# PASSIVE WATER MANAGEMENT

## Uma Niwas, Purulia


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# INTENT & METHODOLOGY

The proposals for water conservation in and around Uma Niwas have been designed to mitigate the many vulnerabilities and challenges to the water resources as well as the larger landscape Without using heavy and technology intensive structures. The proposals look at reviving the natural potential of the land in the catchment area of the Uma Niwas site through natural and passive techniques by adapting traditional knowledge systems.

The proposal works towards the larger conservation and regeneration of the Uma Niwas precincts as well as its surrounding catchment landscape. It is not limited to the precinct property alone but looks at a holistic system of the larger context to ensure a sustained development of the land. This is done by restoring the degraded landscape, reviving the natural systems and building an ecological resilience. It also attempts to revive the traditional water harvesting systems of the region which have proven to be effective in the past. The proposals employ local materials and techniques familiar to the people of the community. This makes it very easy to implement on site without too much external assistance or conflict. The maintenance of these systems in future can also be driven by the community as they are familiar with these interventions.

In this report, the various strategies and proposals that can be implemented on the site and its neighbouring landscape have been detailed out. The locations, dimensions, construction techniques supported with reference images have been included along with an estimated cost of materials and execution.

The outcome of the exercise should be that the Uma Niwas catchment area water to be allowed to retain and percolate maximum within the catchment area through a network of water diversion, retention and detention structures and provide water through the Open dug wells for domestic consumption and Ahars for irrigation and ecological purposes.

# NATURAL SYSTEMS

The natural systems of the region was studied historically and geographically to understand the regional context completely. The study informed the proposed water management strategies to revive and restore the water systems.

Climatic conditions and rainfall patterns were understood as were the traditional systems of water harvesting. Threats and vulnerabilities predominant in the area was also used to understand the major concerns in the area.

*Ahar* and *Bandhs* were traditional water harvesting systems

*Summer:* March to June- **18.5 - 37 ˚C**

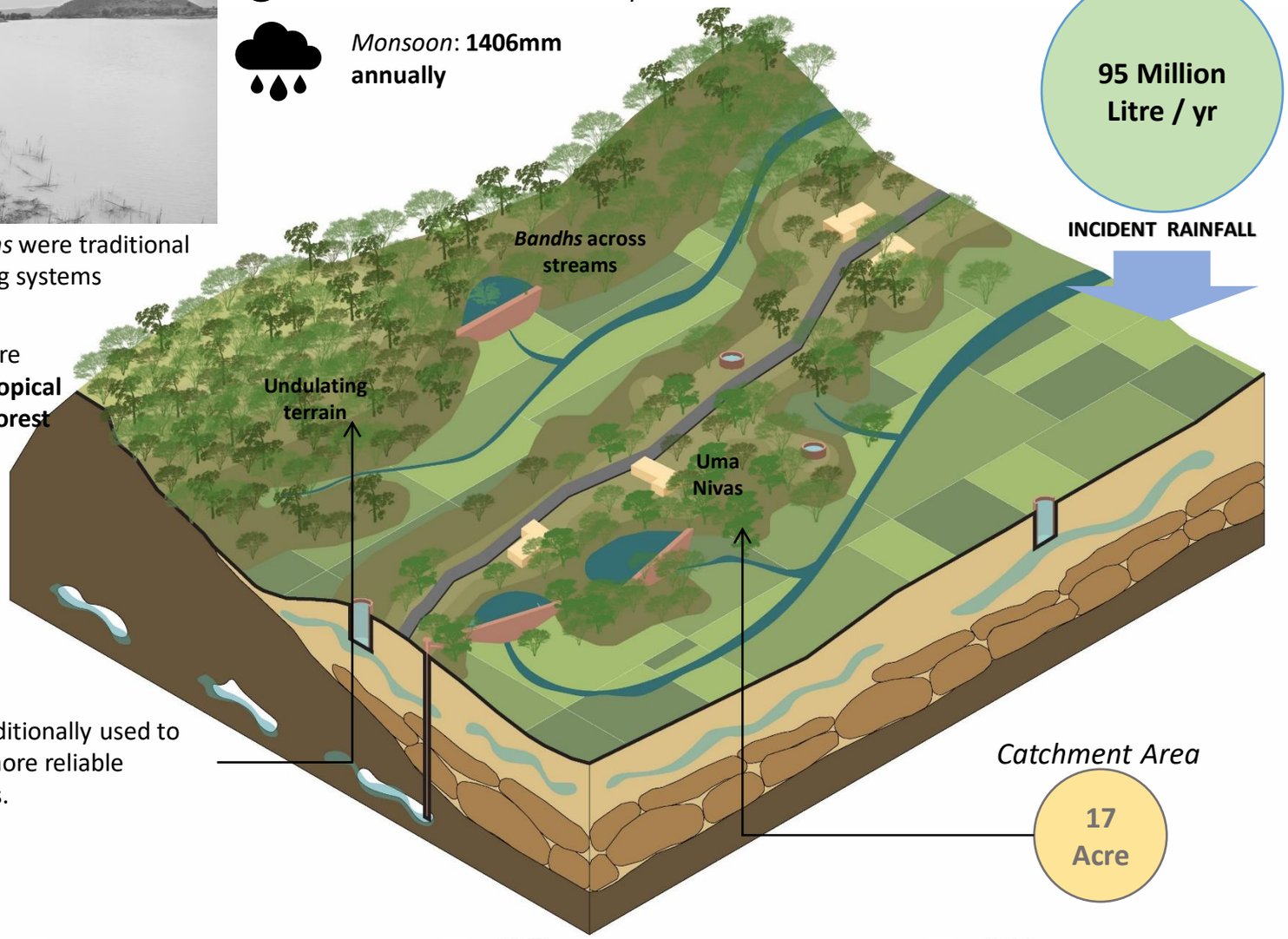
*Winter:* November to February **10 – 24 ˚C**

*Monsoon*: **1406mm annually**

*Available water for Retention and Infiltration:*

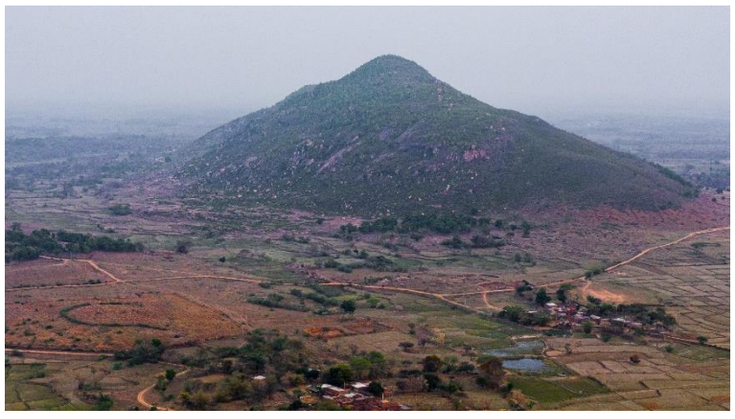
**95 Million Litre / yr**

**INCIDENT RAINFALL**




The hilly parts are covered with **Tropical deciduous Sal forest**

**Open Wells** Traditionally used to tap it into the more reliable shallow aquifers.



## Hydrogeology

The granitic landscape provides development of soil storage and shallow aquifers. Deeper aquifers are not reliable due to crystalline basement.

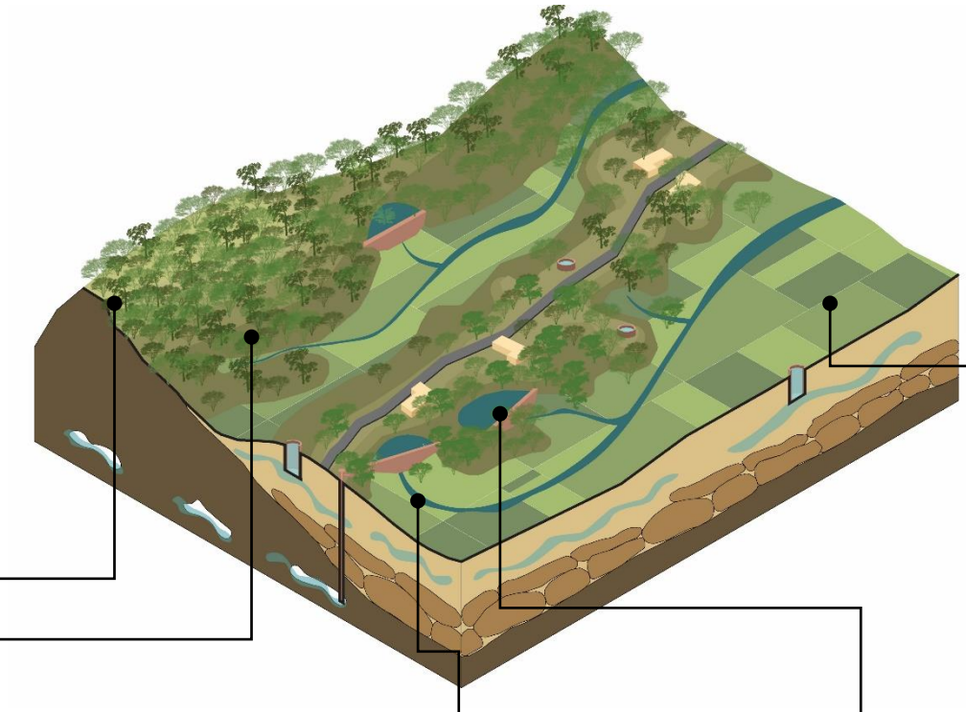
**The Soil Strata is a large reservoir of fresh water supply.**

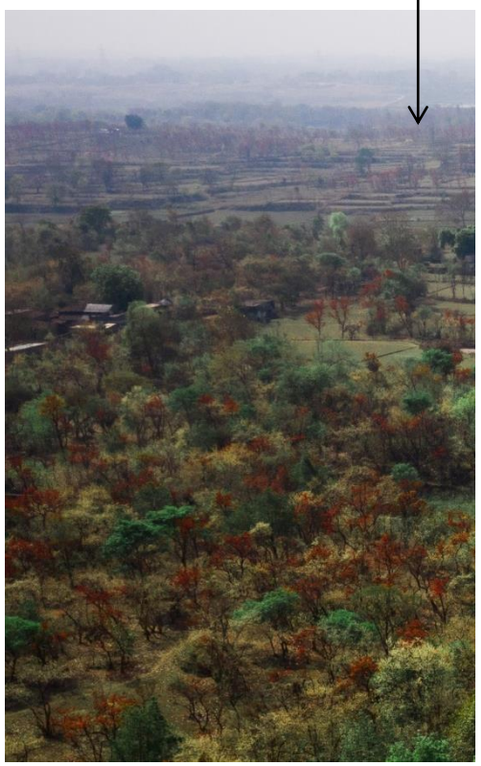
**The agriculture in the region is rain-fed and majorly water dependent of open dug wells and surface flow.**

The soil in the region is **largely lateritic in the uplands and reddish gravelly/ clay loam in the valleys**. Because of the undulating terrain, **the soil cover is thin and gravelly.** The soil is also **acidic and with poor fertility.**

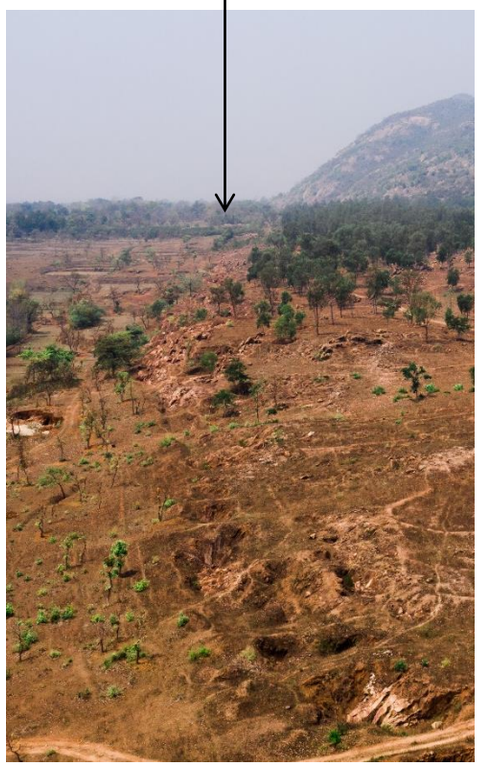
# HABITATS

The natural environment of the region was classified into 5 predominant habitat types. Each habitat requires a specific type of intervention which has been detailed further.

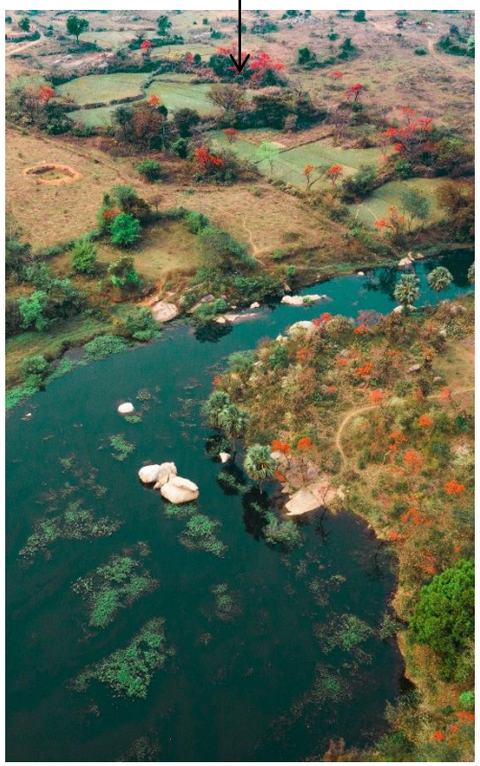




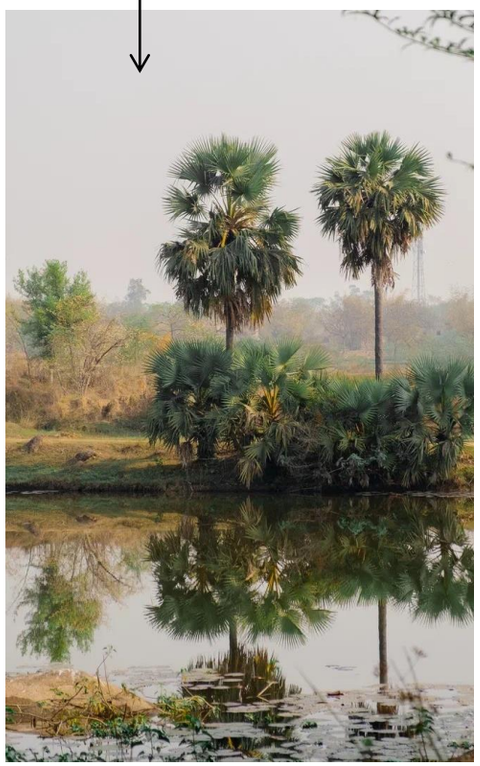
**FORESTS**



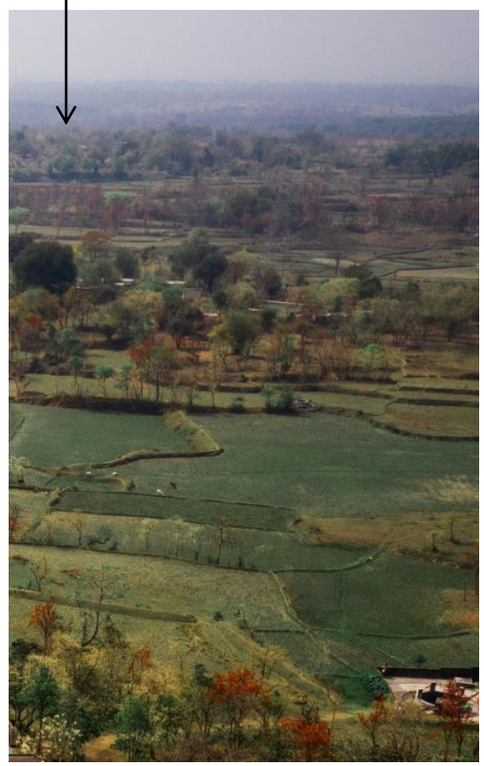
**ROCKY OUTCROP**



**SEASONAL WETLANDS**



**PERENNIAL AHARS & SEASONAL PONDS**



**AGRARIAN LANDSCAPE USED FOR CULTIVATION**

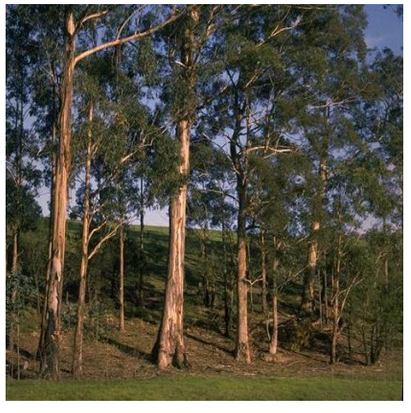
# BIODIVERSITY

The region is covered with a wide range of flora and fauna. These were incorporated into the proposals and will be propogated within the identified catchment area of Uma Niwas to stregthen biodiveristy.

Chhatui

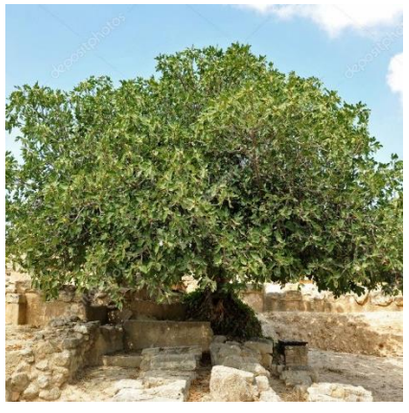
Palas

Arjun



Peepal

Karum



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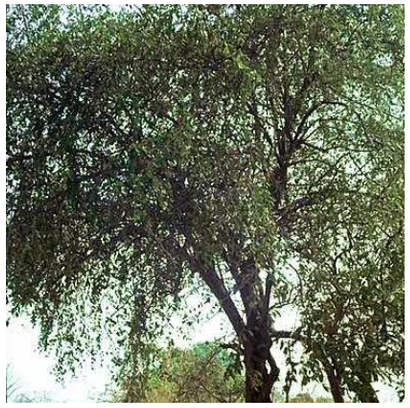


Kul

Mahua

Bhela

Sal

Akashmani

Banyan

# THREATS AND VULNERABILITIES

The threats and vulnerabilities of the region was studied in detail and addressed through the various proposals.

**Over grazing** led to loss of top soil

**Cyclonic Thunderstorms**

**Heat stress**

Rapid surface water run off leads to:

- **Poor ground water percolation**
- **Silting of ponds and stream**
- **Loss of soil moisture**
- **Droughts**
- **Flash floods**

Region is prone to Moderate **Sheet and gully soil erosion.**

Vulnerable to **Forest fire**

Borewells tapping the deep aquifers are **not reliable** due to crystalline basement.

The **fluoride contamination** found in the deep aquifers of the region are the highest in the district, going far beyond permissible levels.

F

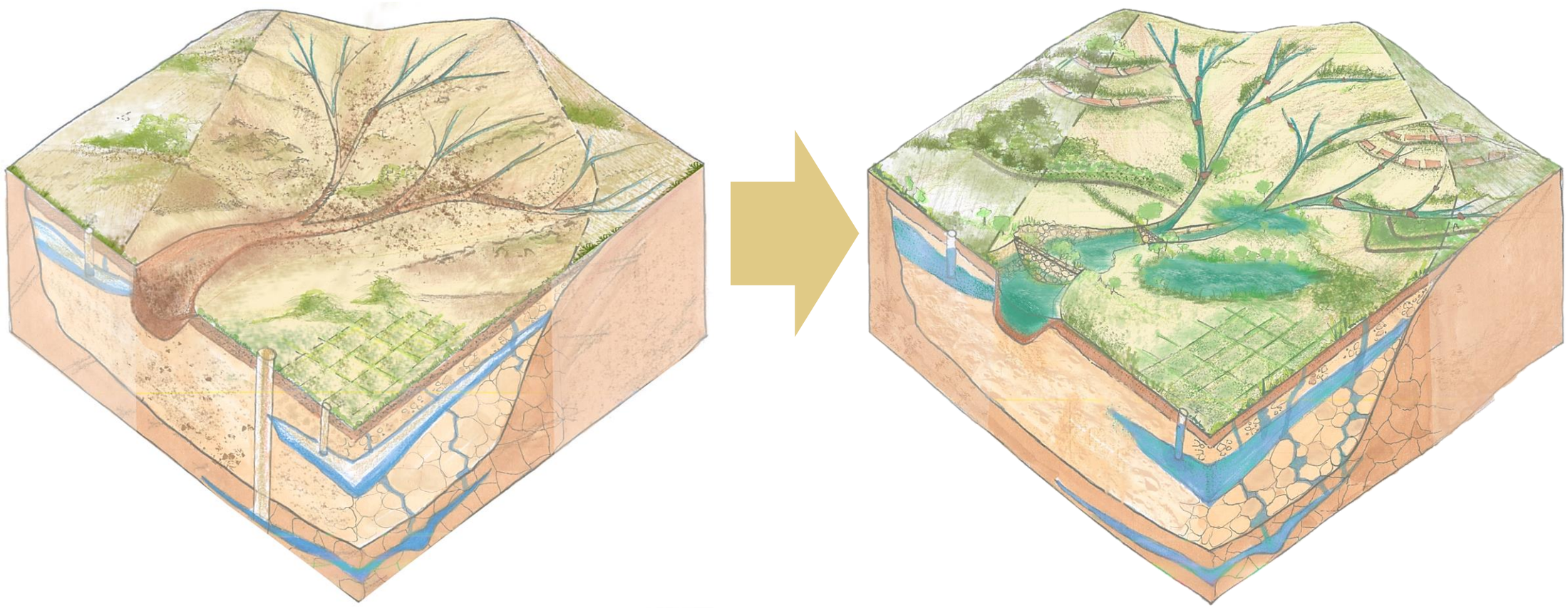
Crop failure and low yield due to climate change.

Drying wells due to lack of water conservation measures

Lack of vegetation cover and monoculture leads to depletion of surface and sub-surface water resource.

**Rural areas of Purulia are Extremely vulnerable to the water stress and drought severity due to climate change.**

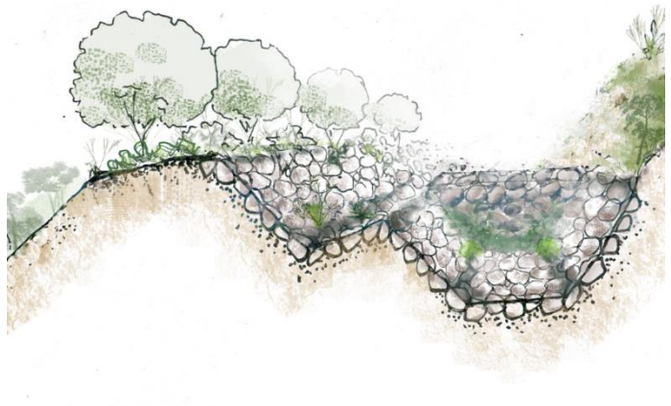
# DESIGN INTENT



The proposal work towards the larger **SOIL CONSERVATION AND LAND REGENERATION** of the Uma Nivas and its surrounding catchment integrated with a holistic **WATER MANAGEMENT** plan for the area.

It will seek to **RESTORE THE DEGRADED LANDSCAPE, REVIVE THE NATURAL SYSTEMS AND BUILD ECOLOGICAL RESILIENCE.**

# DESIGN PARAMETERS



## LAND

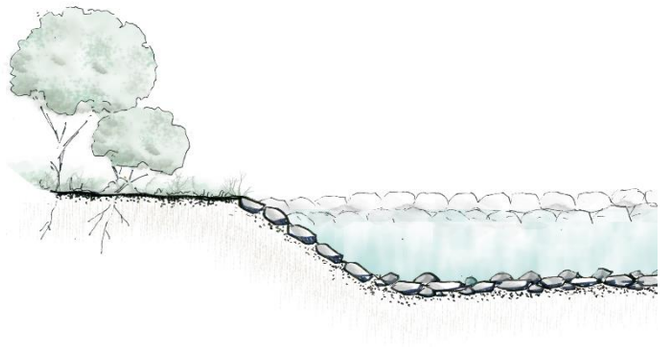
**Soil conservation**

**Soil Moisture retention**

**Nutrition management**

**Erosion control measures**

**Conserve top soil**



## WATER

**Watershed mapping**

**Integrated Roof, surface and ground water management**

**Water retention system**

**Increase water retention & groundwater infiltration**

**Reviving aquifers**

**Wetland habitats**

**Activate Open Dug wells as Primary source of water**

## VEGETATION

**Increased diversity and density of native vegetation cover**

**Develop seed banks, seed collection programs etc**

**In-house nursery**

**Increase Riparian zone**

**Manage grazing**

# SITE AND NEIGHBORHOOD ANALYSIS

The site and surrounding area adjacent to the property boundary was analysed in terms of terrain, vegetation and hydrology.

Terraced paddy cultivation in the primary stream

Medium dense woodland dominated by *palash*

*Bandhs* (embankments) as water retention structures

Active Open Well along the valley

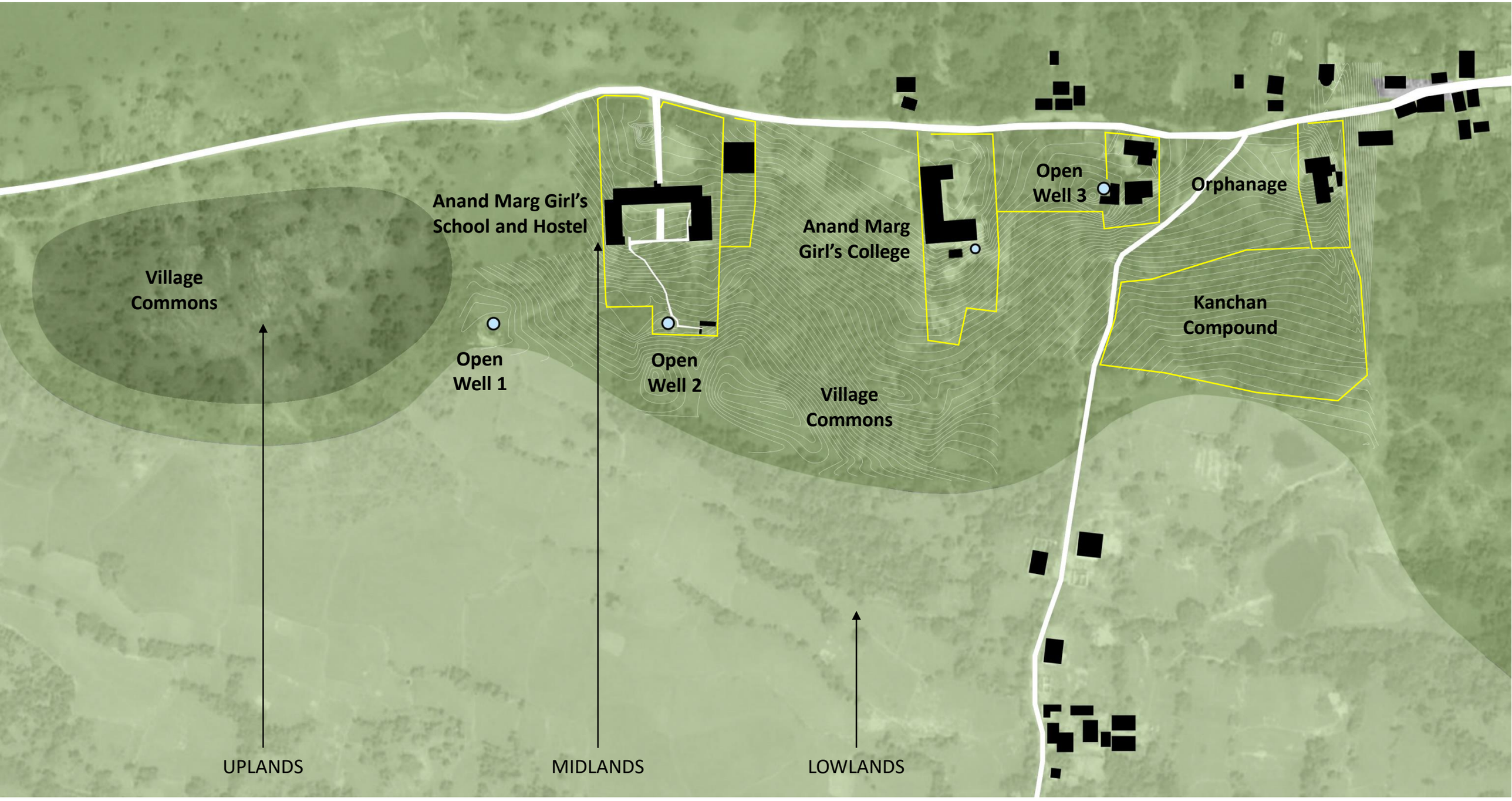
Low hillock with rocky out crop and thin soil cover

# CURRENT SCENARIO

The site area considered if around the Anand Marg Girl's School and Hostel and the Anand Marg Girl's College. It was categorised as Uplands, Midlands and Lowlands. A small mound is located to the west of the Anand Marg Girl's School and Hostel. The area is prone to sheet erosion of soil and heavy run-off water.

The paddy cultivated lands to the south the property is considered lowlands which receives all the run-off water.

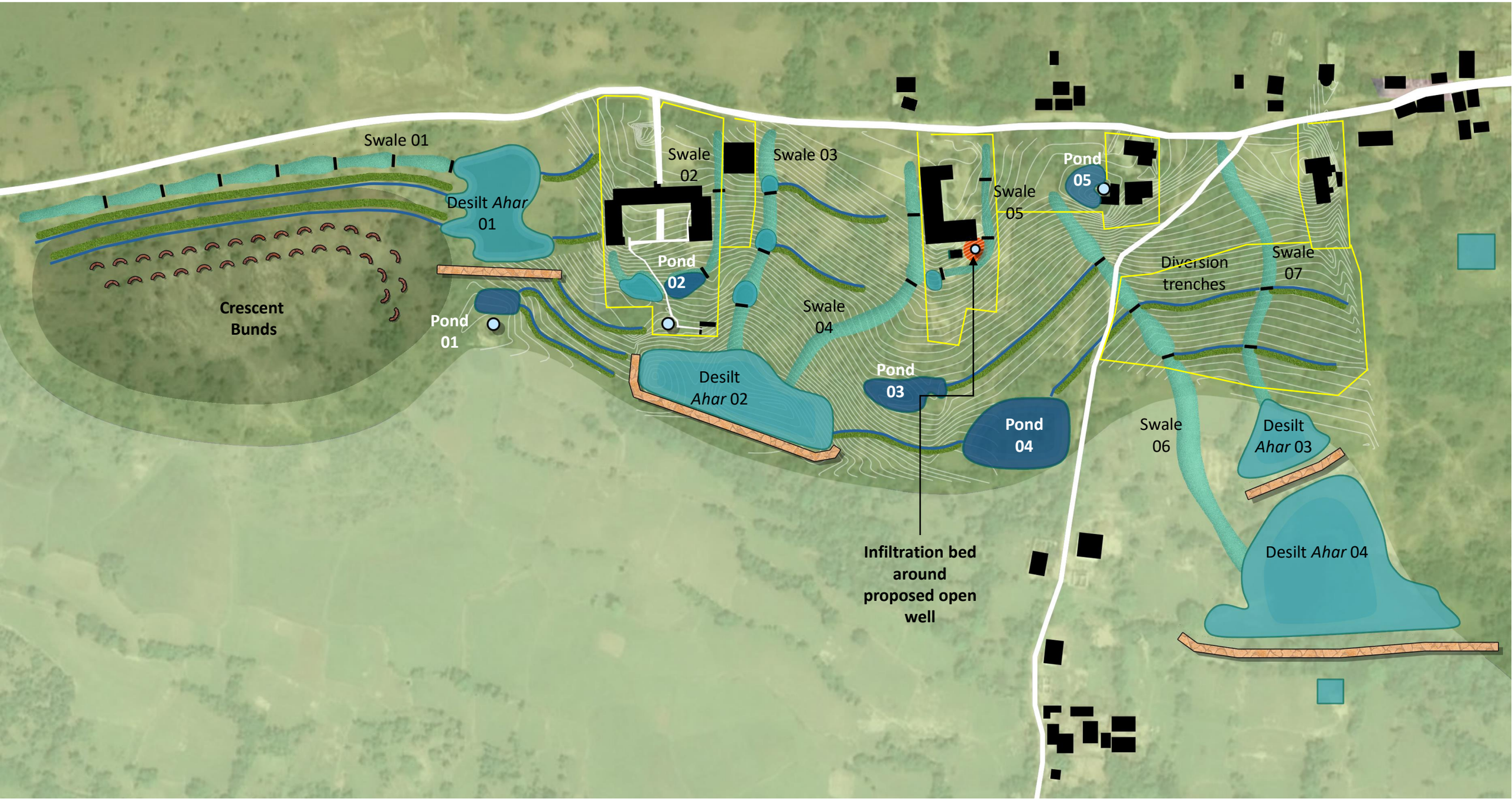
The rest of the terrain is categorised as midlands that gently slopes towards the paddy fields.



# PROPOSED SCENARIO

The proposals for the region have been derived based on the terrain and slope of the region. The intent was to capture the rain water that falls over the region and ensure that they are collected at specific points of the land for future consumption.

By using a combination of earthworks and passive strategies the percolation of rainwater into the ground is increased. Desilting and maintenance of old defunct ahars in the area is also recommended.

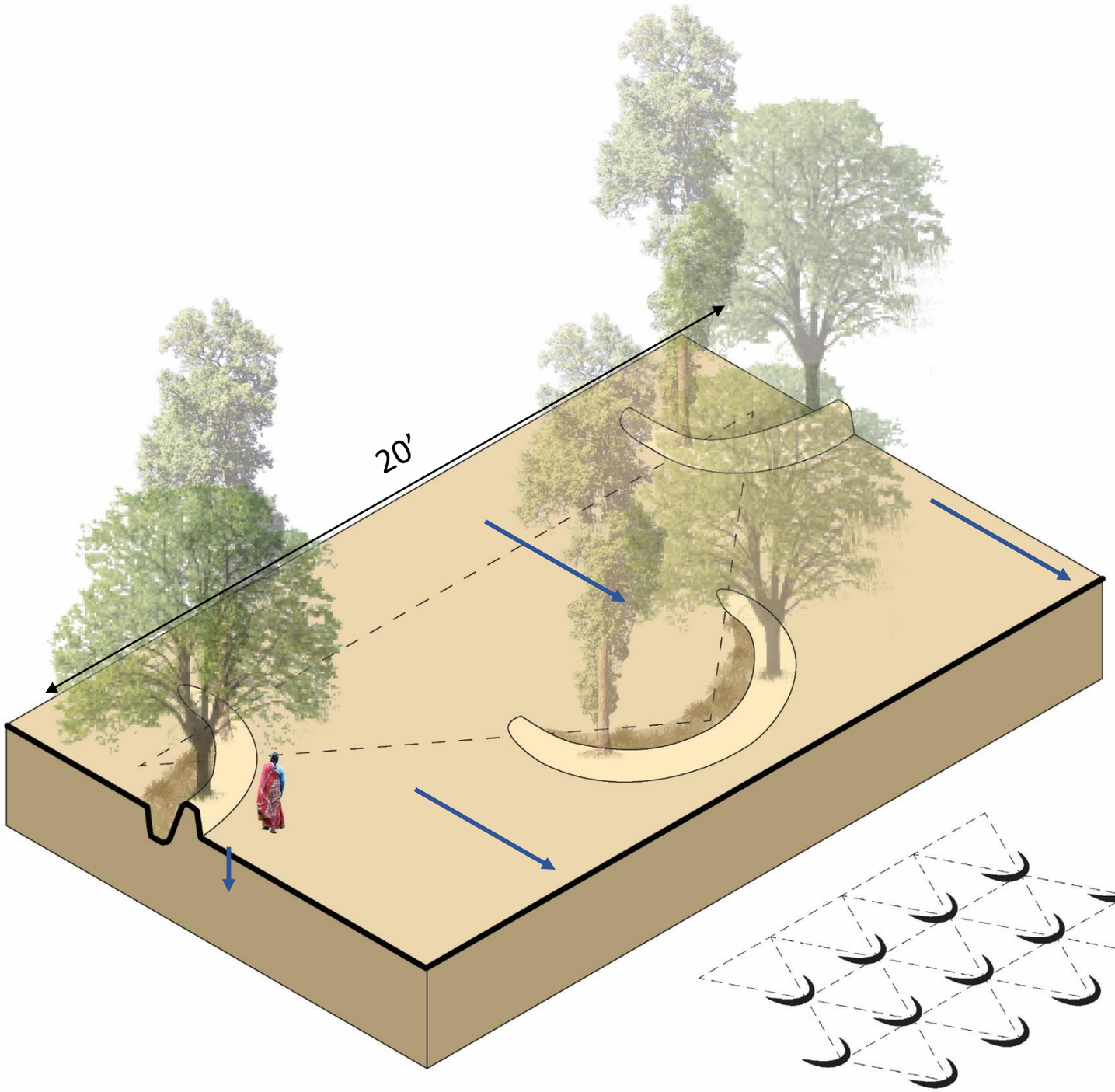


# INTENT & METHODOLOGY

The larger regional study was used to develop new systems that integrate the traditional knowledge systems with modern methods of construction. The stratgies suggested are as follows :

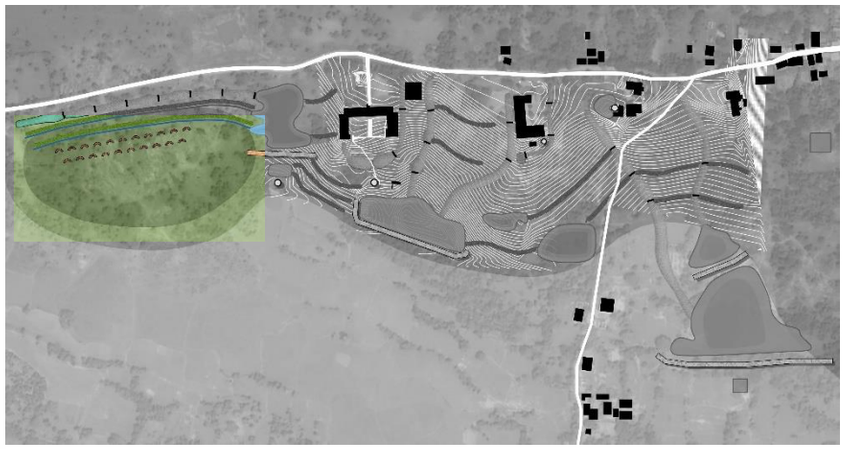
- **Desilting of old *ahars*-** There are four ahars with bandh (earthen embankments) that lie dry to the south of the Uma Niwas properties at present. They are located in the midlands and are to be desilted to an average depth of 3' and revived to collect and hold water in the future monsoons.
- **Swales with Gully Plugs-** This method is used to collect runoff from the surrounding land, allow it to percolate and channelize water in larger quantities from the diversion trenches to the retention ponds and revived *ahars.* The swales with the gully plugs also curb soil erosion from the rain fall. In the proposal 7 swales have been proposed over the catchment (Uma Niwas property and village commons) taking runoff in the south direction into the *Ahars* in the lowlands. The west of the Girls school along the road the Swale 01 will collect the water from the shallow hill and divert it to Ahar 01. Swale 02 will collect water within the compound of Girls school and hold it in seasonal pond 02 for infiltration. The two swales (03 & 04) are between the girls school and the College diverting water to Ahar 02. Swale 05 is to be developed within and along the eastern compound of the college. Swale 06 and 07 collect water from the area in and around the Orphanage and bring it to the Ahar 03 &04.
- **Retention Ponds-** New retention ponds have been proposed at specific locations mindful of the sub-surface flow of water and run-off. These ponds are located along the swales with widened profile and deeper section and the largest ponds are located where the swale ends. The edges of these ponds are to be pitched and stabilised to ensure a healthy riparian edge. These ponds will hold water only for few months and allow maximum ground water infiltration. In the dryer seasons the grass and other vegetation to be allowed to grow on them.
- **Dispersion Trenches-** These act as shallow canals that divert rainwater from the slopes to a network of swales and retention ponds in the lower levels. They can meander through the existing trees and carry the run-off water to existing water retention structures or new ponds at the lower elevations.
- **Crecsent Bunds-** These are bunds that hold water over gradually sloping lands and increase groundwater percolation on the higher elevation of the rocky hill slopes with shallow soil cover. These have been proposed over the small hill to the west of the Girls School.
- **Open Well recharge and filteration pits-** This is a simple method of ensuring that rainwater recharges the open wells/ Bore well and is also duly filtered before it enters the water table around the well. A new open well to be dug within the College precinct for which the local water diviner can give the location. The roof water can be collected and filtered through a horizontal passive filtaration system on ground using gravel beds and then allowed to recharge the existing/ proposed Open well and existing bore well.

# PROPOSALS- CRESCENT BUNDING






Key plan indicating layout for the bunds

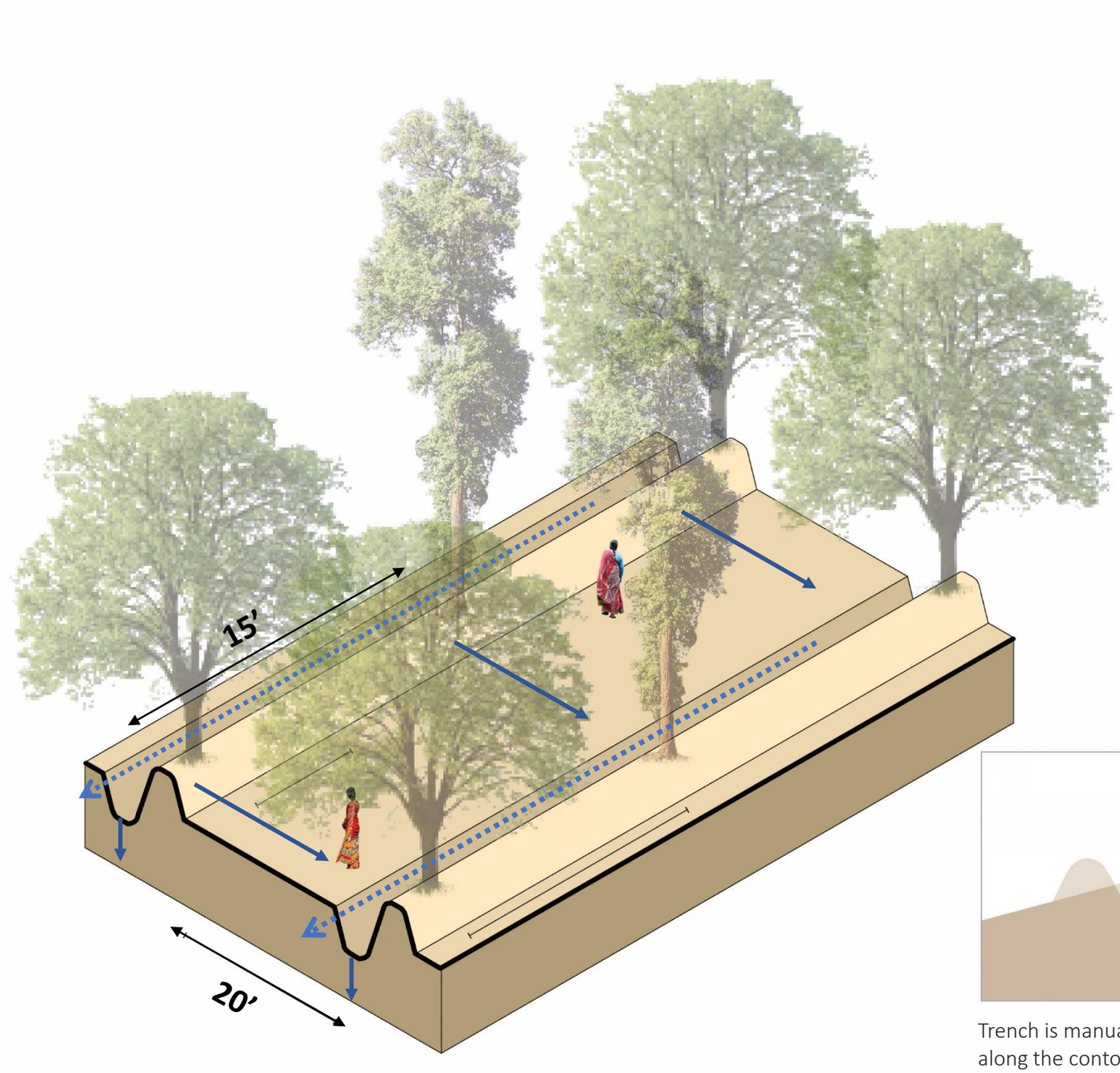


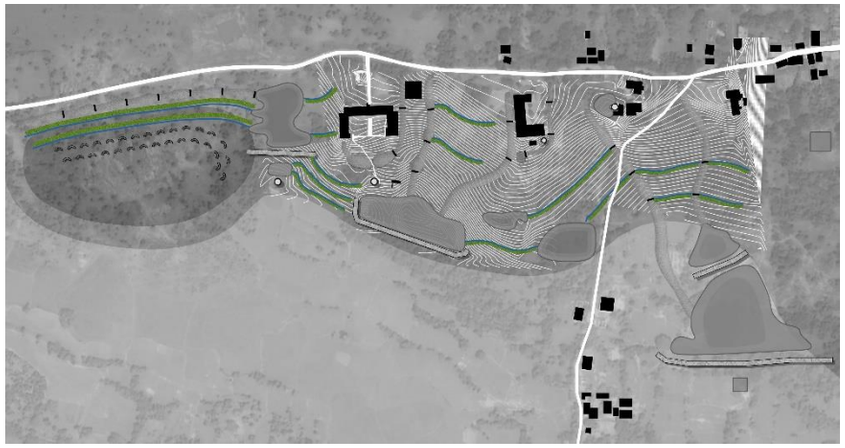
These bunds are to be developed manually on the highlands slopes to mitigate sheet erosion of soil and promote ground water percolation.

Crescent shaped bunds are dug into the ground in the direction of the flow of water. The bunds are planted with native tree saplings.

These bunds can span roughly 10-12' across and can be dug at a distance of 20' from eachother.

# PROPOSALS- DIVERSION TRENCHES



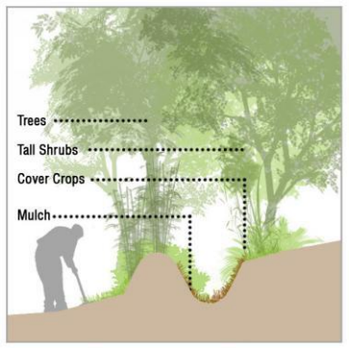
These structures are shallow trenches that are dug 1.5'-2' deep. They are dug along the contour and the dug earth is used to create bunds (also roughly 2' high) along the trench. The invert level of the trench slowly drops towards the water retention structure.

They help collect the run-off water from the sloping terrain and divert them to designated water retention structures like *ahars* and ponds. They also help curb soil erosion and increase soil moisture by reducing the runoff velocity.



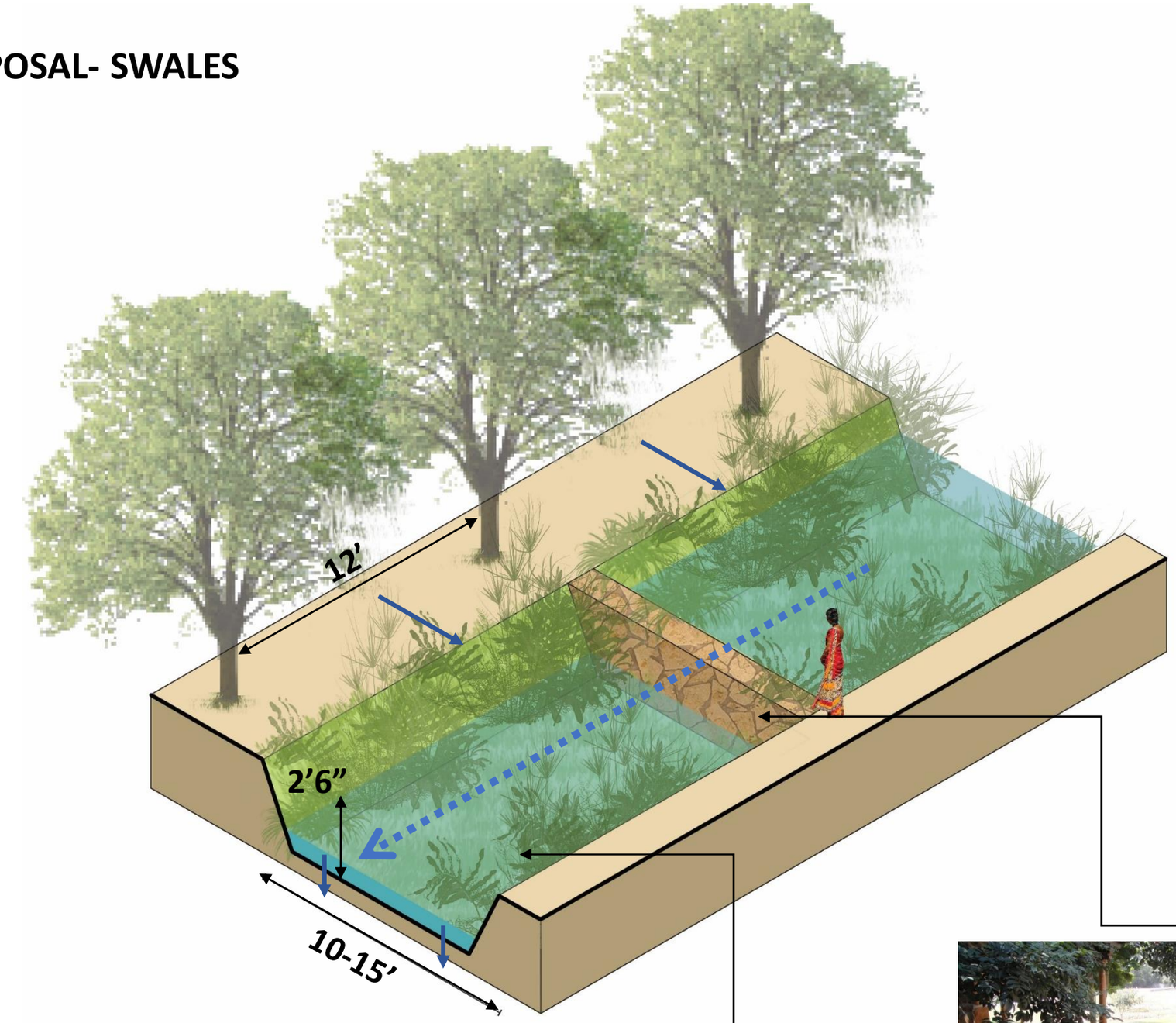
Trench is manually dug along the contour with trench bottom sloping gradually towards the desired direction.

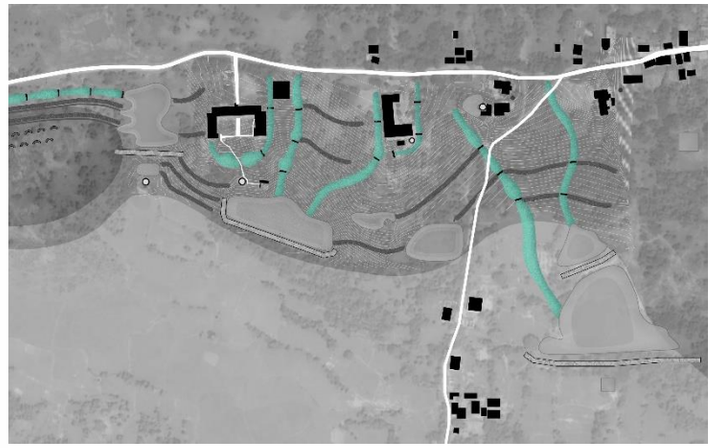
The excavated soil is used to make the bund downstream side of the trench.




The stabilised bund to be planted with native trees saplings and mulched with leaf litter.

# PROPOSAL- SWALES



The swales are 10' wide and 2'-2.5' deep. They are dug along the low laying area and the slopes are treated with dry tone pitching.

These passive system help collect the run-off water from the surroundings and divert them to designated retention structure.

Along the swale high density and diversity of native trees to be planted.

Swale treated with dry stone pitching.

Gully plugs

# PROPOSAL- GULLY PLUG (ACROSS SWALES)

Extent of Gully plug wall marked across swale

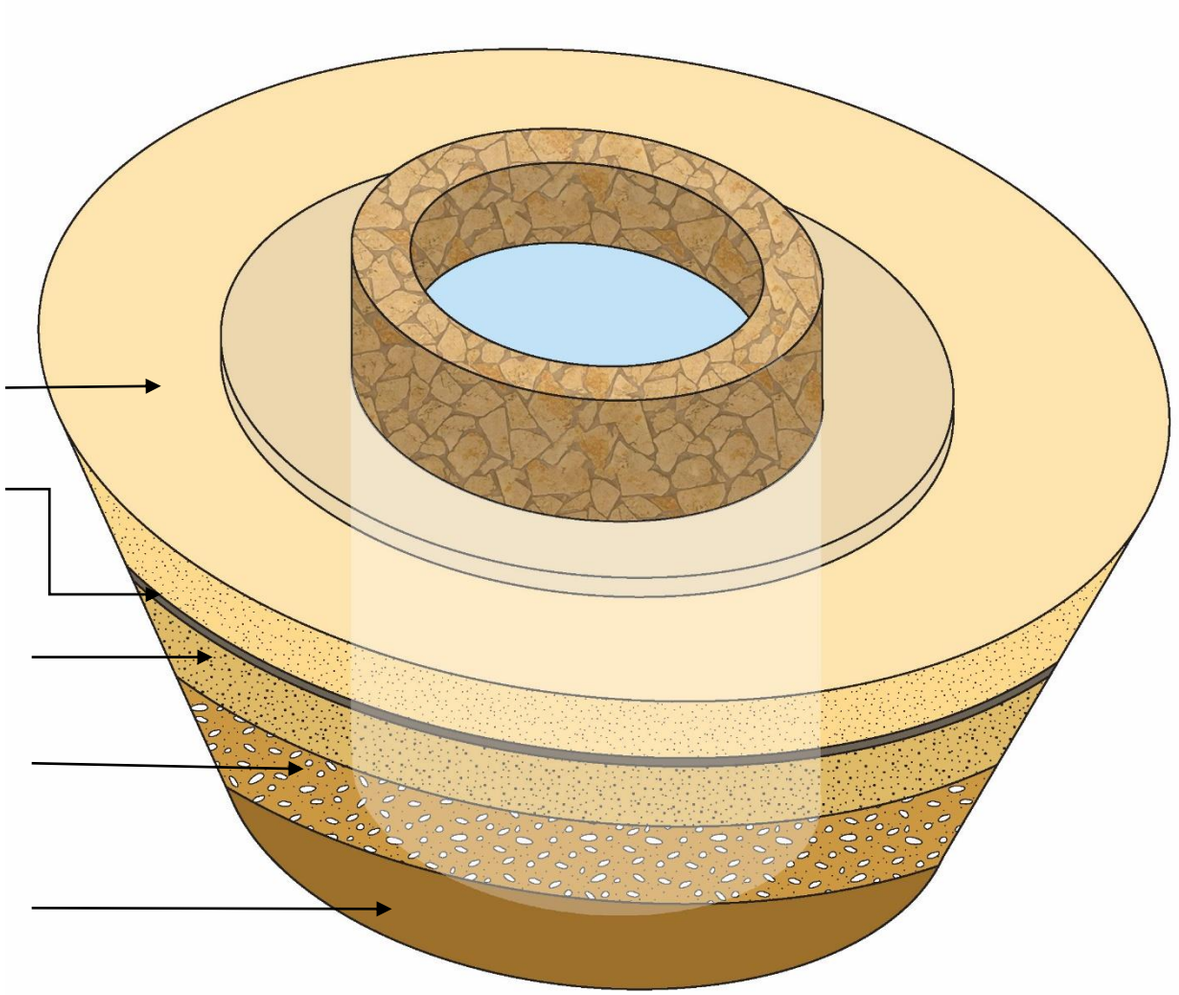
Placing mortar less rocks along the lines marked

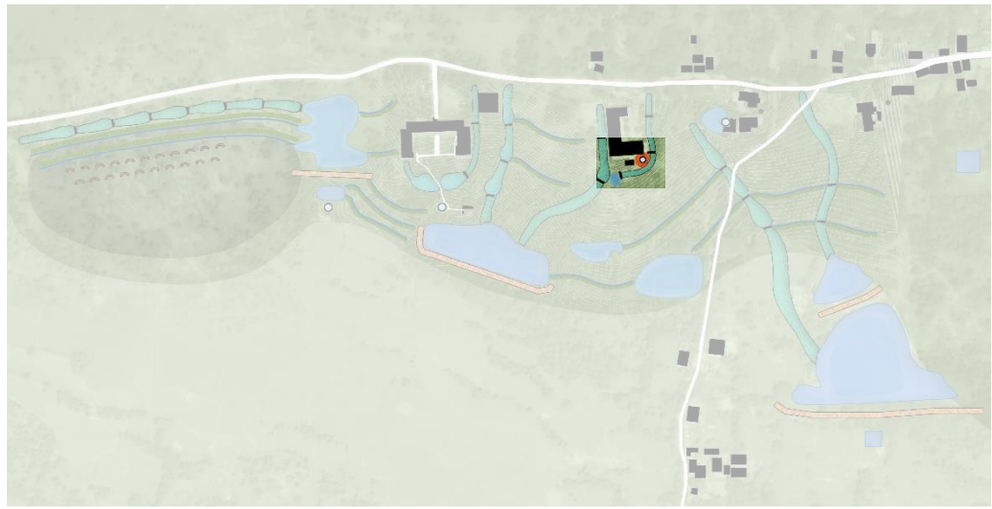
Dry Stone masonry centre to be at least 6” lower than the outer edges

Typical *Gully Plug* view

# PROPOSAL- GULLY PLUG (ACROSS SWALES)

# PROPOSALS- OPEN WELL RECHARGE SYSTEM



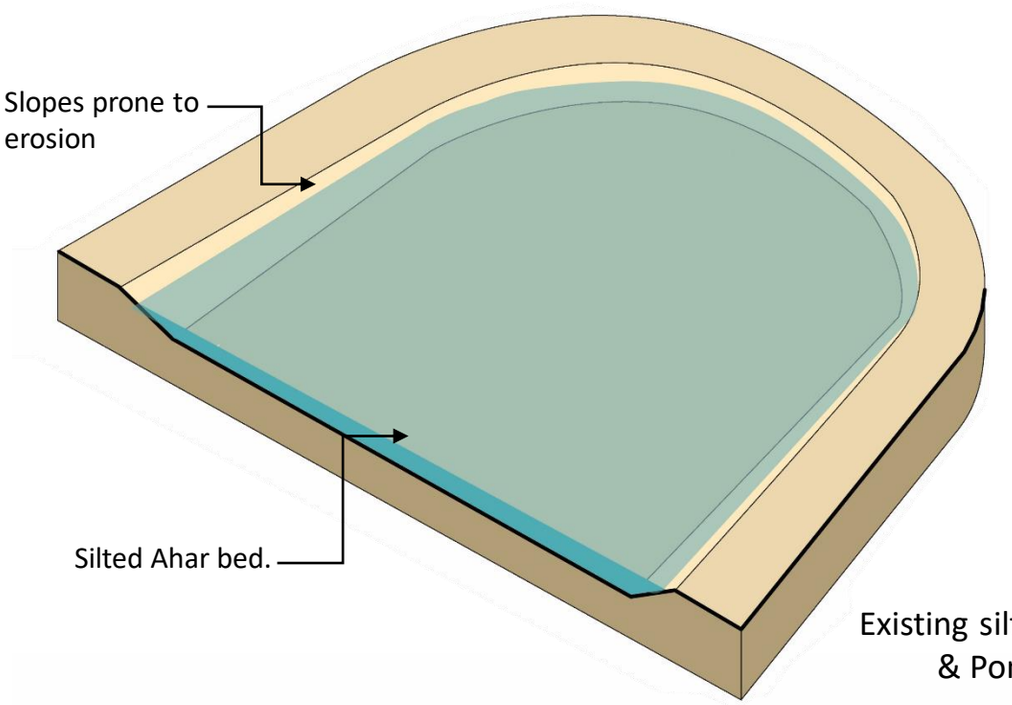



Infiltration beds around the existing open wells can ensure ample recharge of rainwater into the open well.
The roof water, paved surface runoff/ pond/ swale water can be diverted here.
It also helps improve the quality of water that percolates into the ground and increases the soil water storage capacity.

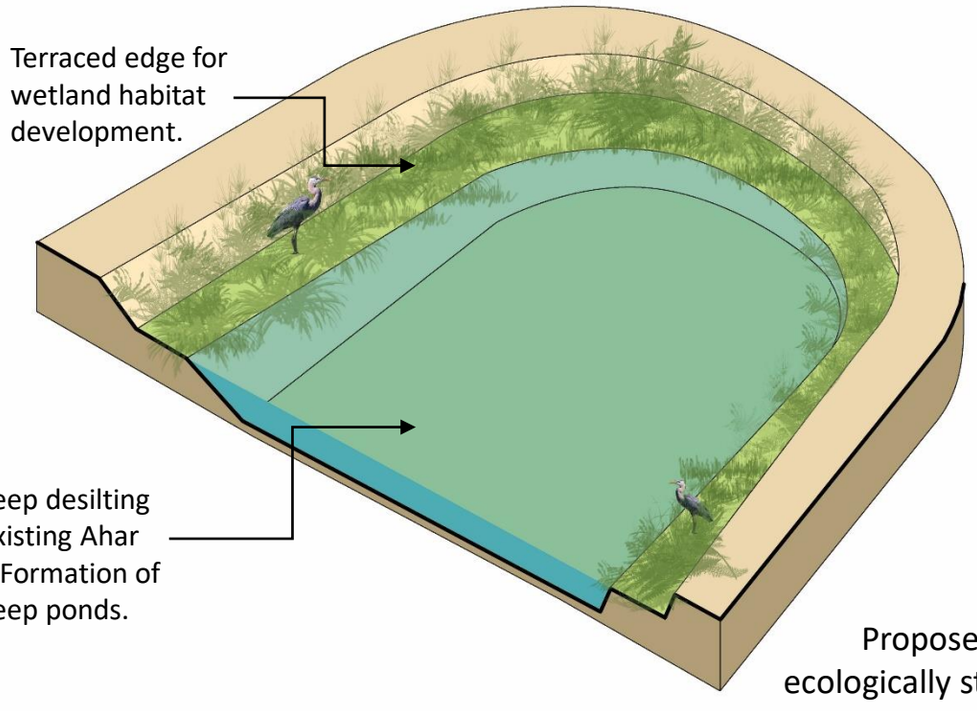
This can be constructed by :

- Water diviner to be employed to identify location of new open well. (Please note- This location may vary from that indicated in the key plan above.)
- Open well to be dug and linked with the roof water management system.
- Dig a 5-6’ hole around the open well.
- The hole is to be layered with 1’ of aggregate of 2.5” in down size.
- This is to be followed by a layer 1’ of aggregate of 1.5” in down size.
- Another 1’ thick layer of aggregate of 1” to be added and a 2” layer of charcoal is added to help further purify the percolating water of any other impurities.
- Finally a layer of river sand and fine aggregate is added and covered with paving materials like stone or paver blocks.

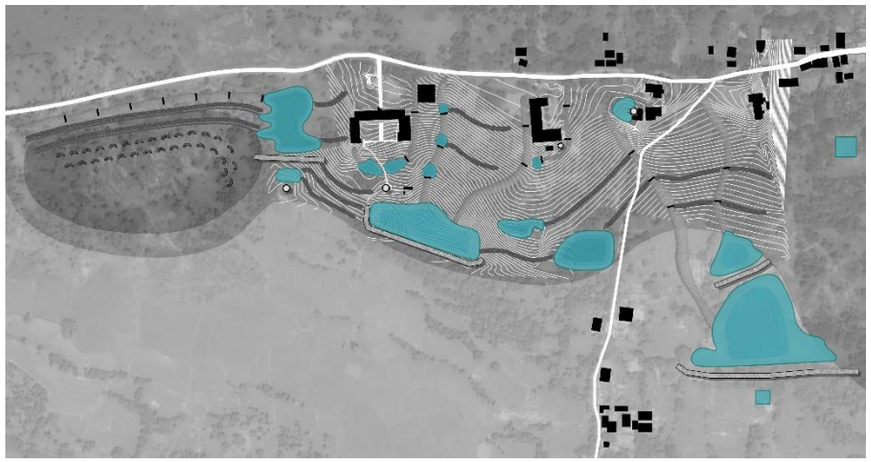
# PROPOSALS- AHAR & SEASONAL DETENTION POND




Existing silted Ahar & Ponds




Proposed Desilted and ecologically stable wetland edges



The Existing Ahar & ponds at present are heavily silted due to heavy soil erosion.

The proposals recommends that the following measures be implemented around these ponds :

- Firstly, desilting of the existing Ahar/ ponds to be done to increase the depth of the ponds and their water holding capacity.
- A stepped edge is to be formed and stabilised to create a wetland habitat for increased biodiversity and reduce evaporation losses.
- The edge is to be stabilised and treated with high density and diversity of native trees.

# PROPOSALS- SEASONAL DETENTION POND

Pond slope edges stabilised with dry stone pitching and grass infill

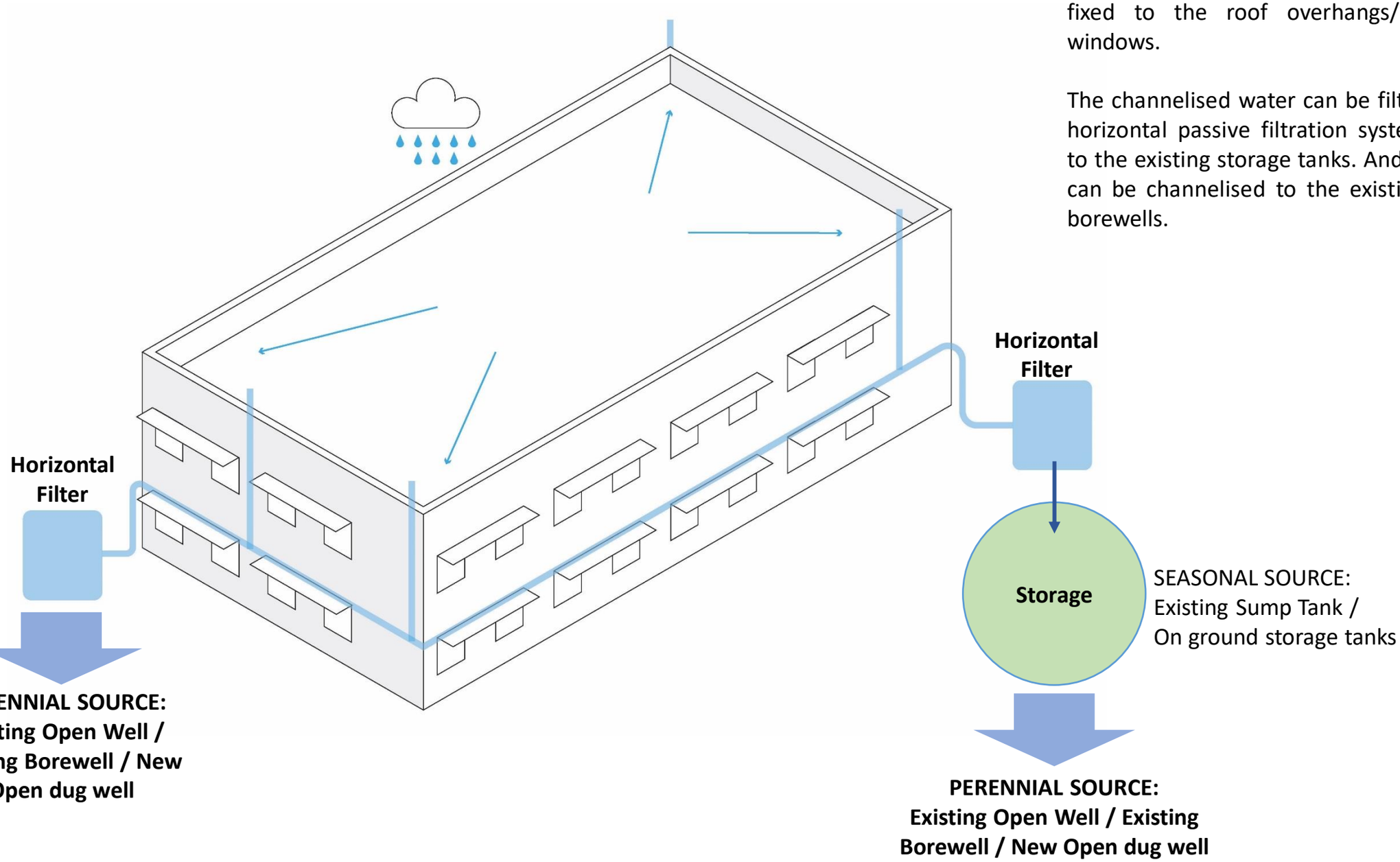
Pond profile will meander around and integrate the existing trees

# PROPOSALS- DESILTING AHAR

Silted and dried up lake bed

Initiating manual de-silting activity after examining the silt quality and depth

# PROPOSALS- ROOF WATER MANAGEMENT




The proposed system serves to capture the rainfall that reaches the roof of the building and recharge the groundwater reserves.

Rainwater from the roof can be directed to select down-take pipes and collected at the intermediate level of the building though a network of pipes fixed to the roof overhangs/ chajjas of the windows.

The channelised water can be filtered through the horizontal passive filtration systems and directed to the existing storage tanks. And the excess water can be channelised to the existing open wells or borewells.

# OUTCOMES

**Swales and seasonal streams**

Before the watershed restoration the ground was devoid of undergrowth as compared to the post restoration work. This is due to increased soil moisture and nutrient availability, which accelerates the natural process of ecological recovery.


# OUTCOMES

**Existing Well**

The well was dry from a decade before the watershed intervention was initiated. The ground water level in and around the school was very low because of the high extraction rate.


# OUTCOMES

**Existing Lake**

Completely dry lake bed before the monsoons, when the gully plugs and other erosion control measures were taken up along with the de-silting of the lake bed.

The de-silitng was required because during the years due continuous erosion from up stream the bed was completely silted.


# OUTCOMES


# OUTCOMES

# OUTCOMES

**Indicators of healthy habitat-** The geo-botanical, hydrological, avifaunal diversity and microclimatic indicators, are the clear signs of environmental and ecological development of the campus. Following are such indicators that have been observed within the campus:

1. Tall & multi layered Canopy cover
2. High soil moisture availability
3. High water level in the Open well
4. Water security for the community
5. Higher crop yield
6. Diversity of insects, reptiles & small mammals
7. High diversity of Flora
8. Very high diversity of Avifauna (246 species)
9. Symbiotic plant groupings


UMA NIWAS
Water Management Strategies

INDÉ
INTEGRATED
DESIGN

# BLOCK ESTIMATES

| Estimate for Passive water management work, Uma nivas, Purulia | | | | | |
|---|---|---|---|---|---|
| Landscape Consultant: Integrated Design | | | | 07-04-2022 | |
| **Sr.No** | **Description** | **Unit** | **Quantity** | **Rate in Rs.** | **Amount in Rs.** |
| | | | | | |
| 1 | **RESERVOIR** | | | | |
| A | **Desilting (Depth of 3')** | Cu.M | 4,932.00 | 180.00 | 8,87,760.00 |
| B | **Formation work and slope stabilising** | sqm. | 1,700.00 | 110.00 | 1,87,000.00 |
| | | | | | |
| 2 | **SWALE** | | | | |
| A | **Earth work (Depth of 2'6")** | Cu.M | 2,295.00 | 80.00 | 1,83,600.00 |
| B | **Dry Stone Pitching** on slopes with local stone | Cu.M | 206.55 | 2,000.00 | 4,13,100.00 |
| | | | | | |
| 3 | **DETENTION PONDS/ WETLANDS** | | | | |
| A | **Earth work (Depth of 3')** | Cu.M | 680.40 | 180.00 | 1,22,472.00 |
| B | **Formation work and slope stabilising** | sqm. | 756.00 | 60.00 | 45,360.00 |
| C | **Dry Stone Pitching** on slopes with local stone | Cu.M | 204.12 | 2,000.00 | 4,08,240.00 |
| | | | | | |
| 4 | **GULLY PLUG** | | | | |
| A | Loose boulder wall of 7m length (avarage), maximum height of 1m, upstream and downstream slopes 1:1 and 3:1 and top width of 0.5m | no. | 21.00 | 4,000.00 | 84,000.00 |
| | | | | | |
| 5 | **DIVERSION TRENCHES & BUNDS** | | | | |
| A | Excavation and Formation | m | 1197 | 20 | 23,940.00 |
| | | | | | |
| 6 | **OPEN WELL RECHARGE SYSTEM** | | | | |
| A | Infiltration beds around the existing open wells | Lumsum | 1 | 80000 | 80,000.00 |
| B | New open well development | Lumsum | 1 | 120000 | 1,20,000.00 |
| | | | | | |
| 7 | **ROOF WATER MANAGEMENT SYSTEM** | | | | |
| A | Roof rainwater harvesting and recharge system | Lumsum | 1 | 100000 | 1,00,000.00 |
| | TOTAL | | | | **25,55,472.00** |