Site Development: Designing with Terrain

Balancing Cost, Access, and Experience on Complex Topography

Projects:

- Favorich Mega Food Park, Karnataka
- Tranquil Peak Resort, Kerala

Scope:

- Site analysis, grading strategy, access planning, infrastructure coordination

Approach:

- Terrain-driven design processes
- Prioritising natural landforms
- Cost optimisation through minimal earthwork
- User accessibility across elevation changes.

Introduction

How do you develop sites on challenging terrain while balancing construction costs, user accessibility, and site character?

Two projects- an industrial food park and a hillside resort required fundamentally different approaches to the same core problem: **making challenging topography work for human activity.**

The terrain analysis became the primary design driver. Despite serving completely different users and programs, both required systematic processes to turn topographic complexity into functional, cost-effective solutions.

Favorich Mega Food Park needed to deliver level, accessible industrial plots while minimising earthwork costs. ***Tranquil Peak Resort*** needed to create intimate guest experiences on steep slopes while maintaining universal accessibility.

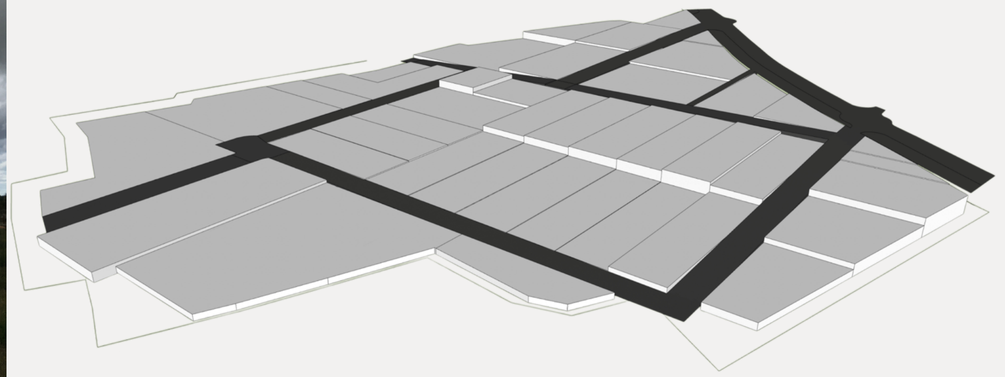
Project 1

Favorich Mega Food Park, Karnataka, India

60 Acres | Industrial Site Development | Built

The Problem

Favorich with their 275-acre industrial food park in Karnataka had begun developing a 60-acre parcel in Phase 1. The site exhibits significant level variation, with a pronounced high point toward the north-east and multiple low points toward the south-west and south-east edges.



EXISTING LAYOUT

Initial infrastructure works had begun before a comprehensive grading strategy was established, resulting in:

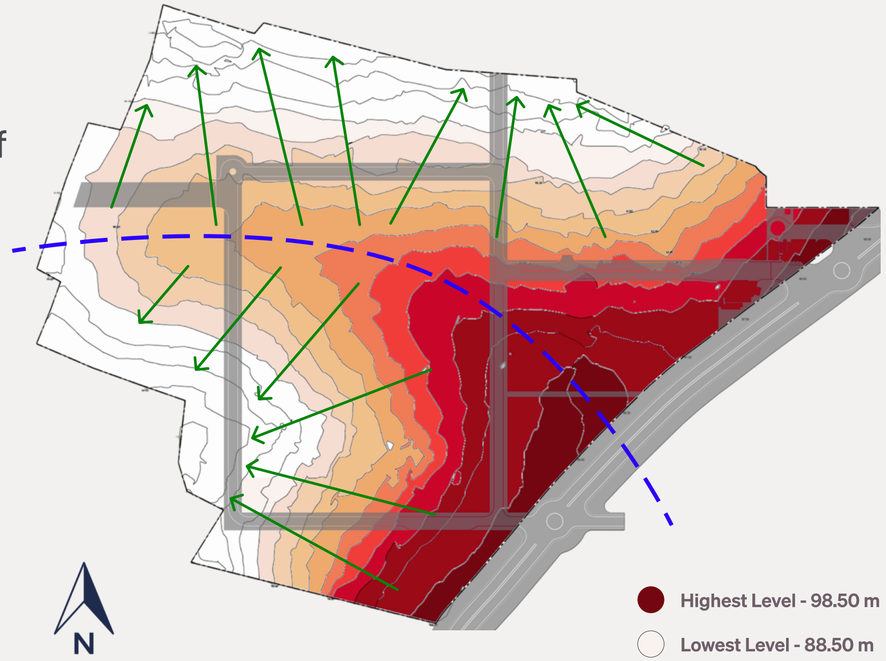
- **Inaccessible plots:** Level differences between road & multiple plots made access impossible.
- **Undefined retention:** No clear system for managing soil between adjacent sites with level differences of up to 10.0m
- **Stormwater Management:** Gravity-flow sewage lines weren't feasible for large portions of the site.

Terrain Analysis

A detailed contour study across 60-acres of phase 1 change was carried out to identify:

- Natural movement of water across the site to map drainage patterns
- Areas suitable for collection and harvesting of rain water
- Existing infrastructure worth retaining
- Problem zones with excessive level differences

This analysis made it clear that flattening the site uniformly would increase earthwork volumes, construction cost, and long-term drainage risk.



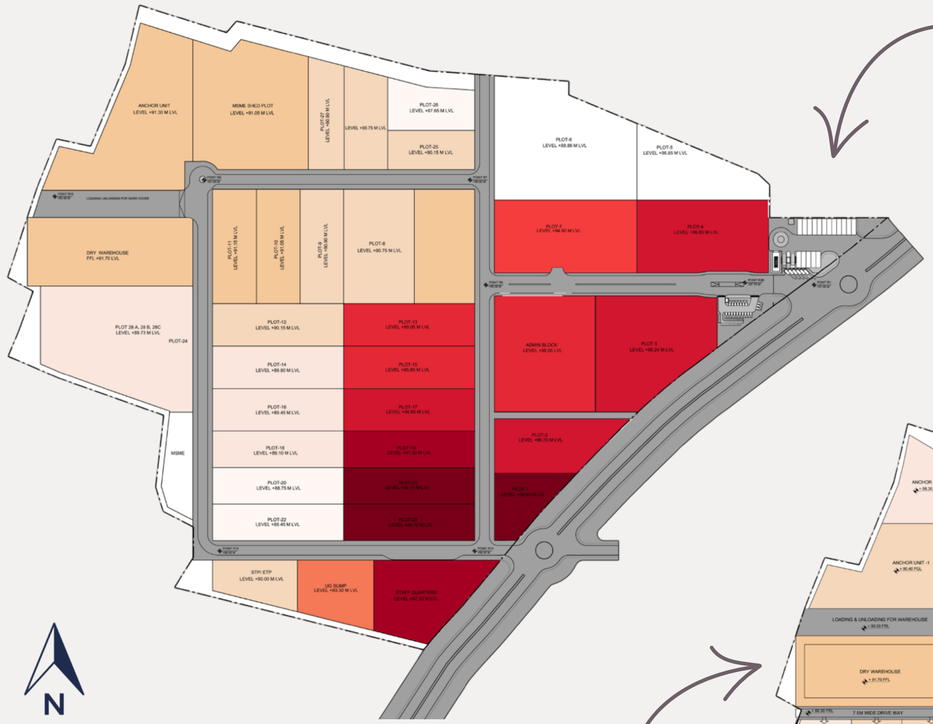
Design Objectives

Established measurable, client-validated goals:

- All plots are flat and 0.30 m above adjacent road level to prevent flooding and ensures drainage.
- Retaining walls are used only where elevation difference exceeds 1.50 m for cost control.
- Stone-pitched embankments of 1:1 slope are used where space permits, between plot edge and site boundary.
- Existing roads and drains are retained wherever feasible to reduce waste.
- Factor cost of saleable land used for infrastructure into total project cost (holistic economics)

Grading Strategies

The cost of the existing layout formed the benchmark for evaluating alternative strategies. Three distinct grading and layout options were generated, each with complete BOQ breaking down costs across earthwork, retaining structures, roads, and land consumption.

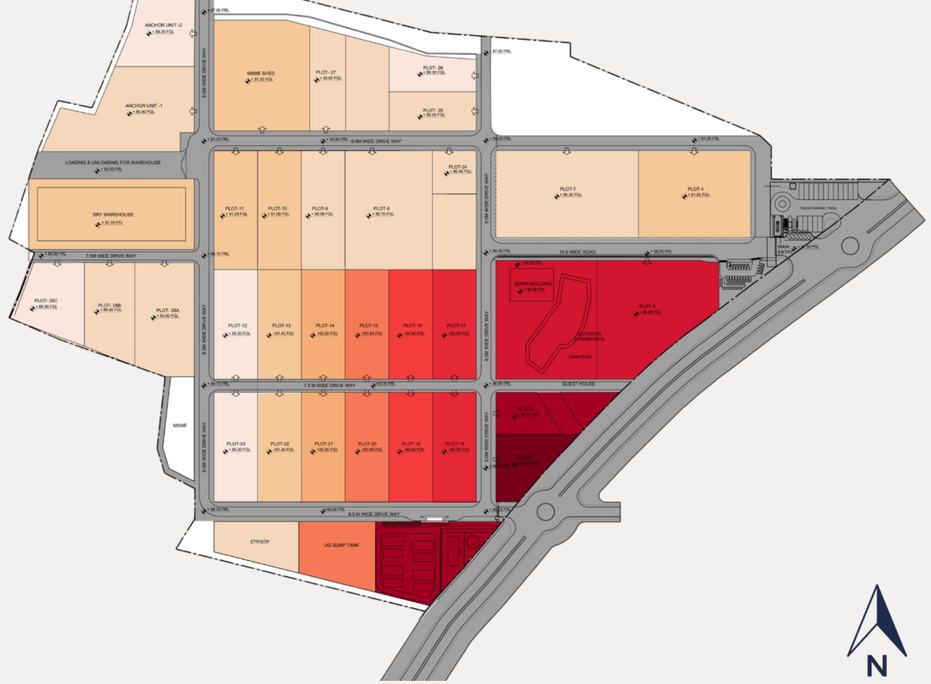


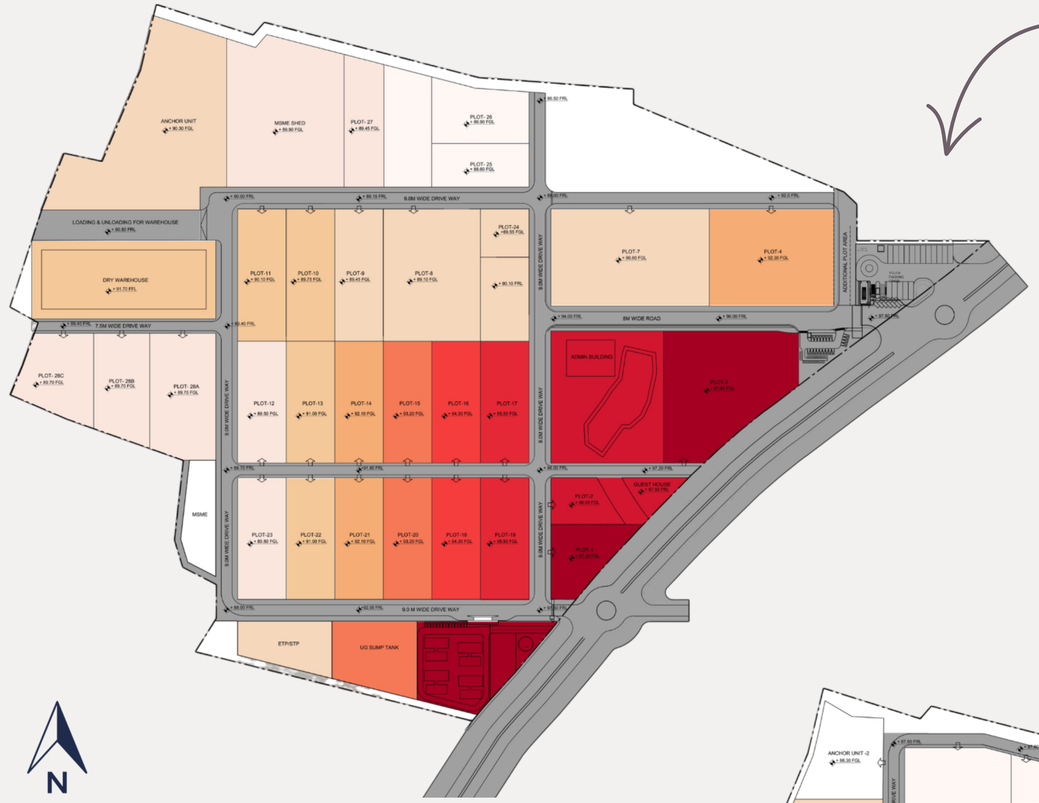
Existing Layout (Baseline: ₹14.90M)

- Original problematic layout with irregular terracing and extreme elevation jumps (+88.5m to +98.5m)
- Multiple plots requiring excessive retaining walls
- Poor accessibility and undefined retention systems

Option 1 (₹13.10M; -12% vs. Existing)

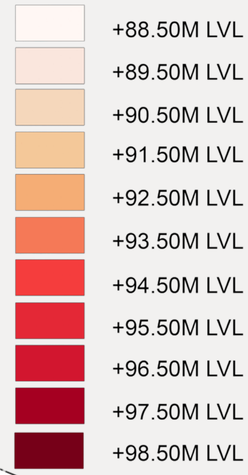
- Modified road alignment following mid-slope contours
- More regularised grid with smoother elevation transitions
- Still required 684 running meters of retaining walls up to 10.5m height

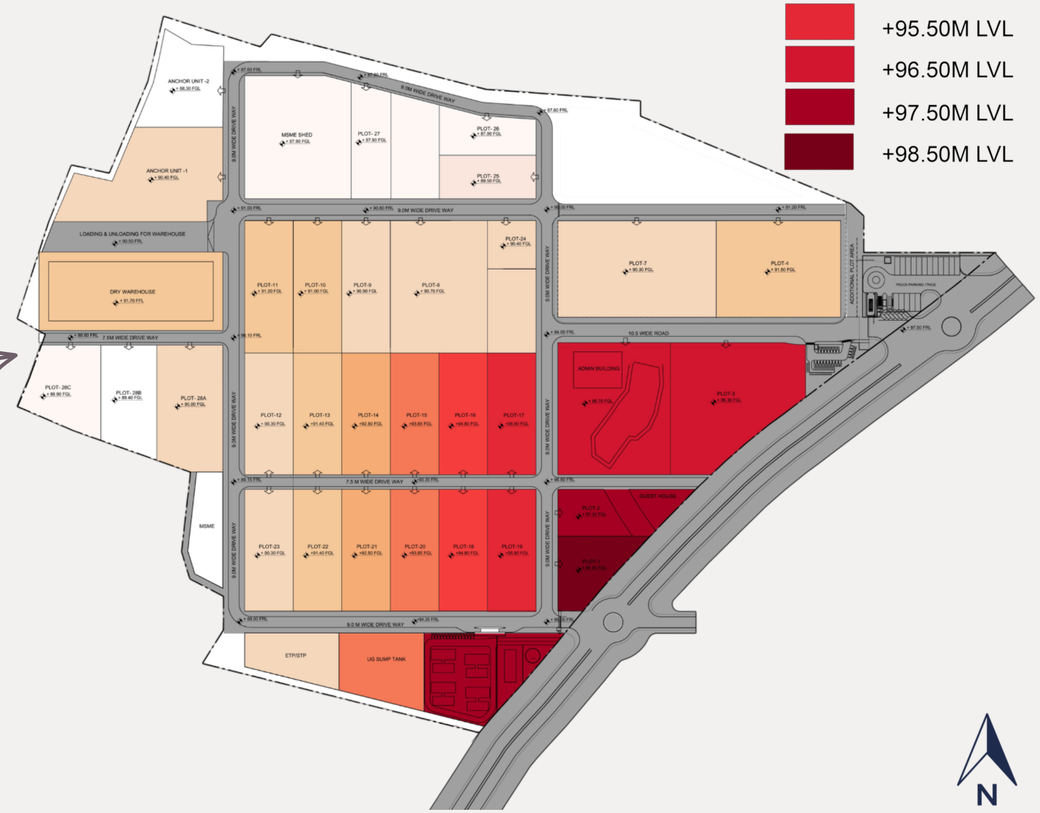




Option 2 (₹12.40M; -17% vs. Existing)

- Terrain-responsive grading minimising cut-and-fill
- Roads follow natural contours creating gradual terracing
- Smoothest colour transitions indicate minimal earthwork intervention





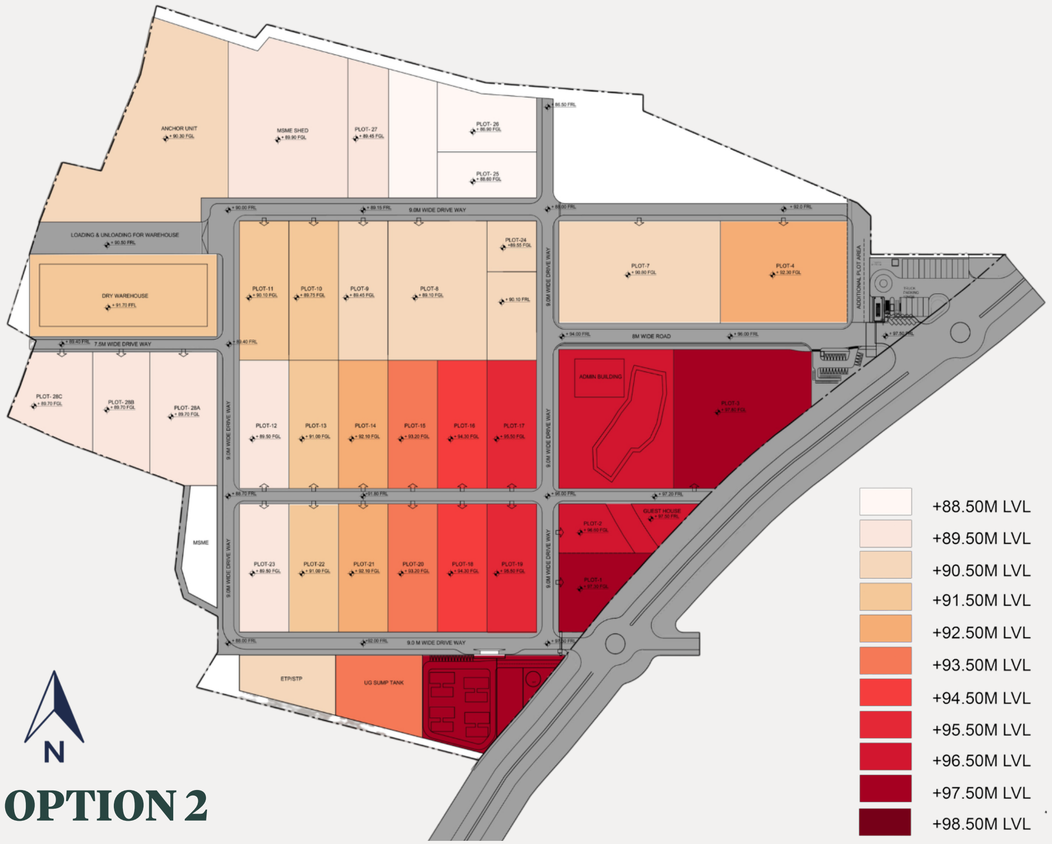
Option 3 (₹13.60M; -09% vs. Existing)

- Alternative retention strategy with more retaining walls
- Similar plot reorganisation to Option 2
- Higher retaining wall costs offset other savings

The Solution

Option 2 delivered the best overall economics, despite requiring the most new road construction (more than double other options).

- **Balanced cut-fill:** Minimal brought-out earth reduced material costs and disposal complexity
- **Modest retaining walls:** Only 289 running meters at manageable 2-5m heights
- **Terrain-responsive logic:** Roads followed mid-slope contours, creating natural terracing
- **Moderate land consumption:** 1.59 acres to infrastructure—middle of range
- **Superior drainage:** New alignment worked with natural ridge-to-valley flow



OPTION 2

Smooth colour gradients indicate fewer abrupt elevation transitions implying gradual changes and less dramatic earthwork. The layout solved accessibility and drainage problems that made the existing layout non-functional.

The best option isn't always the cheapest; it's the one that solves the core problems while delivering the best value.

Infrastructure Strategies

Road Network (5.7% of site):

- 18m wide Main Ring Road - was designed to carry the heavy traffic.
- 12m wide internal roads - provided access to individual plots.
- Standard road sections - 7.5m carriageway + 3.5m drainage + retaining walls.
- Green belt (10m width) - planted along perimeter roads with shoulder for utilities.

Plot Grading System:

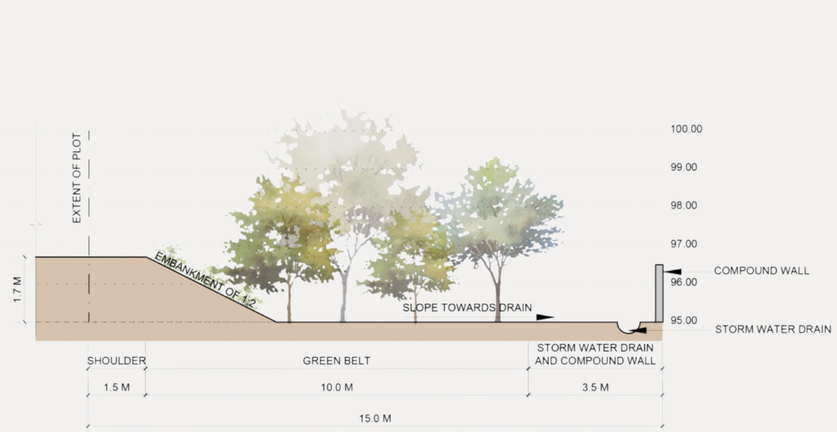
- Terraced plots followed the terrain levels and had defined levels.
- Each plot graded 300mm above adjacent road for positive drainage.
- Retaining walls were provided between plots where elevation changes exceeded 1.50 Meters.
- Stone-pitched embankments (1:1 slope) were provided where space permitted.

Drainage & Water Management:

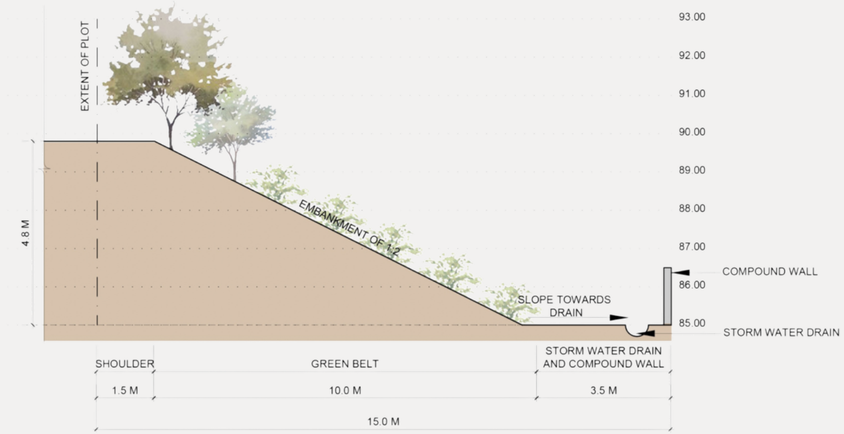
- Gravity-flow storm water system was designed following natural valleys and ridges.
- Compound walls were integrated with storm water drains at site perimeter.
- Rainwater harvesting tanks were positioned at strategic valley convergence points.
- The system captured runoff from entire 60-acre phase for reuse.

Embankment Cross- sections

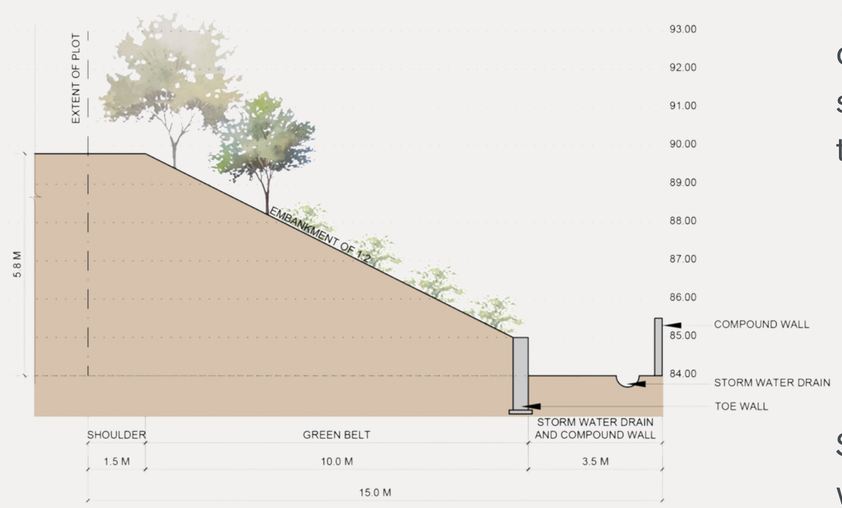
Three standardised cross-sections were developed to address varying terrain conditions across the site:



Section AA (Moderate Slope)



Section BB (Steeper Terrain)



Section CC (Maximum Grade)

The embankments respond to terrain: gentle level differences required smaller embankments and areas with steep level difference of above 5.0m, required a concrete toe wall with the embankments.

- 1.5m wide shoulder was provided for running utilities.
- 10m green belt offered visual buffer & erosion control
- 3.5m drainage zone with compound wall and storm water drain at the bottom handled water runoff.

Stone pitching at 1:1 slope replaced expensive retaining walls where space permitted, reducing costs while maintaining stability.

The Outcome

Quantifiable Results:

- **17% cost reduction** from existing layout (₹2.5M savings in Phase 1)
- **100% plot accessibility:** every site has proper vehicular approach
- **5.7% land for roads**: roughly half the typical 10-12% allocation for industrial parks
- **Clear drainage logic:** defined stormwater system working with terrain

Process Value:

- Cost analysis validated design choices, the numbers proved terrain-responsive approach was both better functionally and economically.
- Multiple costed options gave client clear comparison basis.
- Detailed BOQ enabled accurate budgeting and contractor selection.

Technical Deliverables:

- Detailed master plan showing all plot boundaries, roads, and services.
- Cross-sections through roads showing grading, embankments, and drainage.
- Quantification of all earthwork: cut, fill, retaining structures, embankments.
- Bill of Quantities with technical specifications for all civil work.

Project 2

Tranquil Peak Resort, Paithalmala, Kerala

8 Acres | Hospitality Site Planning | In Progress

The Problem

Tranquil Peak Resort is located on a 8-acre steep hillside in Paithalmala, with an elevation difference of approximately 75 meters across the site. Two natural valleys with seasonal streams cut through the terrain, rendering large portions unsuitable for construction.

Requirements

A boutique resort with:

- 8-10 accommodation units serving diverse guest types
- Main facilities: reception, dining, kitchen, spa, gym, pool
- Staff accommodation and utilities

User Needs

Privacy: Seclusion from other units

Views: Panoramic views on south and west

Connection to nature: Immersive hillside experience

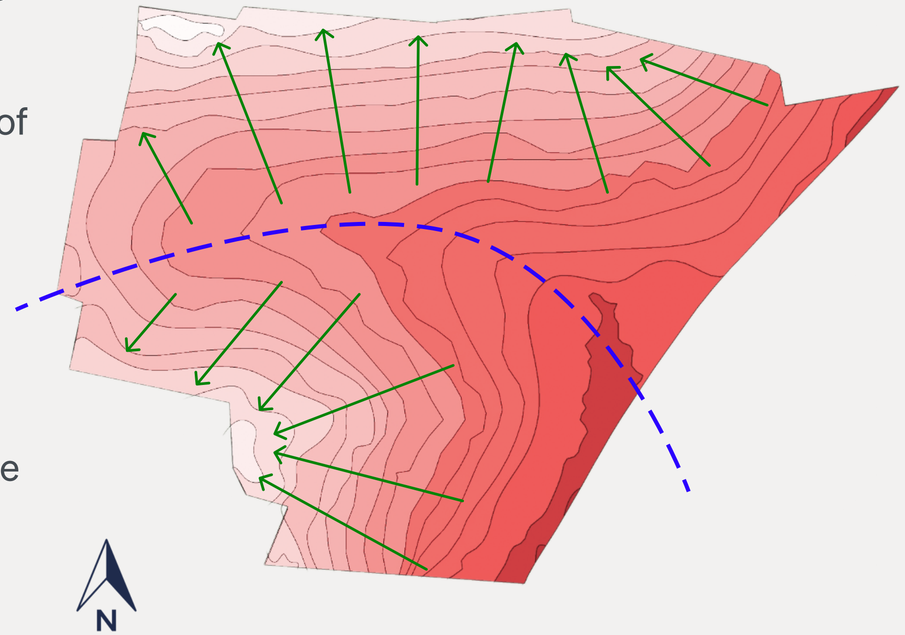
Accessibility: At least one universally accessible unit.

The Design Challenge: How do you create distinct, private experiences on contoured terrain while maintaining accessibility and delivering a memorable spatial sequence?

Terrain Analysis

A detailed contour study across 60-acres of phase 1 change was carried out to identify:

- Natural movement of water across the site to map drainage patterns
- Areas suitable for collection and harvesting of rain water
- Existing infrastructure worth retaining
- Problem zones with excessive level differences



This analysis made it clear that flattening the site uniformly would increase earthwork volumes, construction cost, and long-term drainage risk.

Design Objectives

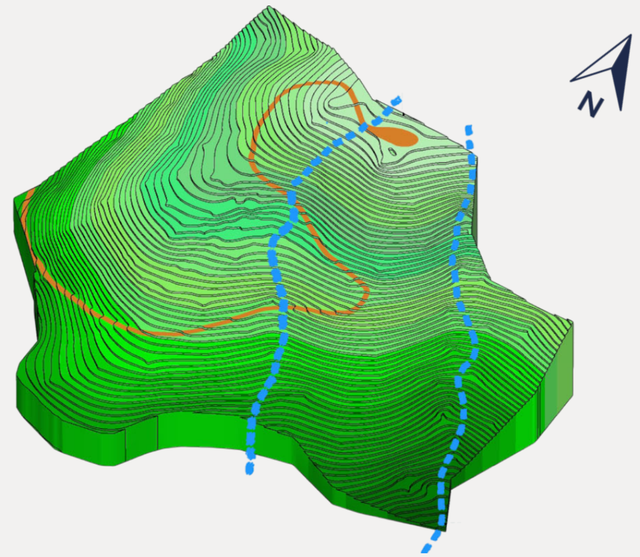
Established measurable, client-validated goals:

- All plots are flat and 0.30 m above adjacent road level to prevent flooding and ensures drainage.
- Retaining walls are used only where elevation difference exceeds 1.50 m for cost control.
- Stone-pitched embankments of 1:1 slope are used where space permits, between plot edge and site boundary.
- Existing roads and drains are retained wherever feasible to reduce waste.
- Factor cost of saleable land used for infrastructure into total project cost (holistic economics)

Site Analysis

Terrain Characteristics

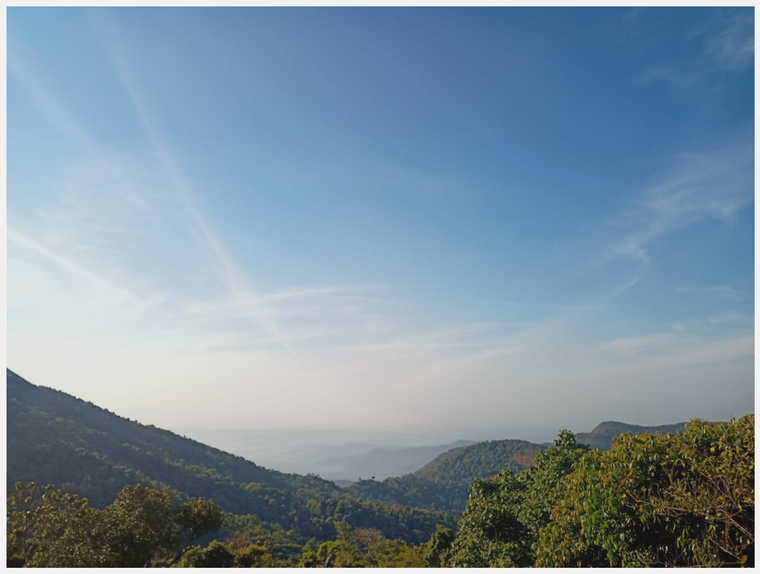
- Maximum slope: 35 degrees (within Kerala's 45-degree building regulation limit)
- Two seasonal valley streams running through site (must remain as ecological buffers)
- Best views toward south and west from upper elevations
- 75m total elevation change across full 8-acre site



Strategic Insight: Rather than fighting the slope, use elevation changes to create spatial hierarchy and experiential drama.

Towards West

Towards South



Design Evolution

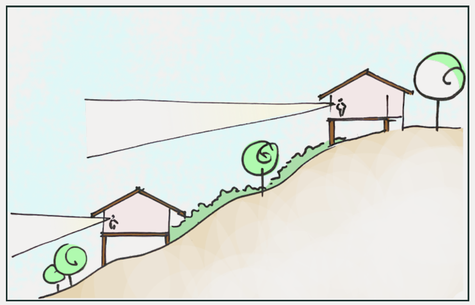
The project evolved over three major revisions across 18 months, with each iteration responding to emerging operational, environmental, and experiential challenges.t

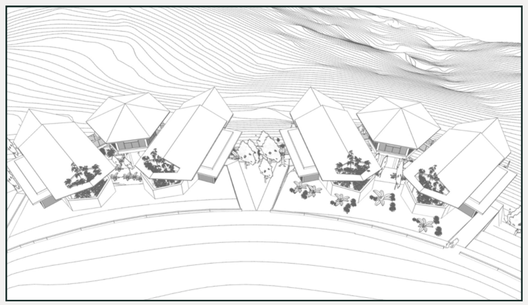
Initial Iteration - March 2022

The earliest site plan focused on programmatic zoning driven by views.

- 8 large standalone suites (each ~645 Sq.Ft.) spread across upper elevations
- Separate spa & pool block at lower level accessed by pedestrian paths
- Reception and restaurant as distinct buildings
- Staff accommodation at site perimeter
- Presidential suite with private pool

Client feedback: "This feels too spread out. Guests and staff will struggle with distances. Operations will be complicated."





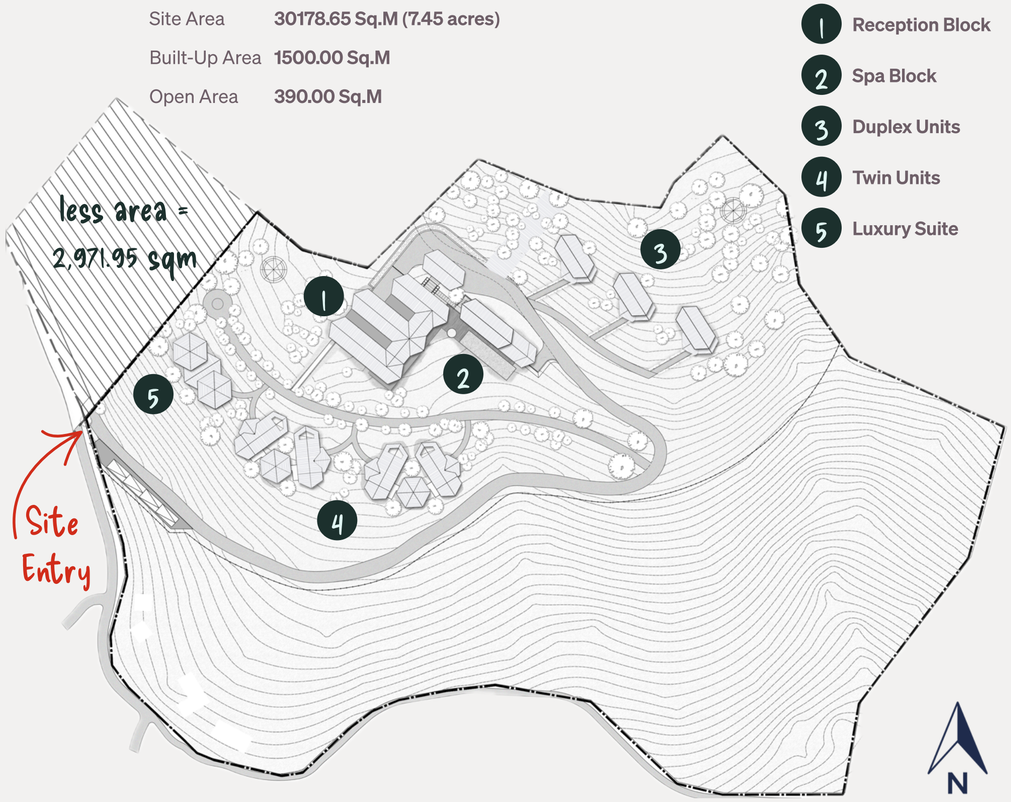
All buildings offer scenic and unobstructed views to the surroundings.

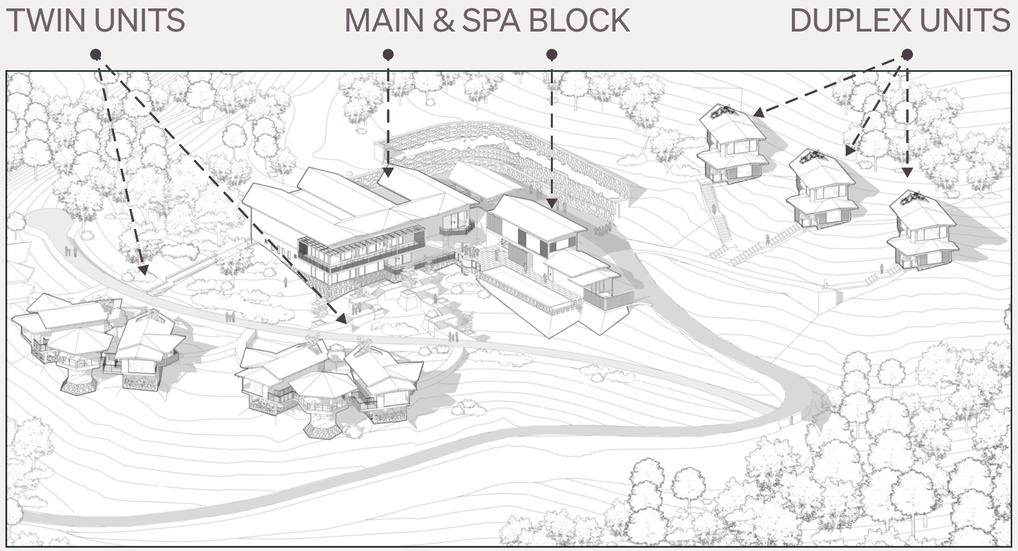
Second Iteration- August 2022

A strategic shift toward compact planning to improve access, security, and operational clarity was made.

- Main block integrated all public functions - reception, dining, spa, gym, pool into split-level design.
- Guest accommodation reorganised into twin units and duplex units.
- Vehicular access was restricted to a primary road, and pedestrian movement became dominant.
- Valleys and steeper slopes were consciously left untouched, reducing the developed footprint.

Client feedback: "We are concerned about circulation being uncomfortable for guests, due to accessibility challenges and insects."





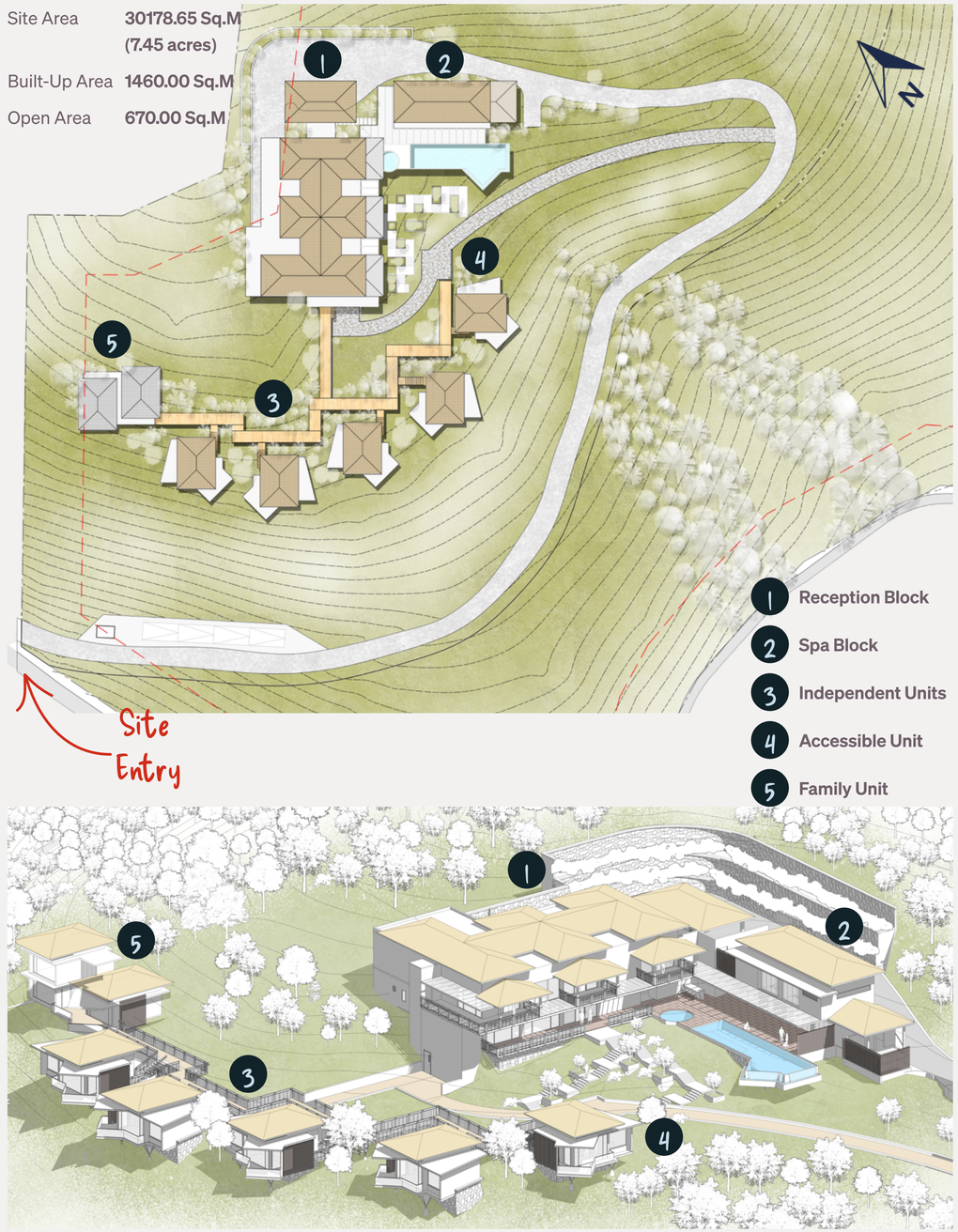
Ariel View

The Final Solution

The final layout treated terrain as the organising structure for both movement and placement.

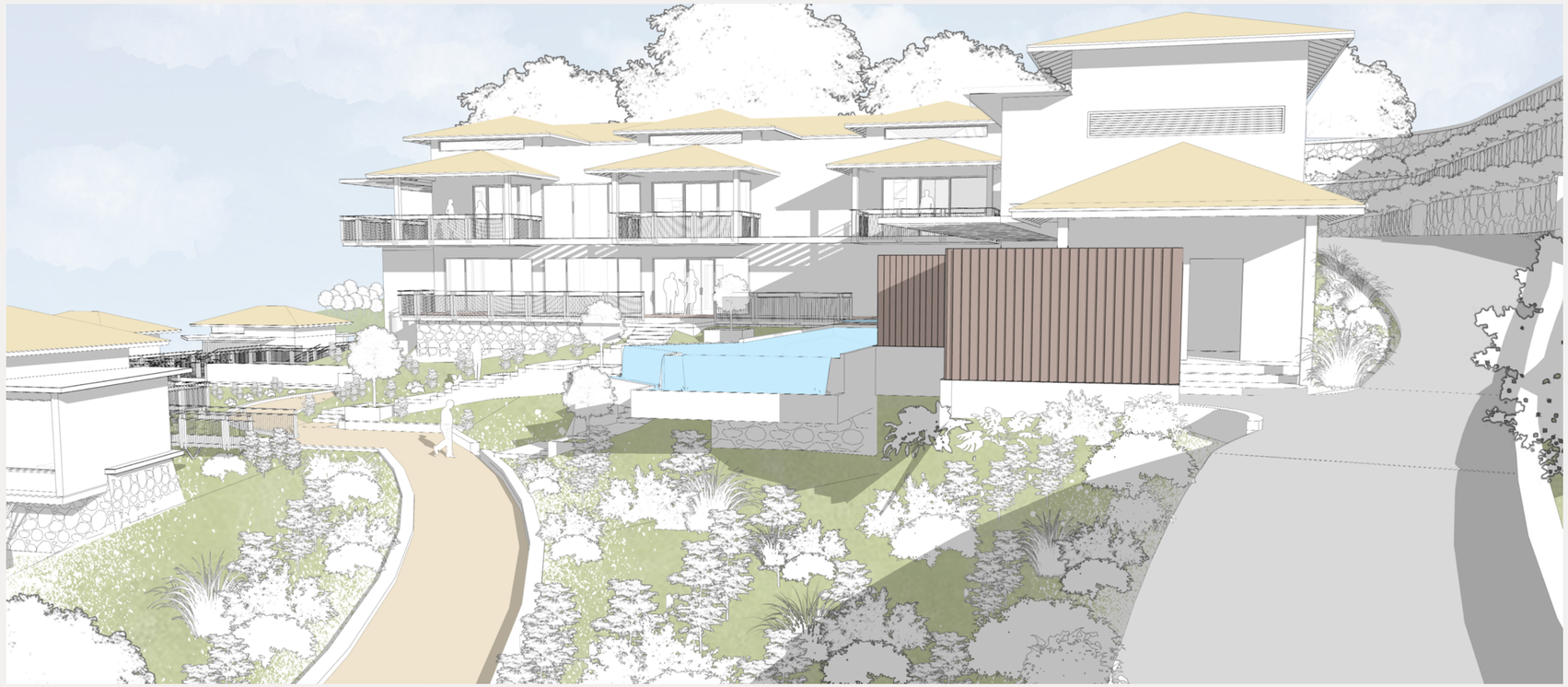
It directly addressed concerns around accessibility and comfort.

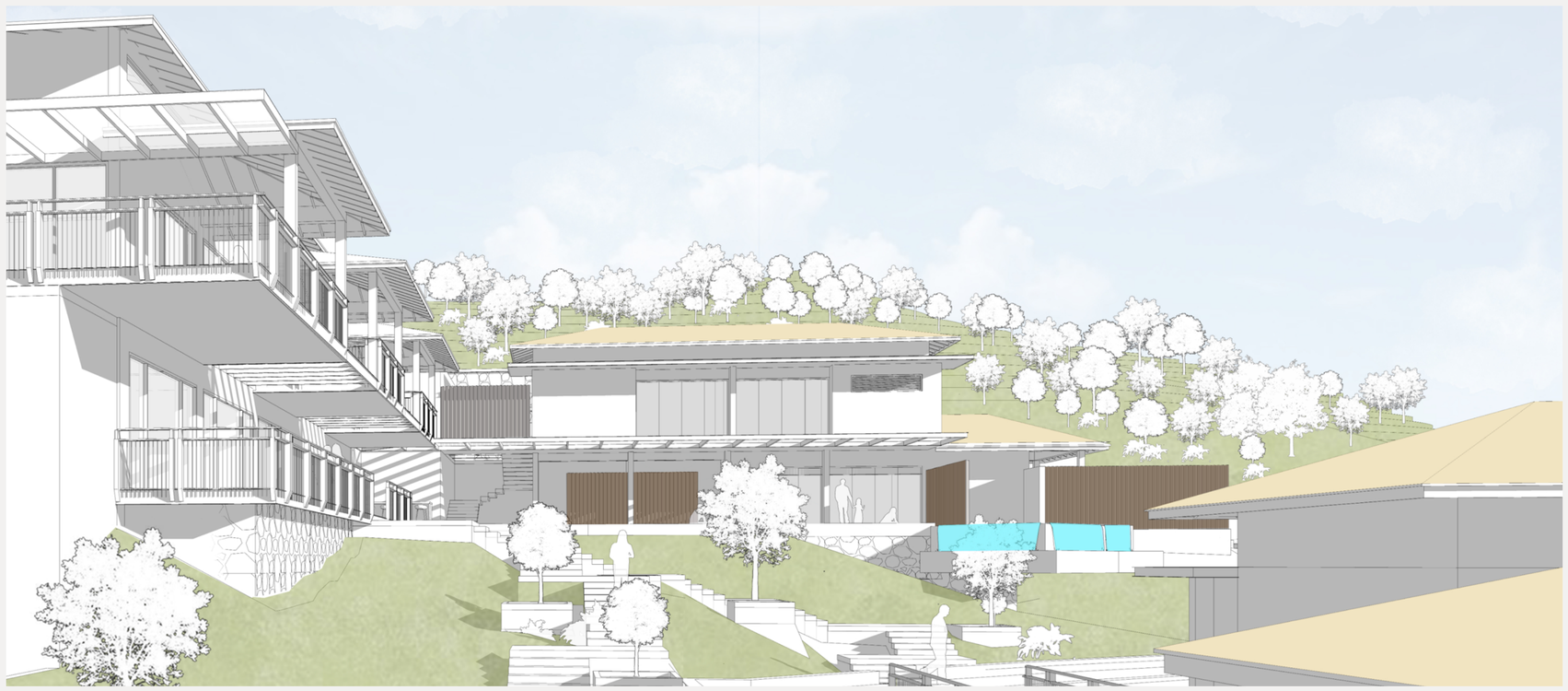
- **90 m of elevated pathways create a barrier-free circulation.**
- Guest rooms raised on stilts, reducing contact with ground vegetation and insects
- Accommodation mix refined to include four independent units, one accessible unit, and one family unit.



Guest Room Diversity:

- *Independent Units:* Units on stilt, designed to work with the slope
- *Accessible Unit:* Ramp access from elevated pathway
- *Family Unit:* With three- bedrooms, to accommodate one large group or multiple smaller groups

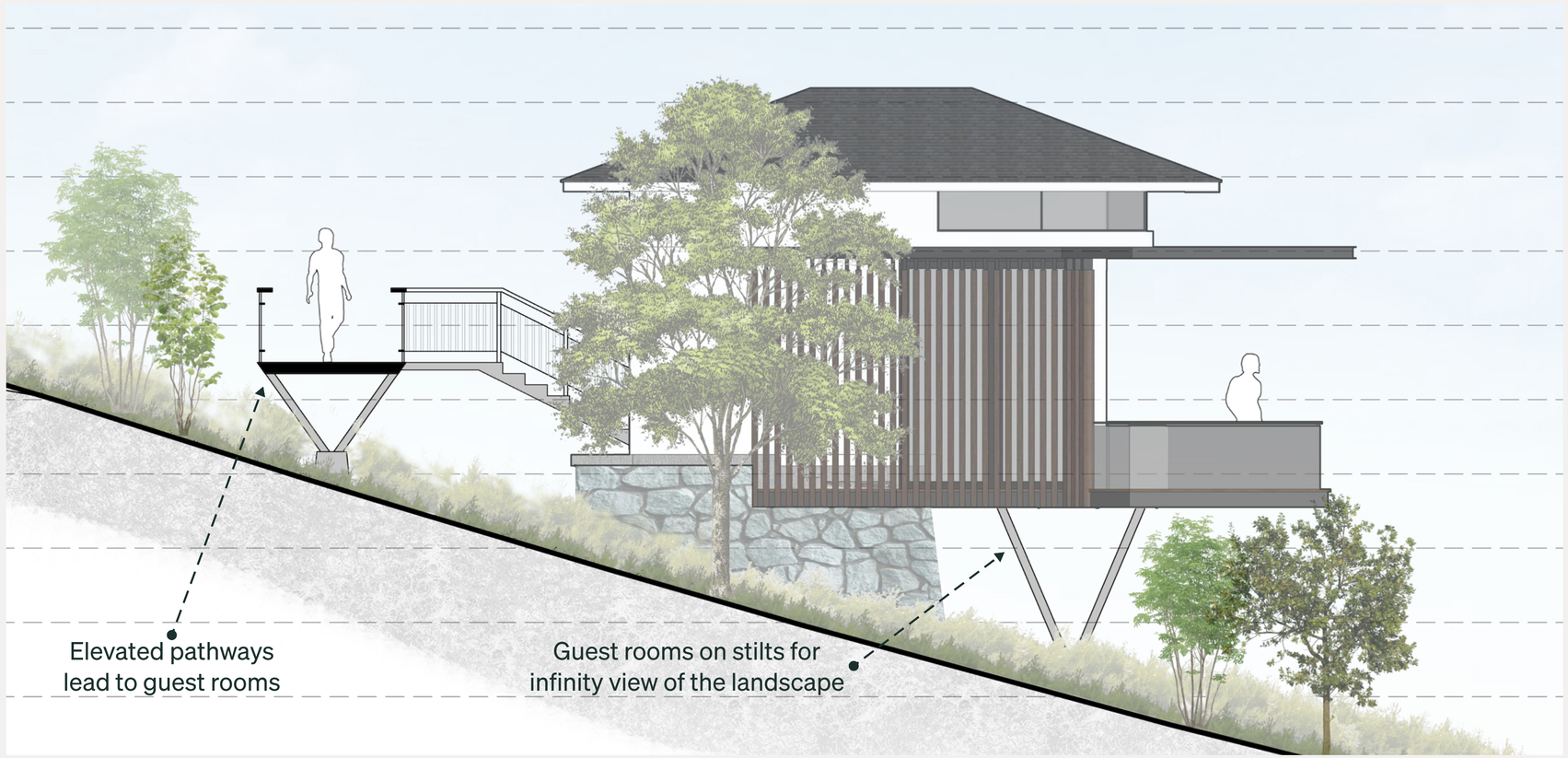




The Elevated Pathway System:

A 90-meter network of raised walkways redefined circulation as a core spatial experience rather than a purely functional link.

- Raised a minimum of 1.5 m above ground, creating a sense of moving through the landscape rather than across it
- Connects the main block to all guest units along a consistent level
- Integrated ramps ensure barrier-free access without regrading the terrain
- Movement becomes experiential, offering shifting views and changing perspectives
- Natural ground plane preserved, with no excavation beneath the pathways



The Outcome

Project Metrics

- Total project cost of ₹16.4 crore, including ₹5 crore allocated to the elevated pathway system
- Built area of 1,460 Sq.M supported by 670 Sq.M of open decks
- Six accommodation units designed to serve the distinct guest profiles
- Full site accessibility achieved on a steep hillside without flattening the terrain

Spatial & Experiential Outcomes

- Circulation reimagined as a memorable spatial sequence through elevated movement
- Buildings raised on stilts preserve the natural ground plane and create a sense of lightness
- Privacy achieved through vertical separation and orientation rather than physical barriers
- Spa and pool positioned to leverage elevation for uninterrupted views

Process & Learning Outcomes

- An 18-month iterative process shaped by evolving client input and cost constraints
- Three major revisions, each addressing a different layer of the problem:
  - Rev 01 clarified spatial distribution
  - Rev 02 resolved operational efficiency and budget alignment
  - Rev 03 strengthened experiential quality and accessibility
- Continuous client collaboration allowed the project to mature beyond its initial vision, demonstrating how iterative refinement can produce more resilient and thoughtful outcomes

Conclusion

Learnings from Site Development & Terrain-Led Planning

Terrain as a System, Not a Surface

Treating topography as the primary organising structure led to clearer access, drainage, and grading decisions. Working with contours reduced earthwork, cost, and long-term maintenance.

User needs shape the response

Understanding who the site was for shaped every major decision, from road alignment to building placement. Similar site constraints produced very different solutions because user priorities differed.

Iteration Improves Outcomes

Design quality improved through structured revisions rather than adherence to an initial vision. Each iteration addressed a different layer: layout clarity, operational efficiency, and experiential quality.

Accessibility Without Erasure

Inclusive movement emerged from circulation strategy and spatial planning. Both projects challenged the assumption that difficult terrain requires aggressive intervention to achieve accessibility.

Constraints as Design Drivers

Constraints became drivers of innovation. Existing infrastructure, steep slopes, and cost limits forced more thoughtful, system-level solutions. The most effective design moves emerged not despite constraints, but because of them.

Across both projects, site planning became an exercise in systems thinking: aligning terrain, movement, cost, and user needs into coherent, buildable frameworks.

Thank you. *:)*

Credits

My team at **Anand & Associates** &

Our clients **Favorich infra pvt ltd** &

Mr. Benley