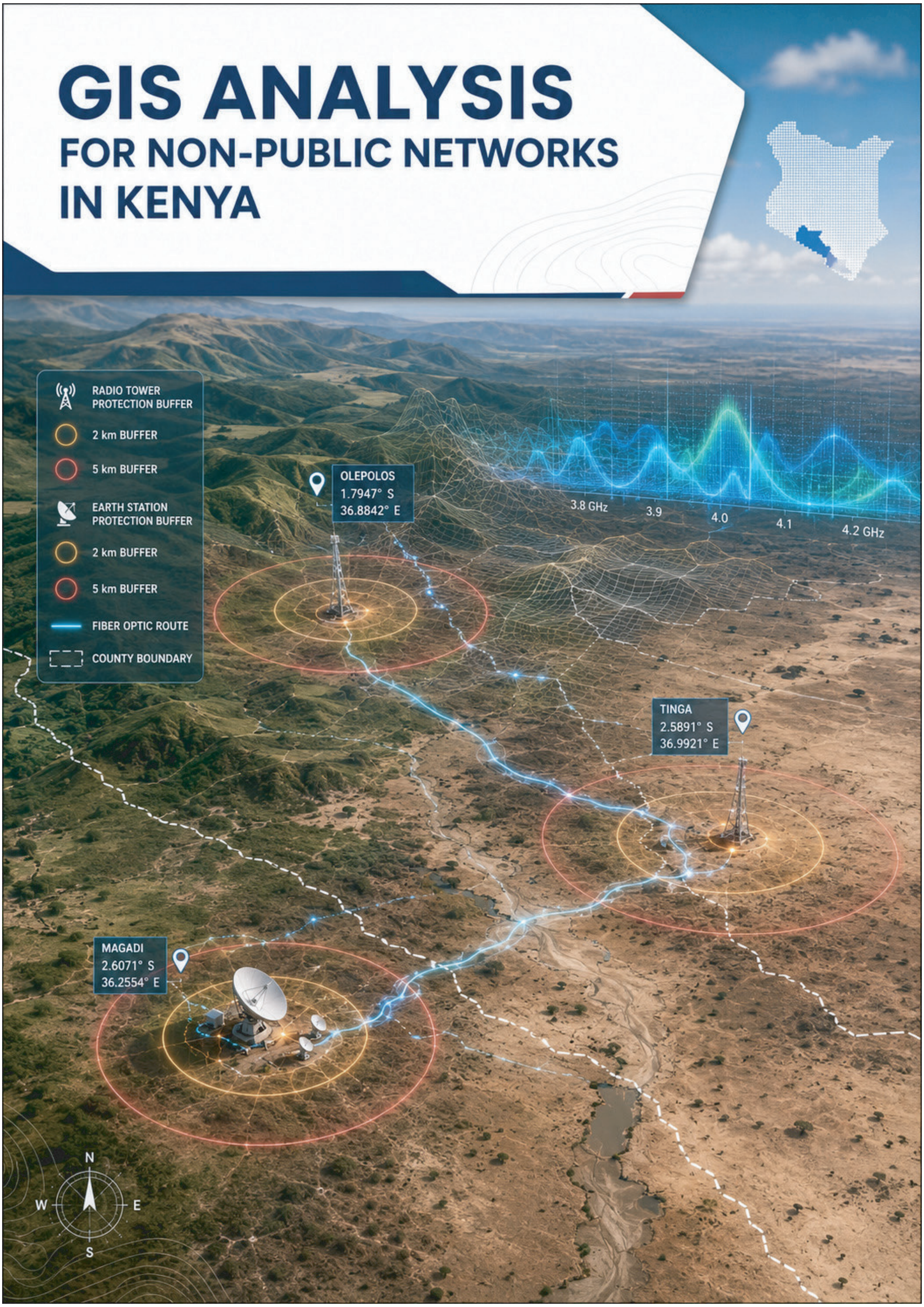
GIS ANALYSIS

FOR NON-PUBLIC NETWORKS IN KENYA


GIS ANALYSIS
FOR NON-PUBLIC NETWORKS
IN KENYA
RADIO TOWER
PROTECTION BUFFER
2 km BUFFER
5 km BUFFER
EARTH STATION
PROTECTION BUFFER
2 km BUFFER
5 km BUFFER
FIBER OPTIC ROUTE
COUNTY BOUNDARY
OLEPOLOS
1.7947° S
36.8842° E
3.8 GHz
3.9
4.0
4.1
4.2 GHz
TINGA
2.5891° S
36.9921° E
MAGADI
2.6071° S
36.2554° E
N
W
E
S

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Executive Summary

This report provides the spatial planning, geographic deployment and zoning logic required to support a practical framework for Non-Public Networks (NPNs) in Kenya across the 1800 MHz (Band 3) and 3.6–4.2 GHz (Bands n77/n78). It presents GIS analysis as policy decision-support for the Communications Authority of Kenya and places geospatial analysis at the centre of pilot design.

Pursuant to CA's licensing framework for Community Networks—which limits such networks to Sub-county administrative boundaries—primary field assessment and pilot design focused on Kajiado West Sub-county. Analysis is anchored to this geographic scope, with comparative reference to industrial NPN models (campus/enterprise) in adjacent areas that operate under distinct constructs.

Conducted from January to June 2026, the work presented in this report integrates field spectrum measurements, stakeholder readiness assessments, and geospatial analysis to inform the anticipated testbed network under a regulatory sandbox environment.

The report confirms that geography is the primary implementation detail: in the Kenyan context, whether a site is technically or commercially viable depends on its relationship to incumbent mobile infrastructure, protection from harmful interference, back-haul availability, topography, settlement patterns, institutional demand, and local implementation constraints. The analysis validates that a single regulatory model is insufficient. The 'use it or share it' principle underpins the recommended zone-based approach: incumbents retain exclusive rights in high-utilisation zones, while underutilised spectrum is availed to NPNs through sharing or local licensing.

The 1800 MHz band remains saturated near incumbent Mobile Network Operator (MNO) infrastructure in Kajiado West, necessitating SLA or local licensing (primary recommendation) or spectrum leasing (alternative) arrangements. In contrast, the 3.6–4.2 GHz C-Band with local licensing opportunities concentrated in the 3.8–4.2 GHz upper portion, where FSS utilisation is lowest, presents geographically isolated "clean spectrum" pockets—particularly in Olepolos, Oltepesi (Tinga), and Ilyagaleni (Kipeto Wind Farm)—suitable for localised light licensing or Standalone Non-Public Networks (SNPNs) subject to FSS earth station and aviation buffer protections.

Geographic Information Systems (GIS) analysis of eight candidate sites within Kajiado West identifies four deployment anchors:

- ***Immediate Pilot Phase (SNPNs):***
  Community Networks):
  - *Oltepesi (Tinga) Health Center* (24hr healthcare use case, high community acceptance)
  - *Oletepesi Hub (Tinga)* (clean spectrum corridor, roadside accessibility)
  - *Namelok Community Network* hub (existing infrastructure, Kisamis/Olepolos corridor)
- ***Secondary Phase (Industrial/Campus NPNs):***
  - *Umma University* (innovation campus with fiber back-haul, SNPN model)
  - *Tata Chemicals Magadi* (industrial automation, security-hardened, SNPN model)

Note: Umma University and Tata Chemicals Magadi are assessed as comparative industrial/campus use cases operating under localised licensing frameworks that are not constrained by Sub-county boundaries, providing a contrast to the Community Network model in Kajiado West.

Critically, majority of the sites require clarification of Standalone Non-Public Networks (S-NPN) versus Public Network Integrated (PNI-NPN) models, indicating an need for the regulatory tool kit proposed.

The GIS workstream translates technical coexistence analysis and regulatory options into place-based authorisation logic that can be applied consistently in a sandbox and, over time, at a national scale. Based on field data collected in Kajiado County and the structured suitability model developed for this study, the strongest initial deployment anchors are Oltepesi Health Center, the Tinga Hub, the Namelok Office/Kisamis node, and Umma University.

These sites offer the best combination of demand, practical access to power, back-haul options, and relatively clear spatial options for either SNPN or PNI-NPN. By contrast, Olepolos Quarry, Saikeri Market, Shams Eco Camp, and the Kipeto–Magadi corridor require more conditional treatment due to proximity to incumbents, access constraints, environmental sensitivities, or the need for stronger supporting infrastructure.

Key Spatial Findings Supporting Regulatory Design:

Geographic Differentiation Required

The 1800 MHz band shows saturation within 2km of MNO sites (Quarry, Olepolos), while the 3.8–4.2 GHz band presents "clean spectrum" opportunities in the western corridor (Olepolos-Tinga). This spatial pattern supports the Regulatory Report's recommendation for differentiated licensing models by zone.

Buffer Zone Necessity

Interference modelling (detailed in Technical Report) mapped onto terrain data indicates minimum exclusion distances of 5km (FSS) and 2km (MNO 1800 MHz) to prevent harmful interference, informing the protection zones proposed in the Regulatory Report.

Backhaul-Critical Topology

Line-of-Sight (LOS) analysis confirms the Namelok-Olepolos-Tinga corridor (12km) is feasible for microwave back-haul (7 GHz). In comparison, the Kipeto-Magadi link (28km) is obstructed by escarpment terrain, indicating infrastructure requirements for sites prioritized in the Regulatory Report's phased approach.

The Spectrum Finder Dashboard - To support ongoing regulatory decisions, this report delivers technical specifications for a National GIS-based Spectrum Finder, enabling:

- **Real-time distinction between SNPN (standalone) and PNI-NPN (integrated) deployment zones;**
- **Searchable fibre routes, population coverage estimates, and terrain-adjusted propagation models;**

Automated interference risk assessment for applicant sites against incumbent protection buffers.

Kajiado's diverse terrain (1,000m–1,850m elevation) and mixed community/ industrial use cases provide an ideal sandbox test case for NPN deployment. The evidence supports proceeding with Phase 1 pilot authorisations at Oltepesi (Tinga), Tinga Hub, and Namelok under SNPN frameworks, while reserving Umma University and Tata Chemicals Magadi for PNI-NPN industrial pilots. This spatially informed, differentiated approach balances innovation with incumbent protection, offering a replicable model for national NPN framework development.

The report further recommends a zone-based spatial licensing logic. In practice, this means that the 1800 MHz band should be approached as a tightly coordinated access environment in incumbent-proximate areas, while both the 1800 and the 3.6–4.2 GHz range can support localised authorisation where clean spectrum pockets are available, and FSS protection distances are respected. This approach is important in Kajiado, where the same legal framework is expected to govern different geographic realities.

Finally, the report proposes the functional architecture of a GIS-enabled Spectrum Finder tool for CA. The tool would consolidate site coordinates, buffer logic, incumbent-protection rules, terrain-aware planning inputs, and site eligibility checks into a single decision-support environment. Such a platform would improve consistency in authorisation decisions, reduce regulatory uncertainty for applicants, and strengthen CA's ability to align innovation, protection of incumbent users, and public-interest connectivity objectives.

1

Introduction

1.1. Context and Rationale

Internationally, NPNs are increasingly used to support enterprise connectivity, campus environments, industrial automation, utilities, research settings, and community-centred service delivery. In 3GPP architecture, the term covers both standalone non-public networks and public-network-integrated non-public networks, with different implications for infrastructure, control, and spectrum access.

For Kenya, the policy relevance of this model lies in two parallel needs. The first is the continued challenge of extending meaningful connectivity to under-served and difficult-to-serve geographies. The second is the growing need for secure, localised, fit-for-purpose wireless systems in education, health, energy, logistics, mining, research, and community service environments. The CA's current strategic direction, the Universal Service Fund (USF) agenda, and the wider digital economy programme all point toward more differentiated approaches to infrastructure extension and service enablement.

This report assesses where non-public network deployment is most viable, what spatial constraints must be observed, and how geospatial evidence should be incorporated into a Kenyan framework for localised non-public network deployments. The analysis is designed to support policy formulation, licensing and pilot implementation by the Communications Authority of Kenya.

Technical Coexistence Analysis: Conducted simulations using datasets, deterministic and statistical simulation tools (ICS-T, Visualyse Pro and SEAMCAT) and tools from CA to establish strict protection criteria for incumbent operators in the 1800 MHz band and the 3600-4200 MHz, while demonstrating opportunistic access by secondary entrants without posing interference.

1.2. The Spatial Challenge of Non-Public Networks

While Kenya's mobile broadband coverage reaches 96% of the population geographically, meaningful connectivity in rural and semi-arid counties like Kajiado remains below 25%—creating a digital divide that constrains economic participation, e-government service delivery, and Industry 4.0 innovation.

The Communications Authority of Kenya (CA), in partnership with the African Advanced Level Telecommunications Institute (AFRALTI), the Dynamic Spectrum Alliance (DSA), Internet Society (ISOC), and Association of Community Networks in Kenya (ACNKe), targets to deploy Non-Public Networks (NPNs) testbeds to address this gap through localised spectrum access.

This report presents the geographic intelligence supporting that pilot. It identifies where NPNs are technically and socially viable in Kajiado County, maps the infrastructure required to connect them, and specifies the spatial decision-support tools needed for national scale-up.

1.3. Purpose and Relation to the Companion Studies

This document is the GIS and spatial planning Component Report of a three-part analysis:

- Draft Technical Analysis Report - Addresses RF engineering, spectrum coexistence simulations (SEAMCAT/ICS-T and Visualyse), propagation modelling, and equipment specifications.
- Draft Regulatory Analysis Report - Addresses legal frameworks, licensing models (LSA, Local Licensing), international benchmarking, and policy recommendations.
- This Report (GIS Analysis) - Addresses site selection, terrain analysis, back-haul routing, population coverage, and the geospatial platform (Spectrum Finder) required to operationalise the above.

The technical report addresses coexistence, coverage, interference, and protection criteria, while the regulatory report examines licensing, spectrum access models, and comparative policy options.

The present report does not reproduce those analyses. Instead, it provides the spatial layer required to operationalise them through site selection, clustering, terrain interpretation, buffer management, deployment phasing, and a national-spectrum-finder concept.

While the companion reports establish how NPNs can technically coexist with incumbents and how they can be regulated, this report establishes where they should be deployed and what infrastructure exists to support them.

1.4. Scope and Geographic Focus

The primary field assessment focused on Kajiado County, the proposed pilot environment. The spatial logic of the study was anchored in the practical needs of a sandbox: identifying realistic candidate sites, differentiating among community, campus, and industrial use cases, and determining which locations are suitable for early piloting, later expansion, or conditional treatment. Where the source material referred to comparative sites outside the immediate community-network corridor, those sites have been retained in this revised report only to the extent that they clarify wider framework options and should not be read as evidence that a single licensing treatment would apply uniformly to all settings.

This geographic scope aligns with the Communications Authority of Kenya's licensing framework for Community Networks (CNs), which restricts such networks to Sub-county administrative boundaries. Consequently, the primary field assessment and pilot deployment analysis focuses specifically on Kajiado West, encompassing the western corridor from Olepolos through Tinga (Saikeri) and the Namelok Community Network operational zone.

Sites within Scope (Kajiado West):

- Namelok-Olepolos Tower (Community anchor)
- Olepolos Quarry (Industrial edge case)
- Namelok Office (Kisamis) (Community hub)
- Shams Eco Camp (Tourism site)
- Oltepesi Health Center (Healthcare priority)
- Tinga Oletepesi Hub (Roadside/backbone)
- Saikeri Market (Community commercial)
- Ilyagaleni, Kipeto Wind Farm (Industrial/Grid - northern edge of sub-county)

The GIS workstream covers five core tasks: first, validation of candidate sites and site typologies; second, spatial suitability assessment using a weighted, multi-criteria framework; third, analysis of terrain, line-of-sight, access, and back-haul feasibility; fourth, translation of band-specific technical and regulatory constraints into spatial rules; and fifth, specification of a GIS-enabled decision-support tool that the Authority can use in future licensing and pilot administration.

1.4.1. Comparative Context

While the primary licensing analysis and Community Network pilot design are strictly confined to Kajiado West per CA requirements, the report references sites in Kajiado's Central (Umma University) and Kajiado's West (Tata Chemicals Magadi) for comparative purposes regarding industrial SNPNs and campus PNI-NPNs, which operate under different licensing constructs (localised licenses and MNO integration frameworks, respectively) that are not constrained by Sub-county boundaries.

1.4.2. Spectrum Bands

- 1800 MHz (n3): Assessed for LSA/leasing potential in MNO-proximate areas.
- 3600–4200 MHz (C-Band): Assessed for local licensing in geographically isolated zones.

Field data collection was done in January 2026; supporting the Q1 2026 testbed network authorisation.

1.5. Report Structure

- Section 2 provides the regulatory spatial context (geographic parameters for licensing);
- Section 3 presents the core GIS analysis: site registry, suitability scoring, terrain modelling, and Spectrum Finder specifications;

Appendices contain the geocoded site registry and raw spatial data attributes.

Detailed technical coexistence analysis is found in the Technical Report; legal and policy frameworks are found in the Regulatory Report.

2

Methodology and Data Inputs

The methodology is based on the approach that a single geographic rule is insufficient for NPN planning in Kenya. Instead, the analysis combines project field data, public geospatial datasets, and band-specific information to produce a differentiated suitability and zoning framework.

2.1. Data Sources and Spatial Inputs

The GIS analysis integrates field observations, project site records, stakeholder readiness inputs, and external spatial datasets that provide the physical and administrative context required for NPN planning.

The project relied on geocoded field collection, population raster data, elevation modelling, land-cover data, and indicative infrastructure layers. External datasets were used only to support spatial interpretation; final authorisation decisions would still require Authority validation, incumbent coordination, and site-specific verification.

Table 21: Spatial Data Inventory used in the GIS Assessment

The GIS analysis integrates field observations, project site records, stakeholder readiness inputs, and external spatial datasets that provide the physical and administrative context required for NPN planning.

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Dataset	Source	Resolution/scale	Year	Use in this report
Field GPS coordinates	Project field collection (Kobo/QGIS)	±3–5 m	**2026**	Site validation and geocoding
Spectrum measurements	Project field measurements	Point observations	**2026**	Band occupancy checks and site screening
Stakeholder assessments	Structured project interviews	Qualitative + geocoded	**2026**	Demand and readiness scoring
Population distribution	WorldPop Kenya population grid	Approx. 100 m	**2020 baseline**	Settlement context and demand estimation
Elevation model	ALOS PALSAR terrain data	12.5 m source / resampled for analysis	**2021**	Terrain and LOS analysis
Land-cover layer	ESA WorldCover	10 m	**2021**	Environmental and surface-context interpretation
Road network	OpenStreetMap plus field checks	Variable	**2025/26**	Access and maintenance feasibility

Note: *Project-derived datasets were complemented by publicly available geospatial products used for planning support, not as a substitute for licensing verification.*

2.2. Analytical Framework

The analytical framework used a weighted linear combination model to avoid treating spectrum availability as the sole determinant of viability. A site was considered more suitable where it combined favourable spectrum conditions with power availability, feasible back-haul, institutional demand, and manageable terrain or access conditions. This revised presentation also introduces a practical decision rule: no site should move into a priority pilot tier solely based on clean spectrum if the underlying implementation conditions are weak.

Table 22: Suitability Criteria and Weights

Criterion	Weight	Operational interpretation	Primary source
Spectrum availability	**25%**	Relative practicality of authorising local access or coordinated use	Field checks + project analysis
Power infrastructure	**20%**	Grid or stable off-grid capacity for continuity of service	Field observation
Back-haul feasibility	**15%**	Availability of fibre, microwave corridor, or realistic fallback options	Field observation + terrain review
Institutional demand and willingness	**15%**	Likelihood of actual use and sustained participation	Stakeholder engagement
Terrain and access suitability	**10%**	Ease of reaching, building, and maintaining the site	DEM + road/access review Project technical and regulatory analysis
1800 MHz coordination burden	**15%**	Degree of incumbent-related complexity where LTE sharing is considered	Project technical and regulatory analysis

2.3. Methodological Cautions

Three limitations are recorded.

- *First*, the field observations represent a project-period snapshot and do not by themselves establish permanent spectrum conditions.
- *Second*, route, fibre, and infrastructure visibility in rural and semi-rural environments may differ from actual serviceability on the ground.
- *Third*, site suitability for a pilot does not automatically resolve the regulatory pathway; it only indicates that a site is more or less promising once technical and licensing checks are applied.

2.3.1. Band-specific Geographic Strategies

The CA's emerging framework distinguishes spectrum access models by frequency band, with direct spatial implications:

- **1800 MHz (IMT Band 3)** - Geographic coordination required. Secondary access is viable only through spectrum leasing (Recommended) or Licensed Shared Access (LSA) (Alternative) within defined contours around incumbent MNO sites. GIS application: 2 km coordination zones around existing base stations (see Section 3.6).
- **C-Band (3.6–4.2 GHz)** - Specifically, the 3.8–4.2 GHz range for local light licensing. Geographic isolation is viable. Local light licensing is permissible in "clean spectrum" pockets outside Fixed Satellite Service (FSS) earth station protection zones. GIS application: 5 Km exclusion buffers around FSS sites; opportunistic authorisation possible in remaining areas

2.3.2. NPN Models: Spatial Definitions

The Regulatory Report defines two deployment models with distinct geographic footprints relevant to GIS analysis:

- **Standalone NPN (SNPN)** - Independent infrastructure requiring dedicated site coordinates, tower locations, and coverage polygons. Suitable for areas outside MNO coverage (e.g., Olkaramatian, Inyonyori).
- **Public Network Integrated (PNI-NPN)** - Network slicing or hosted infrastructure utilising existing MNO site coordinates. Suitable for contained campuses with existing fibre (e.g., Umma University).

2.3.1. Band-specific Geographic Strategies

The Regulatory Report benchmarks frameworks including UK Shared Access, German Local Licensing, and US CBRS. For GIS purposes, the key spatial distinction is between spectrum leasing (1800 MHz, MNO-proximate) and local light licensing (3.8–4.2 GHz, geographically isolated). See Regulatory Report for detailed international analysis.

Table 23: Spatial Constraints from Regulatory Requirements

Constraint	Spatial Parameter	GIS Application
MNO Incumbent Protection	2 km coordination radius	Exclusion zones for 1800 MHz opportunistic use
FSS Earth Station (Ngong)	5 Km radius exclusion	C-Band authorization boundary
Aviation (Orly Airpark, Isinya)	5 Km horizontal, height restricted	Vertical obstacle limits for tower siting
Protected Areas	Conservancy boundaries	Environmental Impact Assessment trigger zones

Table 24: Regulatory Benchmarking: Lessons for Kenya Plus Use Cases

Jurisdiction	Model	Band	Key Feature	Kenya Application
Finland	Local Licenses	2.3 GHz, 26 GHz	1-year renewable, no auction fees	Industrial zones (Magadi, Kipeto)
Germany	Campus Licenses	3.7–3.8 GHz	10-year terms, geographic coordinates	Umma University (Research)
UK (Ofcom)	Shared Access	1800 MHz, 2.3 GHz, 3.6–4.2 GHz	Database-driven, light touch	Community Networks (Namelok corridor)
Canada (ISED)	Localised Licenses	3.5 GHz	50 km² max, 10-year terms	Agricultural IoT (Isinya/ Onion Doctor use case)

2.3.4. Implications for the Planned Testbed in Kajiado County

The international evidence supports a hybrid, band-specific approach for Kenya:

- 1800 MHz: Deploy via LSA or spectrum leasing in areas where MNO coverage exists but capacity is underutilised (e.g., Olepolos, Saikeri), protecting incumbents through strict geo-coordination;
- 3.6–4.2 GHz: Deploy via local light licensing in geographically isolated "clean spectrum" zones (Tinga, Kipeto, Shams Camp), utilizing GIS-based exclusion buffers around FSS sites.

This differentiated approach—reflected in the site-specific recommendations in Section 3—avoids the complexity of nationwide dynamic sharing while enabling meaningful pilots that can scale through regulatory precedent.

Detailed analysis of LSA frameworks, local licensing procedures, and international comparators (Finland, Germany, UK) is provided in the Regulatory Analysis Report. This GIS Report applies the spatial parameters from that regulatory framework to specific site evaluation and tool development.

2.3.5. Spatial Context for the Kenya NPN Framework

The spatial context of NPN regulation matters because the same frequency band can present very different authorisation conditions depending on incumbent density, topography, power and back-haul, and the intended use case.

A site suitable for a contained campus deployment is not necessarily suitable for a community-oriented access model, and a clean spectrum pocket is not necessarily a good pilot site if physical access, demand, or institutional readiness are weak.

2.3.6. Why Geography Matters in the 1800 MHz and 3.6-4.2 GHz Bands

The 1800 MHz band is generally better suited to wide-area LTE-style coverage. Still, it also tends to sit closer to established mobile deployments and therefore requires tighter incumbent-aware planning.

In contrast, the 3.6–4.2 GHz range is more capacity-oriented and can support localised private-network use cases where geography, buffers, and operational controls make sharing or local licensing practical. The result is that spatial planning is not merely descriptive; it actively shapes the choice of band, model, and licensing approach.

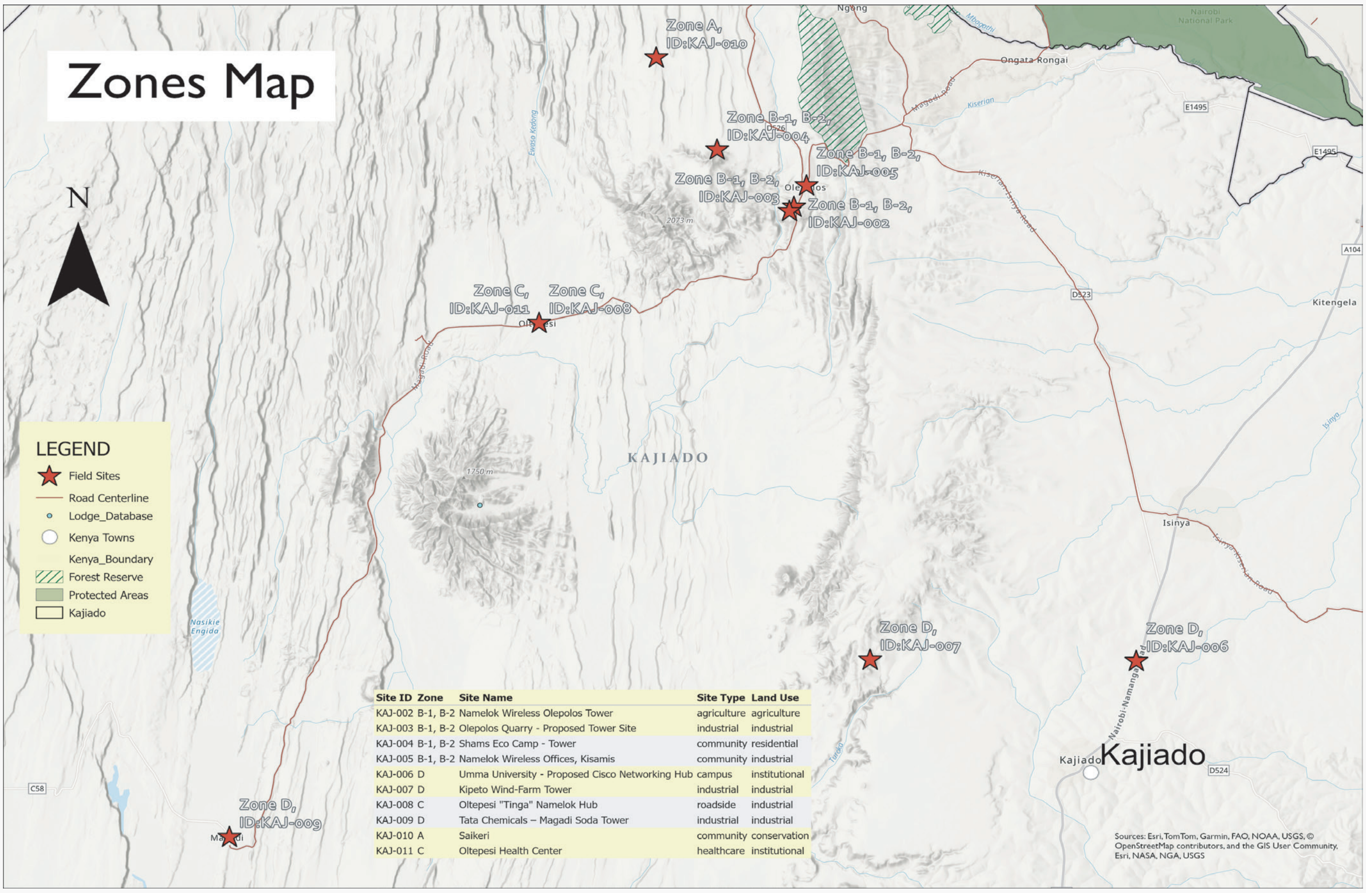


Figure 21: Map of Study Sites in Kajiado West

2.3.7. Special Treatment of SNPN and PNI-NPN Models

This revised report adopts a practical spatial distinction between two NPN models. Standalone NPNs are more appropriate where a site needs independent infrastructure, dedicated local control, or deployment in areas not well served by the host public network's logic.

Public-network-integrated NPNs are more plausible where a contained site already sits within workable public-network or fibre environments and where infrastructure sharing reduces deployment friction. The distinction is especially useful for pilot administration because it prevents the Authority from treating every candidate site as if it required the same authorisation logic.

Table 25: Indicative Spatial Decision Logic for SNPN and PNI-NPN Deployment

Decision variable	SNPN-leaning outcome	PNI-NPN-leaning outcome	Planning implication
Site context	Community, rural anchor, industrial edge, isolated institutional node	Contained campus or enterprise within stronger public coverage	Different infrastructure and licensing logic
Control model	Independent operational control required	Service can be hosted or integrated with a public network	Affects the spectrum-rights design
Back-haul model	Dedicated or separately arranged back-haul	Existing enterprise/public back-haul available	Changes rollout effort
Spatial relationship to incumbents	Needs site-specific protection and separation measures	Can rely more on the host-network architecture	Affects coordination burden

3

GIS Analysis

This chapter presents the geospatial evidence base and mapping deliverables supporting the consortium's Technical Analysis Report (RF engineering and coexistence simulations) and Regulatory Analysis Report (licensing frameworks and policy options). It avoids duplicating SEAMCAT/ICS-T interference calculations (covered in the Technical Report) and detailed legal/regulatory benchmarking (covered in the Regulatory Report), focusing instead on spatial suitability, terrain constraints, and the GIS-based Spectrum Finder tool specifications.

3.1. Introduction and Objectives

This analysis provides the spatial decision-support layer for NPN deployment in Kajiado County. While companion reports address RF coexistence engineering (Technical Analysis) and regulatory framework design (Regulatory Analysis), this chapter delivers:

a. Geocoded site validation and infrastructure mapping for 10 candidate locations;

b. Terrain-adjusted suitability scoring integrating field measurements with elevation, population, and access data;

c. Line-of-Sight (LOS) and back-haul feasibility modelling for microwave corridor planning;

d. Spatial constraint mapping (protected areas, cultural sensitivities, aviation buffers);

e. Phased deployment zoning based on geographic clustering and infrastructure availability;

f. Technical specifications for the national GIS Spectrum Finder (Objective 4 of the Proposal).

3.2. Data Sources and Methodology

The data sources used for GIS analysis are tabulated in Table 3-1.

Table 31: Spatial Data Inventory

Dataset	Source	Resolution/scale	Year	Use in this report
Field GPS coordinates	KoboToolbox (QGIS integration)	±3–5 meters (HDOP <1.5)	**2026**	10 sites; 5-minute averaged readings
Spectrum measurements	Primary (HTZ/ATDI)	Point measurements	**2026**	1800 MHz and 3.6–4.2 GHz
Stakeholder assessments	Structured interviews (Kobo)	Qualitative + geocoded	**2026**	Willingness, NPN model preference
Administrative boundaries	KNBS	1:50,000	**2019**	County, Ward, Sub-location
Population distribution	WorldPop 2020	100m raster	**2020**	Adjusted for 2025 projections
Road network	OpenStreetMap (valiare dated)	1:10,000	**2025**	Seasonal access flags added
Power infrastructure	Kenya Power + Field verification	Vector (grid lines)	**2023/26**	Solar/generator field-verified
Fibre backbone alignments	CA + Operator disclosure	Indicative (1:50,000)	**2025**	Umma and Namelok confirmed
Digital Elevation Model	ALOS PALSAR	12.5m	**2021**	Resampled to 30m for processing
Land cover/Environment	ESA WorldCover	10m	**2023**	Protected area overlays from KWS

3.2.1. Technical Specifications and Coordinate Systems

- Coordinate System: WGS 84 UTM Zone 37S (EPSG:32737)
- Vertical Datum: EGM2008 geoid for elevation accuracy
- Base Mapping: OpenStreetMap, ESRI World Imagery, Mapbox Satellite
- Interpolation: Inverse Distance Weighting (IDW, power=2) for spectrum surface mapping
- Buffer Standards: 500m (low risk), 2km (MNO coordination), 5km (FSS earth station protection)
- Software Stack: QGIS 3.34 LTS, GRASS GIS 8.3, Python (GeoPandas/Rasterio)

3.2.2. Field Data Collection Protocol

Field data was captured using structured KoboToolbox mobile forms integrated with QGIS, ensuring real-time coordinate validation. Key fields included:

- Infrastructure: Power source (Grid/Solar/Generator), fibre presence (Yes/Nearby/Not visible), tower height feasibility;
- Spectrum: Occupancy status (Clear/Intermittent/Unusable/Congested), observed technology, interference sources;
- Environmental: Protected area status (Inside/Outside), aviation proximity, cultural sensitivities;
- Institutional: Use case classification, willingness to participate (Yes/Maybe/No), preferred NPN model (SNPN/PNI-NPN/Undecided).
- Observed spectrum occupancy (visual and instrument-based)
- Photographic documentation (geotagged, minimum 4 cardinal directions per site)

3.2.3. Analytical Framework: Enhanced multi-criteria Model

The suitability model was enhanced to incorporate stakeholder readiness and regulatory risk, recognizing that technical availability alone does not constitute deployment viability.

Table 32: Suitability Criteria and Weights

Criterion	Weight	Operational interpretation	Primary source
Spectrum Availability (3.6–4.2 GHz)	**25%**	Occupied (0) / Guarded (50) / Clear (100)	Field measurement
Spectrum Availability (1800 MHz)	**15%**	Leasing required (33) / Coordination (66) / Clear (100)	Field measurement + CA database
Power Infrastructure	**20%**	None (0) / Solar only (50) / Grid (100)	Field observation + KPLC
Back-haul Feasibility	**15%**	Satellite only (40) / Microwave (70) / Fibre (100)	Field observation + LOS analysis
Institutional Demand & Willingness	**15%**	Low/No (0) / Medium/Maybe (50) / High/Yes (100)	Stakeholder interviews
Terrain/Access Suitability	**10%**	Steep/seasonal (0) / Moderate (50) / Flat/all-weather (100)	DEM + Road data

Normalisation: Linear min-max scaling (0–100)
Aggregation: Weighted Linear Combination (WLC) with stakeholder willingness as a binary gate (sites scoring <50 on willingness excluded from Tier 1 regardless of technical score).

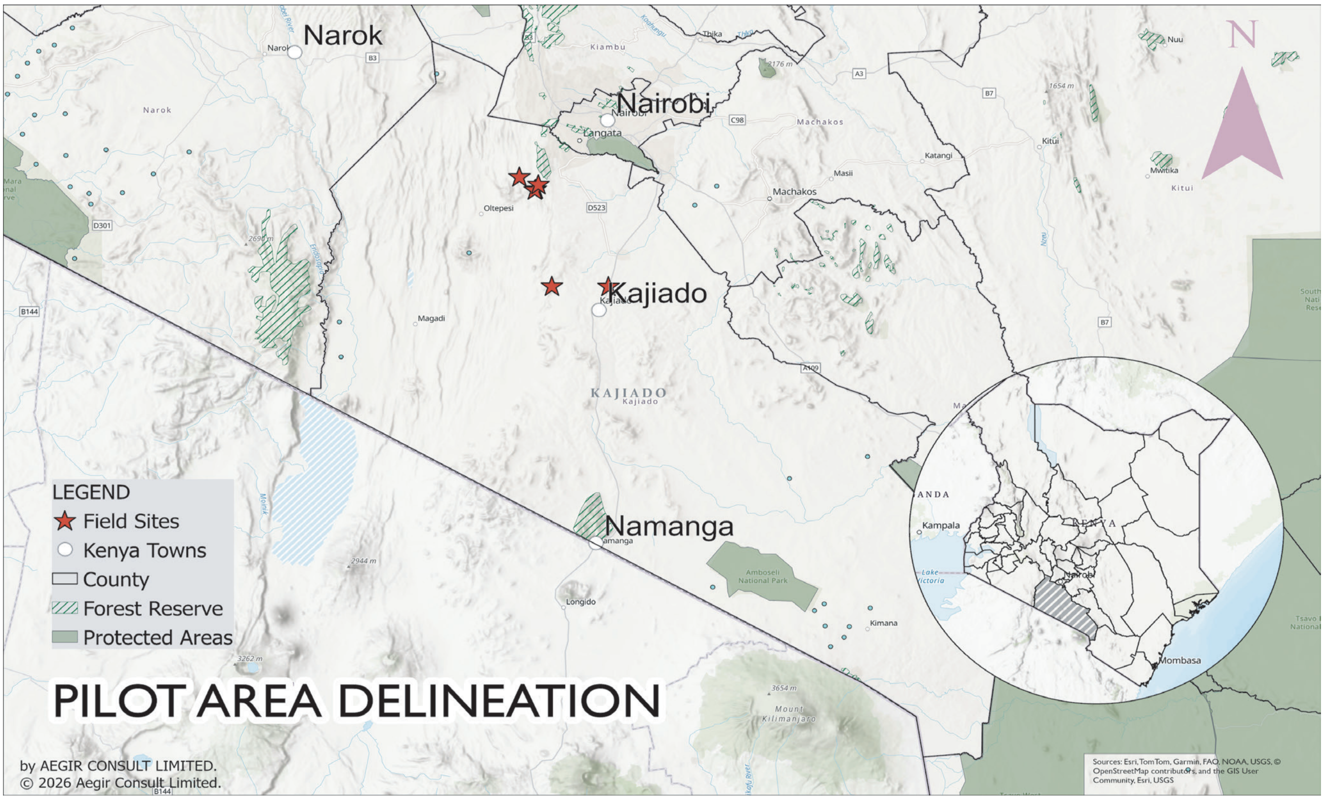


Figure 31: Pilot-Area Site Location Map

3.3. Candidate Site Registry and Typology Summary

The site registry below distinguishes candidate sites by functional role and by the planning issue most likely to influence deployment sequencing.

Table 33: candidate site registry and typology summary

Site	Functional Type	Indicative model	Relative priority	Primary planning issue
Oltepesi Health Center	Healthcare and community anchor	SNPN	**High**	Strong demand; cultural liaison needed
Tinga Hub	Roadside/ backbone and community node	SNPN	**High**	Good anchor function; seasonal access considerations
Namelok Office (Kisamis)	Enterprise & community operations node	SNPN	**High**	Backbone relevance; intermittent incumbent proximity

Site	Functional Type	Indicative model	Relative priority	Primary planning issue
Umma University	Campus and innovation environment	PNI-NPN / campus NPN	**High**	Useful controlled pilot setting
Namelok-Olepolos Tower	Community tower asset	SNPN	**Medium**	Back-haul strengthening required
Kipeto Wind Farm	Industrial / utility setting	SNPN	**Medium**	Environmental and site-governance conditions
Tata Chemicals Magadi	Industrial setting	SNPN	**Medium**	Remote access and hardened operational conditions
Shams Eco Camp	Tourism / local enterprise	SNPN	**Lower**	Seasonal access and limited support infrastructure
Saikeri Market	Commercial community node	Conditional	**Lower**	Stakeholder readiness and deployment acceptance
Olepolos Quarry	Industrial edge case	Conditional SNPN	**Lower**	Incumbent proximity and authorisation burden

3.4. Cluster Interpretation

The western corridor running through Namelok, Olepolos, Tinga, and Oltepesi remains the strongest community-oriented cluster because it combines community-service logic with potentially linkable sites. A second category comprises controlled institutional or industrial sites such as Umma University, Kipeto, and Tata Chemicals, which are useful for illustrating differentiated NPN models but should not automatically be folded into one community-network licensing logic. A third category comprises sites that are strategically interesting but require stronger preparatory work before they become pilot priorities.

3.5. Site Selection Logic

For policy purposes, the most important spatial question is not whether a site is simply possible, but whether it is both authorisable and useful within the timeframe of a regulated pilot. The site-selection logic therefore prioritises implementation realism: a site with modest technical conditions but clear demand, workable power, and accessible deployment conditions may be preferable to a technically attractive site that remains difficult to operationalise.

3.6. Multi-criteria Suitability Analysis

The scoring matrix below consolidates the analysis into a prioritisation tool for policy and pilot planning. The scores should not be treated as final determinations but an evidence-based ordering of sites for further action.

Table 34: Consolidated site suitability and prioritisation matrix

Site	Spectrum	Power	Back-haul	Demand	Terrain	Composite score	Priority tier
Oltepesi Health Center	100	100	50	100	80	93	Tier 1
Tinga Hub	100	100	50	70	90	93	Tier 1
Umma University	93	100	100	70	90	91	Tier 1
Namelok Office	100	100	75	70	80	88	Tier 1
Kipeto Wind Farm	100	80	25	60	70	76	Tier 2
Namelok-Olepolos Tower	100	100	40	60	80	73	Tier 2
Tata Chemicals Magadi	50	100	25	80	60	65	Tier 2
Shams Eco Camp	100	40	25	60	60	59	Tier 3
Saikeri Market	70	100	50	30	70	52	Tier 3
Olepolos Quarry	0	100	25	70	60	48	Tier 3

Note: Scores rest on the project's weighted model and are used here as planning aids.

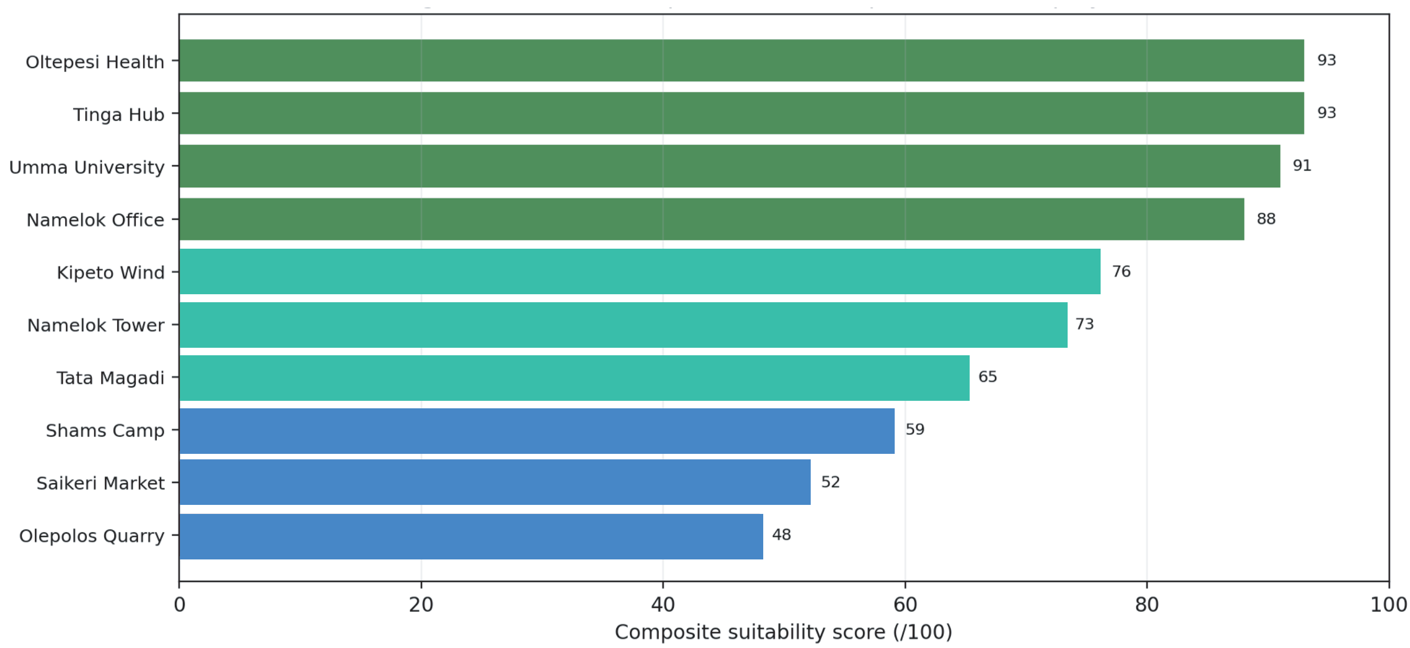


Figure 32: Indicative Site Prioritisation for Phased NPN Deployment

The chart groups sites by pilot priority rather than by legal entitlement. Higher-scoring sites remain subject to site verification, technical compliance review, and the applicable spectrum-access pathway.

3.6.1. Interpretation of Scores

Two findings stand out. First, the western corridor sites perform well because they combine practical deployment value with relatively clearer corridor logic for phased expansion. Second, lower-ranked sites are not irrelevant; rather, they highlight where the framework will need conditional tools, such as stricter coordination, stronger community engagement, or infrastructure upgrades, before deployment.

3.6.2. Why Some Strong Sites Still Require Conditions

Even among the top-ranked sites, the constraints differ. Oltepesi Health Center and Tinga require careful social and operational preparation. Umma University is technically attractive because of its controlled campus environment, but this should not be taken to imply that all community-oriented NPNs can rely on campus conditions. Namelok Office is strategically valuable because of its role as a backbone and operations hub, but the CA would still need to test its relationship with incumbent coverage and practical back-haul design before authorisation.

3.7. Terrain, Back-haul and Spatial Constraints

The project area is topographically and operationally varied. For this reason, spatial suitability cannot be reduced to simple distance or population criteria. Terrain, line-of-sight, seasonal access, power availability, and buffer protections influence whether a site can support a viable NPN deployment.

3.7.1. Back-haul and Line-of-Sight Feasibility

Table 35: Simplified back-haul and line-of-sight feasibility matrix

Link	Distance	LOS status	Indicative requirement	Planning implication
Namelok → Olepolos	6 Km	Clear	Moderate tower height / microwave option	Strong Phase 2 corridor candidate
Namelok → Tinga	8 Km	Partial	Higher structures or repeater option	Feasible with conditional design
Namelok → Oltepesi Health	12 Km	Obstructed	Indirect routing via Tinga preferred	Back-haul should be corridor-based, not direct
Kipeto → Tata Magadi	28 Km	No practical LOS in current assumptions	Alternative back-haul required	Fibre or satellite fallback more realistic

The policy implication is straightforward: in several candidate areas, spectrum availability alone will not yield a successful pilot. Back-haul feasibility is the real gating factor. This is particularly clear in the Magadi–Kipeto case and in the need to treat Tinga as an intermediate corridor node rather than a merely isolated endpoint.

3.7.2. Spectrum Constraint Buffers and Spatial Safeguards

Table 36: Spatial safeguard framework for GIS-informed licensing

Constraint type	Indicative spatial safeguard	Operational purpose	Band relevance
Incumbent mobile sites	Coordination zone around existing sites	Reduce risk of harmful interference in LTE-oriented environments	Primarily 1800 MHz
FSS earth-station environment	Protection / exclusion buffer	Preserve satellite operations and avoid incompatible local assignments	Primarily 3.6–4.2 GHz
Aviation-sensitive areas	Horizontal and height-related controls	Avoid unsafe tower siting	Cross-band
Protected or environmentally sensitive zones	Environmental-screening overlay	Prevent unsuitable infrastructure placement	Cross-band

3.7.3. Population, Demand and Institutional Reach

The geospatial value of candidate sites is tied not only to where they sit, but to whom they can realistically serve. Population grids and institutional anchors, therefore, serve as proxies for likely demand concentration, service relevance, and public-interest value. In the Kajiado corridor, health, education, community service and local enterprise nodes remain more defensible early anchors than sites whose primary justification is experimental rather than immediately service oriented.

3.7.4. Coverage by Deployment Context

Table 37: Planning interpretation of coverage behaviour by deployment setting

Deployment context	Indicative EIRP class	Indicative spatial behaviour	Best-fit use case
Indoor / campus	Lower power	Contained coverage footprint	University or controlled institutional deployment
Rural / community anchor	Medium power	Localised area coverage with terrain sensitivity	Health, hub, or community-service node
Industrial / utility	Higher power within controlled site design	Broader but operationally bounded coverage	Industrial automation or utility operations

3.7.5. Deployment Zoning and Phased Implementation

The phasing model below separates immediate pilot sites from corridor expansion candidates and from conditional or comparative cases.

Table 38: Deployment phasing

Phase	Indicative sites	Primary purpose	Condition for progression
Phase 1: Immediate pilots	Oltepesi Health Center; Tinga Hub; Namelok Office; Umma University	Validate practical NPN models under controlled and community-facing conditions	Site-specific technical and licensing clearance
Phase 2: Corridor expansion	Namelok-Olepolos Tower; selected corridor links	Extend service logic and test back-haul integration	Back-haul and infrastructure readiness
Phase 3: Conditional industrial scaling	Kipeto Wind Farm; Tata Chemicals; selected specialised sites	Test industrial or hardened-use deployments	Environmental, access, security, and spectrum pathway resolution
Deferred / conditional	Saikeri Market; Olepolos Quarry; Shams Eco Camp	Retain as future cases or conditional pilots	Improved readiness or lower-risk authorisation pathway

This phasing is preferable to a single undifferentiated pilot plan because it aligns effort with the maturity of each site. It also gives the Authority a defensible sequence for authorising pilots: begin where service value, practical deployment, and manageable risk converge; then move outward to more conditional settings.

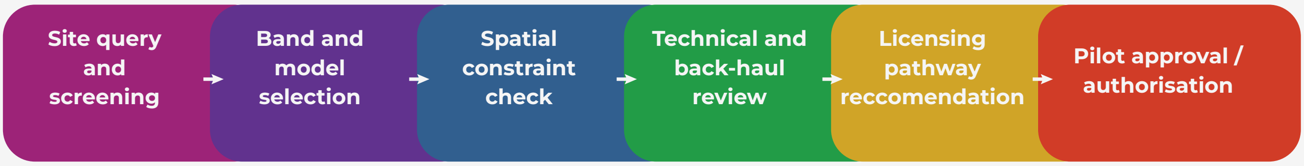


Figure 33: Spatially informed licensing and pilot progression workflow

The workflow illustrates how site screening, band and model choice, spatial constraints, technical review, and licensing recommendation should operate as one sequence.

3.8. Spatial Distribution and Site Registry

Table 39: Complete Site Registry (Kajiado County)

Site ID	Field Name	Category	Ward	Lat/Long	Elev. (m)	NPN Model	Key Constraint
001	Namelok-Olepolos Tower	Community	Olepolos	-1.489, 36.621	1,808	SNPN	Back-haul gap (satellite only)
002	Olepolos Quarry	Industrial	Olepolos	-1.492, 36.619	1,827	SNPN	C-Band busy (private links), Environmental
003	Shams Eco Camp	Tourism	Olkeri	-1.453, 36.577	1,829	SNPN	Seasonal access, Limited hosting
004	Namelok Office (Kisamis)	Enterprise	Kisamis	-1.475, 36.629	1,793	SNPN	Intermittent 1800 MHz
005a	Saikeri Market	Community	Tinga	-1.394, 36.541	1,562	PNI-NPN	Cultural sensitivity, Low acceptance
005b	Umma University	Education	Kajiado North	-1.779, 36.822	1,630	PNI-NPN	Adequate existing connectivity
006	Oltepesi Health Center	Healthcare	Tinga	-1.563, 36.477	1,006	SNPN	Cultural protocols (Maasai)
007	Kipeto Wind Farm	Industrial	Entonet	-1.778, 36.666	1,711	SNPN	Inside protected area (EIA required)
008	Tata Chemicals Magadi	Industrial	Magadi	-1.891, 36.291	609	SNPN	Security-hardened, Remote
009	Oltepesi "Tinga" Hub	Roadside	Tinga	-1.563, 36.473	1,007	SNPN	1800 MHz unused (white space)

Note: *Sites 005a/b share the "Site 005" designation in field data but represent distinct locations (11km apart). Coordinate verification confirmed Umma at -1.779, 36.822 (not the erroneous -1.685, 36.834 from early stakeholder records).*

Note: *Sites 006 and 009 represent adjacent facilities: Oltepesi Health Center (healthcare use case) and Tinga Oletepesi Hub (transport/backbone node), approximately 400m apart within the same spectrum environment.*

**SNPN = Standalone NPN; PNI-NPN = Public Network Integrated (see Regulatory Report for model definitions)*

Key Spatial Clusters:

- Western Corridor (Olepolos-Tinga): Sites 001, 002, 004, 006, 009 within 12km linear distance; natural backbone for community SNPN expansion.
- Southern Industrial (Magadi): Sites 007, 008 separated by a 28km escarpment (see LOS analysis 3.5).
- Central Campus: Site 005b (Umma) isolated near Namanga Road; contained PNI-NPN environment.

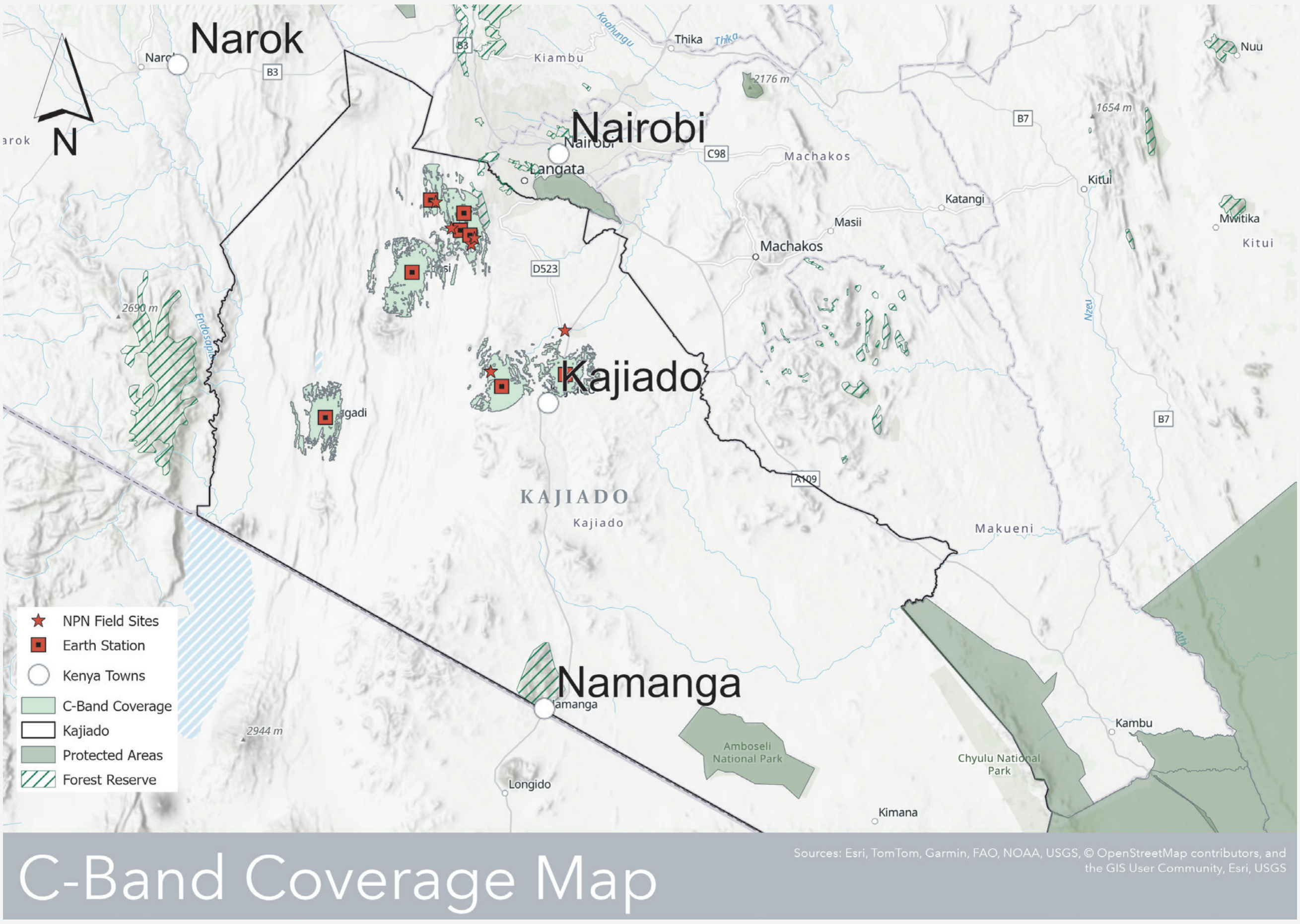


Figure 34: C-Band Spectrum Availability Map

3.9. Quantitative Suitability Analysis

3.9.1. Criteria and Weights

Weights derived from technical feasibility (RF conditions, back-haul) and institutional readiness (stakeholder willingness).

Criterion	Weight	Source
Spectrum Availability (3.6–4.2 GHz)	25%	Field measurements
Spectrum Availability (1800 MHz)	15%	Field + CA database
Power Infrastructure	20%	Kenya Power + Field
Back-haul Feasibility	15%	LOS analysis + Fibre maps
Institutional Demand & Willingness	15%	Stakeholder interviews
Terrain/Access	10%	DEM + Road data

3.9.2. Sensitivity Analysis

One-way sensitivity testing confirms ranking stability:

- ***Spectrum weight ±10%:*** Oltepesi/Tinga remain top-ranked; Tata moves between Tier 2/3;
- ***Back-haul weight ±10%:*** Critical factor for Kipeto-Tata corridor; fibre extension would elevate both to Tier 1;
- ***Willingness threshold:*** If "Maybe" responses downgraded, Kipeto and Shams drop to Tier 3, reinforcing the need for stakeholder engagement before deployment.

Site	Spectrum Score	Power	Back-haul	Demand	Terrain	Composite score	Priority tier
Oltepesi Healthcare centre	100	100	50	80	93	1	Cultural protocols
Tinga Hub	100	100	50	90	93	1	Seasonal road access
Namelok Office	100	100	75	80	88	1	Intermittent 1800 MHz
Umma University	93	100	100	90	91	1	Adequate existing connectivity
Kipeto Wind	100	80	25	70	76	2	Protected area (EIA req.)
Tata Magadi	50*	100	25	60	65	2	C-Band pending verification
Namelok Tower	100	100	40	80	73	2	Back-haul upgrade needed
Saikeri Market	70	100	50	70	52	3	Community acceptance
Olepolos Quarry	0**	100	25	60	48	3	1800 MHz leasing required
Shams Camp	100	40	25	60	59	3	Solar-only, seasonal

**Conservative estimate pending field confirmation (see Technical Report for spectrum sweep)*

***1800 MHz requires MNO coordination (see Regulatory Report for leasing/sharing framework)*

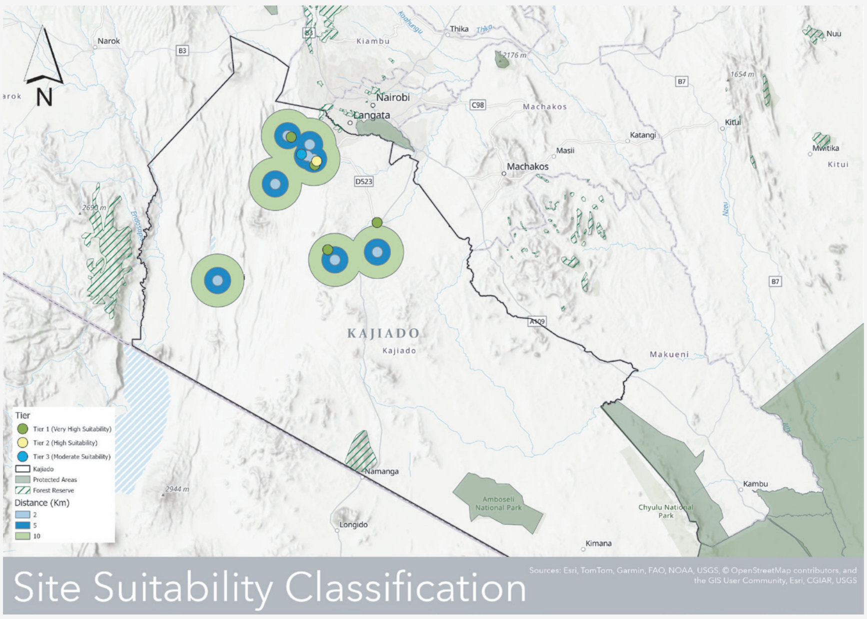


Figure 35: Deployment Suitability Classification Map

3.10. Interference Risk Assessment

3.10.1. Back-haul Feasibility

Based on DEM analysis and field verification:

Link	Distance	Elevation Change	LOS Status	Recommendation
Namelok → Olepolos	6 km	6 km	Clear	5.8/6 GHz microwave (Phase 2)
Namelok → Tinga	8 km	8 km	Partial	25m towers or repeater
Namelok → Oltepesi	12 km	12 km	Obstructed	Via Tinga relay
Kipeto → Tata Magadi	28 km	28 km	No LOS	Satellite (per Technical Report)

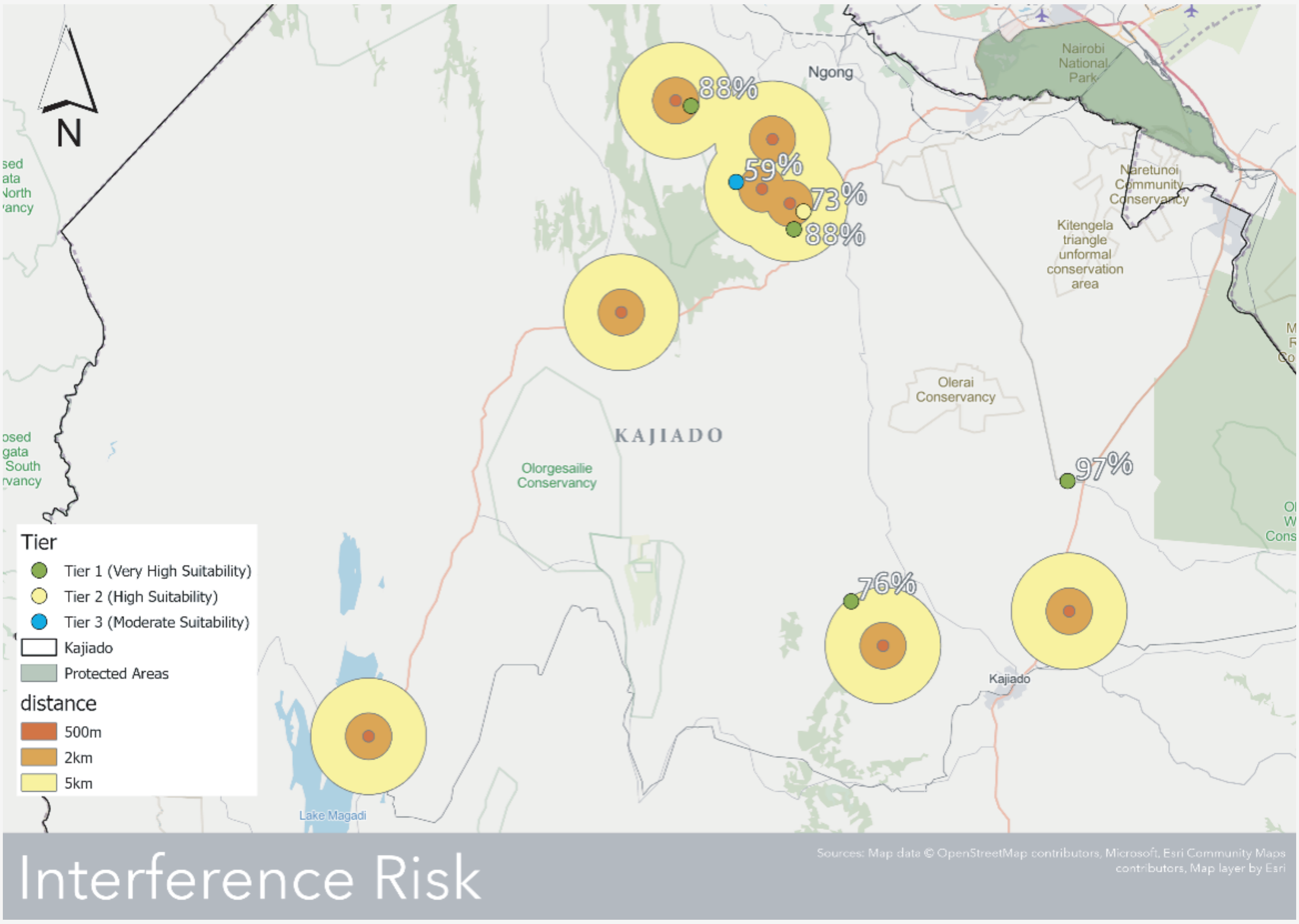
3.10.2. Coverage Modelling (3.6-4.2 GHz)

Propagation estimates using terrain-adjusted Okumura-Hata (see Technical Report for detailed path loss calculations):

- Oltepesi Health (37 dBm, 25m tower): 1.8 km radius covering ~8,500 population
- Umma University (24 dBm indoor): 400m campus coverage
- Tata Magadi (47 dBm industrial): 2.5 km radius (LOS dependent)

3.10.3. Interference Risk by Site

- High Risk: Olepolos Quarry (400m from MNO Site 431). Mitigation: Mandatory spectrum leasing or PNI-NPN via host MNO.
- Medium Risk: Ilyagaleni (Kipeto Wind farm) (1.8 km from fixed wireless link). Mitigation: Coordinate with the incumbent; directional antenna alignment.
- Low Risk: Oltepesi Health, Tinga Hub (>3 km from any MNO site, clear 3.6–4.2 GHz).
- Protected Area Constraint: Kipeto Wind Farm (inside conservancy). Mitigation: EIA and CA wildlife coordination required before tower construction.



3.11. Terrain and Line-of-Sight (LOS) Modelling

Table 312: Critical Link Analysis (ALOS PALSAR 12.5m DEM)

Link	Distance	Elevation Profile	LOS Feasibility	Tower Requirement	Recommendation
Namelok → Olepolos	6 km	-20m (gentle)	Clear	15m	Phase 2 priority
Namelok → Tinga	8 km	-60m (valley)	Partial obstruction	25m	Phase 2 with repeater
Namelok → Oltepesi Health	12 km	Rolling terrain	Obstructed	N/A	Fibre/microwave via Tinga
Kipeto → Tata Magadi	28 km	-1,250m (escarpment)	Multiple obstructions	45m+	Not recommended; Use fibre/satellite

Propagation characteristics at 3.6–4.2 GHz (vs. 3.6 GHz) show slightly reduced range but improved building penetration compared to mmWave.

Table 313: Estimated Coverage Radii by Deployment Scenario

Power Class	EIRP	Terrain	Estimated Radius	Use Case
Low (Indoor)	24 dBm	Urban	100–150 m	Campus (Umma indoor)
Medium (Rural)	37 dBm	Open/semi-arid	1.5–2.0 km	Community anchor (Tinga)
High (Industrial)	47 dBm	Flat/Industrial	2.5–3.5 Km	Magadi Soda Plant (LOS dependent)

Terrain-adjusted estimate for Oltepesi Health (37 dBm, 25m tower): 1.8 km radius covering health facility and surrounding pastoral communities (~8,500 population within 5km).

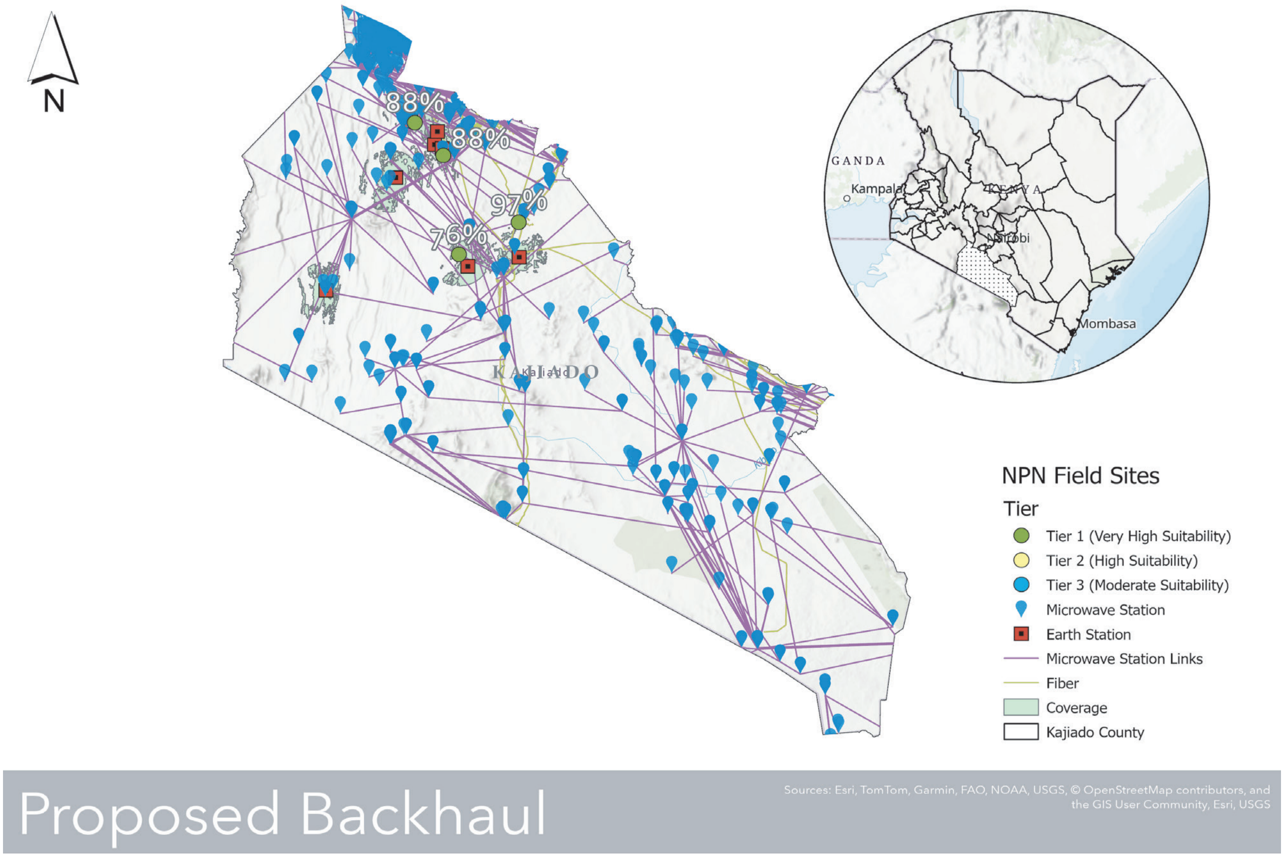


Figure 37: Potential Back-haul Connectivity Network

Specific site estimates:

- Oltepesi (Tinga) Health Centre (medium power, 37 dBm): 1.5 km radius covers the health facility, the surrounding community, and the access road. Approximately 7 km² coverage area.
- Umma University (low power, 24 dBm): 400m radius covers entire campus (approximately 0.5 km²).
- Namelok Office (medium power, 37 dBm): 1.8 km radius covers the office, computer lab, and the surrounding Kisamis area.

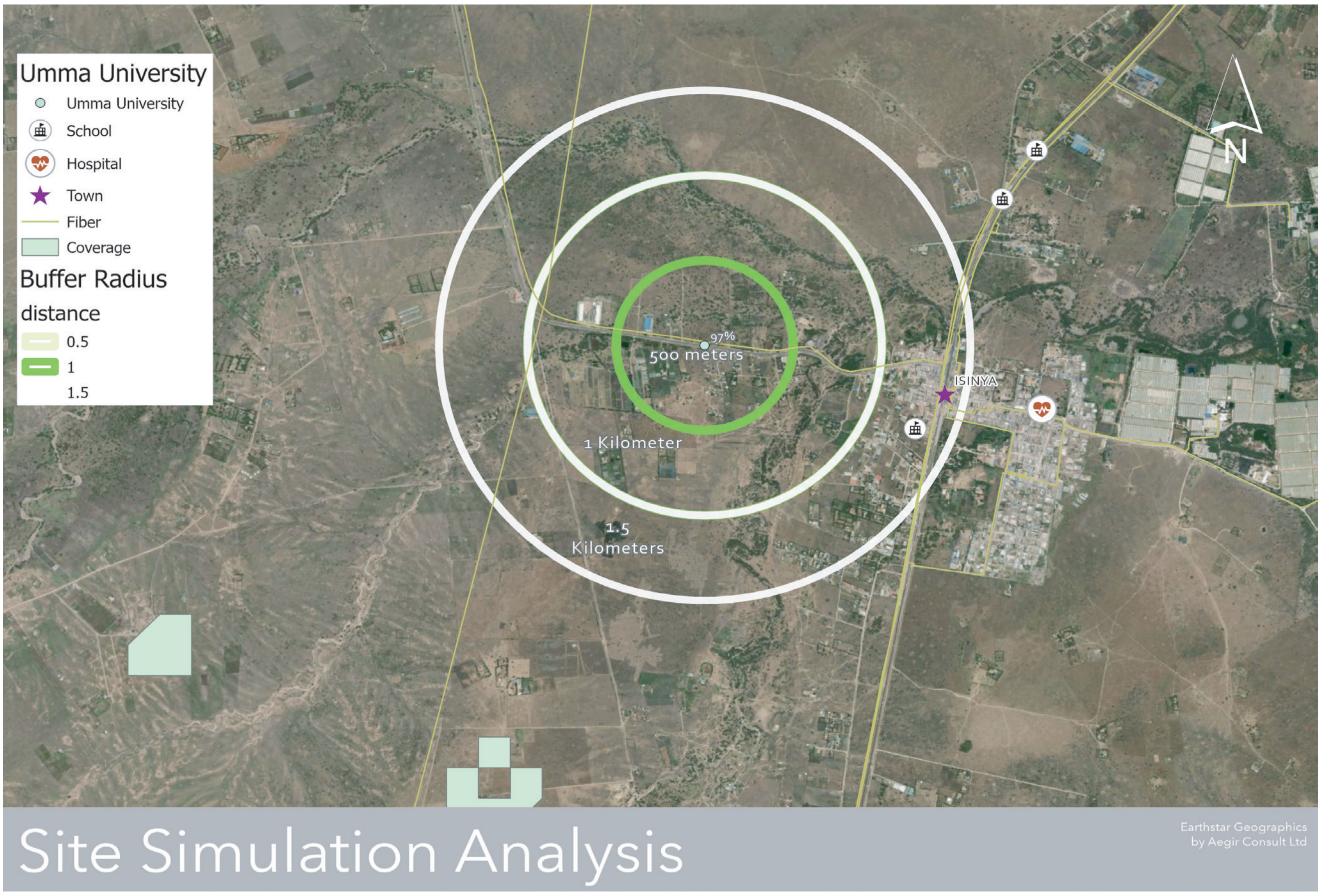


Figure 38: Simulated Coverage Overlay – Tinga Oltepesi Healthcare centre

3.12. GIS-based Deployment Phasing

Phase 1: Anchor Institutional SNPNs (Months 0–6)

- ***Oltepesi Health Center*** (Healthcare SNPN): Solar+grid hybrid, 3.6–4.2 GHz clean spectrum, immediate community benefit;
- ***Tinga Oletepesi Hub (Community SNPN):*** 1800 MHz white space (unused), roadside accessibility, Namelok infrastructure anchor;
- ***Namelok Office (Community backbone):*** Fibre back-haul present, computer lab facility, 3.6–4.2 GHz for high-capacity community hotspot.

Phase 2: Corridor Expansion (Months 6–12)

- ***Namelok ↔ Olepolos:*** 5 GHz microwave link (LOS verified), extending SNPN coverage to Quarry industrial zone (pending leasing);
- ***Namelok ↔ Tinga:*** 5 GHz microwave with 25m towers, connecting health center to backbone;
- ***Saikeri Market:*** Conditional PNI-NPN deployment pending community acceptance resolution.

Phase 3: Industrial Scale & Innovation (Months 12–24)

- Umma University: PNI-NPN innovation lab (5G campus network, IoT, Cisco Academy);
- ***Tata Chemicals Magadi:*** Industrial SNPN for automation (requires dedicated C-Band allocation, security-hardened);
- ***Kipeto Wind Farm:*** Grid monitoring SNPN (pending EIA clearance).

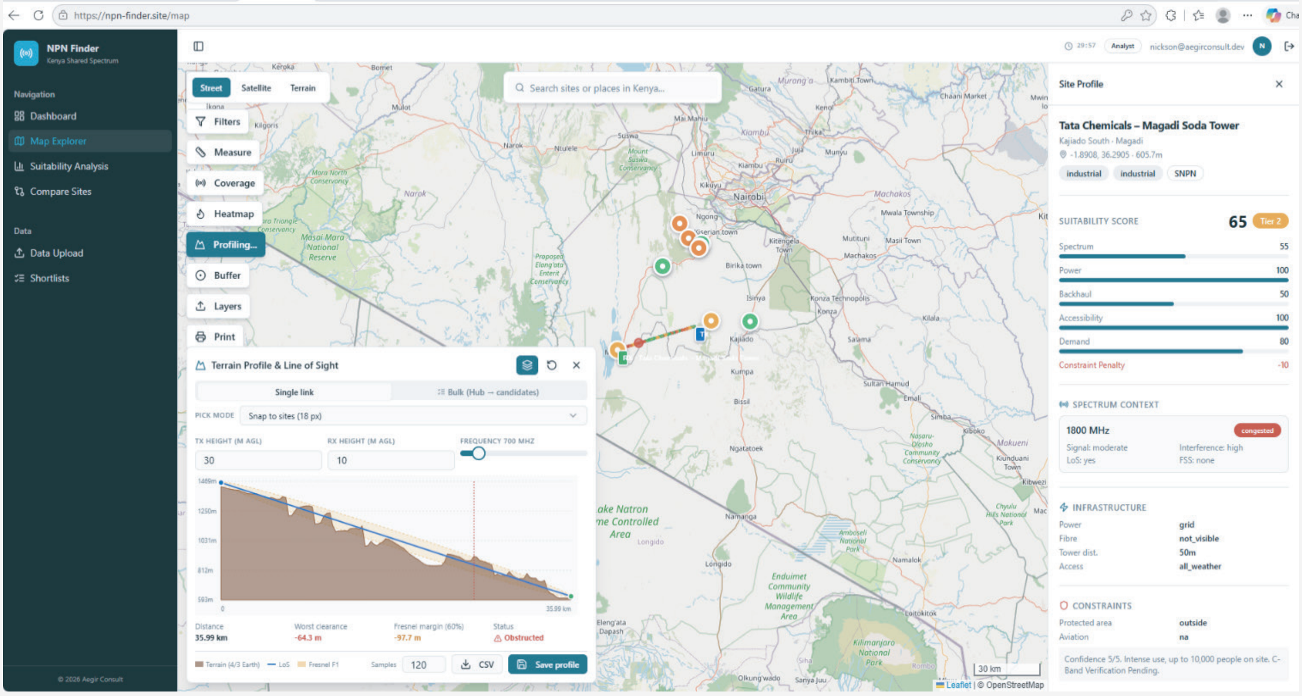


Figure 39: Terrain Profile – Kipeto Windfarm to Tata Magadi Corridor

3.13. Environmental and Social Spatial Considerations

3.13.1. Environmental Constraints

- **Kipeto Wind Farm** - Inside protected area (EIA required);
- **Tata Magadi** - Proximity to Lake Magadi (alkaline wetland—equipment corrosion risk, environmental monitoring required);
- **Olepolos Quarry** - Active mining—dust/vibration hardening for equipment.

3.13.2. Social and Cultural Considerations

- **Oltepesi Health Center -:** Maasai community protocols require cultural liaison before tower construction;
- **Saikeri Market -** Low community acceptance (land tenure concerns)—defer until stakeholder engagement is completed;
- **Shams Eco Camp** - Seasonal access limits emergency maintenance; redundant power required.

3.13.3. Limitations and Uncertainties

- **Temporal Spectrum Variation** - Measurements represent January 2026 (dry season); FSS satellite activity may vary seasonally.
- **Fibre Route Accuracy -** CA fibre alignments are indicative only; ground-truthing is required before back-haul commitment.
- **3D Building Data** - Absence of LiDAR limits urban propagation accuracy at Umma University;
- **Stakeholder Dynamics** - "Maybe" willingness responses (Kipeto, Tata) require confirmation before licensing.

3.13.4. Key GIS Findings

- **Four Tier-1 sites validated for immediate pilot: Oltepesi Health Center, Tinga Hub, Namelok Office (SNPNs), and Umma University (PNI-NPN).**
- **Western corridor viable: 12km Olepolos-Tinga**

- cluster supports SNPN backbone with microwave LOS feasibility.
- 1800 MHz constrained: Quarry and Olepolos require MNO leasing per the 'use it or share it' regulatory principle (see Regulatory Report, Section 4). (see Regulatory Report);
- Magadi-Kipeto isolated: 28km escarpment prevents microwave back-haul; fibre or satellite required (per Technical Report back-haul analysis).
- Social license is geographic: Cultural (Oltepesi) and environmental (Kipeto) constraints must be

3.14. Summary

The GIS analysis confirms the spatial viability of differentiated NPN deployment in Kajiado County, with clear geographic clustering that supports phased implementation. The Olepolos-Tinga corridor offers ideal conditions for community SNPNs (clean spectrum, institutional willingness and LOS feasibility). At the same time, Umma University and Tata Magadi serve distinct PNI-NPN and industrial SNPN use cases.

The analysis provides CA with spatially explicit recommendations: authorize local light licensing for the upper C-Band (3.8–4.2 GHz) in the western corridor, mandate spectrum leasing for 1800 MHz near incumbent sites, and designate protected-area buffers before industrial deployment. The resulting evidence base directly supports the Q1 2026 testbed and the development of the national Spectrum Finder tool.

The analysis provides the spatial intelligence layer for the consortium's integrated recommendations while avoiding duplication of RF engineering (Technical Report) and regulatory framework design (Regulatory Report).

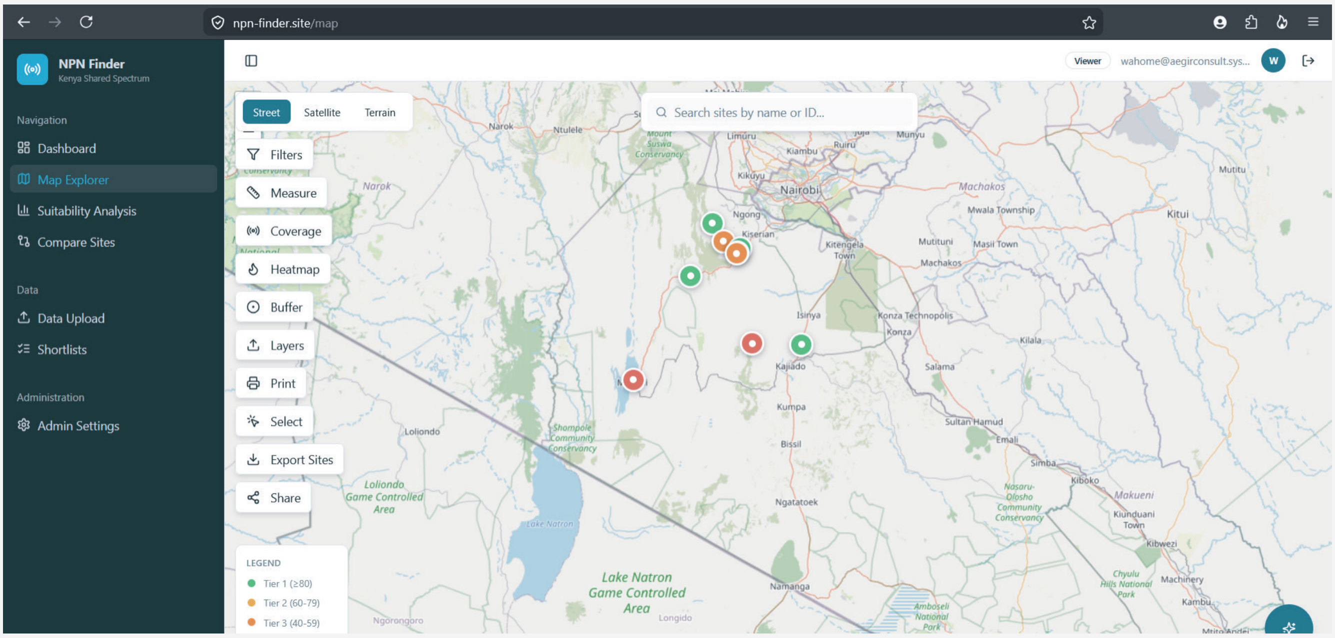


Figure 310: NPN Finder platform

Cross-Reference Guide:

- **RF Interference Simulations:** See Technical Analysis Report (SEAMCAT/ICS-Telecom results).
- **Licensing Framework Options:** See Regulatory Analysis Report (LSA, Local Licenses, Spectrum Leasing).
- **Stakeholder Workshop Findings:** See Regulatory Analysis Report (Annex A).
- **Equipment Specifications:** See Technical Analysis Report (Section 4).

4

GIS Requirements for a CA Spectrum Finder Tool

A major practical deliverable arising from this report is the concept of a GIS-enabled Spectrum Finder tool. In policy terms, the tool would not replace licensing judgment. Rather, it would standardise the first layer of spatial due diligence by enabling the Authority to test site coordinates against incumbent proximity, protection buffers, model suitability, indicative back-haul conditions, and basic planning rules before a full authorisation review is undertaken.

4.1. Spectrum Finder Tool

To avoid duplication with Regulatory Report (licensing procedures) and Technical Report (RF parameters), this section specifies only the GIS and spatial functionality required for CA's decision-support platform.

Core GIS Layers:

a. Spectrum Availability Surface - Interpolated 1800 MHz occupancy (LSA zones) and 3.6–4.2 GHz local licensing zones

b. NPN Model Suitability - Binary classification (SNPN-suitable vs PNI-NPN-suitable) based on infrastructure density

c. Constraint Overlay - Protected areas (KWS), FSS buffers (5 km), MNO coordination zones (2 km), cultural sensitivity flags.

d. Infrastructure Finder - Fibre POIs (Umma, Namelok), microwave LOS feasibility (green/amber/red), power grid vs. off-grid.

Analytical Functions:

a. Site Suitability Calculator - Automated scoring based on Table 3.3 criteria

b. Interference Buffer Checker - Real-time distance calculation to nearest incumbent

c. Coverage Estimator -Terrain-adjusted propagation preview (linked to Technical Report path loss models)

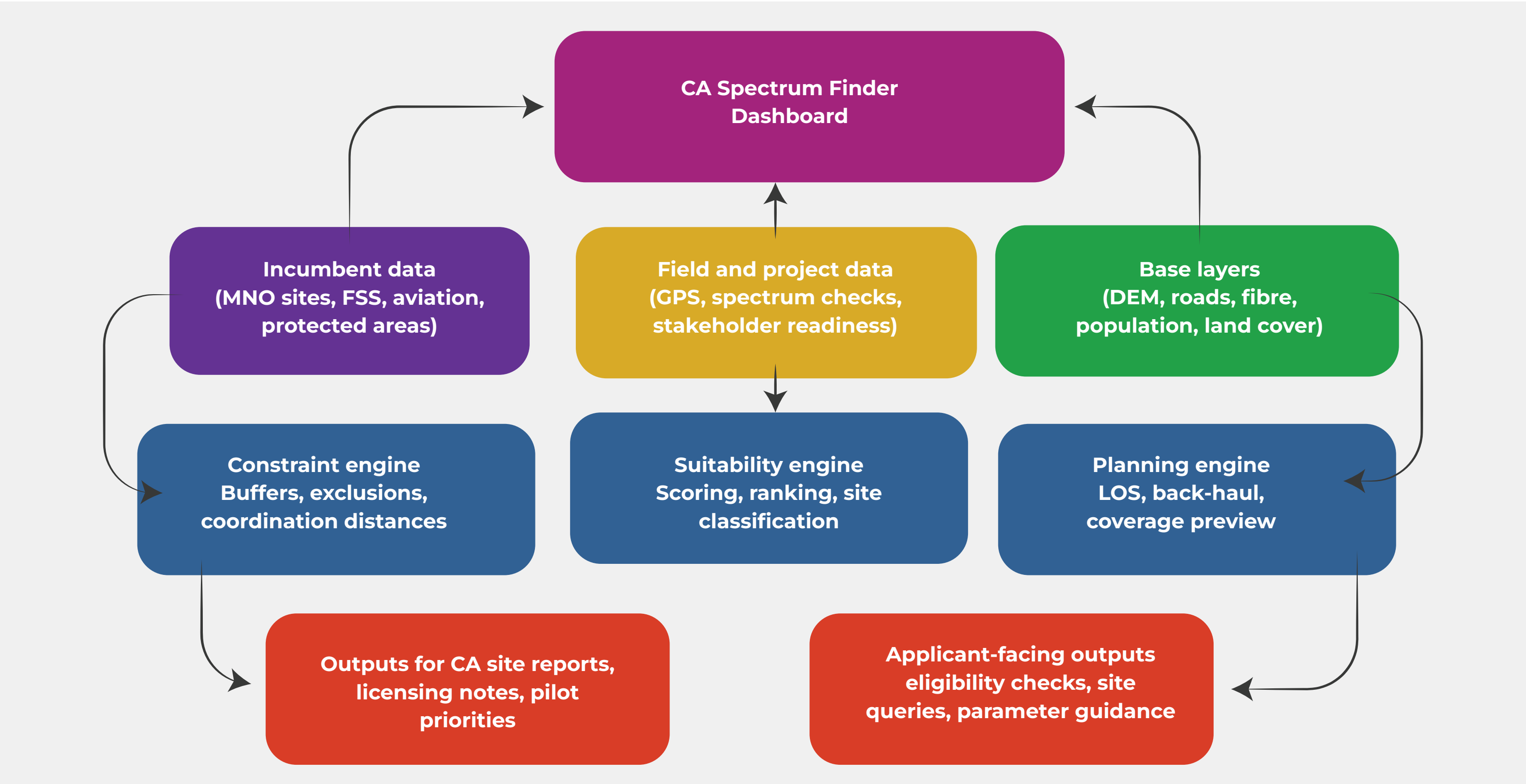


Figure 4-1: Conceptual Architecture of a GIS-enabled Spectrum Finder for NPN planning

4.2. Core Functional Requirements

At minimum, the tool should support five functions. First, it should allow a site to be queried by coordinates or place name. Second, it should test that site against incumbent-protection and exclusion logic. Third, it should distinguish whether the site is more likely to support an SNPN or a PNI-NPN pathway. Fourth, it should display a planning summary on terrain, access, power, and back-haul context. Fifth, it should generate a preliminary licensing note that indicates whether the site is suitable for further review, conditional review, or deferral.

4.3. Why Tool Matters

The significance of the tool is institutional as much as technical. Without a structured spatial decision-support layer, authorisation decisions are more likely to be inconsistent, slower, and more difficult to audit. A Spectrum Finder would reduce ambiguity for applicants, improve internal CA coordination, and create a reusable evidence base for future NPN policy implementation.

4.4. Indicative Governance of the Tool

Operational ownership of the tool should remain with the CA. However, its value will depend on structured data inputs from multiple sources, including incumbent site records, protected-area layers, field-verification data, and future pilot results. The tool should therefore be viewed as a regulated planning repository rather than as a public self-authorising platform.

5

Key Findings, Policy Implications and Recommendations

5.1. Key Findings

Firstly, the study confirms that Kajiado offers a viable but differentiated pilot environment. Community, campus, and industrial cases cannot be governed effectively through a single undifferentiated spatial rule.

Secondly, the western Namelok–Tinga–Oltepesi corridor is the most coherent community-oriented spatial cluster for early pilot deployment. It combines site functionality, service relevance, and corridor logic better than the other candidate groupings.

The 1800 MHz band is more likely to require tighter coordination in incumbent-proximate locations, while the 3.6–4.2 GHz range offers more attractive opportunities for localised authorisation where spatial safeguards can be maintained. Back-haul is the practical hinge of the framework. A site with spectrum potential but weak back-haul is not pilot-ready.

Thirdly, social and environmental constraints are not peripheral issues. In several locations, they are integral to whether a site should advance, be conditioned, or be deferred.

5.2. Policy Implications for the Communications Authority of Kenya (CA)

The CA should treat spatial planning as a core part of the licensing framework. A future NPN framework will be more credible if site eligibility and incumbent protection conditions are informed by structured geospatial checks and case-by-case justification.

The report also suggests that licensing should be accompanied by planning instruments. These include maps, buffers, prioritisation logic, cluster definitions, and a digital spectrum-finder environment.

5.3. Recommended Spatial Policy Actions

Table 51: Spatial Policy Actions arising from the GIS Workstream

Recommendation	Rationale	Priority
Adopt a zone-based spatial planning approach for pilot NPN authorisation	Avoids treating all candidate sites as if they face the same incumbent, terrain & service conditions	Immediate
Use the western corridor as the principal early community test environment	Provides the clearest combination of public-interest value and phased expansion potential	Immediate
Differentiate community, campus, and industrial pilots in the framework	Improves policy precision and reduces implementation confusion	Immediate
Develop a Spectrum Finder decision-support tool	Strengthens consistency, transparency, and auditability in site screening	Short term
Require infrastructure and back-haul readiness checks before pilot approval	Prevents technically interesting but operationally weak pilots from being prioritised	Short term

6

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Appendices

7.1. Appendix I: Back-haul Maps

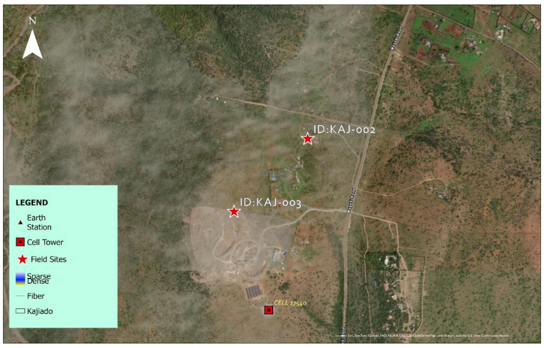


Figure A 1: Site 2 and 3

Figure A 2: Site 4

Figure A 3: Site 5

Figure A 4: Site 6

Figure A 5: Site 7

Figure A 6: Site 8 and 11

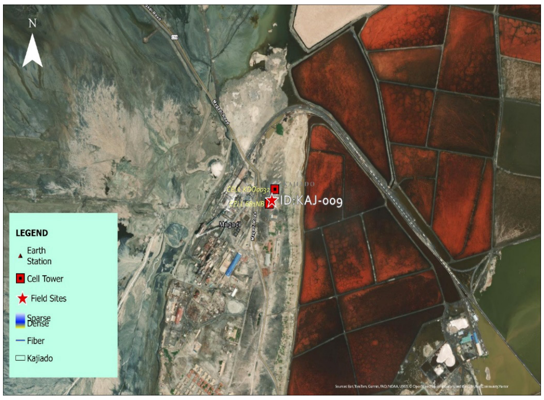


Figure A 7: Site 9

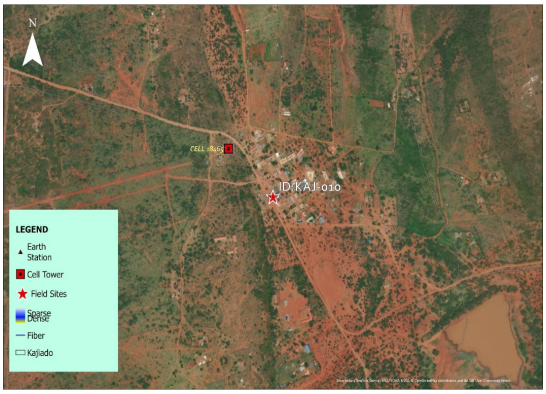


Figure A 8: Site 10

Distance to Grid Maps

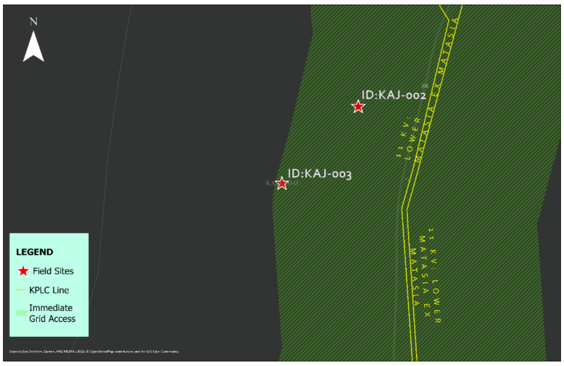


Figure A 9: Site 2 and 3 (Covered)

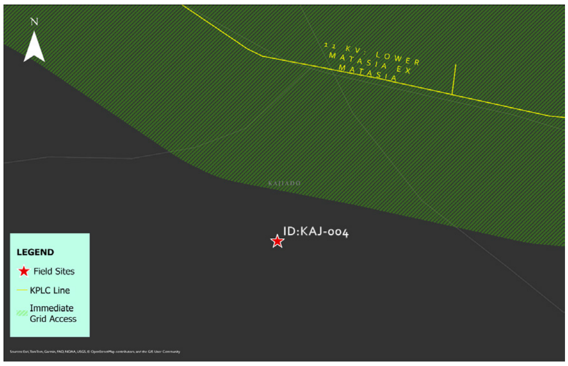


Figure A 10: Site 4 (Uncovered)

Figure A 11: Site 5 (Covered)

Figure A 12: Site 6 (Covered)

Figure A 13: Site 7 (Uncovered)

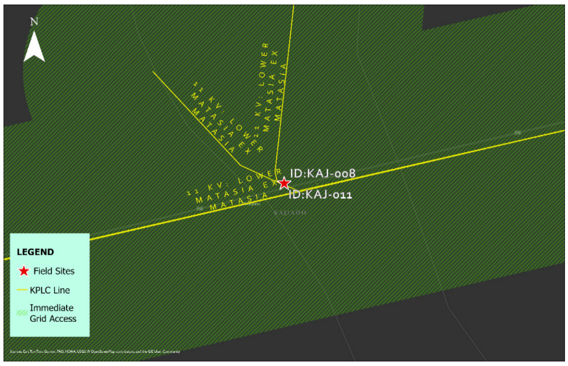


Figure A 14: Site 8 and 11 (Covered)

Figure A 15: Site 9 (Covered)

Figure A 16: Site 10 (Covered)

7.2. Potential Population Coverage Maps

Potential Population Coverage Maps

Figure A 18: Sites 2,3,4,5,10

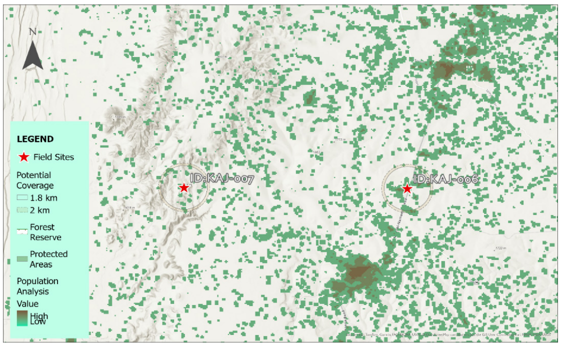


Figure A 19: Site 6 and 7

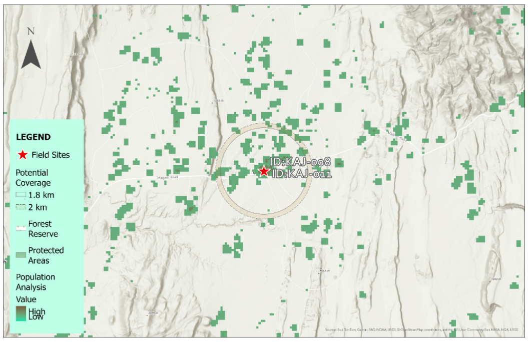


Figure A 20: Site 8 and 11

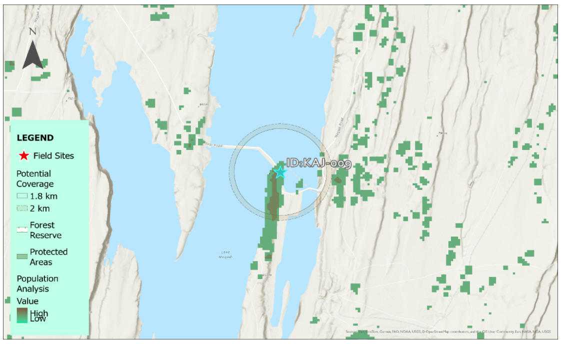
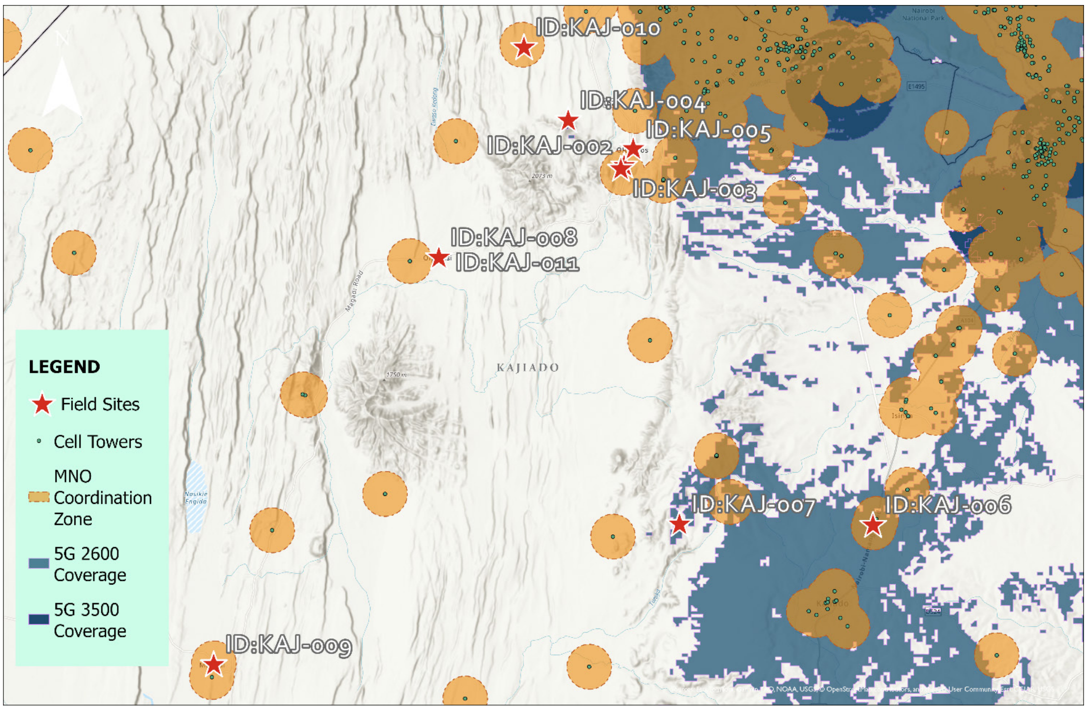


Figure A 21: Site 9

7.3. Appendix III: Broadband Coverage Analysis Maps

All Sites – (Site 8 outside 5G Coverage and 4 out of MNO Coordination Zones)



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