through major part of the year with highly unpredictable, low rainfall (300mm average). The site is located on the foothills of sandstone marvel, the Umaid Bhawan Palace. The site when acquired for promotion was a rocky terrain with wild vegetation on steep unruly contours.

This narrow and long piece of township site stretches to a

length of about 2km with more than half of its area devoted to landscaping. While the craggy and rocky site is morphed into exquisite Jodhpur sandstone finished houses and buildings, these solid stone buildings, their concrete roads and the harsh, hot and arid climate are balanced by an opulence of soft verdure and flowing cool water. The central core of the township has been developed as lush green lawns, replete with trees, plants and water. Birkha Bawari is in one of the deeper troughs of this central core, blending harmoniously with the landscape of the township. Designed to hold about 150 million litres of harvested rainwater, when at its fullest, it serves as a rich source of water for irrigation and for sustenance of the huge tracts of green, in an otherwise water scarce region.

'Bawari', in the vernacular, means a stepped well. Unlike a cylindrical well, where water is drawn through Persian wheel or its equivalent, *Bawari* is a linear step-well, where steps lead down into the well water. 'Birkha', in local dialect means rain.

The centuries old exquisite *Bawaris* of Rajasthan and Gujarat are brilliant examples of art, architecture and engineering interlaced together. The design idea of the project was inspired



SECTION

from the myriad traditional 'Kund' (stepped ponds) and 'bawari' or 'vav' (stepped wells). Though there may not be examples of both forms in simultaneity, the structure has been designed as a unique combination of 'Kund' and 'Bawari'. The former is only symbolic, to be used as a forecourt and grand entrance into the earth and the latter:

The architectural structure is 224m long, average 10.5m wide with an average depth of 11m from the ground level and an average water depth of 7m. It is 6-storeys deep at the farthest end and about 18m below the surrounding ground.

It was designed, as was the tradition, to gradually descend into the earth. Geological investigation had revealed the first subterranean stream at 20m from ground level. Since this was to be a rainwater harvesting structure, the depth was thus restricted

to 18m to stay clear from any underground stream of water.

One of the most distinctive features of the structure is the innovative way in which the retaining walls have been conceived and constructed. It is a synthesis of a re-interpreted structural system of the age-old barrel-vaulted roofs, local construction practices and site-quarried material of sandstone to create slender retaining walls, as deep as 18m below earth.

In simple terms, a conventional vaulted roof has been upended as 'vaulted wall' (standing on ends). Instead of the conventional retaining walls for countering the earth pressure, the concept of tunnels or barrel vaulted roofs has been re-interpreted as retaining walls in form of upended 'barrel vaults'. Pillars of the conventional vaults that transfer load on ground, here become beams transferring thrust on the opposite sides





and the pillars of this system only hold-up and provide bearing plate for connecting these short stone beams with long single piece beams facing structural and physical constraints.

A novel composite structure for the subterranean reservoir has been created by a series of segments of such 'vaulted walls' placed opposite one another and held against each other by a trabeated (post and beam) structure. The vaults on opposite sides nullify each other's thrust and counter-balance each other.

The thickness of these 'vault-like' walls is merely 0.7m which is very slender relative to the average thickness of a conventional dam-like retaining wall. Consequently, minimum excavated space was displaced by the structure of the step-well, allowing for a larger volume of water storage.

The construction of this step-well shaped rainwater harvesting structure celebrates and contemporises the vernacular sandstone architecture of Jodhpur. The architecture of this step-well is truly indigenous. The coursed masonry walls of this step-well are built of red sandstone sourced from the site of the township of which it is a part. The red sandstone hillocks on the site were levelled to run roads through and make plains for plots. The superfluous material on the site was converted into the principal material of construction of this step-well. The residue and scrap were used for in-fills, base and the



foundation concrete. The structural stones for posts and beams, flooring and steps were sourced from local quarries of Jodhpur, from within a radius of 15km. The excavated earth was disposed off within the site in filling the undulated land, achieving a geological equilibrium.

This ingenious structural system is an innovation born of experience in stone and local construction practices, common



FactFile

Client: Ess Gee Real Estate Developers Pvt Ltd., Mumbai

Design team: A Mridul, Rajendra Roop Rai and Hitesh Rathore

Consultants: A Mridul (Structural System), Saurabh Varshney (Structural Design), Kishore Pradhan (Landscape)

Built-up area: 5750sq m

Contractors: M/s Sana Constructions (Civil)

Cost of project: Rs 8 crore

Year of completion: 2009

sense and instinct rather than of complex structural calculations. Its creation is especially significant as it is constructed of locally available natural building material, built by local craftsman, to collect nature generated water – the rainwater from the township's catchment, by help of natural energy – the gravity, without resorting to mechanical and electrical means.

This clean, energy saving method, using natural energy to collect natural resource for sustaining nature, should go a long way in alleviating the acute water shortage faced by the region and contribute to the efforts in mitigating the threat of global warming.

The design not only provides means of nurturing the verdure that it complements in the township's landscape, it also serves as a socio-cultural space for the residents, as has been the

tradition associated with centuries old step-wells. The forecourt, in the form of a stepped *kund* offers majestic space for gatherings and casual sauntering. All along the walls of the Bawari, there is a meandering promenade lined with landscaped parks. The trabeated system, holding the opposite walls together also serve as bridges connecting either sides designed as verandahs directly overlooking the water below, a prized spot for visitors. These verandahs have been provided at two levels, one at the ground level and another one, a storey below, touching the water level when the Bawari is at its fullest.

The architecture of this Bawari is totally utilitarian, without the lavish adornments like that in ancient step-wells. The finishing of the stones used is rock-faced or rough-hewn, gently chiselled only to achieve definite shapes.

Being a subterranean structure, nothing of it is apparent from afar. The approach and the sudden revelation of a majestic structure make the descent, dramatic and exhilarating. Albeit shorn of intricate carvings and richly embellished components like in ancient step-wells, it acquires grandeur of its own by the manner in which the massive curved stone wall segments have been concatenated through links of the trabeated frames, creating a grand panoramic view of an eco-friendly structure celebrating stone architecture. ✚